

# Charting a course for methanol marine fuel

Eelco Dekker, Chief EU Representative

Methanol Institute

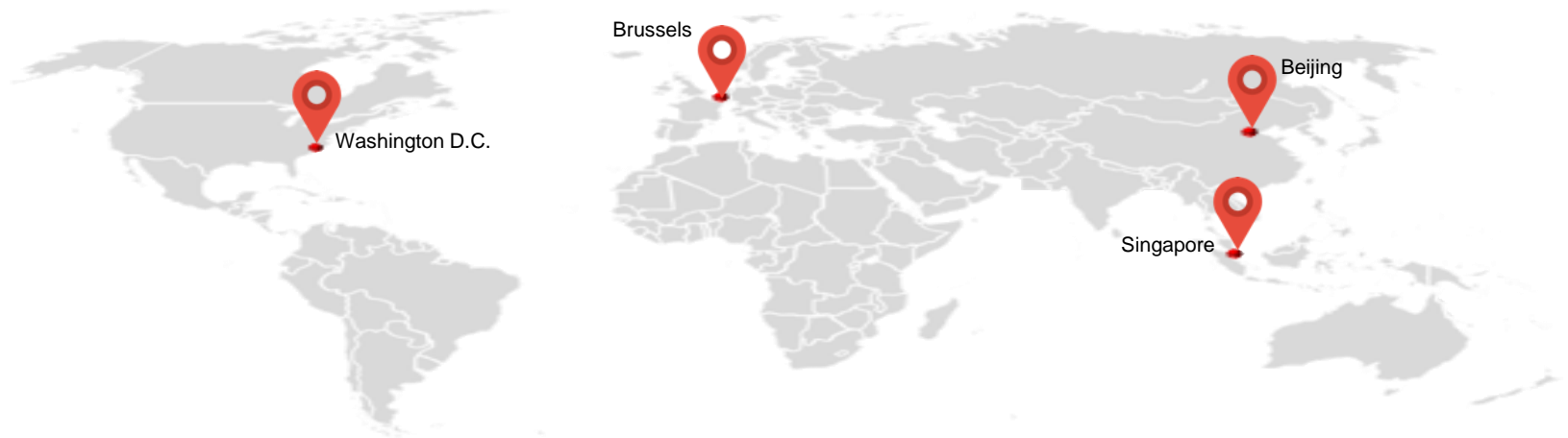
Athens, November 30<sup>th</sup>, 2018

**01**

**Who we are**

# A global industry association

- First formed in 1989, the Methanol Institute (MI) serves as the trade association for the global methanol industry.
- MI represents the world's leading methanol producers, distributors and technology companies from offices around the world



## **MI provides value to its members by:**

- Ensuring safe handling of methanol and its derivatives
- Promoting methanol growth by furthering methanol as an essential chemical commodity and an emerging source of clean and renewable energy
- Influencing global regulatory and public policy initiatives that impact the methanol industry

# 2018 members

## Tier 1



## Tier 2



شركة قطر الإضافات البترولية المحدودة  
Qatar Fuel Additives Company Limited



MITSUBI & CO.



PETRONAS



OCI



## Tier 3



Ecofuel



Sipchem  
instant everywhere



شركة ساساب للميثانول للخدمات (م.م.م)  
Sasab Methanol Company LLC (SMC)



JM

Johnson Matthey  
Inspiring science, enhancing life



Mitsubishi International Corporation

## Tier 4



منتجات  
Muntajat



LEBZI HALAL



NW  
INNOVATION  
WORKS



IMTT  
INDUSTRIAL METHANOL TECHNOLOGY



NAKHODKA  
FERTILIZER PLANT

HALDOR TOPSOE



IGP Methanol

Rationmiles

CLARIANT



Enerkem



Coogee Chemicals



solvadis

we do chemistry

# Working close cooperation with

- **European Sustainable Shipping Forum (ESSF)**
- **International Bunker Industry Association**
- **Lloyd's Register**
- **Dangerous Goods Advisory Council**
- American Chemistry Council
- Asian Clean Fuels Association
- China Ministry of Industry & Information Technology
- China Nitrogen Fertilizer Industry Association
- Chinese Association of Alcohol & Clean Ether Fuels & Automobiles
- European Chemical Industry Council (CEFIC)
- Formacare
- Gasification & Syngas Technologies Council
- German Regenerative Methanol Network
- Gulf Petrochemicals and Chemicals Association
- International DME Association
- International Methanol Producers & Consumers Association
- National Biodiesel Board
- National Institution for Transforming India (NITI Aayog)
- Oslo University Hospital
- Peking University Centre for Global New Energy Strategic Studies
- Solar Fuels Institute



