THE MARINE FUEL OF THE FUTURE

METHANOL AS A SUSTAINABLE SOLUTION

SUSTAINABLE BIOMASS
(Residues, MSW, etc)

Fermentation → Biogas → Biomethane

Gasification → Syngas

Kraft Process

Biomethane + Syngas → Reactor & Distillation → Bio-Methanol

SYNTHETIC FUELS

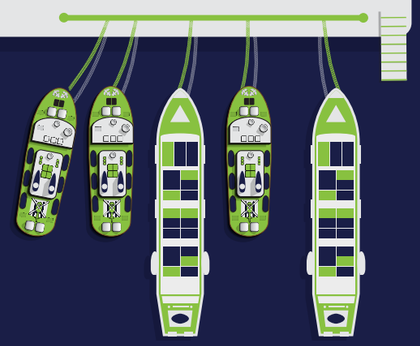
Renewable Electricity → Electrolysis → H_2

CO_2 → Carbon Capture → CO_2

H_2 + CO_2 → Syngas → Reactor & Distillation → Renewable Methanol

Bio-Methanol + Renewable Methanol → **Renewable Methanol**

RETROFITS ECONOMICALLY VIABLE



METHANOL FUELED VESSELS AND PILOTS

DUAL FUEL

Chemical Tankers 11+9*

Ropax Ferry 1

Pilot Boat 1

FUEL CELL

Tourist Boat 2

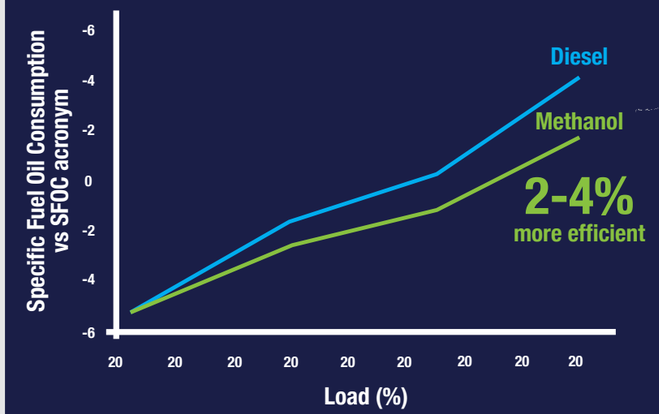
Ferry 1

PROJECT R&D

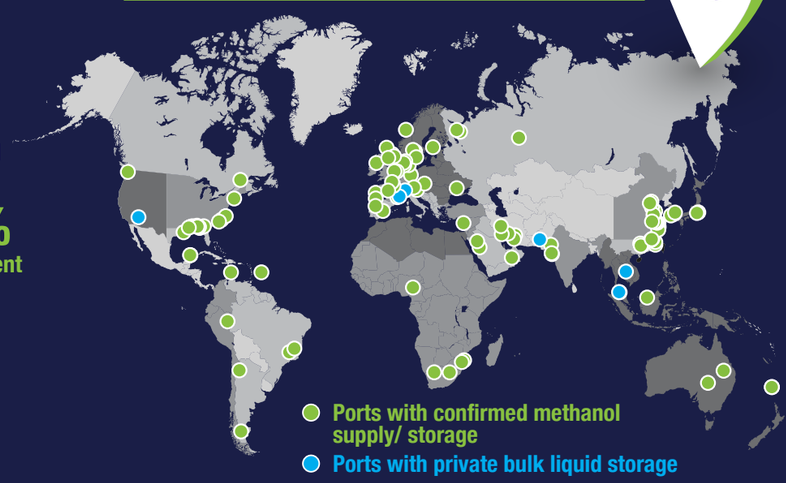
Cruise Ships, Fishing Boats, Barges, Dredges, Others 4

*9 additional new builds scheduled for delivery by 2023

METHANOL IS MORE EFFICIENT THAN DIESEL IN ICE



METHANOL AVAILABLE IN OVER 100 PORTS TODAY



LNG VS METHANOL

FUEL TYPE	LNG	METHANOL
Heat capacity	49,200 kJ/kg	20,000 kJ/kg
Density	425 kg/m3	800 kg/m3
Volumetric factor (vs MDO)	1,8	2,4
Fuel Gas Supply System Cost 15 MW	$2,5 mln	$0,5 mln
Availability	+	+++
Engine price	+ 25 %	+ 25%
Fuel Price (vs MGO)	++	+

