Global Centre for GREEN FUELS

Ethanol & Methanol as Maritime Fuels

Technical Viability, Market Dynamics, and Regulatory Considerations

IMO Biofuel Technical Seminar
4 Albert Embankment, London, UK

Chris Chatterton, Maritime Advisor

February 12th, 2026

GCGF Introduction

Global Centre for GREEN FUELS

Expertise in Biofuels

We bring decades of experience in advising governments worldwide on biofuel policies, technology, and market trends.

Global Impact

We drive policies that accelerate biofuel adoption and contribute to a sustainable energy future.

Innovative Solutions

Through cutting-edge research and collaboration, we advance the efficiency and sustainability of biofuels.

Strategic Partnerships

We connect governments, industries, and institutions to scale the adoption of low-carbon fuels.

Commitment to Sustainability

We support clean energy transitions that benefit both the environment and the economy.

Tailored Support

We provide market insights, policy guidance, and strategic solutions to empower stakeholders in the biofuels sector.

Global Centre for GREEN FUELS

OUR TEAM

GCGF is led by a team of seasoned professionals, industry experts, and thought leaders committed to driving meaningful change.

CLARENCE WOO

Managing Director

LIYIN KE

Communications Manager

STEPHANIE NG

Finance & Admin Manager

CHRIS CHATTERTON

Maritime Advisor

GABRIEL HO

Technical Advisor

KENNETH LIM

Program and Partnerships Manager

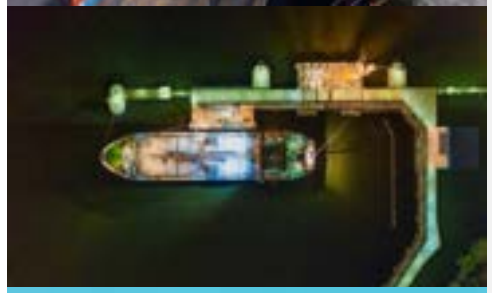
MEMA Vision & Mission

Policy

IMO, EU, LCA

Product Stewardship | Safety | Training

Crew, best practice, safe handling & bunkering



Technology & OEM Validation

Engine test, trials, retrofits, innovation, ISO standard & specification

Fuel | Logistics | Availability

Procurement, bunkering, SMOPS, e-BDN

"To make ethanol and methanol the world's most trusted, scalable and commercially viable clean fuels for global shipping."

Agenda

Demand

Supply

Market Development

Pricing

Standards

Safe Handling

In-Service

Demand

Alcohols are 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

E

4 ALBERT EMBANKMENT
LONDON SE1 7SR

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

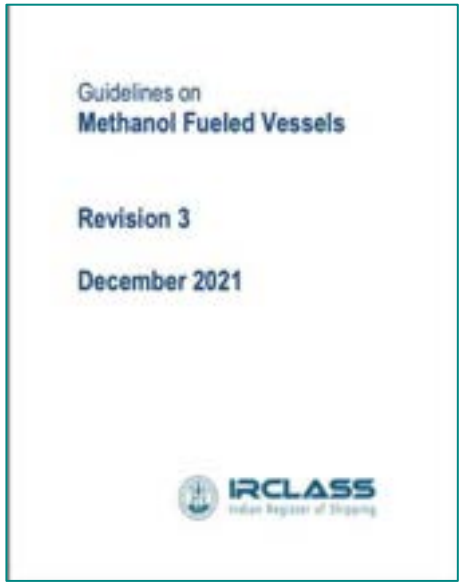
METHANOL AND ETHANOL FUELED VESSELS
JULY 2024


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


METHANOL AND ETHANOL-FUELLED SHIPS

NR670 - JULY 2024

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

IMO submission for Ethanol

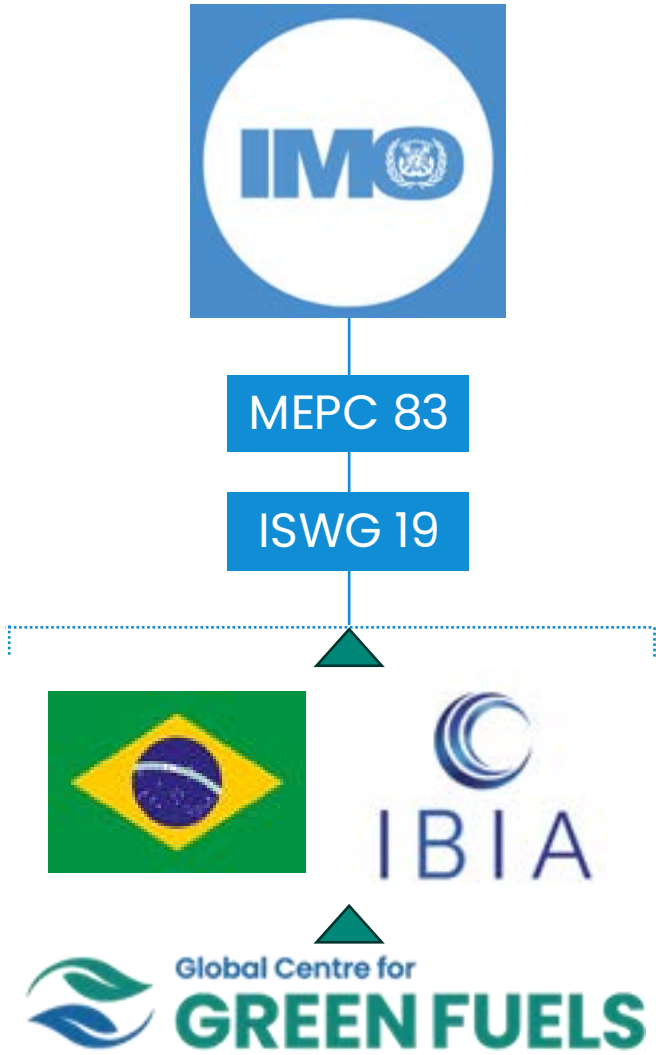
- GCGF joined **IBIA** (**International Bunker Industry Association**) as a member in November 2024

- 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

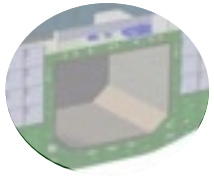
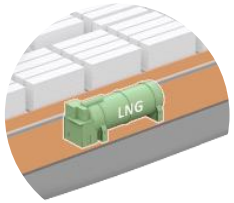
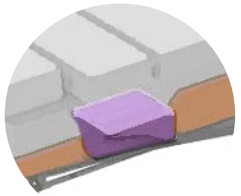
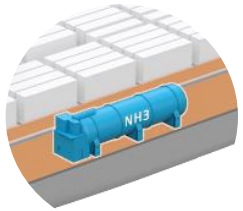
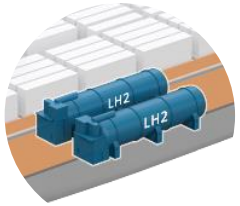
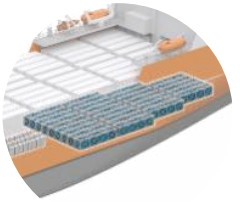
3. Revise IGF Code to highlight the differences between Methanol and Ethanol with an additional submission for MSC 110



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

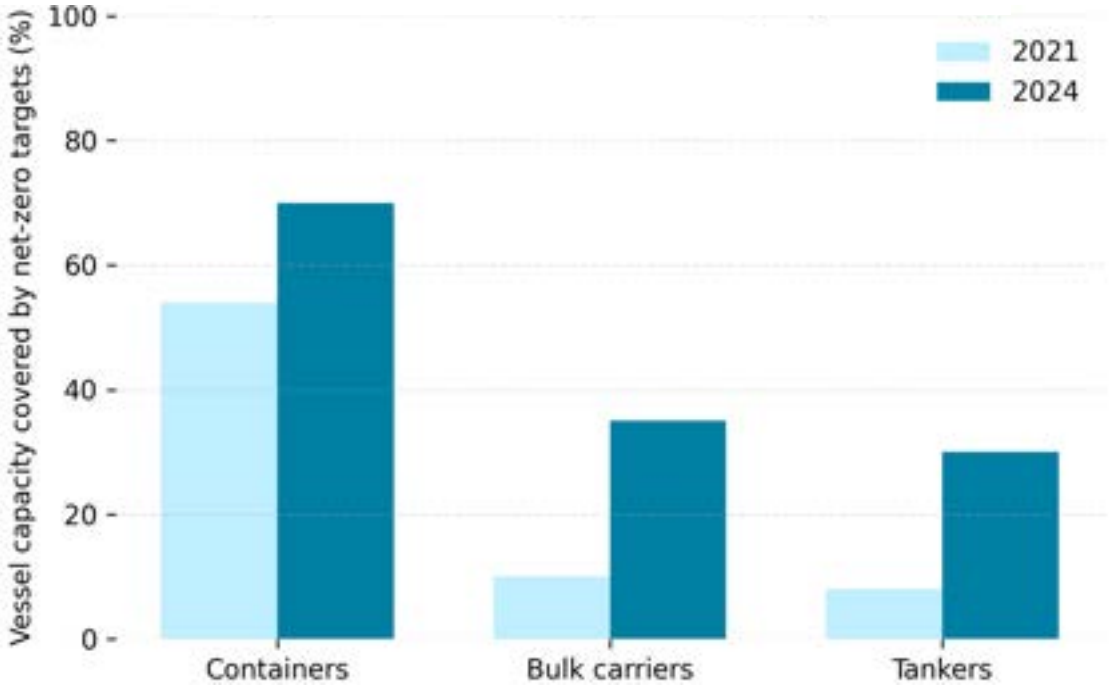
Gross tank estimations based on Wärtsilä experience considering inspection spaces needed around the tanks. Cylindrical tanks only considered for LNG, if stored in prismatic tank then LNG gross tank size factor is better for LNG than for methanol.

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

Source: Wartsila

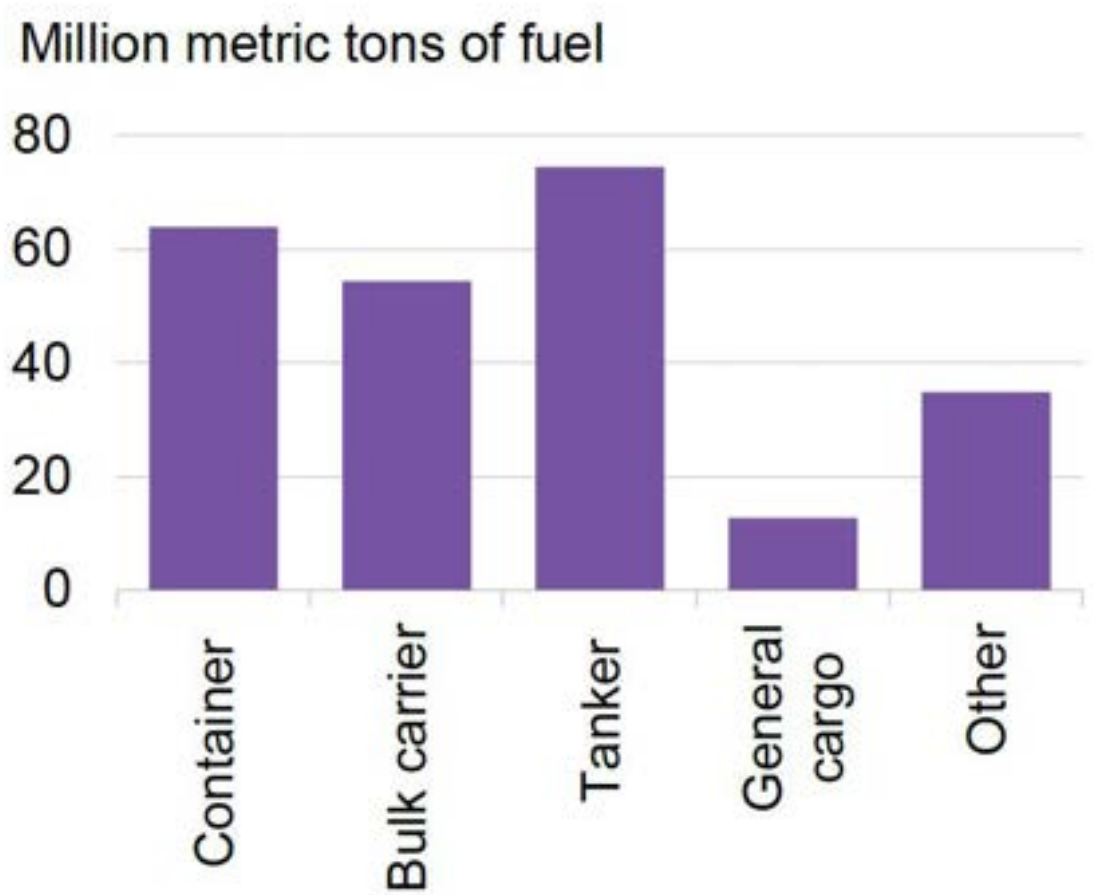
Net Zero Targets | Fuel Oil_{eq} by Type

Percentage of vessel capacity covered by corporate net-zero targets



Source: BloombergNEF. Maersk Mc-Kinney Moller Centre for Zero Carbon Shipping, Clarksons, GCGF. Note: DWT refers to deadweight tonnage.

