



Methanol for Marine Applications: A Practical Clean-Burning Marine Fuel Alternative

Gregory Dolan, CEO

Methanol Institute

CMA Shipping 2016

Stamford – 21 March 2017

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WHO WE ARE

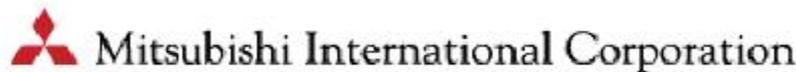
Global methanol representation

- The Methanol Institute (MI) was first formed in 1989 to represent US methanol producers in Washington.
- 28 years later, MI is truly a global trade association supporting the expansion of the methanol industry in every corner of the world from offices in:

Singapore | Washington | Brussels | Beijing



OUR 2017 MEMBERS



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**TRANSITION TO
ENERGY RESOURCE**

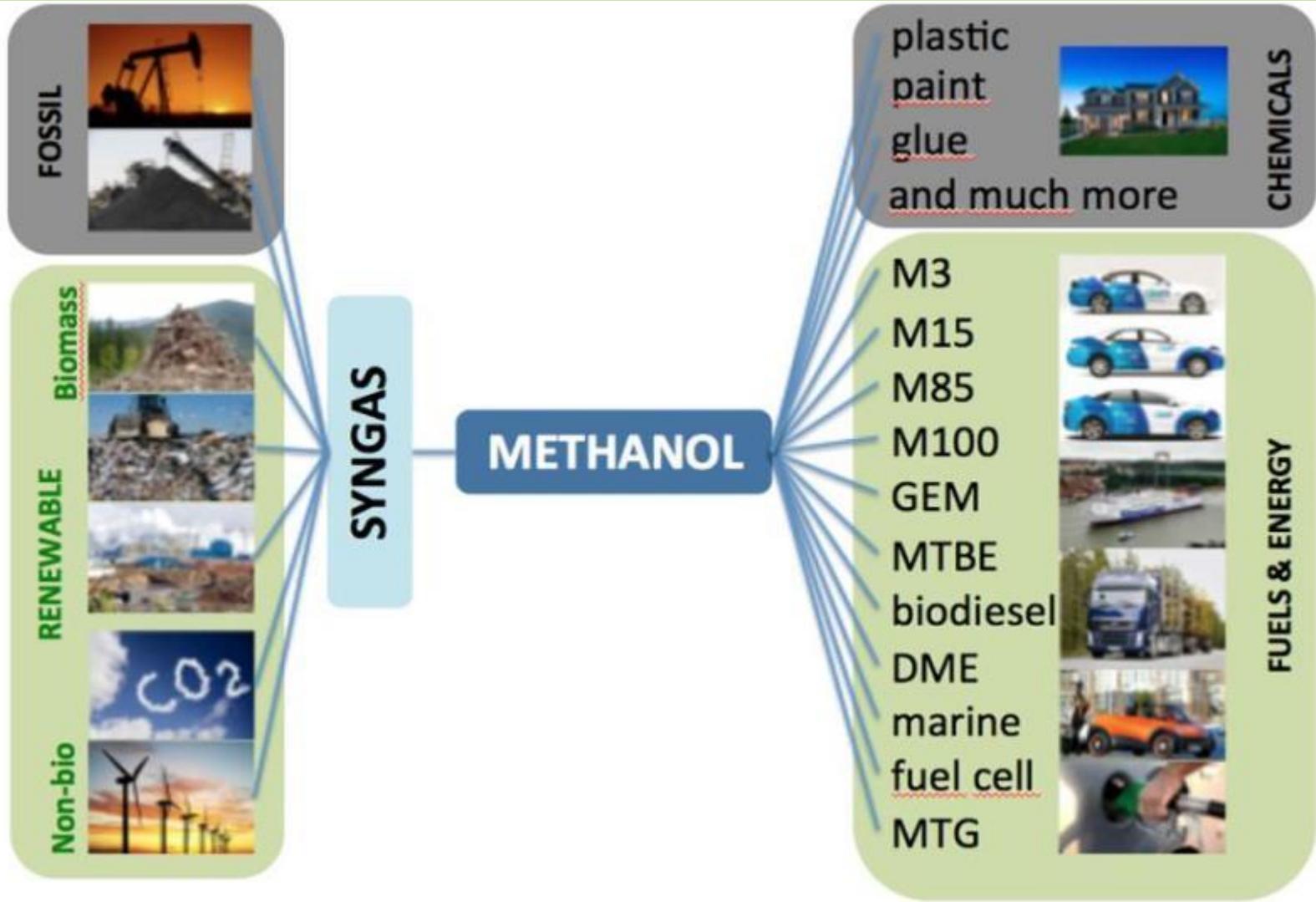
Alternative Fuel Drivers

- ✓ **Scale:** The feedstock base needs to be large enough to support global transportation market.
- ✓ **Sustainability:** There needs to be a viable pathway to low- & no-carbon transport, while reducing smog.
- ✓ **Subsidy:** Can't rely on government support forever, so someone needs to make money.
- ✓ **Seamless:** Keep the customer in mind.
- ✓ **Methanol:** Checks all the drivers!