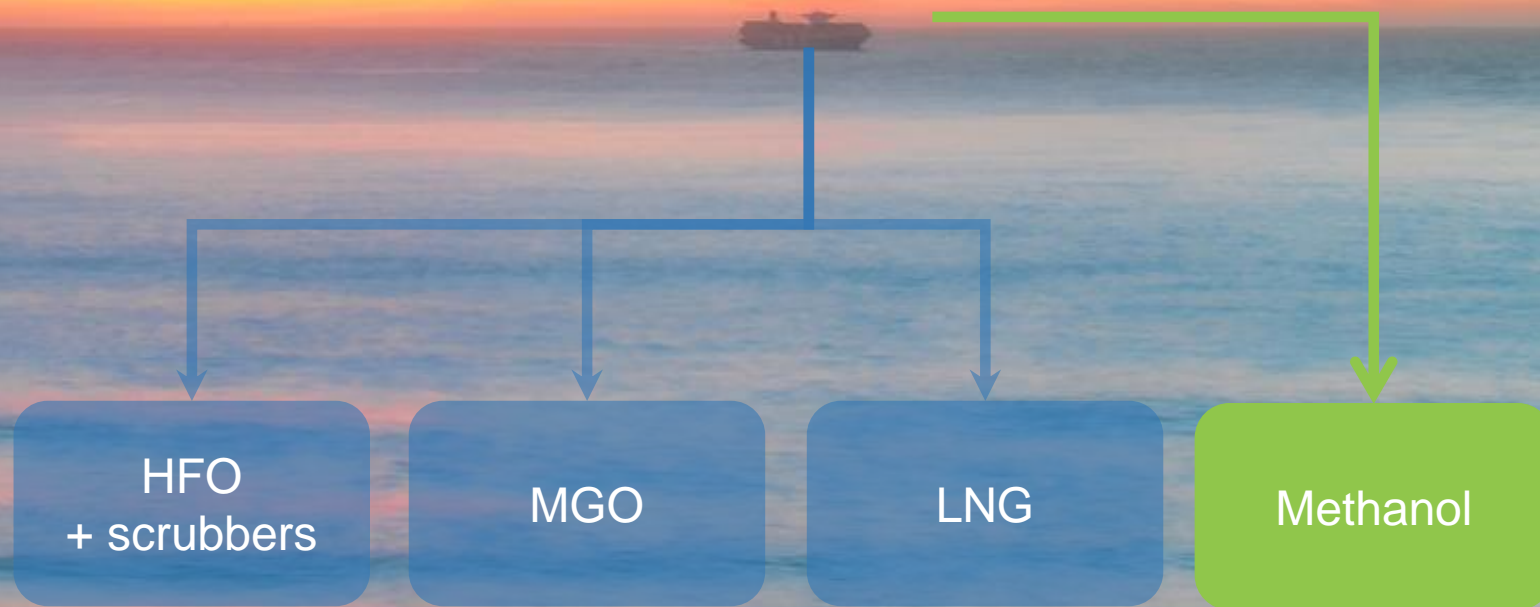
PEKING  
UNIVERSITY



NITI Aayog



# Several options available to ship owners



# Driving forces for methanol marine fuel

SUPPLY

DEMAND

LEGISLATION



**02**

# Methanol supply



# Methanol is simplest of alcohols

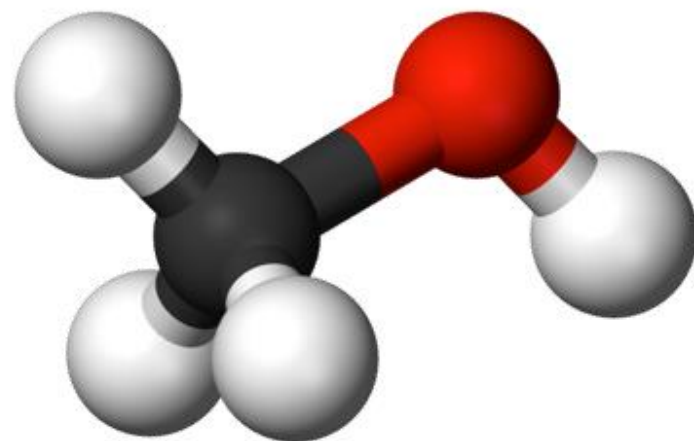
- Simple molecule rich in hydrogen, with only a single carbon bond
- Clear and colorless liquid at room temperature and ambient pressure
- Also known as “wood alcohol,” methanol can be produced from a wide range of feedstocks