Volume of heavy fuel oil-equivalent fuel consumption by vessel type



Source: BloombergNEF, International Maritime Organization's Fourth Greenhouse Gas Study.

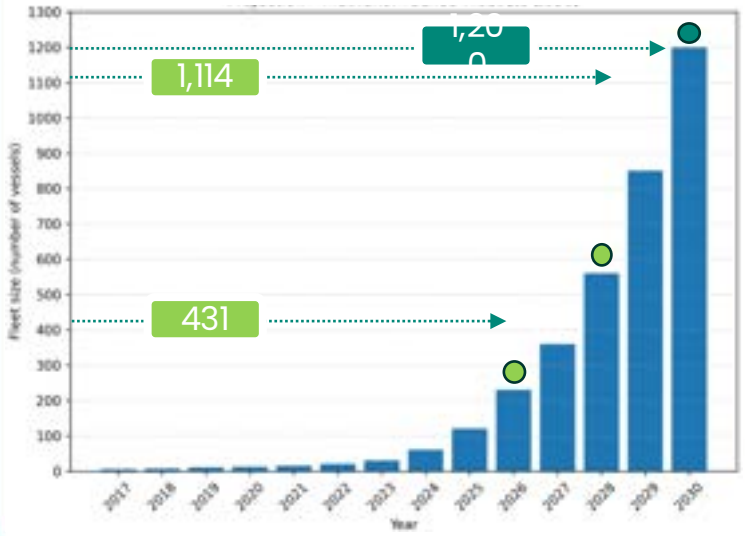
Methanol Fleet & Future Fuel Mix

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

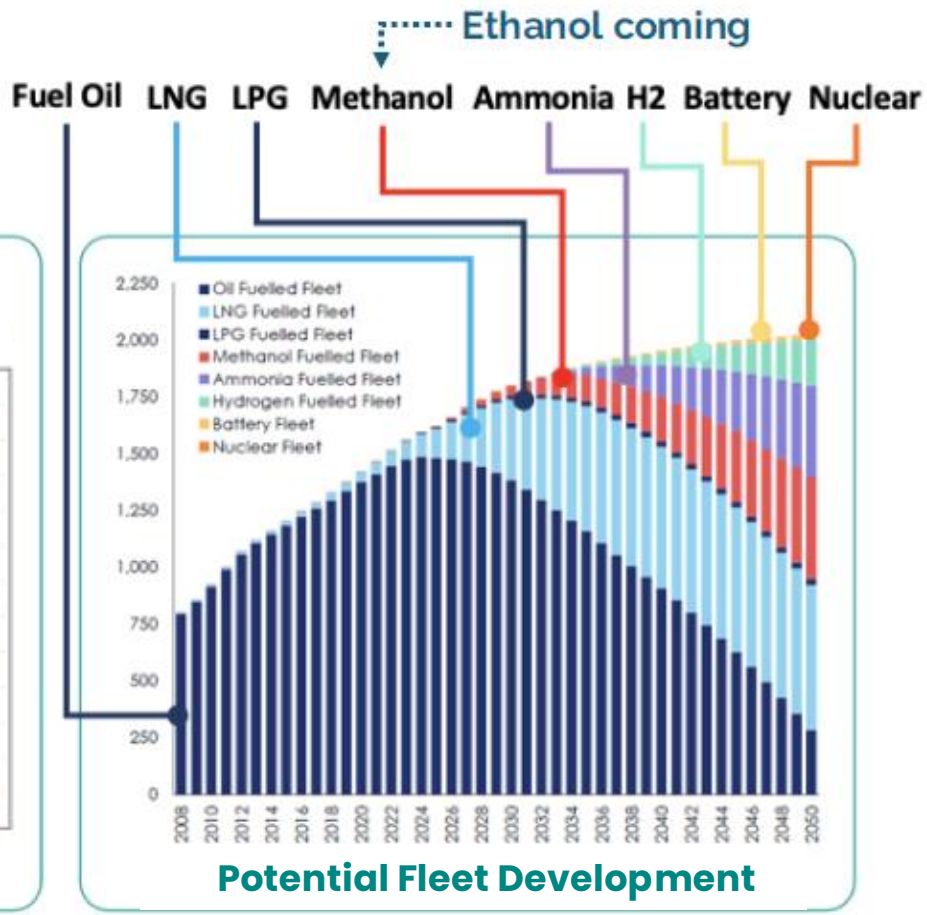
Methanol DF Main Engines

Conservative Estimate of for 1,200 vessels consuming 20,000mt pa of MeOH is **24M mtpa**

Projection – Methanol Fuelled Fleet



Fuels



Potential Fleet Development

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

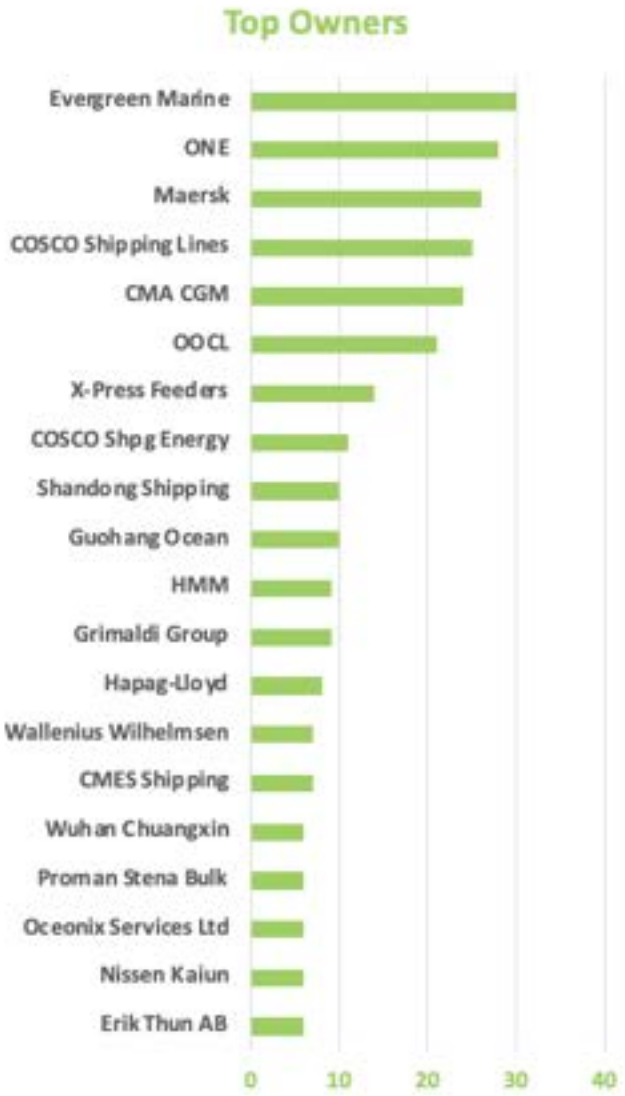
Every fuel has its unique development pathway

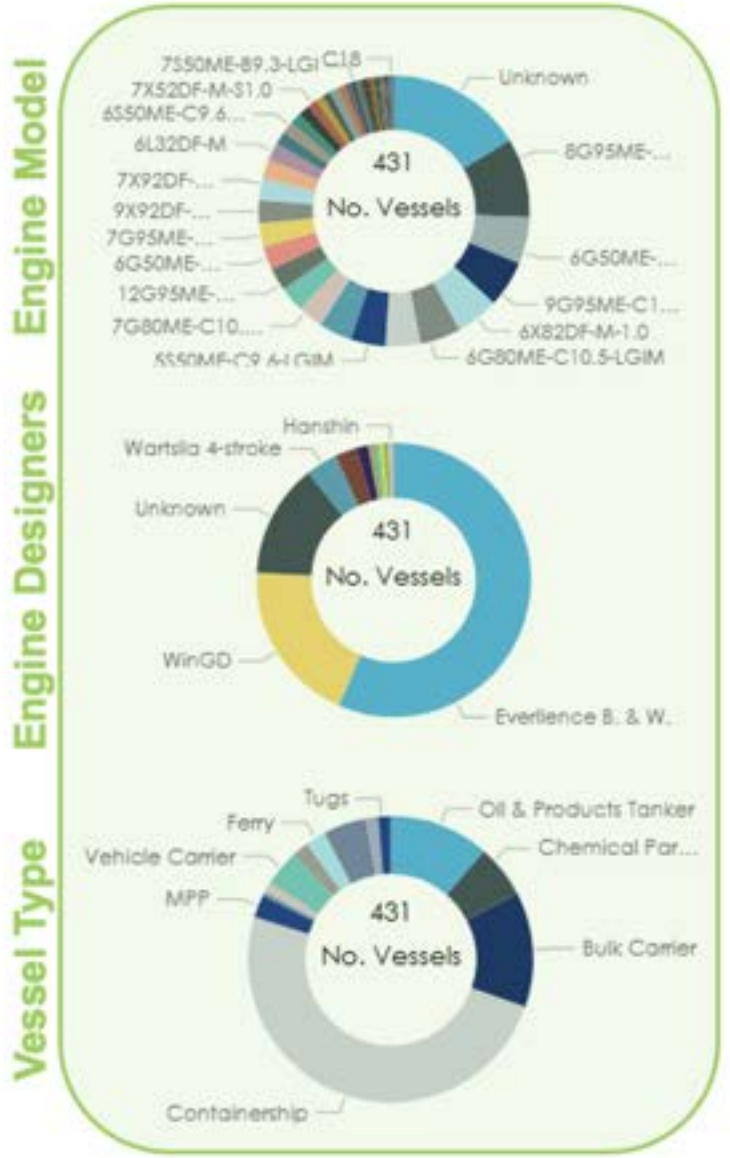
Source: LR, Clarksons, GCGF

Methanol Fleet

New Build Order Book January 2026

Alt Fuel Uptake by Number of Vessels				
Alt Fuel	Fleet	% Fleet	Order Book	% Order Book
MeOH	108	0.1%	323	4.1%





