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DEVELOPMENT, METHANEX



BERIT HINNEMANN,
HEAD OF GREEN FUELS SOURCING,
A.P. MOLLER-MAERSK



Welcome to the Web Conference

The Future of Methanol

What Is the Transport Energy Outlook?

A membership-based service that provides policy, market and technology competitive intelligence and research analysis on transport energy issues by providing original in-depth monthly reports and posts, live events and Q&A support for members.

Deliverables



Covering the Energy Transition in Transport:

- Biofuels, Low Carbon Fuels
- Hydrogen
- Electrification
- Other Advanced Alternative and Novel Fuels
- Fuel Economy
- Car Bans
- Transport-Related Climate Change & Air Pollution Drivers
- Autonomy
- Sustainable Mobility



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METHANOL INSTITUTE

Singapore | Washington | Brussels | Beijing | Delhi

Methanol as a Future Proof Fuel



Gregory Dolan, CEO

The Future of Methanol
Transport Energy Strategies Webinar
13 December 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



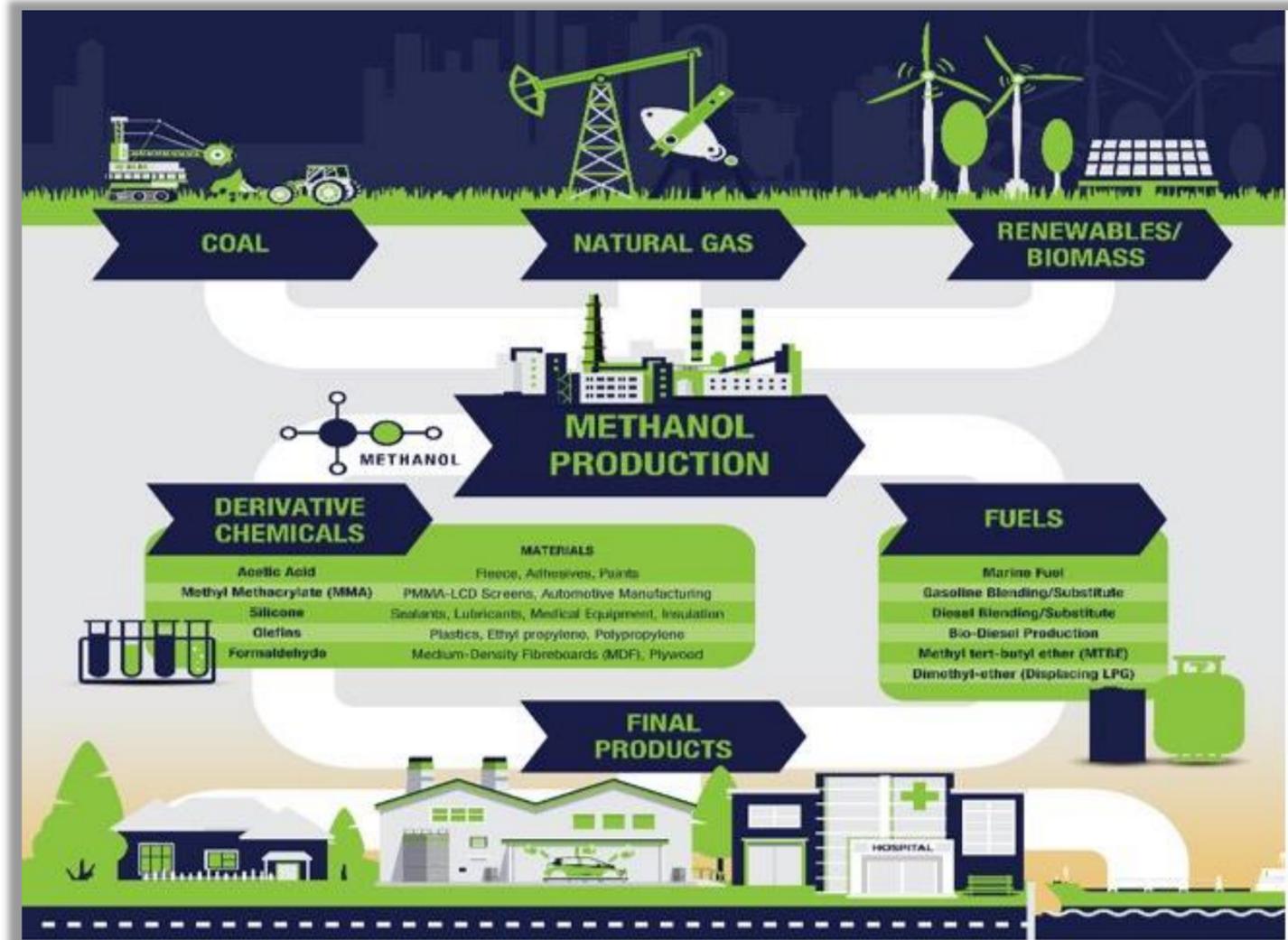
Tier 3



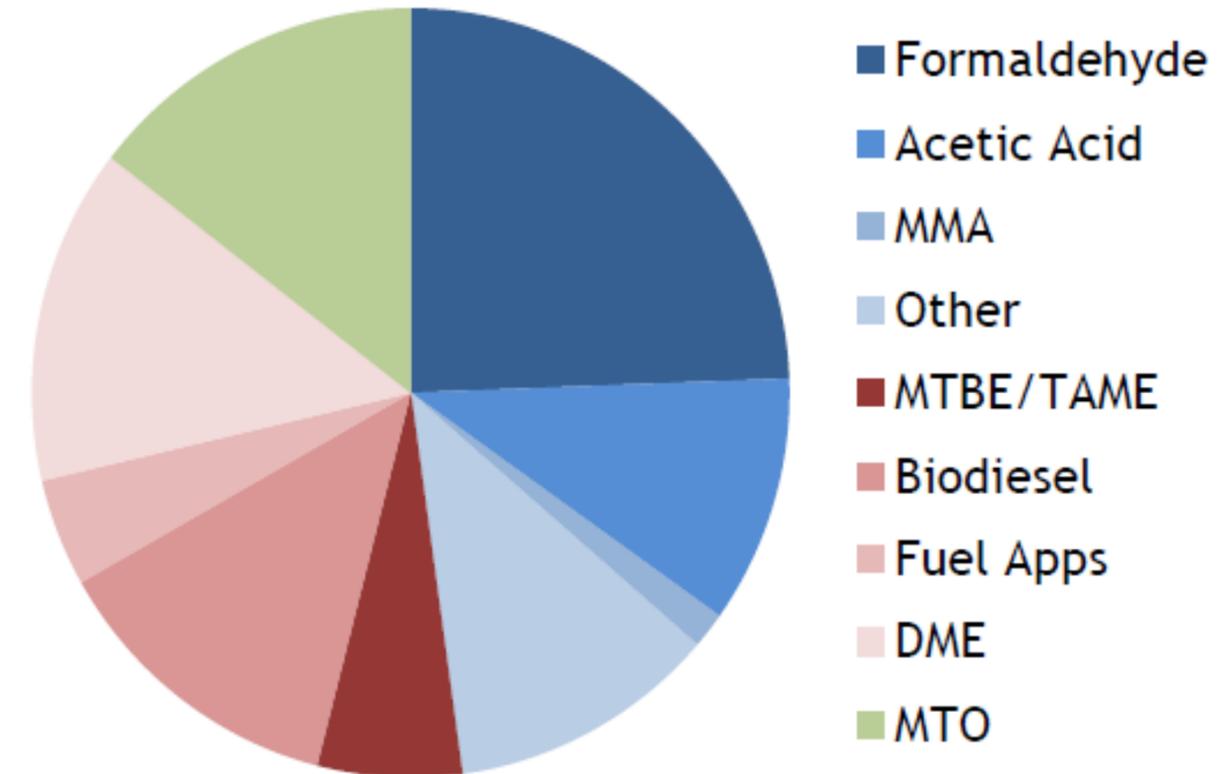
Tier 4



Essential Methanol



2022 ~ 92.5 mn t

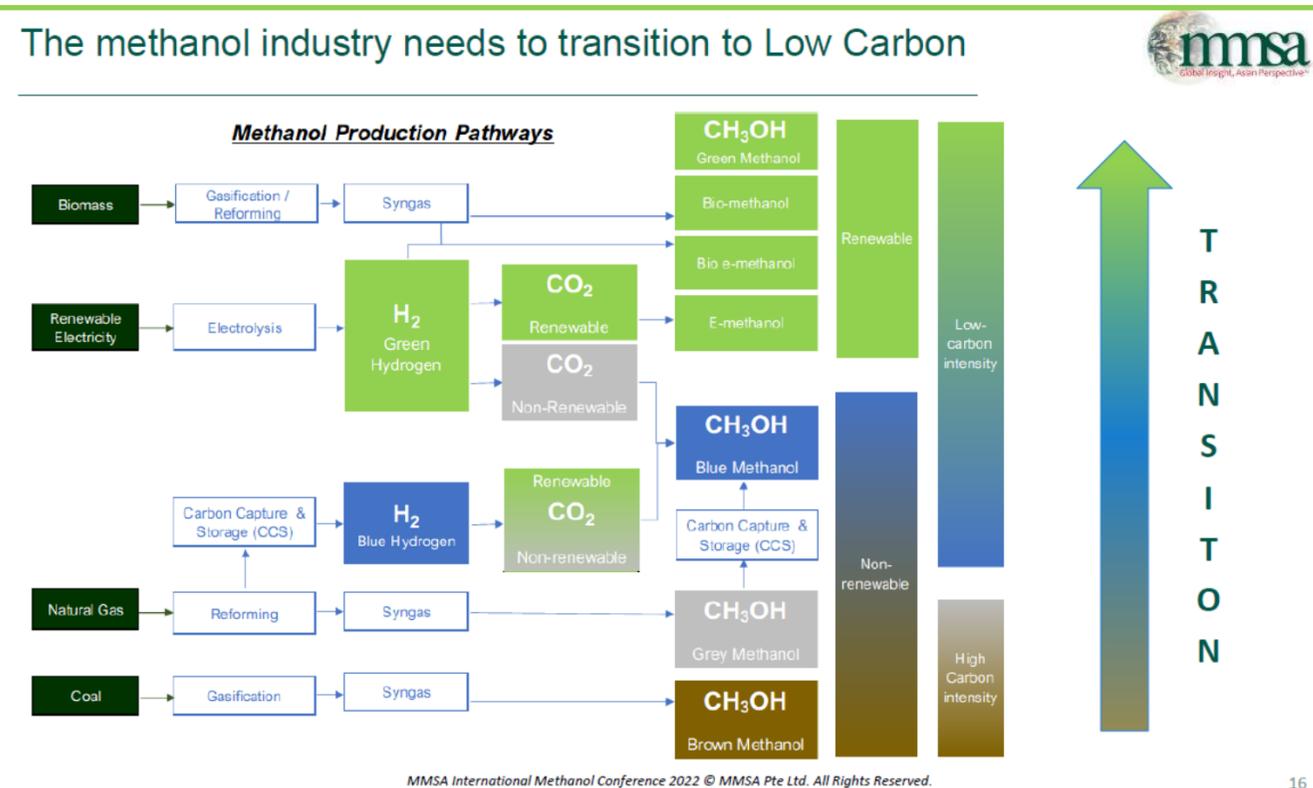


Excludes China's captive CTO sector

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



The methanol industry needs to transition to Low Carbon



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

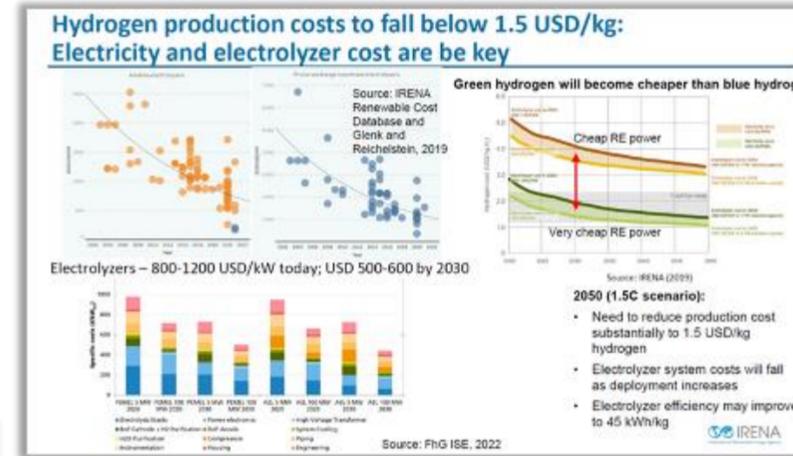
Bio-methanol

- 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/

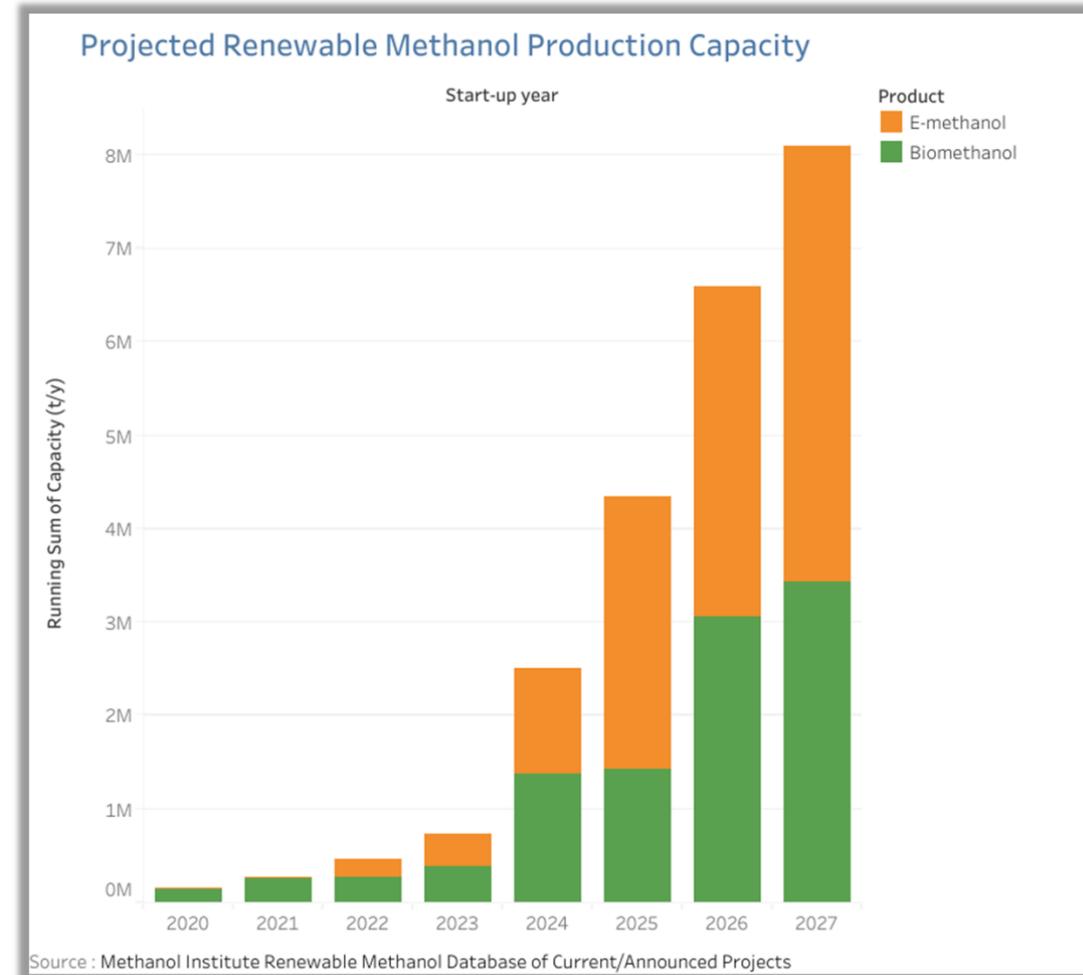
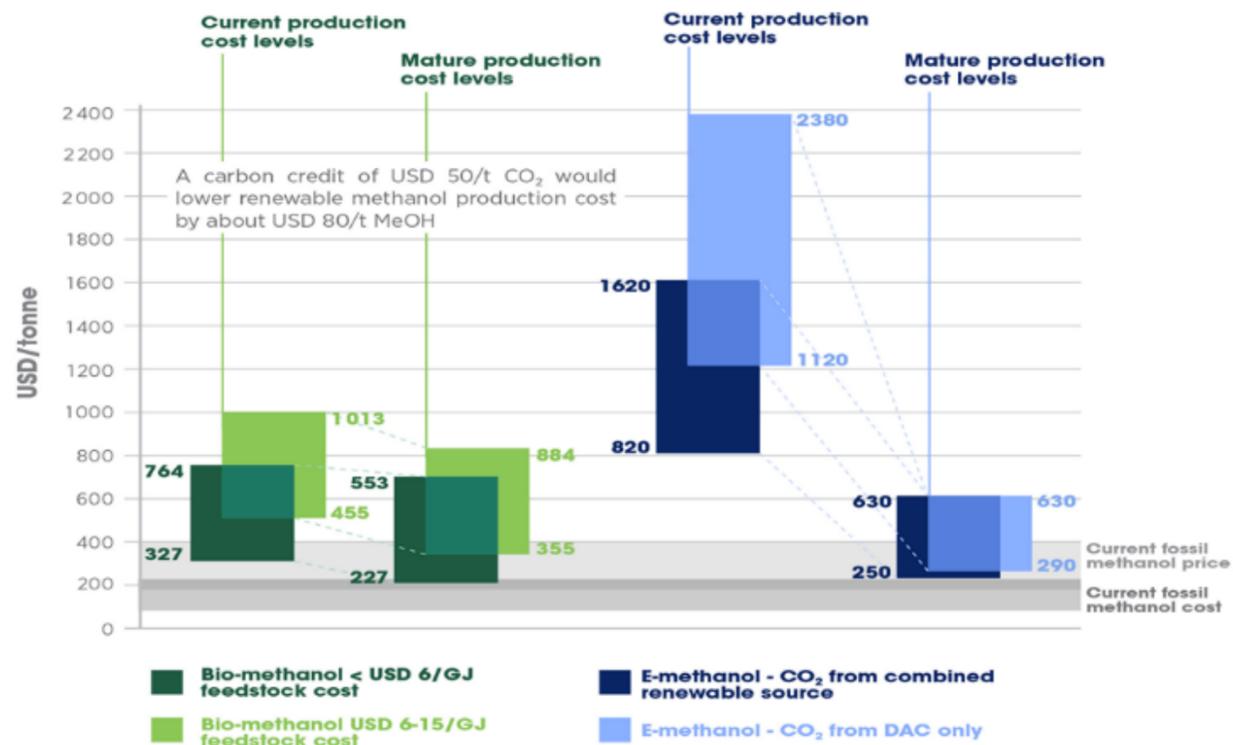


Example biobased industry in Europe: 200-300 Mt recoverable CO₂

- 569 pulp & paper mills – 50 Mt CO₂
 - 528 chemicals plant
 - 491 timber mills
 - 1100 biomethane units – 5 Mt
 - 339 liquid biofuels plant – 5 Mt
 - 202 starch & sugar plant
 - 147 composites & fibres plant
- Additionally
- Power & CHP plant – 50 -100 Mt (Drax etc)
 - 450 waste incinerators – 40-120 Mt

