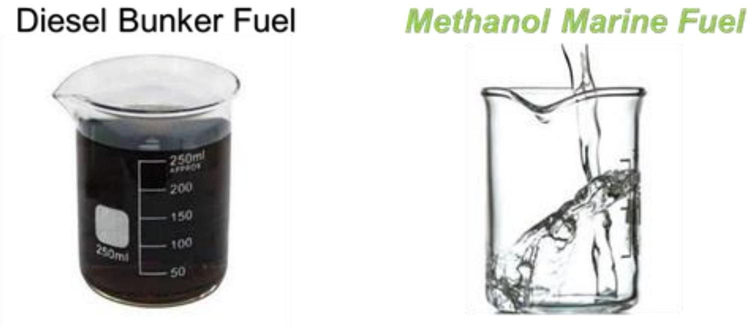
METHANOL
INSTITUTE

Methanol: An Emerging Marine Fuel

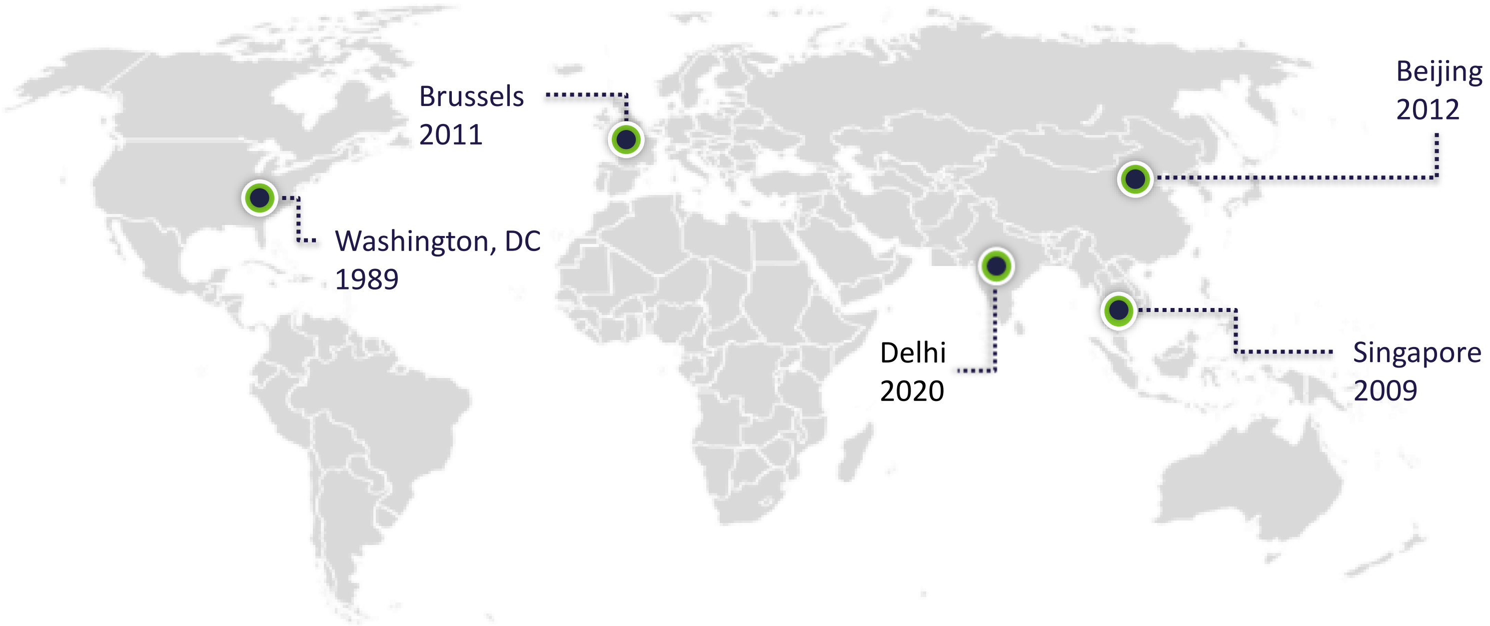


Methanol Institute -- October 2021

Singapore | Washington | Brussels | Beijing | Delhi

Our History

- The Methanol Institute (MI) was established in 1989
- 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

METHANOL INSTITUTE

Tier 1

PRO MAN

methanex
the power of agility

سابك
sabic

OCI

Tier 2

شركة قطر لإضافات الوقود المحدودة
Qatar Fuel Additives Company Limited

MITSUBISHI GAS CHEMICAL

MITSUI & CO., LTD.

ATLANTIC METHANOL

PETRONAS

Oman Methanol Company L.L.C.
شركة عمان للميثانول ش.م.م

Tier 3

eni
ecofuel

سبكيم
Sipchem
EXCELLENCE everywhere

YCI METHANOL ONE

JM Johnson Matthey
Inspiring science, enhancing life

Mitsubishi International Corporation

Tier 4

Enerkem

ADVENT

ClearFlame
ENGINE TECHNOLOGIES

CLARIANT

Advanced Chemical Technologies Inc.

HALDOR TOPSØE

OLDENDORFF 1921 100 2021

CARBON RECYCLING INTERNATIONAL
carbonrecycling.is

Stena Bulk

FUELSAVE
GREEN TECHNOLOGY

solvadis
we do chemistry

IMTT

Palcan

CASALE

HELM PROMAN METHANOL

Liquid Wind

OMAN TRADING INTERNATIONAL

TRICON ENERGY

Element 1
Powering Innovation

Double Green Bridge NW INNOVATION WORKS

RH2C
Renewable Hydrogen Canada Corporation

Blue World Technologies

Nebraska Public Power District
Always there when you need us

MOL
Mitsui O.S.K. Lines

SOUTHERN GREEN GAS
exporting Australia's sunshine ®

FiTech

mmsa
Global Insight, Asian Perspective

msc

RIX
FOCUSED ON THE FUTURE

GANE ENERGY

MAERSK

GREENFIELD GLOBAL

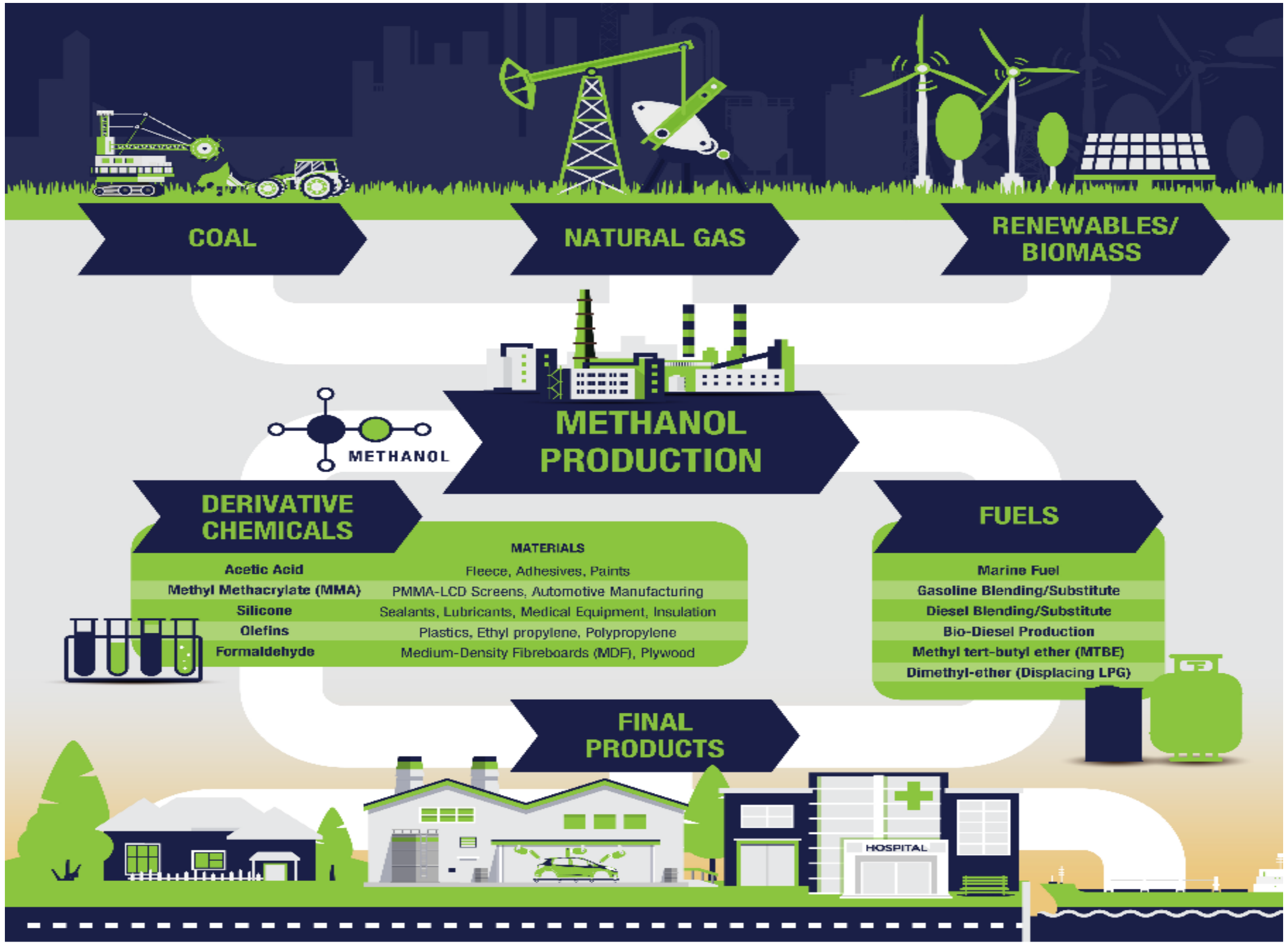
RUSCHEM

WASTEFUEL

ABEL ENERGY

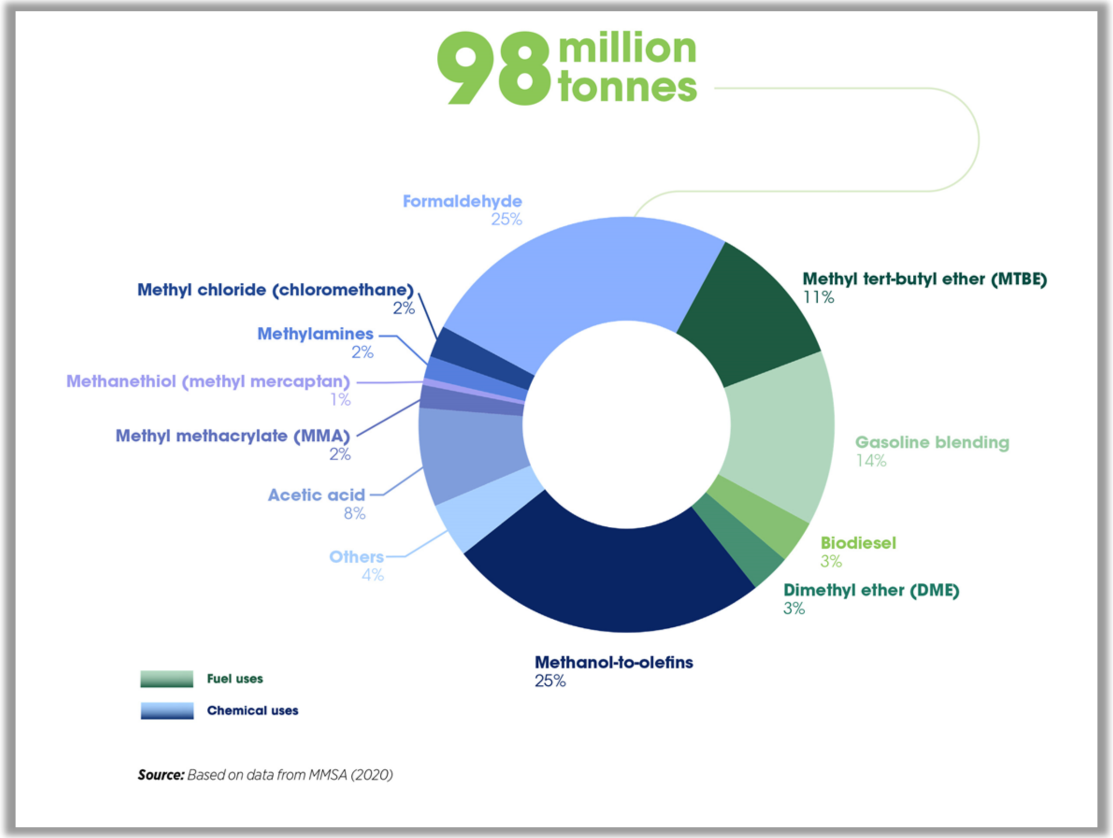
www.methanol.org/join-us

Essential Methanol



	MATERIALS
Acetic Acid	Fleece, Adhesives, Paints
Methyl Methacrylate (MMA)	PMMA-LCD Screens, Automotive Manufacturing
Silicone	Sealants, Lubricants, Medical Equipment, Insulation
Olefins	Plastics, Ethyl propylene, Polypropylene
Formaldehyde	Medium-Density Fibreboards (MDF), Plywood

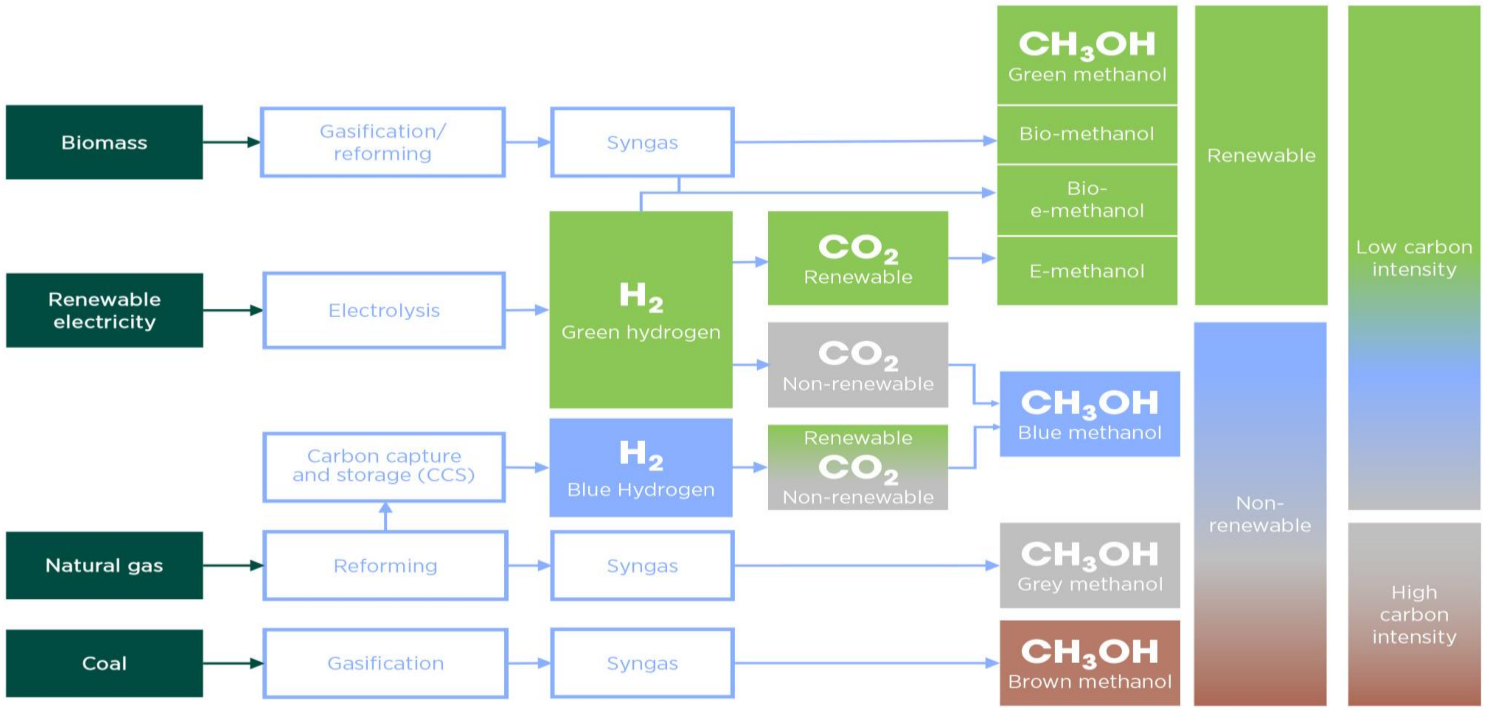
Marine Fuel
Gasoline Blending/Substitute
Diesel Blending/Substitute
Bio-Diesel Production
Methyl tert-butyl ether (MTBE)
Dimethyl-ether (Displacing LPG)