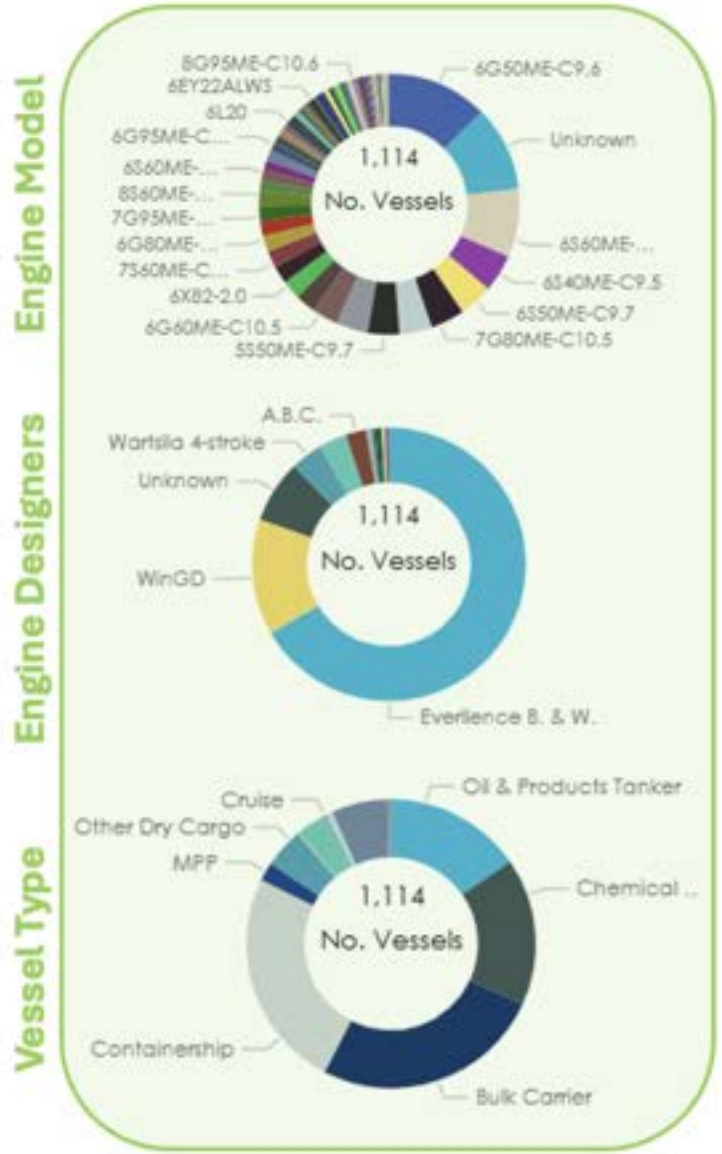
Source: Clarksons, GCGF

Methanol | Ethanol Fleet

Retrofit | Ready Calender

January 2026

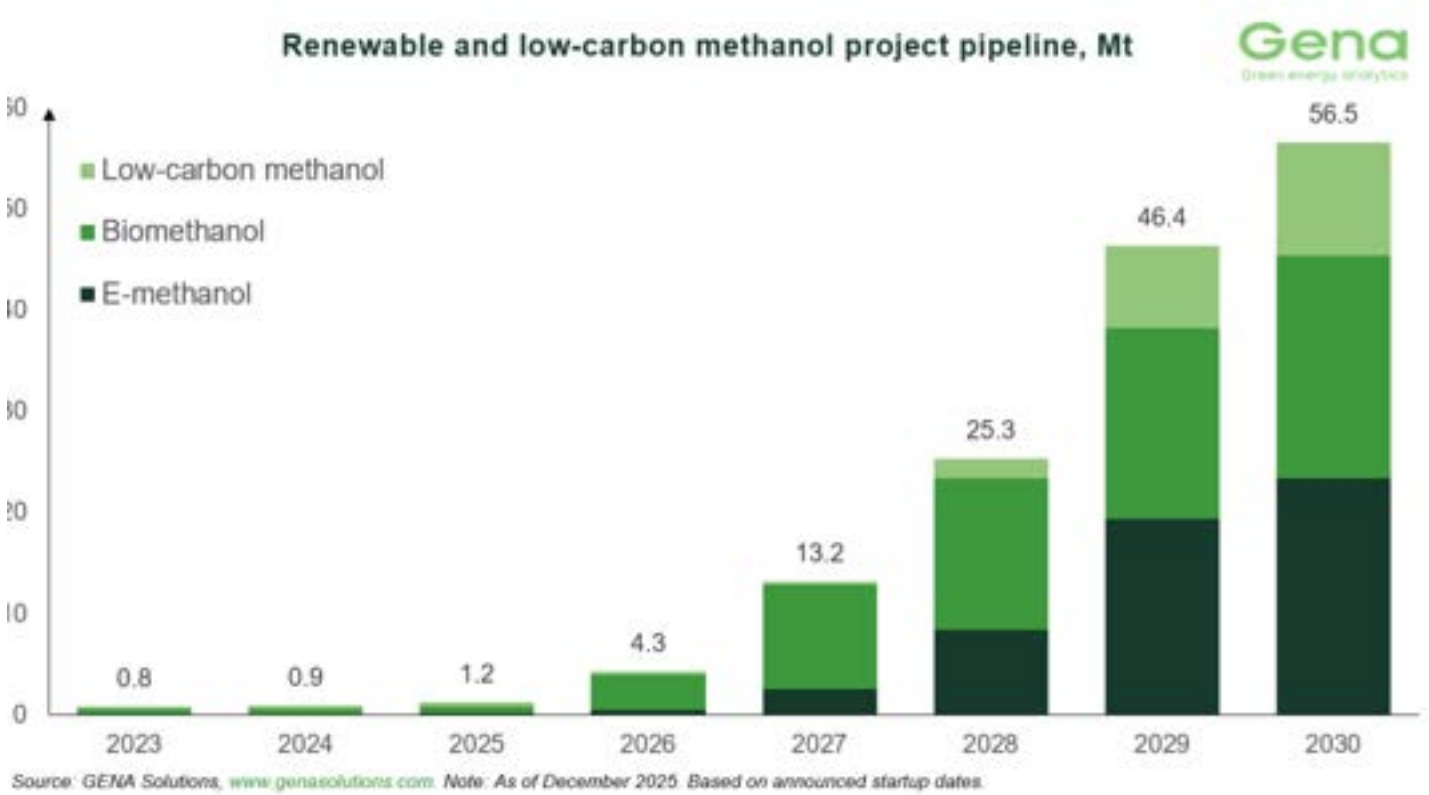
Alt Fuel Uptake by Number of Vessels				
Alt Fuel	Fleet	% Fleet	Order Book	% Order Book
MeOH/EtOH	293	0.3%	821	10.5%



Source: Clarksons, GCGF

Supply

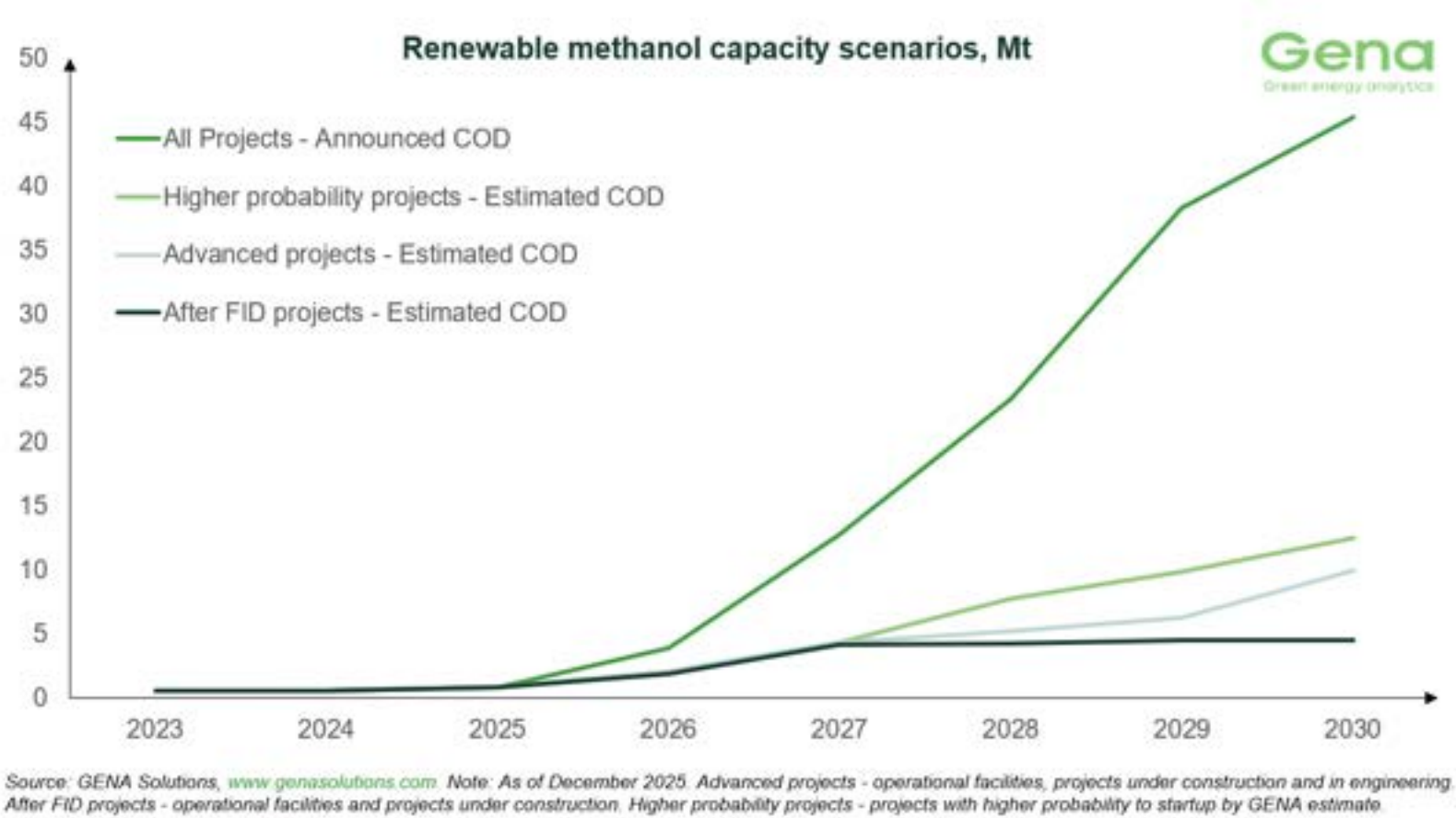
Renewable Methanol: Project Pipeline



- By the end of December 2025, Project Navigator Methanol tracked **273** renewable and low-carbon methanol projects totaling **56.5 Mt by 2030**, including 23.3 Mt of e-methanol, 22.1 Mt of bio-methanol, and 11.2 Mt of low-carbon methanol.
- In 2025, **94 projects were added** and **34 halted projects were removed**, bringing the renewable methanol project pipeline to **12.4 Mt above December 2024 levels**, while low-carbon methanol capacity rose by **3 Mt**.
- **2025 saw multiple first-of-a-kind industrial-scale facilities start operations**, including a 42 kta e-methanol plant in Denmark and two 50 kta bio-methanol plants in China: one based on biomass gasification and one hybrid facility combining biomass gasification with electrolysis.
- **Eight commercial-scale renewable methanol projects started construction or reached FID** during 2025, while another twelve projects entered the FEED stage.
- By the end of **2026**, renewable methanol capacity may reach **around 2 Mt**. Longer-term growth will largely depend on regulatory developments and rising demand across maritime, chemical, aviation, and road transport sectors, with **2030 capacity estimated at 6–13 Mt**.

Sources: GENA

Renewable Methanol: Supply Scenarios

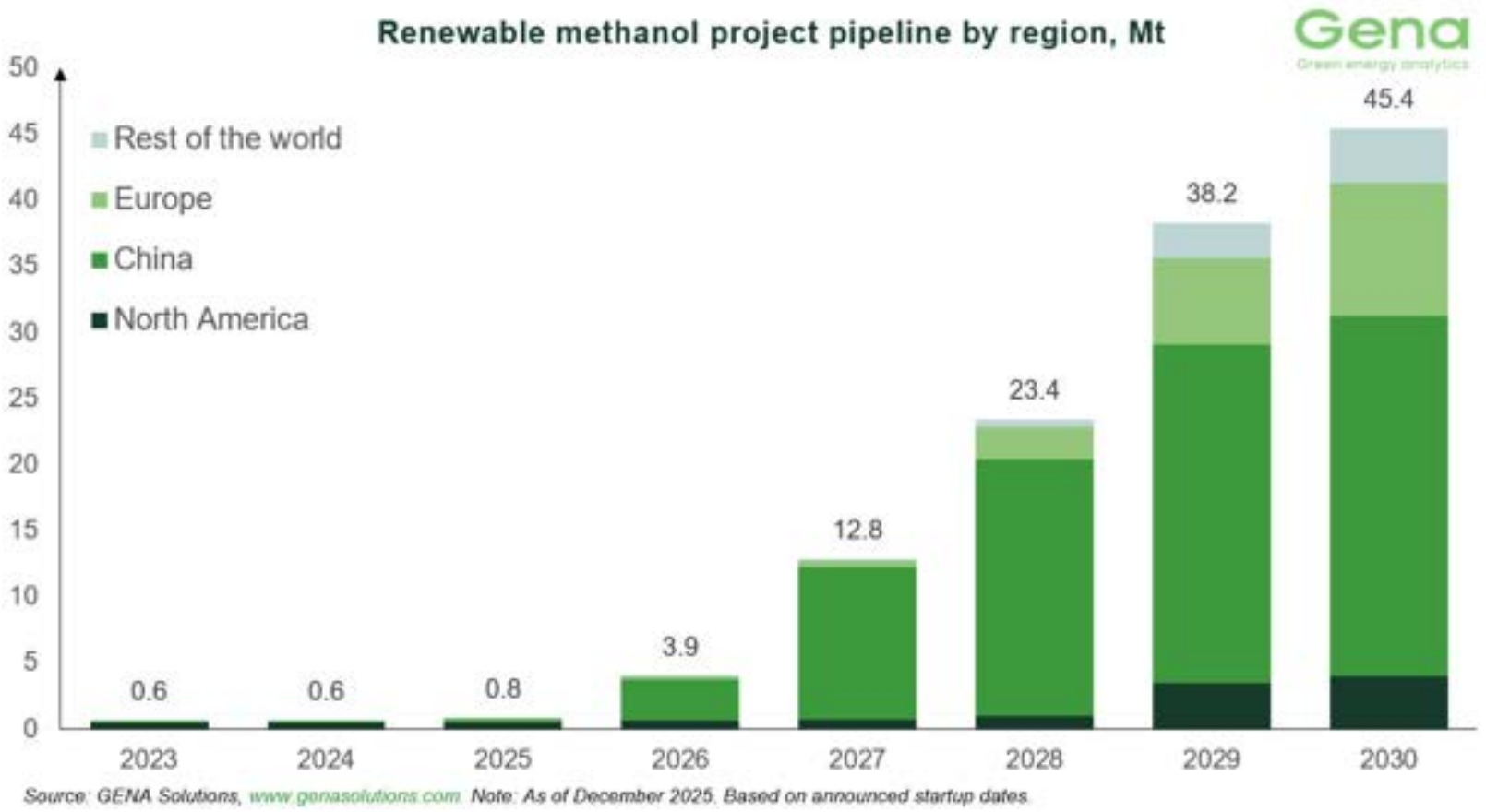


Source: GENA Solutions, www.genasolutions.com. Note: As of December 2025. Advanced projects - operational facilities, projects under construction and in engineering. After FID projects - operational facilities and projects under construction. Higher probability projects - projects with higher probability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

- In 2026, we expect renewable methanol capacity could reach about 2 Mt—a more than two-fold increase compared to 2025. At the same time, there will **likely be a slowdown in project pipeline growth compared to 2024–2025**, partially due to an increase in the number of frozen projects.
- Further growth of renewable methanol capacity will depend substantially on **regulatory developments**—especially the fate of the IMO Net-Zero Framework—as well as **demand growth** in maritime, chemicals, aviation, and road fuels.
- In particular, the development of methanol-to-jet and methanol-to-olefins projects could create substantial new markets for e-methanol and bio-methanol.
- GENA estimates that renewable methanol capacity could range from **6 to 13 Mt by 2030**.

