



METHANOL INSTITUTE

Singapore | Washington | Brussels | Beijing | Delhi

Methanol on the Water

Gregory Dolan, CEO

October 2022



MI History

- 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



Members



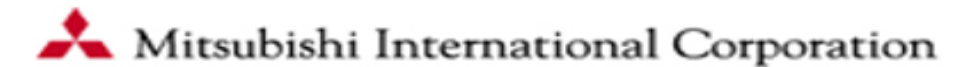
Tier 1



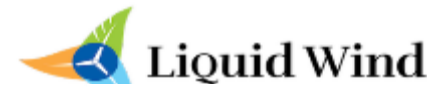
Tier 2



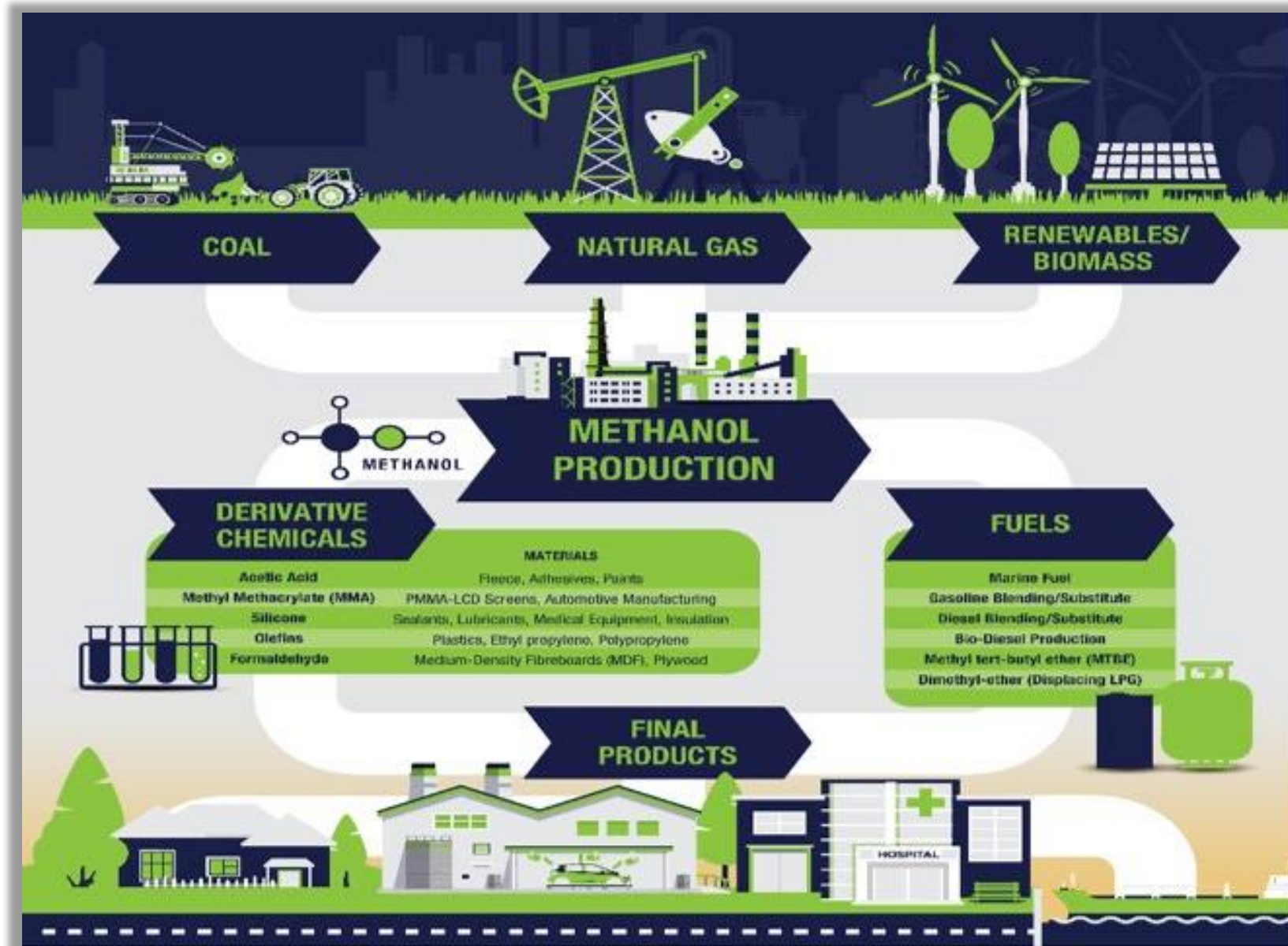
Tier 3



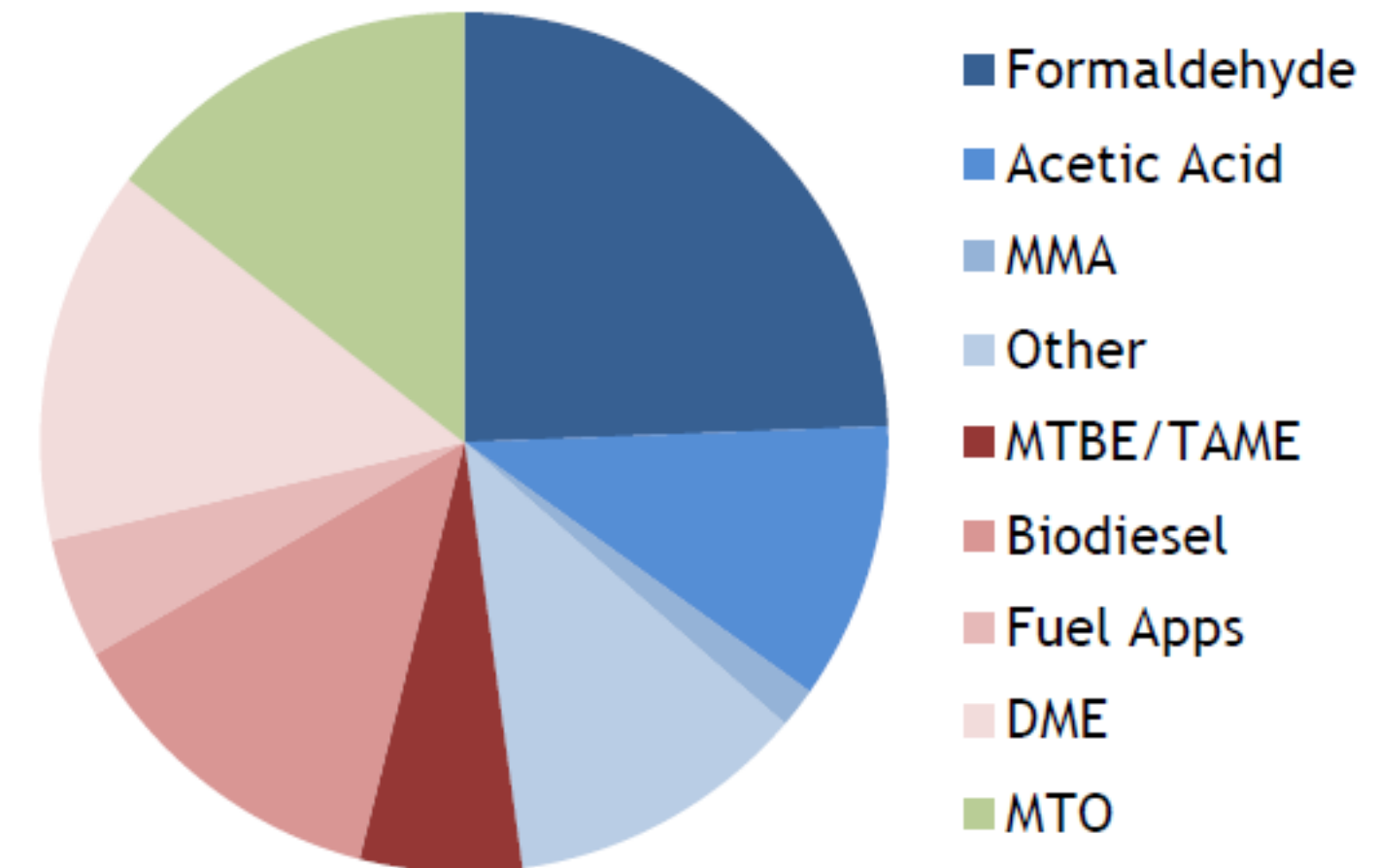
Tier 4



Essential Methanol



2022 ~ 92.5 mn t

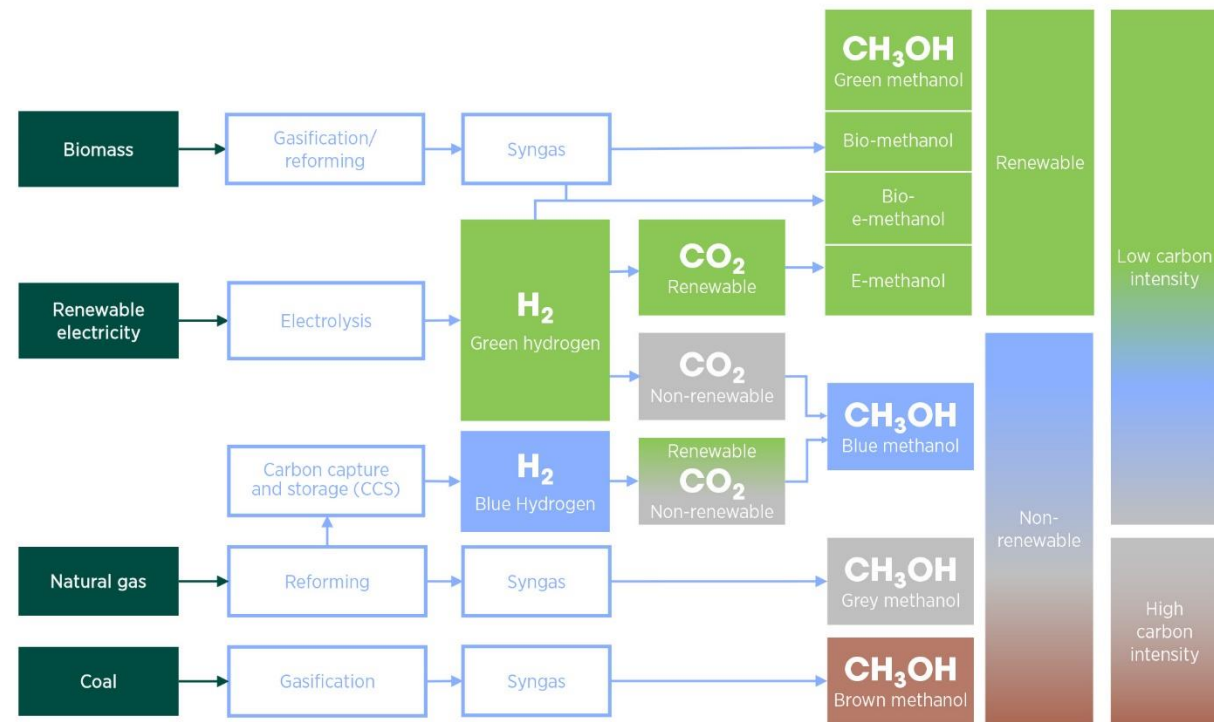


Excludes China's captive CTO sector



2018 83.1 mn t
2019 89.6 mn t
2020 87.7 mn t
2021 88.3 mn t
2023 95.8 mn t

Figure 2. Principal methanol production routes



Renewable CO₂: from bio-origin and through direct air capture (DAC)

