METHANOL INSTITUTE

Methanol as a Marine Fuel

January 2020

What is Methanol?

A clear, colourless fuel, liquid at ambient temperature, miscible in water

More environmentally benign than conventional marine fuels (HFO, MGO, MDO).

Already used as a transport fuel all over the world

Diesel Bunker Fuel

Methanol Marine Fuel

What is Methanol's relevance to IMO2020?

Methanol is among the lowest emission fuels for marine engines

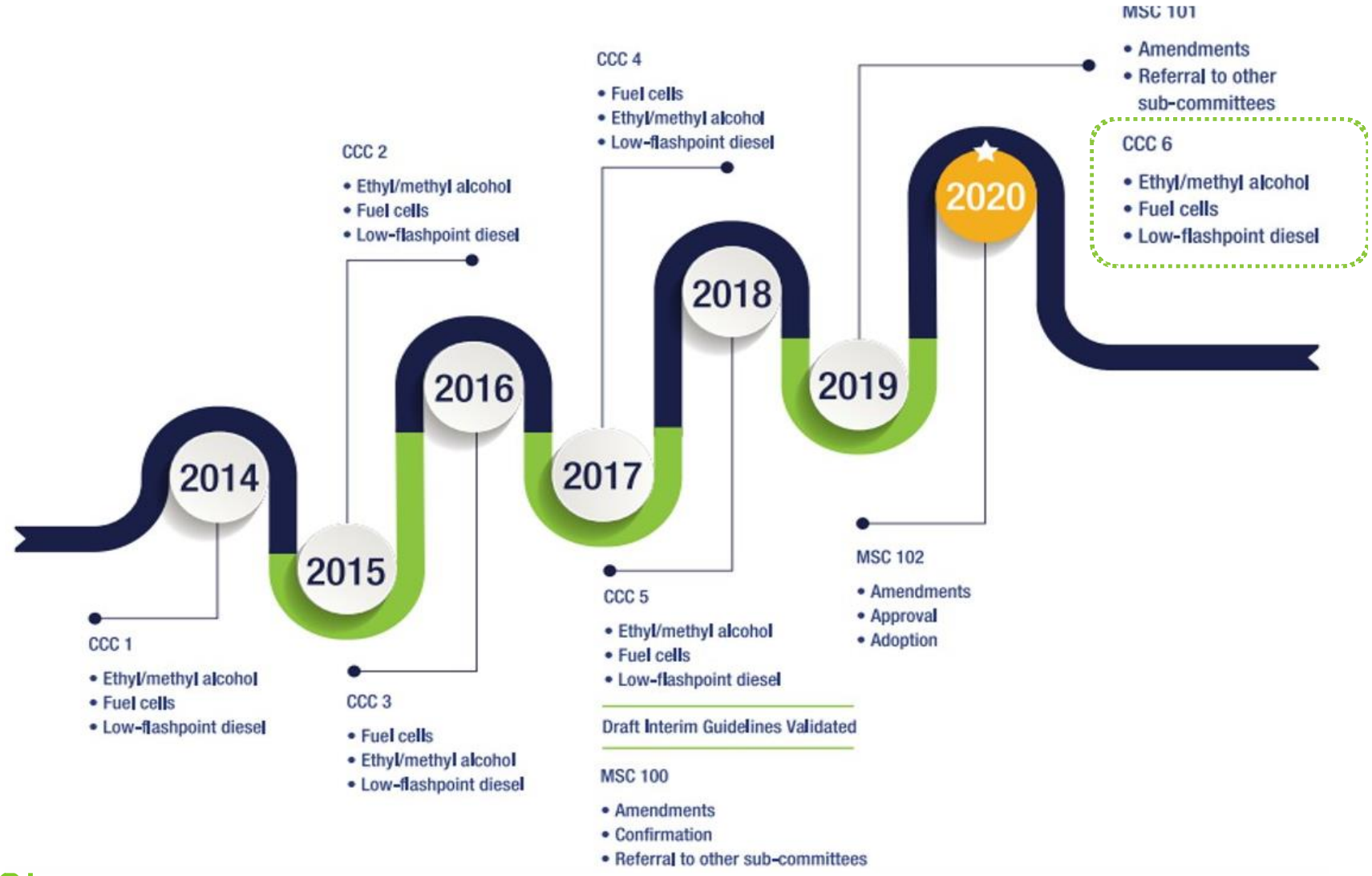
Source: Stena Lines -- Emission reductions when compared to alternative fuels currently available (fuel oil)

How does Methanol address the IMO interim strategy?