MGO VS METHANOL

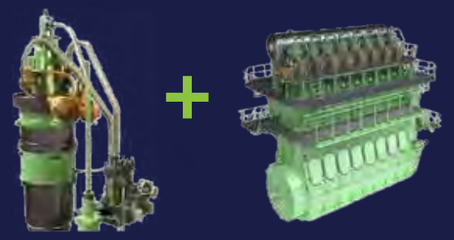
METHANOL INSTITUTE

Methanol Institute www.methanol.org

ADVANCED DUAL FUEL TECHNOLOGY

MAN ME-LGI METHANOL

ME-B Engine + LGI-M Technology



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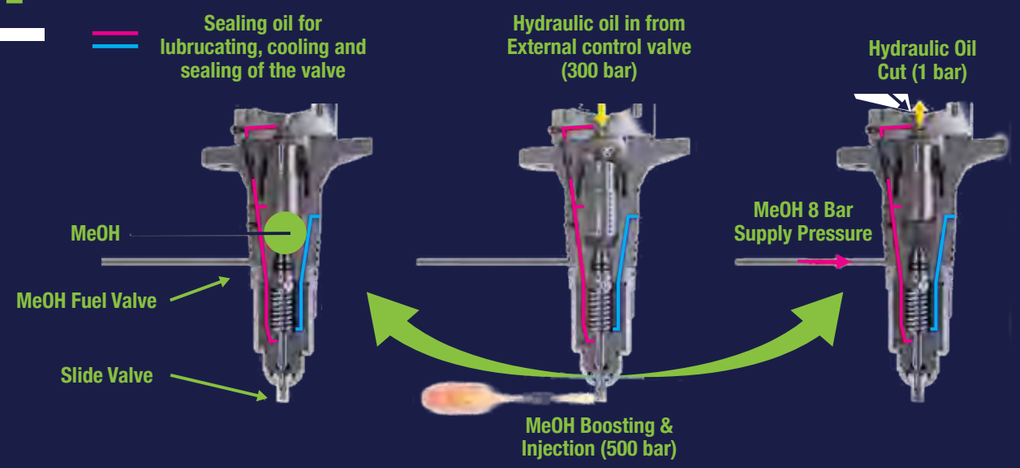
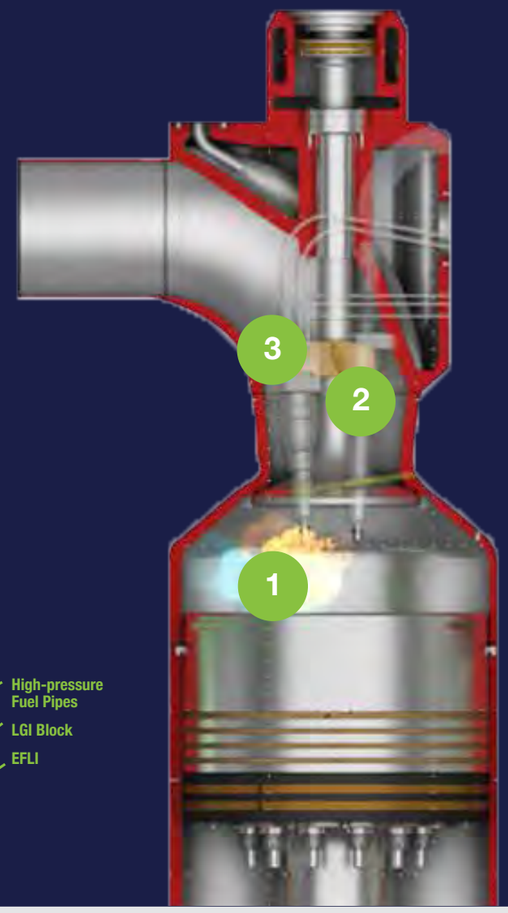
ME-B LGI-M

THE FUEL BOOSTER INJECTION VALVE

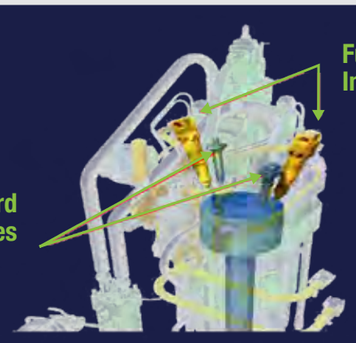
Principle of the FBIV – Fuel Booster Injection Valve



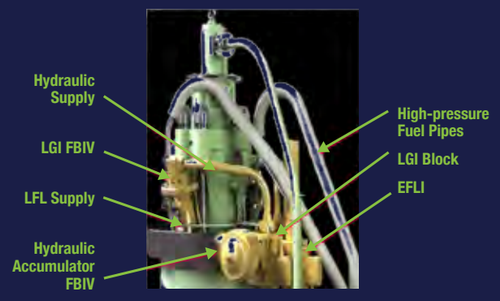
1. Combustion Illustration
   Yellow = Pilot Oil
   Blue = Methanol
2. Conventional Slide Fuel Valve
3. Methanol Injection Valve (FBIV-M)



4 FUEL VALVES PER CYLINDER



TWO STANDALONE FUEL SUPPLY SYSTEMS



ME-LGI METHANOL DEVELOPMENT MILESTONES

2015

- **LGI Demonstration Event** at RCC 4T50ME-X
- **Test at MES** 7S50ME-B9-3-LGIM
- **Test at HHI** 7G50ME-B9 3LGIM

2016

- **1st Sea Trials On Methanol** MNS Taranaki Sun & HMD Lindanger

2017

- **Development of Test III** compliance by water in methanol

2019

- **NOx Certification** 6G50ME- C9.5 LGIM-W at HHI June 2019

2020

- **Order Book** of 14 LGIM engines in total, 11 in service >65,000 running hours accumulated on Methanol

MAN www.man-es.com