Formula:  $\text{CH}_3\text{OH}$

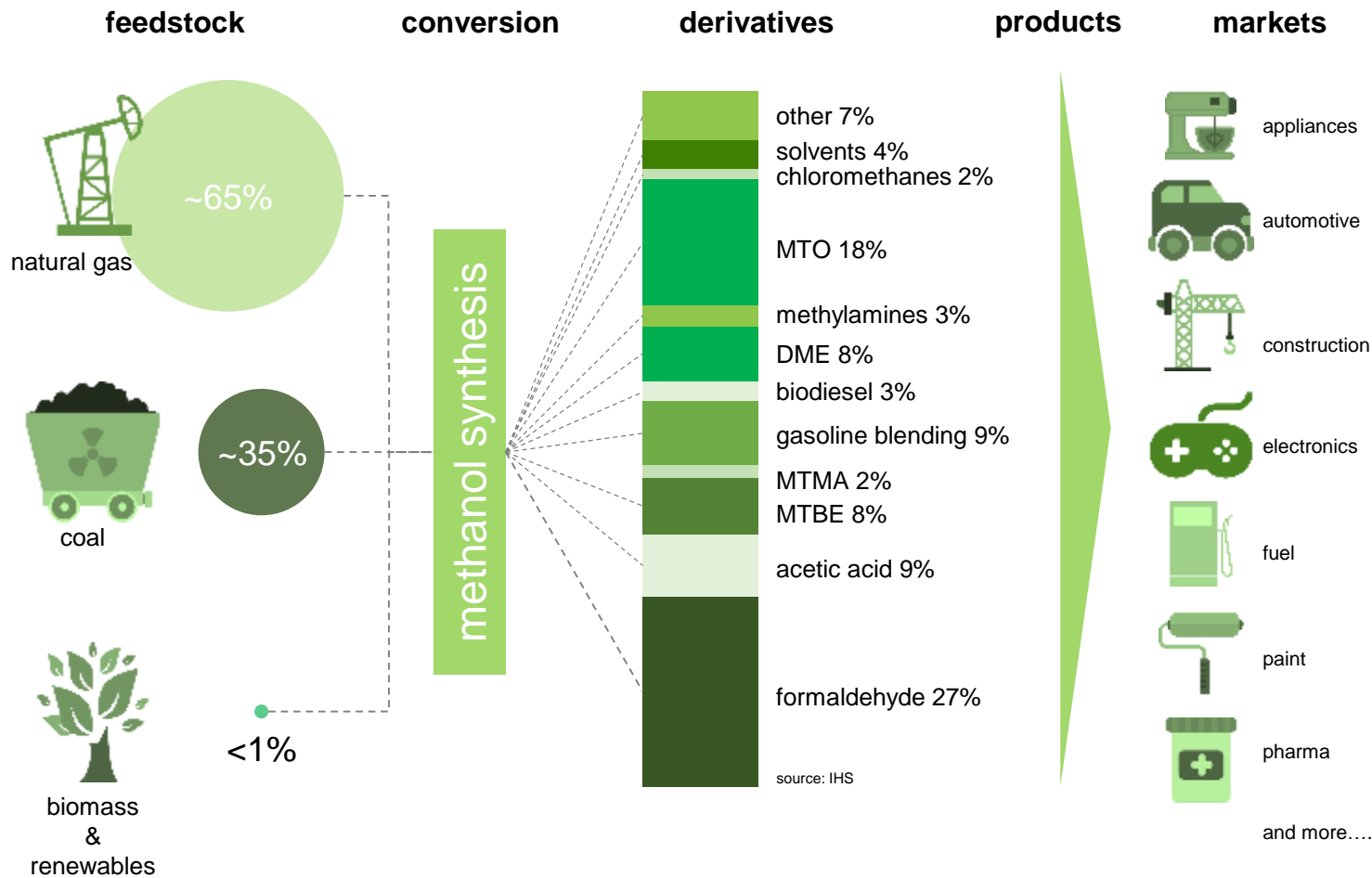
Density:  $0,792 \text{ g.cm}^{-3}$

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

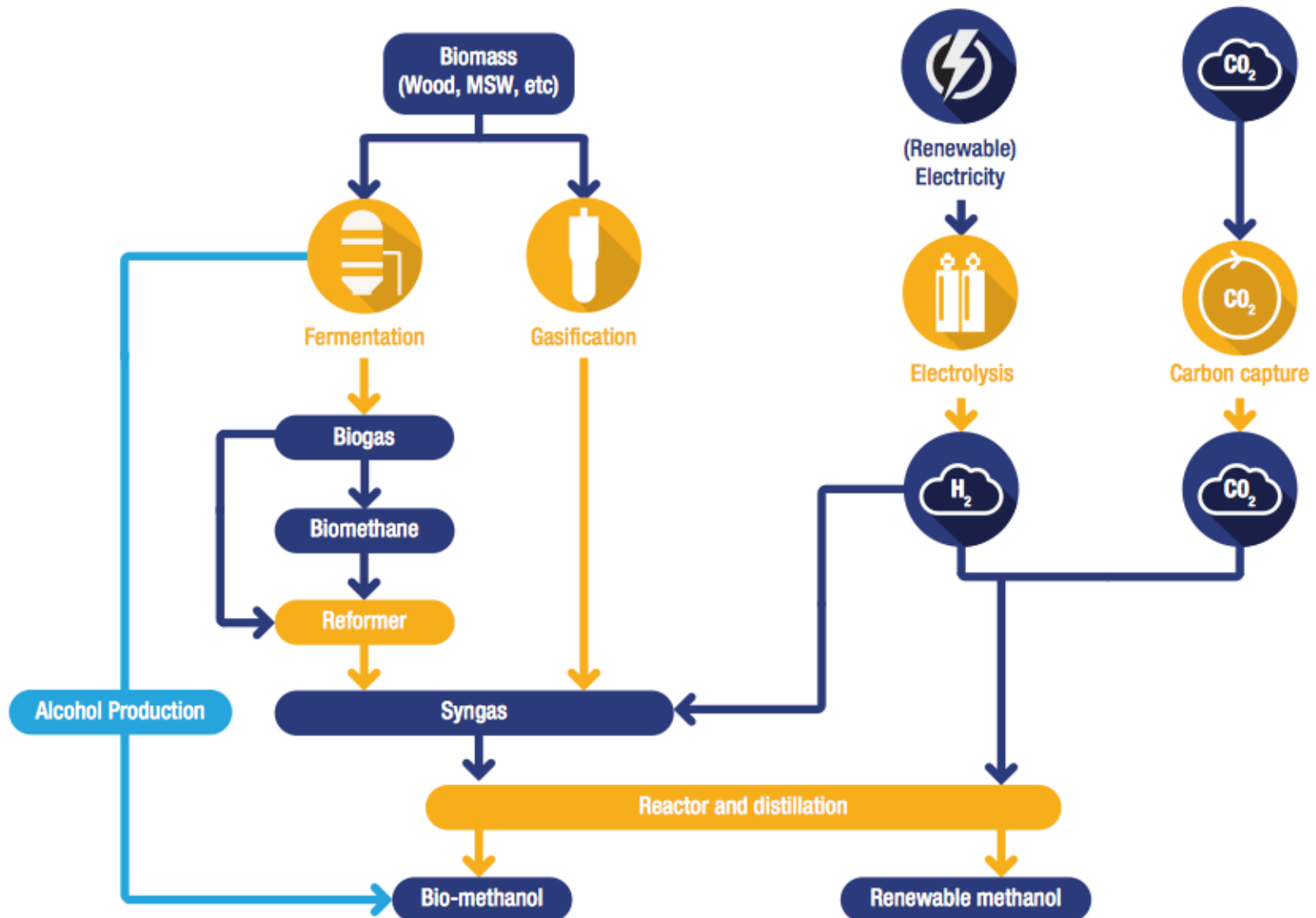
Appearance: colourless liquid



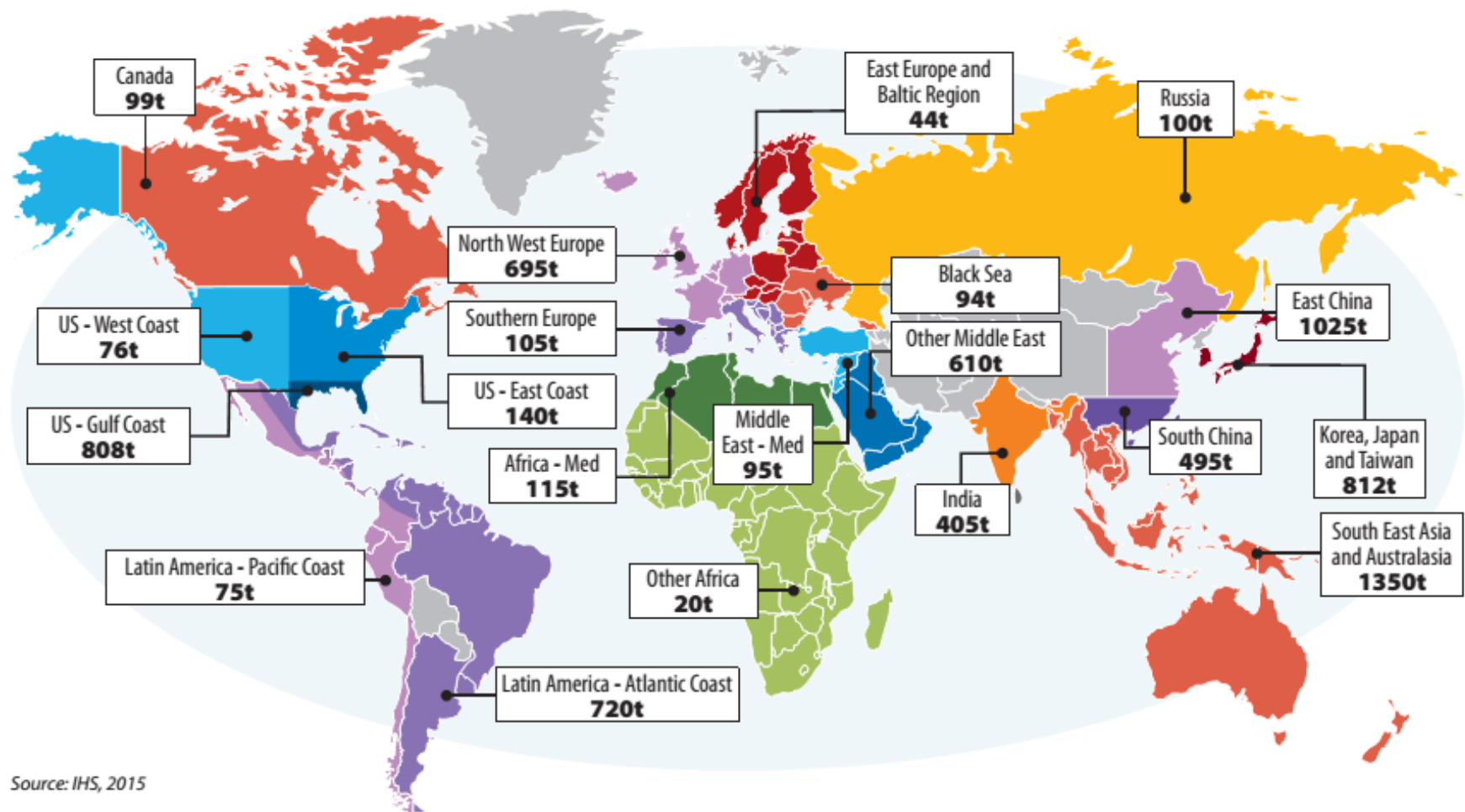
# Broad feedstock range, many applications