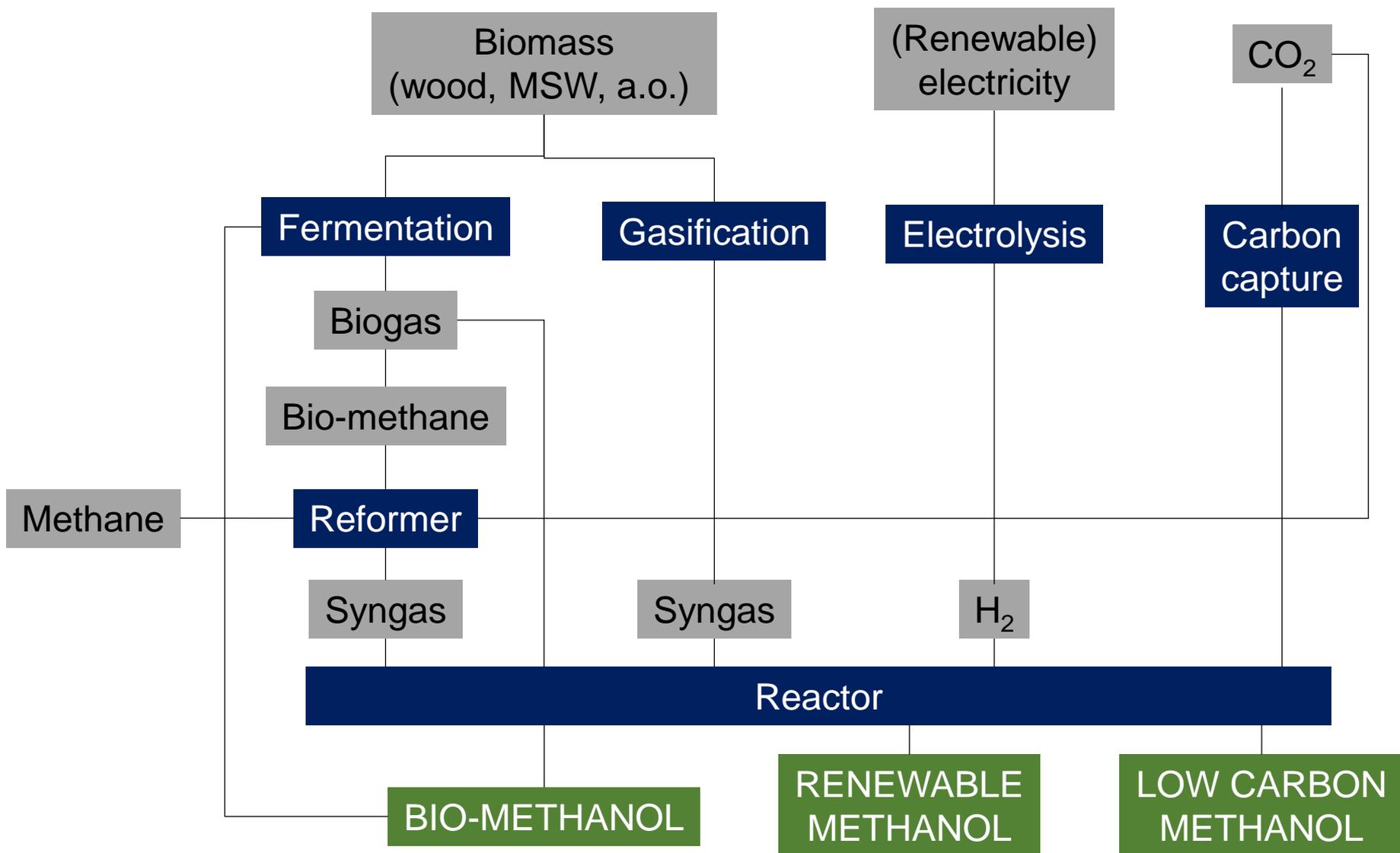


**Feedstock:
Abundant/Sustainable**

**Market:
Large/Diverse**



Many pathways exist already

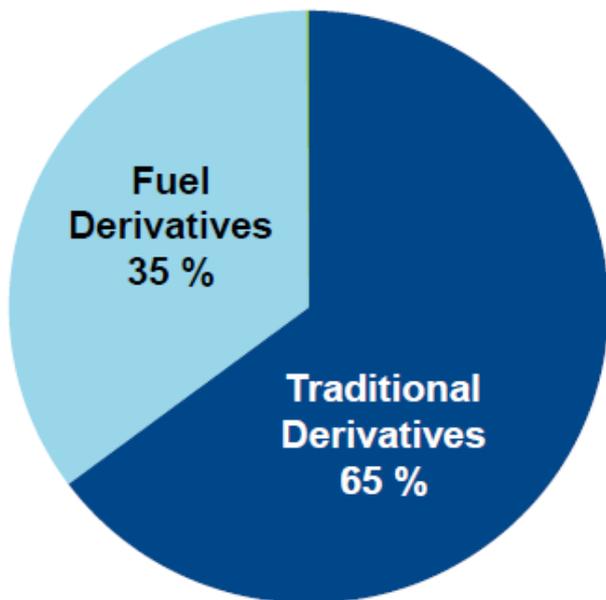


Project overview

Status	Company	Country	Feedstock	Product
COMMERCIAL	BioMCN	The Netherlands	Bio-methane	Bio-methanol
	CRI	Iceland	Renewable electricity	Renewable methanol
	Enerkem	Canada	MSW	Bio-methanol
	Methanex	Canada	CO ₂	Low carbon methanol
	Oberon	USA	Biogas	Bio-methanol and DME
	QAFAQ	Qatar	CO ₂	Low carbon methanol
R&D and FEASIBILITY	BKW	Switzerland	Renewable electricity	Renewable methanol
	Enerkem	The Netherlands	MSW	Bio-methanol
	Infraserve	Germany	Catalyist research	Renewable methanol
	Innogy	Germany	Renewable electricity	Renewable methanol
	Lowlands Methanol	The Netherlands	MSW	Bio-methanol
	OPTIMeOH	Germany	Biogas	Bio-methanol
	STEAG	Germany	CO ₂ and electricity	Low carbon methanol
	Swerea	Sweden	Steel mill emissions	Low carbon methanol
	ZASt	Germany	CO ₂ and renewable electricity	Renewable methanol
ON HOLD or STOPPED	BioMCN	The Netherlands	Crude glycerine	Bio-methanol
	Chemrec	Sweden	Black liquor	Bio-methanol & DME
	Varmlandsmetanol	Sweden	Forestry residues	Bio-methanol
	Woodspirit	The Netherlands	Wood residue	Bio-methanol