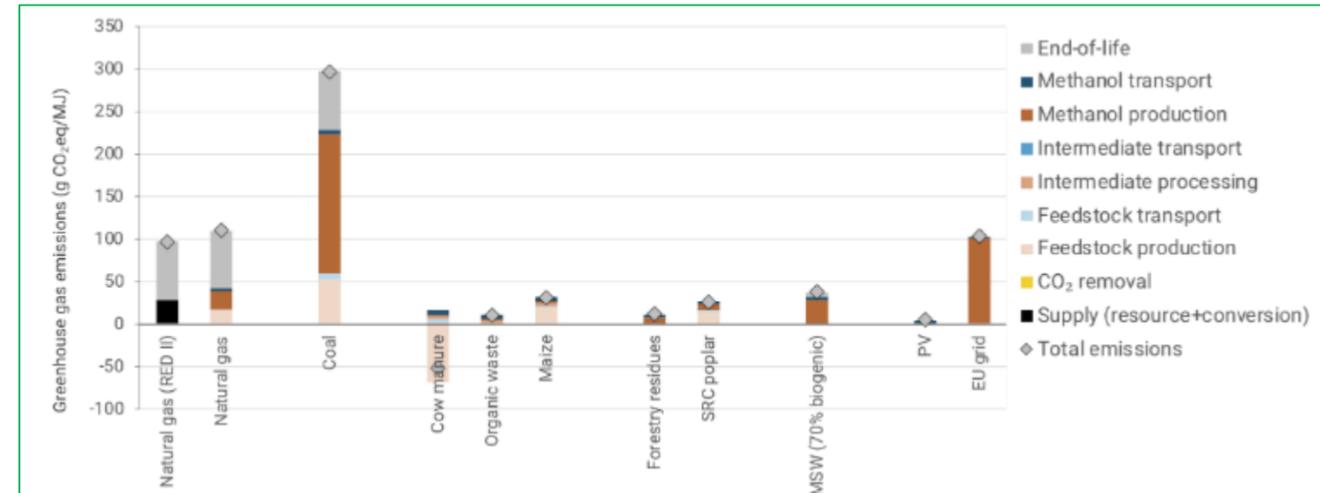


Figure 3. Current and future production costs of bio- and e-methanol

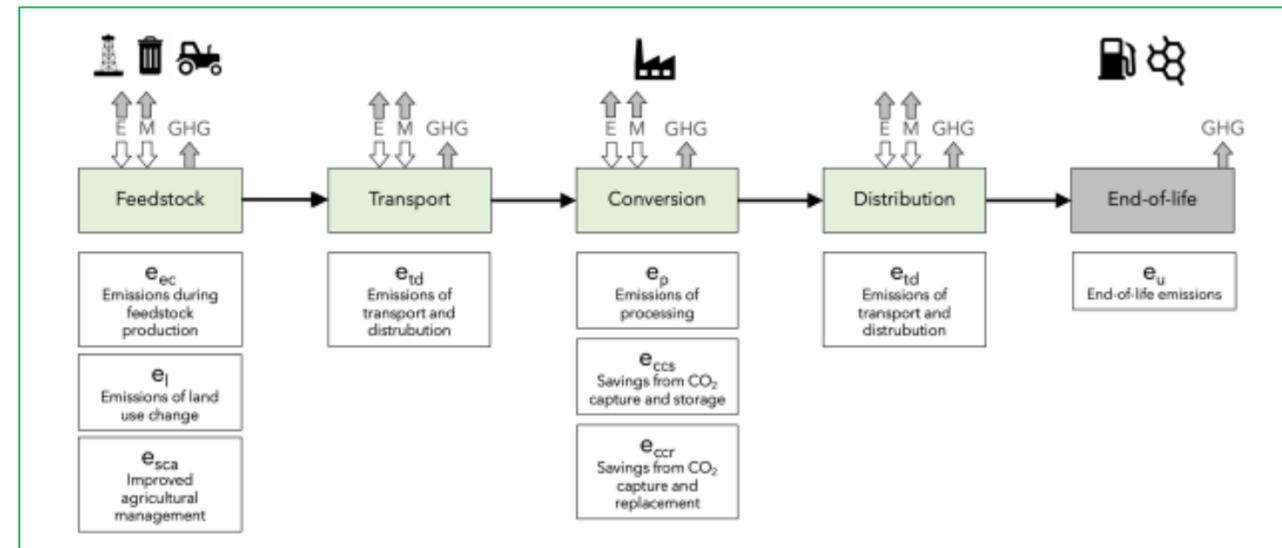


Carbon Intensity Accounting

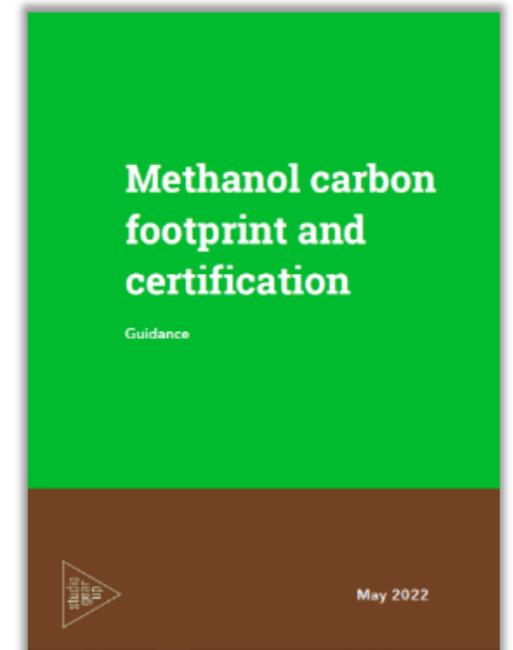
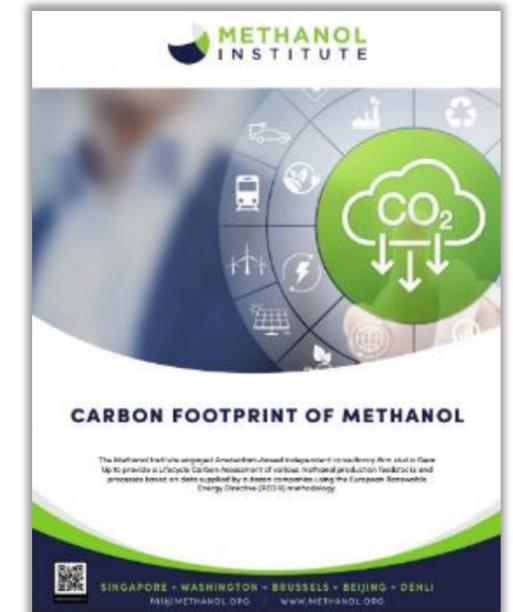
- In January, MI released a report from Amsterdam-based consulting firm studio Gear Up on “Carbon Footprint of Methanol”
- Depending on feedstock and production process methanol’s carbon footprint can be reduced by 65-90%
- In May, International Methanol Producers and Consumers Association working with 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**



<https://www.methanol.org/policy-initiatives/europe/>

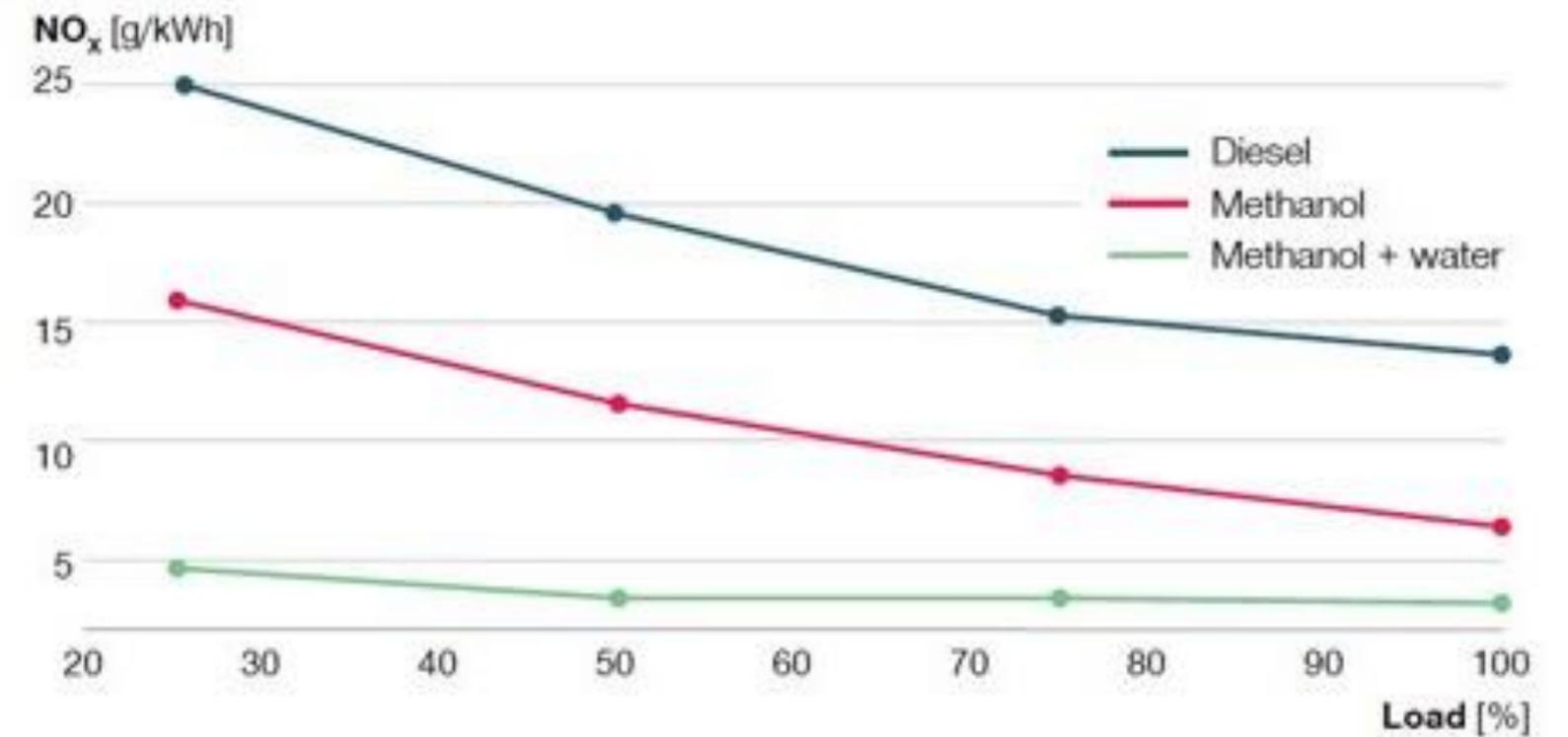
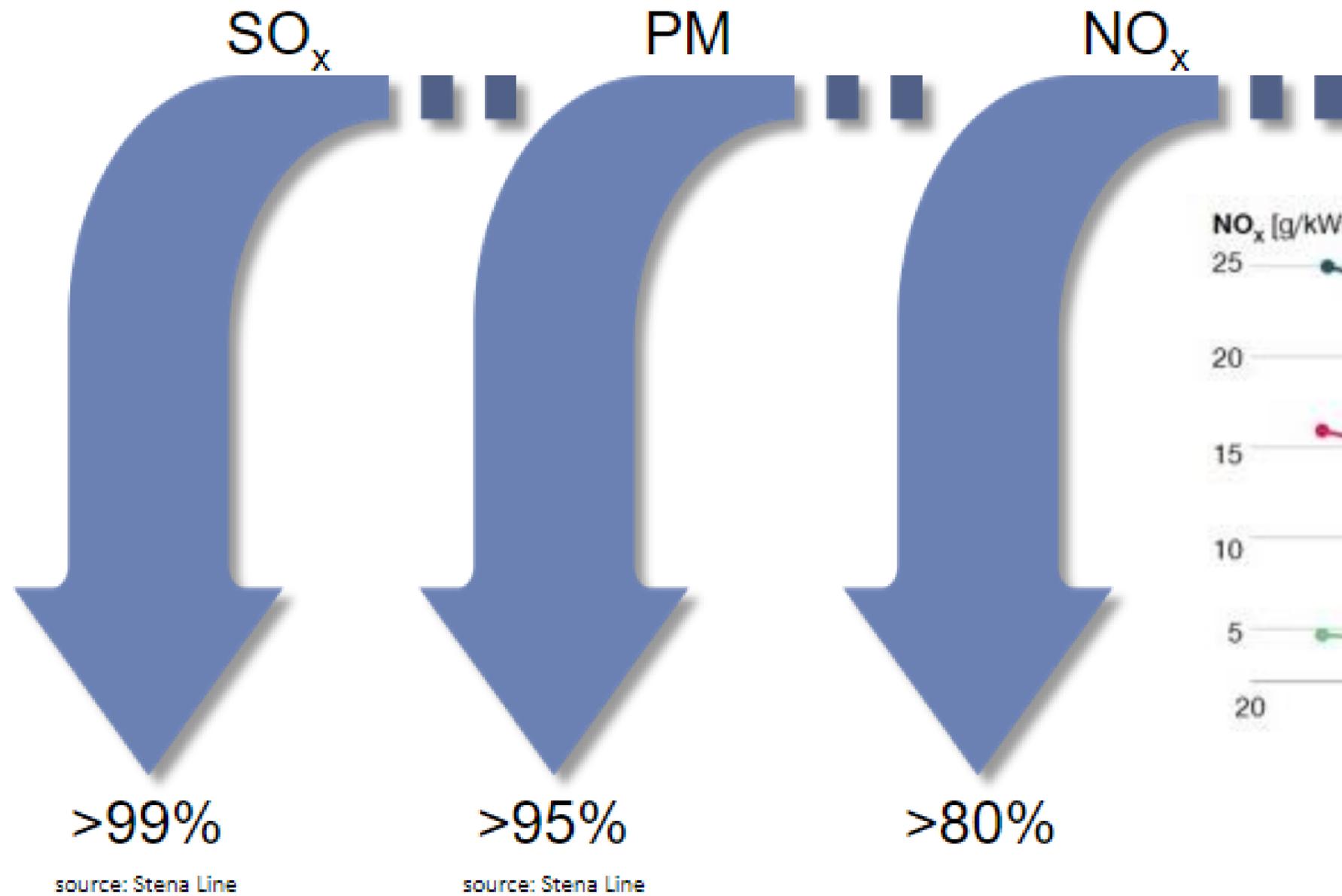


<https://www.impca.eu/IMPCA/Technical/IMPCA-Documents>



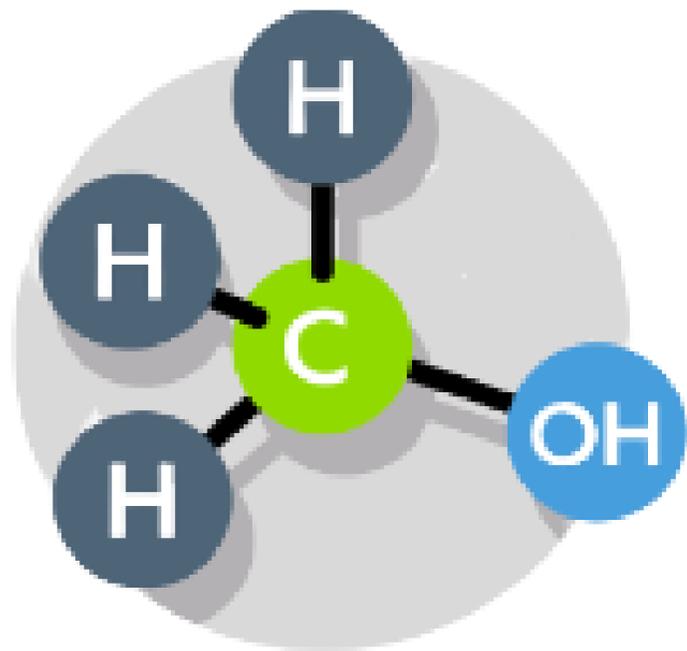
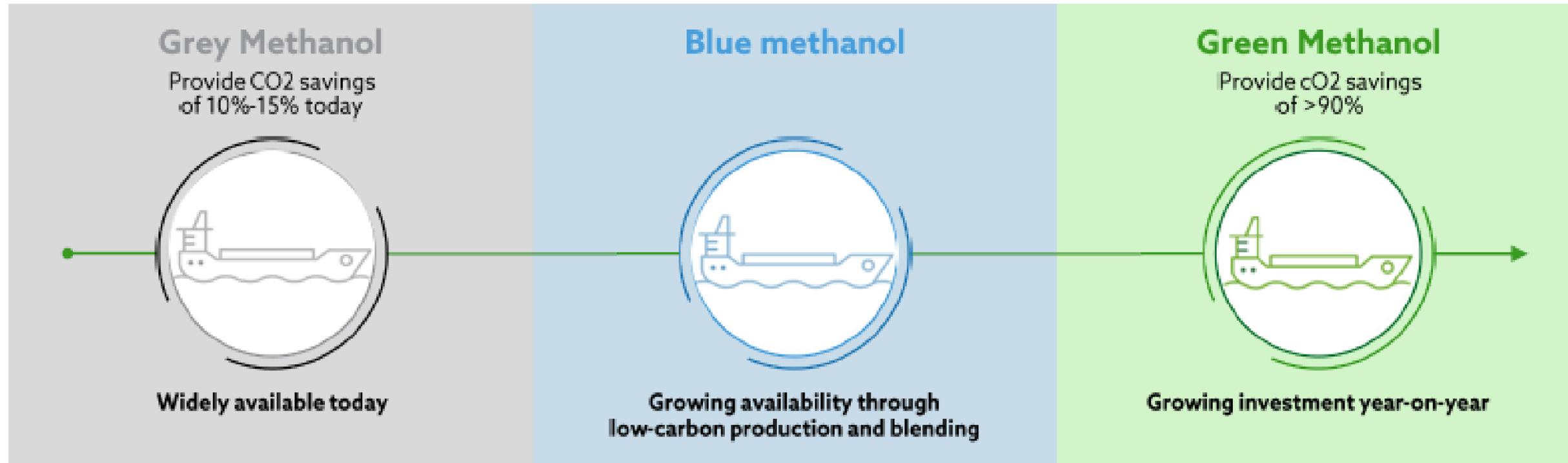
Improving Local Air Quality

Emission reduction potential:



source: MAN ES

The Methanol Molecule



- 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 says that can methanol

PUBLISHED THU, AUG 24 2021

Anna Engel

KEY POINTS

- Maersk says it has capacity
- According to



Cargill in order talks for first-ever methanol-fuelled bulkers

Ocean transportation president Jan Dieleman says Global Maritime Forum discussions on carbon-cutting gives the confidence to say, 'Let's go for it'

3 October 2022 12:14 GMT UPDATED: 3 October 2022 18:30 GMT

Norwegian Cruise Line Holdings Proceeding with Methanol Tests



Norwegian Cruise Line discussed its future fuel plans during the premier of Norwegian Prima in New York (NCL)
PUBLISHED OCT 12, 2022 5:14 PM BY THE MARITIME EXECUTIVE

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 decarbonisation of sustainable fuels.