Non-renewable CO₂: from fossil origin, industry

While there is not a standard colour code for the different types of methanol production processes; this illustration of various types of methanol according to feedstock and energy sources is an initial proposition that is meant to be a basis for further discussion with stakeholders



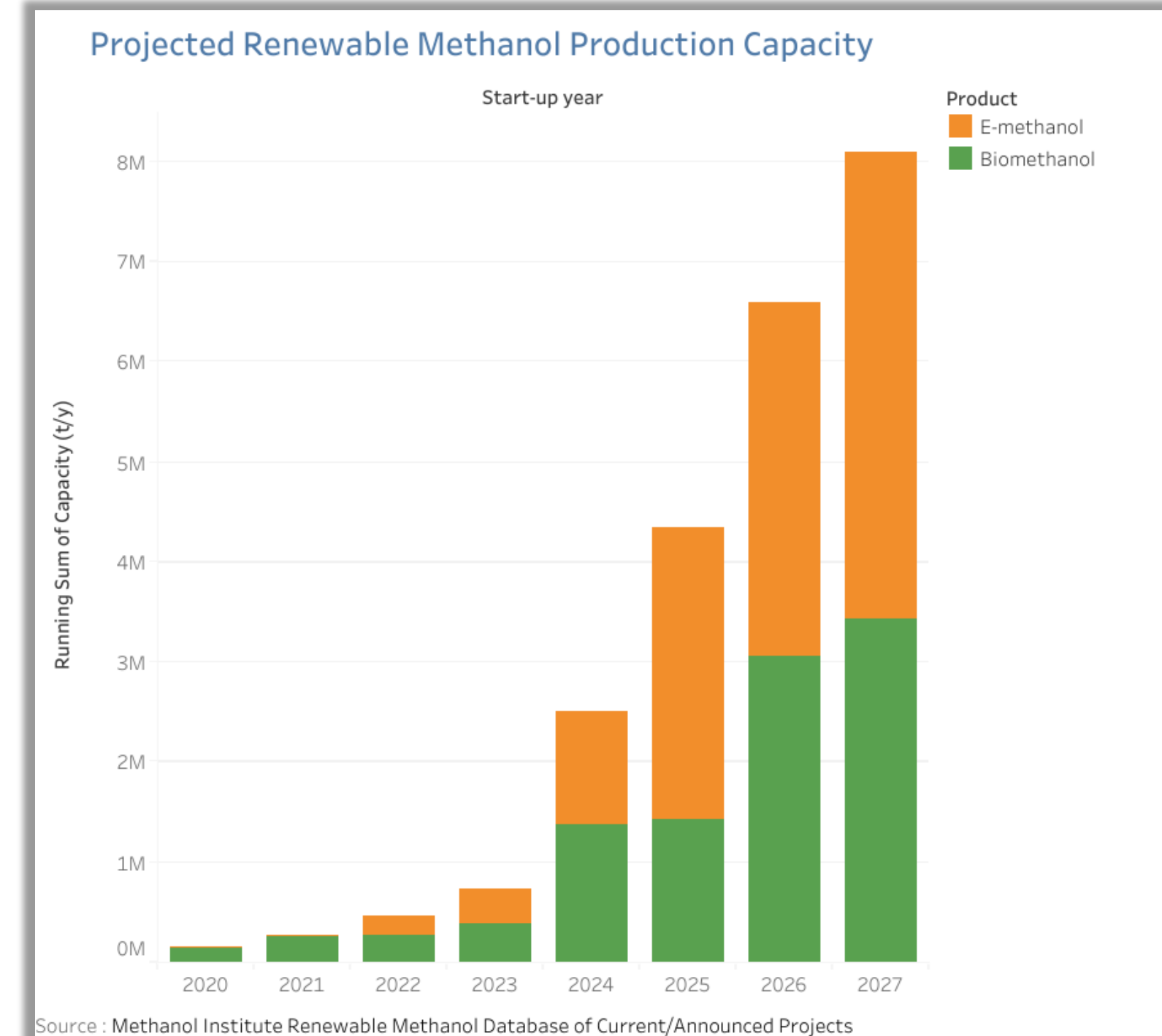
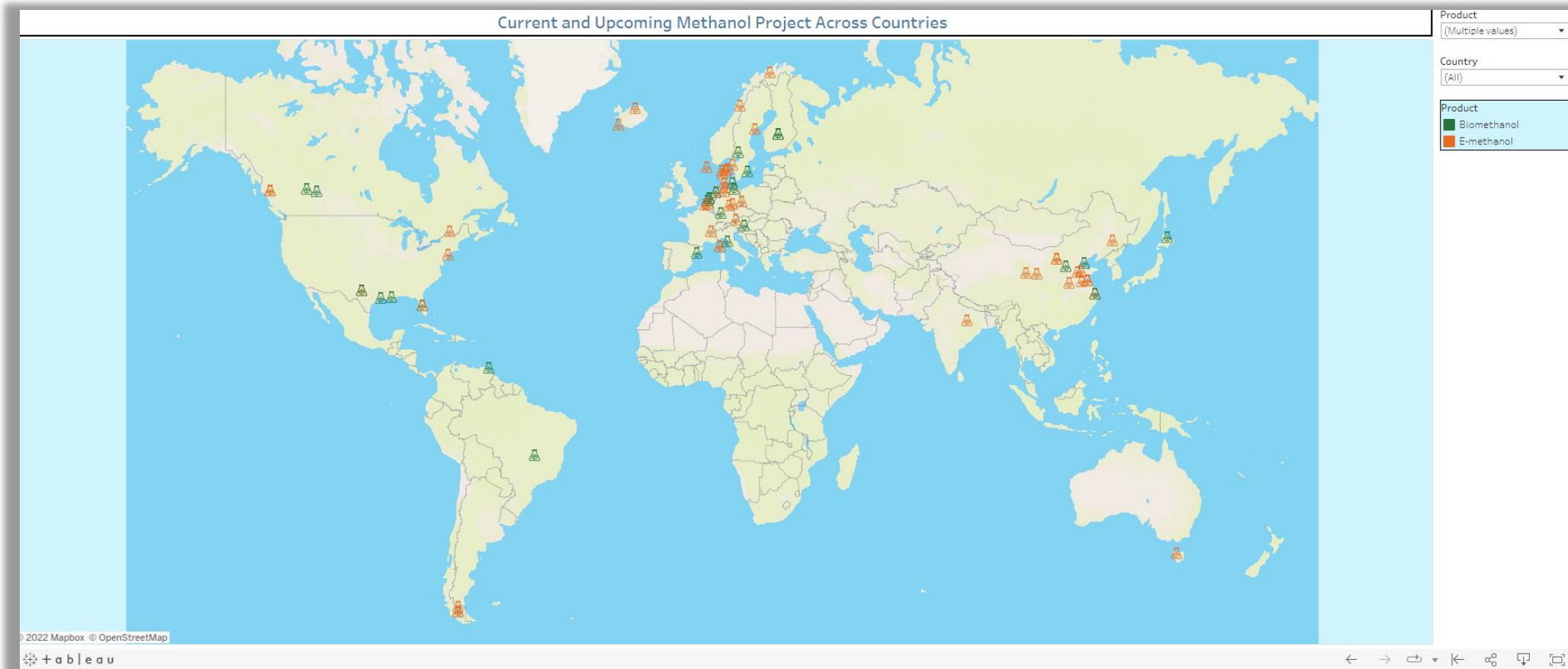
E-Methanol