# Several low carbon pathways exist



# Widely available around the world



Methanol storage capacity estimates (thousand tons)

# Methanol is easy to handle

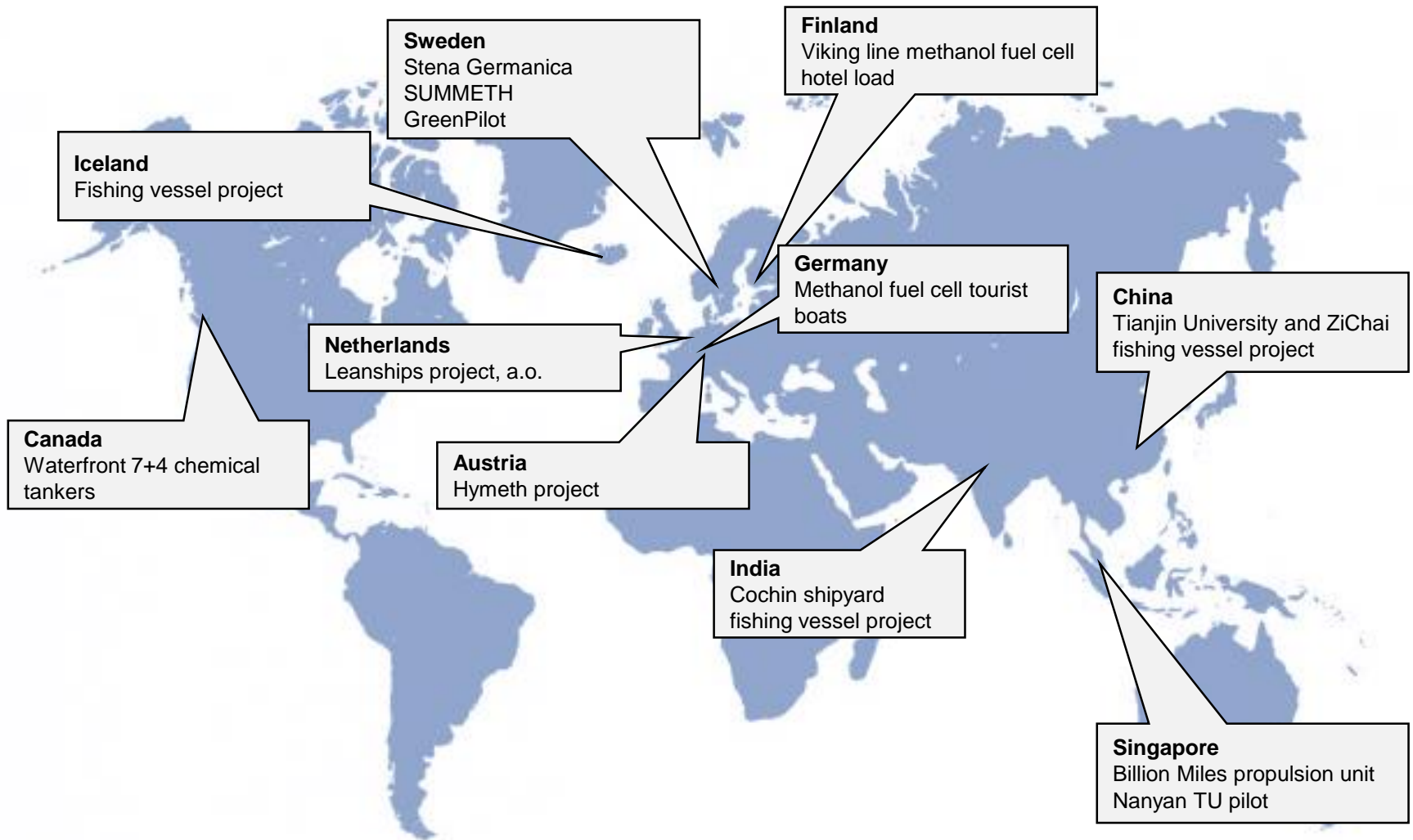
- Liquid at atmospheric pressure
- Available in many ports around the world and along rivers
- Low infrastructure cost
- Flexible, modular system
- Environmentally friendly as it is biodegradable



**03**

# Methanol marine fuel demand

# Many marine initiatives around the world



# Examples of vessels running on methanol

## COMBUSTION ENGINE



7x +4x

1x

1x

chemical  
tankers

ROPAX  
ferry

Pilot  
boat

MOL, WL,  
Marinvest

Stena Line

Swedish  
Maritime  
Admin.

2 stroke  
MAN

4 stroke  
Wärtsilä

high speed  
Scania,  
Volvo, a.o.