Oil displacement drives demand growth

2011 Global Methanol Demand by Derivative

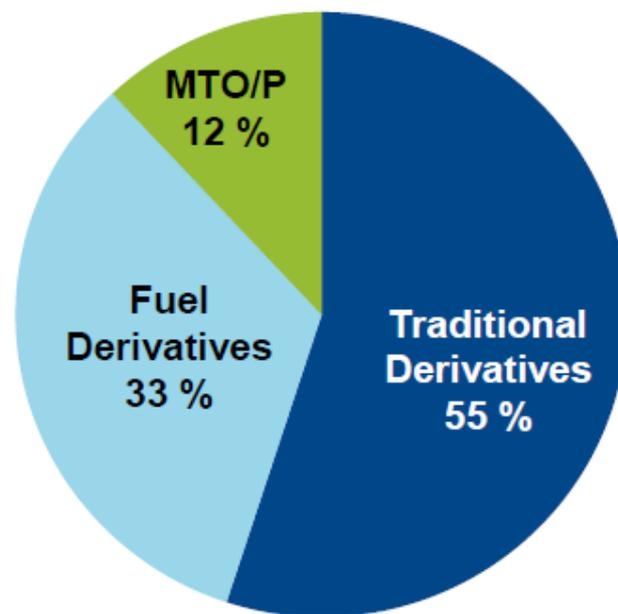


Total Methanol Demand = 53 million metric tons

Source: IHS Markit

© 2016 IHS Markit

2016 Global Methanol Demand by Derivative



Total Methanol Demand = 75 million metric tons

Source: IHS Markit

© 2016 IHS Markit

Methanol is a versatile fuel source

- Out of the ~75 million metric tons of methanol sold globally in 2015, energy and fuel uses represent one-third of total demand
- From 2009-2015, direct methanol fuel blending has increased at an annual rate of nearly 23%

FUELS

- Neat fuel
- Low blends
- High blends
- GEM
- MTBE
- Biodiesel
- DME & OME
- MTG