- 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 Database

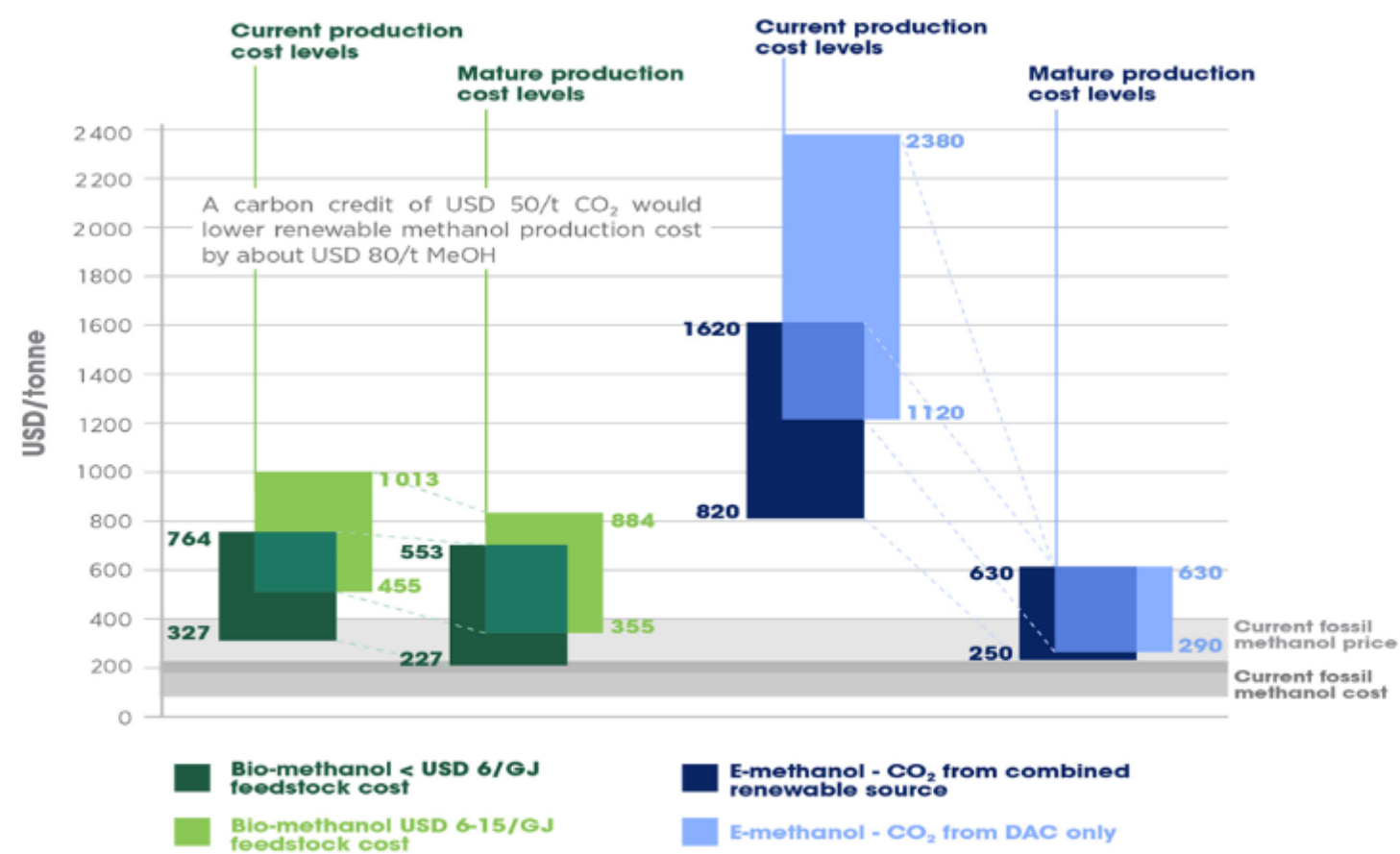


www.methanol.org/renewable/



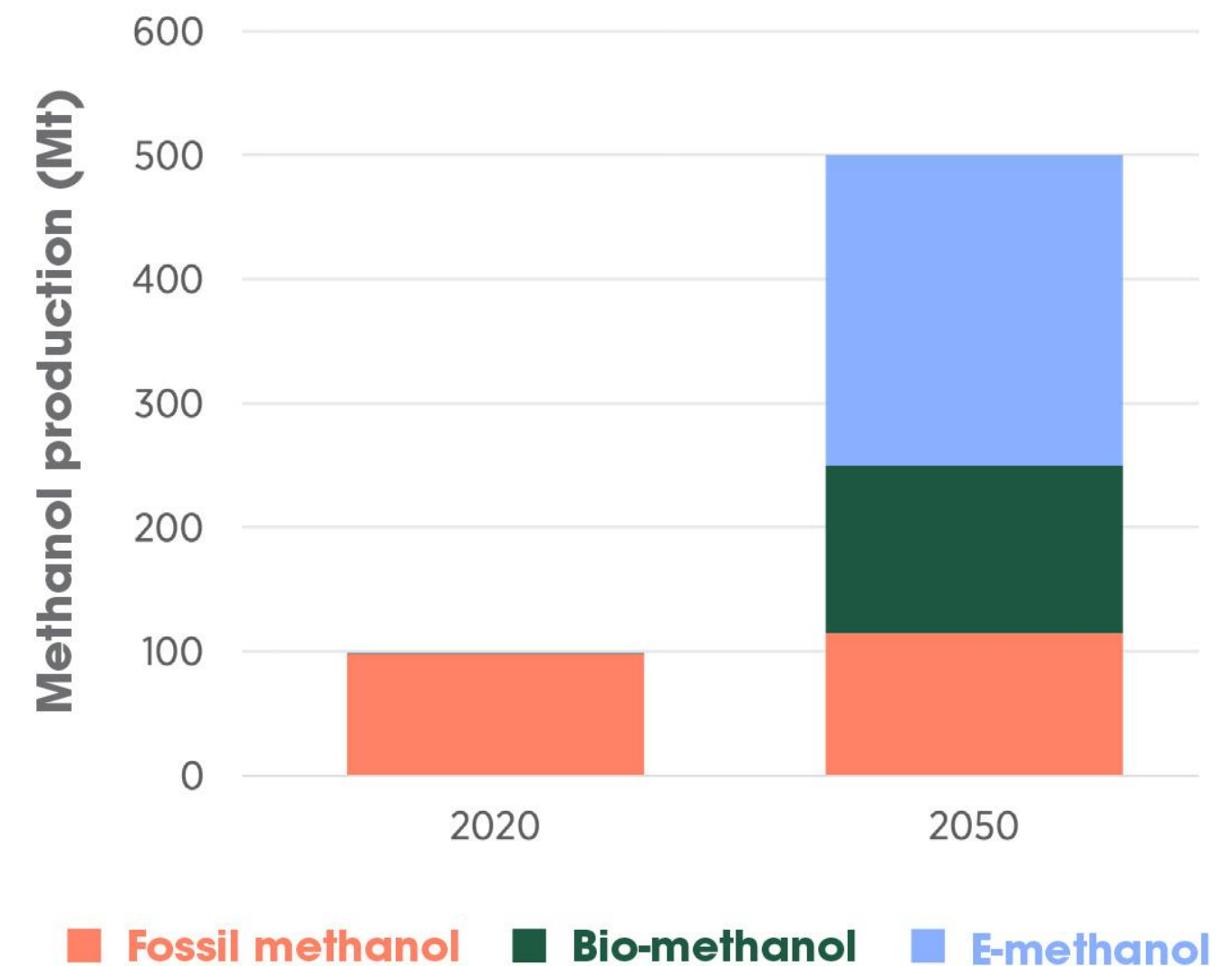
www.methanol.org/renewable/

Figure 3. Current and future production costs of bio- and e-methanol



Notes: MeOH = 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.

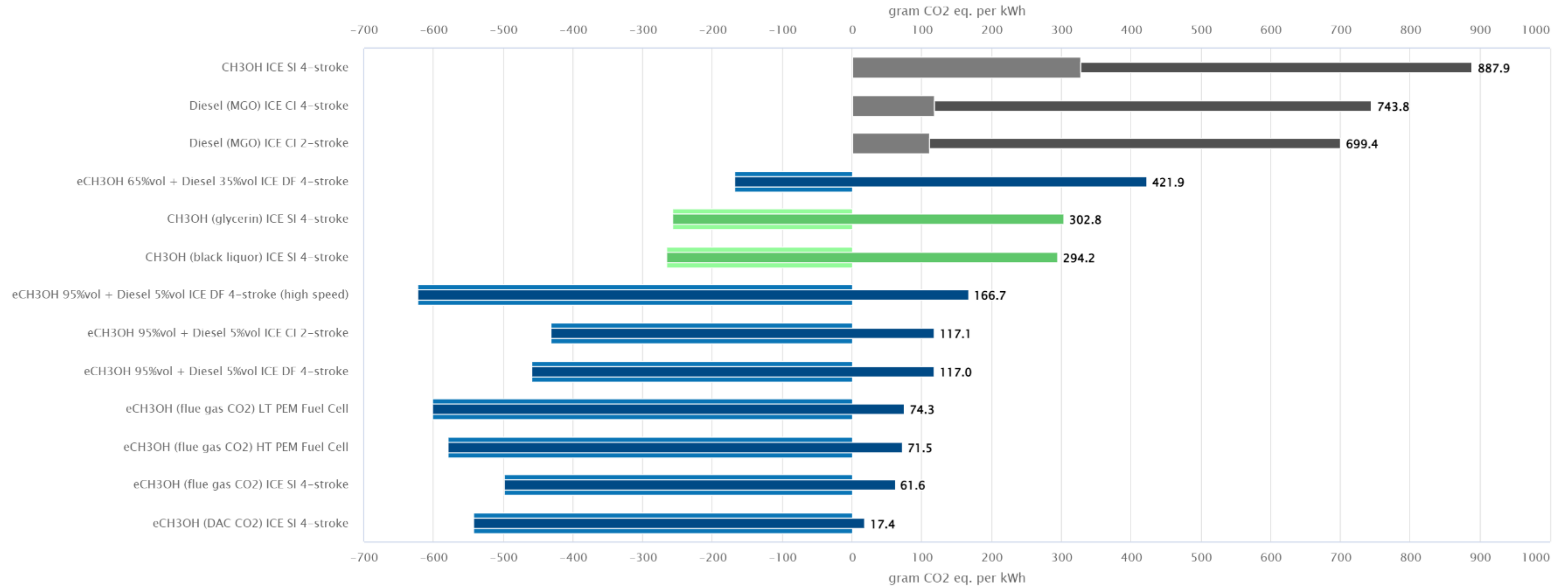
Figure 47. Current and future methanol production by source



Significant CO2 Reduction Potential

GWP 20 – WTW (WWT+TTW)

Emissions (Global warming potentials) for stacks



<https://sustainablepower.application.marin.nl/well-to-wake>

Improving Local Air Quality

Emission reduction potential:

