Marine Methanol

Gregory Dolan, CEO

JULY 2023
• The Methanol Institute (MI) was established in 1989
• More than three decades later, MI is recognized as the trade association for the global methanol industry
• We facilitate methanol’s increased adoption from our Singapore headquarters and regional offices in Washington DC, Brussels, Beijing and Delhi
Marine
2022: “...the Year Methanol Went Global in the Shipping Industry”
• Comprehensive report into all aspects of methanol as a marine fuel, using all available knowledge, experience, tools and insights available to date, with numerous contributors

• Features case studies from Maersk, Waterfront Shipping, Proman Stena Bulk, and Stena Germanica

• Focus on support for policy proposals which MI could then use to push our key messaging and sensibly localized policy solutions to the global decarbonization effort

https://www.methanol.org/marine/
Methanol Leading Decade

Alternative shipping fuels outlook - 2030

Source: S&P Global Commodity Insights

- Nuclear
- Biofuels
- Battery
- Ammonia
- Hydrogen
- Battery+Diesel
- Methanol
Game Changer 1: IMO IGF Code
Game Changer 2.0: Maersk Vessel Orders

- **21 Feb 2021**: Maersk announces that the world’s first carbon neutral container vessel by 2023 will operate on dual-fuel methanol
- **24 Aug 2021**: Maersk accelerates fleet decarbonization ordering eight 16,000 TEU ocean-going vessels to operate on methanol
  - $1.4 billion order each vessel $175 million 10-15% more expensive
- **5 Oct 2022**: Maersk orders additional six 17,000 TEU methanol dual-fuel vessels, in total now ordered 19 vessels to be delivered by 2025
  - **18 April 2023**: Maersk’s first methanol dual-fueled feeder vessel (2,100 TEU) moved from drydock to water at Korean shipyard
  - Each ship will require 35,000-40,000 tons of methanol annually or a total of over 750,000 tons of methanol
  - **Customer Pull**: Maersk’s 200 largest customers asking for carbon neutral transport

“That means that if we end up finding exactly the right solution then there will be a big retrofit opportunity for us.” Maersk CEO Soren Skou speaking during Maersk’s on 10 February earnings call

“The reason that we have gone for methanol on the first one is that it is the most mature from the technology perspective; we can get an engine that can burn it.” Morten Bo Christiansen, head of decarbonization at Maersk

https://www.maersk.com/news/articles/2022/10/05/maersk-continues-green-transformation
Game Changer 2.1: Maersk Methanol Supply

- **10 March 2022**: Maersk began announcing a series strategic partnerships with now ten leading companies -- including MI members Proman, Orsted, European Energy, Wastefuel, and SunGas Renewables -- with the intent of sourcing at least 730,000 tons/year of green methanol by end of 2025

- Maersk estimates will need 6 million tons of renewable methanol by 2030 to fuel 25% of their 700-vessel fleet
Dominating Container Orderbook

Current orderbook: propulsion method by capacity/order date

<table>
<thead>
<tr>
<th>ALPHALINER</th>
<th>Fuel Oil</th>
<th>LNG</th>
<th>Methanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 2020</td>
<td>26%</td>
<td>17%</td>
<td>62%</td>
</tr>
<tr>
<td>H2 2020</td>
<td>74%</td>
<td>83%</td>
<td>30%</td>
</tr>
<tr>
<td>H1 2021</td>
<td>64%</td>
<td>55%</td>
<td>14%</td>
</tr>
<tr>
<td>H2 2021</td>
<td>24%</td>
<td>37%</td>
<td>48%</td>
</tr>
<tr>
<td>H1 2022</td>
<td>12%</td>
<td>48%</td>
<td>8%</td>
</tr>
<tr>
<td>H2 2022</td>
<td>8%</td>
<td>8%</td>
<td>92%*</td>
</tr>
<tr>
<td>H1 2023*</td>
<td>100%</td>
<td>8%</td>
<td>92%*</td>
</tr>
</tbody>
</table>

* at 24/02/2023. Based on current orderbook: does not include vessels ordered since 2020 and delivered.

https://splash247.com/methanol-boxship-orders-growing-more-rapidly-than-all-other-fuel-types/
Methanol Dual-Fuel Orderbook

Methanol fuelled newbuilding update
(Source: Clarkson, June 2023)

Clarksons forecasts suggest a significant climb in methanol capable and methanol ready orders. In 2022, methanol accounted for 3% of the orderbook (7% by GT). By 2030 this could be close to 20%, representing up to 1,000 vessels.