Source: *Based on data from MMSA (2020)*

Brown, Grey, Blue and Green

Figure 2. Principal methanol production routes



Renewable CO_2: *from bio-origin and through direct air capture (DAC)*

Non-renewable CO_2: *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

Cost of Production

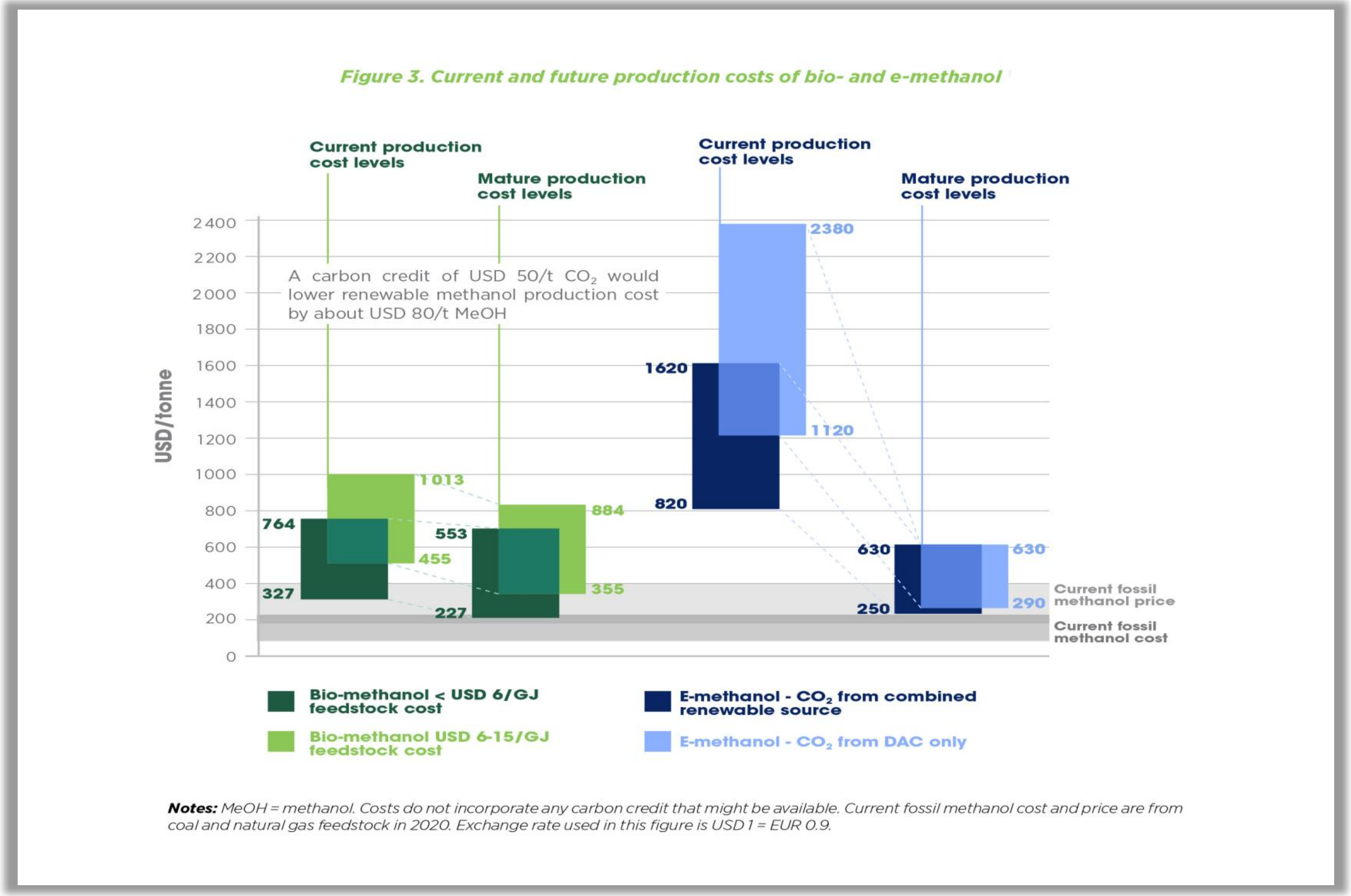
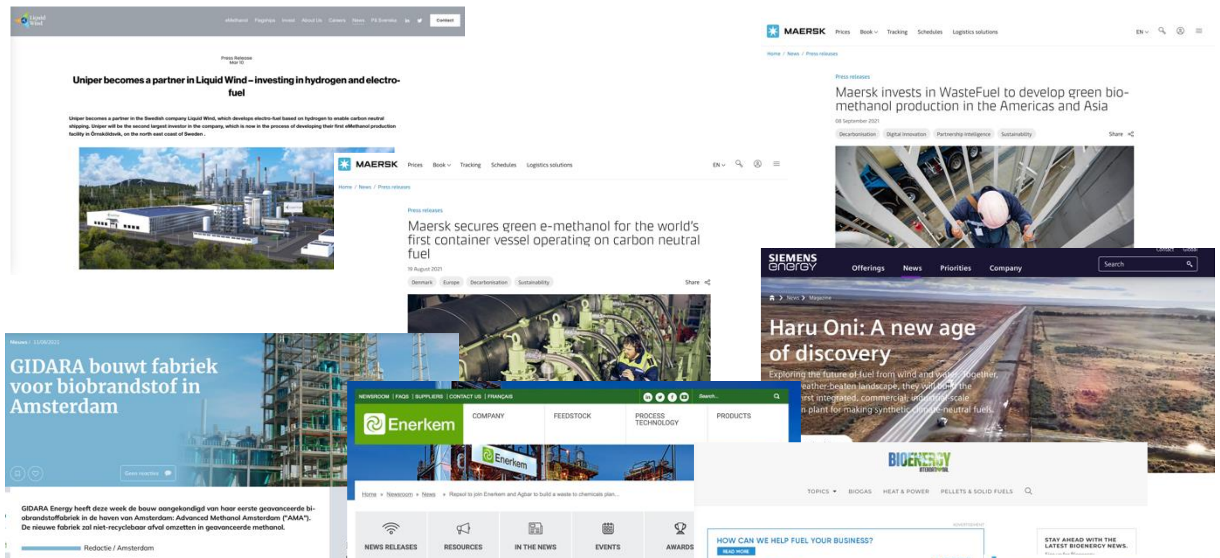


Figure 3. Current and future production costs of bio- and e-methanol

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.*

More & More Renewable Projects



Uniper becomes a partner in Liquid Wind – investing in hydrogen and electro-fuel

Uniper becomes a partner in the Swedish company Liquid Wind, which develops electro-fuel based on hydrogen to enable carbon neutral shipping. Uniper will be the second largest investor in the company, which is now in the process of developing their first eMethanol production facility in Örnsköldsvik, on the north east coast of Sweden.

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

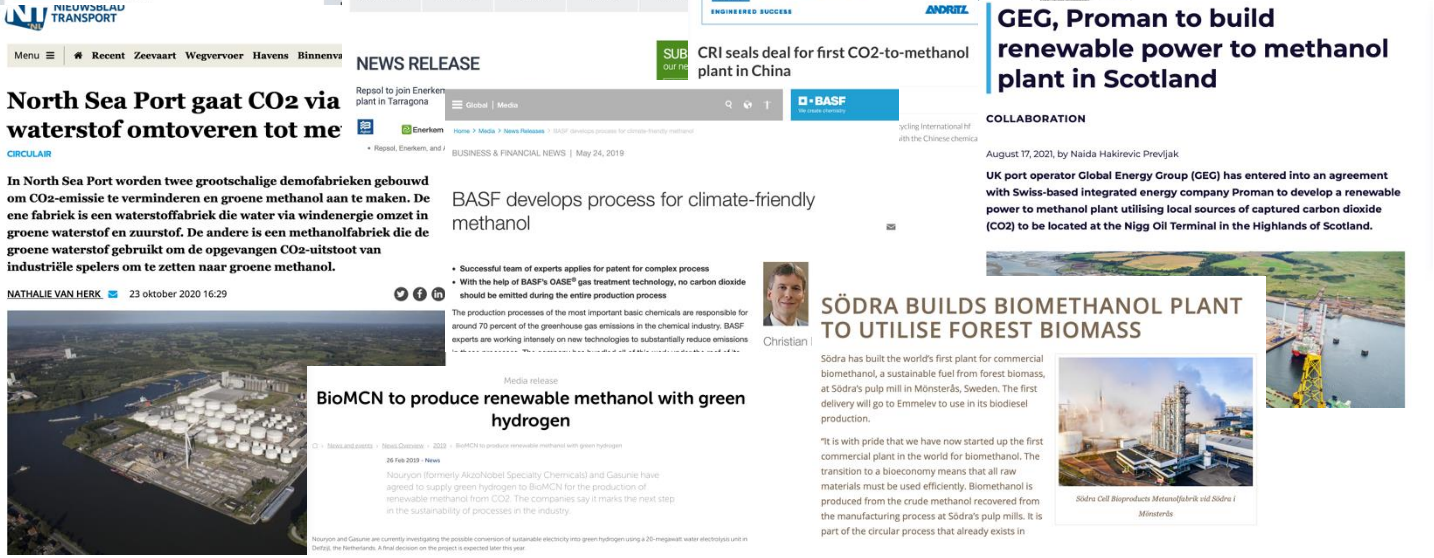
Maersk secures green e-methanol for the world's first container vessel operating on carbon neutral fuel

GIDARA bouwt fabriek voor biobrandstof in Amsterdam

GIDARA Energy heeft deze week de bouw aangekondigd van haar eerste geavanceerde biobrandstoffabriek in de haven van Amsterdam: Advanced Methanol Amsterdam ("AMA"). De nieuwe fabriek zal niet-recyclebaar afval omzetten in geavanceerde methanol.

Redactie / Amsterdam

Haru Oni: A new age of discovery



North Sea Port gaat CO2 via waterstof omtoveren tot me

In North Sea Port worden twee grootschalige demofabrieken gebouwd om CO2-emissie te verminderen en groene methanol aan te maken. De ene fabriek is een waterstoffabriek die water via windenergie omzet in groene waterstof en zuurstof. De andere is een methanolfabriek die de groene waterstof gebruikt om de opgevangen CO2-uitstoot van industriële spelers om te zetten naar groene methanol.

NATHALIE VAN HERK 23 oktober 2020 16:29

NEWS RELEASE

Repsol to join Enerkem plant in Tarragona

CRI seals deal for first CO2-to-methanol plant in China

GEG, Proman to build renewable power to methanol plant in Scotland

COLLABORATION

August 17, 2021, by Naida Hakirevic Prevljak

UK port operator Global Energy Group (GEG) has entered into an agreement with Swiss-based integrated energy company Proman to develop a renewable power to methanol plant utilising local sources of captured carbon dioxide (CO2) to be located at the Nigg Oil Terminal in the Highlands of Scotland.

BUSINESS & FINANCIAL NEWS | May 24, 2019

BASF develops process for climate-friendly methanol

- Successful team of experts applies for patent for complex process
- With the help of BASF's OASE® gas treatment technology, no carbon dioxide should be emitted during the entire production process

The production processes of the most important basic chemicals are responsible for around 70 percent of the greenhouse gas emissions in the chemical industry. BASF experts are working intensively on new technologies to substantially reduce emissions

Media release

BioMCN to produce renewable methanol with green hydrogen

26 Feb 2019 - News

SÖDRA BUILDS BIOMETHANOL PLANT TO UTILISE FOREST BIOMASS

Södra has built the world's first plant for commercial biomethanol, a sustainable fuel from forest biomass, at Södra's pulp mill in Mönsterås, Sweden. The first delivery will go to Emmelev to use in its biodiesel production.

"It is with pride that we have now started up the first commercial plant in the world for biomethanol. The transition to a bioeconomy means that all raw materials must be used efficiently. Biomethanol is produced from the crude methanol recovered from the manufacturing process at Södra's pulp mills. It is part of the circular process that already exists in

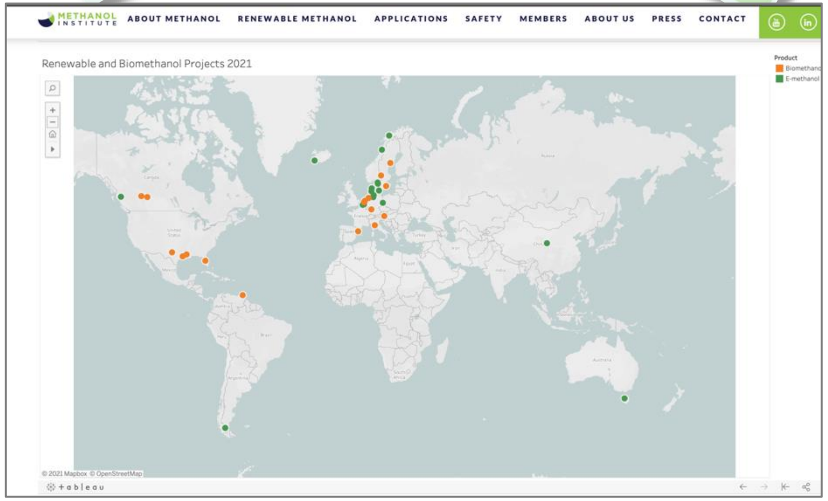
Södra Cell Bioproducts Metanolfabrik vid Södra i Mönsterås

IRENA

INNOVATION OUTLOOK

RENEWA

METH

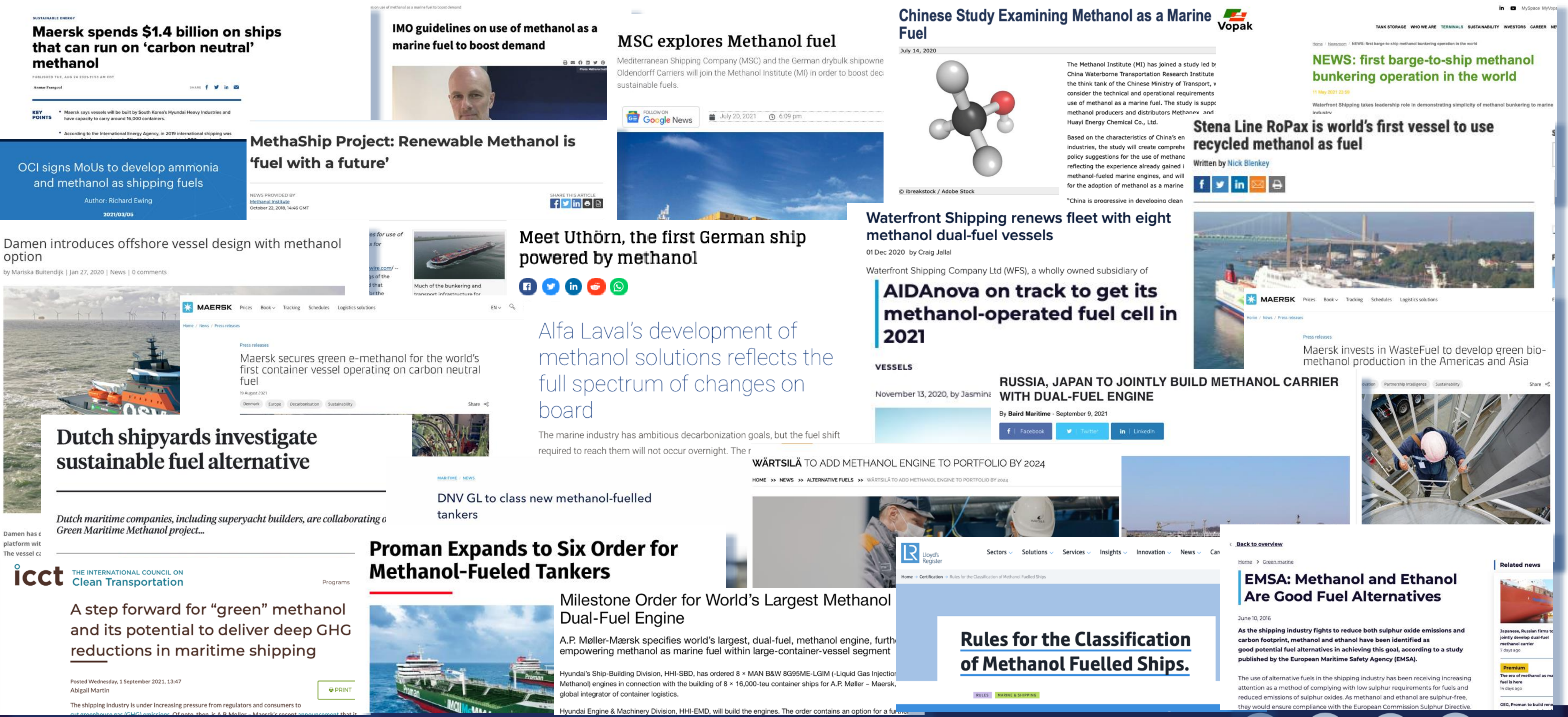


Renewable and Biomethanol Projects 2021

https://www.methanol.org/renewable/

Methanol Making Headlines

METHANOL INSTITUTE



SUSTAINABLE ENERGY

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

PUBLISHED TUE, AUG 24 2021-11:53 AM EDT

Anmar Frangoul

KEY POINTS

- Maersk says vessels will be built by South Korea's Hyundai Heavy Industries and have capacity to carry around 16,000 containers.
- According to the International Energy Agency, in 2019 international shipping was

---

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 shipowne Oldendorff Carriers will join the Methanol Institute (MI) in order to boost dec sustainable fuels.

FOLLOW ON Google News

July 20, 2021 6:09 pm

Chinese Study Examining Methanol as a Marine Fuel

July 14, 2020

© ibreakstock / Adobe Stock

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

Based on the characteristics of China's en industries, the study will create comprehe policy suggestions for the use of methan reflecting the experience already gained i methanol-fueled marine engines, and will for the adoption of methanol as a marine

"China is progressive in developing clean

Vopak

TANK STORAGE WHO WE ARE TERMINALS SUSTAINABILITY INVESTORS CAREER

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

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

11 May 2021 23:59

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

OCI signs MoUs to develop ammonia and methanol as shipping fuels

Author: Richard Ewing

2021/03/05

MethaShip Project: Renewable Methanol is 'fuel with a future'

NEWS PROVIDED BY
Methanol Institute
October 22, 2018, 14:46 GMT

SHARE THIS ARTICLE

Damen introduces offshore vessel design with methanol option

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

Much of the bunkering and transport infrastructure for

Meet Uthörn, the first German ship powered by methanol

Waterfront Shipping renews fleet with eight methanol dual-fuel vessels

01 Dec 2020 by Craig Jallal

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

MAERSK Prices Book Tracking Schedules Logistics solutions EN

Home / News / Press releases

Press releases

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

19 August 2021

Denmark Europe Decarbonisation Sustainability Share

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

---

MAERSK Prices Book Tracking Schedules Logistics solutions

Home / News / Press releases

Press releases

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

---

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

By Baird Maritime - September 9, 2021

Facebook Twitter LinkedIn

Dutch shipyards investigate sustainable fuel alternative

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

MARITIME / NEWS

DNV GL to class new methanol-fuelled tankers

WÄRTSILÄ TO ADD METHANOL ENGINE TO PORTFOLIO BY 2024

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

---

icct THE INTERNATIONAL COUNCIL ON Clean Transportation

Programs

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

PRINT

The shipping industry is under increasing pressure from regulators and consumers to

---

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, furth empowering methanol as marine fuel within large-container-vessel segment

Hyundai's Ship-Building Division, HHI-SBD, has ordered 8 × MAN B&W 8G95ME-LGIM (-Liquid Gas Injectior Methanol) engines in connection with the building of 8 × 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 fu

---

Lloyd's Register Sectors Solutions Services Insights Innovation News

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

Rules for the Classification of Methanol Fuelled Ships.

RULES MARINE & SHIPPING

< Back to overview

Home > Green marine

EMSA: Methanol and Ethanol Are Good Fuel Alternatives

June 10, 2016

As the shipping industry fights to reduce both sulphur oxide emissions and 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.

Related news

Japanese, Russian firms t jointly develop dual-fuel methanol carrier
7 days ago

Premium
The era of methanol as ma fuel is here
14 days ago

Why Use Methanol as a Marine Fuel?

What are the benefits of methanol as a marine fuel?

Isn't methanol toxic?

How to handle in case of a fire?

Does methanol reduce carbon emissions?

What do I need to do in case of a spill?

Is there enough methanol available?

How does methanol compare to other alternative fuels?

Is methanol globally available?

How much does methanol cost compared to fuel oil?

Is methanol IMO Tier III compliant?

How is methanol made?

Where can I bunker methanol?

What changes do I need to make to my vessel?