In operation, conventional Methanol offers significantly lower CO2 emissions compared to conventional marine fuel.

If produced from one of numerous renewable pathways, such as biomass or renewable electricity combined with recycled carbon dioxide, Methanol has the potential to significantly reduce CO2 emissions on a well-to-propeller basis.

Progression through the IMO process



Regulation and Safety

In June 2018, MSC 99 invited the International Standards Organization to develop a standard for methyl/ethyl alcohol as a marine fuel.

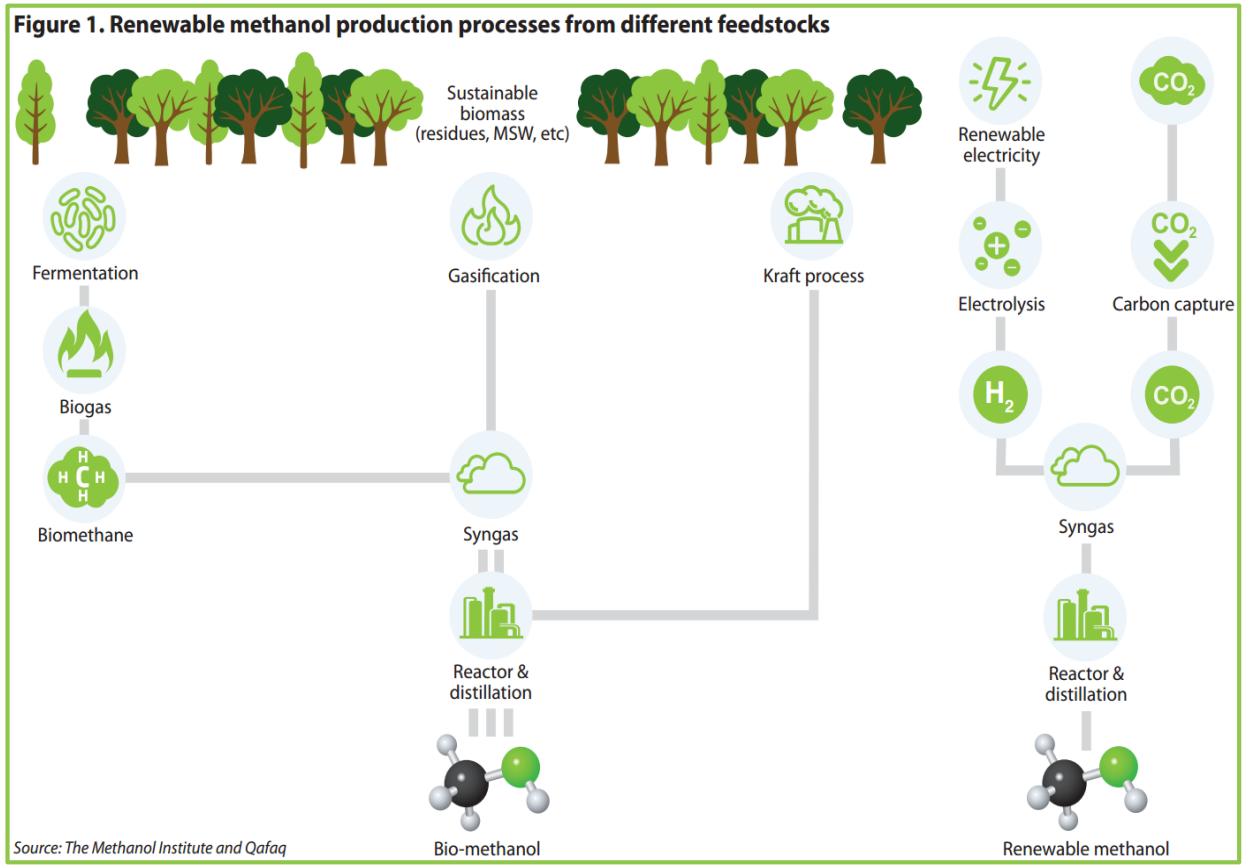
In September 2019, the IMO's CCC5 sub-committee completed interim guidelines covering the safety of ships using Methanol as fuel, with the ultimate goal of adding a new chapter to the IGF Code as soon as possible.