Methanol ready orderbook by sector

Methanol capable orderbook by sector

FUEL FOR THOUGHT: Methanol
Leading by Example - Tankers

- In 2016, Methanex subsidiary Waterfront Shipping launched first methanol dual-fuel 50,000-DWT chemical tanker, the Cajun Sun

- WFS now has 18 methanol dual-fuel vessels in its fleet, with over 140,000 hours of operating hours

- In December 2022, Proman Stena Bulk took delivery of its fourth methanol-fueled tanker, and has two more methanol vessels on the way

- In February 2023, the dual-fuel vessel Cajun Sun, operated by WFS and chartered from MOL, completed the first-ever net-zero voyage fuelled by bio-methanol. By blending ISCC-certified bio-methanol that has negative carbon intensity with natural gas-based methanol, net-zero greenhouse gas emissions on a lifecycle basis were achieved for the 18-day trans-Atlantic voyage. This innovative fuel solution, produced at our ISCC-certified plant in Geismar, offers shipping companies the ability to achieve net-zero carbon emissions today, supporting the industry’s transition to a low-carbon future.

Methanol Fuelled Vessels on the Water and on the Way

To learn more about each project, click on the project title.

**China (March 2023)**
COSCO has placed orders for four 16,000 teu methanol-fueled ships at its affiliated yard in Yangzhou for an undisclosed price basis delivery in the second half of 2023.

**Singapore (March 2023)**
Singapore’s Consort Bunkers has signed a contract with China Merchants Industry Holdings (CMIH) Jinding for a series of six 6,500-duty methanol-fuels new buildings, to be delivered in 2025.

**Denmark (March 2023)**
Fischer & Wiesmann has signed a letter of intent with Tsuneishi Shipbuilding, for the construction of at least two methanol dual-fuel 85,200 DWT Kamsarmax bulk carriers. The vessels have been ordered in partnership with Cargill, which will operate the vessels for a period of at least seven years.

**China (March 2023)**
China State Shipbuilding Corporation has signed a cooperation agreement with France’s CMA CGM Group to produce 16 large methanol dual-fuel container vessels worth more than 21 billion yuan (about 3 billion U.S. dollars).
Since 2016, MAN has received orders for 110 large, two-stroke methanol engines, with 24 already in operation in chemical tankers operated by MI members. Another 100+ engine orders on the way!!!
The world’s first methanol-fueled towboat is set to join the fleet of Metairie, La., based Maritime Partners LLC and become available for charter in 2023 to meet the pressing demand for sustainable towboat operations.

The vessel, the M/V Hydrogen One, will be IMO 2030 compliant, meet the USCG’s Subchapter M requirements, and have an operational range of 550 miles before refueling. It is being developed by Maritime Partners in cooperation with Elliott Bay Design Group, e1 Marine, and ABB.

Decarbonizing the towboat sector poses substantial challenges, particularly due to towboats’ inherent size, space, and weight limitations. Batteries are only suitable for boats that operate on fixed routes and can recharge daily, and a towboat’s limited storage capacity restricts the use of pressurized or cryogenically stored gases as fuels. There are also very few dockside facilities to load such marine fuels, which severely constrains a vessel’s range and functionality.

The ship has been designed by Elliott Bay Design Group using proven, efficient technology throughout, from ABB’s electrical power distribution and automation to e1 Marine’s methanol-to-hydrogen fuel cell.
CoMeBust – Methanol Pilot

CoMeBust-Me
CONVERSION METHODS FOR COMBUSTION OF METHANOL

PROJECT PARTNERS
ScandiNAOS AB
- To provide ship design
- To provide Dual-fuel kits

Sjöfartsverket
- Ship owner & operator
- To convert the ship to methanol operation

Chalmers
- To employ one Post doc. Dedicated for applied dual fuel research

Swedish Energy Agency
- To cover 50% of project costs

Industry partner (Methanol institute and Proman AG)
- To fund the project with approx. €200,000 cash.