SO_x

PM

NO_x

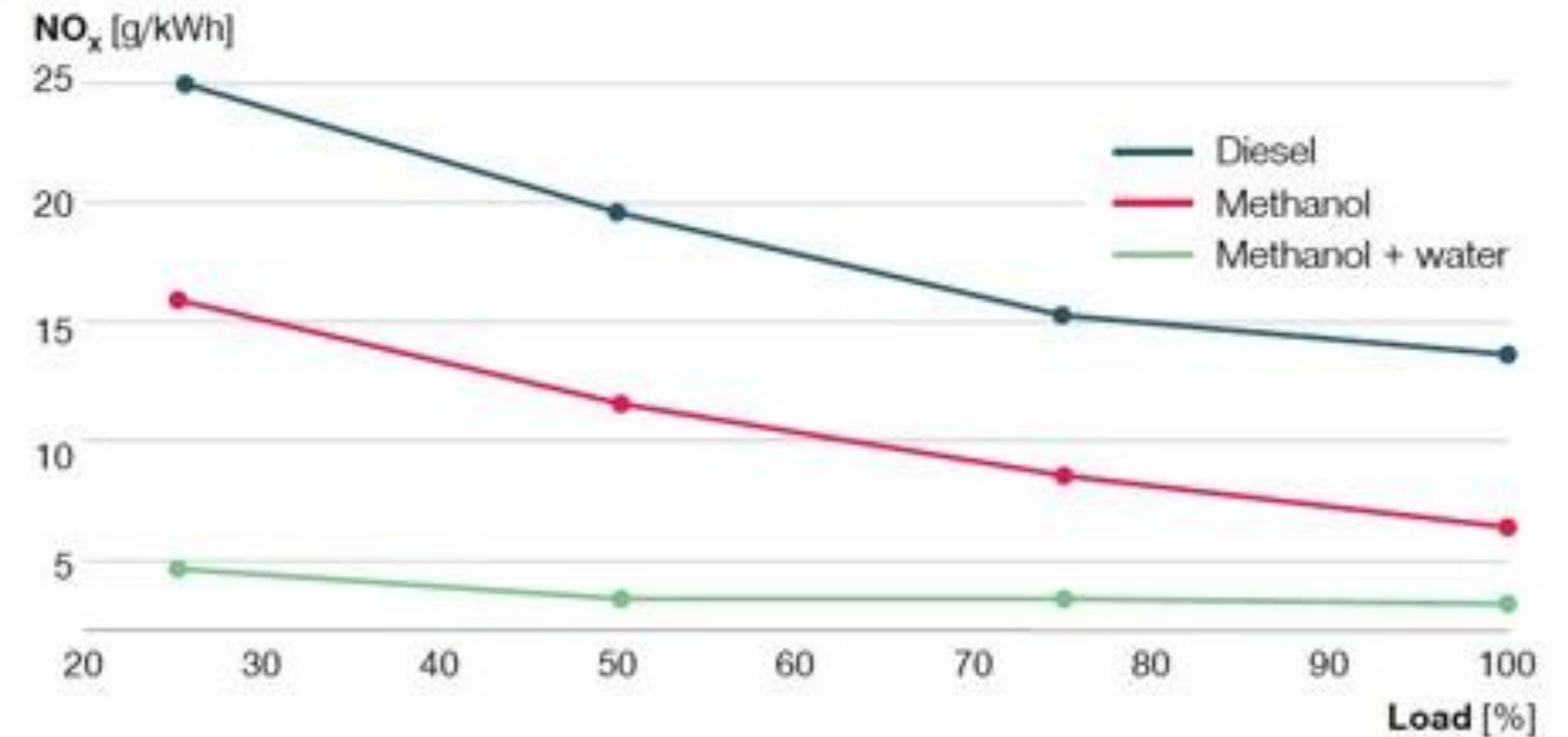
>99%

source: Stena Line

>95%

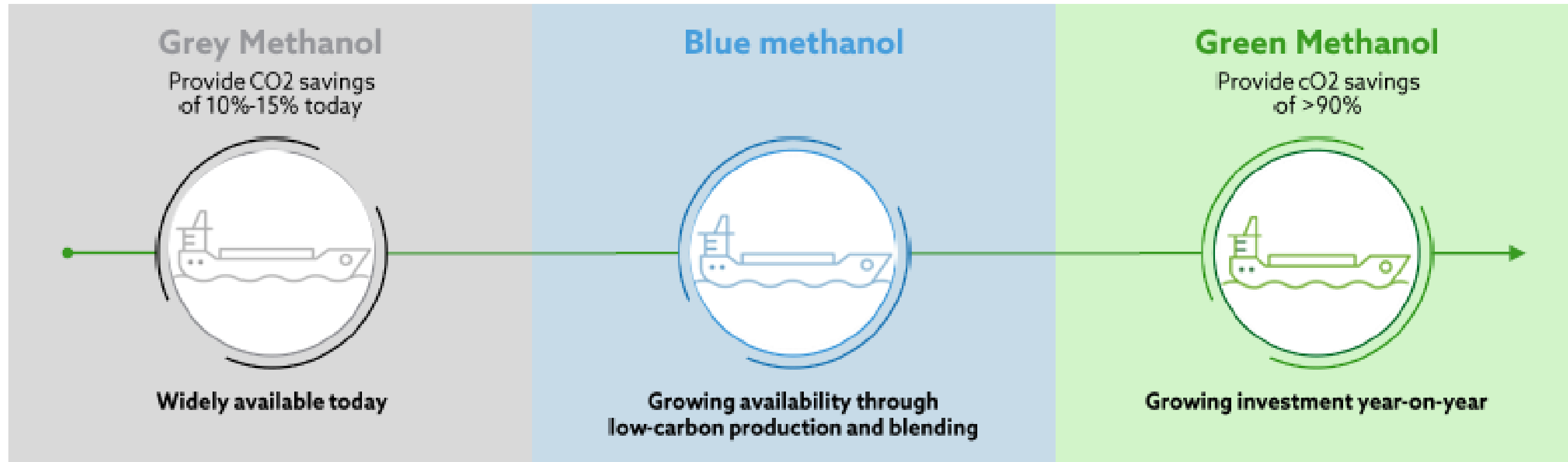
source: Stena Line

>80%

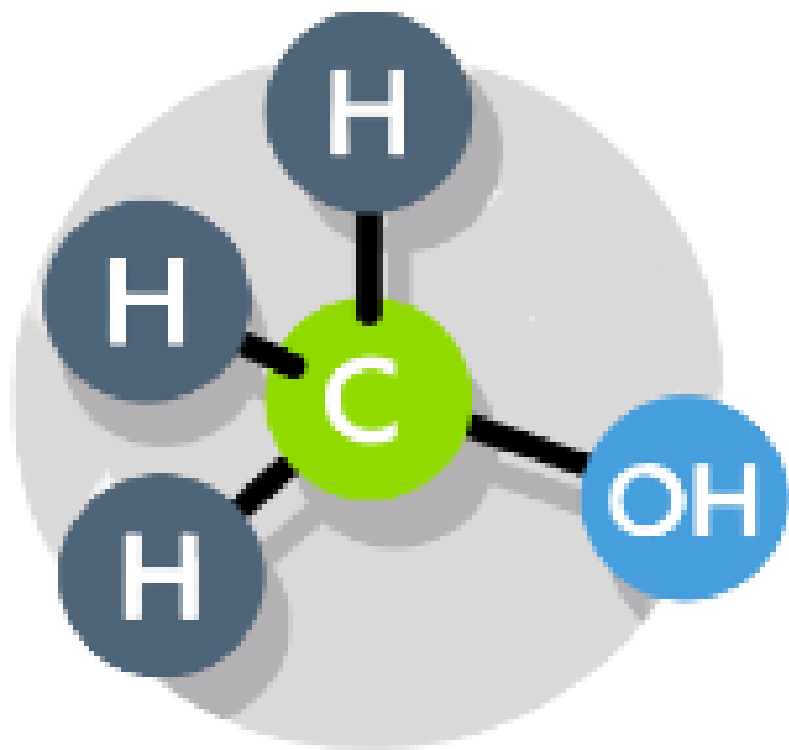


source: MAN ES

The Methanol Molecule



PRO
MAN



- Methanol molecule is the same energy and chemical characteristics no matter how it is produced
- Completely fungible from grey to blue to green facilitating blending with reduced carbon intensity as low carbon and net carbon-neutral supply grows
- Methanol runs well in existing engines with few modifications and significantly lower CAPEX when compared with other available alternative fuels



Methanol Making Headlines



Maersk spends \$1.4 billion on ships that can run on 'carbon neutral' methanol

PUBLISHED THU, AUG 24 2021 11:53 AM EDT

Amber Ewing

KEY POINTS

- Maersk says vessels will be built by South Korea's Hyundai Heavy Industries and have capacity to carry around 10,000 containers.
- According to the International Energy Agency, in 2019 international shipping was

OCI signs MoUs to develop ammonia and methanol as shipping fuels

Author: Richard Ewing

2021/03/05

IMO guidelines on use of methanol as a marine fuel to boost demand



MSC explores Methanol fuel

Mediterranean Shipping Company (MSC) and the German drybulk shipowner Oldendorff Carriers will join the Methanol Institute (MI) in order to boost decarbonization of sustainable fuels.

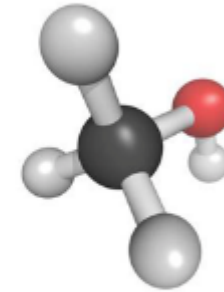
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July 20, 2021 6:09 pm



Chinese Study Examining Methanol as a Marine Fuel

July 14, 2020



© iStockphoto / Adobe Stock

The Methanol Institute (MI) has joined a study led by China Waterborne Transportation Research Institute, the think tank of the Chinese Ministry of Transport, to consider the technical and operational requirements for the use of methanol as a marine fuel. The study is supported by methanol producers and distributors Methanex and Huayou Energy Chemical Co., Ltd.

Based on the characteristics of China's industries, the study will create comprehensive policy suggestions for the use of methanol reflecting the experience already gained in methanol-fueled marine engines, and will focus on the adoption of methanol as a marine fuel.