Meet Uthörn, the first German ship powered by methanol



CMA CGM will spend another \$1bn on methanol container ships, says Saade

French liner giant is ready to double order for green vessels in China

9 November 2022 10:03 GMT UPDATED: 9 November 2022 12:07 GMT

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 Injected 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

Chinese Study Examining Methanol as a Marine Fuel

July 14, 2020

COSCO Orders 12 Ultra-Large, Green Methanol Containerships for \$2.9B



COSCO will invest \$2.9 billion for methanol dual-fuel ultra-large containership (COSCO)
PUBLISHED OCT 28, 2022 4:17 PM BY THE MARITIME EXECUTIVE

Waterfront Shipping methanol dual-fuel

01 Dec 2020 by Craig Jallat

Waterfront Shipping methanol dual-fuel 2021

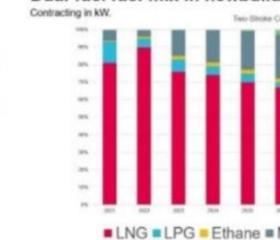
01 Dec 2020 by Craig Jallat

RUSSIA, JAPAN TO JOINTLY WITH DUAL-FUEL ENGINES

By Baird Maritime - September 9, 2021

Methanol Engines with Major Order

Dual-fuel fuel-mix in newbuilding



Methanol newbuilds elbow LNG out of the spotlight in October

08 Nov 2022 by John Snyder

Rules of Methanol Fuelled Ships.

PUBLISHED OCT 18, 2022 11:26 AM BY THE MARITIME EXECUTIVE
[By: MAN Energy Solutions]

carbon footprint, methanol and ethanol have been identified as good potential fuel alternatives in achieving this goal, according to a study published by the European Maritime Safety Agency (EMSA).

The use of alternative fuels in the shipping industry has been receiving increasing attention as a method of complying with low sulphur requirements for fuels and reduced emissions of sulphur oxides. As methanol and ethanol are sulphur-free, they would ensure compliance with the European Commission Sulphur Directive.

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

11 May 2023 22:07

Pax is world's first vessel to use methanol as fuel

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

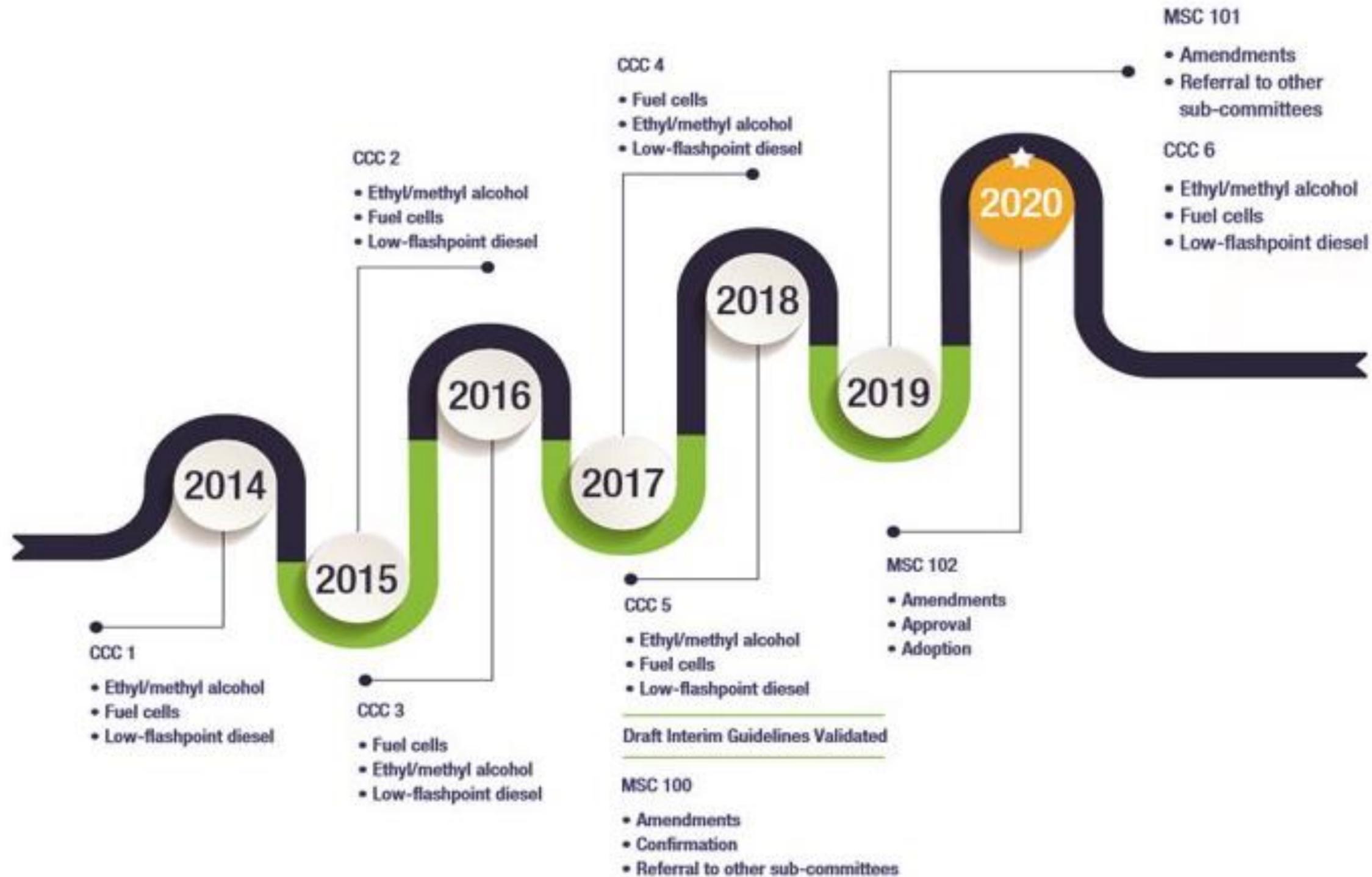
Focus On Methanol

Methanol: An accessible early an shipping

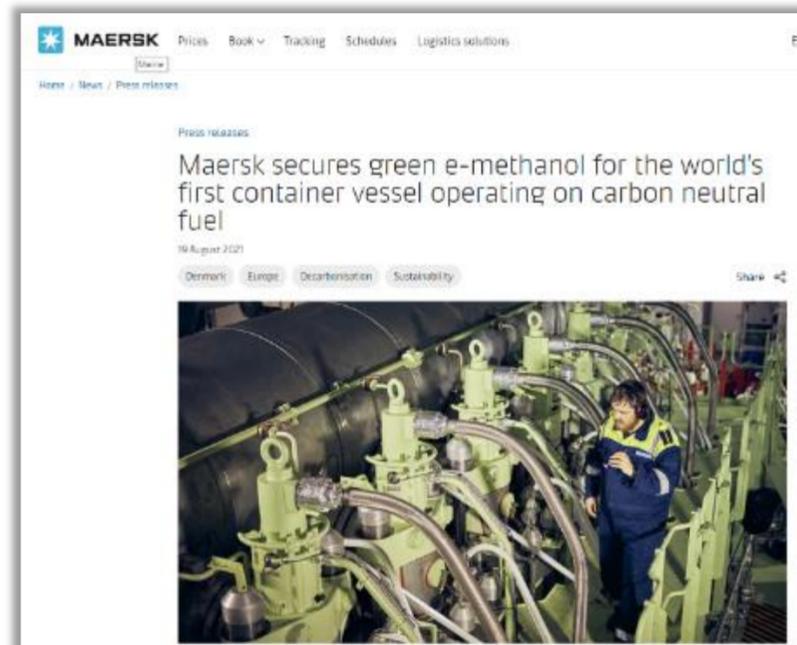
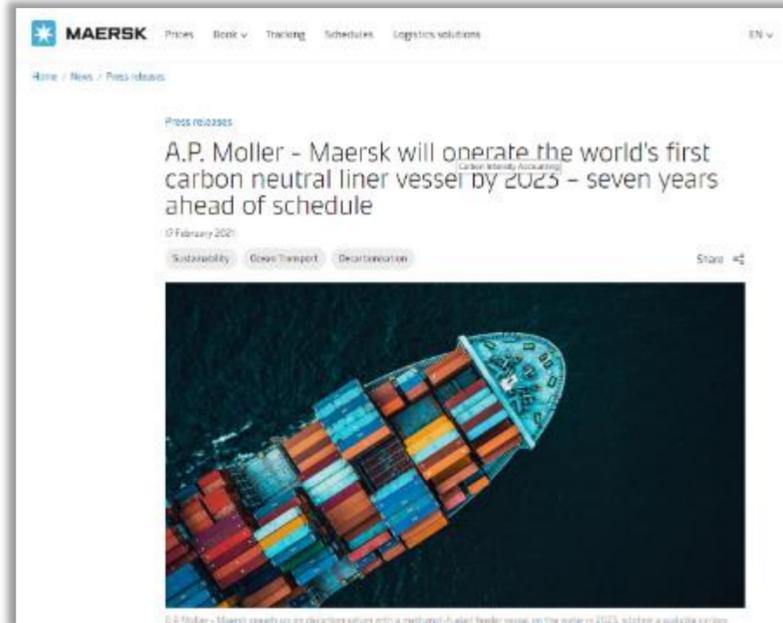
Methanol is key solution for coping decarbonisation

Today, research suggests

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

<https://www.maersk.com/news/articles/2022/10/05/maersk-continues-green-transformation>

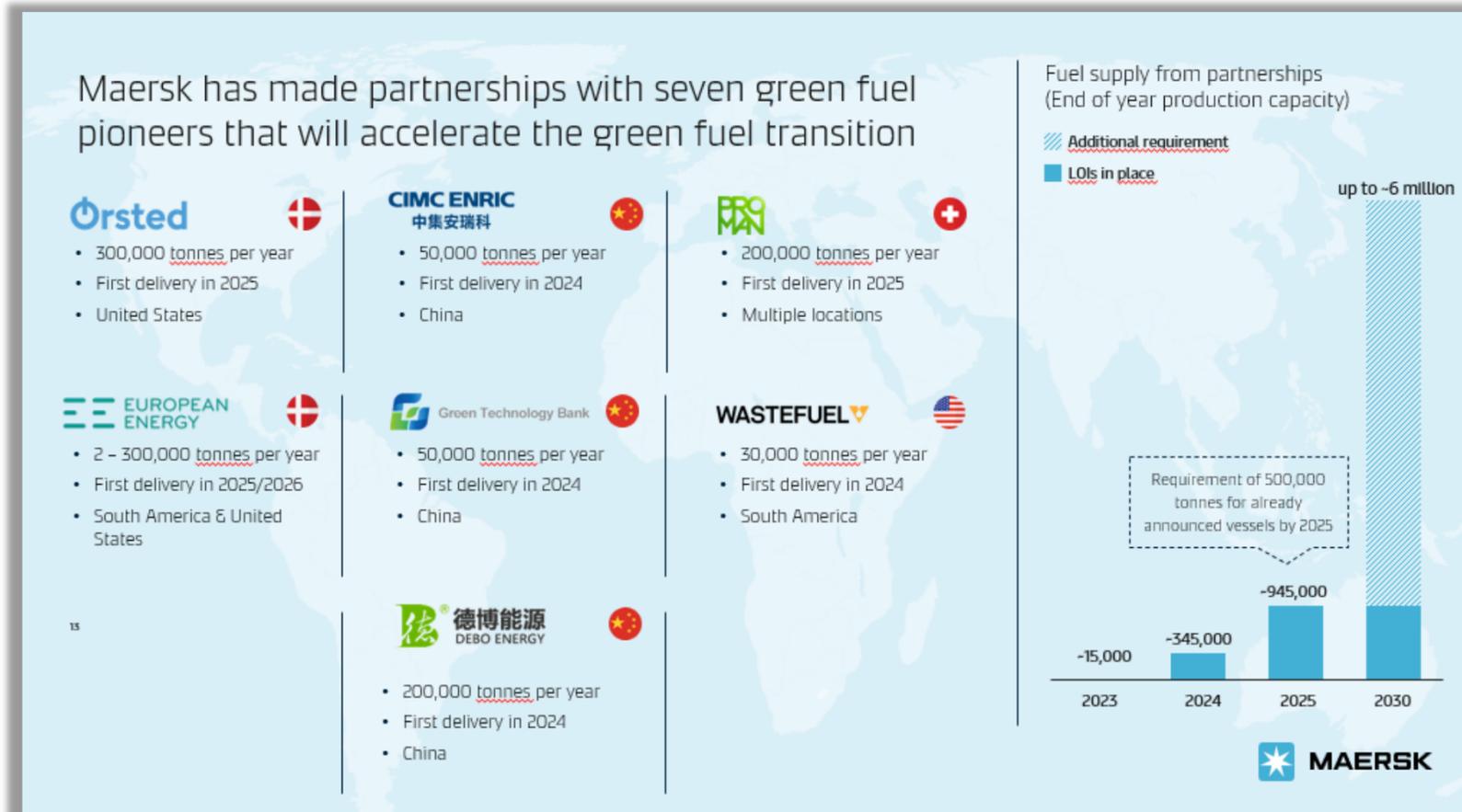


- **21 Feb 2021:** Maersk announces that the world’s first carbon neutral container vessel by 2023 will operate on dual-fuel methanol
- Maersk has now ordered 2,100 TEU methanol dual-fueled feeder vessels from Korean shipyard
- **24 Aug 2021:** “Maersk accelerates fleet decarbonization with 8 large ocean-going vessels to operate on carbon neutral methanol”
- 16,000 container (Twenty Foot Equivalent – TEU) vessels
- \$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
- **Each ship will require 35,000-40,000 tons of methanol annually or a total of 500,00 tons of methanol**
- **Customer Pull:** Maersk’s 200 largest customers asking for carbon neutral transport

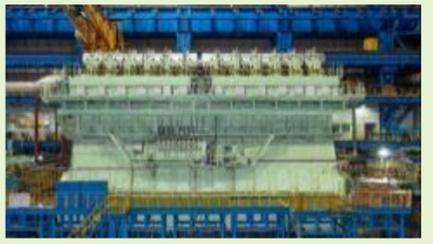
Game Changer 2.1: Maersk Methanol Supply



- **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
- **19 August 2022:** Maersk announces additional bio-methanol supply partnership with China's Debo
- Maersk estimates will need 6 million tons of renewable methanol by 2030 to fuel 25% of their 700-vessel fleet



On the Water and On the Way



METHANOL INSTITUTE SINGAPORE - WASHINGTON - BRUSSELS - BEIJING - DEHLI

Methanol Fuelled Vessels on the Water and on the Way

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

United Arab Emirates (November 2022)
Al Seer orders 4 IMO-compliant tankers constructed by K Shipbuilding at Jinhae Shipyard, expected to be delivered by Q4 2024.

USA (November 2022)
Disney Cruise Line acquired the cruise ship Global Dream, currently under construction at German shipyard Meyer Werft, which will be one of the first in the cruise industry to be powered by green methanol, expected in 2025.

Norway (November 2022)
Cecon Contracting entered an agreement for the construction of a cable installation vessel that will feature a methanol dual fuel system and a battery pack, expected in the first quarter of 2025.

Germany (November 2021):
Alfred Wegener Institute took delivery of a new research vessel UTHORN, built by Shipyard Fassmer

France (November 2022)
CMA CGM plans to double its order for methanol-fuelled container ships from China with six more 15,000 TEU methanol-powered boxships, totaling 12 ships e ro-ro for the country's coastal trades.



MI@methanol.org | www.methanol.org

f t @MethanolToday

Engines Available and More Coming



ADVANCED DUAL FUEL TECHNOLOGY

MAN ME-LGI METHANOL

ME-B Engine + LGI-M Technology = ME-B LGI-M

THE FUEL BOOSTER INJECTION VALVE

Principle of the FBIV - Fuel Booster Injection Valve

1. Conventional Injection Valve
2. Conventional Dual Fuel Valve
3. Methanol Injection Valve (FBIV)

4 FUEL VALVES PER CYLINDER

TWO STANDALONE FUEL SUPPLY SYSTEMS

ME-LGI METHANOL DEVELOPMENT MILESTONES

- 2016: 1st Development of ME-LGI Methanol
- 2017: 1st 2-Stroke Methanol Engine Ignited
- 2018: 1st 4-Stroke Methanol Engine Ignited
- 2019: 1st 2-Stroke Methanol Engine Approved
- 2020: 1st 4-Stroke Methanol Engine Approved

Methanol Institute | www.methanol.org

Since 2016, MAN has received orders for 80 large, two-stroke methanol engines, with 20 already in operation in chemical tankers operated by MI members. Another 120+ engine orders on the way!!!

WÄRTSILÄ 32 METHANOL

September 01, 2022 | News, Technology

WinGD and HSD Engine in JDP on methanol-fueled two-stroke engines

Written by Nick Eberly

2021-12-07 Product news

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



Rolls-Royce developing mtu methanol engines to make shipping greener

BUSINESS DEVELOPMENTS & PROJECTS

December 22, 2021, by Naïda Hakirevic Prevljak

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

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

Methanol to be available for maritime use from 2024

Monday, November 29, 2021

CATERPILLAR MARINE TO SUPPORT SELECT CAT® 3500E SERIES ENGINES WITH DUAL FUEL METHANOL

READ MORE

CSSC's self-developed 6M320DM methanol fuel engine successfully ignited for the first time

2022-10-05 05:06 (UTC)



2-STROKE AND 4-STROKE

HHI-EMD methanol engine gains type approval

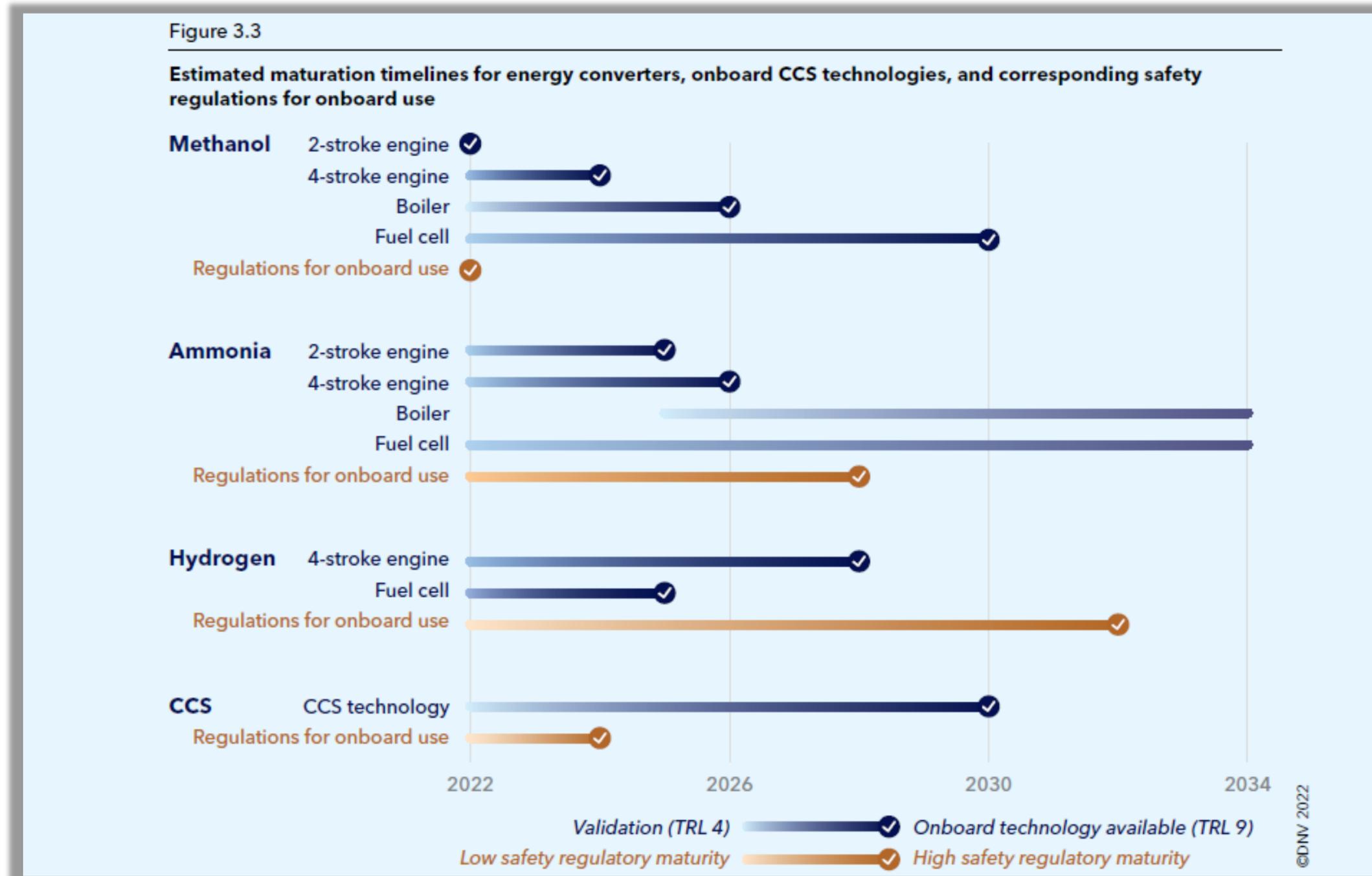
19/10/2022

Hyundai Heavy Industries - Engine & Machinery Division's new methanol dual fuel HIMSSEN engine has completed type approval testing with seven class societies including KR, ABS and DNV.