Bunkering: simple, straightforward

Methanol is subject to the same bunkering guidelines and safety standards as conventional marine fuels

Methanol-fuelled tankers are bunkered during cargo loading, *Stena Germanica* has recorded thousands of hours of safe operations and over 400 successful stems placed since its conversion to Methanol.

Methanol: Net Carbon-Neutral Pathways



> *Renewable methanol is an ultra-low carbon chemical produced from sustainable biomass, often called bio-methanol, or from carbon dioxide and hydrogen produced from renewable electricity.*

Renewable Methanol Emission Reductions: CO2 by up to 95%; NOx by 80%; virtually eliminating SOx and Particulate Matter (PM)

Methanol Vessels On the Water

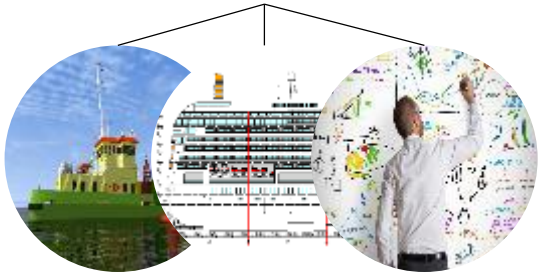
DUAL FUEL

9x - +2	1x	1x	1x
chemical tankers	ROPAX ferry	Pilot boat	dry bulk
MOL, WL, Marinvest	Stena Line	MI/SMA ScandiNaos	Jiang Long
2 stroke MAN	4 stroke Wärtsila	high speed Scania, Weichai	DMCC Yuchai
new build	retrofit	retrofit	new build

FUEL CELL

2x	1x
Tourist Boat propulsion	Ferry hotel load
Innogy HTWG Konstanz	Viking Line
SerEnergy fuel cells	
retrofit	retrofit

PROJECT and R&D



Cruise ships, fishing boat, barge, dredge, a.o.

SUMMETH/MARTEC, Lean Ships, Methaship, Billion Miles, FiTech, India, PCG Product Vessel, NTU Test Port of Rotterdam Barge, **Green Maritime Methanol, FastWater**