"China is progressive in developing clean



NEWS: first barge-to-ship methanol bunkering operation in the world

11 May 2021 20:05

Waterfront Shipping takes leadership role in demonstrating simplicity of methanol bunkering to marine industry

Stena Line RoPax is world's first vessel to use recycled methanol as fuel

Written by Nick Blenkey



Maersk invests in WasteFuel to develop green bio-methanol production in the Americas and Asia

Damen introduces offshore vessel design with methanol option

by Mariska Buitendijk | Jan 27, 2020 | News | 0 comments



Maersk secures green e-methanol for the world's first container vessel operating on carbon neutral fuel

16 August 2021

Unleash Europe Decarbonisation Sustainability

Share

Meet Uthörn, the first German ship powered by methanol



Alfa Laval's development of methanol solutions reflects the full spectrum of changes on board

The marine industry has ambitious decarbonization goals, but the fuel shift required to reach them will not occur overnight. The r

Waterfront Shipping renews fleet with eight methanol dual-fuel vessels

01 Dec 2020 by Craig Jallat

Waterfront Shipping Company Ltd (WFS), a wholly owned subsidiary of

AIDAnova on track to get its methanol-operated fuel cell in 2021

VESSELS

November 13, 2020, by Jasmina

RUSSIA, JAPAN TO JOINTLY BUILD METHANOL CARRIER WITH DUAL-FUEL ENGINE

By Baird Maritime - September 9, 2021



WÄRTSILÄ TO ADD METHANOL ENGINE TO PORTFOLIO BY 2024

HOME >> NEWS >> ALTERNATIVE FUELS >> WÄRTSILÄ TO ADD METHANOL ENGINE TO PORTFOLIO BY 2024



Home - Certification - Rules for the Classification of Methanol Fuelled Ships

Rules for the Classification of Methanol Fuelled Ships.

RULES MARINE & SHIPPING

DNV GL to class new methanol-fuelled tankers

Proman Expands to Six Order for Methanol-Fueled Tankers



Milestone Order for World's Largest Methanol Dual-Fuel Engine

A.P. Møller-Mærsk specifies world's largest, dual-fuel, methanol engine, further empowering methanol as marine fuel within large-container-vessel segment

Hyundai's Ship-Building Division, HHI-SBD, has ordered 8 x MAN B&W 8G95ME-LGIM (-Liquid Gas Injection Methanol) engines in connection with the building of 8 x 16,000-teu container ships for A.P. Møller - Maersk global integrator of container logistics.

Hyundai Engine & Machinery Division, HHI-EMD, will build the engines. The order contains an option for a f

Dutch shipyards investigate sustainable fuel alternative

Dutch maritime companies, including superyacht builders, are collaborating on Green Maritime Methanol project...



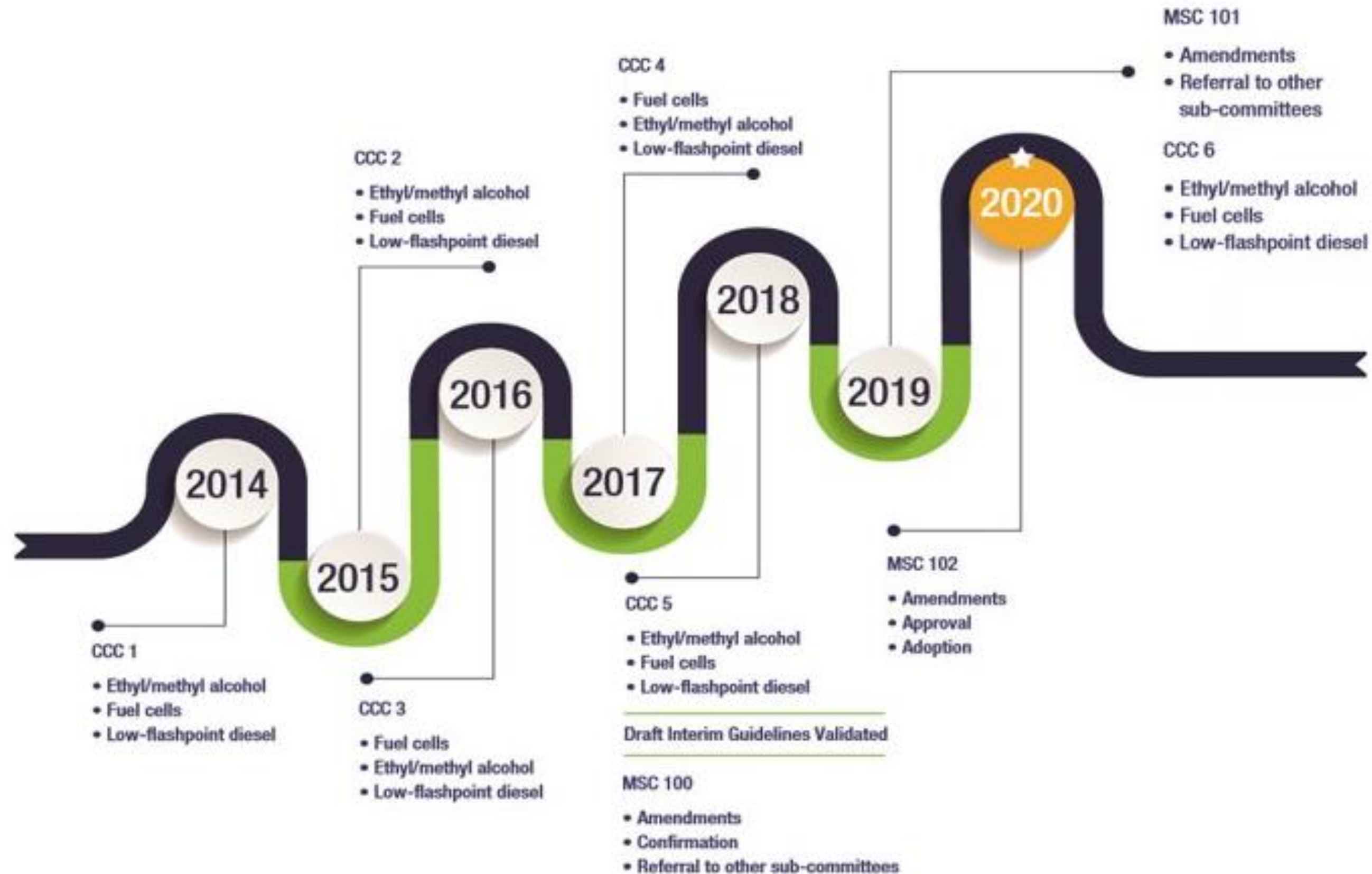
A step forward for "green" methanol and its potential to deliver deep GHG reductions in maritime shipping

Posted Wednesday, 1 September 2021, 13:47
Abigail Martin

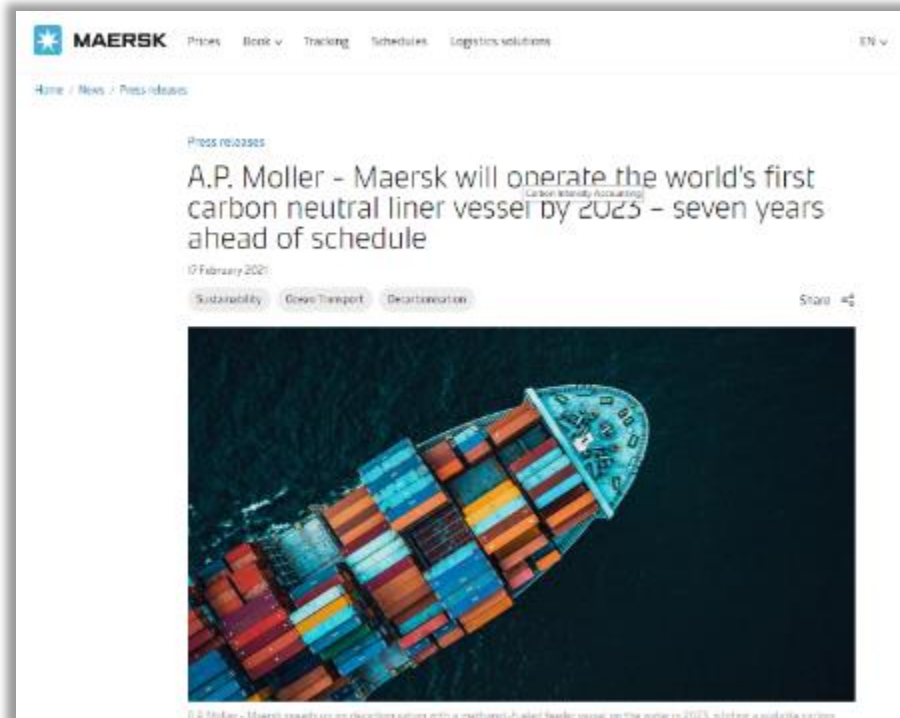
The shipping industry is under increasing pressure from regulators and consumers to cut greenhouse gas (GHG) emissions. Of note, the ICCT and A.P. Møller - Maersk's recent announcement that it



Game Changer 1: IMO IGF Code



Game Changer 2: Maersk Vessel Orders



“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



“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

- **21 Feb 2021:** Maersk announces that the world’s first carbon neutral container vessel by 2023 will operate on dual-fuel methanol
- Maersk has now ordered 2,100 TEU methanol dual-fueled feeder vessels from Korean shipyard
- **24 Aug 2021:** “Maersk accelerates fleet decarbonization with 8 large ocean-going vessels to operate on carbon neutral methanol”
- More than half of Maersk’s 200 largest customers have carbon targets for their supply chains
- 16,000 container (Twenty Foot Equivalent – TEU) vessels
- Delivery in 2024, approved option for 4 additional vessels in 2025
- \$1.4 billion order each vessel \$175 million 10-15% more expensive
- ***Each ship will require 35,000-40,000 tons of methanol annually or a total of 500,00 tons of methanol***