Source: HHI-EMD



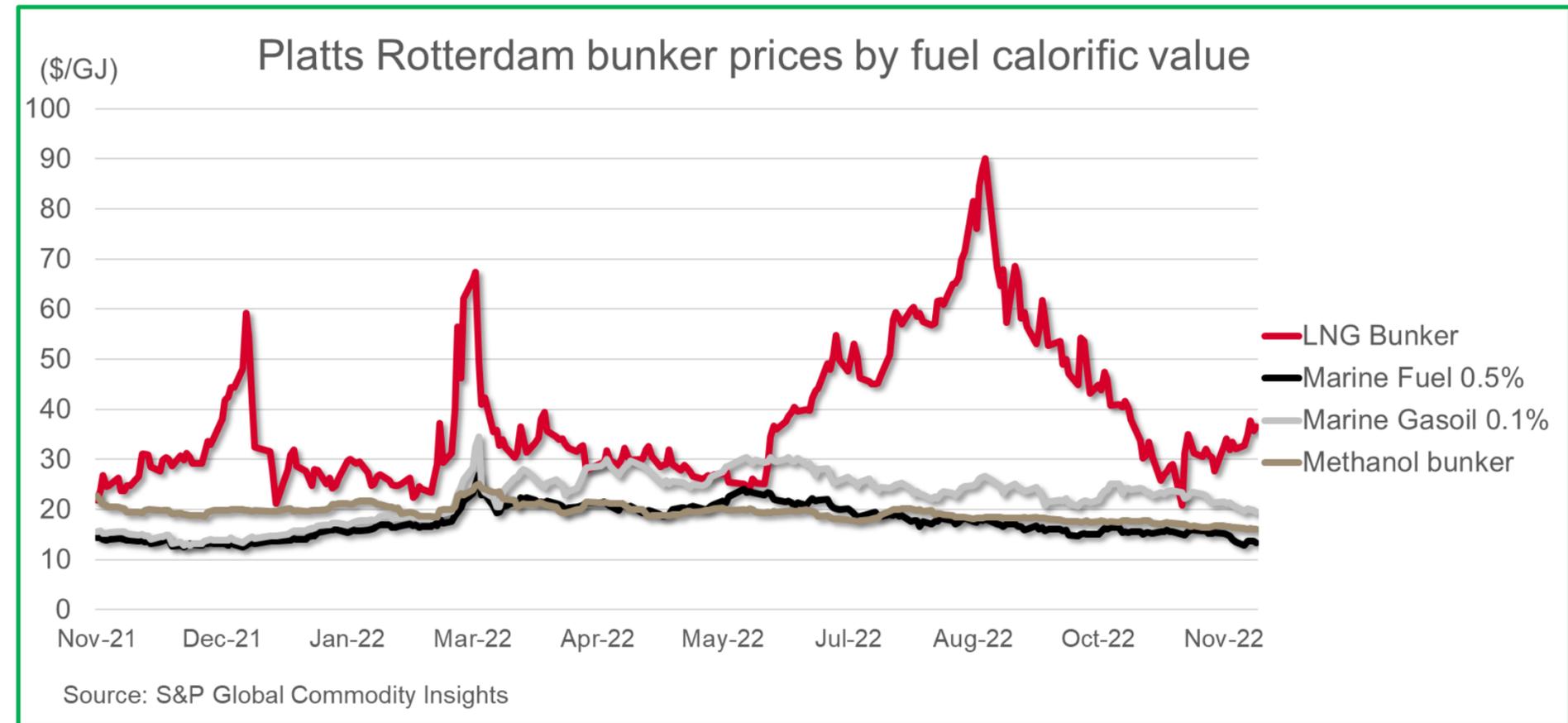
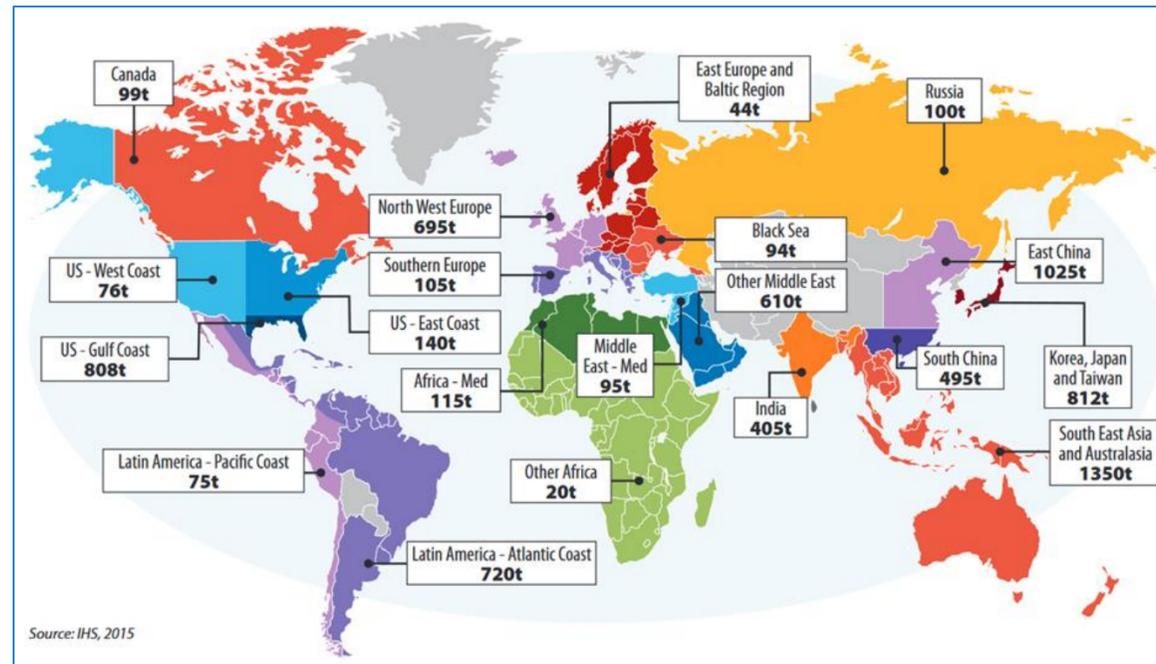
Technology Readiness



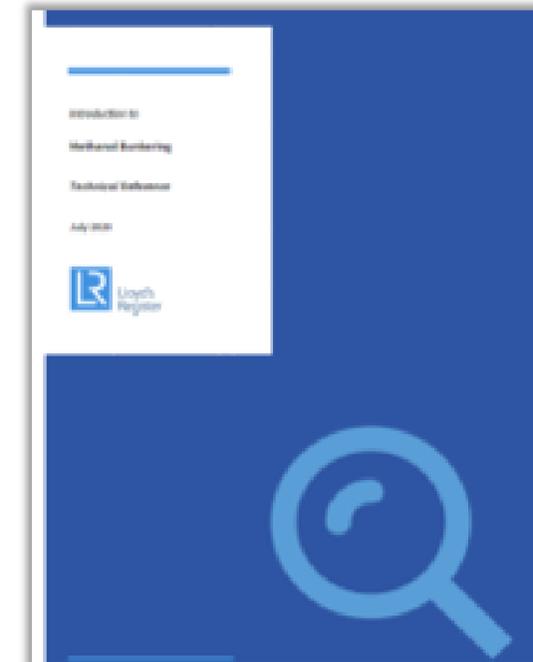
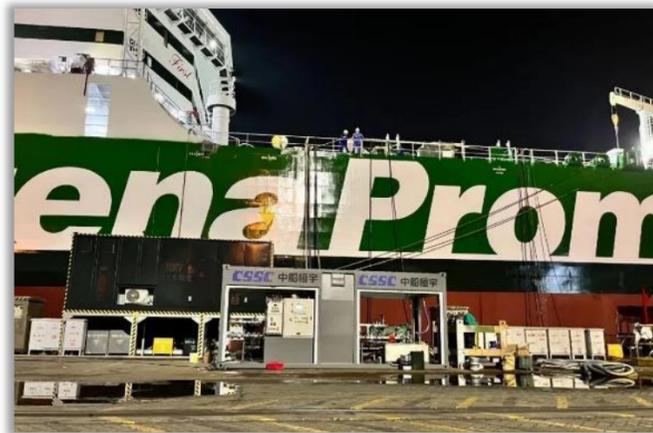
<https://www.dnv.com/maritime/publications/maritime-forecast-2022/index.html>

Available and Affordable

Methanol Trading Hubs – Storage Capacity



Easily Bunkered



- Methanex/Waterfront Shipping loaded and/or demonstrated methanol bunkering as a marine fuel (locations where Methanex does not have methanol production are in red):

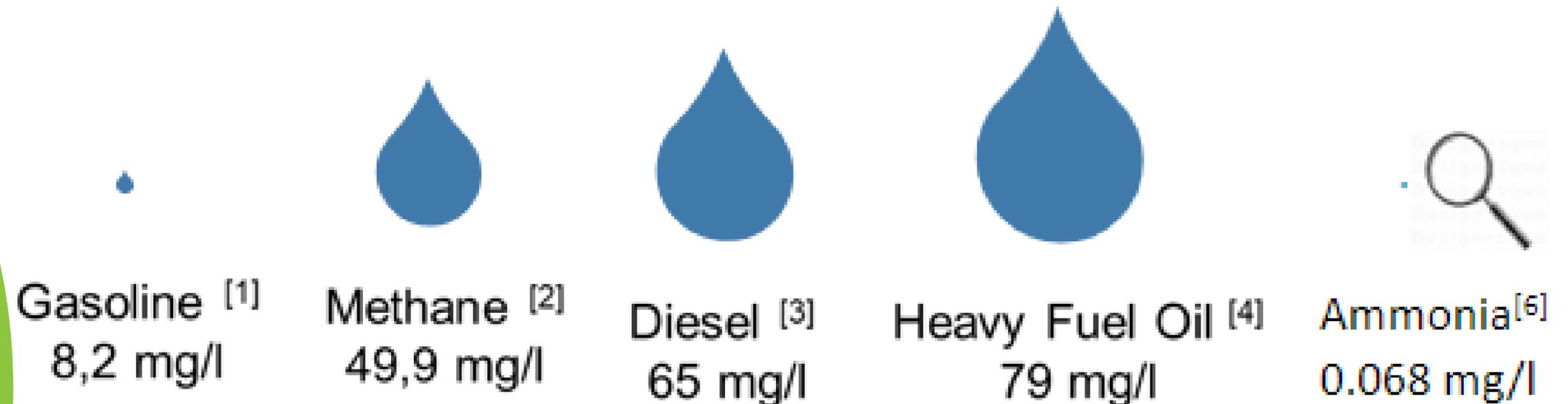
Ulsan, South Korea (Hyundai HMD Shipyard; since 2016); New Plymouth, New Zealand (since June 2016) Geismar, USA (since August 2016); Trinidad (since April 2017); Punta Arenas, Chile (since February 2019); **Houston, USA** (since June 2020); **Rotterdam, Netherlands** (inaugural global bunkering demonstration, May 2021); **Onsan, South Korea** (May 2022); **Taicang, China** (August 2022)

- Oct 2022: China Shipbuilding Hengyu Energy (Shanghai), a subsidiary of China State Shipbuilding Corporation (CSSC), has completed the bunkering of three methanol-powered product tankers built by Guangzhou Shipyard International. The 49,900-ton tankers were fueled with a total of 240 tons of methanol, a major milestone for the Chinese methanol fueling track record. The vessels are owned by Proman Stena Bulk.

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

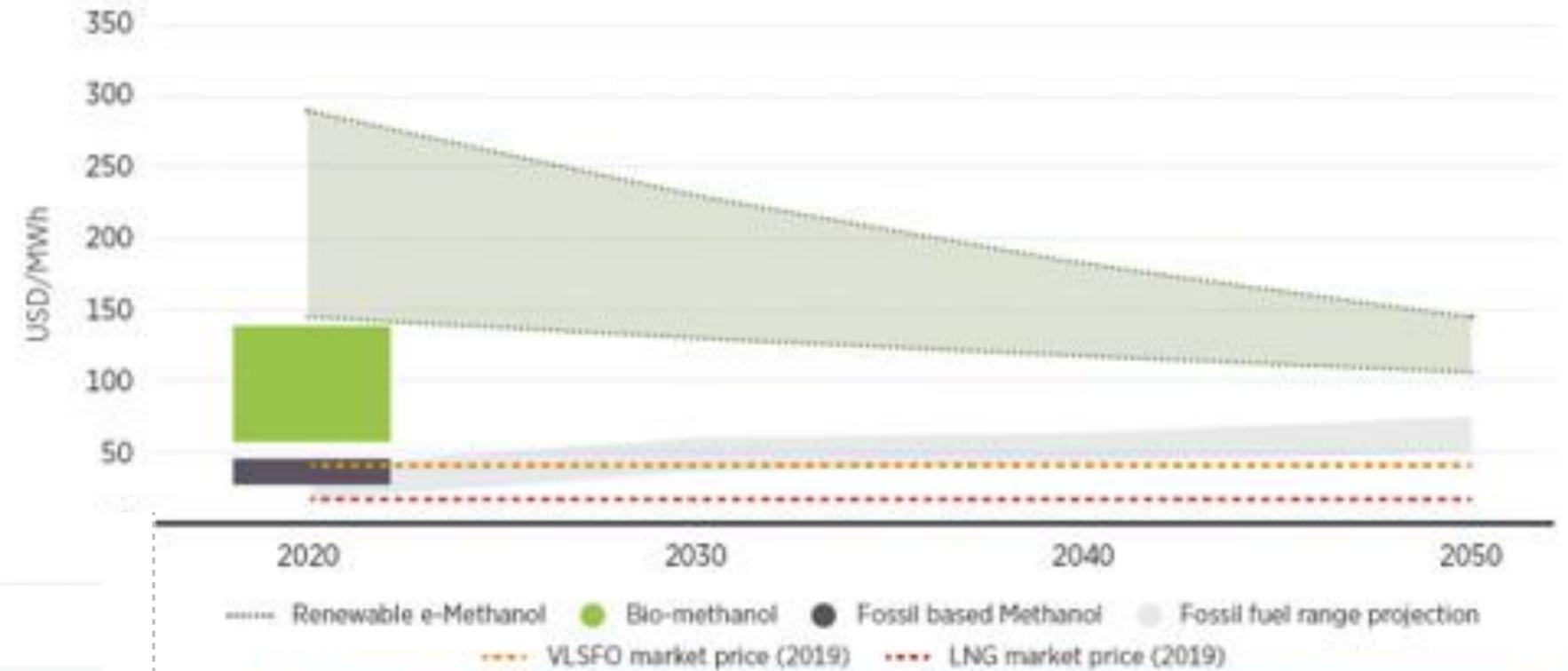
[5] ECHA, European Chemical Agency, registration dossier Methanol

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

Projections – Methanol vs Ammonia

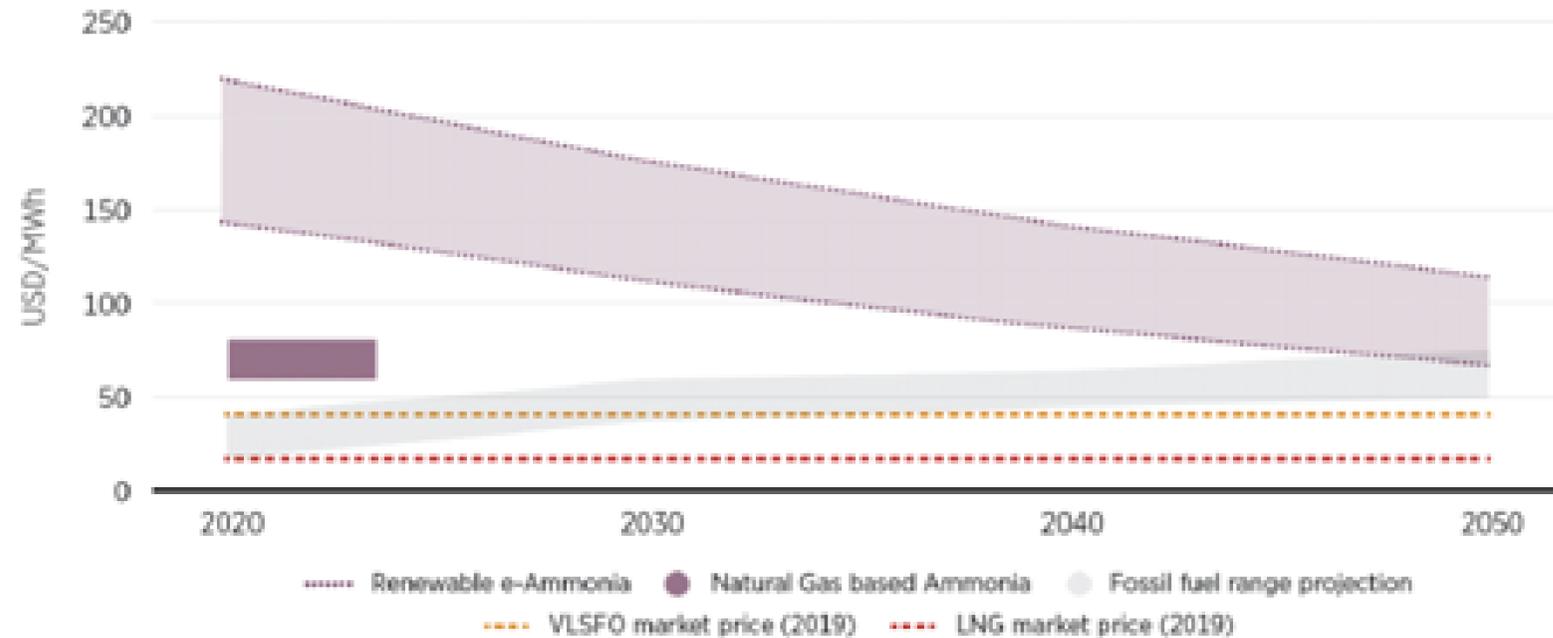
- IRENA “Decarbonise the Shipping Sector”
- Short-term, advanced biofuels play key role
- Medium and long-term e-methanol and e-ammonia more promising green hydrogen-based fuels
- By 2050, shipping uses 38 million tonnes of renewable methanol and 183 million tonnes of renewable ammonia