Sources: GENA

Renewable Methanol: Regional Project Pipeline



- **China, Europe, and North America** are expected to be the three main centers of renewable and low-carbon methanol production.
- These regions **account for 95% of bio-methanol, 87% of e-methanol, and 100% of low-carbon methanol projects**.
- China holds the largest share of both the bio-methanol (78%) and e-methanol (43%) pipelines. Europe follows with 33% of e-methanol and 11% of bio-methanol. North America leads in low-carbon methanol, with a 96% share.
- **China** is advancing faster in renewable methanol development than other regions. The country **accounts for more than 90% of all renewable methanol capacity currently under construction**.
- Low production costs and CAPEX, availability of biomass and renewable electricity, and shorter project development periods are among the major factors driving faster project development in China.

Sources: GENA

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**

Bunkering & Storage Capacity

Source: https://public.tableau.com/app/profile/kelloneimak/viz/MethanolInstituteRM-Ports/PortsDashboard, OOCL, 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).

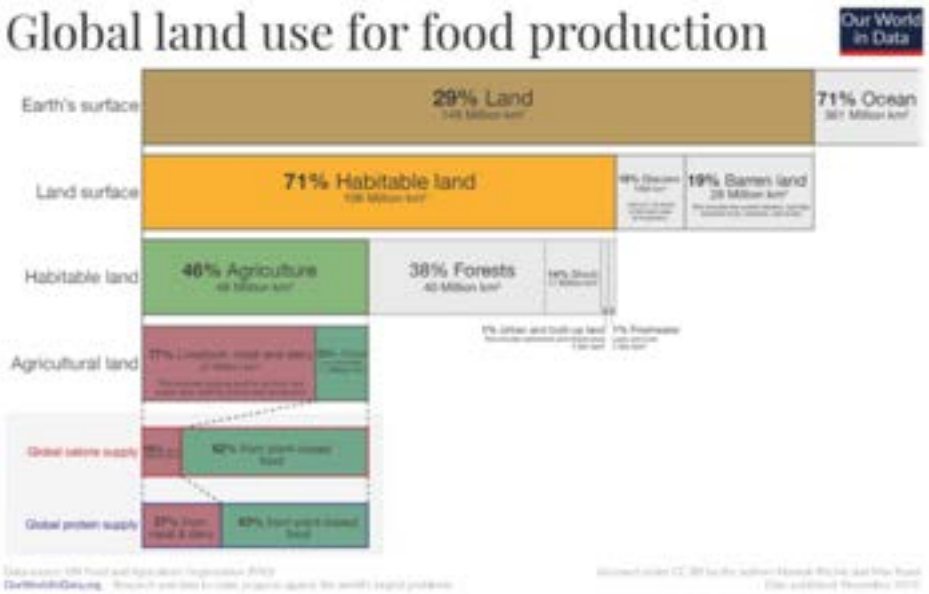
- Ethanol is relatively **safer and benign** compared to other fuels.

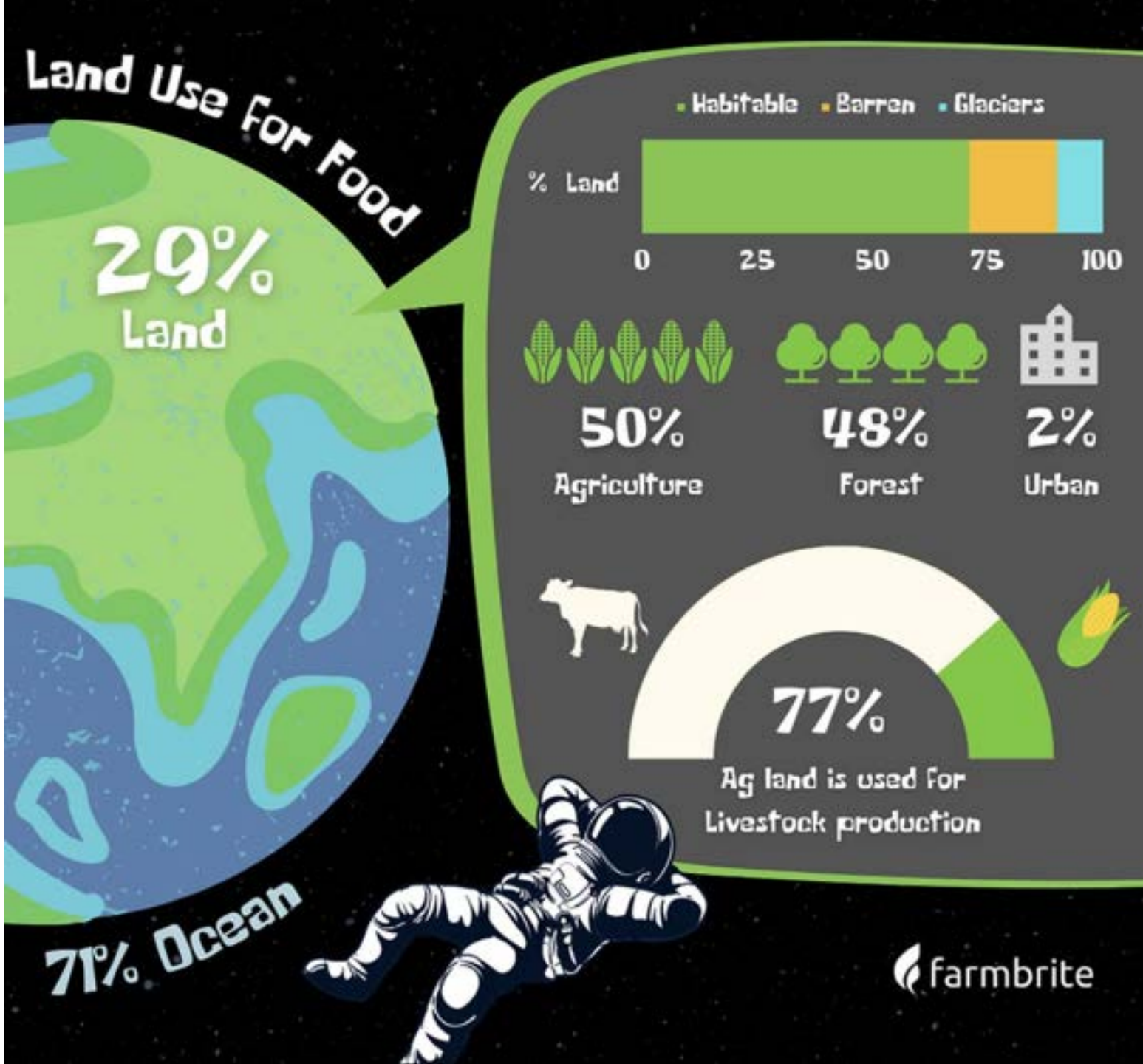
- Widely available

Sources: GCGF

Global Land Use

- **Land is limited:** Only ~29% of Earth is land, and **over half of habitable land is already agricultural** — expansion drives land-use change
- **The issue is efficiency, not food vs fuel: ~77% of agricultural land serves livestock and feed**, making productivity gains more impactful than new land
- **Feed and fuel scale together:** Integrated systems increase **output per hectare** using existing land, without forest conversion
- **Trade matters:** Feed exports enable **local protein production** in land-constrained markets more efficiently than exporting finished protein

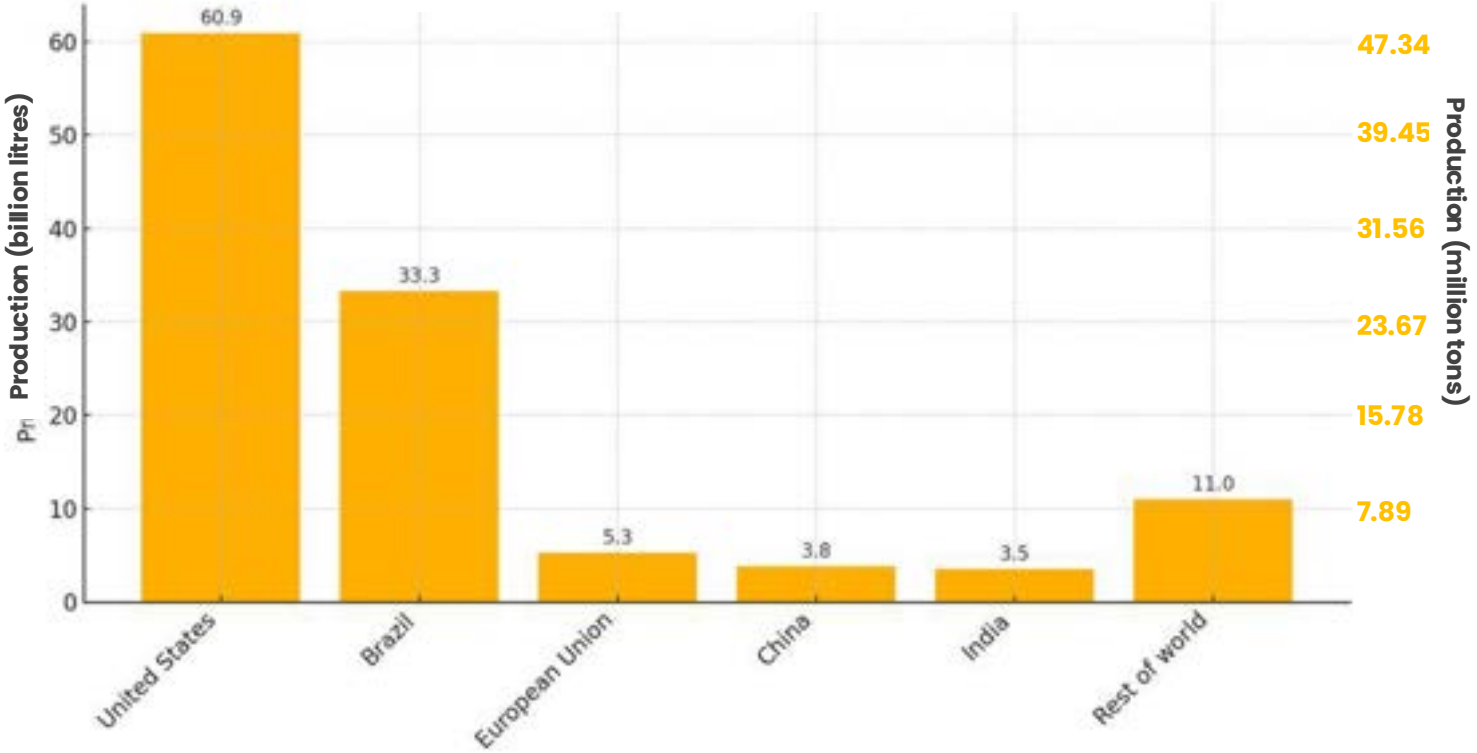




Global Supply Dynamics 2024 - 2030

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.

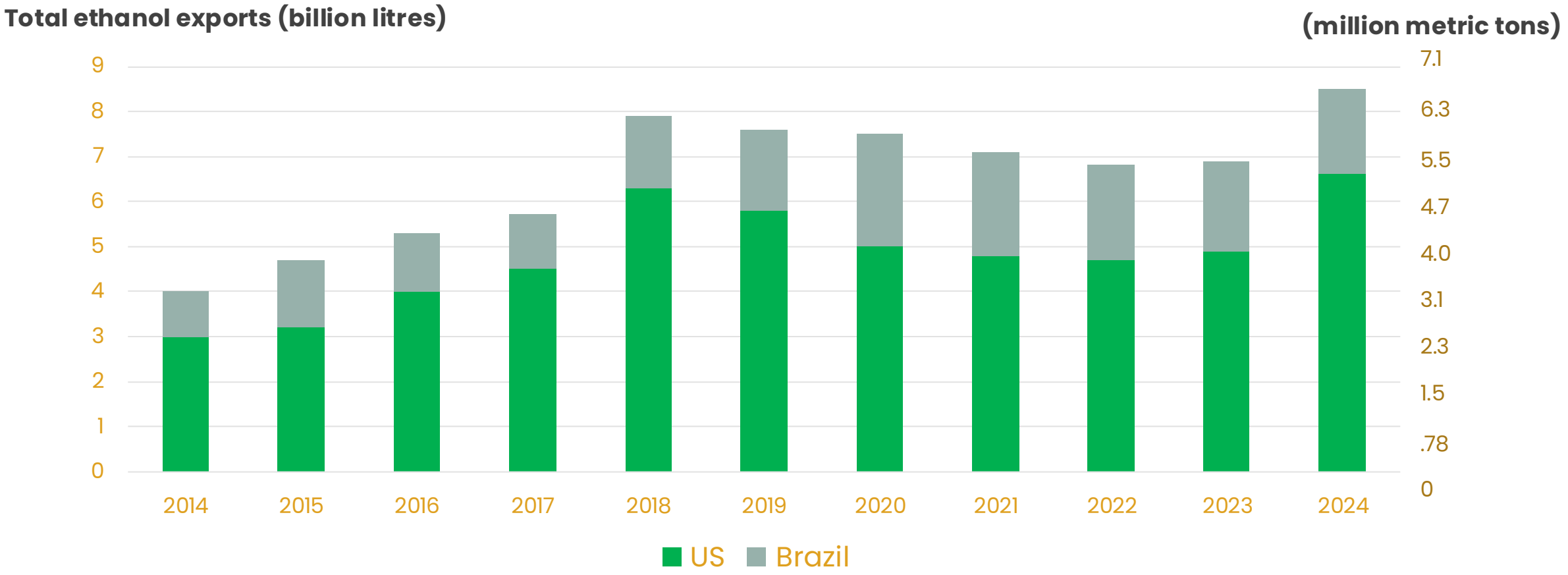
Global Ethanol Forecast to 2030

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)