new build

retrofit

retrofit

## FUEL CELL



2x

1x

Tourist  
boat

Ferry

Innogy

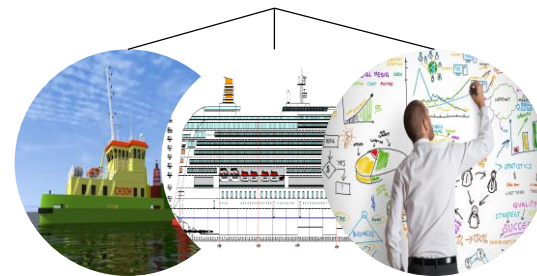
Viking Line

Serenergy fuel cell stacks

retrofit

retrofit

## PROJECT and R&D



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

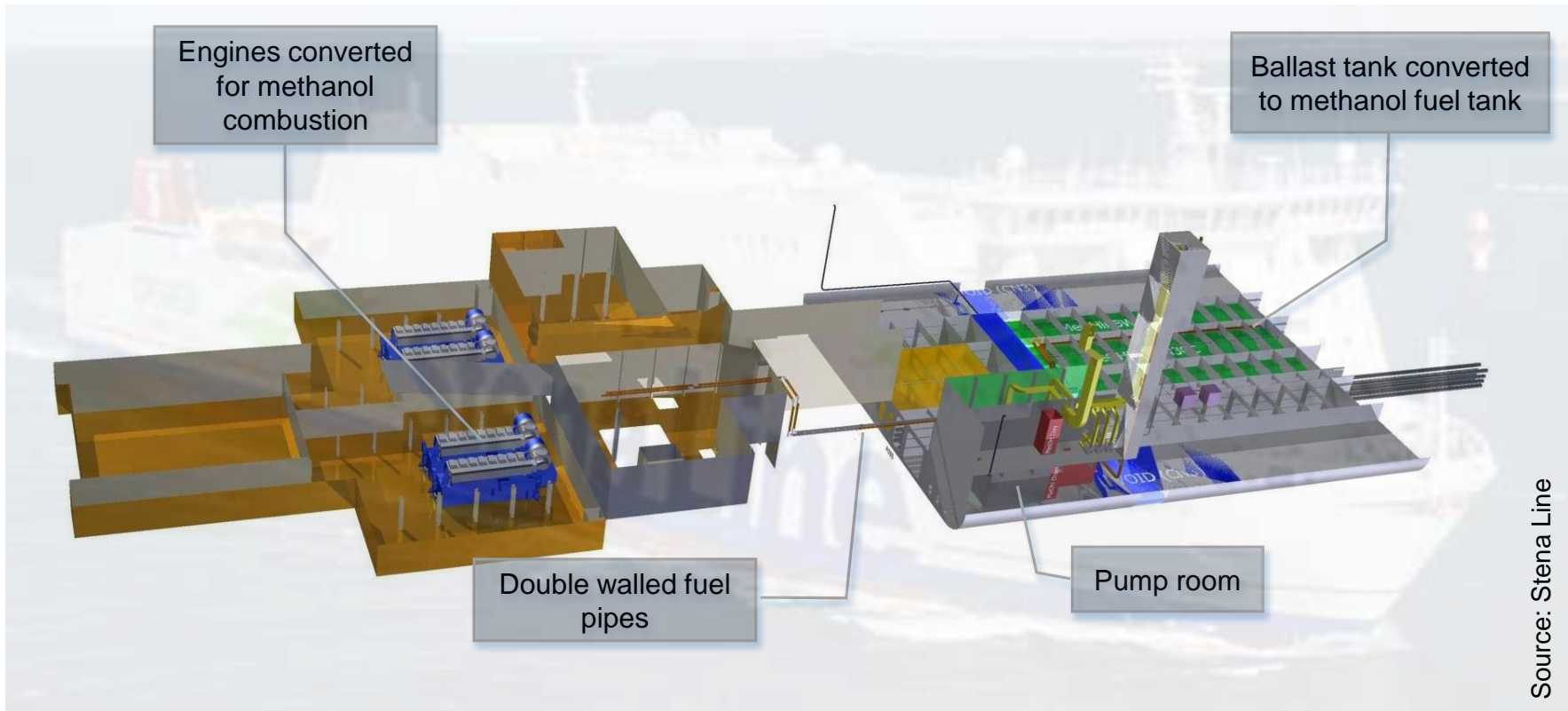
Billion Miles, Summeth/Martec,  
HyMeth Ship, Lean Ships,  
Methaship, a.o.

SI hybrid, dual fuel, etc.

new build & retrofit



# Dual fuel engine ensures flexibility



- Pilot fuel assisted diesel combustion concept  
Methanol is ignited by a small amount of diesel pilot fuel
- Crew and passenger safety top priority  
Safety measures include a.o. double walled pipes, ventilation, high pressure oil valves, nitrogen blanketing

# Four new ocean going vessels on order

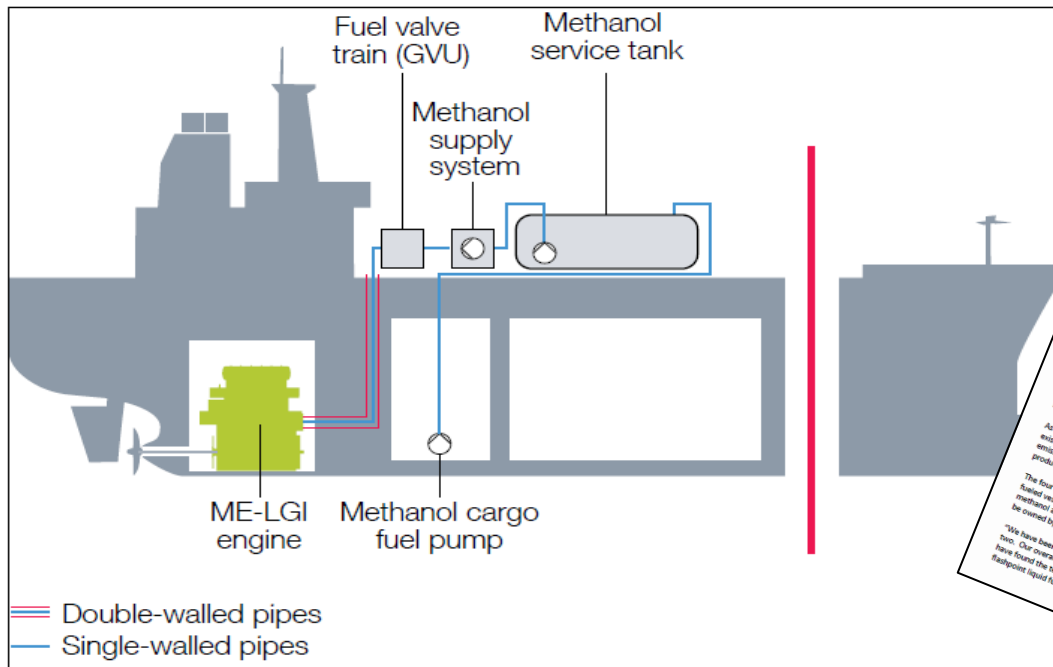


Fig. 4: ME-LGI system overview



<https://bit.ly/2AMUoTf>

- Over 20.000 service hours on methanol
- Most challenges solved; few remaining challenges expected to be solved soon
- Methanol: water mixture reduces NOx below Tier III levels

# Methaship methanol low carbon pathway

Two designs – 1x cruise and 1x ropax

Project partners:

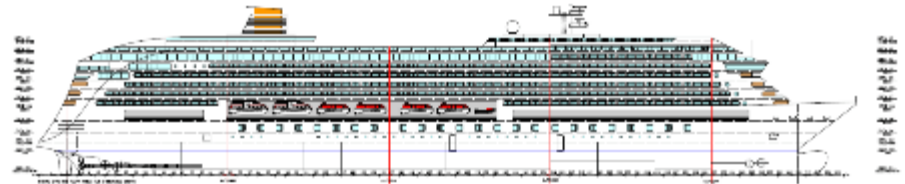
Lloyds Register, Meyer Werft,  
HELM, Flensburger Schiffbau-  
Gesellschaft

MethaShip is a national research project funded by the BMWi (Federal Ministry for Economic Affairs and Energy)

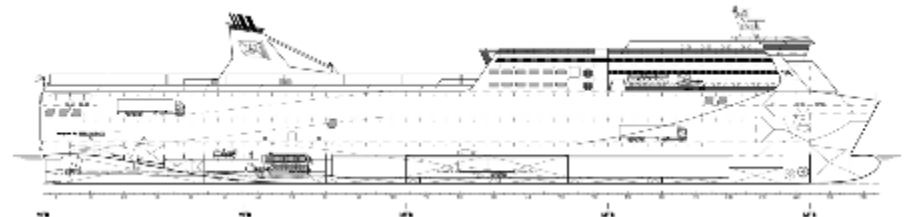
45-month project, closed on 28 May 2018

<https://bit.ly/2Qla2uC>

Main data	
Length	238.0 m
Width	32.2 m
Tonnage	62 800 GT
Passengers	2050 + 570 Crew
Engines	4 x 9 MW medium speed engines
Main fuel	Methanol



Main data	
Length	199.8 m
Width	28.6 m
Draught	6,5 m
Passengers	600 + 50 Crew
Engines	Dual Fuel 2 x 9 MW medium speed
Main fuel	Methanol



# Lean ships looks at high speed engines

Part of a larger Horizon 2020 project, the team aims to demonstrate high-speed diesel engine converted to dual fuel operation, and maintain 100% diesel capability

The outcome could offer a possible retrofit solution, including for smaller vessels

Testing is performed on a Volvo Penta D7 engine at Ghent University





# Various projects in Sweden

**Sustainable Marine Methanol supported by MI**  
Road ferry with engine capacity of about 350 kW

The research concluded that there are no obstacles to the efficient use of Methanol in a converted diesel engine and that smaller vessel conversion projects are feasible and cost-effective, with levels of safety that easily meet existing requirements

Potential for bio-methanol to be progressively blended into the mix as more becomes available

<https://bit.ly/2D3o4x3>



**GreenPilot project received funding from MI and Swedish Maritime Administration**

Tested WeiChai 6-cyl, 365kW, M100 converted NG engine provided by FiT, and Scania converted NG engine in high-speed, rescue/pilot vessel

Sea trials started on WeiChai engine in March, which concluded year end, 2017

Closing workshop was 3 May 2018 Gothenburg

<https://bit.ly/2qvGCPg>



# LR fuel calculator helps make comparison



User Guide

## Fuel Choice Calculator

Vessel Type ⓘ

Bulk Carrier

Capacity ⓘ

176506

DWT

Design Speed ⓘ

11.7

Kts

Average loaded DWT ⓘ

141204.8

tonnes

Annual Distance  
Travelled ⓘ

56712

Nm

Select open or closed  
loop option for EGCS

☒ Open

☐ Closed

Methane Slip ⓘ

3

%

Time spent inside ECA ⓘ

50

%

Asset expected life ⓘ

25

years

Annual fuel  
consumption  
conventional fuel ⓘ

5756.213

mt/y

Calculate

All

Fuel consumption & Costs

NPV & Total Cost

<https://bit.ly/2livYXk>

**04**

# Rules and regulations

# Methanol enables significant emission reductions



source: Stena Line

Emission reductions when compared to alternative fuels currently available  
(fuel oil)



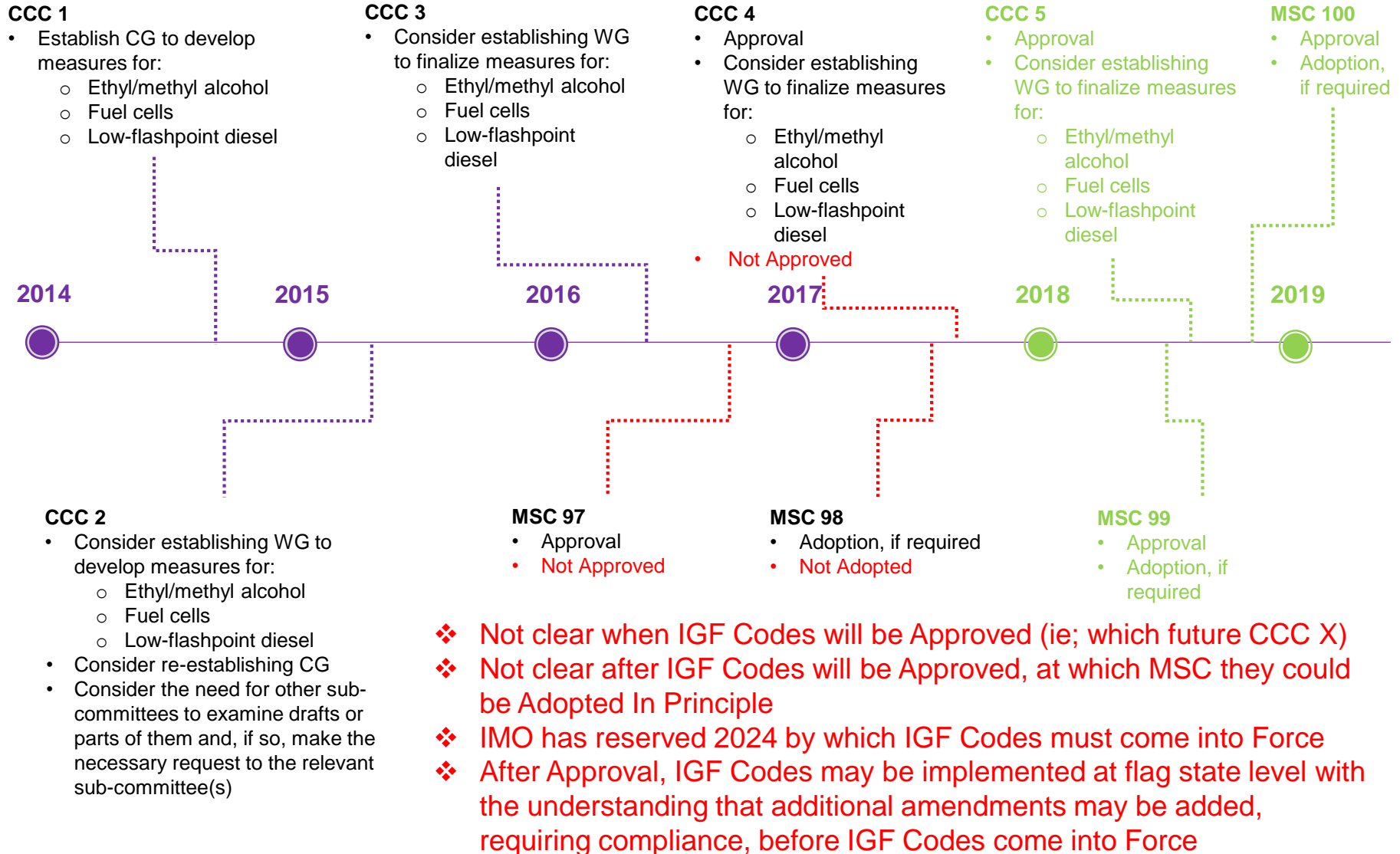
# Methanol is also a low flash point fuel