Methanol cost projections

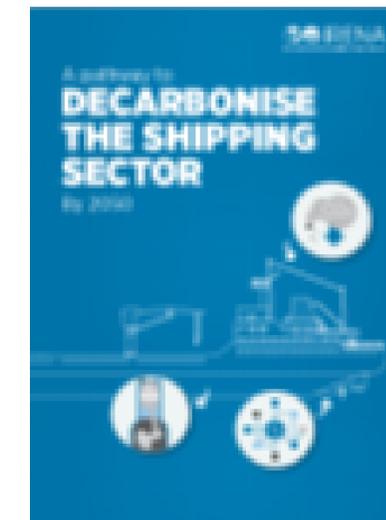


A Pathway to Decarbonise the Shipping Sector by 2050 (International Renewable Energy Agency, 2021)

Ammonia cost projections



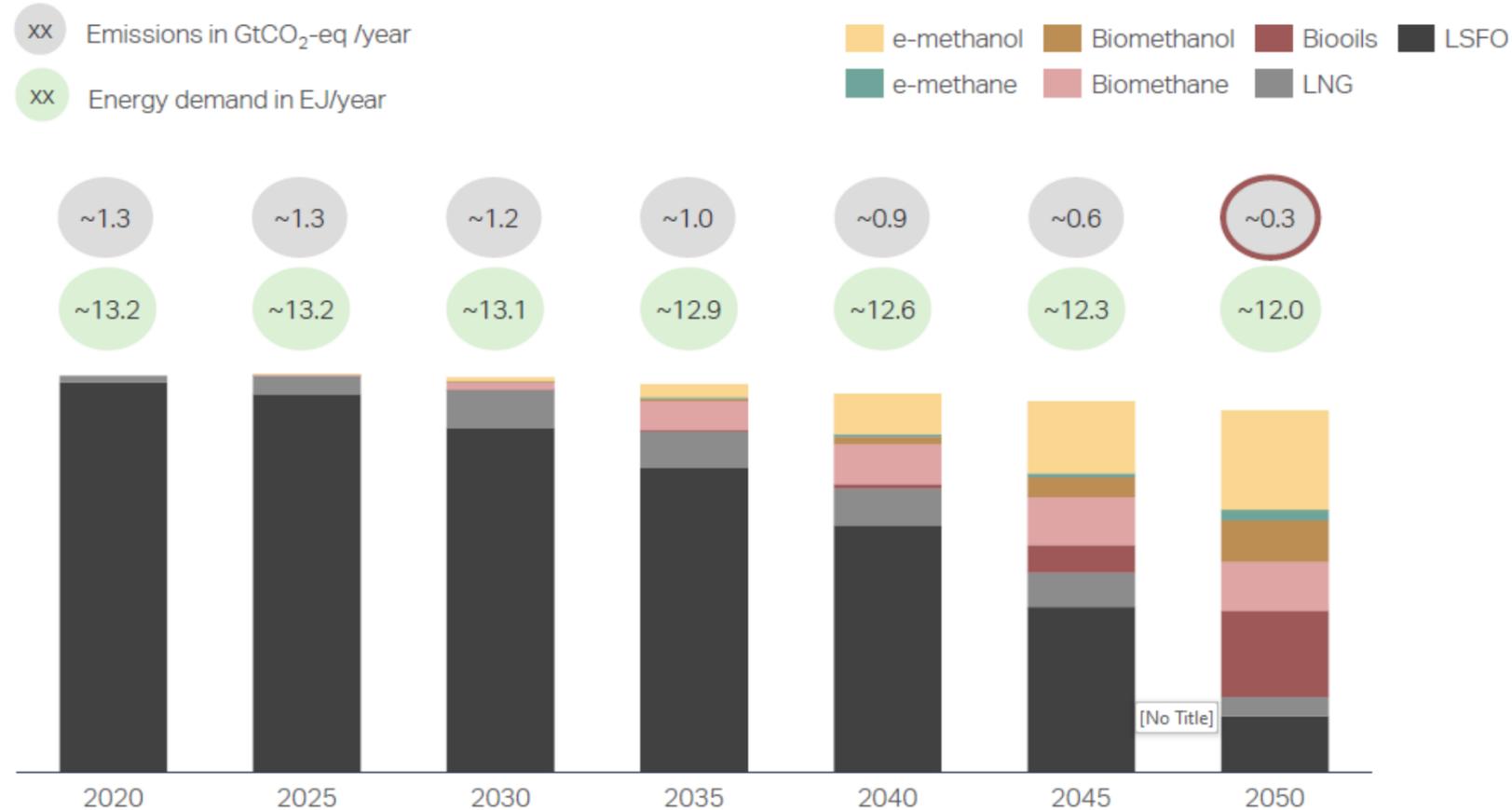
A Pathway to Decarbonise the Shipping Sector by 2050 (International Renewable Energy Agency, 2021)



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.

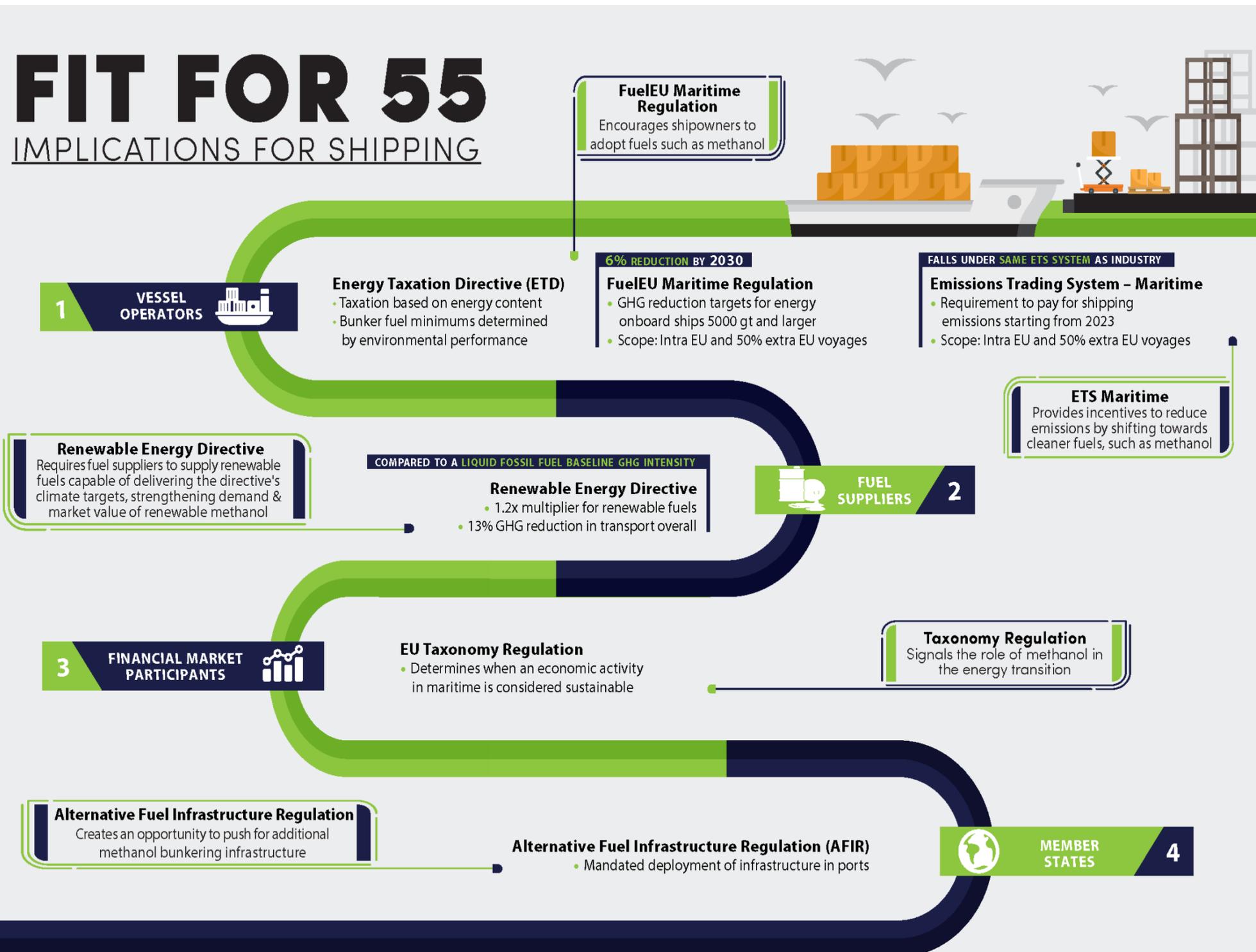
As previously argued, the Center does not consider any global maritime emission level above 0.1 GtCO₂-eq in 2050 qualifying as net zero emissions. Notably, the ~0.3 GtCO₂-eq/year emissions is not in line with the abatements needed to follow a Path to Zero. Further regulatory focus in the form of even 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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Regulatory Developments

FIT FOR 55 IMPLICATIONS FOR SHIPPING



- FUELEU Maritime poised to grow methanol demand significantly
 - WtW approach recognizing reduced carbon intensity in upstream profile
 - EP & Council developments indicate eligibility of use of “blue” product and blends
- ETS sets price on carbon but does not recognize reduced carbon intensity of methanol –TTW approach under EU MRV
 - May include CH4 now and more GHG at later stage
- RED employs 1.2 multiplier for renewable fuels in maritime and sets a high GHG reduction targets; How will MS implement?
- ETD stipulates energy content-based taxation bridging the price gap between alternative fuels and fossils significantly
- Discussion at IMO level on WtW approach – pressure from the EU

Road Transport



China M100 Cars

- M100 taxi numbers continue to grow in Gui Yang and Shanxi will be the next province for future growth
- All the M100 vehicles are China VI emission standard (equivalent to Euro 6 with additional formaldehyde and unburnt methanol certifications)
- In 2022, Geely began selling methanol ICE/electric hybrid.
- The hybrid car reduces M100 fuel consumption from 13.6 to 9.3 L/100km, a fuel economy of less than 30 cents RMB (USD\$0.043)/km



Methanol Fueled Vehicles in China (by Sept. 2022)

Province	City	Vehicle Type	Vehicle No.
Shanxi	Jinzhong	Taxi/service	130
	Tai Yuan	Passenger car	3
	Xin Zhou	Passenger car	12
	Yun Cheng	Taxi	14
Shannxi	Xi'An	Taxi	8,124
	Bao Ji	Taxi	585
		Mini MPV	15
	Yu Lin	Self-Dumping Truck	5
	Han Zhong	Taxi	20
Guizhou	Gui Yang	Taxi/private	17110
	Tong Ren	Taxi	239
	Bi Jie	Taxi	100
Gansu	Ping Liang	Taxi	150
He Long Jiang	Wu Chang/Harbin	Taxi	48
Xin Jiang		HD Truck	1000
		Total	27555

[1] https://www.miit.gov.cn/datainfo/dljdelscqjyicpgg/pamoosn/art/2022/art_e29ab6828d7e49029d8b660233d8ea79.html

[2] <https://dh.geely.com/ss1fml>

China M100 Trucks

Increased activity commercializing M100 HD trucks underway. 300 HD trucks on road with 500 sales, the total number of could reach around 1000 by the end of 2022. This is delayed due to the global auto-chip shortage, development of the new 13L engine and deployment of M100 filling stations

In June, Geely announced first methanol HD rolling off the production line in its Jin Zhong base. The methanol HD truck is 2nd generation with newly developed 13L methanol HD engine. The tandem truck powered by methanol demonstrated in 2021.

In August, Geely announced its new energy truck target with methanol HD truck to achieve 50k units by 2026; as well as the latest model of its HD truck under development, Farizon, is expected to be an EV HD truck with methanol rage extension for total range over 1,000 km, small market sale will be offered by the end of 2023.

2 Committee Call 6 March 2022
2 Committee Call 6 March 2022



Danish Pilot Project



- Geely Emgrand 7 Methanol-fueled car has been delivered from its previous location in Iceland to Denmark
- Additional two Euro 6 Geely M100 cars have now been delivered to Denmark as well
- The Danish Minister of Transport Tine Bramsen visited Aalborg on 28 March to see demonstration of fueling station adjacent to Blue World Technologies headquarters, with Geely methanol car and truck
- <https://www.dr.dk/nyheder/seneste/se-billederne-af-europas-foerste-power-x-lastbil-der-er-ankommet-til-danmark>
- At the UNITI Expo held in Stuttgart, Germany on 17-19 May, Circle K had a methanol fuel booth in the expo area, with container fueling tank, Geely truck and 2 passenger cars on display

Hydrogen Carrier Fuel



METHANOL AS A HYDROGEN CARRIER

Methanol → Hydrogen → Electricity

1 Carbon intensity of the grid determines the carbon intensity of electrified applications. Most grids have low integration of renewable energy capacity.

Country	Germany	UK	USA	China	India
Carbon intensity of Grid kgCO ₂ eq/kWh	0.40	0.20	0.42	>0.70	0.70

2 Renewable energy generation has to be **X3 or X4** larger than electricity demand to address intermittency. Cost to integrate fully renewable grids:
 USA >USD 4.5 trillion
 EU >USD 3.6 trillion
 India >USD 11 trillion

3 Rising cost of electricity brings cost of H₂ to **>USD 3.5/kg** (based on price of US industrial electricity).

4 Electrolysis of water requires **50 – 55 kWh/kg** of H₂. H₂ produced is not green with a carbon intensity of **21 kgCO₂eq/kg of H₂** (based on carbon intensity of US grid electricity).

5 Methanol has a low carbon intensity, and can be **carbon-neutral**, when produced from sustainable feedstocks such as municipal solid waste (MSW), agricultural waste, and captured CO₂.

6 Bio-methanol produced from MSW can produce H₂ at a carbon intensity of **2.15 kgCO₂eq/kg of H₂ = 90% GHG SAVINGS** compared to electrolysis.

7 As the *most effective hydrogen carrier*, methanol is:
 • **Simple** – Stored and transported as a liquid
 • **Efficient** – Highest hydrogen to carbon ratio of liquid fuels
 • **Green** – A pathway to carbon-neutral transport
 • **Now** – Immediate solution for the adoption of hydrogen

8 Vehicles with onboard methanol reformation incur **LOWER CAPEX and OPEX for LONGER RANGE, SHORTER REFILL TIME and LOWER EMISSIONS**

METHANOL INSTITUTE



Practical Solution For FCVs/EVs

- Reformed Methanol Fuels Cells (RMFC) as *range extender* for battery electric vehicles
- Increasing range of electric vehicles from 300 to 1000 kilometers
- 3-minute refill with liquid methanol, no charging infrastructure
- Reform methanol at the fueling station to supply hydrogen for fuel cell vehicles and charging for electric vehicles