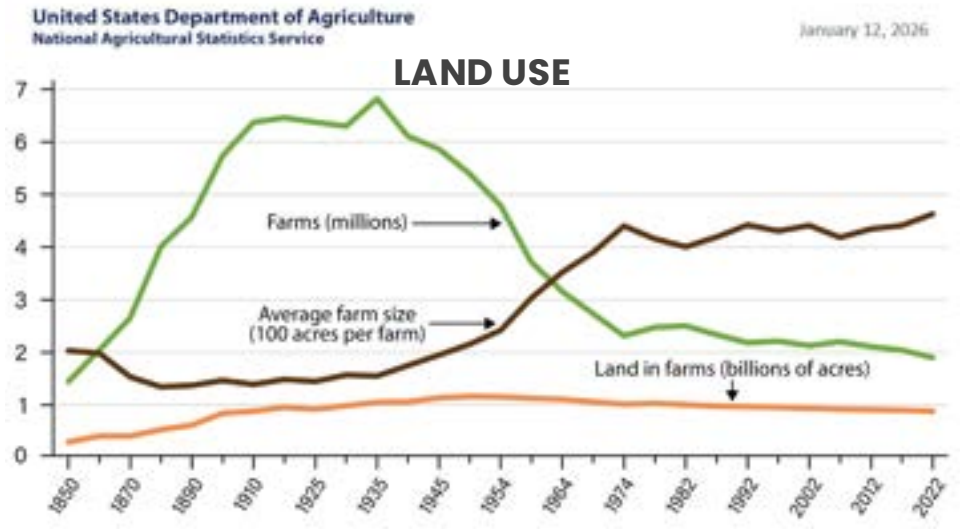
Source: GCGF

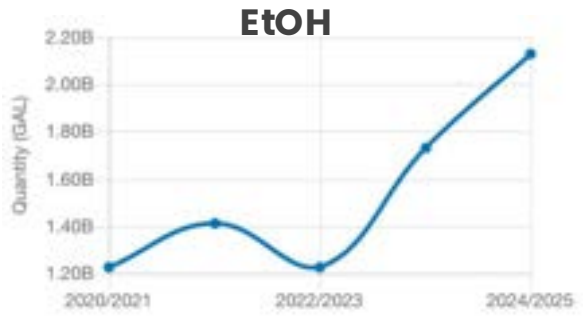
US & Brazil Exports



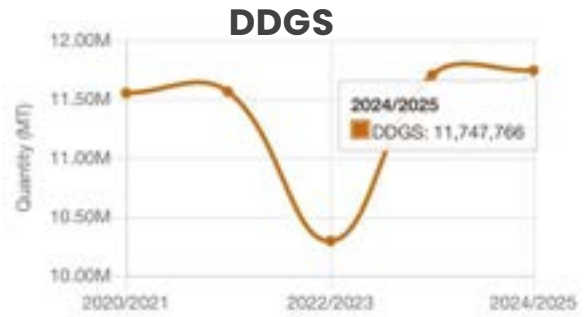
Sources: https://grains.org/markets-tools-data/tools/top-u-s-export-customers/
https://www.spglobal.com/commodity-insights/en/news-research/latest-news/refined-products/012425-feature-traders-weigh-potential-increase-in-brazil-eu-ethanol-flows-in-2025
EIA & UNICA
Compiled by: GCGF

US Feed Grain Equivalent Factors





PREVIOUS MARKET YEAR (SEP-NOV 2024/2025)	CURRENT MARKET YEAR (SEP-NOV 2025/2026)
517,469,204	544,765,610 ↑ 5.3%
$1,112,747,929	$1,238,658,365



PREVIOUS MARKET YEAR (SEP-NOV 2024/2025)	CURRENT MARKET YEAR (SEP-NOV 2025/2026)
3,088,309	3,059,660 ↓ -0.9%
$751,542,778	$727,652,827

- **Yields drive growth, not land expansion:** US corn yields have risen steadily (≈125 → ~185 bushels/acre since the mid-1990s), delivering more output per hectare without expanding farmland.
- **Total farmland is stable or declining:** US land in farms has **fallen over the long term**, while average farm size has increased — indicating consolidation and efficiency, not land-use change.
- **Production scales despite fewer farms:** The number of farms has declined, yet total agricultural output continues to rise, showing structural productivity gains.
- **Feed output grows alongside fuel:** DDGS and feed grain equivalents remain stable to rising, demonstrating that ethanol production **adds feed supply rather than displacing it**.
- **At-scale decoupling achieved:** The US system shows **output growth fully decoupled from land expansion**, validating feed-and-fuel scale without land-use change.

Data Source: U.S. Census Bureau Trade Data; Feed conversions from FAS/OGA., USDA, USGBC, GCGF

90% Certified Production via Brazil's RenovaBio

Brazil ensures no deforestation from ethanol production thanks to RenovaBio

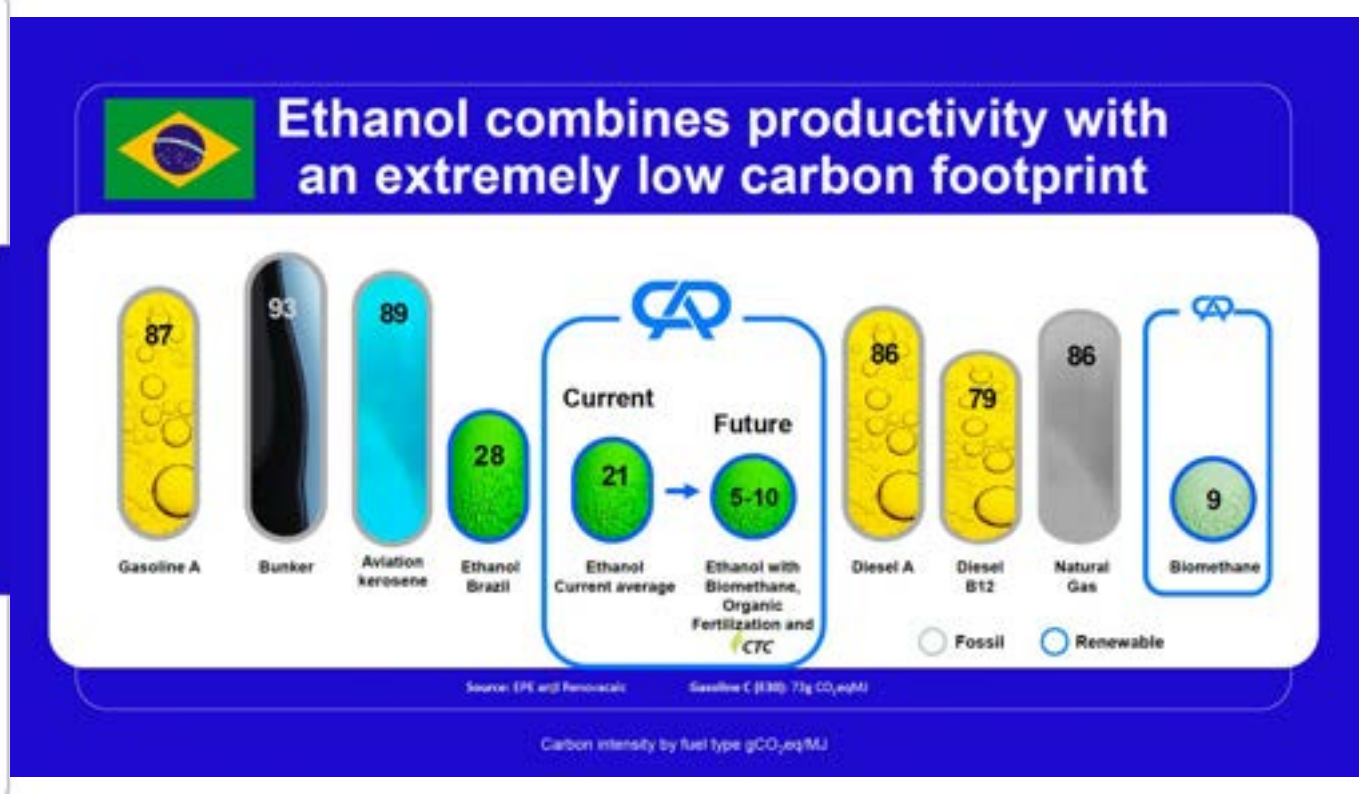
+90% of ethanol plants are certified under RenovaBio

RenovaBio

The Brazilian Biofuels Policy (RenovaBio) establishes:

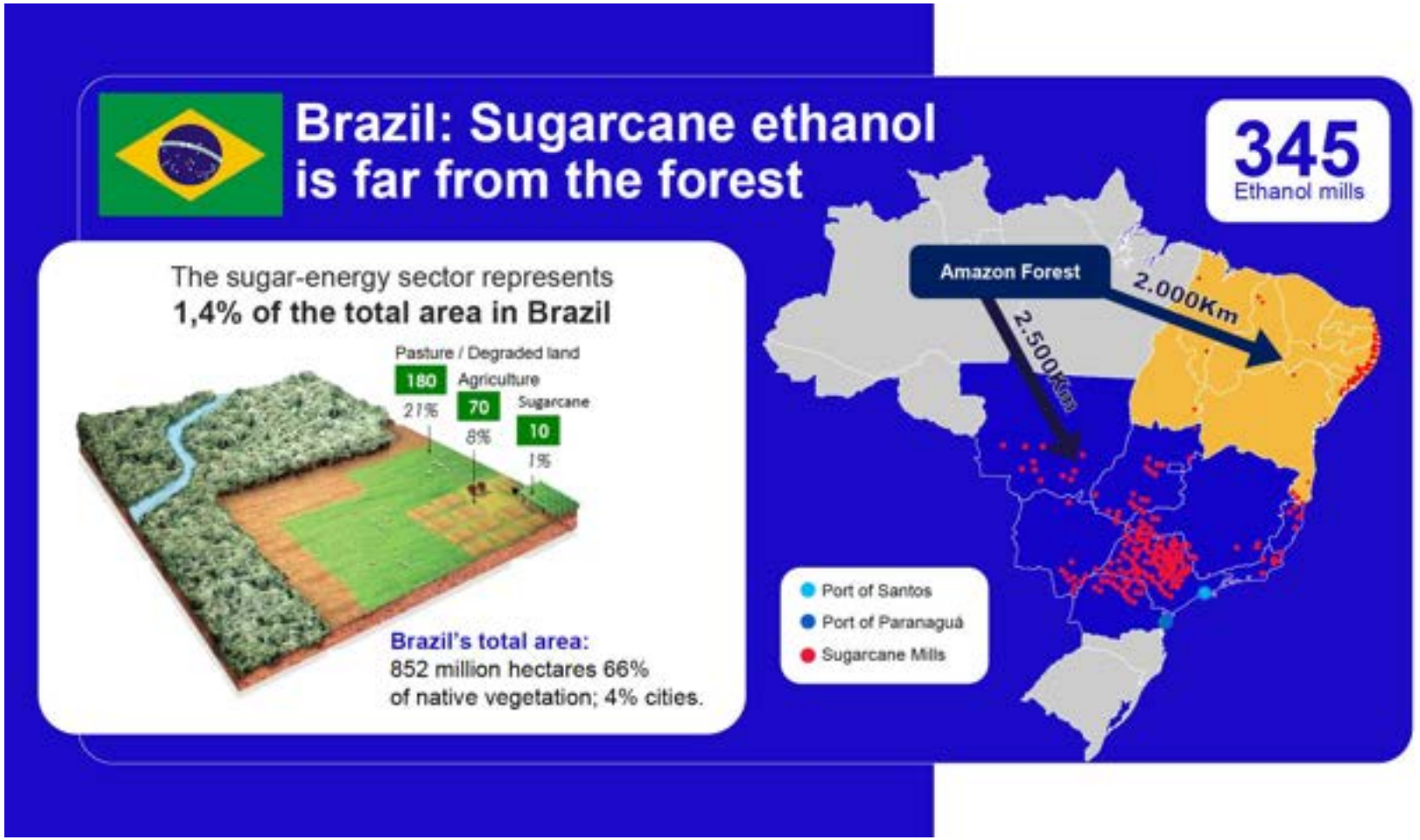
- The non-suppression of native vegetation after the publication date of the Resolution that regulates the certification process
- Rural Environmental Registry (CAR) must be regularized

ZERO DEFORESTATION



Source: Copersucar, RenovaBio, ANP

Brazilian Agri-Clusters Located Near Ports



Main Corn Production States

- MY to MY can swing by 5-7% between crops depending on climate, cropping conditions, etc
- Crop switching occurring on degraded pasture land to soya due to profitability and liquidity
- Many corn ethanol plants are co-located with sugarcane ethanol plants
- Corn ethanol only uses the starch for ethanol production – the remaining proteins and fibers are converted to DDG (animal feed)

Sources: UNICA, USDA, GCGF

Energy Security

Interplay in Decarbonization & Energy Security

1. **Ethanol is blended into gasoline at concentrations ranging from 5% to 85% for land transport applications globally, and it is recognized as a key decarbonization solution**

2. **Ethanol is emerging as an important feedstock for sustainable aviation fuel, with more than 5 million tons of supply coming online by 2030**

Ethanol's Role in Energy Security

- **Brazil:** Sugarcane and corn ethanol offsets 40% of gasoline demand, thereby enhancing trade balance resilience.