Properties	HFO	MGO	LNG	Methanol
Physical state	liquid	liquid	cryogenic liquid	liquid
Boiling temperature at 1 bar [°C]	-	175 – 650	-/- 161	65
Density at 15°C [kg/m³] (LNG shown at -/-160°C)	989	Max. 900	448	796
Dynamic viscosity at 40°C [cSt]	-	3,5	-	0,6 (at 25°C)
Lower heating value [MJ/kg]	40	43	50 (at -160°C, 1 bar)	20
Lubricity WSD [µm]	-	280-400	-	1100
Vapour density air = 1	-	>5	0,55	1,1
Flash point (TCC) [°C]	>60	>60	-/-175	12
Auto ignition temperature [°C]	-	250-500	540	464
Flammability limits [by % vol. of mixture]	-	0,3 – 10	5 – 15	6 - 36

Source: EMSA

Study on the use of ethyl and methyl alcohol as alternative fuels in shipping

# Draft guidelines methanol completed



# Comparing apples to apples



	METHANOL	DIESEL	GASOLINE
Hazard pictograms (CPL)			
Signal word: (CPL)	Danger	Danger	Danger
Hazard statements (CPL)	<p>H225 Highly flammable liquid and vapour.</p> <p>H301 Toxic if swallowed.</p> <p>H311 Toxic in contact with skin.</p> <p>H331 Toxic if inhaled.</p> <p>H370 Causes damage to organs.</p>	<p>H226: Flammable liquid and vapour.</p> <p>H304: May be fatal if swallowed and enters airways.</p> <p>H313: Causes skin irritation.</p> <p>H332: Harmful if inhaled.</p> <p>H351: Suspected of causing cancer.</p> <p>H373: May cause damage to organs through prolonged or repeated exposure.</p> <p>H411: Toxic to aquatic life with long lasting effects</p>	<p>H224: Extremely flammable liquid and vapour.</p> <p>H304: May be fatal if swallowed and enters airways</p> <p>H313: Causes skin irritation</p> <p>H340: May cause genetic defects</p> <p>H350: May cause cancer</p> <p>H361: Suspected of damaging fertility or the unborn child</p> <p>H336: May cause drowsiness or dizziness</p> <p>H411: Toxic to aquatic life with long lasting effects</p>
Precautionary statements (CLP)	<p>P210 - Keep away from heat. - No smoking</p> <p>P280 - Wear protective gloves, protective clothing, eye protection, face protection</p> <p>P303+P361+P353 - IF INHALED: remove victim to fresh air and keep at rest in a position comfortable for breathing</p> <p>P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower</p> <p>P301+P310 - IF SWALLOWED: Immediately call a POISON CENTRE or doctor</p> <p>P403+P233 - Store in a well-ventilated place. Keep cool</p>	<p>P201: Obtain special instructions before use</p> <p>P210: Keep away from heat/sparks/open flames/hot surfaces - No smoking</p> <p>P240: Ground/bond container and receiving equipment</p> <p>P241: Use explosion-proof electrical/ventilatory/lighting equipment</p> <p>P242: Use only non-sparking tools</p> <p>P243: Take precautionary measures against static discharge</p> <p>P280: Do not breathe dust/fume/gas/vapour/spray</p> <p>P284: Wash hands thoroughly after handling</p> <p>P273: Avoid release to the environment</p> <p>P280: Wear protective gloves/protective clothing/eye protection</p> <p>P301+P310 - IF SWALLOWED: Immediately call a POISON CENTRE or doctor/physician</p> <p>P302+P352 - IF ON SKIN: Wash with plenty of soap and water</p> <p>P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower</p> <p>P304+P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing</p> <p>P312: Call a POISON CENTRE or doctor/physician if you feel unwell</p> <p>P311: Call a POISON CENTRE or doctor/physician if you feel unwell</p> <p>P313: Do NOT induce vomiting</p> <p>P320: In case of first aid: Use water spray or foam for extinction</p> <p>P330: Collect spillage</p> <p>P403+P233: Store in a well-ventilated place. Keep container tightly closed</p> <p>P403+P233: Store in a well-ventilated place. Keep cool</p> <p>P405: Store locked up</p> <p>P501: Dispose of contents/container in accordance with local/regional/national/international regulation</p>	<p>P201: Obtain special instructions before use</p> <p>P202: Do not handle until all safety precautions have been read and understood</p> <p>P210: Keep away from heat/sparks/open flames/hot surfaces - No smoking</p> <p>P233: Keep container tightly closed</p> <p>P240: Ground/bond container and receiving equipment</p> <p>P241: Use explosion-proof electrical/ventilatory/lighting equipment</p> <p>P242: Use only non-sparking tools</p> <p>P243: Take precautionary measures against static discharge</p> <p>P280: Do not breathe fume/gas/mist/vapour/spray</p> <p>P284: Wash hands thoroughly after handling</p> <p>P273: Use only outdoors or in a well-ventilated area</p> <p>P273: Avoid release to the environment</p> <p>P280: Wear protective gloves/protective clothing/eye protection</p> <p>P301+P310 - IF SWALLOWED: Immediately call a POISON CENTRE or doctor/physician</p> <p>P302+P352 - IF ON SKIN: Wash with plenty of soap and water</p> <p>P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower</p> <p>P304+P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing</p> <p>P312: If exposed or concerned: Get medical advice/attention</p> <p>P311: Call a POISON CENTRE or doctor/physician if you feel unwell</p> <p>P313: Do NOT induce vomiting</p> <p>P320: In case of first aid: Use water spray or foam for extinction</p> <p>P330: Collect spillage</p> <p>P403+P233: Store in a well-ventilated place. Keep cool</p> <p>P405: Store locked up</p> <p>P501: Dispose of contents/container in accordance with local/regional/national/international regulation</p>