The Simplest of Alcohols

- Simple molecule rich in hydrogen, with only a single carbon bond
- Clear and colorless liquid at room temperature and ambient pressure
- Also known as “wood alcohol,” methanol can be produced from a wide range of feedstocks

lower emissions

easy handling

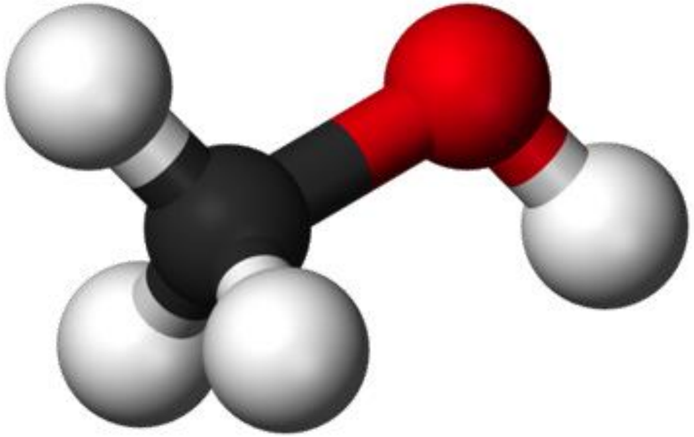
climate neutral

Formula: CH_3OH

Density: 0,792 $g.cm^{-3}$

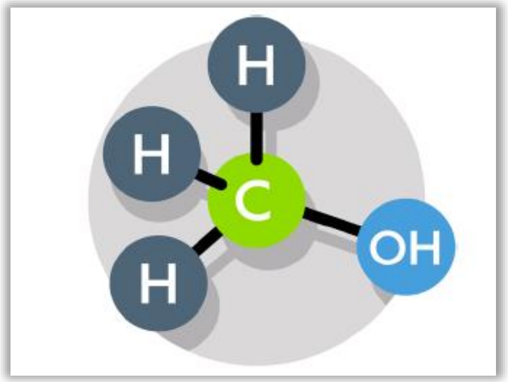
Molar mass: 32,04 g mol^{-1}

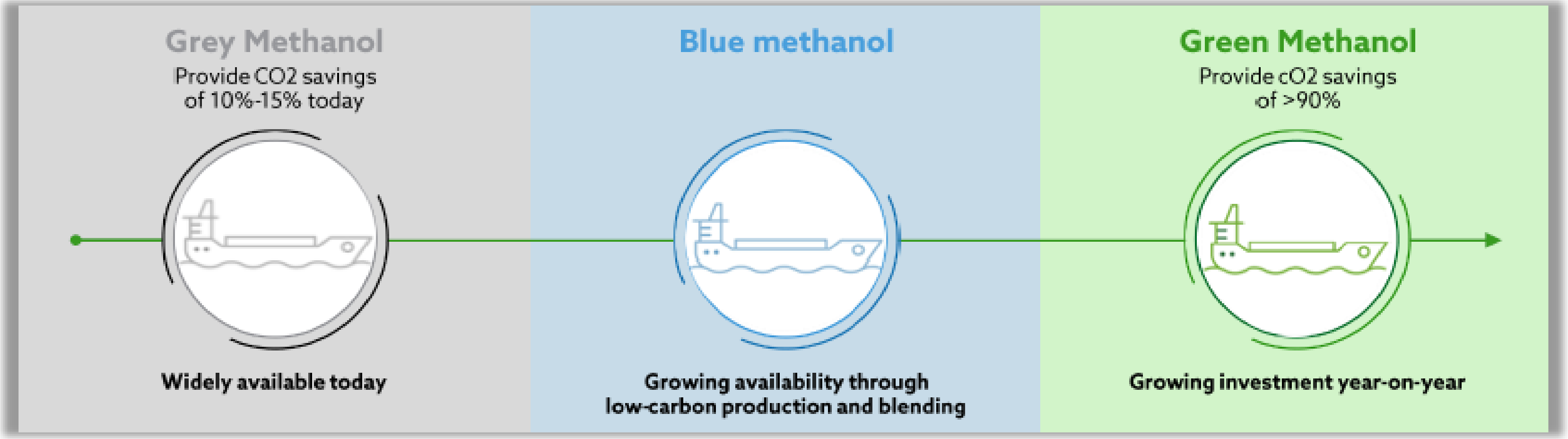
Appearance: colourless liquid



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
- Immediate benefits in reducing SOx, NOx, and PM
- Methanol runs well in existing engines with few modifications and significantly lower CAPEX when compared with other available alternative fuels





Grey Methanol

Provide CO2 savings of 10%-15% today

Widely available today

Blue methanol

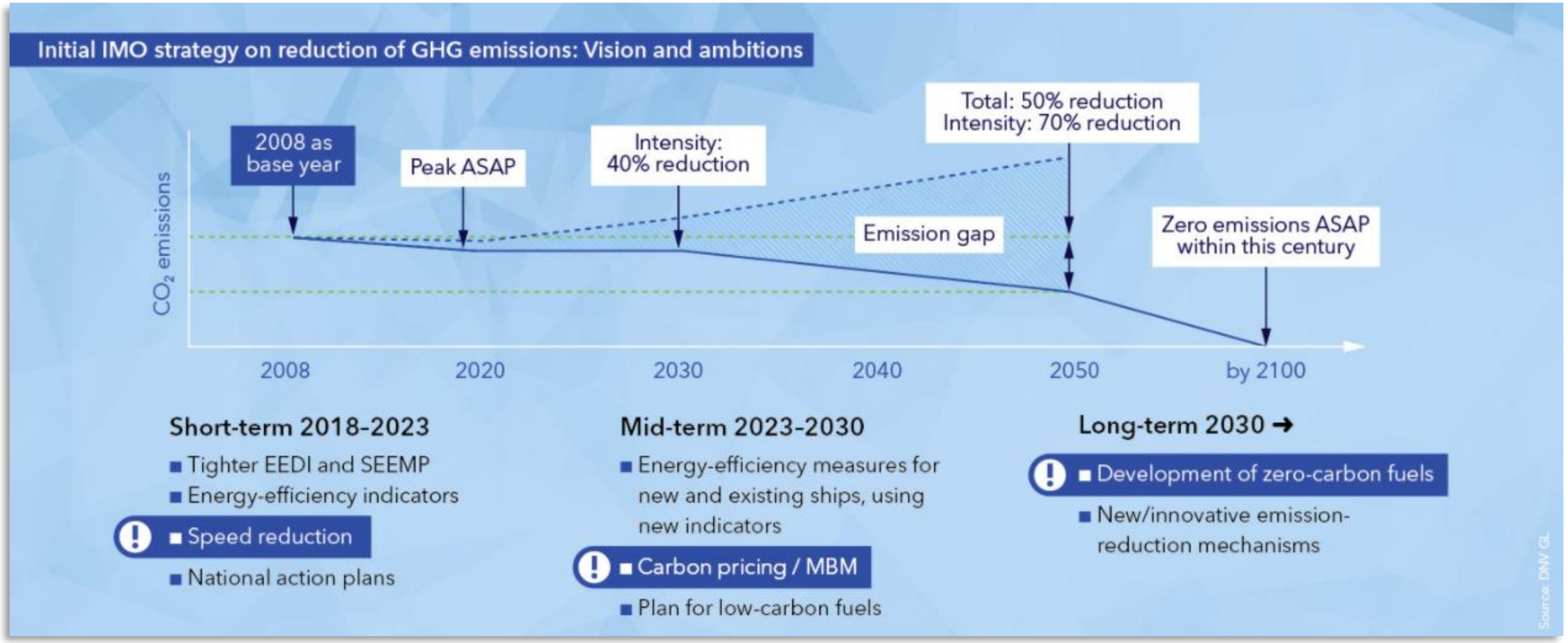
Growing availability through low-carbon production and blending

Green Methanol

Provide cO2 savings of >90%

Growing investment year-on-year

IMO 2050 GHG “levels of ambition”

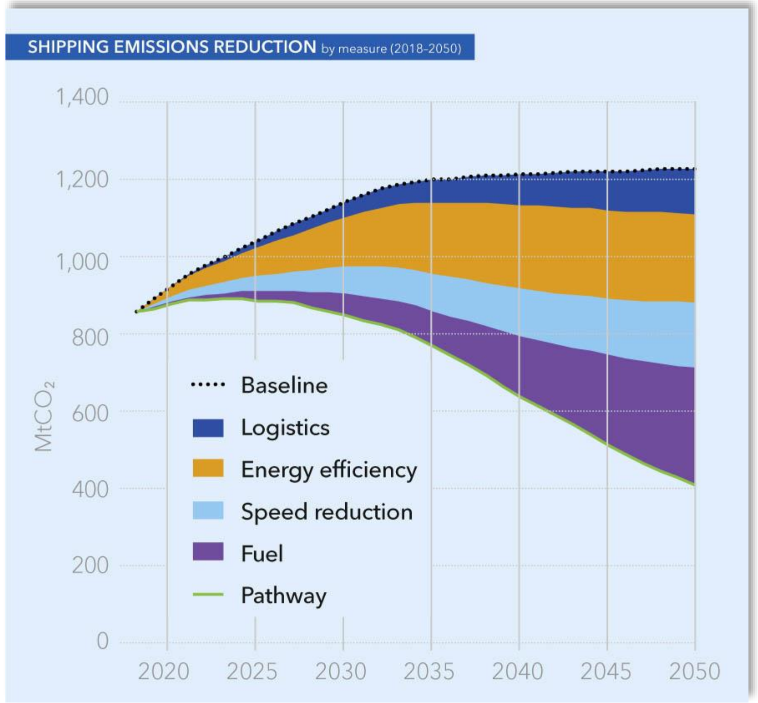

Initial IMO strategy on reduction of GHG emissions: Vision and ambitions

Short-term 2018-2023
- Tighter EEDI and SEEMP
- Energy-efficiency indicators
- Speed reduction
- National action plans

Mid-term 2023-2030
- Energy-efficiency measures for new and existing ships, using new indicators
- Carbon pricing / MBM
- Plan for low-carbon fuels

Long-term 2030 ➜
- Development of zero-carbon fuels
- New/innovative emission-reduction mechanisms

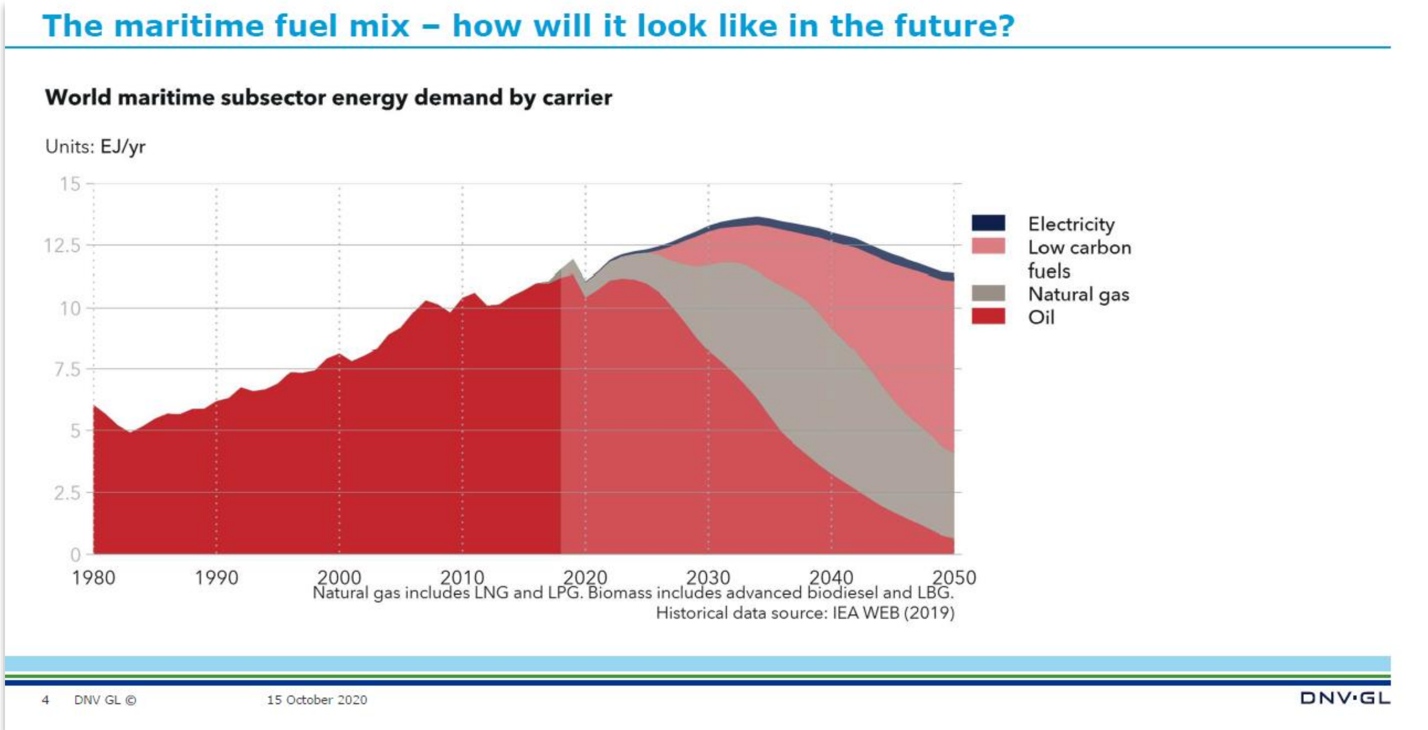
https://www.dnvgl.com/expert-story/maritime-impact/How-newbuilds-can-comply-with-IMOs-2030-CO2-reduction-targets.html



https://www.dnvgl.com/expert-story/maritime-impact/the-future-proof-ship.html

- *2023 will be a critical year for IMO in determining their mid-term and long-term strategy on reduction of GHG emissions*
- Energy-efficiency, logistics and speed reductions dominate mid-term tools (2023-2030)
- Fuels play an increasing role over 2030-2050 timeframe in meeting IMO GHG ambitions

Maritime fuel Mix Sea Change



The maritime fuel mix – how will it look like in the future?

World maritime subsector energy demand by carrier

Units: EJ/yr

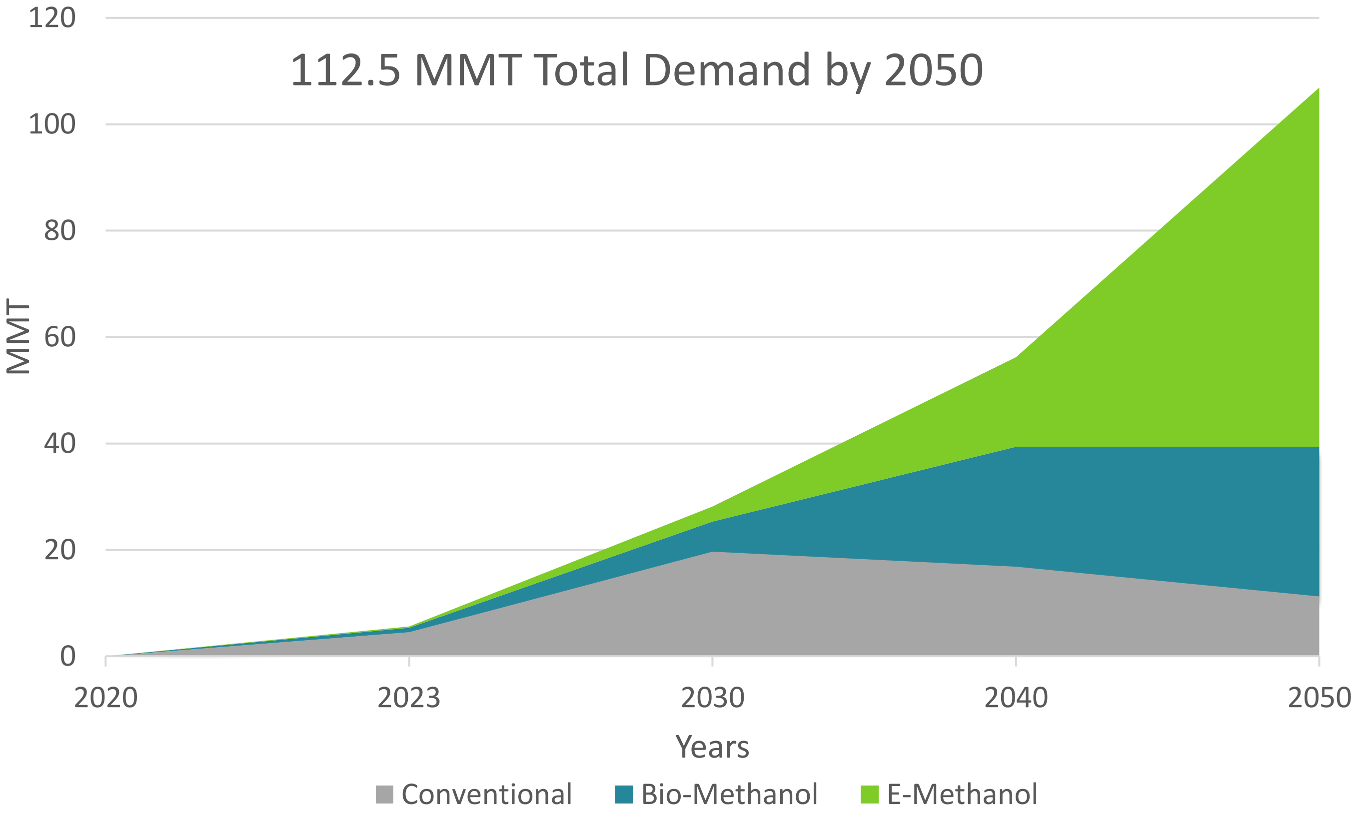
Natural gas includes LNG and LPG. Biomass includes advanced biodiesel and LBG.
Historical data source: IEA WEB (2019)

4 DNV GL © 15 October 2020 DNV·GL

https://www.dnvgl.com/expert-story/maritime-impact/Prepare-for-a-decarbonization-pathway.html

- DNV-GL 2050 Maritime Forecast assumes that a mixture of improved utilization and energy efficiencies, combined with a massive fuel decarbonization, will see IMO 2050 goal being met
- Shipping's fuel mix in 2050 will have switched from being almost entirely oil dominated today, to a mix dominated by **low- and/or net carbon neutral fuels (60%)** and natural gas (30%, mostly LNG)
- Fossil LNG gains a substantial share following the IMO ambitions. However, as regulations tighten in ***2030 or 2040***, depending on the decarbonization pathway, we see bio-LNG, e-LNG, bio-MGO and e-MGO used as drop-in fuel for existing ships, ***while bio-methanol, blue ammonia or e-ammonia are used for newbuilds and some retrofits***
- In the Decarbonization ***by 2040*** scenarios, instead of a transition via LNG, ***the fleet shifts directly to carbon-neutral methanol or ammonia***, with bio-MGO and e-MGO as drop-in fuels for existing ships

What is Potential Methanol Prize?

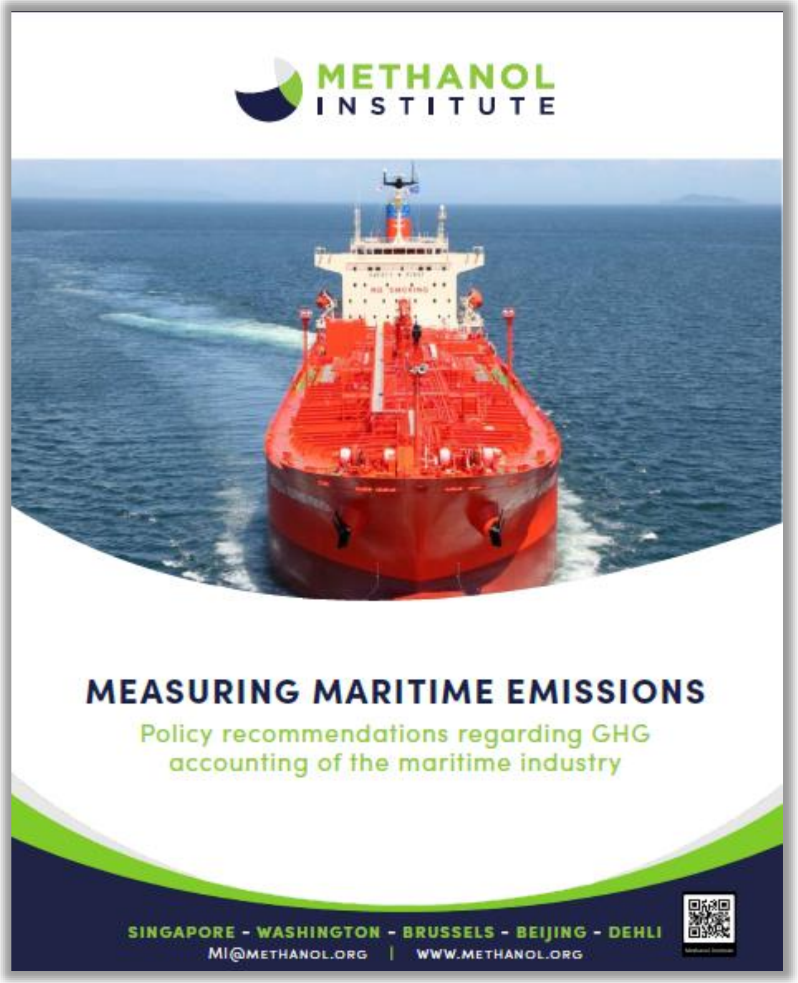


Assumption: 25% 2050 demand = 2.25 EJ (per DNV) = 112.5 MMT methanol, see similar calculation for ammonia, https://www.ammoniaenergy.org/articles/maritime-fuel-mix-could-be-25-ammonia-by-2050/

- The ammonia industry recently looked at DNV forecast and assumed ammonia would represent 25% of the maritime fuel mix by 2050, and if we assume methanol has similar share, we can speculate on the role of conventional versus green methanol:
  - Conventional methanol dominates from 2020-2030, with initial volumes of bio-methanol being blended.
  - From 2030-2040, conventional methanol begins to give way to increasing volumes of bio-methanol and e-methanol.
  - From 2040 onwards, e-methanol becomes one of the dominant marine fuels.
  - By 2050, methanol and ammonia each represent 25% of global bunker fuel, with methanol demand of 112.5 MMT/annual

Measuring Maritime Emissions

The Methanol Institute (MI) is calling on maritime policy-makers to adopt a ‘well-to-wake’ approach in GHG accounting of fuels to support the decarbonization of maritime transport. MI believes an approach that accounts for GHG emissions of the fuel’s entire value chain is essential to stimulate the uptake of renewable fuels that can drive the maritime industry’s energy transition.