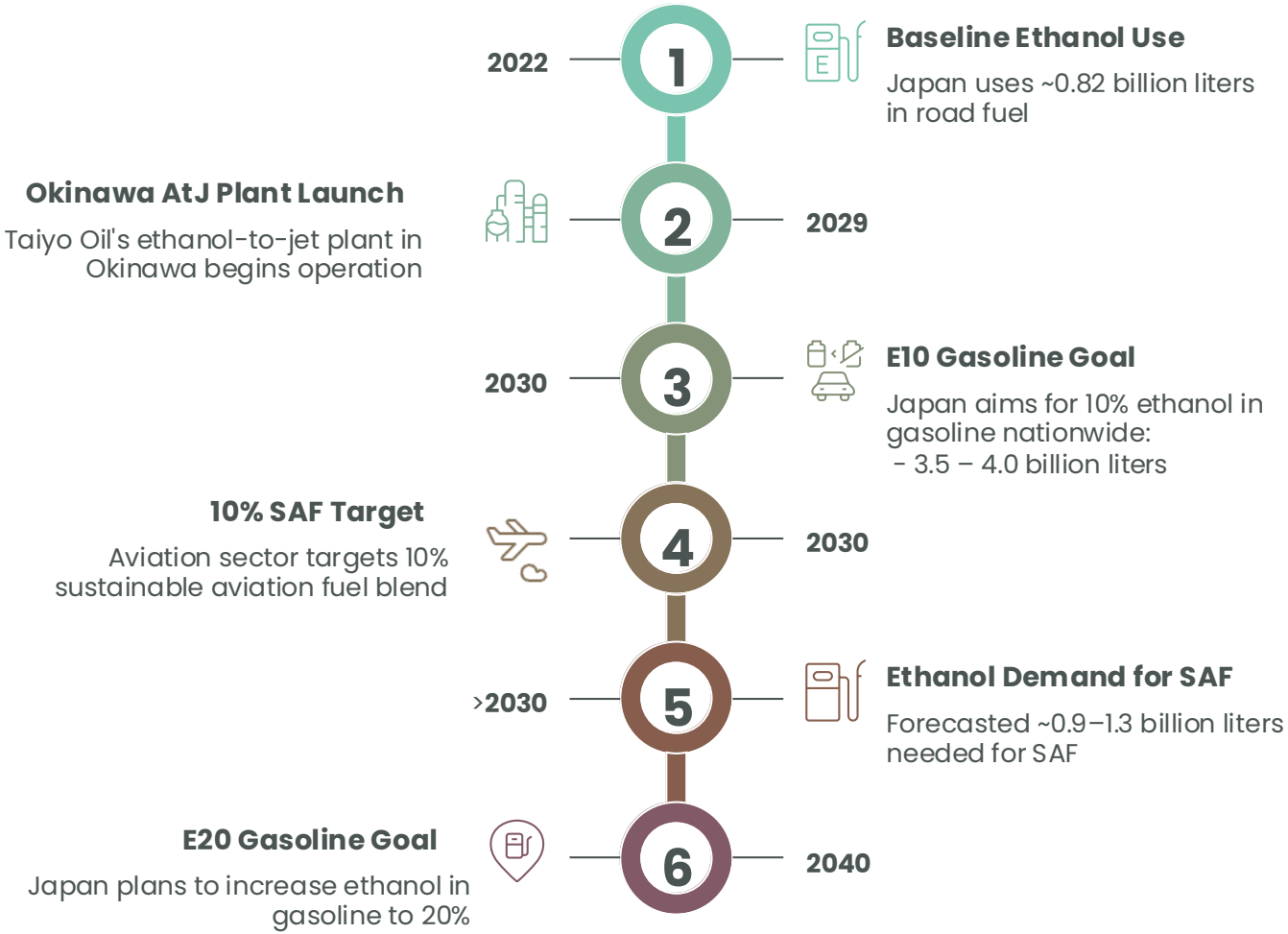
- **India:** Achieving a 20% ethanol blending target by 2025 is projected to reduce crude oil imports by approximately $1.7 billion annually.

- **United States:** In 2021, U.S. ethanol production reached around 15.8 billion gallons, primarily blended as E10, E15, or E85. This blending strategy reduces crude oil imports by offsetting roughly 1.5 million barrels per day, saving an estimated $6–8 billion annually.

- **Europe: L**eading countries such as France and Germany are increasingly incorporating ethanol into their fuel mix as part of EU renewable energy initiatives. These efforts aim to reduce fossil fuel imports, with projected annual savings estimated between €1–2 billion.

https://www.energy.gov/eere/bioenergy/synthetic-aviation-fuel-grand-challenge, https://www.eia.gov/, http://www.unica.com.br/, www.petroleum.nic.in

Ethanol in Japan – Land, Air & Sea Case Study



Japan may pursue ethanol as a synergistic strategy – building a harmonised supply chain to fuel cars, planes, and ships together, multiplying climate benefits across all transport modes.

Synergies include:

- Shared blending, logistics, and import terminals
- Single LCA and certification platform for multi-sector deployment
- Harmonised standards across maritime, aviation, and automotive fuels
- Lower transition costs by leveraging ethanol-ready infrastructure
- Resilience through diversified demand across sectors

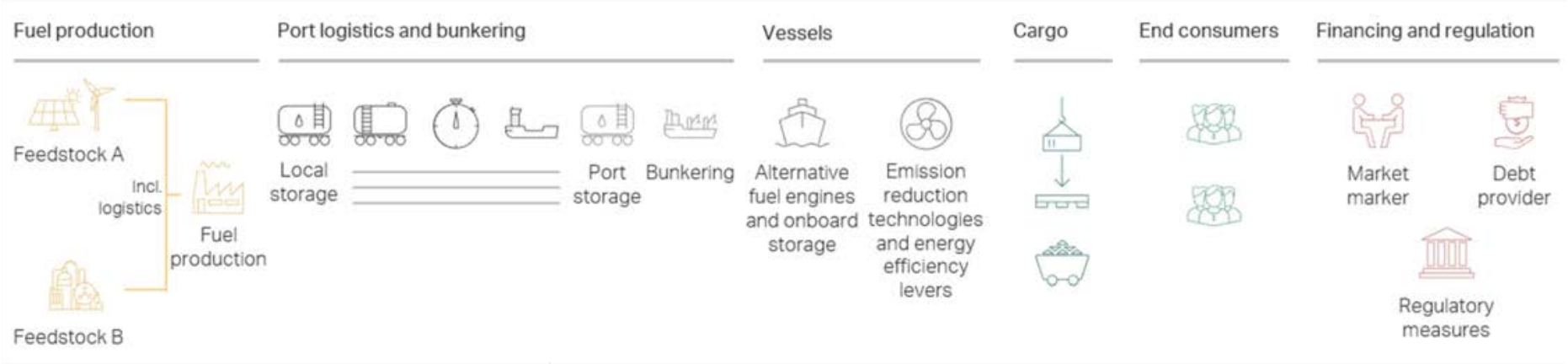
Source: GCGF

Green Corridors

The Clydebank Declaration was launched at COP26 to facilitate rapid decarbonization of the shipping industry. Its signatories support establishing "green shipping corridors – zero-emission maritime routes between two (or more) ports" with an intent to establish at least six corridors by 2025 and "many more" by 2030.

Once operational, green corridors will:

- Contribute to the development of alternative fuel supply chains, offtake, and lead to reduced cost
- Unite individual first mover actions across the value chain, identifying cost-gaps and developing measures to overcome these gaps and accelerate decarbonization processes in a specific geographical area
- Ethanol may play a key role in the green corridors where methanol DF vessels already voyage or have a presence, to include:
  - Shanghai – SIN
  - SIN – ARA
  - India – SIN – Japan
  - SIN - Japan
  - Korea – Seattle
  - SIN – Long Beach
  - Brazil – China
  - C40s



Sources: MMMCACS, GCGF

Green Corridors

Port of Rotterdam | Singapore Green and Digital Corridor

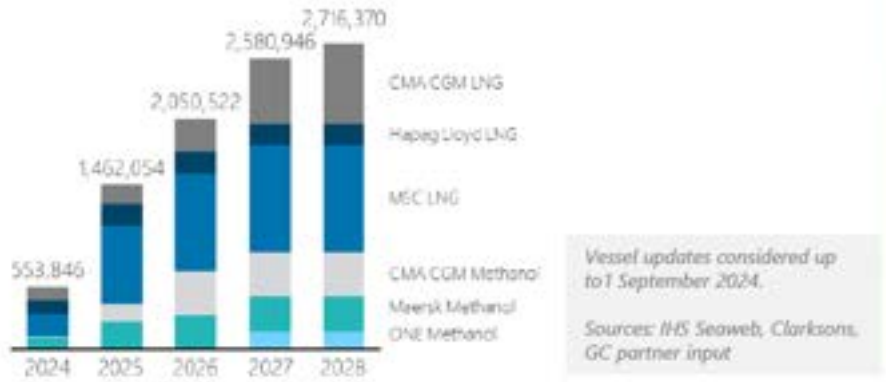
- **In 2028 GC shipping partners are expected to have >200 vessels capable of sailing on sustainable fuels, mainly either methanol or bio-methane**
- **Potential demand of >2.5M mtpa across both fuels**

In 2028, the GC partners will have **>200 vessels, larger than 8,000 TEU**, capable of sailing on methane or methanol globally

~25% of the GC partner vessel capacity could sail on sustainable fuels in 2030

Sustainable Fuel Fleet Capacity GC Partners

Cumulative TEU capacity order book of container vessels >8,000 TEU (million TEU)



Vessel updates considered up to1 September 2024.

Sources: IHS Seaweb, Clarksons, GC partner input

THE OPPORTUNITY

Potential **bio-/e-methane** demand from the order book is estimated between 1.5 – 2.1 million tonnes p.a. in 2030. Including existing demand, estimated **total potential demand is 3 million per annum.**

Potential **bio-/e-methanol** demand is estimated between 2.2 – 3 million tonnes p.a. in 2030. Including existing demand, the estimated **total potential demand sums up to 2.6 million per annum**

This is ~2% of the annual fuel consumption of vessels >5,000 Gross Tonnage (IMO 2022)

These vessels are all DUAL FUEL

- These vessel can switch between fuels
- Making the demand highly uncertain
- Ensuring availability of affordable is sustainable fuels is essential

Source: Port of Rotterdam

PRICE

Alternate marine fuels price comparison

Fuel (bunker grade)	Spot price (US$/t)	Energy density (MJ/kg)	Energy multiplier vs VLSFO	VLSFO-eq price (US$/t)	Multiple of VLSFO	Break-even spot price (US$/t)	CI Range (gCO_2eq/MJ)	Key take-away
VLSFO	485	40.5	1.00×	485	1.0×	485	~90 – 94	Fossil Baseline
LNG	650	50.0	0.81×	527	1.09×	598	~70 – 85*	Lower CO_2, methane risk
Ethanol	650	26.8	1.51×	982	2.02×	321	~15 – 55	Lowest-cost scalable, liquid renewable
Green methanol	1,000	19.9	2.04×	2,035	4.20×	239	~5 – 20	Strong CI, High cost, scalable
Green ammonia	1,000	18.6	2.18×	2,177	4.49×	223	0 – 10	Best CI, Worst Economics

Source: GCGF **LNG CI highly sensitive to methane slip (engine and upstream)*

STANDARDS

Ethanol as a marine fuel

- An industry standard for ethanol as a marine fuel is required and involves a comprehensive technical, safety, and environmental assessment – currently carried out by ISO

- It is likely similar to ISO 6583:2024 (methanol as a marine fuel), but with ethanol-specific considerations.