TECHNOLOGIES

- SI & CI engines
- Turbines
- Fuel cells
- Stoves



SEGMENTS

- Road & non-road transportation
- Power & heat generation, and
- Marine

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MARINE FUELS

The Clear Alternative Marine Fuel

Diesel Bunker Fuel



Methanol Marine Fuel



Marine Fuel in Transition

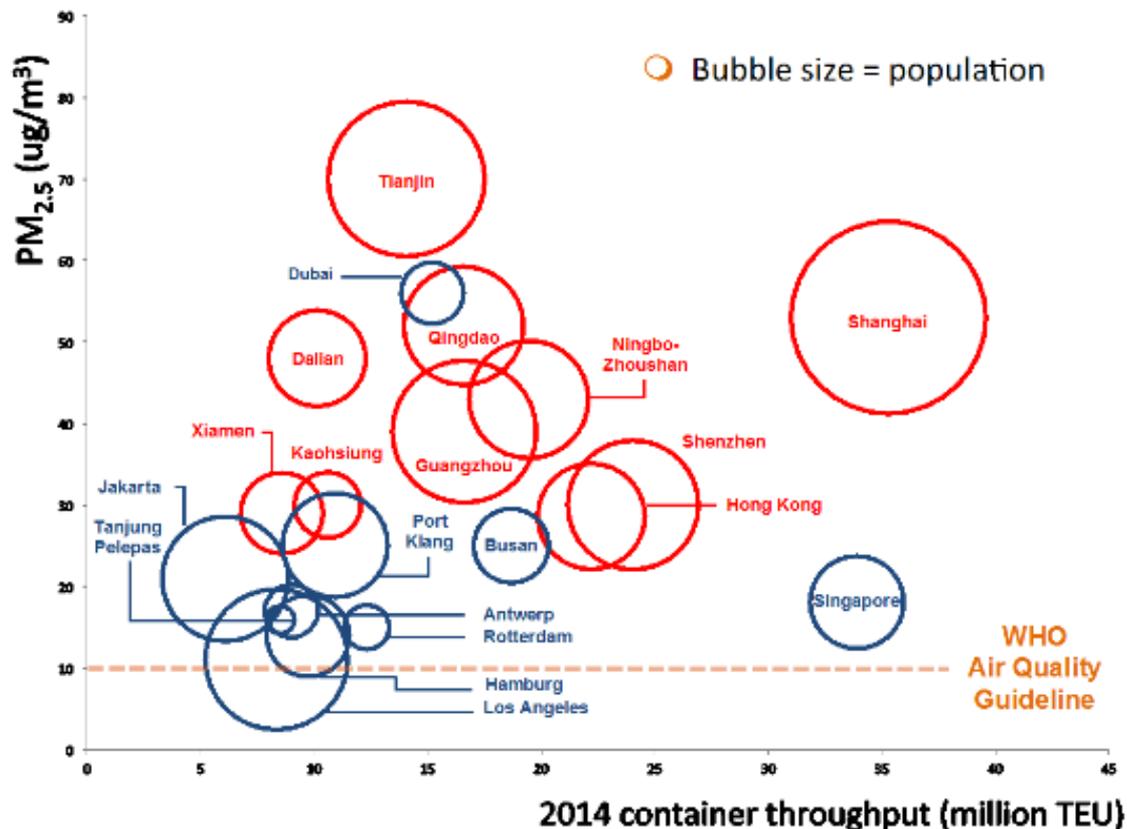


- Over 90,000 commercial vessels on world's oceans, consuming 370 million tons of bunker fuel (Heavy Fuel Oil and Middle Distillates).