Source: Green Pilot Project

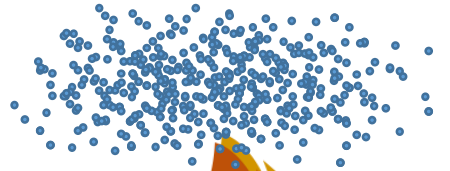
# Methanol has lower fire risk



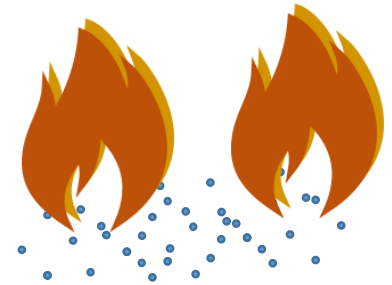
Methanol



evaporates slowly



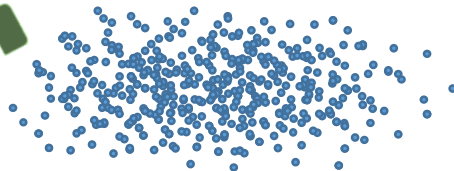
needs lots of vapour to burn



confined fire zone;  
fires less likely



Gasoline



evaporates fast



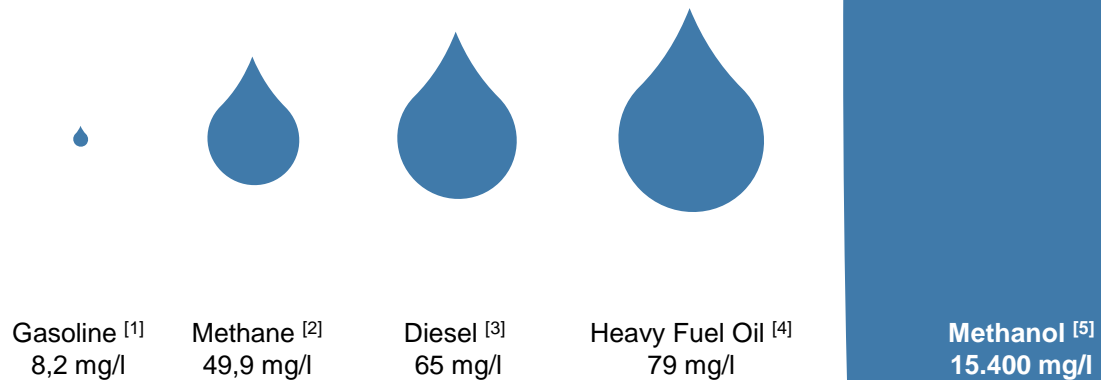
needs little vapour to burn



broad fire zone;  
fires more likely

# Putting things in perspective

LC50 - Lethal dosis fish



Sources:

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

<sup>[2]</sup> ECHA, European Chemicals Agency, registration dossier Methane

<sup>[3]</sup> ECHA, European Chemical Agency, registration dossier Diesel

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

<sup>[5]</sup> ECHA, European Chemical Agency, registration dossier Methanol

# Safer for the environment

	Maritime accident	Maritime accident	Simulation
Ship	Erika	Tanio	-
Fuel	Heavy Fuel Oil	Heavy Fuel Oil	Methanol
Released amount	19 000 t	13 500 t	10 000 t
Affected coastline	400 km	200 km	0 km
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

Source: MethaShip

**05**

**Moving forward**

# MI focused actions on marine fuels

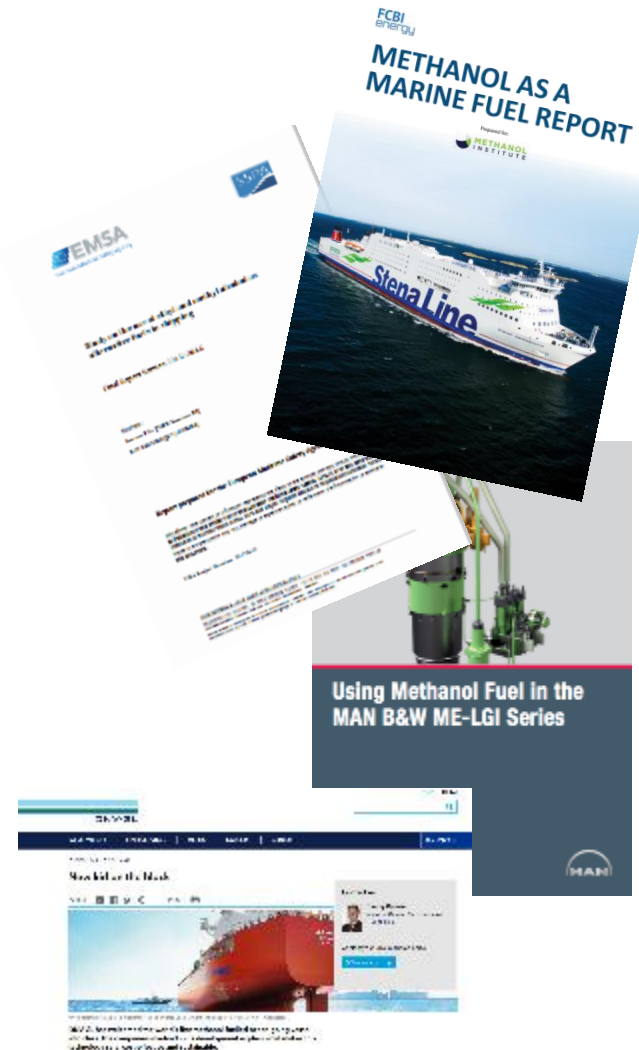
- Participate in formation of international regulations and safe handling guidelines for methanol as alternative fuel
- Work with engine OEMs on new build and conversion offerings across multiple scales
- Encourage and support pilot demonstrations of methanol marine fuels in multiple markets, to validate environmental, technical and economic merits
- Direct marketing campaign





# Methanol...

- is plentiful, available globally
- can be made 100% renewable
- runs well in existing engine technology and has potential for further optimization
- complies with increasingly stringent emission reduction regulations
- requires only minor modifications to current bunkering infrastructure
- is biodegradable!
- safe handling can rely on long history and experience in shipping and industry
- cost are relatively modest and drop as experience mounts
- shows slight regional price variation
- <http://www.methanol.org/marine-fuel/>



**06**

# Contacts

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