METHANOL INSTITUTE

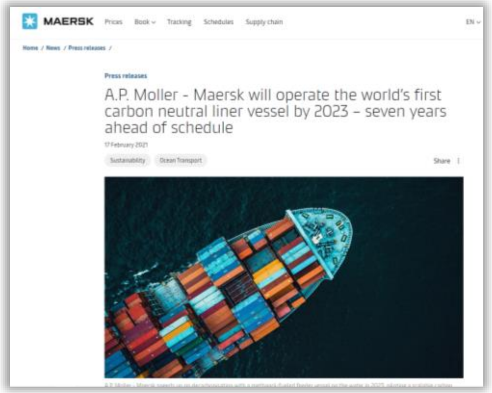
MEASURING MARITIME EMISSIONS

Policy recommendations regarding GHG accounting of the maritime industry

SINGAPORE - WASHINGTON - BRUSSELS - BEIJING - DEHLI
MI@METHANOL.ORG | WWW.METHANOL.ORG

https://www.methanol.org/marine/

Maersk: Methanol Game Changer



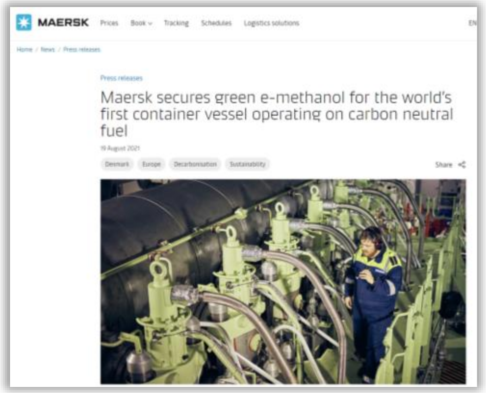
Home / News / Press releases /

Press releases

A.P. Moller - Maersk will operate the world's first carbon neutral liner vessel by 2023 – seven years ahead of schedule

17 February 2021

https://www.maersk.com/news/articles/2021/02/17/maersk-first-carbon-neutral-liner-vessel-by-2023



Home / News / Press releases

Press releases

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

19 August 2021

https://www.maersk.com/news/articles/2021/08/18/maersk-secures-green-e-methanol

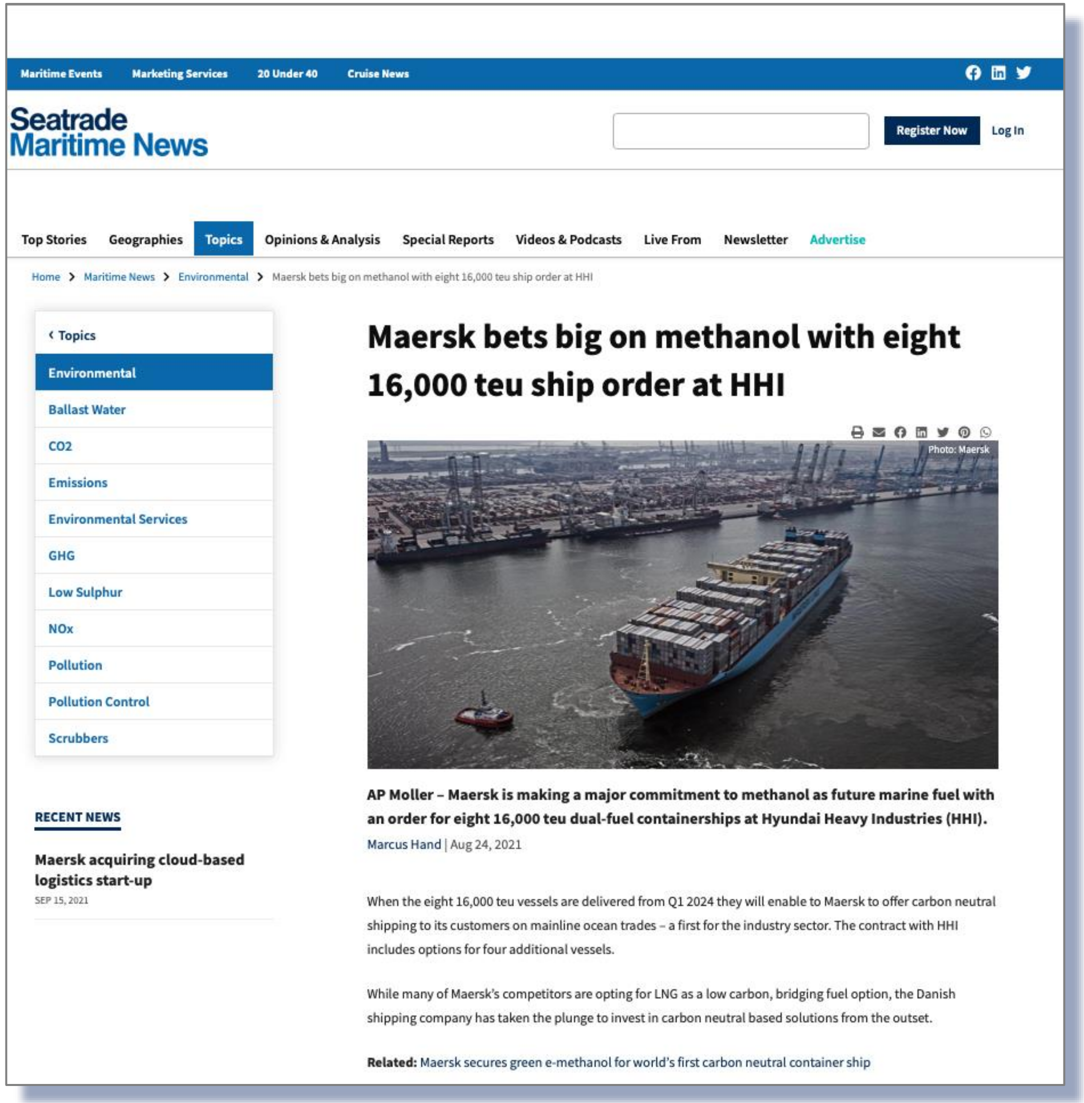
"The reason that we have gone for methanol on the first one is that it is the most mature from the technology perspective; we can get an engine that can burn it." Morten Bo Christiansen, head of decarbonization at Maersk

"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 duel-fueled feeder vessels from Korean shipyard
- 19 Aug 2021: Maersk secures 10,000 tons green e-methanol from Reintegrate in Denmark, using biogenic CO2 and solar power
- ***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, 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

https://www.maersk.com/news/articles/2021/08/24/maersk-accelerates-fleet-decarbonisation

Methanol Fleet Growing Steadily



Maritime Events Marketing Services 20 Under 40 Cruise News

Seatrade Maritime News

Register Now Log In

Top Stories Geographies Topics Opinions & Analysis Special Reports Videos & Podcasts Live From Newsletter Advertise

Home > Maritime News > Environmental > Maersk bets big on methanol with eight 16,000 teu ship order at HHI

‹ Topics
- Environmental
- Ballast Water
- CO2
- Emissions
- Environmental Services
- GHG
- Low Sulphur
- NOx
- Pollution
- Pollution Control
- Scrubbers

RECENT NEWS

Maersk acquiring cloud-based logistics start-up
SEP 15, 2021

Maersk bets big on methanol with eight 16,000 teu ship order at HHI

Photo: Maersk

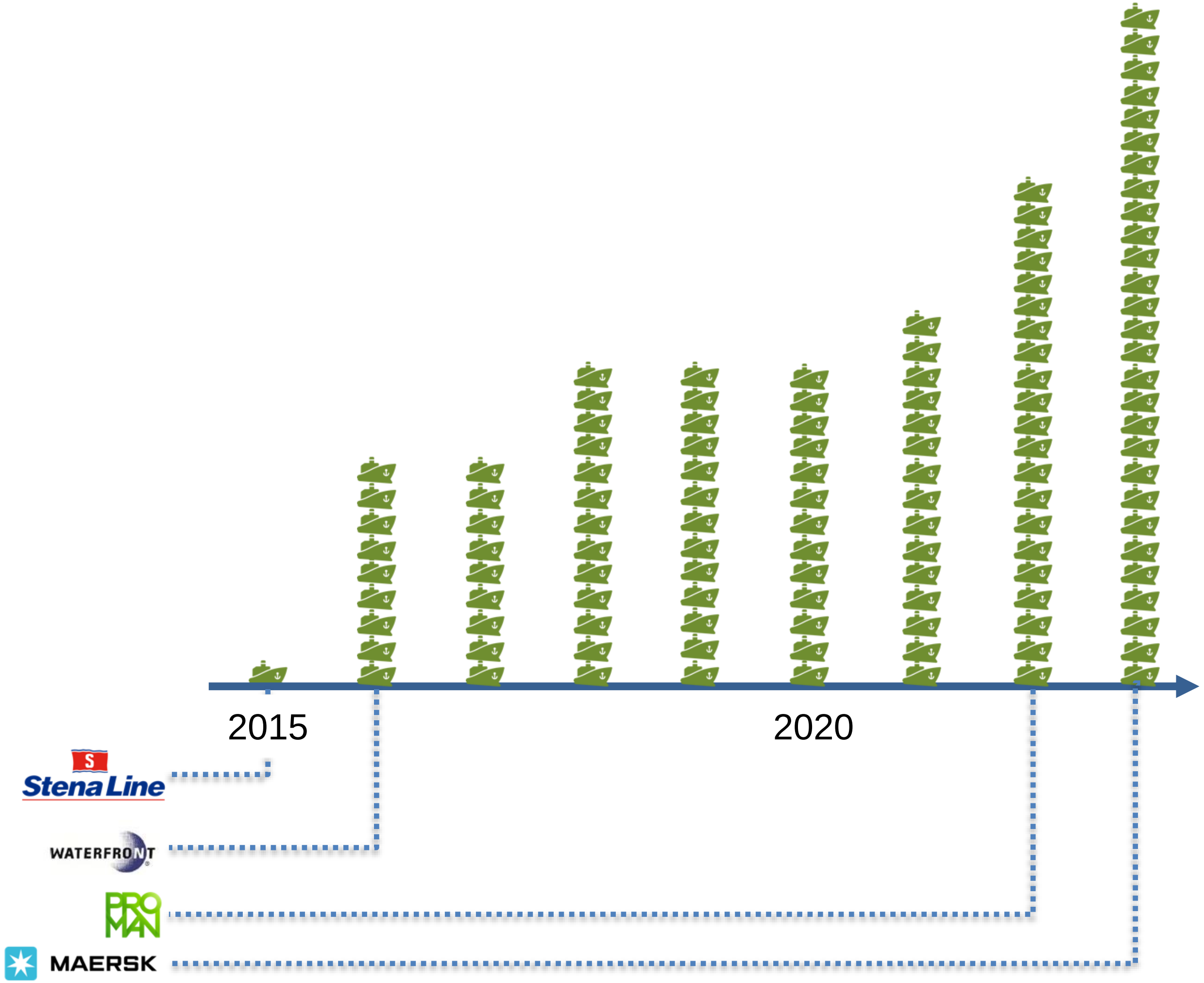
AP Moller – Maersk is making a major commitment to methanol as future marine fuel with an order for eight 16,000 teu dual-fuel containerships at Hyundai Heavy Industries (HHI).

Marcus Hand | Aug 24, 2021

When the eight 16,000 teu vessels are delivered from Q1 2024 they will enable to Maersk to offer carbon neutral shipping to its customers on mainline ocean trades – a first for the industry sector. The contract with HHI includes options for four additional vessels.

While many of Maersk's competitors are opting for LNG as a low carbon, bridging fuel option, the Danish shipping company has taken the plunge to invest in carbon neutral based solutions from the outset.

Related: Maersk secures green e-methanol for world's first carbon neutral container ship

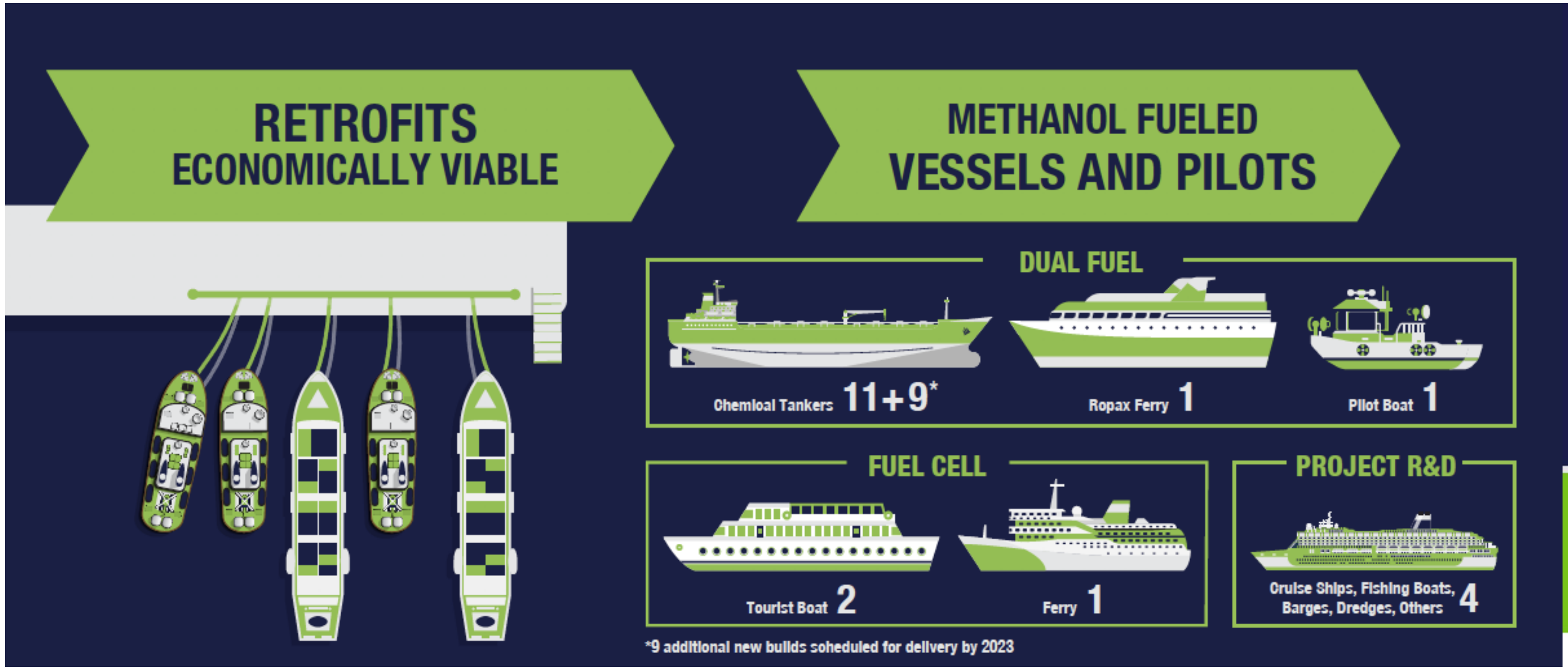


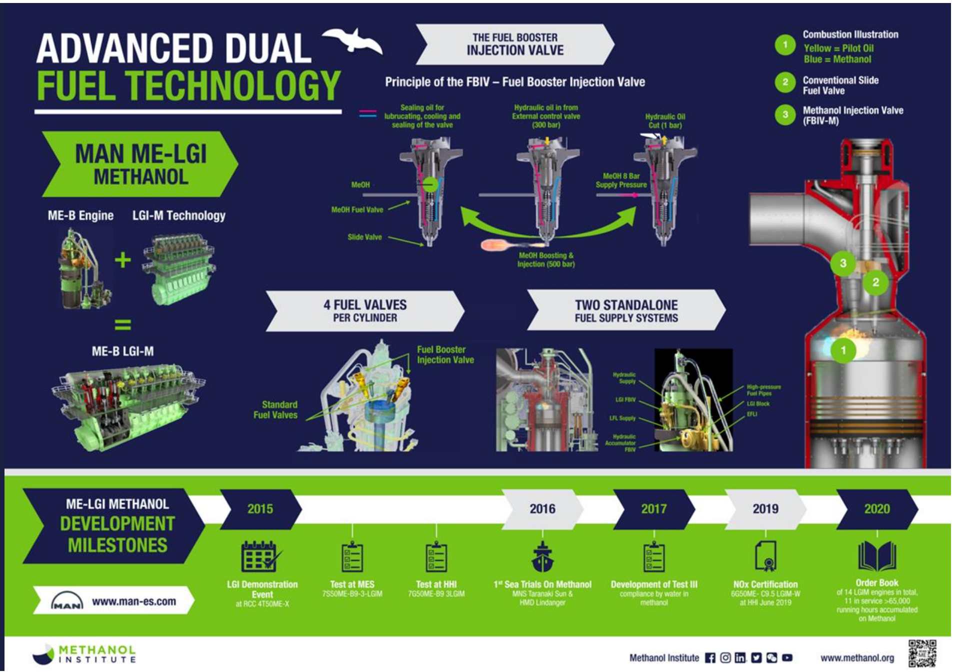
OCI and more to come

On the Water

METHANOL INSTITUTE

Engines Mature & Available





100,000 Hours of Operations

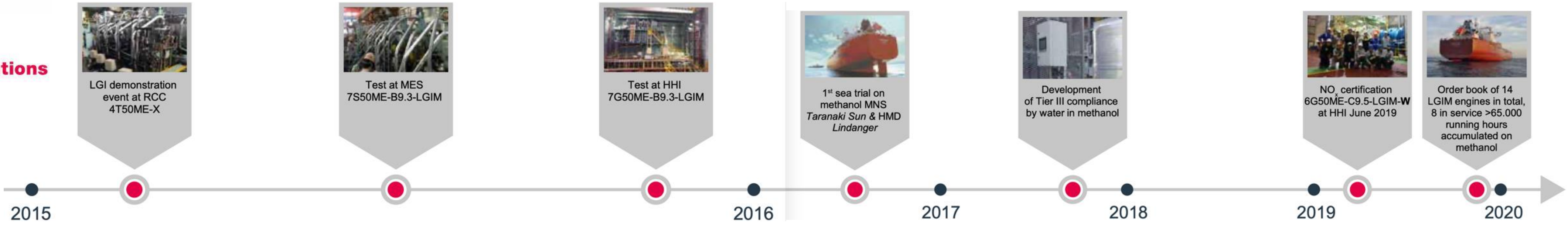
More on the Way

- *Denmark:* Maersk *orders* one 2,100 teu methanol dual-fuel container ship, and 8 16,000 teu vessels with option for 4 additional methanol fueled ships
- *Sweden/Switzerland*: Proman Stena Bulk – joint venture of shipowner Stena Bulk and Proman Shipping a subsidiary of methanol producer Proman – to build now six 50,000 dwt tankers with methanol dual-fuel engines first deliveries 2022
- *Netherlands:* OCI NV, MAN, Eastern Pacific Shipping first methanol retrofit by 2023, newbuilds and retrofits
- *United States*: e1 Marine and Ardmore Shipping to deploy methanol-to-hydrogen generator and fuel cell system for propulsion and APU
- *Netherlands:* Damen Shipyards delivering first "methatug" to Port of Antwerp in 2022
- *Netherlands*: Damen Shipyards has developed new concept Offshore Support Vessel (OSV) to operate on methanol
- *Netherlands*: Van Oord has ordered self-elevating offshore installation vessel running on methanol
- *Ukraine*: Danube Shipping Company orders up to 33 river pushers using ABC 'hybrid' engines with methanol capability
- *Japan*: Sumitomo Heavy wins Approval in Principle from ClassNKK for methanol dual-fuel tanker
- *Germany*: Shipowner Liberty One has ordered new multipurpose (MPP) ship powered by methanol
- *Germany*: Shipowner SAL Heavy Lift to install FUELSAVE hydrogen/methanol injection system in 6 vessels
- *Germany*: Abeking & Rasmussen shipyard designing "green cruise" concept vessel using methanol fuel cells for hotel load and methanol propulsion engines
- *Germany*: AIDAnova will employ methanol fuel cells for propulsion under Pa-X-ell2 project
- *Germany*: Shipyard Fassmer has order from Alfred Wegener Institute to build methanol-powered research vessel UTHORN
- *Germany*: Port of Emden to receive new, methanol-powered harbor boat
- *Canada*: Naval architecture firm Robert Allan Ltd unveils methanol-fueled Raptor 2400 crew transfer vessel