- One container ship: SO_x = 50 million cars
- 15 largest ships: SO_x emissions = 760 million cars in the world

<https://www.theguardian.com/environment/2009/apr/09/shipping-pollution>

Environmental & Health Hazards

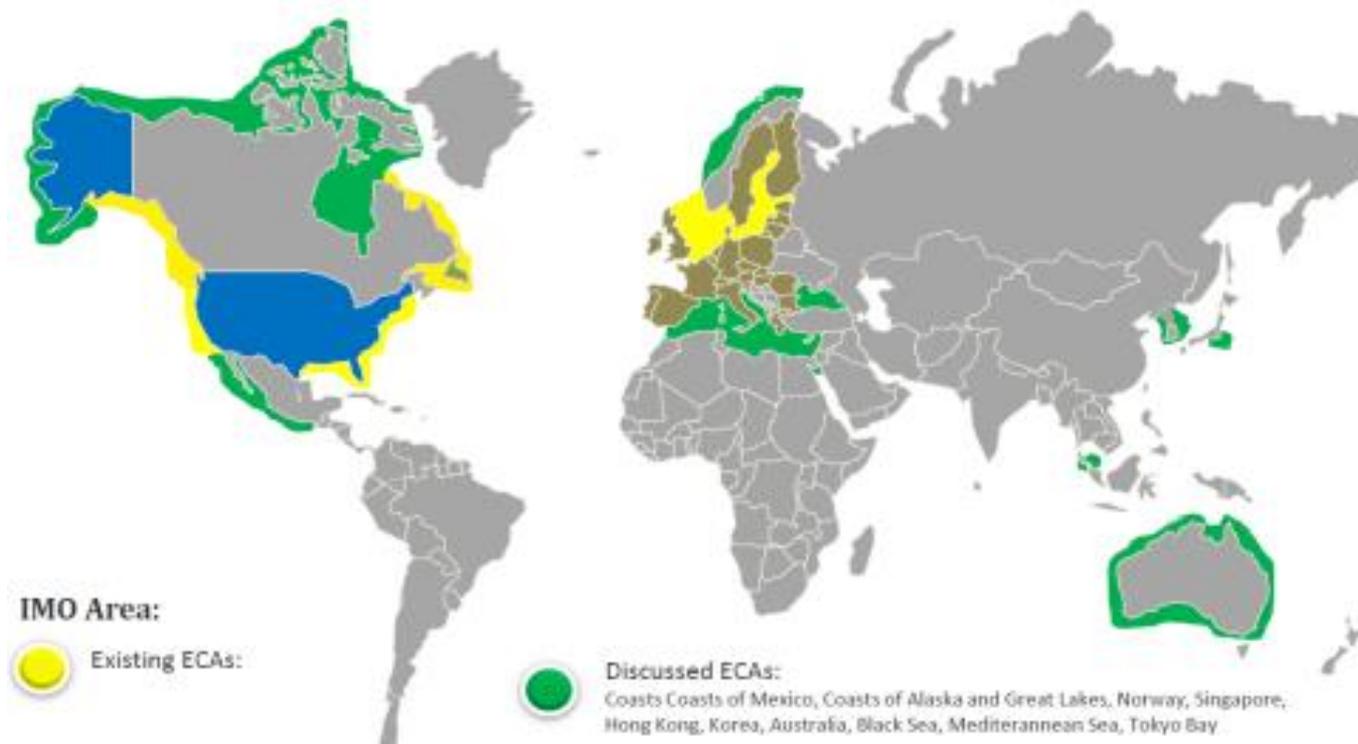
- National Oceanic and Atmospheric Administration: Globally shipping accounts for 60,000 deaths and US\$330 billion in health costs
- Natural Resources Defense Council: Shipping at intersection of high population, choking pollution, and rapid growth