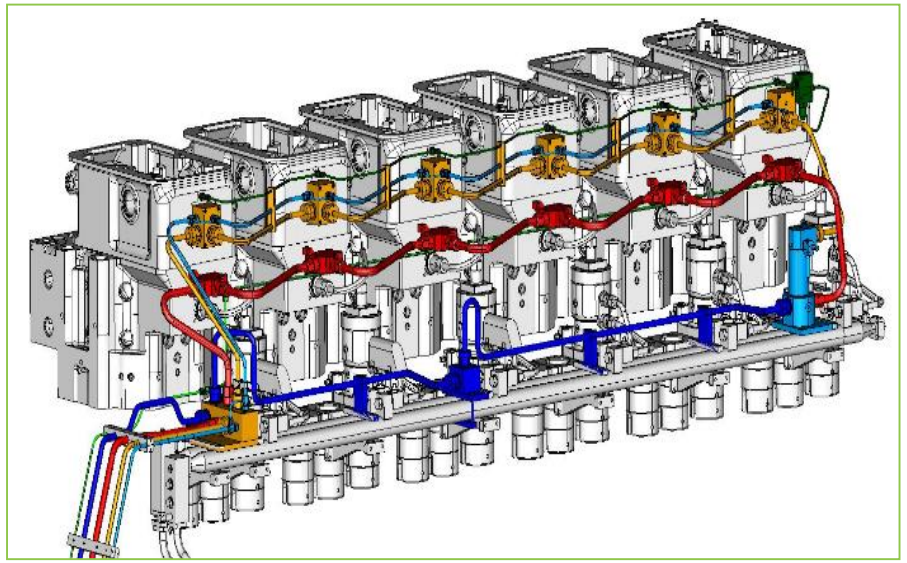
SI hybrid, dual fuel, fuel cells

new build & retrofit

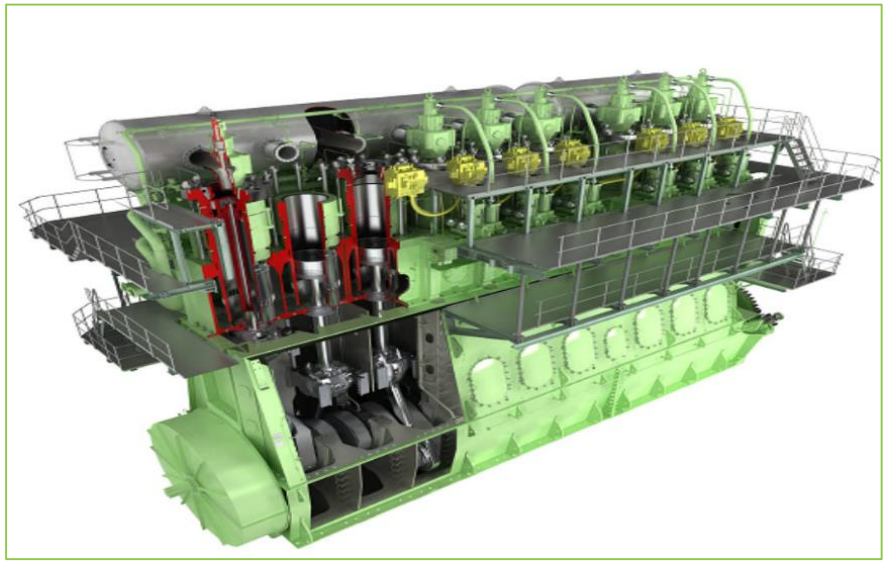
…with more on the way

- **Sweden/Switzerland:** Proman Stena Bulk – joint venture of shipowner Stena Bulk and Proman Shipping a subsidiary of methanol producer Proman – to build two 50,000 dwt tankers with methanol dual fuel engines
- **Netherlands:** Damen Shipyards has developed new concept Offshore Support Vessel (OSV) to operate on methanol
- **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

What type of engines can use Methanol?