Engines Offering Broadening

METHANOL INSTITUTE

MAN Energy Solutions



LGI demonstration event at RCC 4T50ME-X

Test at MES 7S50ME-B9.3-LGIM

Test at HHI 7G50ME-B9.3-LGIM

1st sea trial on methanol MNS *Taranaki Sun* & HMD *Lindanger*

Development of Tier III compliance by water in methanol

NO_x certification 6G50ME-C9.5-LGIM-**W** at HHI June 2019

Order book of 14 LGIM engines in total, 8 in service >65.000 running hours accumulated on methanol

WÄRTSILÄ

2015

THE MOTORSHIP

INSIGHT FOR MARINE TECHNOLOGY PROFESSIONALS

WÄRTSILÄ TO ADD METHANOL ENGINE TO PORTFOLIO BY [illegible]

LATEST PRESS RELEASES

2021

ANGLO BELGIAN CORPORATION

We power your future

2021

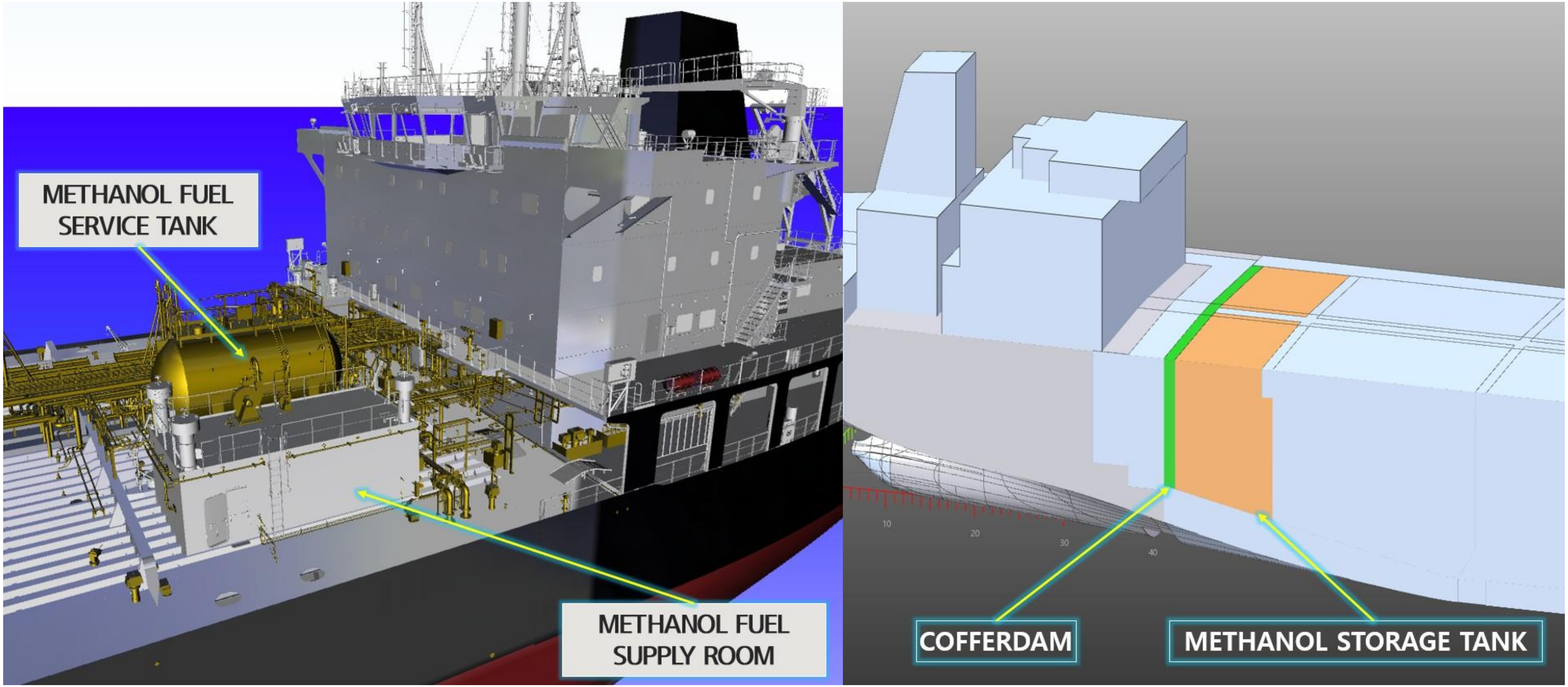
ScandiNAOS AB

2016

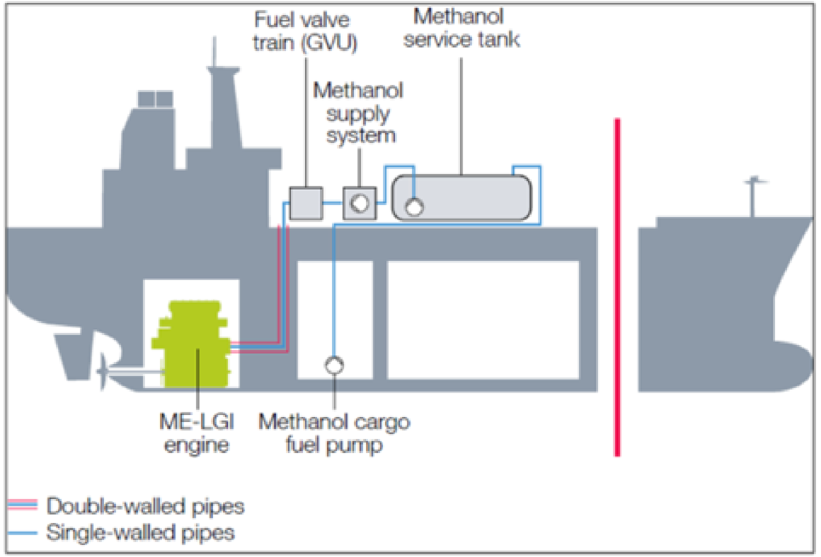
2021

www.methanol.org/join-us

Methanol Dual Fuel Standardized Design

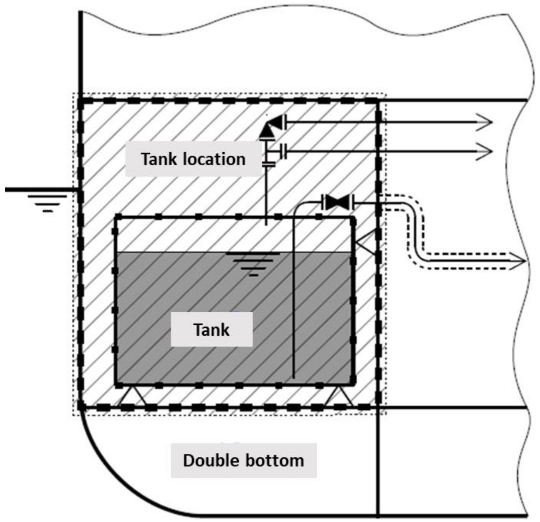


Practical Fuel Storage



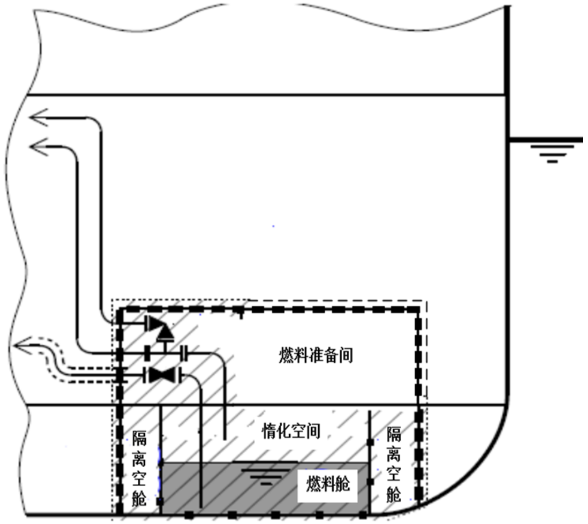
Source: Westfal-Larsen

Independent Tank

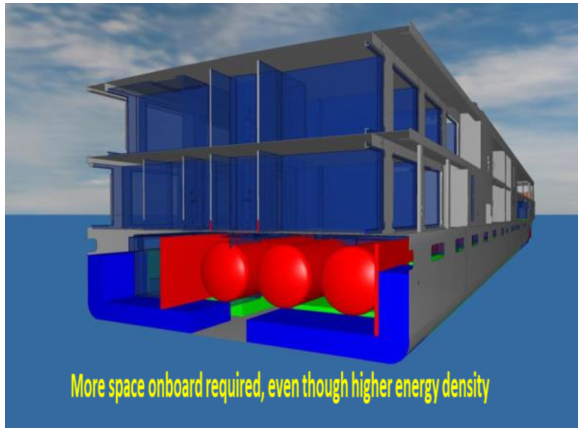


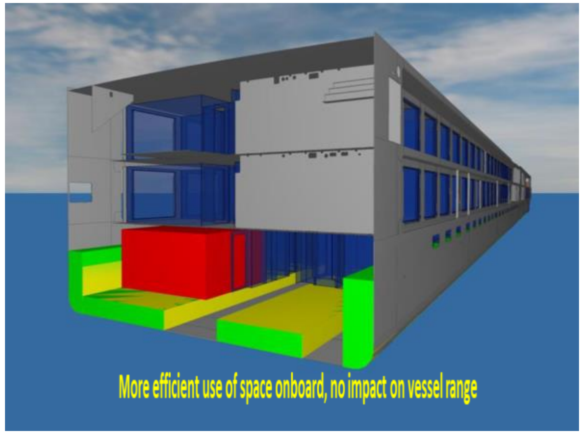
Methane at -162° C

Integral Tank

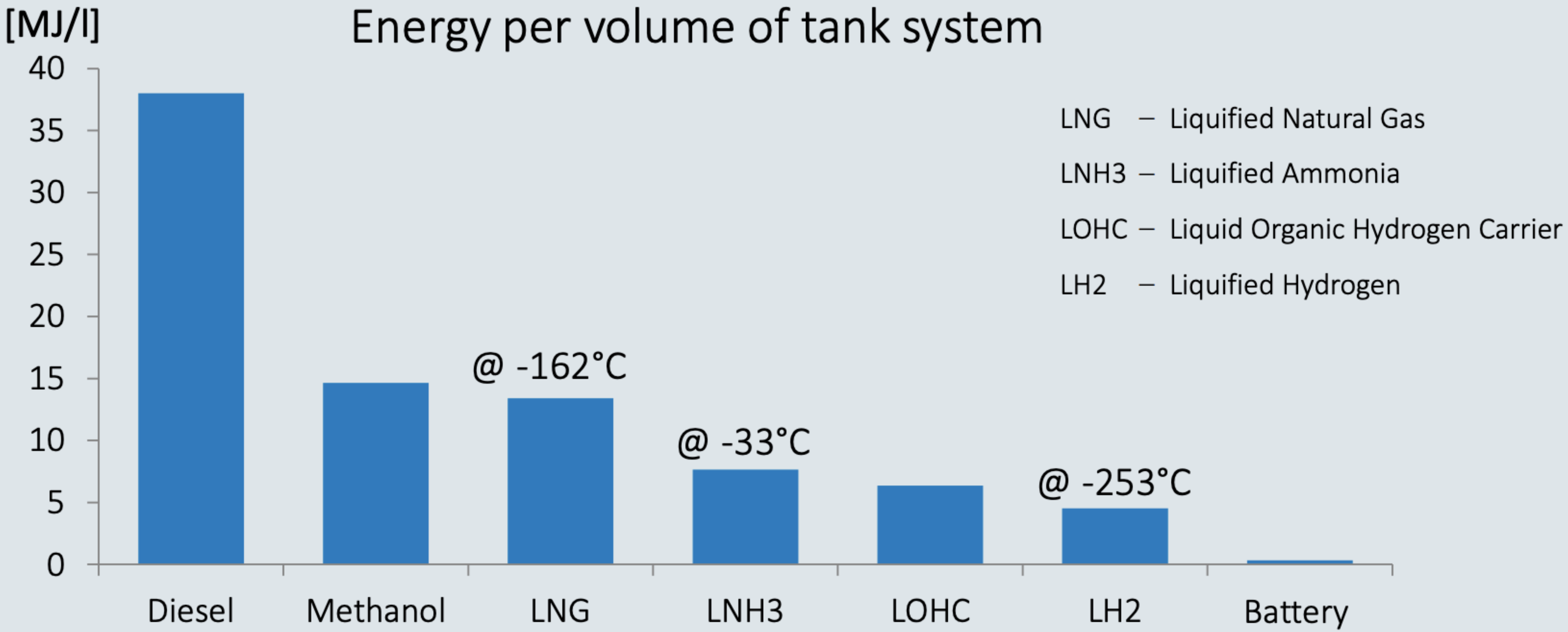


Methanol at ambient temperature





Fuel Storage Volume Comparison

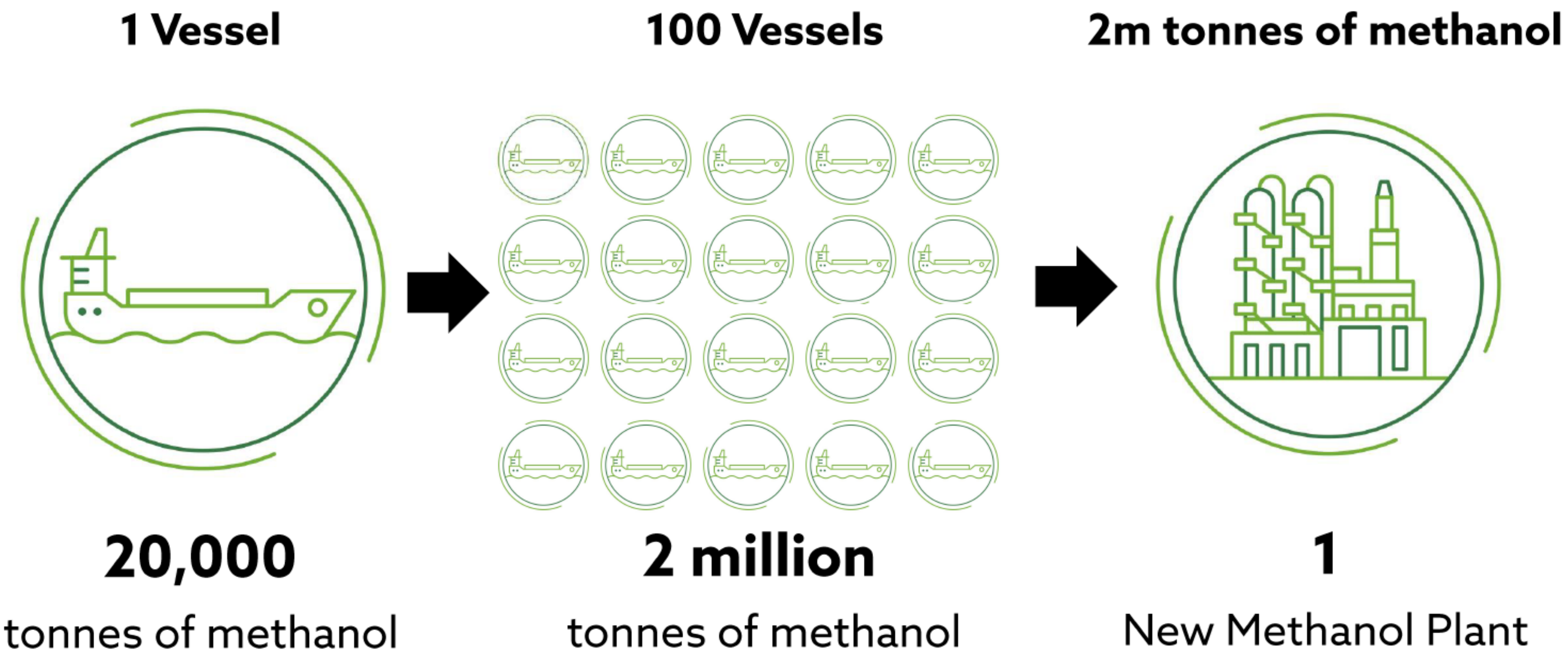


*Based on marine, on-board storage

Source: Meyer Werft

Battery, H2, LOHC and LNH3 may not be suitable for long distances

Methanol Scalability



1 Vessel

20,000

tonnes of methanol

100 Vessels

2 million

tonnes of methanol

2m tonnes of methanol

1

New Methanol Plant

PROMAN

Takes 2 years to build new ship, and 3 years to build new methanol plant

Green Maritime Methanol

- MI part of an industry consortium organized by TNO to study the use of (green) methanol in short sea shipping, a spin-off from the Horizon 2020 LeanShips project.
- TNO is an internationally renowned research institute with a great reputation for objective analysis.
- The GMM 1.0 study set the stage for a pilot with actual ships on the water with project partners (Horizon 2020 or other) under GMM 2.0.
- Focus is on renewable methanol but the technology, safety guidelines and policy can be used for conventional methanol too.