Game Changer 2.1: Maersk Methanol Supply



Production Capacity Estimation Table

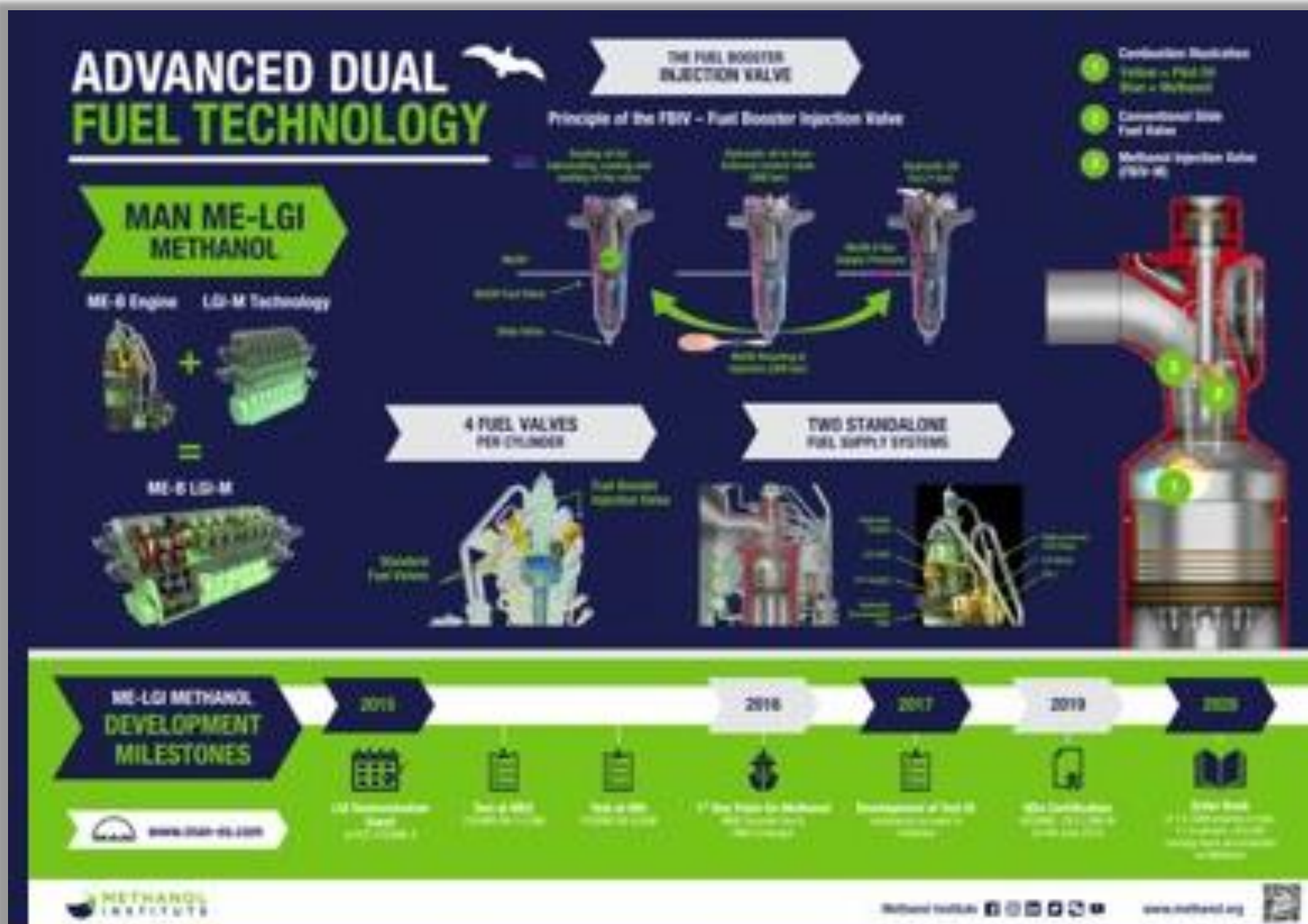
Strategic Partners	Type of fuel	Production Capacity in 2024 (end of year) tonnes/year	Production Capacity in 2025 (end of year) tonnes/year	Production capacity added after 2025 tonnes/year	Geography
CIMC ENRIC	bio-methanol	50,000	-	200,000	China
Debo	bio-methanol	200,000	-	-	-
European Energy	e-methanol	-	2-300,000	-	North & South America
GTB	bio-methanol	50,000	-	300,000	China
Orsted	e-methanol	-	300,000	-	North America
Proman	bio & e-methanol	-	100,000	-	North America
WasteFuel	bio-methanol	30,000	-	-	South America
TOTAL	-	330,000	6-700,000	500,000	-

- **10 March 2022:** Maersk announces strategic partnerships with six leading companies -- including MI members Proman and Wastefuel -- 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



<https://www.maersk.com/news/articles/2022/08/19/maersk-engages-in-green-bio-methanol-partnership-with-debo>

Engines Available and More Coming



Since 2016, MAN has received orders for 72 large, two-stroke methanol engines, with 19 already in operation in chemical tankers operated by MI members. Many more orders on the way!!!



Rolls-Royce developing mtu methanol engines to make shipping greener

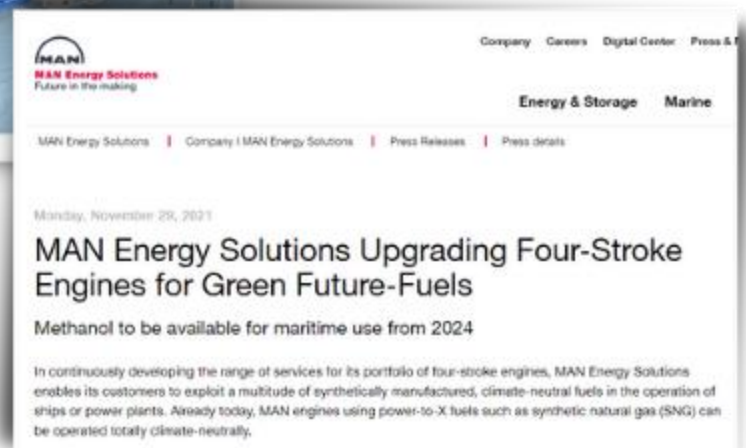
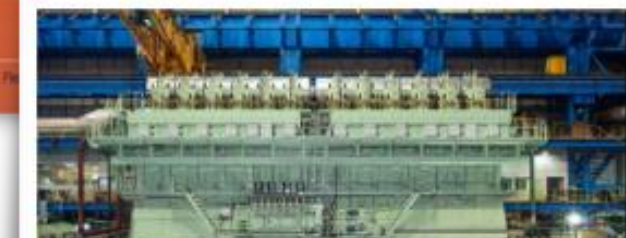
BUSINESS DEVELOPMENTS & PROJECTS

December 22, 2021, by Naida Hakreovic Prevjak

Focusing on methanol as a fuel for climate-friendly shipping, technology company Rolls-Royce aims to set standards in high-speed methanol engines.



WinGD Expects Methanol and Ammonia-Fueled Engines By 2024 and 2025



Monday, November 29, 2021

MAN Energy Solutions Upgrading Four-Stroke Engines for Green Future-Fuels

Methanol to be available for maritime use from 2024

In continuously developing the range of services for its portfolio of four-stroke engines, MAN Energy Solutions enables its customers to exploit a multitude of synthetically manufactured, climate-neutral fuels in the operation of ships or power plants. Already today, MAN engines using power-to-X fuels such as synthetic natural gas (SNG) can be operated totally climate-neutrally.



Industries Products and solutions Service and support

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2021-12-07 Product news

ABS grants Alfa Laval the marine industry's first approval in principle (AIP) for firing boilers with methanol



On the Water and On the Way



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Methanol Fuelled Vessels on the Water and on the Way

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

Sweden (2015):
One of the world's largest ropax ferries - Stena Germanica - has been operating on methanol fuel since 2015.

Canada (2016-2019):
Methanex Waterfront Shipping and their partner vessel operators - Mitsui OSK Lines, Westfal-Larsen, Marininvest, IINO, and NYK Group - began operating a fleet of 11 50,000 dwt chemical tankers with dual-fuel methanol engines.

Germany (Jul 2018):
Shipowner SAL Heavy Lift to install FUELSAVE hydrogen/methanol injection system in 6 vessels

Germany (Mar 2019):
Abeking & Rasmussen shipyard designing "green cruise" concept vessel using methanol fuel cells for hotel load and methanol propulsion engines

Netherlands (Jan 2020):
Damen Shipyards has developed a new concept Offshore Support Vessel (OSV) to operate on methanol

Germany (Jan 2020):
Shipowner Liberty One has ordered a new multipurpose (MPP) ship powered by methanol

 MI@methanol.org | www.methanol.org

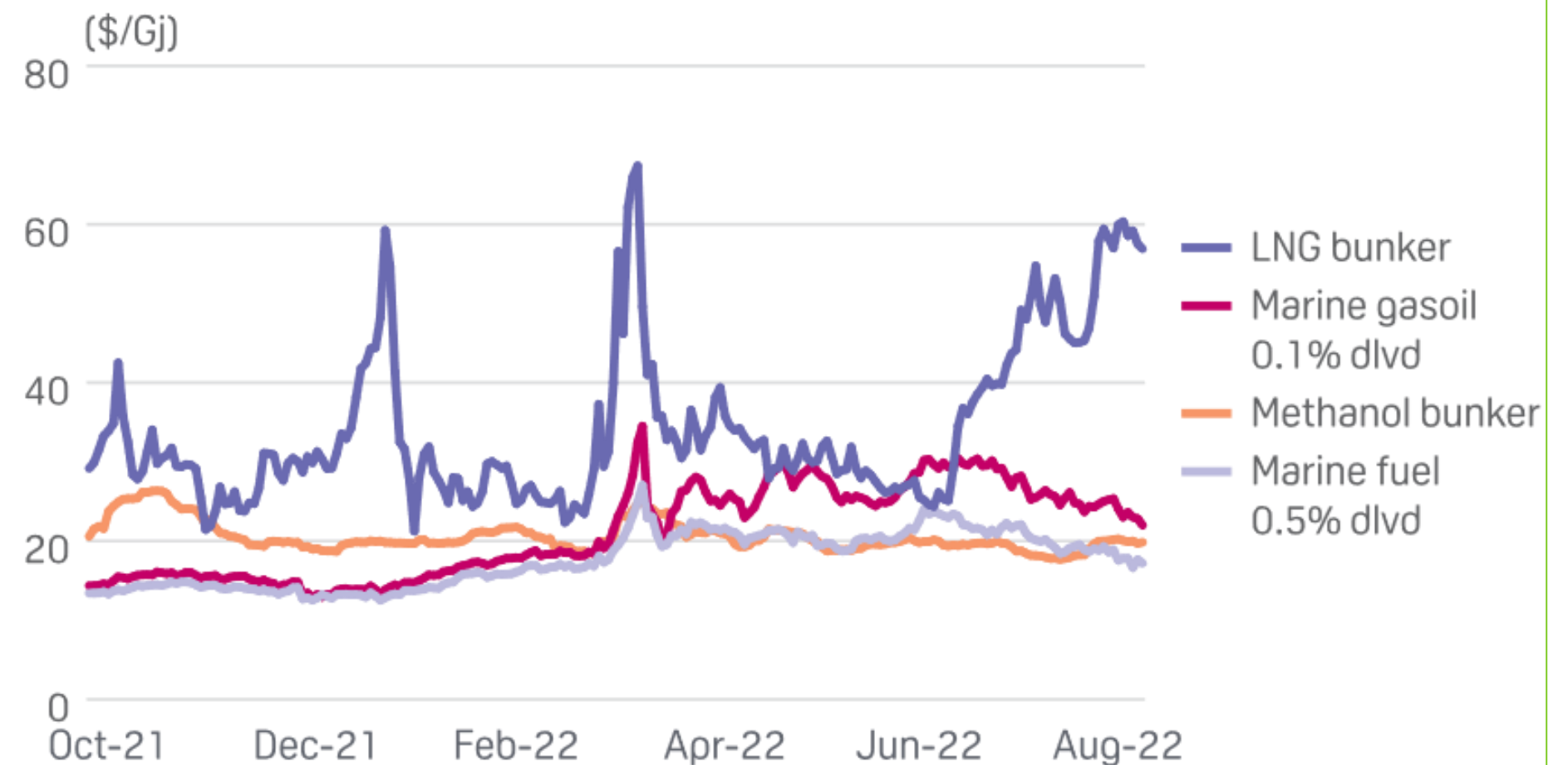
  [@MethanolToday](https://twitter.com/MethanolToday)