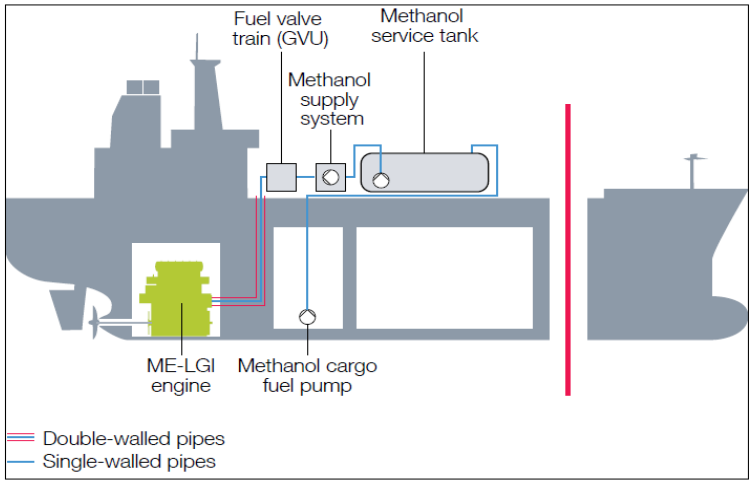
Source: Wärtsilä



Source: MAN ES

Source: Clean Shipping International

MAN Duel-Fuel Engine – Waterfront Vessel Configuration

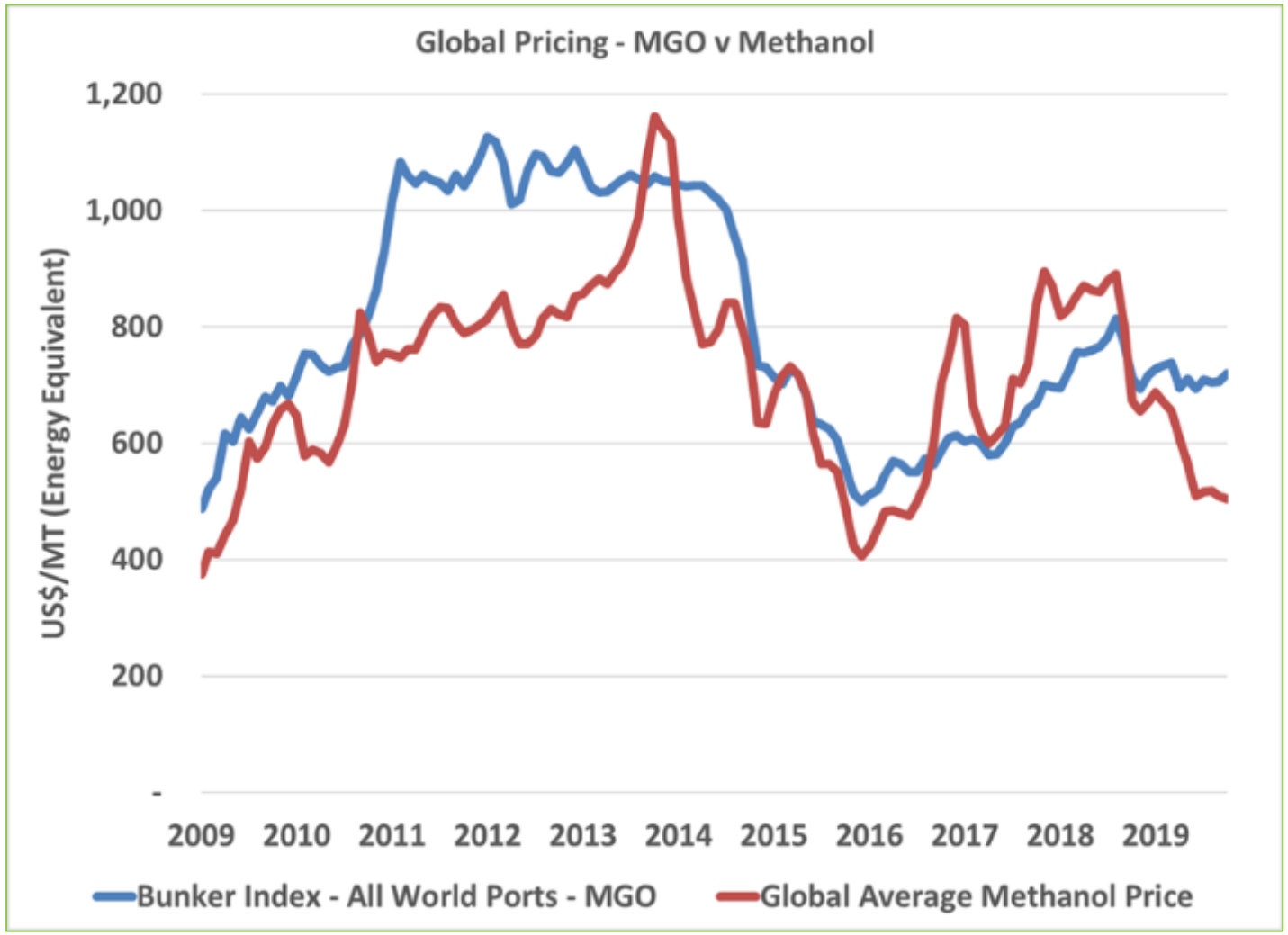


“We developed the ME-LGIM engine in response to interest from the shipping world in alternatives to heavy fuel oil. With the growing demand for cleaner marine fuels, methanol is a sulphur-free alternative that meets the industry’s increasingly stringent emission regulations.”