Fuel Cell Vehicle Canister Rapid Fueling



SMALL, PERSONAL, PASSENGER AND PACKAGE DELIVERY VEHICLES

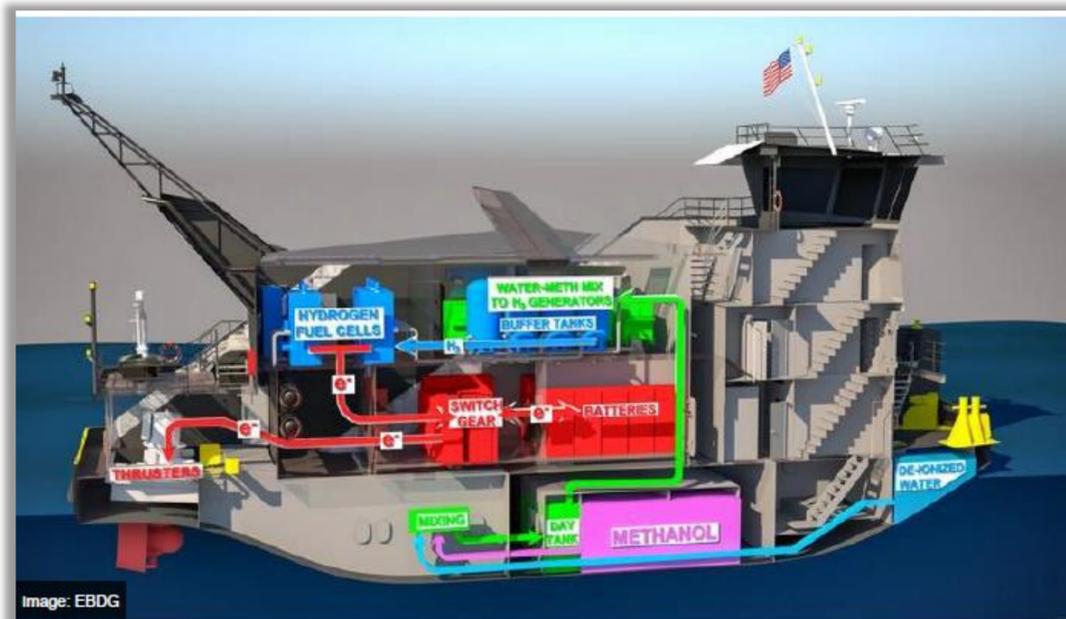
LOWER POWER REQUIREMENTS = LOWER COST

METAL HYDRIDE AND HYDROGEN “VENDING MACHINES” UNLOCK LOGISTICS & OPERATING COSTS

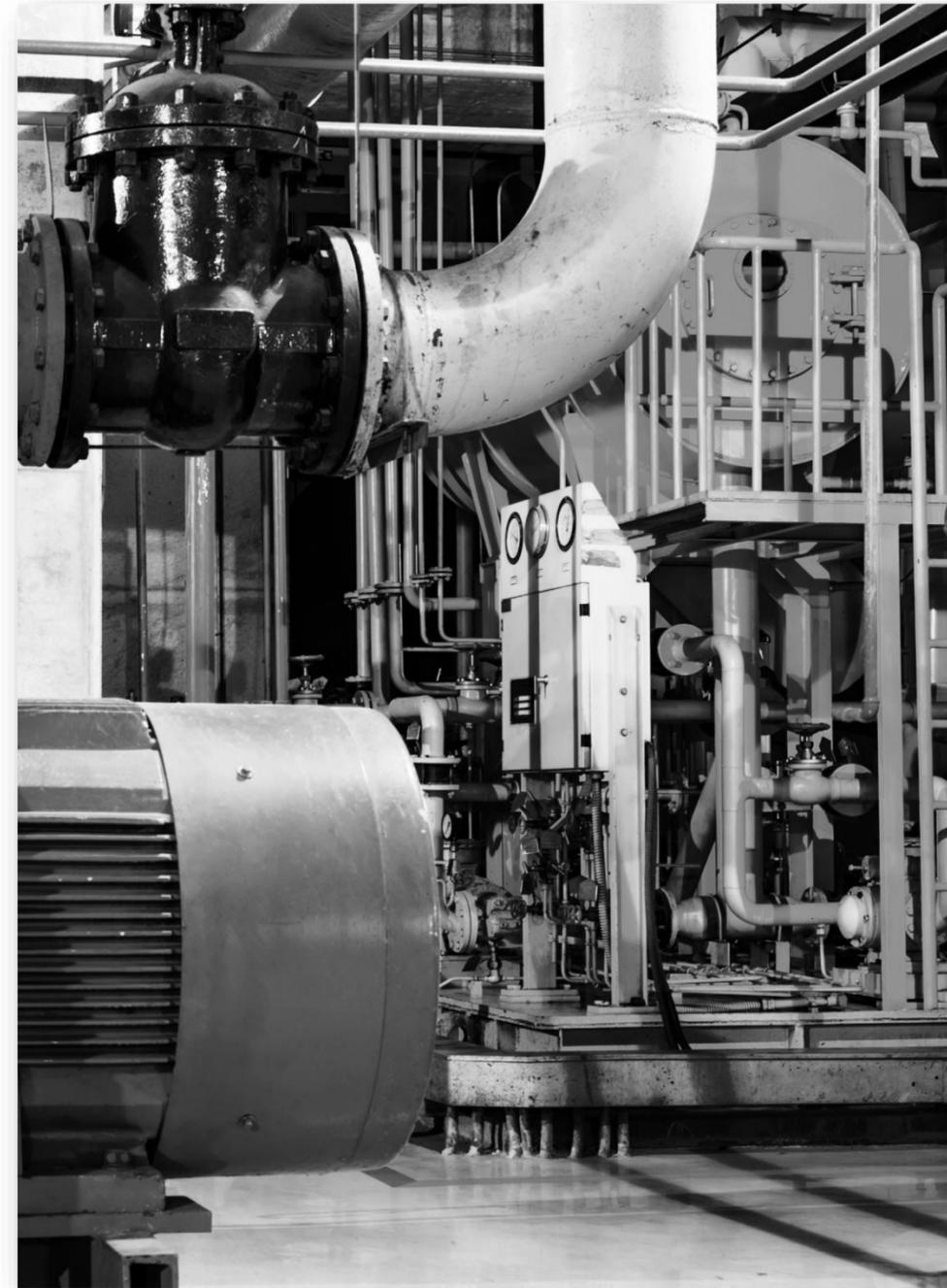




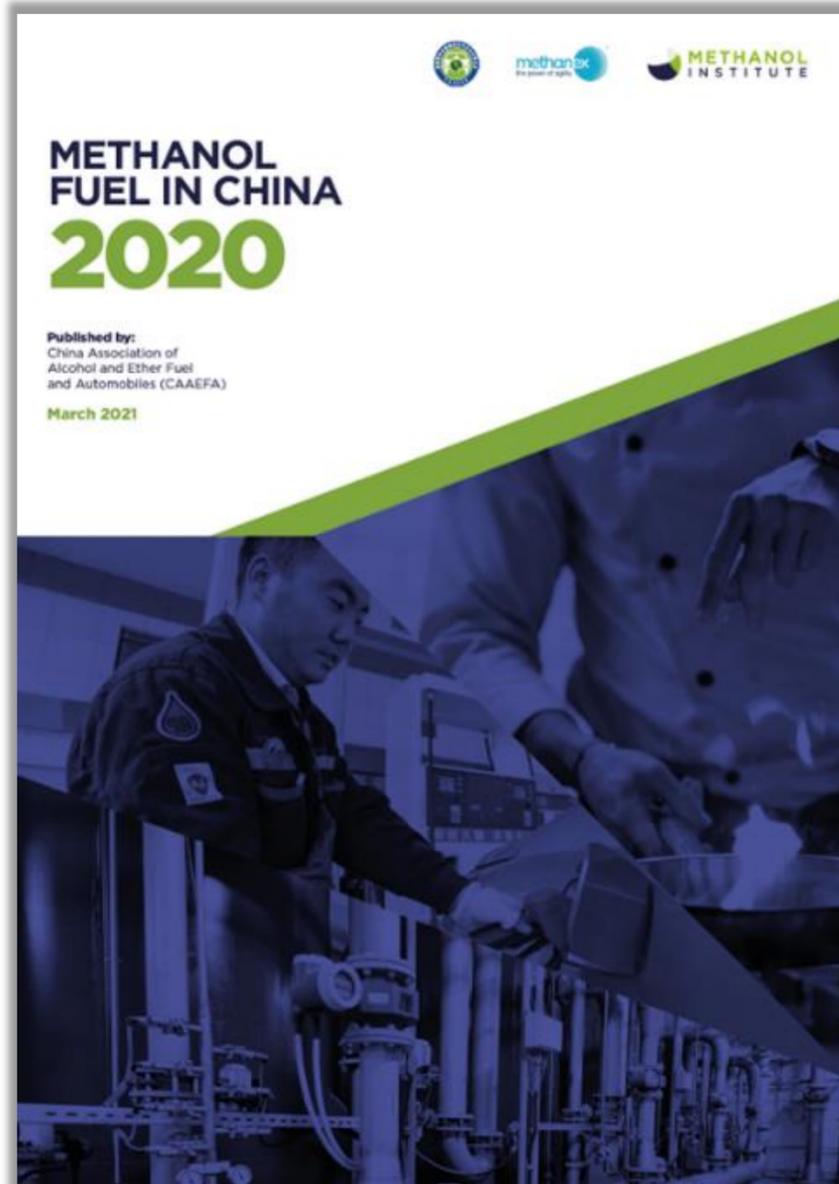
- The world's first methanol-fueled towboat is set to join the fleet of Metairie, La., based Maritime Partners LLC and become available for charter in 2023 to meet the pressing demand for sustainable towboat operations.
- The vessel, the M/V Hydrogen One, will be IMO 2030 compliant, meet the USCG's Subchapter 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.



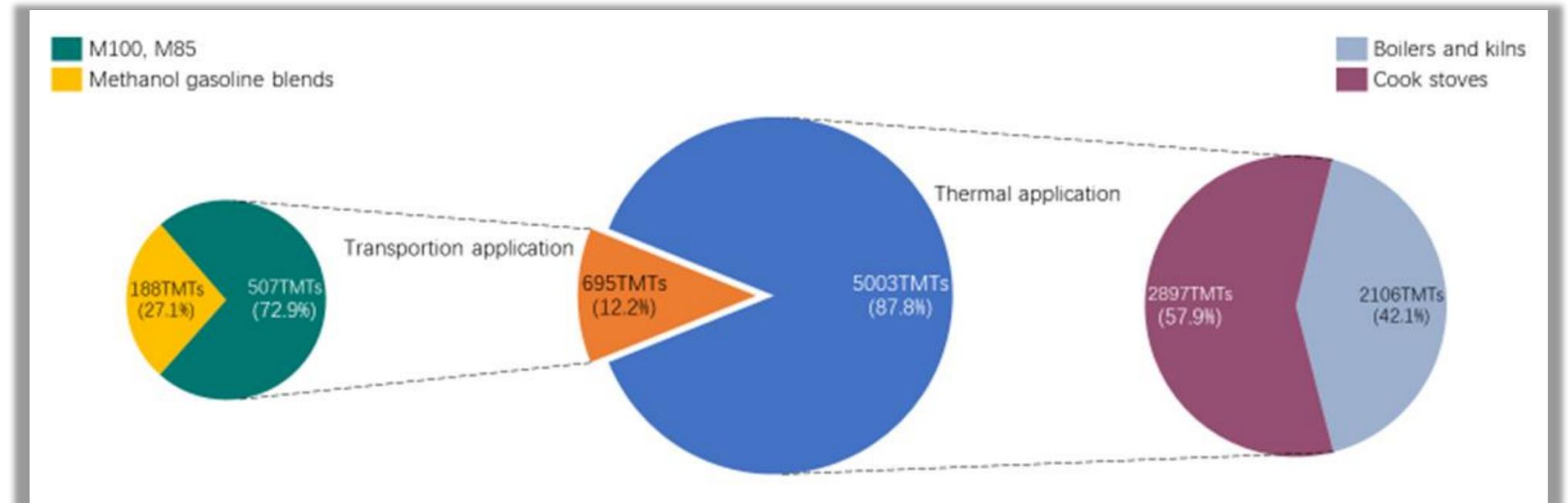
Heat and Power



Methanol Fuel in China



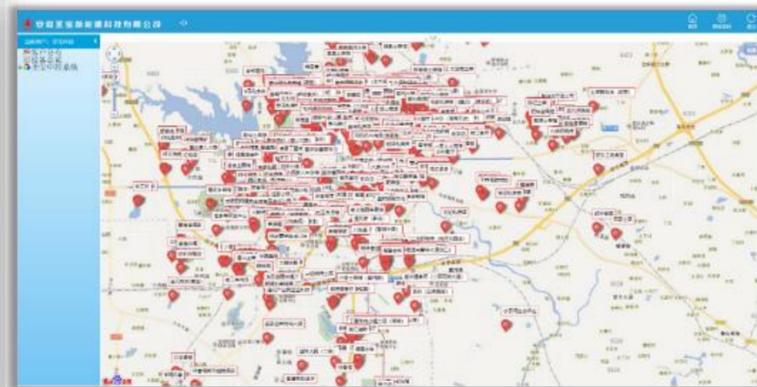
<https://www.methanol.org/heat/>



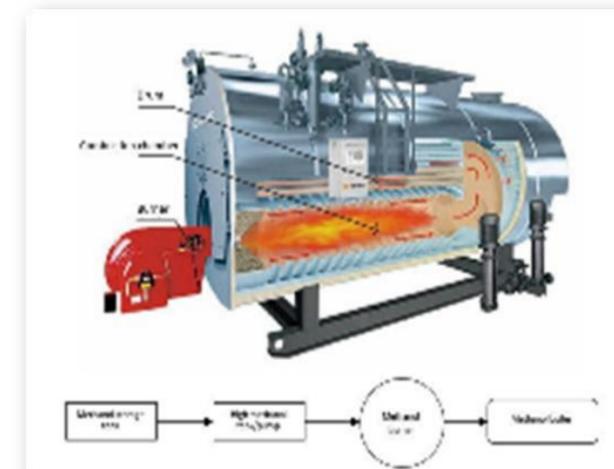
- MI released survey report in 2020 on Methanol Fuel in China
 - 77 companies completes questionnaire
 - 300 companies participated in phone interviews
 - Dozens of site visits
- Close to 6 MMT of methanol fuel found in the survey
- Transportation fuel includes methanol vehicle fuel M100, M85 and methanol gasoline blending
- Thermal applications include boilers, kilns, and cook stoves

Cook Stoves and Industrial Boilers

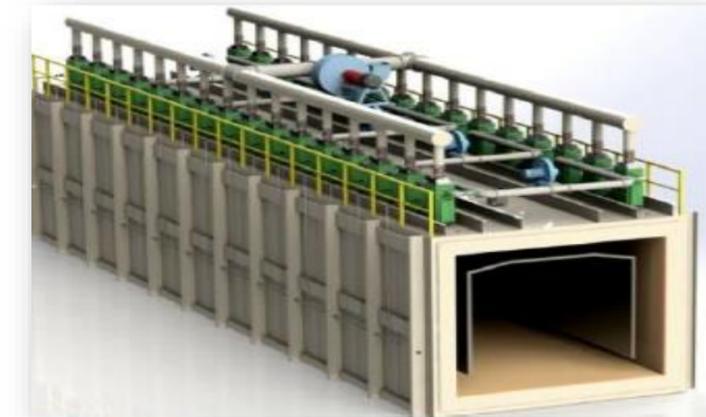
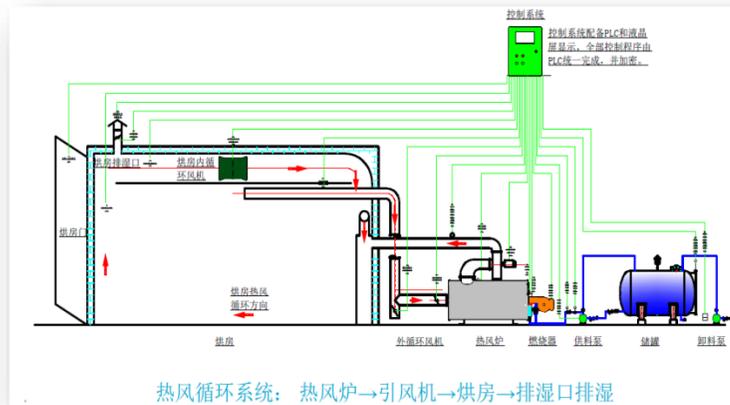
- Different types methanol cook stoves: Single heating, stir fry, steaming
- Widely used in restaurants, central kitchens, mainly cost-driven
- MI and Methanex working with Chinese partners on national cook stove safety standards



- Industrial boilers are widely used for heating and industrial steam
- Many cities in China prohibiting use of coal and diesel fuels
- Capacity ranged from 1 to 20 ton/hour
- One steam ton capacity consumes 110 kg of methanol, and runs 24/7
- Methanol fuel is used neat or as blend with diesel fuel



Kilns & Home Heating



- Glass/ceramic kilns – China makes 60% of world's glass products; methanol uses less air intake and produces cleaner flue gas for superior finish



- Beginning in 2018, China using methanol for home heating
- In Shanxi Province, methanol used to heat 50,000 households in 10 counties
- Small heaters for individual families and centralized 2- & 4-ton steam boilers for larger buildings

China: Gensets

- Since 2019, MI has worked with China's Ministry of Industry and Information Technology to develop methanol fueled gensets for electric power generation
- In 2021, Chinese manufacturers announced plans to manufacture three categories of power output: 3-5 kW; 30 kW; and 300-500 kW
- First 200 kW methanol genset being tested in Russia
- MI working with Chinese partners on national standards for methanol gensets



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Transport Energy Strategies Webinar

December 13, 2022



Methanol

A Low Emission Liquid Fuel for Today
and the Future

Ayca YALCIN
Director, Global Market Development



Agenda

1

Introduction

2

Methanol & Sustainability

3

Emerging Applications of Methanol

- Marine Fuels
- Road Vehicle Fuels & Other Applications

4

Methanol's role in the Transition to a Low-Carbon Future



Methanex Corporation

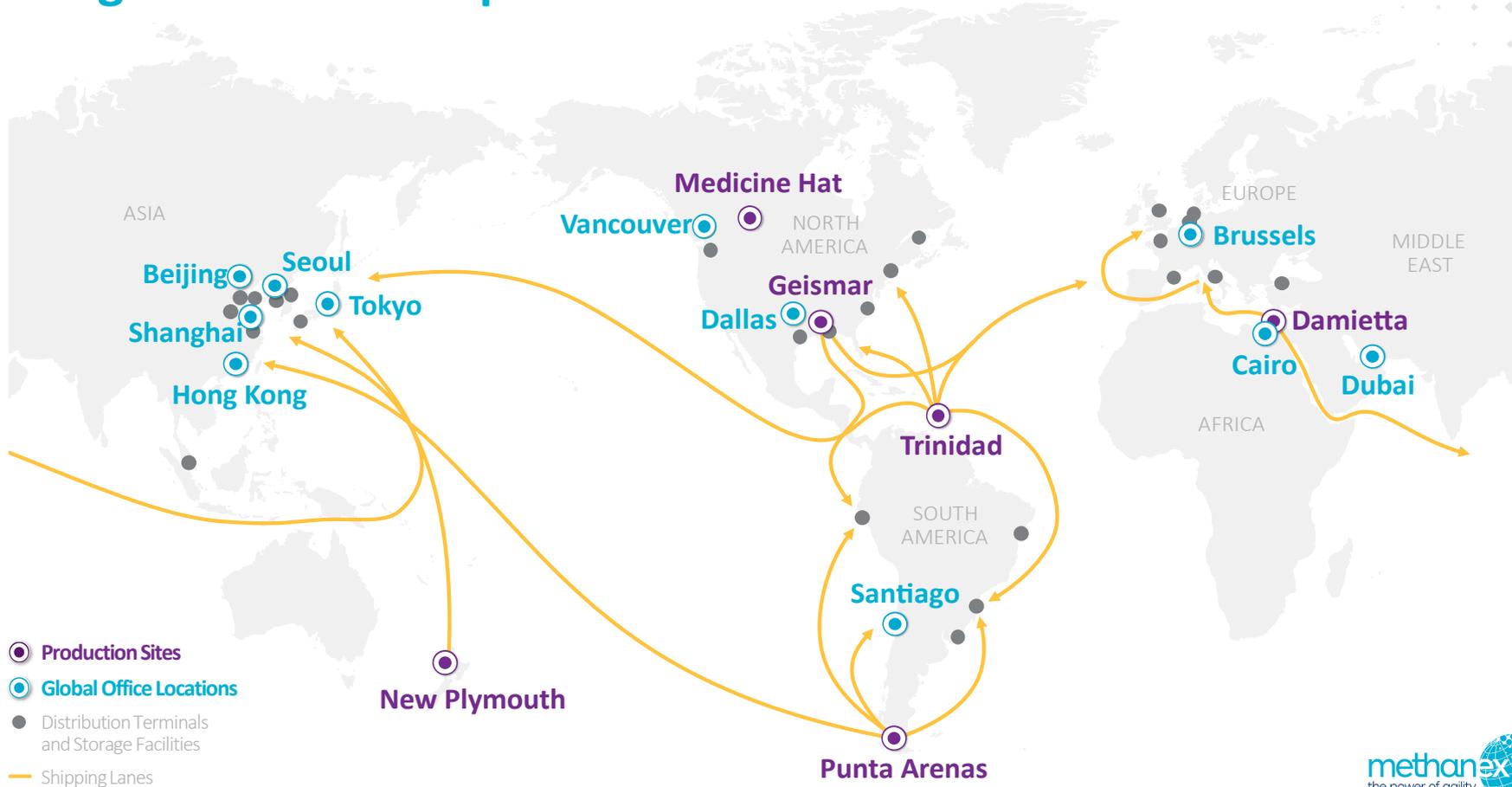


Company Overview



World's largest producer and supplier of methanol to major international markets

Integrated Global Capabilities





About Methanol

Sustainability benefits of methanol as a product

Methanol is an essential ingredient in modern life

CHEMICAL END USES

BUILDING MATERIALS



AUTOMOTIVE MANUFACTURING



PHARMACEUTICALS

CLOTHING AND TEXTILES



HIGH-TECH APPLICATIONS



MEDICAL EQUIPMENT

ENERGY-RELATED END USES

MARINE FUEL



VEHICLE FUEL



INDUSTRIAL + COMMERCIAL APPLICATIONS



DOMESTIC APPLICATIONS



Emerging applications of Methanol

Methanol is a cleaner-burning alternative fuel



Methanol meets IMO requirements and is cost competitive over the cycle



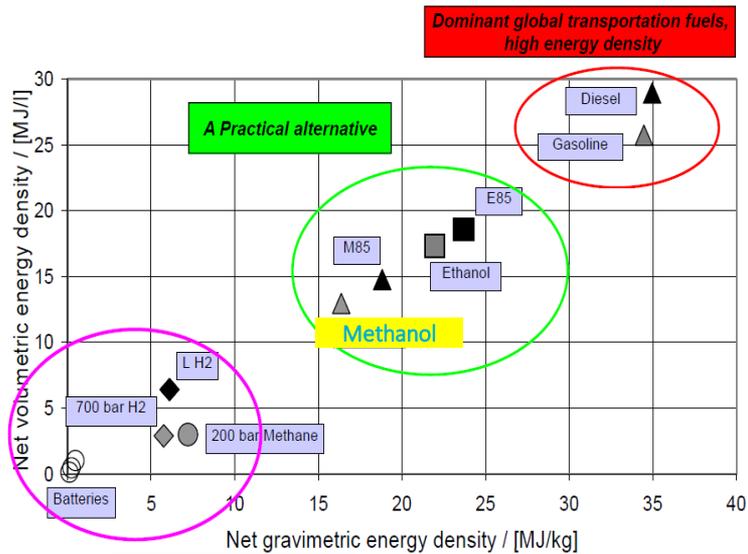
Methanol reduces emissions when blended with or substituted for gasoline



Methanol is used as an alternative to coal for industrial boilers, kilns, and cooking stoves to reduce emissions

Methanol - a practical alternative liquid fuel

Methanol's energy density & liquid fuel properties make it a pragmatic alternative fuel

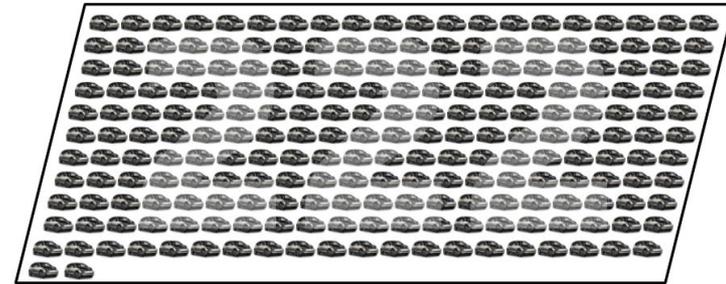


Low energy density
High on board storage costs

LOTUS
ENGINEERING



1 m³
Methanol



222 BMW i3 electric cars

*Storage capacity of one BMW i3 first generation battery is 21,6 kWh.