https://greenmaritimemethanol.nl/

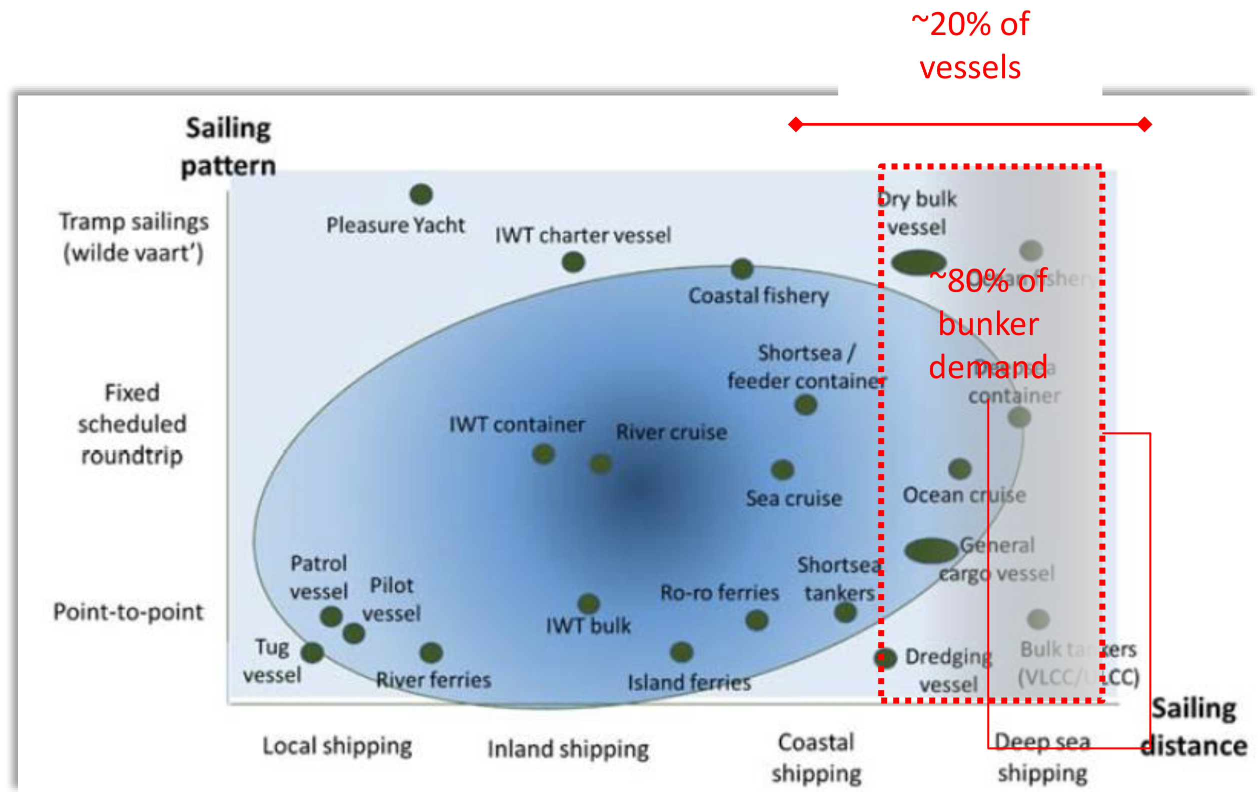
TNO: Potential Vessel Segments

- For Green Maritime Methanol program, TNO conducted assessment of market potential for Dutch/EU market for methanol as a marine fuel

- Heatmap of “methanol-applicability of shipping segments”

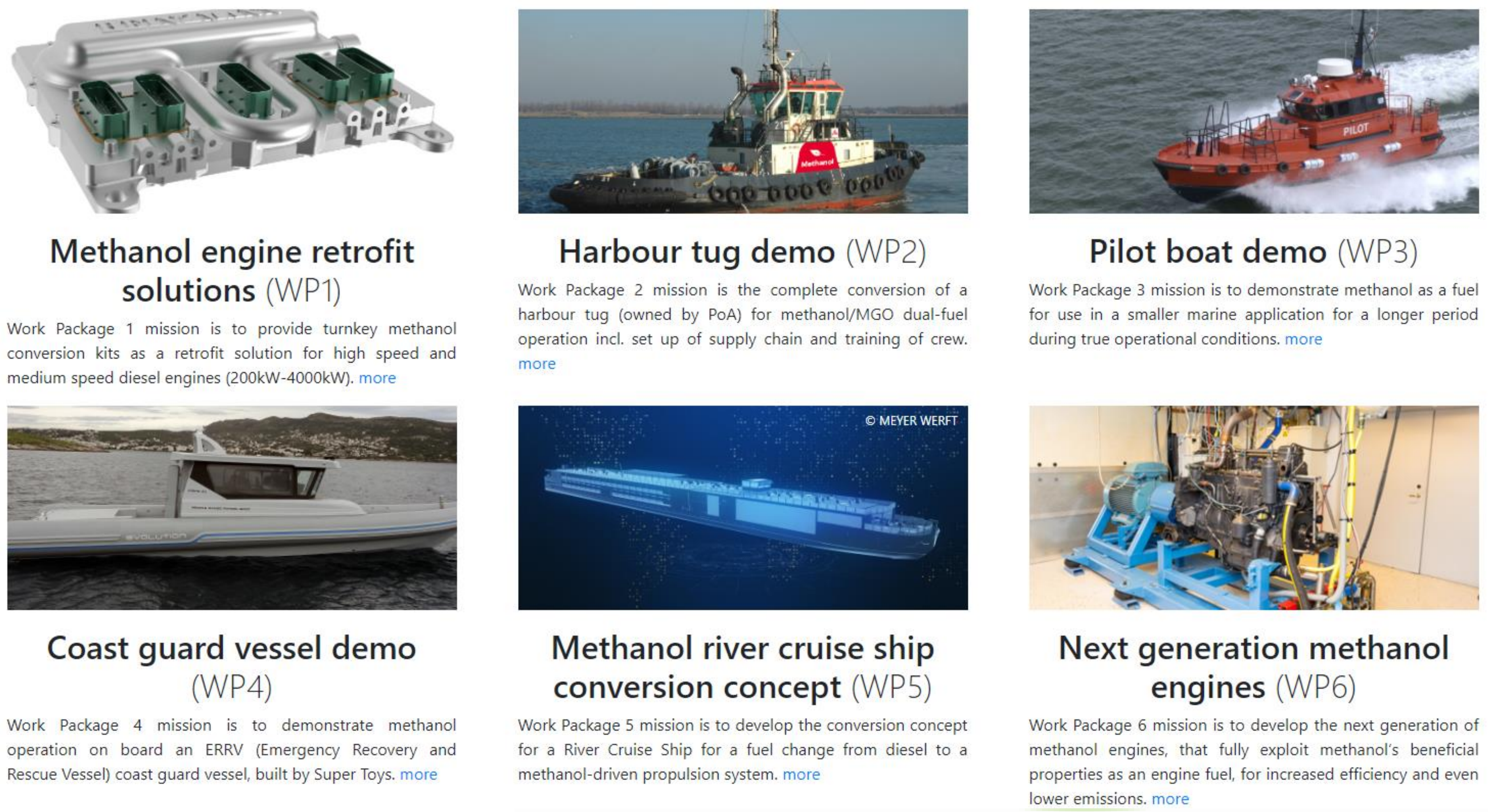
- Most shortsea and inland shipping markets appear feasible in terms of operational profiles, fuel consumption, and sailing patterns

- But important to recognize that the ocean-going vessels make of 20% of vessels and fully 80% of bunker demand



Source: TNO Report for GMM, Sept 2020

FASTWATER.eu



Methanol engine retrofit solutions (WP1)

Work Package 1 mission is to provide turnkey methanol conversion kits as a retrofit solution for high speed and medium speed diesel engines (200kW-4000kW). more

Harbour tug demo (WP2)

Work Package 2 mission is the complete conversion of a harbour tug (owned by PoA) for methanol/MGO dual-fuel operation incl. set up of supply chain and training of crew. more

Pilot boat demo (WP3)

Work Package 3 mission is to demonstrate methanol as a fuel for use in a smaller marine application for a longer period during true operational conditions. more

Coast guard vessel demo (WP4)

Work Package 4 mission is to demonstrate methanol operation on board an ERRV (Emergency Recovery and Rescue Vessel) coast guard vessel, built by Super Toys. more

Methanol river cruise ship conversion concept (WP5)

© MEYER WERFT

Work Package 5 mission is to develop the conversion concept for a River Cruise Ship for a fuel change from diesel to a methanol-driven propulsion system. more

Next generation methanol engines (WP6)

Work Package 6 mission is to develop the next generation of methanol engines, that fully exploit methanol's beneficial properties as an engine fuel, for increased efficiency and even lower emissions. more

WTRI – China & Singapore

China

- China Waterborne Transport Research Institute (under Ministry of Transport) proposed study to provide a roadmap for the adoption of methanol as a marine fuel for China
- Techno-Economic Assessment; Policy analysis/recommendations
- China annually consumes 20-30 MMT of bunker fuel
- There are 630,000 vessels operating in China's coastal regions (including fishing fleet) and inland waterways (140,000 vessels)
- In terms of potential methanol demand, marine applications have the potential to be no less in size than the China market for boilers or cook stoves, or conservatively in the low single digits, in millions of tons demand, over the next five years
- Total Budget = USD$140,000, with MI as USD$50,000 sponsor, other sponsors Methanex, Sinopec, Shanghai Huayi Group

Singapore

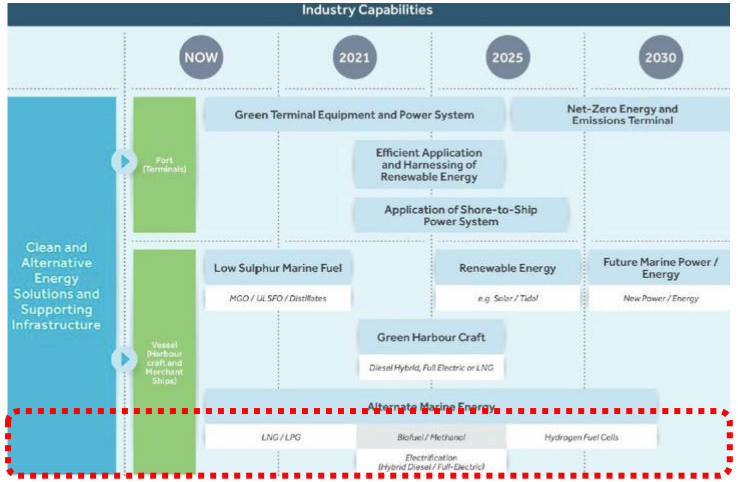
- Singapore's Maritime Institute and MPA recently instructed the Marine Energy Test Bed Department of NTU to engage WTRI in a similar study as MI engaged WTRI
- Study to commence in September with MI participation
- Study will assess feasibility of methanol fuelled vessels in China and Singapore in line with MPA's Roadmap 2030

Currently:

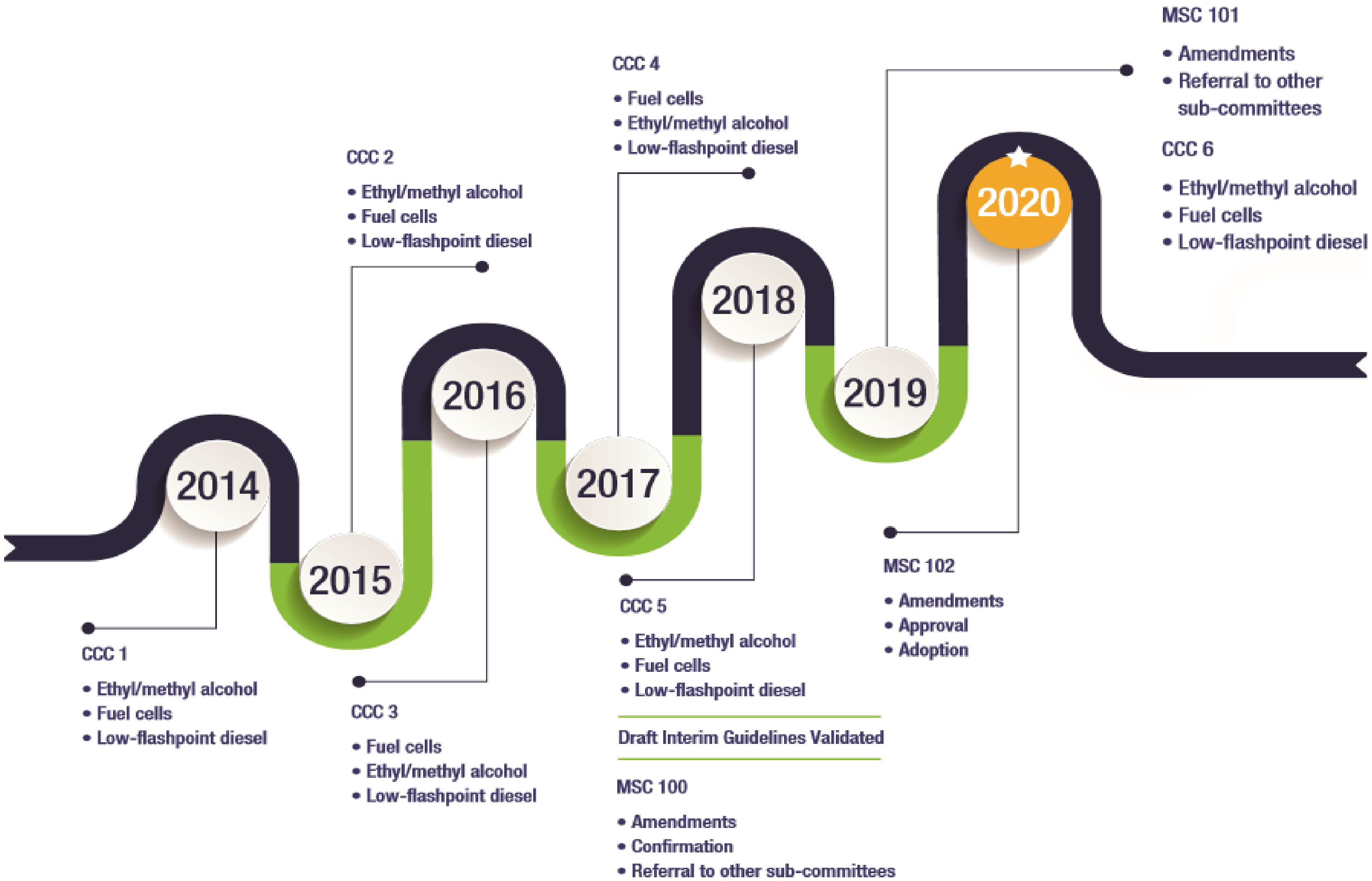
- ❖ Reviewing final draft
- ❖ Circulated to MFC for feedback
- ❖ Planned Jul/Aug for formal release

Targeted outcome is to
- ○ **obtain MSA endorsement**
- ○ **allow CCS to begin to class methanol-fueled vessels**
- ○ **create bunkering hubs**
- ○ **begin to develop standardized methanol designed vessels**

Singapore MPA Roadmap 2030



IMO IGF Code Methanol Approval



CCC 1
- Ethyl/methyl alcohol
- Fuel cells
- Low-flashpoint diesel

CCC 2
- Ethyl/methyl alcohol
- Fuel cells
- Low-flashpoint diesel

CCC 3
- Fuel cells
- Ethyl/methyl alcohol
- Low-flashpoint diesel

CCC 4
- Fuel cells
- Ethyl/methyl alcohol
- Low-flashpoint diesel

CCC 5
- Ethyl/methyl alcohol
- Fuel cells
- Low-flashpoint diesel

Draft Interim Guidelines Validated

MSC 100
- Amendments
- Confirmation
- Referral to other sub-committees

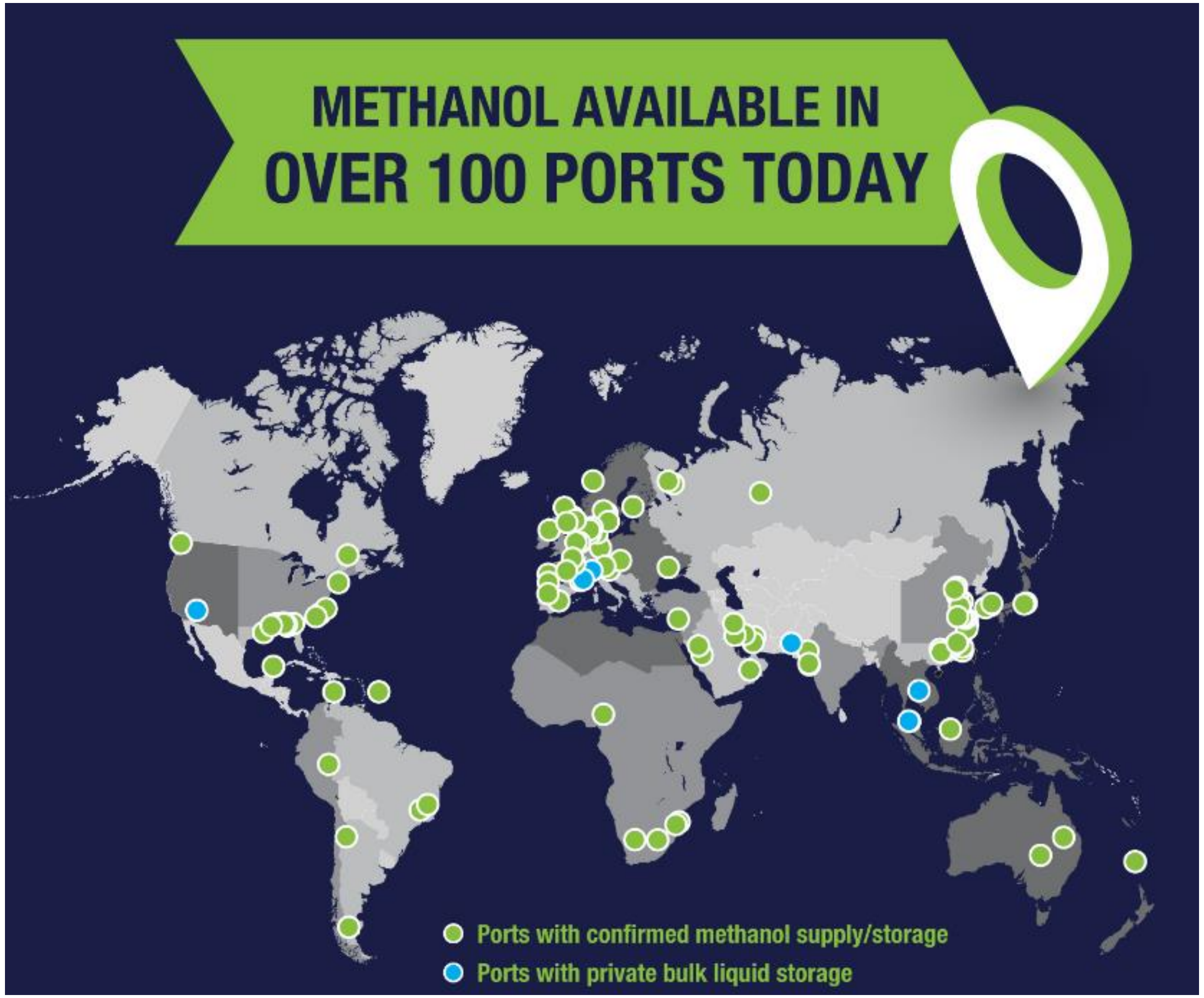
MSC 101
- Amendments
- Referral to other sub-committees

CCC 6
- Ethyl/methyl alcohol
- Fuel cells
- Low-flashpoint diesel

MSC 102
- Amendments
- Approval
- Adoption

Methanol Trading Hubs

Available and Easily Bunkered




Introduction to

Methanol Bunkering

Technical Reference

July 2020

Lloyd's Register


CEN Workshop Agreement
SIS-CWA 17540:2020

Skeppsteknik – Specifikation för bunkring av metanol som fartygsbränsle

Ships and marine technology – Specification for bunkering of methanol fuelled vessels

sis Svenska Institutet för Standarder

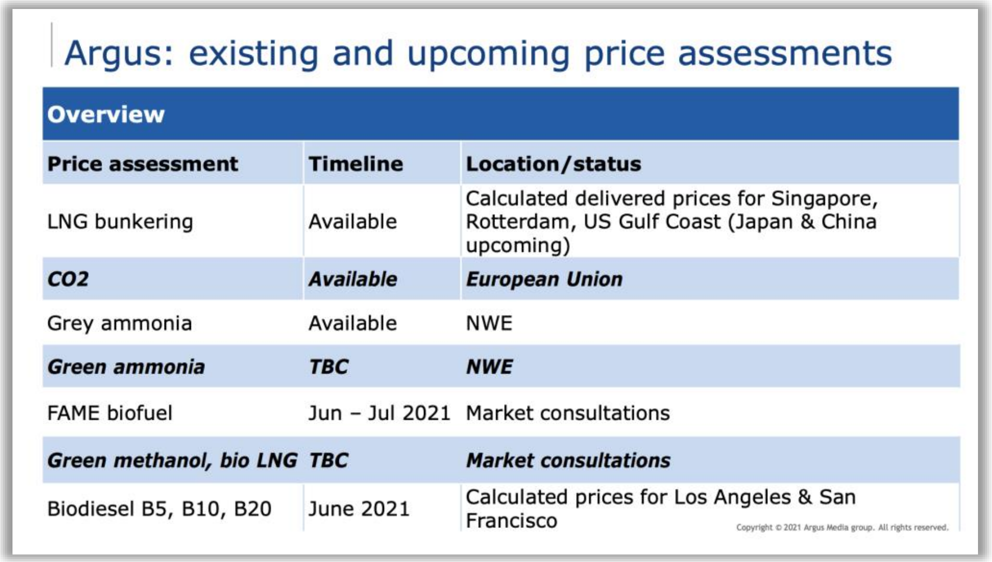
Språk: engelska/English
Utgåva: 1

Methanol Barge Bunkering

- 300mt stem successfully delivered May 2021
- Stem placed per LR/MI Methanol Bunkering TR
- Partners included:
  - Methanex
  - Port of Rotterdam
  - Vopak
  - NYK
  - TankMatch