René Sejer Laursen, Promotion Manager at MAN Energy Solutions

https://marine.man-es.com/two-stroke/2-stroke-engines/me-lgim

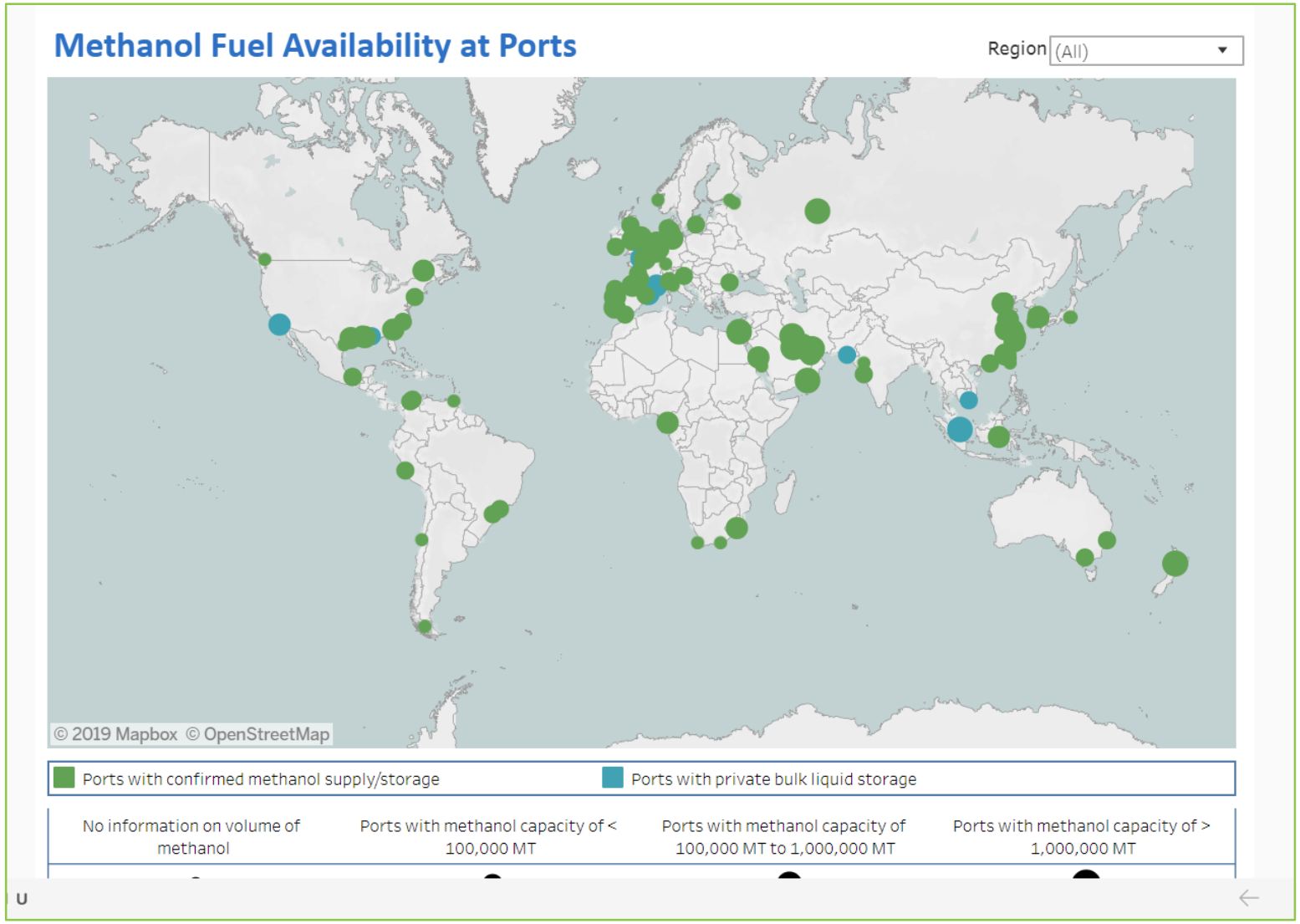
Compliance Cost Comparison



"Methanol is an economically competitive marine fuel over the cycle"

Paul Hexter, CEO Waterfront Shipping

Methanol is Globally Available



Industry Engagement

Marine Fuel Calculator

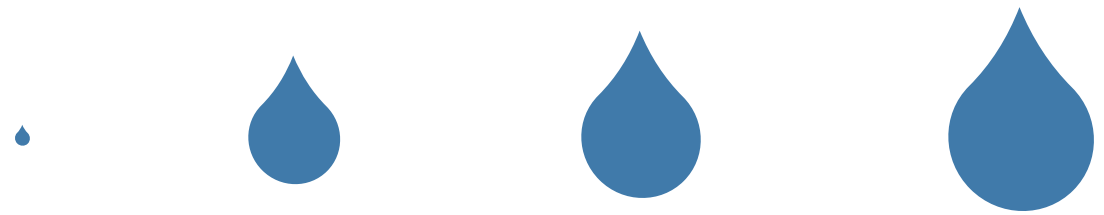
- MI has engaged Lloyd's Register to develop a calculator ship operators can use to understand the CAPEX, OPEX and other metrics of the various options for complying with IMO rules, including methanol

Methanol Marine Fuel and Safe Bunkering Guidelines

- As part of the Methaship project, and in cooperation with MI, Lloyd's Register is also developing a marine fuel and safe bunkering guidelines report that will be shared with the IMO

Pollution in Perspective

LC50 - Lethal Dosis: 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

Methanol [5]
15.400 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

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Methanol is:

- A simple, safe liquid fuel, miscible in water
- Plentiful, available globally, price competitive
- Works with existing engine technologies as a drop-in or a dual fuel
- Complies with IMO2020 provides a pathway to IMO 2030 and 2050
- Requires only minor modifications to current bunkering infrastructure

What Do The Operators Say?