Source: bse engineering (Germany) – “Why methanol in the transport sector”

Methanol as a Marine Fuel



CREOLE SUN
PANAMA
IMO 9450214

The innovation in the marine industry

Waterfront Shipping has been leading the innovation since 2013

2013

Concept Design
- Engine Development



2016

WFS 1st generation vessels
launched



Cajun Sun

2020

WFS 3rd generation
vessels ordered (+8)

2020

IMO methanol
guidelines approved

2022+

100< methanol vessels in
operation or on order &
multiple methanol engine
providers

2015

Stena Germanica
Conversion 1°
methanol ferry



2015-2019

Leanships, SUMMETH,
Green Pilot,
MoT China Fishing Boat

2019

WFS 2° generation
vessels launched



Creole Sun

2020/2021

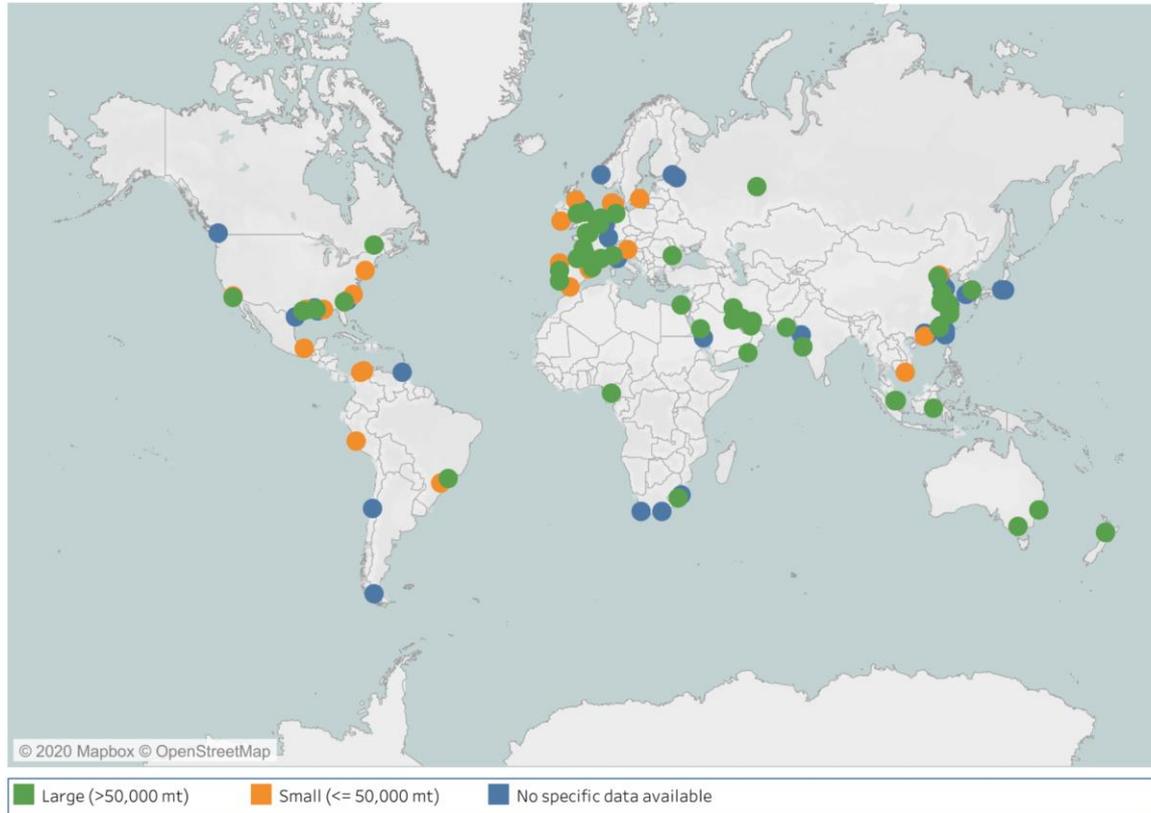
Major industry players
adopting methanol as a
marine fuel

2020-2024

Fastwater
Project

Available at over 125 ports worldwide

- Methanol is one of the world's top traded commodities and is available at the top ports through existing infrastructure



Sources: Methanol Institute, Methanex, DNV,

Methanol Bunkering

- ✓ It has similar bunkering guidelines and safety standards as conventional marine fuels
- ✓ First barge to ship methanol bunkering was safely done using a standard barge and the existing infrastructure
- ✓ Can easily & safely be replicated at any port



World's first barge-to- ship methanol bunkering operation In partnership with the Port of Rotterdam, Vopak, TankMatch and NYK Shipping

Methanol Vehicle Fuels & Other Fuel Applications



Methanol's growth as a vehicle fuel

Methanex supported the growth by sponsoring pilots, establishing guidelines, organizing safety seminars

Interest in methanol as a vehicle fuel growing globally.

Israel, Italy, Denmark, Iceland, Germany, India, Trinidad...etc) piloting/commercializing methanol as a vehicle fuel



2018
Launch of **M100 taxi** in Xi'an



2018
Launch of **GEELY M100 heavy duty truck**

2020/2021
~18,000 M100 taxis running in Guizhou



2020/2021
Development of three national standards

2025+
Estimated ~70,000+ methanol vehicles in operation with ~1.5MMT of methanol demand

2012-2016

2 guidelines for design, construction, operation and management of **methanol filling stations** in China piloted

2016-2017

4 Responsible Care seminars in four pilot cities in cooperation with MIIT and GEELY

2019

Published *"The Guidance of Developing Methanol Vehicles Applications in Some Parts of China"* jointly with 8 ministries

2022

Supported the launch of GEELY methanol hybrid vehicles

2022

~30,000 M100 vehicles running in China



Thermal applications emerged in China as a coal substitute

Methanol used as a cost-effective cleaner-burning fuel for industrial boilers, kilns, furnaces and cook stoves

Methanex has been supporting methanol use as a thermal fuel in China that has now reached an annual demand of > 6 MMT

2016

MeOH fueled boiler pilot in Beijing



2018

Group standards for MeOH as a boiler fuel implemented



2019

MeOH fueled kiln pilot in Fujian



2021

Development of group standard "Technical Safety Code for Civil Alcohol-based Liquid Fuel"

2019/2020

Sponsored industry survey initiated by China Association of Alcohol and Ether Fuel and Automobiles (CAAEEFA)

Safety seminars in selected regions

2022

Beijing 2022 Winter Olympics and Paralympics ceramic mascots produced by MeOH fueled kiln



Transition to a Low-Carbon Future



methanex
the power of agility



Drivers for Green Development

Growing interest in demand not yet matched by economically viable supply

Climate Treaties and Regulations



Voluntary efforts driven by growing climate focus



Developing Technologies

Power to X



Waste to Chemicals

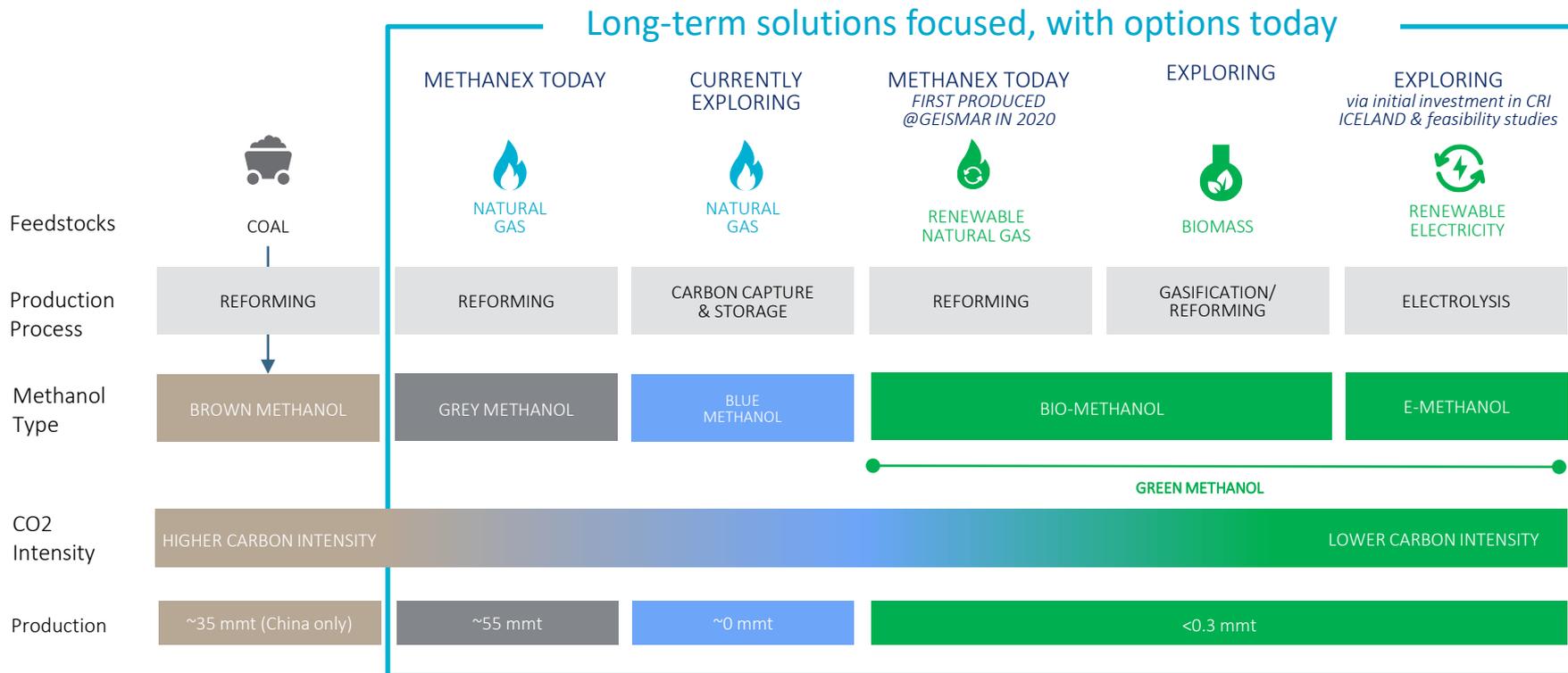


Carbon Capture & Storage



Methanol's role in the transition to a low-carbon economy

Methanol can be produced from different feedstocks and by using different energy sources



Reducing Emissions: an opportunity & a challenge



- Methanol benefits to low carbon economy
 - Energy-efficient buildings
 - Electric, lower-weight cars
 - Solar panels
 - Wind turbines
 - Low emission fuels
- High heat required in production (approx. 900°-1000°C)
- Alternative production technologies (e.g., renewable electricity & renewable feedstock) not yet economically viable at scale
- Manufacturing plants have long lifespans
- Commodity business

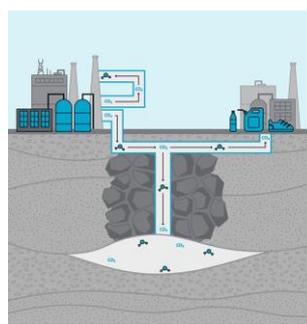
Our approach to a low carbon future I: Emission reduction from operations

We are exploring several opportunities at our existing sites, and getting ready to implement low carbon solutions

Plant efficiency



Carbon capture, utilization and storage feasibility



Research and development into new plant design



Alternative feedstocks and renewable energy



Complete G3: World-class emissions intensity

Our approach to a low carbon future II : Growing Markets for Methanol

We are actively supporting the growth of emerging markets

Marine fuel



Vehicle fuel



Thermal applications, such as industrial boilers



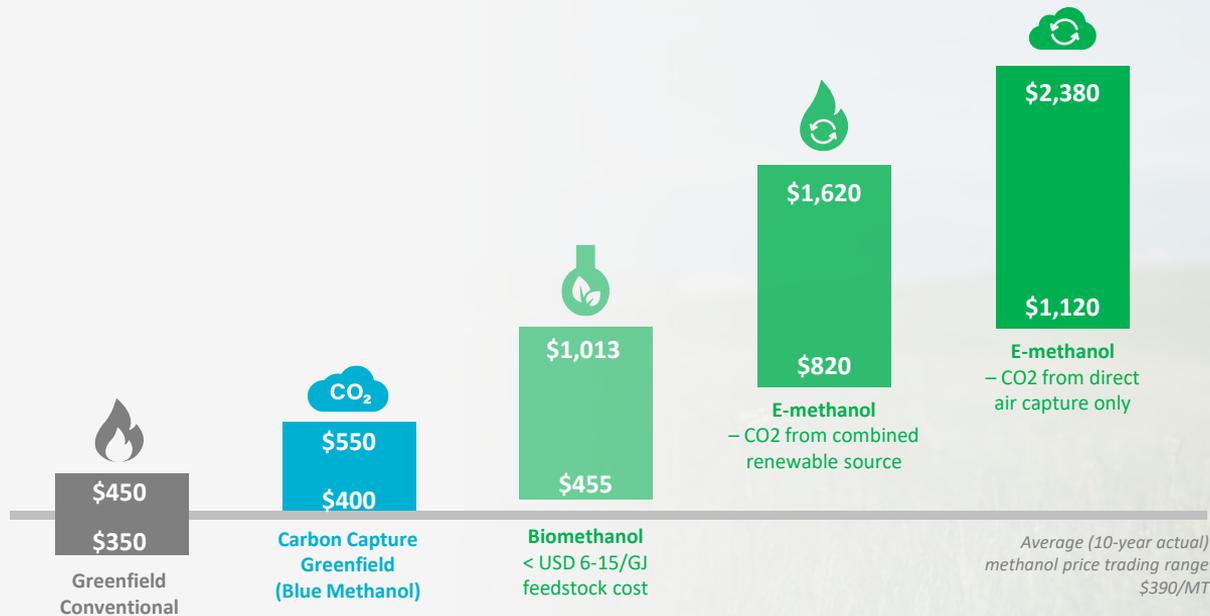
Low carbon methanol as a feedstock



Price response required to incentivize new low-carbon methanol production

Range of current capital and production costs for different forms of methanol

USD \$/tonne of methanol*



How do we achieve a step change reduction in our overall CO2 emissions?

To meet society's goals for net zero by 2050 requires a multipronged approach.

Methanex is dedicated to work with stakeholders to build a sustainable future together.



Capital investment in research and development to enable the broad scale-up of new technologies



Public policies that incentivize research and development and support industries to transition to low carbon economy



Collaboration among technology companies



Customers willing to pay a “green premium” for a lower carbon product



Thank you

Ayca YALCIN

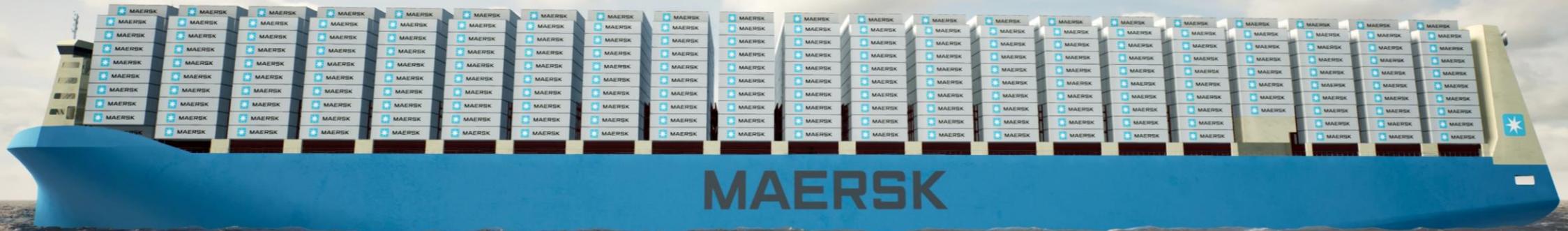
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 [@Methanex](https://twitter.com/Methanex)

Decarbonising shipping at Maersk



**Berit Hinnemann, Head of Green Sourcing Strategy
and Business Development**

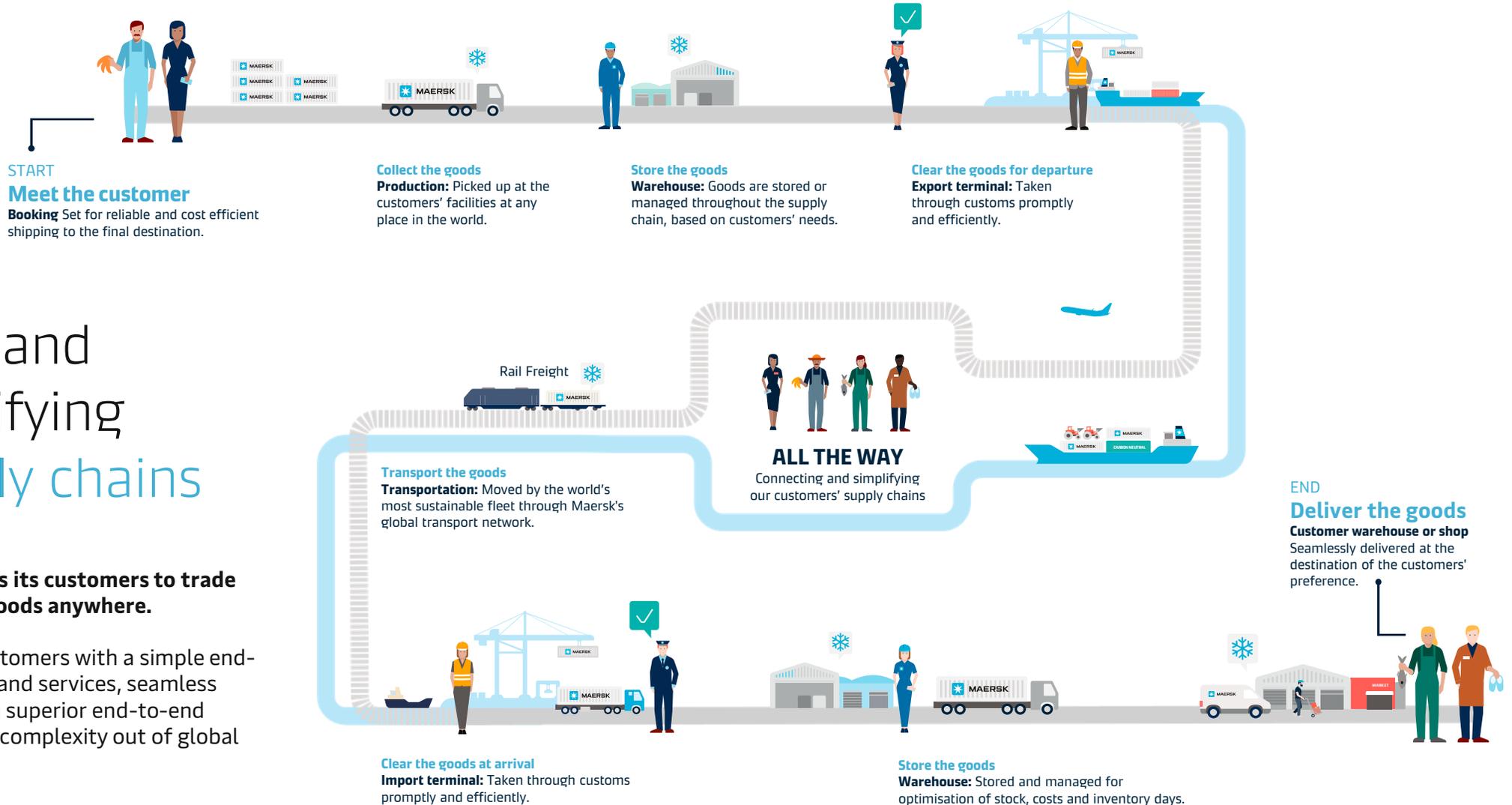
**The Future of Methanol
Transport Energy Strategies Webinar
19 December 2022**

OUR BUSINESS

Connecting and simplifying global supply chains

A.P. Moller - Maersk enables its customers to trade and grow by transporting goods anywhere.