- Key differences between methyl/ethyl alcohol:

Aspect	Methanol	Ethanol
Energy Density	~19.7 MJ/kg	~26 MJ/kg
Flash Point	11°C	13°C
Hygroscopic Nature	High	Moderate
Storage Corrosiveness	Higher risk (Al and Cu)	Lower but still present
Emissions (NOx, SOx)	Low	To be determined

Sources: GCGF


SAFE HANDLING

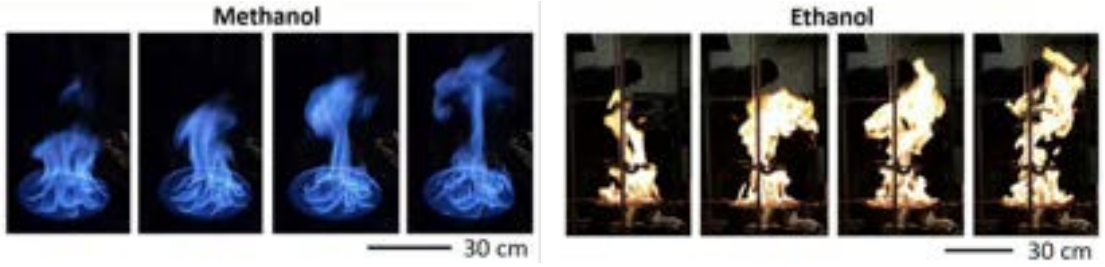
Comparisons in terms of safety and hazardous fuels

	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

Ethyl | Methyl Safety, Fire Fighting

- **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



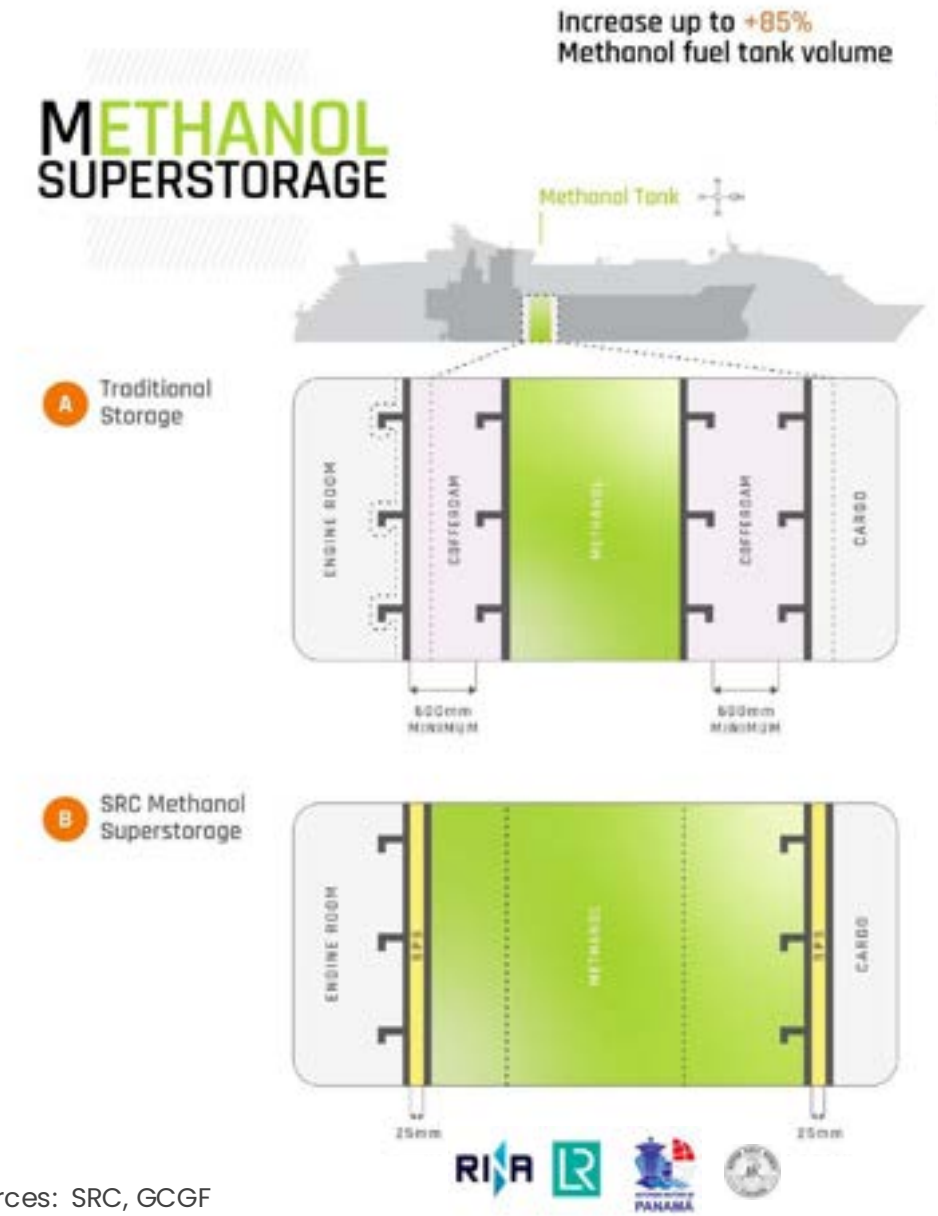
Sources: GCGF

Handling and Storage as per MSC Circ. 1 - 1621

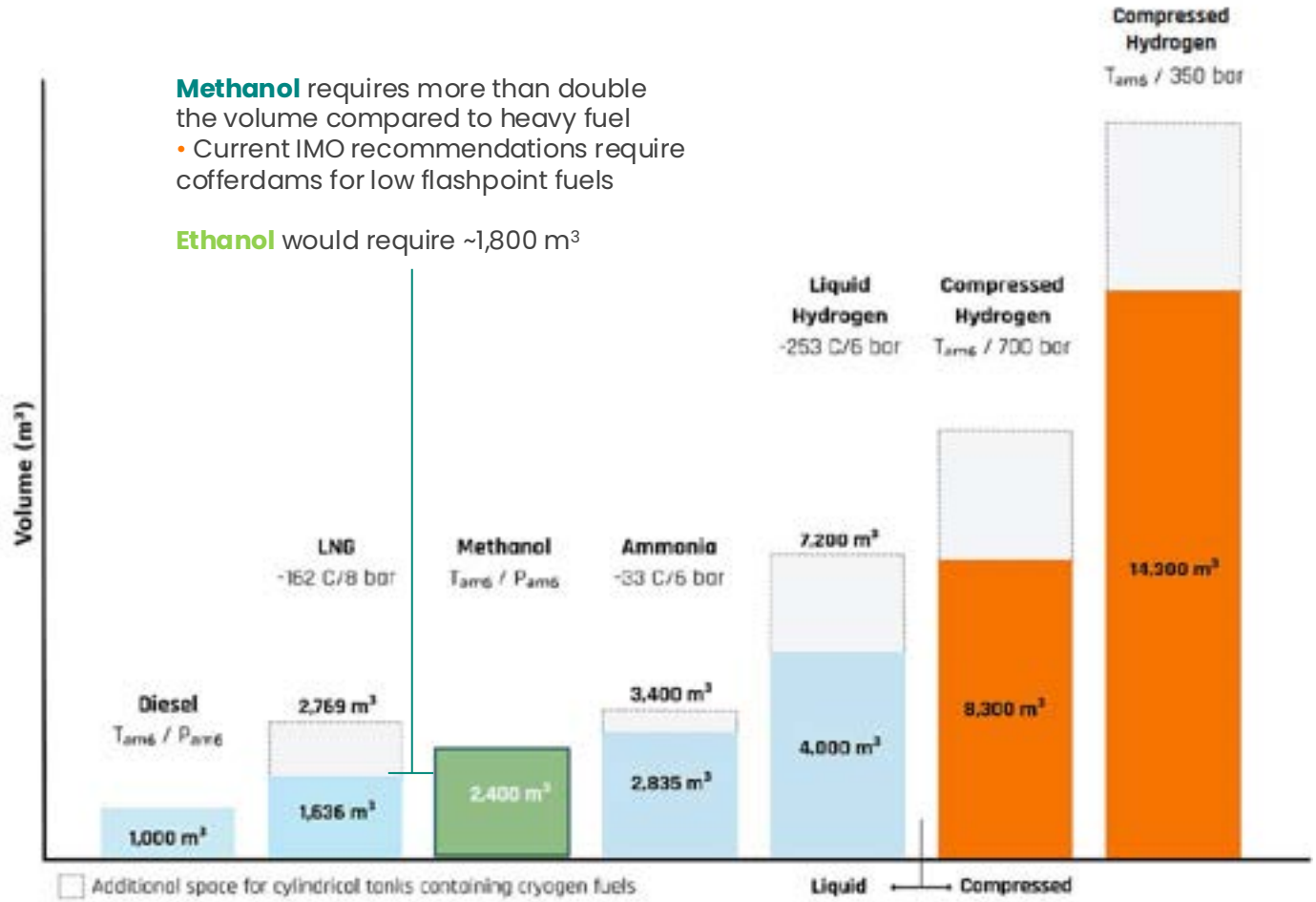
- **Conveniently stored in ambient pressure and temperature**
- **Conventional Cofferdam arrangement but consideration for ballast water tank conversions and "Sandwich Structured Cofferdams":**
  - Triple barrier arrangement
  - Alternative to traditional cofferdams

Sources: SRC, GCGF

Sandwich Structured Cofferdams



Instead of cofferdams, the **Methanol Superstorage** solution utilizes a SPS (**Sandwich Plate System**) with a core thickness of 25mm, eliminating the need for cofferdams and maximizing the available volume for storing methanol



Sources: SRC, GCGF

Methyl | Ethyl Fuel Supply System & Bunkering

- **ALFA LAVAL, Sun Rui, Headway** – Low Flash Point Supply Systems are methyl/ethyl compliant.
- **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/ethanol "multi-fuel" engines since 2025

- **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 similar

Sources: DRÄGER, ALFA LAVAL, GREEN MARINE,. GCGF

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IN-SERVICE

AP Moller Maersk

Denmark | October 10, 2025 – In a bold stride towards decarbonizing maritime transport, A.P. Moller – Maersk continues to push the envelope by turning its container vessel, *Laura Mærsk*, into a floating test lab for next-generation sustainable fuels.

Building on its historic milestone as the world's first container vessel to operate solely on methanol in 2023, Maersk is now trailblazing further innovation by testing a cutting-edge fuel blend: e-methanol combined with 10% ethanol, known as E10.

Maersk has been among the early adopters of methanol as a lower-carbon fuel.

"The reason for blending it is to enlarge the availability and the sourcing pool for these dual-fuel vessels," **Peter Normark Sorensen**, senior fuel transition manager at Maersk, said.

He added that the trials will help determine whether there are any differences between standard methanol and the E10 blend, such as ignition quality, corrosion or lubricity issues, and emissions performance.

> **The E10 bunkered is a mixture of 90% e-methanol and 10% ethanol**

The testing period is expected to run for about one to one-and-a-half months.

The trial comes as engine makers explore similar pathways for ethanol use in shipping.

Firms including **Everllence** and **WinGD** are developing dual-fuel engines capable of running on ethanol, with WinGD planning to launch a two-stroke ethanol engine **next year**.

WinGD says the fuel's combustion and emission profile is similar to methanol.

Japan experience

IINO Lines (Japan) — **Nihon Shipyard** — methanol DF VLCC (~309–310k dwt) — **delivery 2027** — **to be time-chartered to Idemitsu Tanker**. This was billed as Japan's first methanol DF crude-oil tanker order.

NYK Line (Japan) — **Nihon Shipyard** — methanol DF VLCC (Malaccamax, ~310k dwt) — **delivery 2028** — **long-term charter to Idemitsu Tanker**.

Idemitsu Tanker (Japan) — **two** methanol DF VLCCs — **deliveries 2028 & 2029** — design concept by Idemitsu/IINO/NYK/**Nihon Shipyard**; (yard not explicitly named in the release, but NSY is part of the consortium).

Source: Everllence, iino, Nihon, Lloyds List, Marine Link

DSIC VLCC dual fuel technology

CMES / Haihong Shipping — DSIC (Dalian) methanol dual-fuel VLCC (newbuild)

- First VLCC to actually be **specified with a MAN 7G80ME-LGIM** methanol dual-fuel main engine. Engine was delivered/inspected by CCS on **July 4, 2025**
- Hull under construction at DSIC with delivery previously slated around **April 2026**.
- Rated power of 32,970 kW and a maximum speed of 72 rpm, main engine is IMO TIER II emission standards

COSCO Shipping Energy — DSIC VLCCs "methanol/LNG-dual-fuel ready" (newbuild program)

- COSCO has contracted **six 307k dwt VLCCs at DSIC** with deliveries from **April 2027–Nov 2028**
- **Methanol/LNG dual-fuel ready** (i.e., designed for future methanol installations, not confirmed as fitted from day one).
- Earlier, DSIC/COSCO also secured AiP for a **green methanol-fuelled VLCC design**.

Source: CCS, Riviera

COSCO US$1.7Bn NB Expansion

COSCO Shipping Development disclosed on 31st October, 2025 via the Shanghai Stock Exchange that it has commissioned two domestic shipyards to construct:

- **23 Kamsarmax methanol-ready, 87,000-dwt bulk carriers** via wholly owned subsidiary Hainan Development Shipping
  - Dalian COSCO Shipping Heavy Industry, worth more than US$1.0Bn
  - first vessel is expected to be delivered by May 2027, with the remaining units entering service by the end of 2028.
  - time chartered to COSCO Shipping Bulk for 240 months following delivery

- **6 methanol/LNG dual-fuel ready 307,000-dwt VLCC**s, valued at approximately US$716M
  - first VLCC is scheduled for delivery by April 2027, with the remainder expected to join the fleet by November 2028
  - VLCCs will be time chartered to COSCO Shipping Energy Transportation under 240-month leases following delivery

- This latest order follows a series of bulk carrier investments by COSCO earlier this year, including:
  - **10 210,000-dwt Newcastlemax bulk carriers** methanol- and ammonia-ready
  - **30 multipurpose vessels**, all placed with Chinese shipyards

Peak FO?