STENA LINE

"We are very enthusiastic about Methanol's possibilities and it has the potential to be the maritime fuel of the future"

Carl-Johan Hagman
CEO
Stena Line

MARINVEST / SKAGERACK INVEST

"We have found the technology for handling Methanol is well developed and offers a safe dual-fuel solution for low-flashpoint liquid fuels"

Patrik Mossberg
Chairman
Marinvest/Skagerack Invest

MITSUI O.S.K. LINES, LTD.

"Investing in technology that encourages the use of a fuel like Methanol that significantly reduces emissions is a step forward for both our company and the shipping industry"

Akio Mitsuta
Senior Managing Executive Officer
Mitsui O.S.K. Ltd

WESTFAL-LARSEN MANAGEMENT

"We have found Methanol to be one of the best alternative fuels due to its wide availability, the use of existing infrastructure, and the simplicity of the engine design and ship technology"

Rolf Westfal-Larsen Jr.
CEO
Wesfal-Larsen Management

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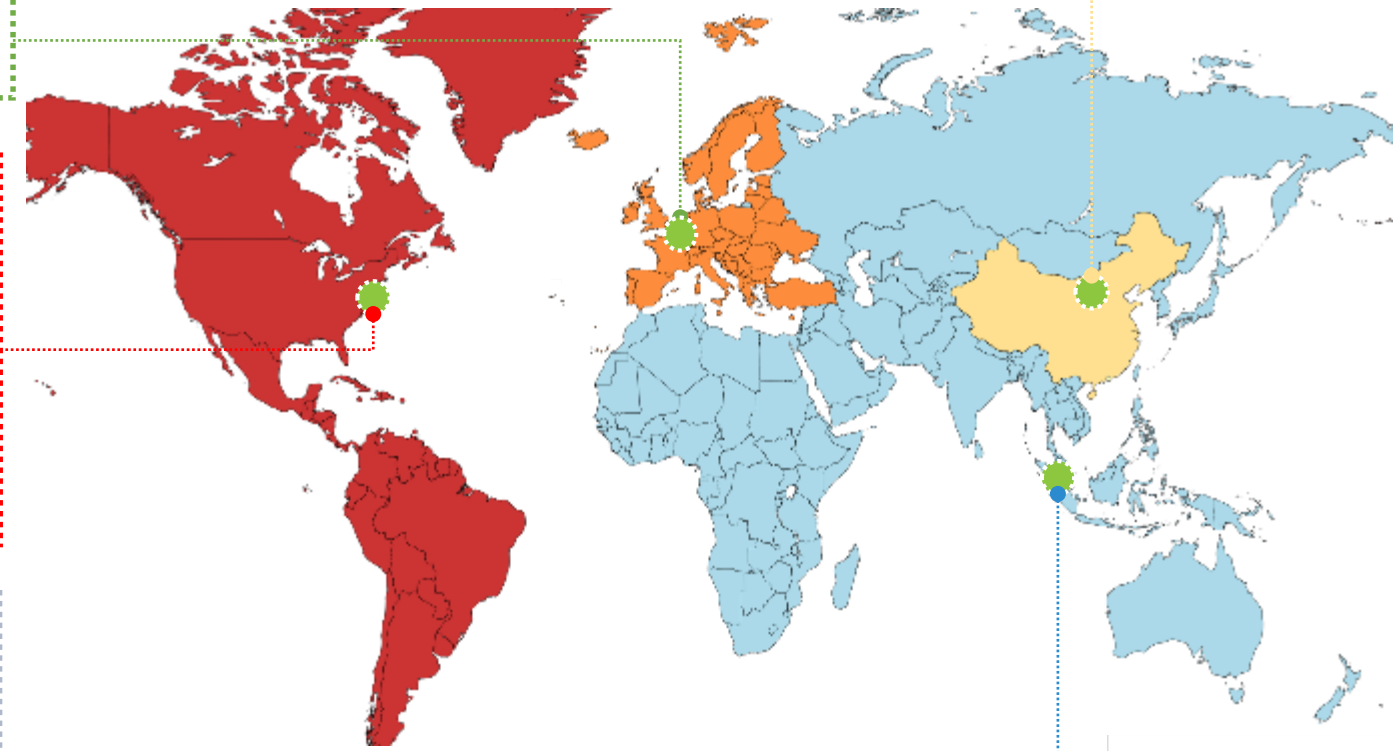

www.methanol.org www.methanolfuels.org