TOTAL Project budget 8.6MSEK = €850,000

PROJECT MAIN TASKS

Engine conversion
- ScandiNAOS: Dual fuel kit 50-85% Diesel replacement
- Suitable engine for Sjöfartsverket
- Kit is Generic for any diesel engine 200-1000kW
- IMO Tier III (Emission approval)

Ship conversion
- Tanks
- Ventilation
- Safety system

Research
- Chalmers university to employ one dedicated post doc researched supporting methanol engine development

Methods to Reach High Diesel Displacement
- Cooler combustion air
- EGR
- De-rate
- Lower compression ratio
Technology Readiness

Figure 3.3

Estimated maturation timelines for energy converters, onboard CCS technologies, and corresponding safety regulations for onboard use

- **Methanol**
  - 2-stroke engine
  - 4-stroke engine
  - Boiler
  - Fuel cell
  - Regulations for onboard use

- **Ammonia**
  - 2-stroke engine
  - 4-stroke engine
  - Boiler
  - Fuel cell
  - Regulations for onboard use

- **Hydrogen**
  - 4-stroke engine
  - Fuel cell
  - Regulations for onboard use

- **CCS**
  - CCS technology
  - Regulations for onboard use

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Available and Affordable

Friday 26 May

*S&P Methanol*

Rotterdam Methanol = $290/tonne

Ship and Bunker

Rotterdam VLSFO = $534/tonne

Rotterdam MGO = $675/tonne
Easily Bunkered

Methanol Bunker Vessel Planned for Northern Europe

Global Energy Group orders first methanol bunkering tanker for Singapore

First dual-fuel methanol bunker barge headed for Rotterdam

www.methanol.org/join-us
Bunker & Safe Handling Guidelines

- Bunker guidelines have been released by International Association of Ports and Harbors, Lloyd's Register and EU CEN

- Guidelines cover:
  - Truck-to-Ship bunkering
  - Shore-to-Ship bunkering
  - Ship-to-Ship bunkering

- Additional guidelines being developed by leading ports including Port of Rotterdam and Port of Singapore

- FASTWATER.eu project has released report on methanol supply, bunkering and infrastructure

Marine Spills Still Happen….

Methanol [5] 15,400 mg/l
- Methanol is a more environmentally-benign fuel in marine environments
- In a waterbody, nearly 200 times more methanol is needed to kill half the number of fish than marine heavy fuel oil

LC 50: Lethal Dose: Fish

<table>
<thead>
<tr>
<th>Fuel</th>
<th>LC 50 mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>8.2</td>
</tr>
<tr>
<td>Methane</td>
<td>49.9</td>
</tr>
<tr>
<td>Diesel</td>
<td>65</td>
</tr>
<tr>
<td>Heavy Fuel Oil</td>
<td>79</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.068</td>
</tr>
</tbody>
</table>

Sources:
[1] Petrobras/StatOil ASA, Safety Data Sheet, ECHA registration dossier Gasoline
[4] GKG/ A/S Dansk Shell, Safety Data Sheet
Crew Training

GREEN MARINE

• Denmark-based company has finalized a specialist training programme for crews onboard methanol dual-fuel vessels, supplementing baseline regulatory training requirements with practical, experience-based learning.

• The crew training programme was created based on practical knowledge gathered over a decade of experience working on Methanol dual fuel vessels with services from design consultancy to newbuilding construction supervision, technical management and operations.

• The curriculum, which can be delivered onboard, in a classroom or online, was developed to address the knowledge gaps between theoretical regulation and practical experience in the use of Methanol as marine fuel. GREEN MARINE is able to supplement regulatory baselines with real life experiences based on operational experience, emergency troubleshooting and the application of historical data.

“Our methanol specialists are captains and chief engineers with first-hand knowledge of working with Methanol as a fuel and how to ensure these dual fuel ships operate safely,” said Morten Jacobsen, CEO of GREEN MARINE. “Theoretical knowledge is little use in real life situations when you need to know what to do; we bridge that gap and provide practical knowledge to support crews in adopting this methanol dual fuel technology.”

THOME GROUP

• Working with Thome Group Singapore/Philippines/India, where they maintain their largest hubs in Asia, a methanol crew training platform is being created as senior trainers, classroom and onsite facilities are available as well as appropriate government networks for certification.

• Thome has already started on this work and have the basic SOLAS/IGF/STCE requirement for the Basic and Advanced IGF trainings already in hand. So, the task Thome completed is to make it methanol specific.