Making history in record time | Methanol at 50% of main engine operation

Antonia Maersk:

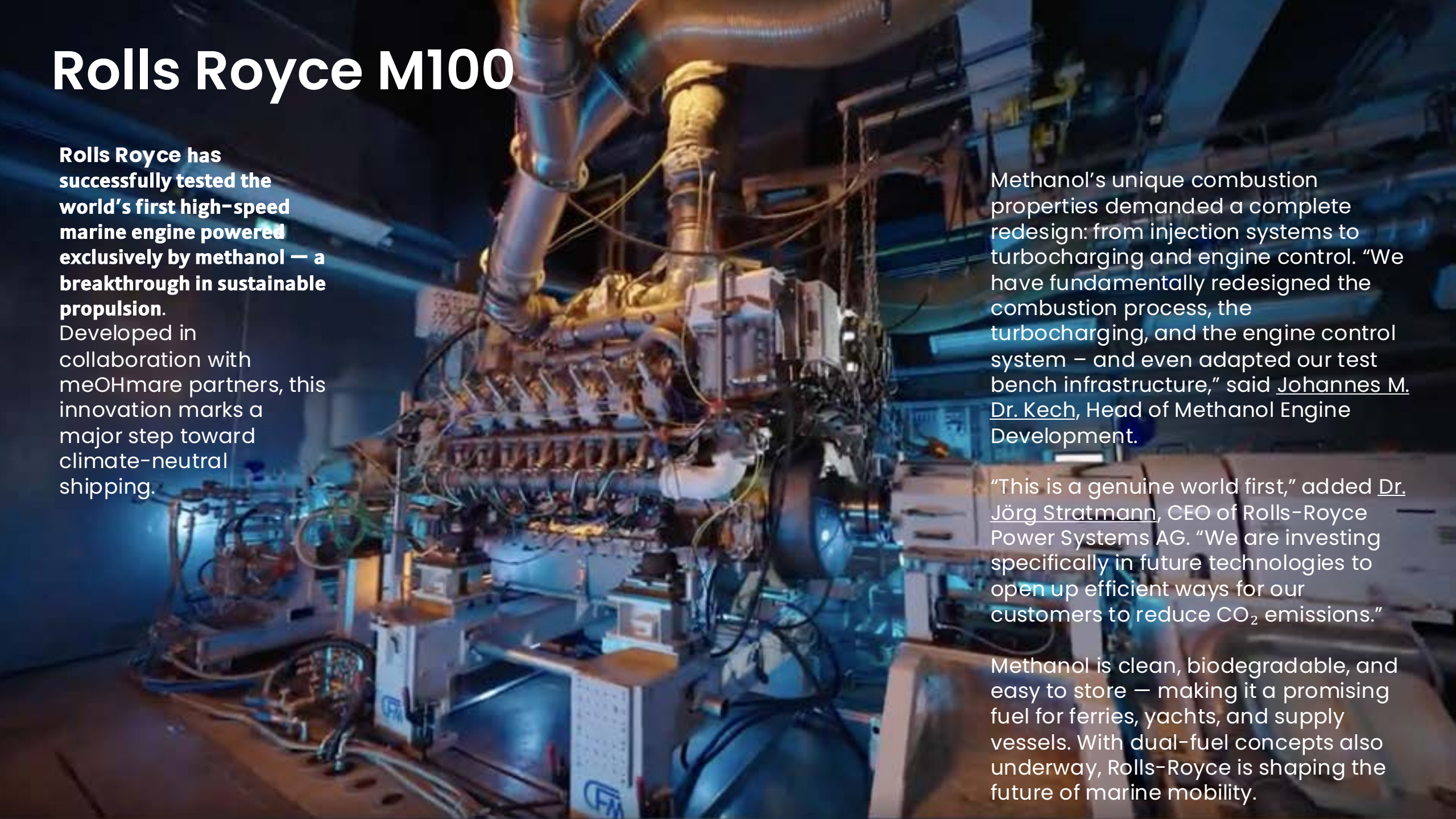
- **4,668 hours on methanol, perfectly matched by 4,668 hours on conventional fuel.**
- This 50/50 achievement marks the first real-world operational balance between conventional and low-flashpoint fuels — an inflection point for the industry.
- With over 37,400 tonnes of methanol bunkered and 32,275 tonnes consumed, the vessel averaged ~7.1 tonnes/hour, proving both performance stability and energy efficiency under commercial service.
- **This milestone shows how fast the sector is moving from pilots to practice — where methyl/ethyl alcohols are no longer "alternatives," but part of the new normal.**

Mono-fuel MeOH Inland Vessels: China

88 Vessels

Segment	Owner/Program	Yard/Builder	Count (vessels)	Vessel type	Size/Notes	Engine/System	Status	Primary source
Inland (Pearl River/Xijiang)	Zhaoqing West River project (operator: Zhaoqing Haifa Shipping)	— (systems by CIMC Blue Water)	50	Mono-fuel methanol 集散两用 (inland cargo)	Project start 21 Jan 2025 (CCS class)	CIMC Blue Water methanol fuel system	Opened under construc-tion	https://www.zgsyb.com/news.html?aid=712875
Inland (Pearl River)	Guangdong Chuangying 20-ship series	Qingyuan Chenlong Shipyard	20	Mono-fuel methanol 集散两用 (inland cargo)	First 8 started 9 Sep 2025 (CCS class)	Weichai single-fuel methanol engines	Opened under construc-tion	https://www.eworldship.com/html/2025/NewShipUnderConstrunction_0922/215085.html
River-sea (江海直达)	Wuhan Innovation JiangHai Transport	Jiangsu QinFeng Shipbuilding	16	Mono-fuel methanol river-sea cargo ships	15,000t & 19,600t types; signed 28–30 Sep 2024	CS8L21DF-M / CS9L21DF-M (mono-fuel methanol, 7-1-1 Institute)	Contracted (in order)	https://www.xindemarinenews.com/m/view.php?aid=565866
Inland (Yangtze/Lower reaches)	Nanjing Pengfei Logistics	SanDianShui New Energy (Wuhu)	2	Mono-fuel methanol inland cargo (120 m)	Signed 22 Aug 2025	—	Contracted (in order)	https://www.eworldship.com/html/2025/NewOrder_0822/214408.html

Rolls Royce M100



Rolls Royce has successfully tested the world's first high-speed marine engine powered exclusively by methanol — a breakthrough in sustainable propulsion.
Developed in collaboration with meOHmare partners, this innovation marks a major step toward climate-neutral shipping.

Methanol's unique combustion properties demanded a complete redesign: from injection systems to turbocharging and engine control. "We have fundamentally redesigned the combustion process, the turbocharging, and the engine control system – and even adapted our test bench infrastructure," said Johannes M. Dr. Kech, Head of Methanol Engine Development.

"This is a genuine world first," added Dr. Jörg Stratmann, CEO of Rolls-Royce Power Systems AG. "We are investing specifically in future technologies to open up efficient ways for our customers to reduce CO_2 emissions."

Methanol is clean, biodegradable, and easy to store — making it a promising fuel for ferries, yachts, and supply vessels. With dual-fuel concepts also underway, Rolls-Royce is shaping the future of marine mobility.

MeOH/EtOH Blend Tests

GCGF Conducted Independent Fuel Laboratory Testing

- 8 types of fuels used in this test, which are anhydrous methanol conforming to GB/T 683-2006
- 5 types of blended fuels with staged mass fraction ratios of anhydrous methanol to anhydrous ethanol, anhydrous ethanol conforming to GB/T 678-2023, and fuel ethanol conforming to GB 18350-2013
- It should be noted that the engine adopts a vehicle-mounted high-pressure common rail injection system, so the pilot fuel used is No. 0 diesel fuel for vehicles conforming to GB 19147-2016

The specific testing sequence as follows:

1. Anhydrous Methanol Benchmark Test
2. Anhydrous Methanol/Anhydrous Ethanol Blended Fuel Test: with mass percentages of 90/10, 75/25, 50/50, 25/75, and 10/90 respectively
3. Anhydrous Ethanol Test
4. Fuel Ethanol Test

Everllence MeOH/EtOH Blend Tests

Tuesday, September 23, 2025
Everllence has confirmed the **successful running on ethanol – at all load points – of a 90-bore ME-LGIM (-Liquid Gas Injection Methanol) engine in Japan.**

Everllence pioneered the ME-LGIM platform over a decade ago with the first commercial engine entering service in 2016 within the methanol-carrier segment. Building on experiences from these engines, Everllence scaled up its methanol burning portfolio in 2021 with the first ME-LGIM for a vessel outside the methanol carrier segment and now enjoys prominence as the best-selling, methanol-burning engine across all vessel segments with more than 225 units ordered for newbuildings alone and more than 50 engines in operation already.

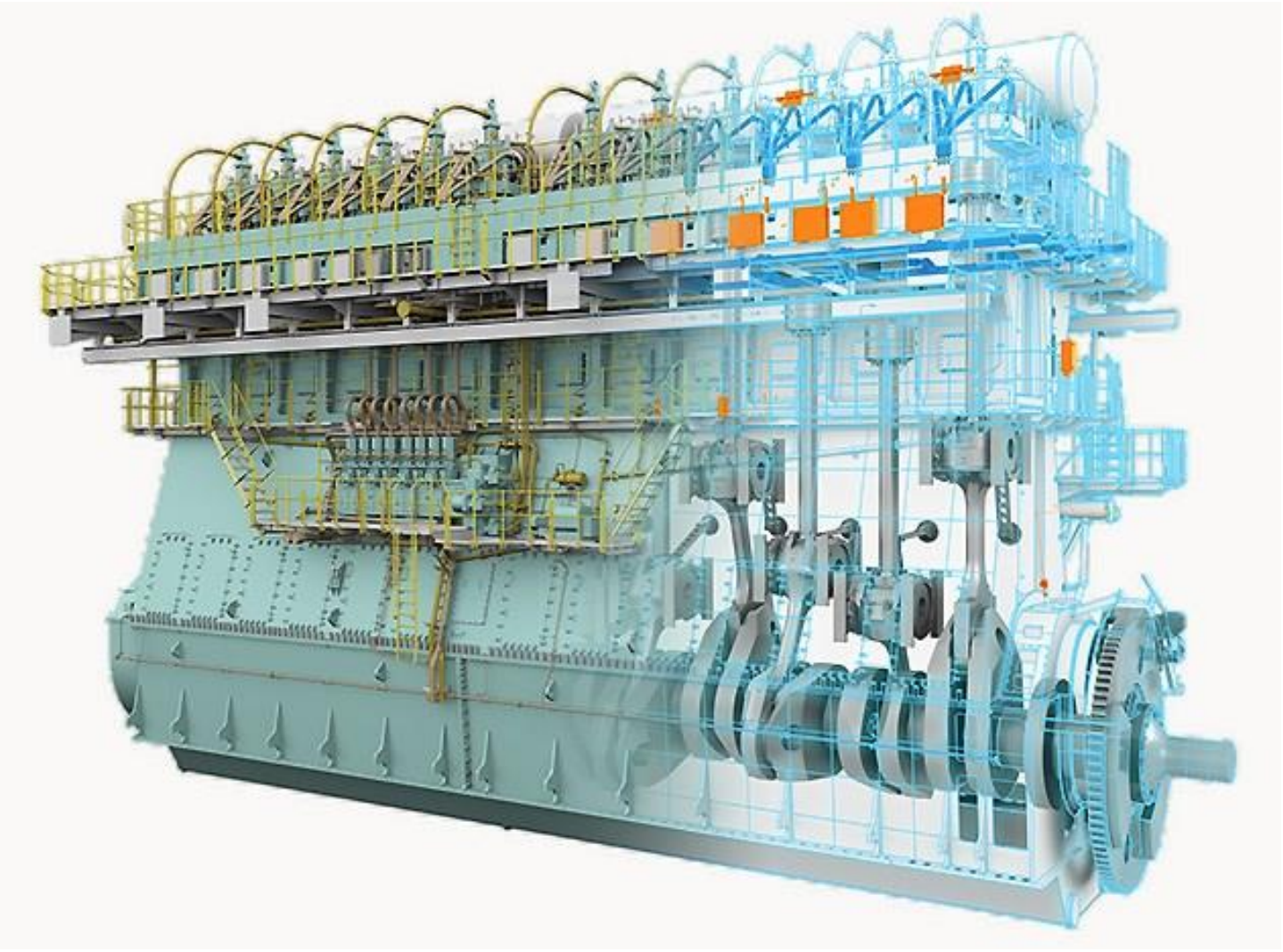
Building further on the ME-LGIM platform, the successful operation on ethanol means Everllence now has a fully operational engine with which to document ethanol capabilities.

WinGD's First EtOH Pilot

WinGD set to embark on first pilot project with a shipowner for its new ethanol engine

"WinGD is set to kick off a feasibility study for a pilot project in which its new two-stroke ethanol engine would be installed on a vessel. Deliveries for new buildings and retrofit applications will start in 2027."

WinGD First EtOH Fueled Engine



The announcement follows a decade of investigation into ethanol fuel—including **full-scale engine tests in 2018**—and the successful launch of a methanol-fuelled engine that uses the same combustion concept and is subject to the same safety regulations as the new ethanol engine.

The **new engine will be adapted from the X-DF-M methanol-fuelled engine**. The diesel-cycle concept—available across the full range of bore sizes currently offered by WinGD—will feature an adapted control system and fuel injector nozzle arrangement to account for the higher energy density of ethanol and the consequently lower fuel volumes required.

WinGD has been studying ethanol fuel, which has a similar combustion and emissions profile to methanol, since 2014 beginning with a project financed by the Swiss Federal Office of Energy. WinGD later led work to develop a flexible injector for alcohol fuels as part of the EU-funded HERCULES 2 project starting in 2016.