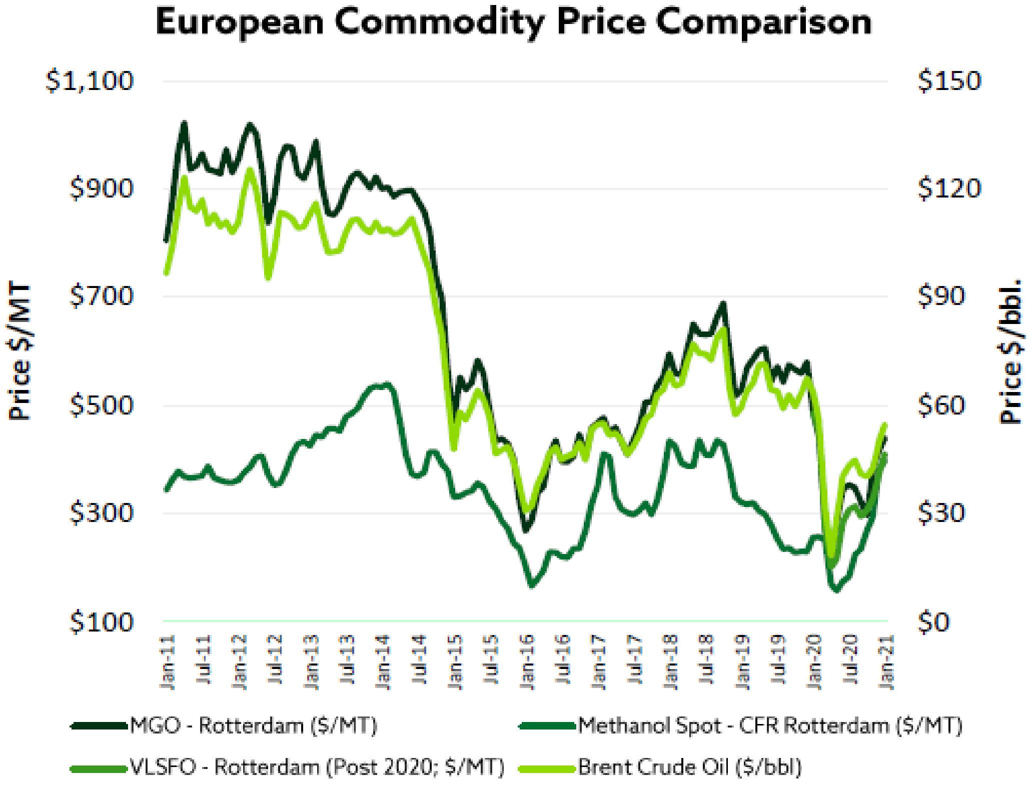
- Require more such demonstrations at leading ports
- Will support pilots and general uptake of methanol
- Ports of interest:
  - Antwerp, Rotterdam
  - Zhoushan, Ningbo
  - Singapore
  - Panama
  - Others

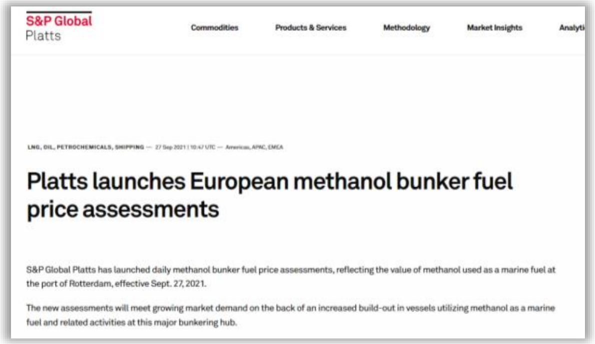
Methanol Pricing



Argus: existing and upcoming price assessments

Overview		
Price assessment	**Timeline**	**Location/status**
LNG bunkering	Available	Calculated delivered prices for Singapore, Rotterdam, US Gulf Coast (Japan & China upcoming)
CO2	***Available***	***European Union***
Grey ammonia	Available	NWE
Green ammonia	***TBC***	***NWE***
FAME biofuel	Jun – Jul 2021	Market consultations
Green methanol, bio LNG	***TBC***	***Market consultations***
Biodiesel B5, B10, B20	June 2021	Calculated prices for Los Angeles & San Francisco



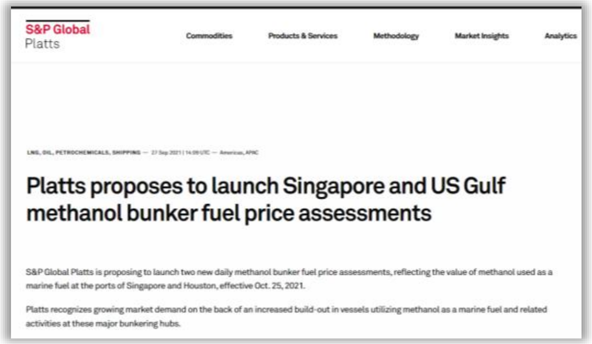


LNG, OIL, PETROCHEMICALS, SHIPPING — 27 Sep 2021 | 10:47 UTC — Americas, APAC, EMEA

Platts launches European methanol bunker fuel price assessments

S&P Global Platts has launched daily methanol bunker fuel price assessments, reflecting the value of methanol used as a marine fuel at the port of Rotterdam, effective Sept. 27, 2021.

The new assessments will meet growing market demand on the back of an increased build-out in vessels utilizing methanol as a marine fuel and related activities at this major bunkering hub.



LNG, OIL, PETROCHEMICALS, SHIPPING — 27 Sep 2021 | 14:09 UTC — Americas, APAC

Platts proposes to launch Singapore and US Gulf methanol bunker fuel price assessments

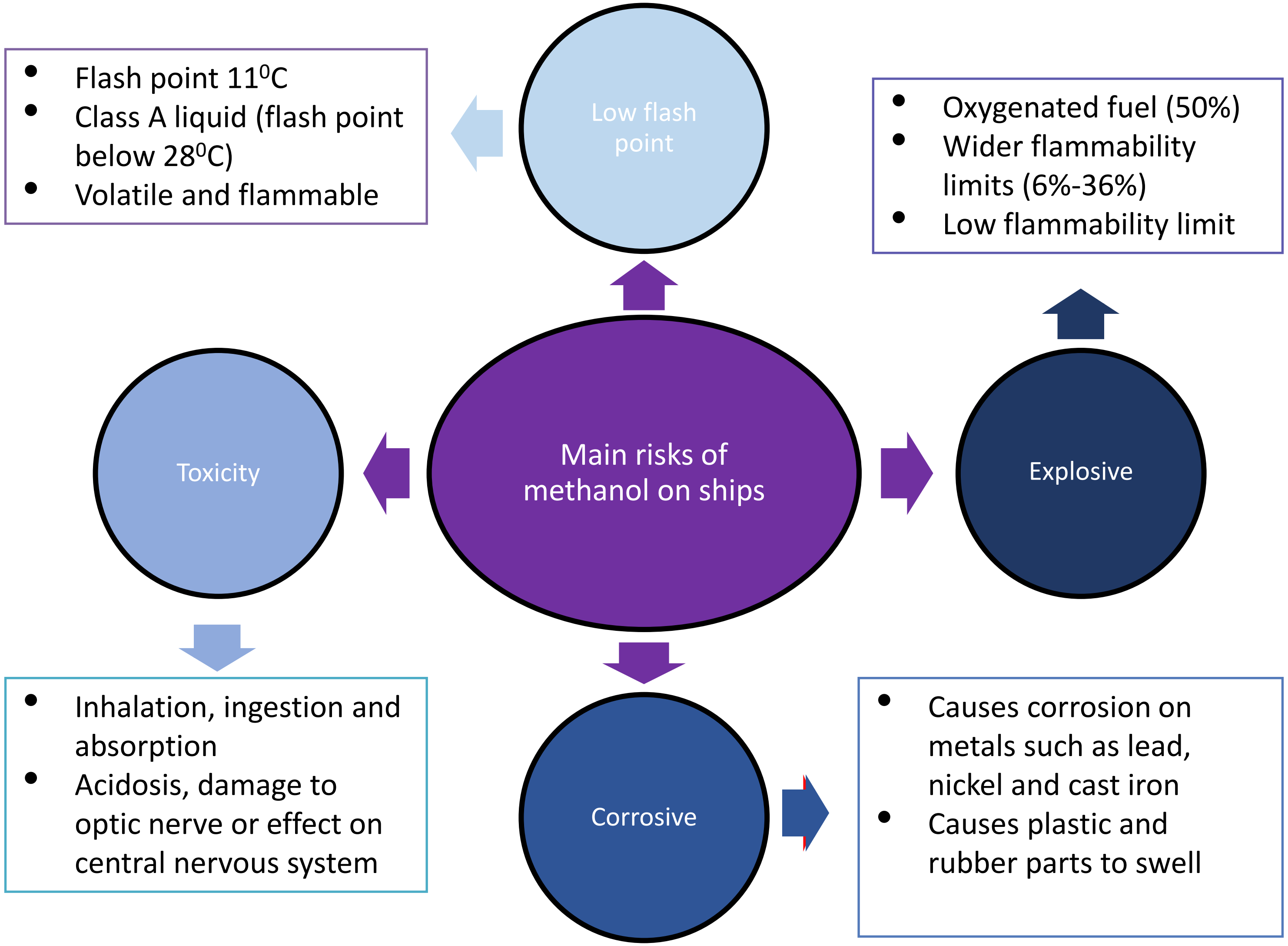
S&P Global Platts is proposing to launch two new daily methanol bunker fuel price assessments, reflecting the value of methanol used as a marine fuel at the ports of Singapore and Houston, effective Oct. 25, 2021.

Platts recognizes growing market demand on the back of an increased build-out in vessels utilizing methanol as a marine fuel and related activities at these major bunkering hubs.

Maersk estimate that a doubling of fuel costs would only add 6c to the price of $100 trainers

Maersk Sustainability Report 2020

Main Risks of Methanol as a Fuel 1 of 2



Main risks of methanol on ships

Low flash point

- Flash point 11^{0}C
- Class A liquid (flash point below 28^{0}C)
- Volatile and flammable

Explosive

- Oxygenated fuel (50%)
- Wider flammability limits (6%-36%)
- Low flammability limit

Corrosive

- Causes corrosion on metals such as lead, nickel and cast iron
- Causes plastic and rubber parts to swell

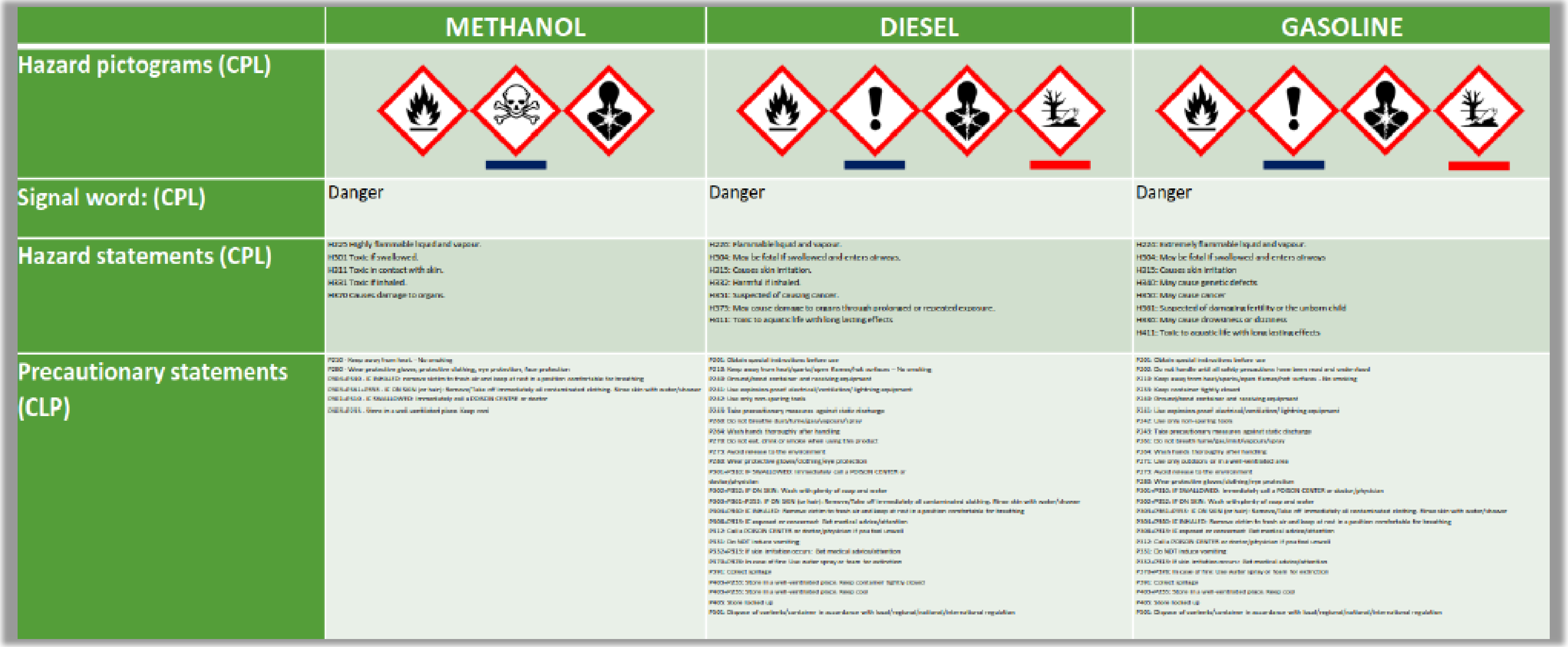
Toxicity

- Inhalation, ingestion and absorption
- Acidosis, damage to optic nerve or effect on central nervous system

Main Risks of Methanol as a Fuel 2 of 2

Risks	Countermeasures
Fire	• Fire caused by static electricity: Anti-static measures such as grounding of the pipeline between fueling party and party receiving the fuel • Use of explosion-prevention equipment • Vapour detection • Prohibiting smoking as flame is invisible
Explosion	• Refueling station should be located on an open deck • Purging and inerting of the pipeline
Fuel leakage	• Use of qualified and certified refueling equipment, including qualified hose • Approved emergency cutoff procedures • Automatic emergency cutoff system
Toxicity	• Personnel protection equipment
Overfilling	• Fuel tank maximum level alarm to immediately close the refueling valve • Should be equipped with a pair of sensors on the fuel tank
System failure	• Manual shutoff valve to shutoff the fuel tank (primary valves)
Power outage	• Mechanical closure of refueling valve (ESD)

Hazard Comparison



	METHANOL	DIESEL	GASOLINE
Hazard pictograms (CPL)			
Signal word: (CPL)	Danger	Danger	Danger
Hazard statements (CPL)	H225 Highly flammable liquid and vapour. H301 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. H315: Causes skin irritation. H332: Harmful if inhaled. H351: Suspected of causing cancer. H373: May cause damage to organs through prolonged or repeated exposure. H411: Toxic to aquatic life with long lasting effects.	H224: Extremely flammable liquid and vapour. H304: May be fatal if swallowed and enters airways H315: Causes skin irritation H340: May cause genetic defects H350: May cause cancer H361: Suspected of damaging fertility or the unborn child H336: May cause drowsiness or dizziness H411: Toxic to aquatic life with long lasting effects
Precautionary statements (CLP)	[illegible]	[illegible]	[illegible]

Methanol classified as "not more dangerous" than other fuels such as gasoline or diesel – fuels largely familiar to most people

Improving Local Air Quality

Emission reduction potential:

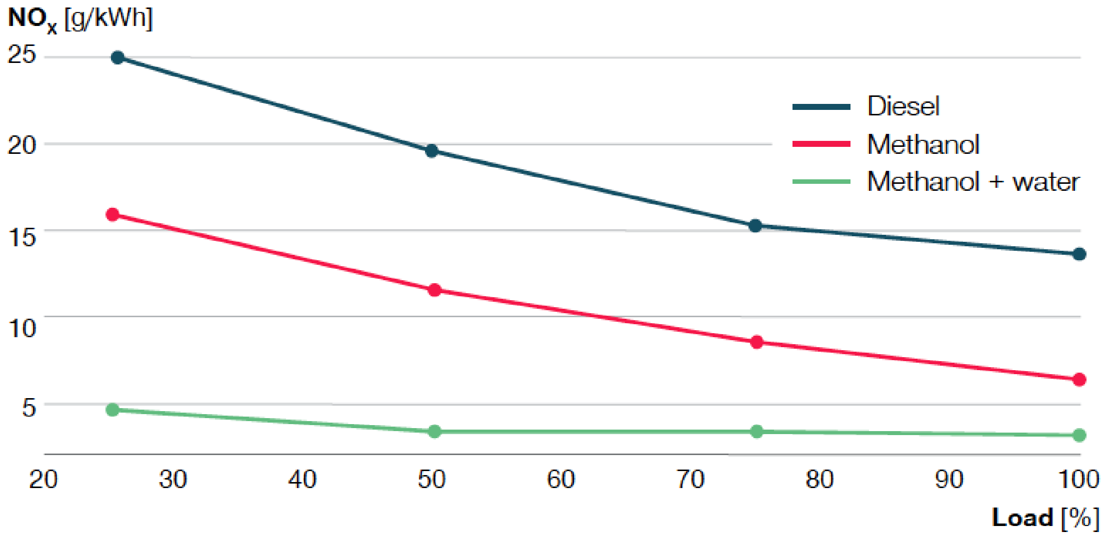
SO_x >99%

source: Stena Line

PM >95%

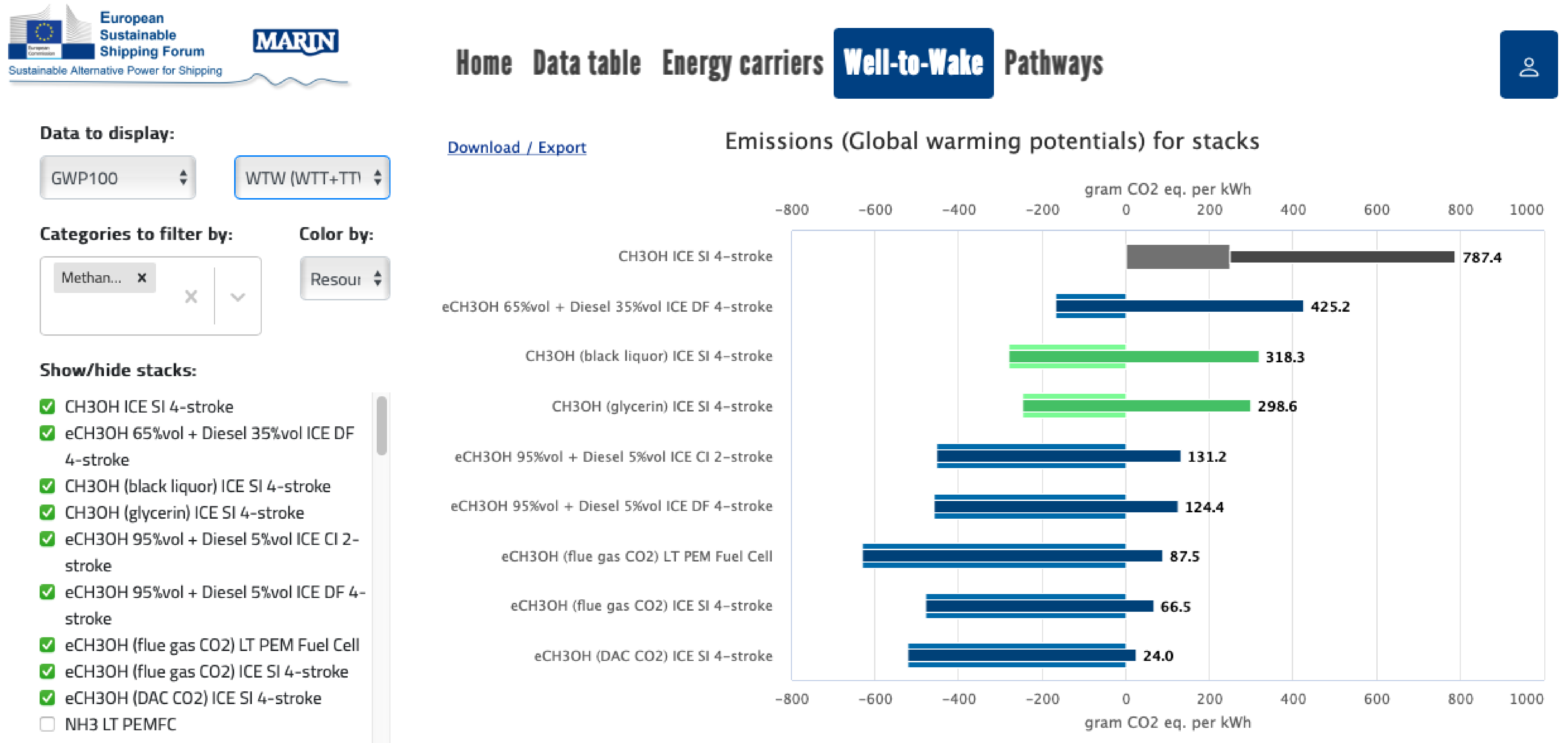
source: Stena Line

NO_x >80%



source: MAN ES

Significant CO_2 Reduction Potential



Data to display: GWP100 | WTW (WTT+TT

Categories to filter by: Methan... ×

Color by: Resour

Show/hide stacks:

- ☑ CH3OH ICE SI 4-stroke
- ☑ eCH3OH 65%vol + Diesel 35%vol ICE DF 4-stroke
- ☑ CH3OH (black liquor) ICE SI 4-stroke
- ☑ CH3OH (glycerin) ICE SI 4-stroke
- ☑ eCH3OH 95%vol + Diesel 5%vol ICE CI 2-stroke
- ☑ eCH3OH 95%vol + Diesel 5%vol ICE DF 4-stroke
- ☑ eCH3OH (flue gas CO2) LT PEM Fuel Cell
- ☑ eCH3OH (flue gas CO2) ICE SI 4-stroke
- ☑ eCH3OH (DAC CO2) ICE SI 4-stroke
- ☐ NH3 LT PEMFC

Emissions (Global warming potentials) for stacks

source: https://sustainablepower.application.marin.nl

Oil Spills Still Happen….

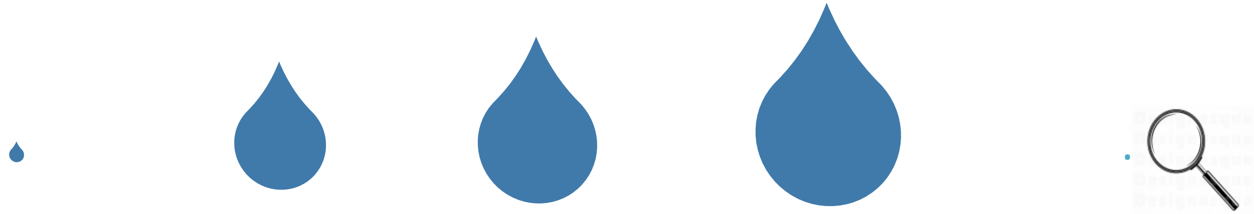
Pollution in Perspective

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



Gasoline [1]
8,2 mg/l

Methane [2]
49,9 mg/l

Diesel [3]
65 mg/l

Heavy Fuel Oil [4]
79 mg/l

Ammonia[6]
0.068 mg/l

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**

Spill & Salvage Economic Impact

Economic Impact – HFO vs Methanol :

	Maritime accident	Maritime accident	Simulation
Ship	**Erika**	**Tanio**	-
Fuel	Heavy Fuel Oil	Heavy Fuel Oil	Methanol
Released amount	19000 t	13500 t	10000t
Affected coastline	400km	200km	0km
Total damage	$914M	-	-
Cleaning	$100M	$50M	$0
Fishing industry	$98,3M	-	-
Tourist industry	**$400-500M**	-	-
Claim for damages	**$120M**	**$17M**	-
Killed birds	~ 60,000	~ 40,000	->0

MeOH spill simulations

Simulation 1[8]:

- ○ **Release of 10,000 tons Methanol at open Sea**
  Concentration of 0,36% after 1 hour

Simulation 2[8]:

- ○ **Release of 10,000 l/h from a coastal pier**

Concentration of 0,36% after 1 hour
Concentration of 0,13% after 3 hours

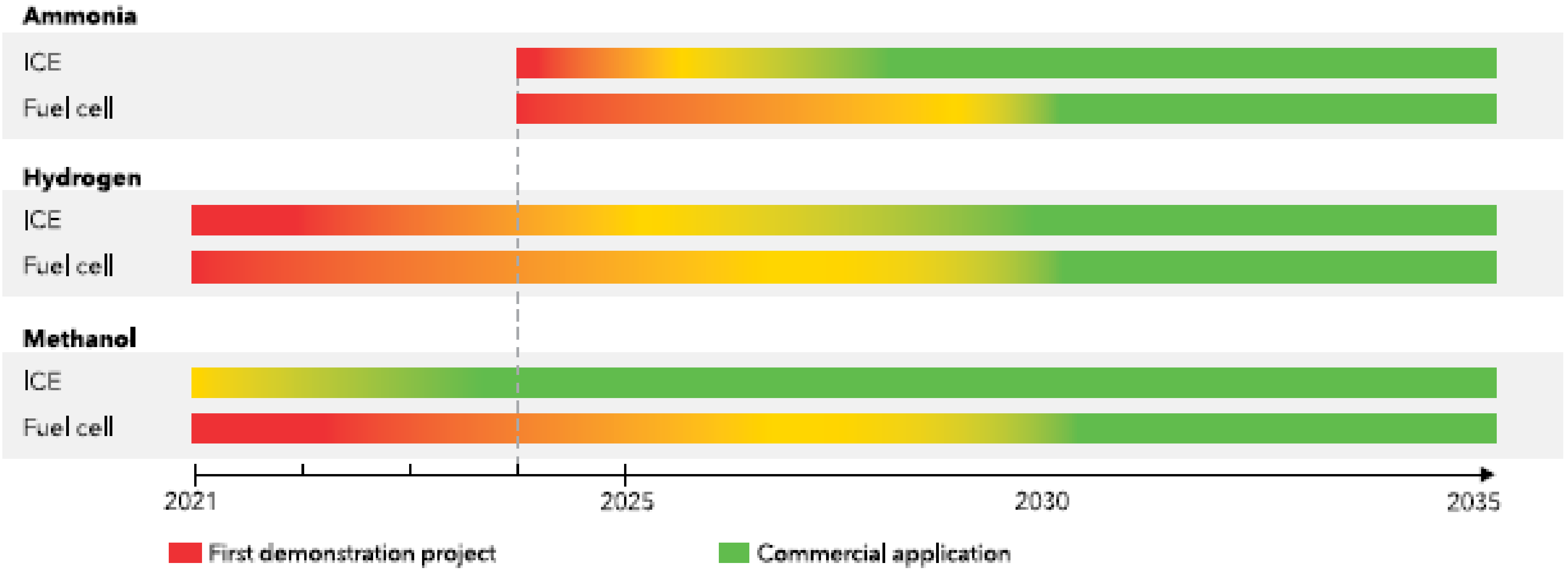
[8] Malcolm pirnie, Inc, Technical Memorandum

Sources : Economic, Social & Environmental Effects of the "Prestige" Oil Spill, Meyer-Werft

- Less toxic then gasoline or diesel
- Methanol poisoning is not carcinogenic and requires simple treatment
- No additional GHG potential (methane slip)
- Miscible in water – large spill concentration will rapidly decrease with only very short-term effects
- Far less hazardous to the environment
- Methanol is fully miscible with water and dissolves readily
- It is biodegradable and does not bioaccumulate
- Methanol is not rated as toxic to aquatic organisms using the GESAMP rating system (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) (acute and chronic toxicity measures)

Technology Readiness

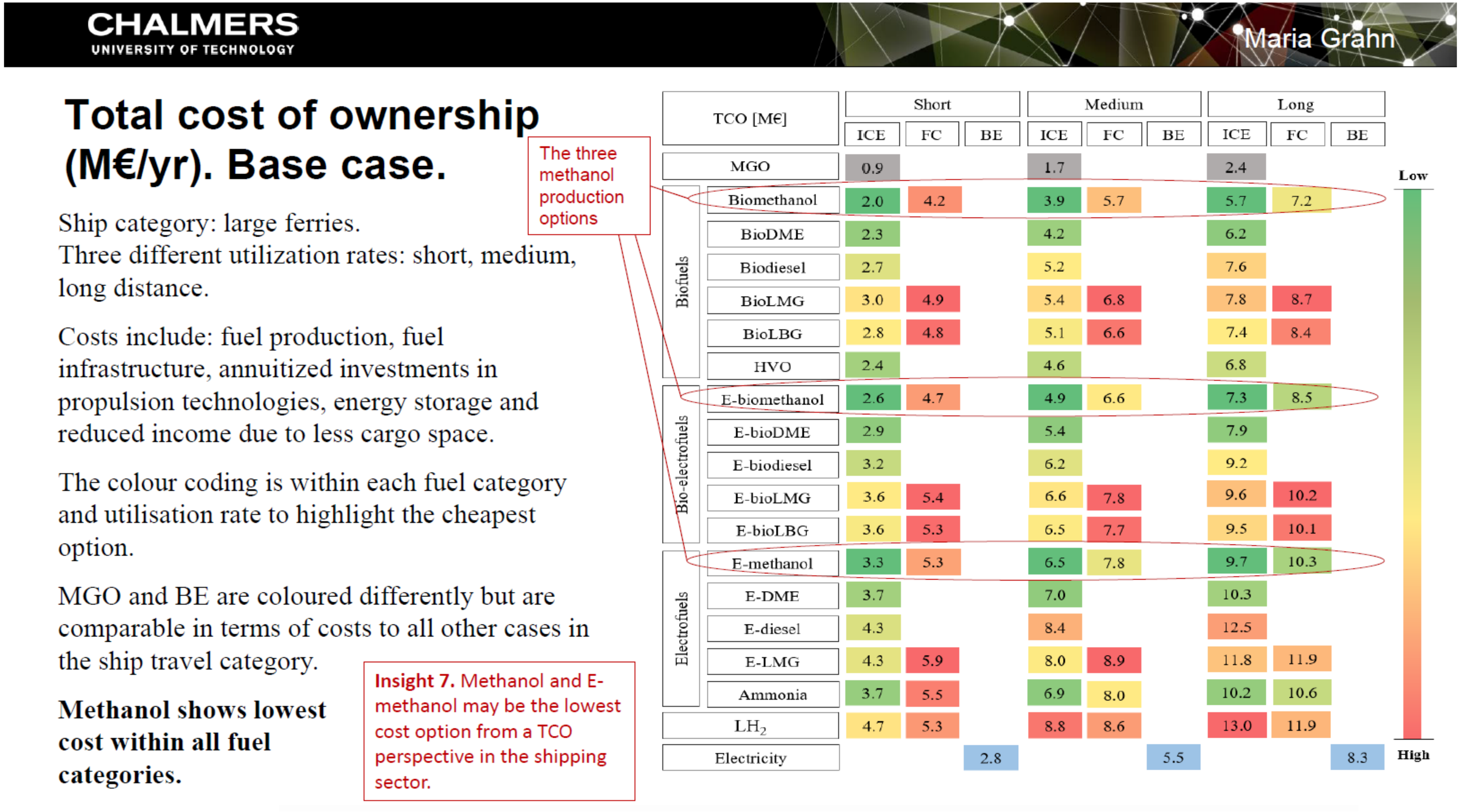
Timeline for expected availability of alternative fuel technologies – our best estimate for when these may be available for onboard use



Key: Internal combustion engine (ICE)

©DNV 2021

Stacking Up Green Competition



CHALMERS
UNIVERSITY OF TECHNOLOGY

Maria Grahn

Total cost of ownership (M€/yr). Base case.

The three methanol production options

Ship category: large ferries.
Three different utilization rates: short, medium, long distance.

Costs include: fuel production, fuel infrastructure, annuitized investments in propulsion technologies, energy storage and reduced income due to less cargo space.

The colour coding is within each fuel category and utilisation rate to highlight the cheapest option.

MGO and BE are coloured differently but are comparable in terms of costs to all other cases in the ship travel category.

Methanol shows lowest cost within all fuel categories.

Insight 7. Methanol and E-methanol may be the lowest cost option from a TCO perspective in the shipping sector.

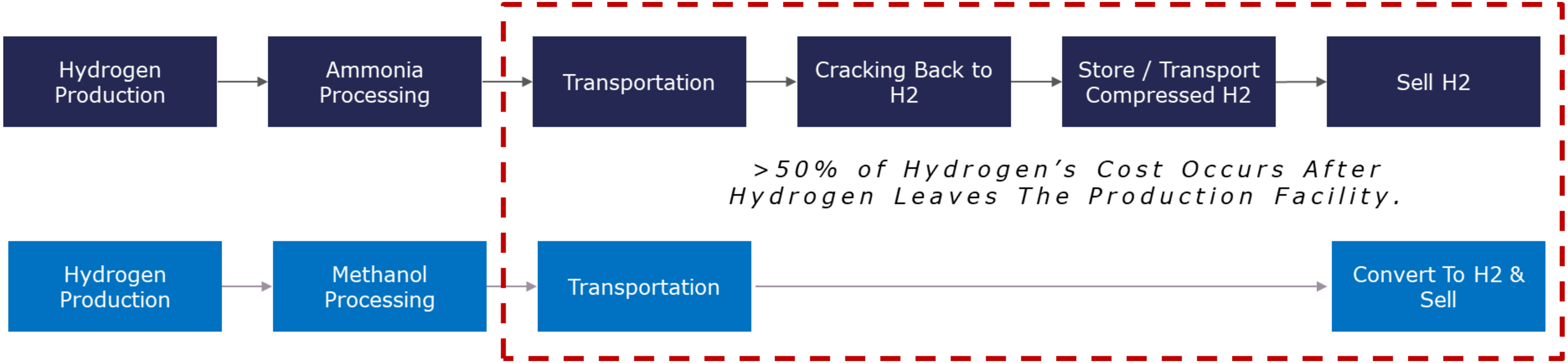
	TCO [M€]	Short			Medium			Long		
		ICE	FC	BE	ICE	FC	BE	ICE	FC	BE
	MGO	0.9			1.7			2.4		
Biofuels	Biomethanol	2.0	4.2		3.9	5.7		5.7	7.2	
	BioDME	2.3			4.2			6.2		
	Biodiesel	2.7			5.2			7.6		
	BioLMG	3.0	4.9		5.4	6.8		7.8	8.7	
	BioLBG	2.8	4.8		5.1	6.6		7.4	8.4	
	HVO	2.4			4.6			6.8		
Bio-electrofuels	E-biomethanol	2.6	4.7		4.9	6.6		7.3	8.5	
	E-bioDME	2.9			5.4			7.9		
	E-biodiesel	3.2			6.2			9.2		
	E-bioLMG	3.6	5.4		6.6	7.8		9.6	10.2	
	E-bioLBG	3.6	5.3		6.5	7.7		9.5	10.1	
Electrofuels	E-methanol	3.3	5.3		6.5	7.8		9.7	10.3	
	E-DME	3.7			7.0			10.3		
	E-diesel	4.3			8.4			12.5		
	E-LMG	4.3	5.9		8.0	8.9		11.8	11.9	
	Ammonia	3.7	5.5		6.9	8.0		10.2	10.6	
	LH_2	4.7	5.3		8.8	8.6		13.0	11.9	
	Electricity			2.8			5.5			8.3

Low

High

Methanol vs Ammonia

Ammonia – Converting Ammonia to Hydrogen requires higher heat (600C to 900C = Outside Heat Source), more expensive equipment, and large centralized facilities for Hydrogen distribution to end users. Public spaces cannot currently convert Ammonia to Hydrogen without high costs and/or public safety risk.



Hydrogen Production → Ammonia Processing → Transportation → Cracking Back to H2 → Store / Transport Compressed H2 → Sell H2

>50% of Hydrogen's Cost Occurs After Hydrogen Leaves The Production Facility.

Hydrogen Production → Methanol Processing → Transportation → Convert To H2 & Sell

Methanol – Methanol can convert to Hydrogen at lower temperatures (300C to 450C). Methanol also leverages existing liquids infrastructure and converts to Hydrogen with proven technology that is less expensive, safer, and with a limited footprint.

Source: Webber Research and Advisory

Methanol Marine SWOT

STRENGTHS

AVAILABLE COMPLIANT LIQUID

NEW BUILD & RETROFIT

SAFE HANDLING EXPERIENCE

SUSTAINABLE PATHWAYS

ENGINE/INFRA AVAILABILITY

WEAKNESSES

ENERGY DENSITY

ALT FUEL UNDERSTANDING

LIMITED RM AVAILABILITY

FULLY COMPLIANT FUEL, READILY AVAILABLE, COMPETITIVE ON BOTH CAPEX AND OPEX CRITERIA, WITH A RANGE OF FUTURE PROOF PATHWAYS

THREATS

DELAY OF GHG POLICY

CONTINUED LOW OIL PRICE

SPACE ON-BOARD

OPPORTUNITIES

EFFICIENT LOGISTICS | DESIGN

TRADING | PRICE COMPETITIVE

FEEDSTOCK FLEXIBILITY | BLEND

Our Conclusions


Increasing number of vessels


More OEM’s offering engines


Liquid at atmospheric pressure


Very low emissions


Environmentally friendly


Broad range of sustainable feedstocks


Cost competitive


Available in most major ports

Future proof

Our Contacts

Eelco Dekker
Chief EU Representative
edekker@methanol.org

Matthias Olafsson
Manager of Government & Public Affairs - Europe
molafsson@methanol.org

Greg Dolan
CEO
gdolan@methanol.org

Larry Navin
Director of Government and Public Affairs Americas / Europe Operations
lnavin@methanol.org

London Douglas
Social Media and Web Manager
ldouglas@methanol.org

Zhao Kai
Chief China Representative
kzhao@methanol.org

Chris Chatterton
COO
cchatterton@methanol.org

Tim Chan
Assistant Director of Government & Public Affairs (AP/ME)
tchan@methanol.org

Belinda Pun
Executive Manager
bpunr@methanol.org

Prakriti Sethi
India Representative
psethi@methanol.org