Available, Easily Bunkered, Affordable



BUNKER PRICE ROTTERDAM BY FUEL CALORIFIC VALUE



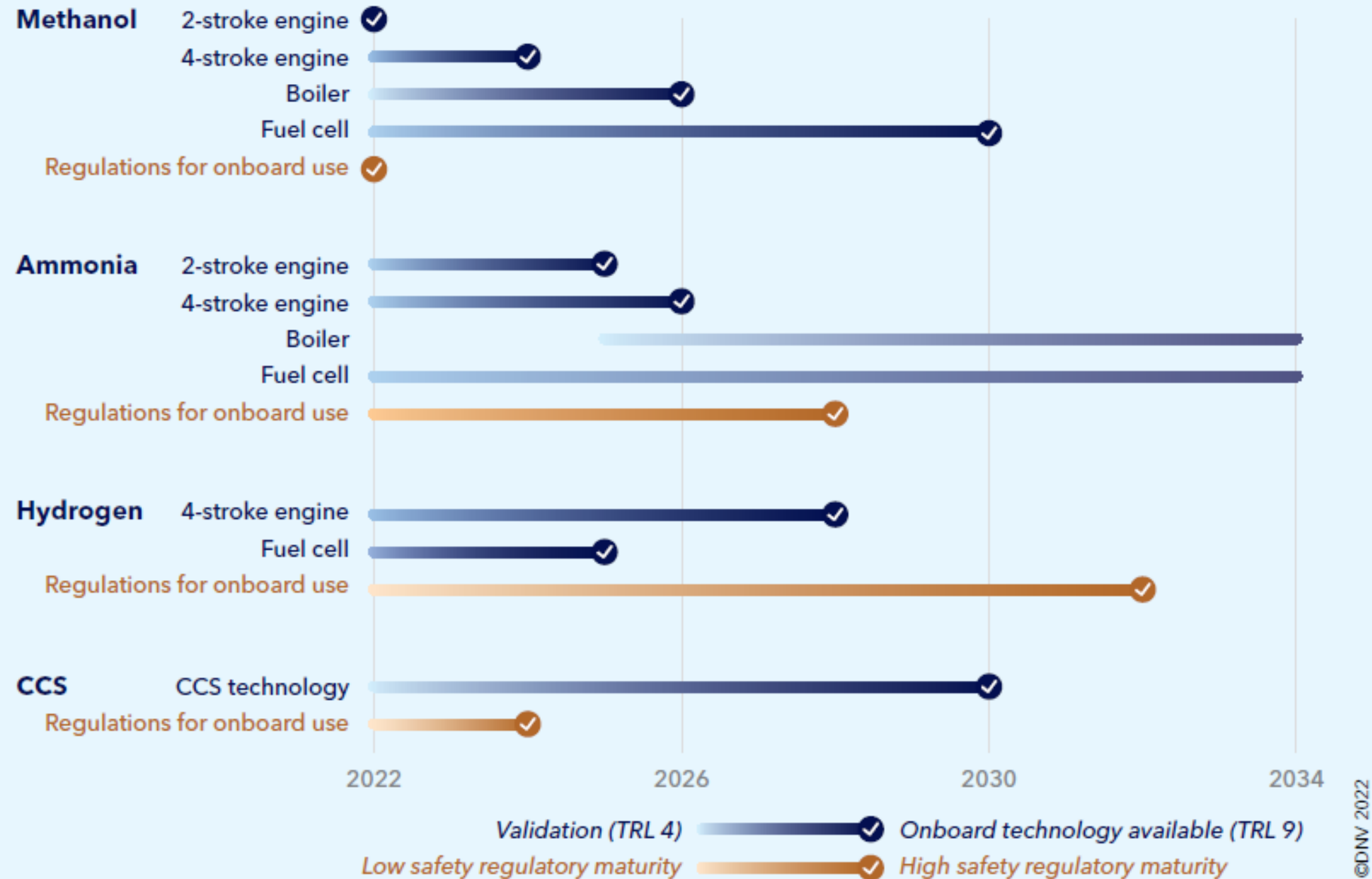
Source: S&P Global Commodity Insights



Technology Readiness

Figure 3.3

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

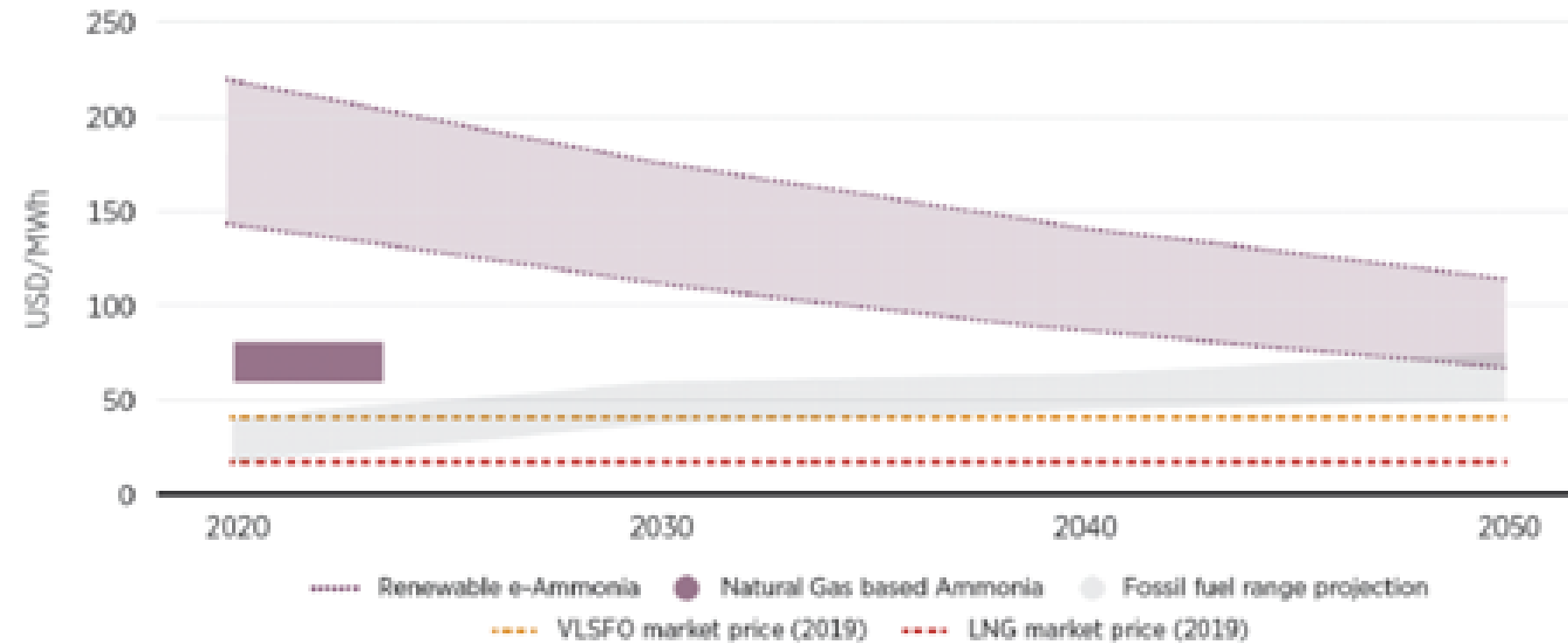


<https://www.dnv.com/maritime/publications/maritime-forecast-2022/index.html>

Projections – Methanol vs Ammonia

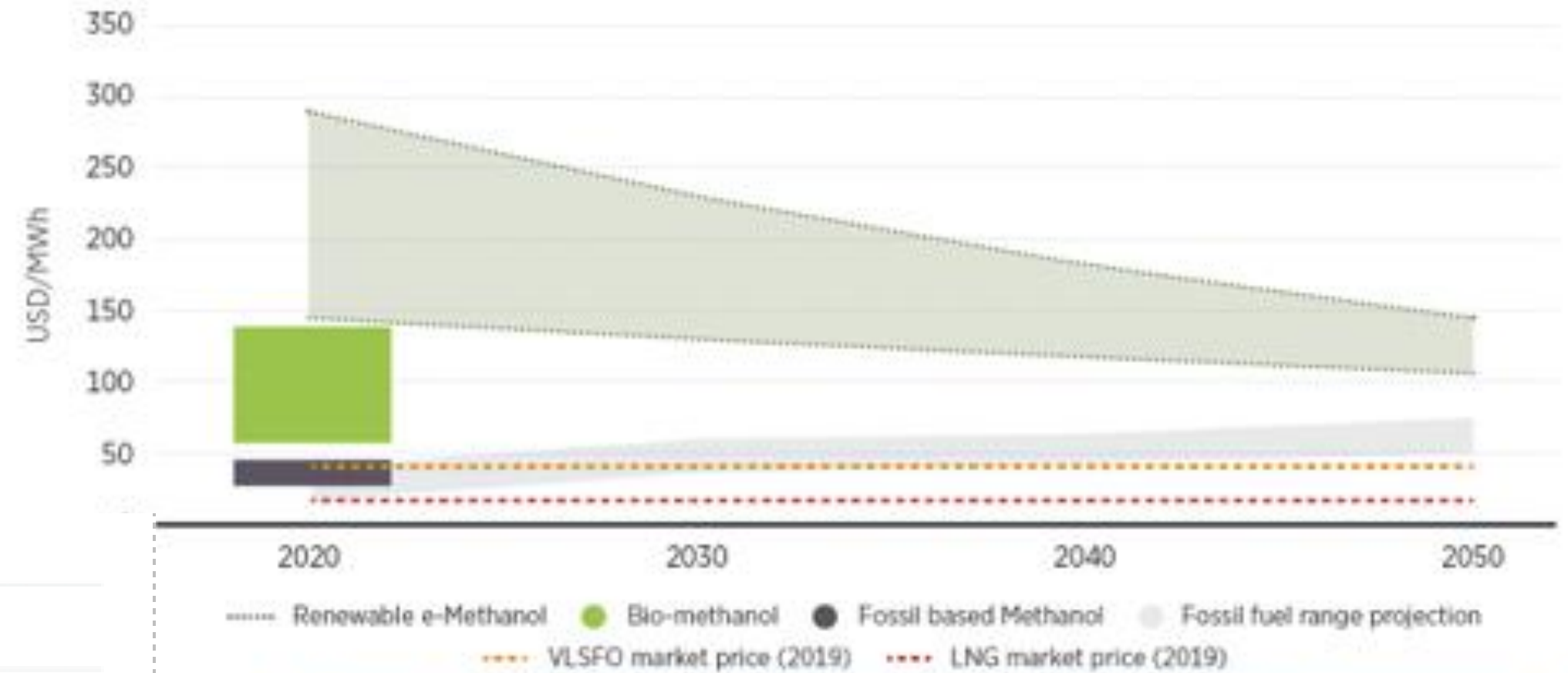
- IRENA “Decarbonise the Shipping Sector”
- Short-term, advanced biofuels play key role
- Medium and long-term e-methanol and e-ammonia more promising green hydrogen-based fuels
- By 2050, shipping uses 38 million tonnes of renewable methanol and 183 million tonnes of renewable ammonia

Ammonia cost projections



A Pathway to Decarbonise the Shipping Sector by 2050 (International Renewable Energy Agency, 2021)

Methanol cost projections



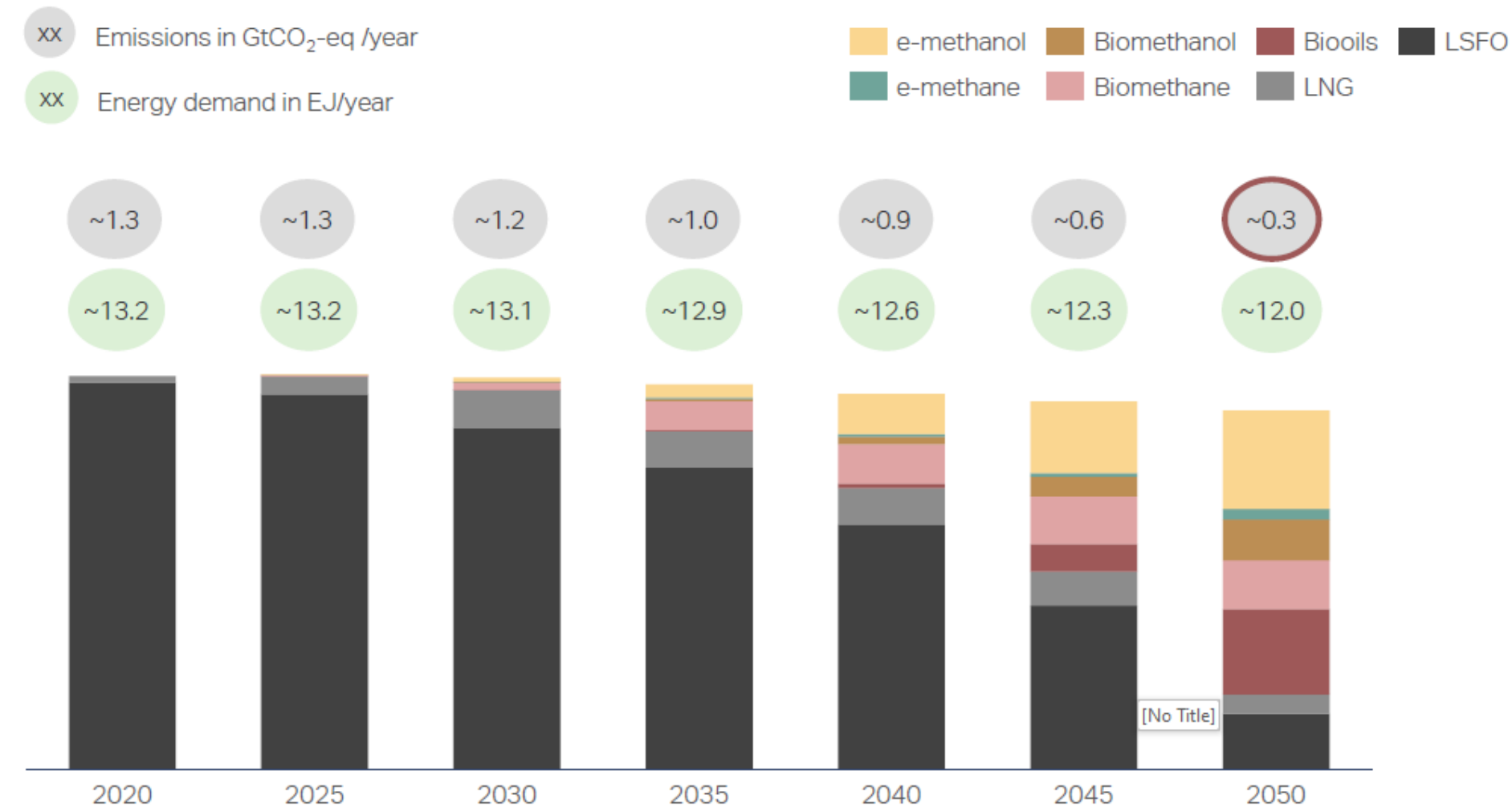
A Pathway to Decarbonise the Shipping Sector by 2050 (International Renewable Energy Agency, 2021)



What if ammonia not accepted?

Additionally, if ammonia is not accepted as a safe marine fuel, then other fuel options would drive the transition

Alternative Scenario 3: All else equal except that ammonia is not classified as a safe marine fuel



Source: NavigaTE