• Two pilots successfully completed by March and now looking at a ‘train the trainer’ approach with quite a bit of external demand already.

IBIA

• IBIA hosts a series of paid bunkering course work offered on-line and in-person with methanol now being addressed.

• IBIA is currently compiling comprehensive knowledge for certified course planning through dedicated working groups (MI is represented in the methanol working group).

• Planning to produce a course module on methanol.

GREEN MARINE

• Planning to produce a course module on methanol.

GREEN MARINE
June 2022: Together in Safety, a non-regulatory shipping industry consortium initiated the “Future Fuels Risk Assessment,” a cross-industry study to evaluate the potential operational risks of LNG, methanol, hydrogen and ammonia.

The study, which involved a series of hazard identifications (HAZID) workshops across a set of operational scenarios, found of the four fuels reviewed, methanol poses the least overall risk, followed by LNG, hydrogen and ammonia.

Methanol scored the lowest risk ratings within navigation-related scenarios, as well as in scenarios related to ship operations.

Methanol also scored the lowest risk ranking in the external event scenario of hull breach from ship collision.

The study identified some ‘intolerable’ risks associated with ammonia that need to be resolved before it can be used at scale as a bunker fuel.

Bud Darr, Executive Vice President, Maritime Policy, MSC Group: “Without the safety issues being thoroughly identified and properly addressed, we will not reach the end state we need. Safety and net zero GHG operations must go hand-in-hand in a world powered by future fuels at sea.”

https://togetherinsafety.info
Methanol Supply
Essential Methanol

Source: S&P Commodity Insights

- Formaldehyde
- Acetic acid
- MMA
- Others
- MTBE/TAME
- Biodiesel
- Fuel applications
- DME
- MTO

Million metric on

- 2018
- 2019
- 2020
- 2021
- 2022 (exp)
- 2023 (exp)

85 mn tons
Low Carbon and Net Carbon-Neutral

E-Methanol
- Feedstocks: green hydrogen and captured CO₂
  - Green hydrogen produced from the electrolysis of water with renewable energy (e.g. solar, wind, geothermal etc.)
  - CO₂ from industrial flue gas (e.g. steel, cement, ethanol), biogenic sources, or direct air capture
- E-methanol is a very-low to net carbon-neutral fuel

Bio-methanol
- Feedstocks: Municipal Solid Waste (MSW), Agricultural Waste, Black Liquor, Bio-Methane from wastewater treatment, landfills, or animal husbandry
- Feedstocks can be gasified or anaerobically digested to produce syngas used in methanol production
- Avoided emissions from landfills, incinerators, or dairy farms potentially allow bio-methanol to be a net carbon-negative fuel
Renewable Methanol

www.methanol.org/renewable/

Figure 47. Current and future methanol production by source

Notes: NOK = methanol. Costs do not incorporate any carbon credit that might be available. Current fossil methanol cost and price are from coal and natural gas feedstock in 2020. Exchange rate used in this figure is USD 1 = EUR 0.9.
“With 80 renewable methanol projects already announced, we are seeing clear signs of an incoming wave of bio-methanol and e-methanol production”

Gregory Dolan, CEO, Methanol Institute

Increasing Scale – Bigger Players

- Increasing scale: To date, e-methanol and biomethanol plants have been in range of 4,000-10,000 tons/year, and we are now seeing announced plants with planned capacity of 50,000, 100,000, 250,000 tons/year

- Expanding from project developers like Carbon Recycling International, Enerkem, Liquid Wind and Gidara, we are seeing major utilities like European Energy, Orsted, Iberdola, SunGas Renewables, and Engie

- We are also seeing interest in methanol from oil/gas majors including new MI members Aramco, BP, ENI/Ecofuel, TotalEngines as well as Chevron, ExxonMobil, and Sinopec
Carbon Intensity Accounting

• In January, MI released a report from Amsterdam-based consulting firm studio Gear Up on “Carbon Footprint of Methanol”

• Depending on feedstock and production process methanol’s carbon footprint can be reduced by 65-90% 

• In May, International Methanol Producers and Consumers Association working with sGU released a “backpack” calculator can help determine the carbon footprint of methanol depending on feedstock, conversion technologies, and the fate as either fuel or chemical

• **Call to Action:** MI and IMPCA working together assist the methanol industry in developing a common platform for carbon intensity accounting