Maersk works to provide customers with a simple end-to-end offering of products and services, seamless customer engagement and a superior end-to-end delivery network, taking the complexity out of global supply chains.



The science is clear: We are in a climate emergency and global logistics is part of the problem

3.5 bn tons of CO₂ emissions emitted from global logistics every year

3% of global CO₂ emissions emitted from international shipping

34 mio tons of CO₂ directly emitted from A.P. Moller-Maersk operations (scope 1)

+10 mio tons of fuel oil consumed each year by the A.P. Moller-Maersk fleet

Taking leadership in decarbonising logistics

2018

2022

2030

2040



- Launched Net Zero ambition
- Introduced ECO Delivery
- Defined future fuels priority
- Invested in 13 green methanol-enabled vessels



- Accelerated targets towards 2030 and 2040
- Invested in 6 more green methanol-enabled vessels



- Industry-leading green customer offerings across the supply chain
- Aligned with a Science Based Target 1.5-degree pathway



- Net zero across our business and 100% green solutions to customers



Our all-in climate strategy

- new ambitions launched in January 2022

2040

Climate-neutral: Net-zero emissions across entire business

2030

Ocean: ~50% reduction in carbon intensity; 25% of all cargo transported on green fuel

Terminals: ~70% absolute reduction of greenhouse gas emissions

Air: Min. 30% of cargo transported using Sustainable Aviation Fuels (SAF)

Warehouses/depots: Min. 90% green operations

Inland transportation: Min. 20% of cargo moves on low/zero emissions technology

Decarbonising Ocean

2030 Targets



Ocean

~50% reduction in emission intensity from 2020 baseline

Min. **25%** of Ocean cargo transported with green fuels

Key Levers



Fuel efficiency improvements

- Network optimisation
- Network execution
- Technical management

Transitioning to green fuels

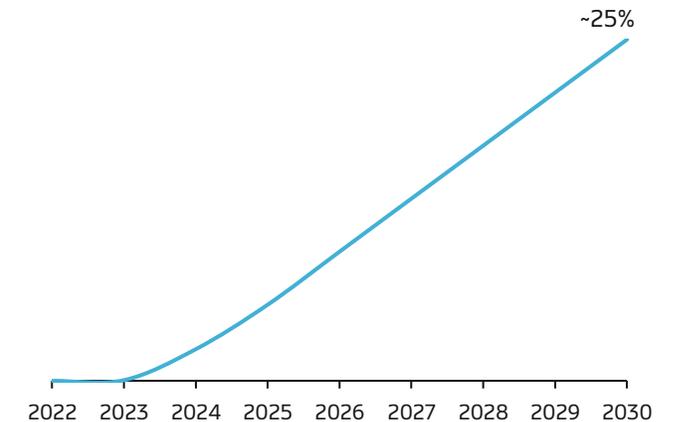
- Investment in green vessels via existing fleet renewal plan
- Potentially retrofit select existing vessels
- Introduce chartered green vessels
- Use of bio-diesel as a gap closer

Actions

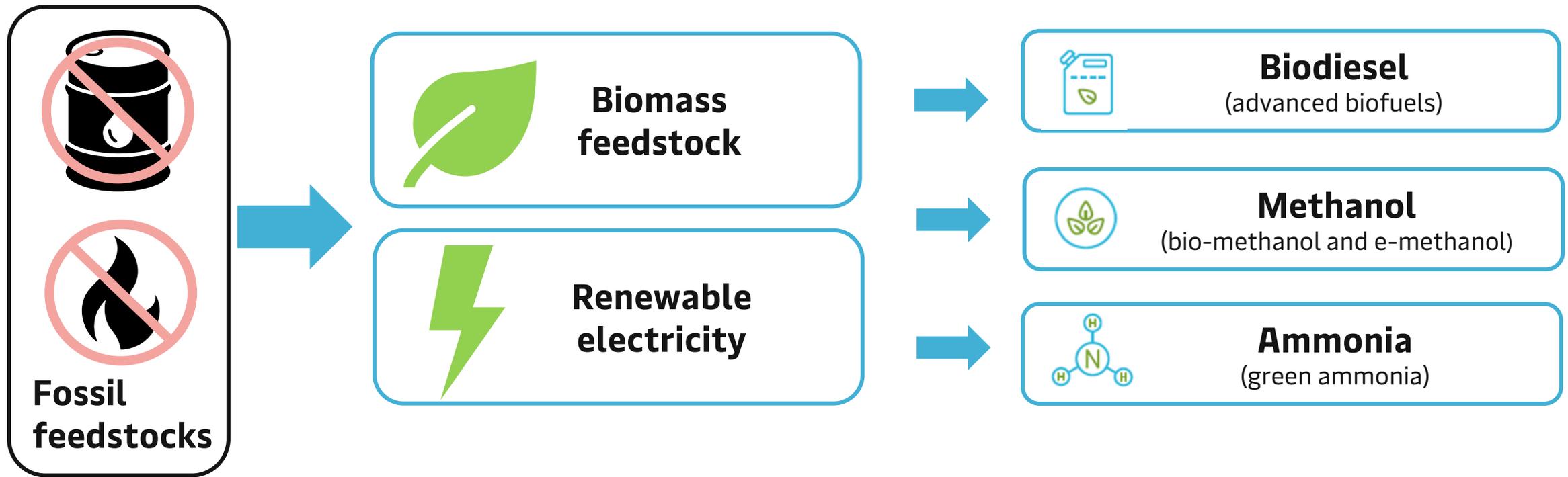


19 green methanol-enabled vessels on order through 2025

Green fuel enabled TEU capacity (% of total fleet by year end)



We need to transition our fleet from fossil fuels to green fuels produced from biomass and renewable electricity



Note: Green fuels are defined as fuels with zero or very low greenhouse gas emissions on a lifecycle basis

To address the climate crisis, for our fleet, we must leap-frog directly to green fuels

Solutions that we KNOW can solve the climate problem	Solutions that we KNOW can solve the climate problem	Solutions that we THINK/HOPE can solve the climate problem
<h3>Biodiesel (net zero)</h3>	<h3>Green methanol (net zero)</h3>	<h3>Green ammonia (zero carbon)</h3>
<p> Biodiesel (advanced biofuels)</p> <ul style="list-style-type: none"> ✓ Can be used as drop-in fuel in existing vessels and with existing supply chain and infrastructure ✓ Will also be needed as pilot fuel ✓ Promising innovation within advanced biofuels ❖ Availability and scalability is limited ❖ Price pressure due to competing demand from other industries 	<p> Bio-methanol  E-methanol</p> <ul style="list-style-type: none"> ✓ Vessel technology is available ✓ Operational experience at sea exists ✓ Easy to handle (liquid) and supply chain/bunkering can be managed ✓ Existing fleet can be retrofitted at reasonable cost ✓ Best solution for the full marine ecosystem ✓ Bio-methanol cheapest short-medium term ❖ Main limitation is availability of biogenic CO2 	<p> E-ammonia</p> <ul style="list-style-type: none"> ✓ Likely cheapest long term ✓ 'The perfect e-fuel' – great scale potential ✓ Zero-carbon ✓ First vessel technology ready in ~3 years ❖ Large engines only available end decade ❖ No operational experience at sea ❖ Difficult to handle/bunker (gas) ❖ Toxic – safety challenges on board ❖ Environmental impact of ammonia and N2O emissions needs to be understood

 **We see green methanol in combination with biodiesel as the only certain and scalable pathway towards significant impact this decade**

Note: Green fuels are defined as fuels with zero or very low greenhouse gas emissions on a lifecycle basis

Green Fuels

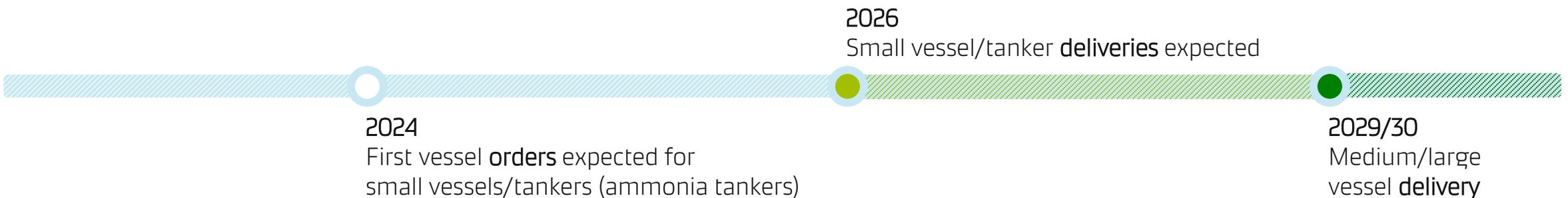
Expected technology maturation timeline

Green methanol

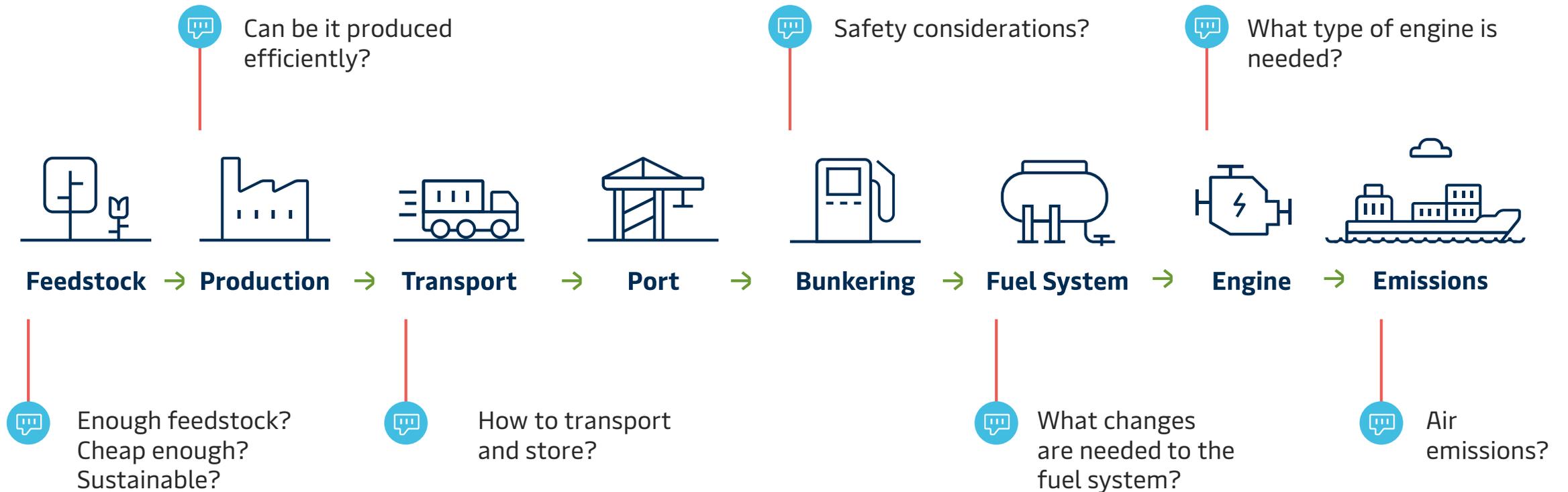
//// Piloting //// Scaling



Green ammonia (current expectations; scalable late this decade)



For each of the fuels, transformation needs to happen across the entire fuel supply chain





- The new large container vessels represents a completely new vessel design
- Accomodation is moved forward and engine exhaust routed aft
- 16.000 m³ methanol tanks enabling full round trip operation
- They will be 20% more energy efficient than industry standard

We need to break the chicken-and-egg problem: Maersk accelerates fleet decarbonisation starting in 2023

1

Our first "pilot scale" carbon neutral container ship in 2023

- 10,000 ton/year of green methanol secured

2

Our first series of 12 large carbon neutral container ships in 2024 and 2025 and 6 large container ships in 2025

- We have announced eight green methanol offtake partnerships and will continue to develop partnerships

Securing adequate supplies of cost competitive green fuel will be a challenge but can be done

Sourcing levers



Drop-in biodiesel
ECO Delivery fuel today;
gap-closer going forward



Signed green fuel MOUs¹
MOUs for +1.5m tons of
methanol signed and strong
pipeline

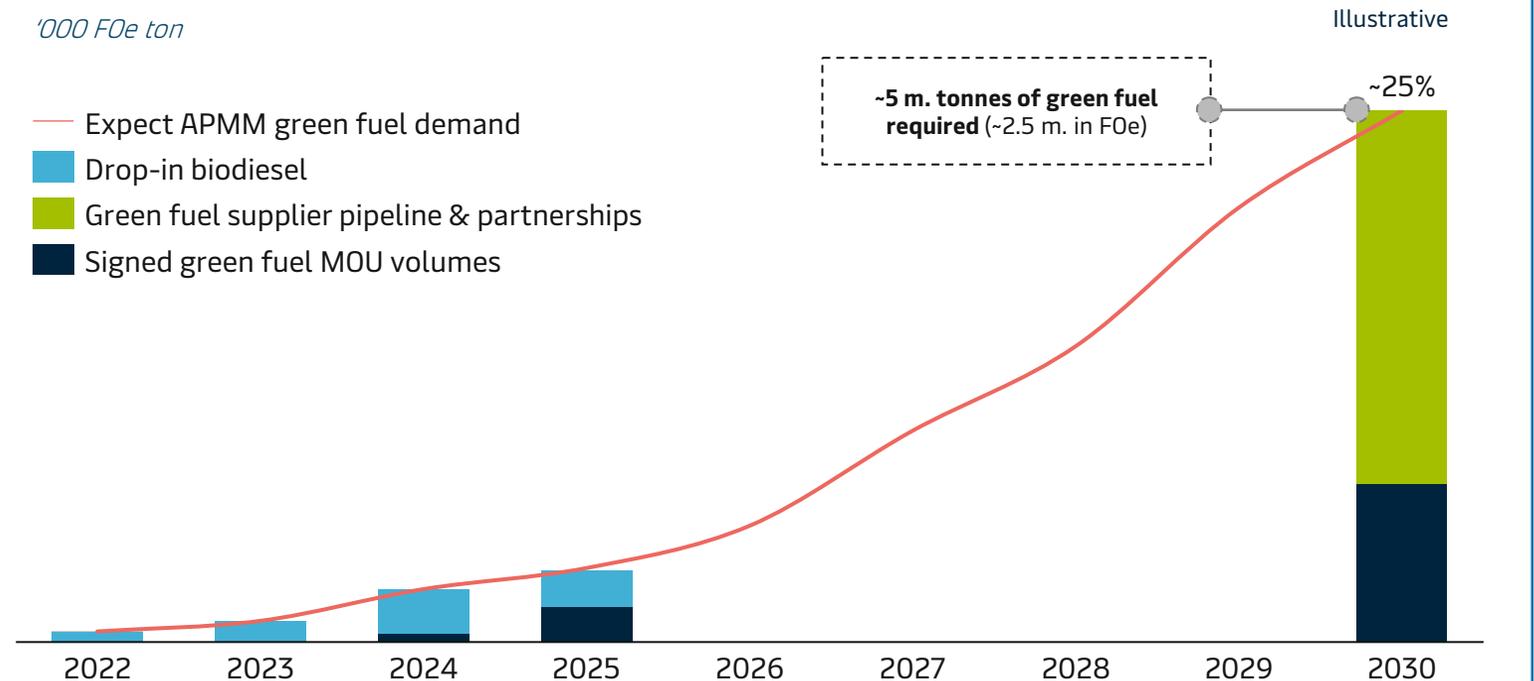


Signed partnerships with
sovereign governments

Expected green fuel requirement and sourcing lever

'000 FOe ton

- Expect APMM green fuel demand
- Drop-in biodiesel
- Green fuel supplier pipeline & partnerships
- Signed green fuel MOU volumes



(1) MOUs signed – still require final validation and contracting

Signed MOUs

Eight leading partners will support us on the journey – with more to come

Orsted

- 300,000 tonnes per year
- First delivery in 2025
- United States



CIMC ENRIC
中集安瑞科

- 250,000 tonnes per year
- First delivery in 2024
- China



**PRO
MAN**

- 100,000 tonnes per year
- First delivery in 2025
- Multiple locations



**Carbon
Sink^{LLC}**

- 100,000 tonnes per year
- First delivery in 2027
- United States



**EUROPEAN
ENERGY**

- 2-300,000 tonnes per year
- First delivery in 2025/2026
- South America & United States



Green Technology Bank

- 350,000 tonnes per year
- First delivery in 2024
- China



WASTEFUEL

- 30,000 tonnes per year
- First delivery in 2024
- South America



Debo

- 200,000 tonnes per year
- First delivery in 2024
- China



Thank you