If ammonia does not meet the safety standards for storage, handling and operations onboard, overall maritime emissions may well increase.

This would result in a fuel composition where almost half of the fuel mix is supported by biofuels and a third by e-fuels such as e-methanol and e-methane.

As previously argued, the Center does not consider any global maritime emission level above 0.1 GtCO₂-eq in 2050 qualifying as net zero emissions. Notably, the ~0.3 GtCO₂-eq/year emissions is not in line with the abatements needed to follow a Path to Zero. Further regulatory focus in the form of even higher emission levies than those discussed earlier and/or tighter energy efficiency regulation thus seems to be justified in a scenario where ammonia is not accepted as a safe marine fuel.

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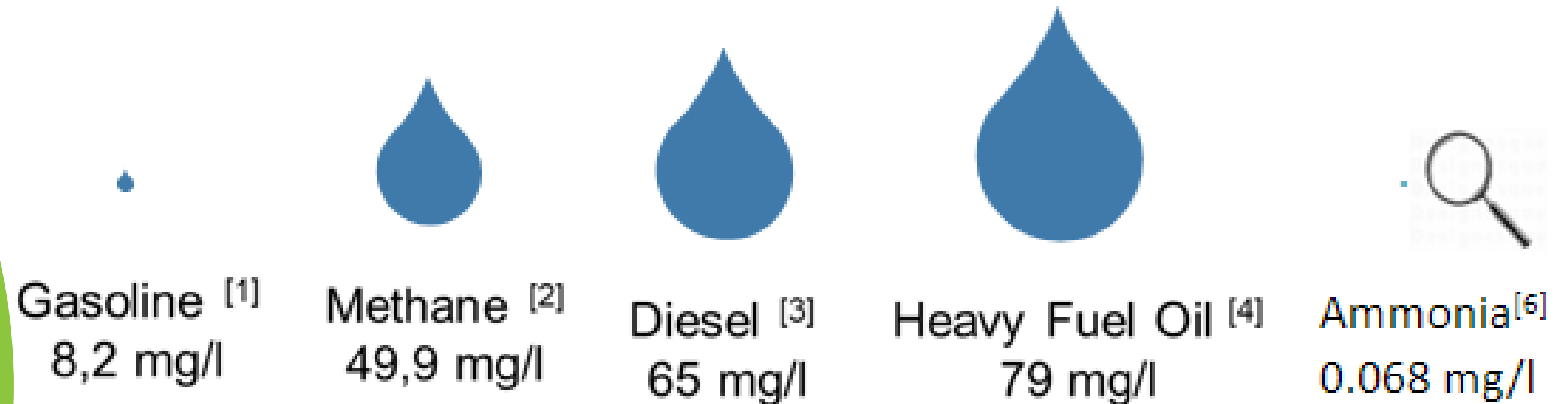


Marine Spills Still Happen....

LC 50: Lethal Dose: Fish

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



Sources:

[1] Petrobras/Statoil ASA, Safety Data Sheet, ECHA registration dossier Gasoline

[2] ECHA, European Chemicals Agency, registration dossier Methane

[3] ECHA, European Chemical Agency, registration dossier Diesel

[4] GKG/ A/S Dansk Shell, Safety Data Sheet

[5] ECHA, European Chemical Agency, registration dossier Methanol

[6] ECHA, European Chemical Agency, registration dossier Ammonia

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