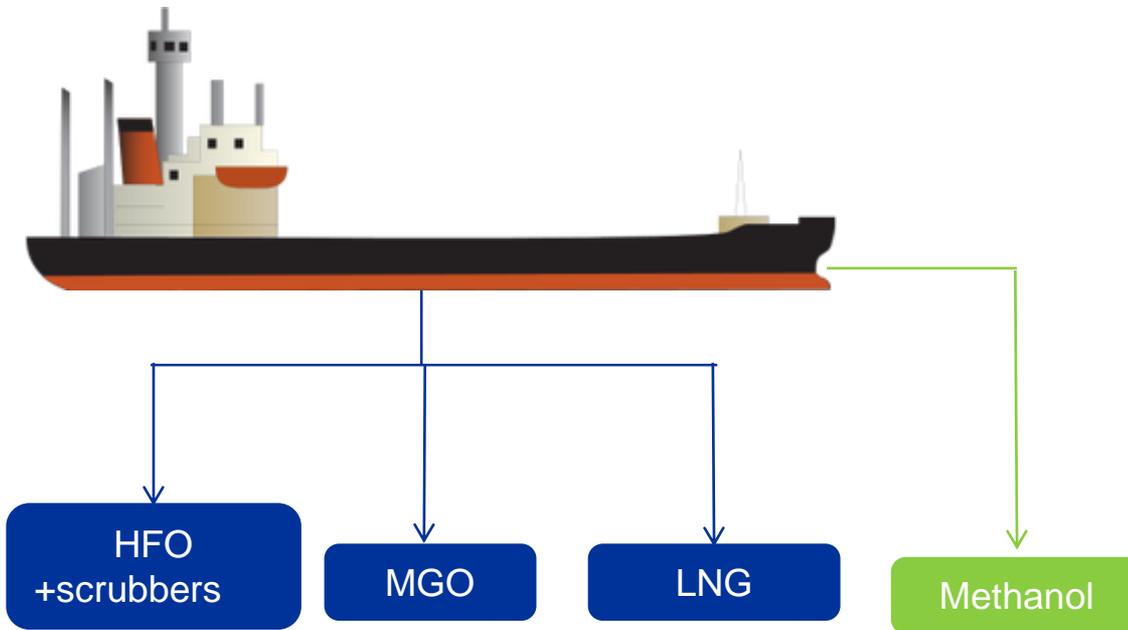
Source: Natural Resources Defense Council

Emissions regulations driving market

- The International Maritime Organization has adopted regulations for SOx and NOx that are transforming the shipping industry
- While 2020 global SOx reductions may be met with low sulfur fuels, the combination of SOx and NOx reductions driving shipboard solutions
- Next up: Greenhouse gas emissions



Options available to ship owners



Methanol fueled vessel projects



WFS, MOL, WL,
Marinvest

Stena Lines

Swedish Maritime
Administration, MI

Methaship,
Leanship.

7 chemical tankers

1 RoPax ferry

1 pilot boat

Cruise ship, ferry

2-stroke MAN

4-stroke Wärtsila

Volvo, Scania, FiTech

Various

New build

Retrofit

Retrofit

New build

Operational

Operational

Testing

Design phase

DNV GL / ClassNK

Lloyds Register

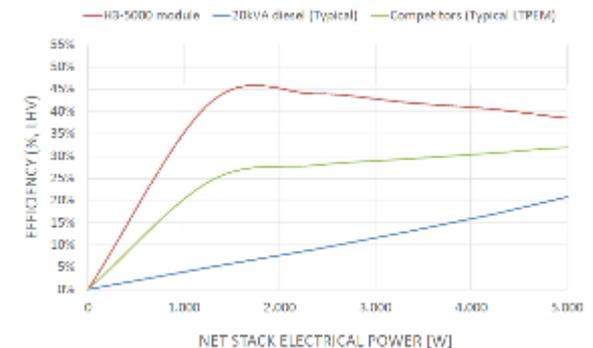
Various

Methanol fuel cells improve electrical efficiency

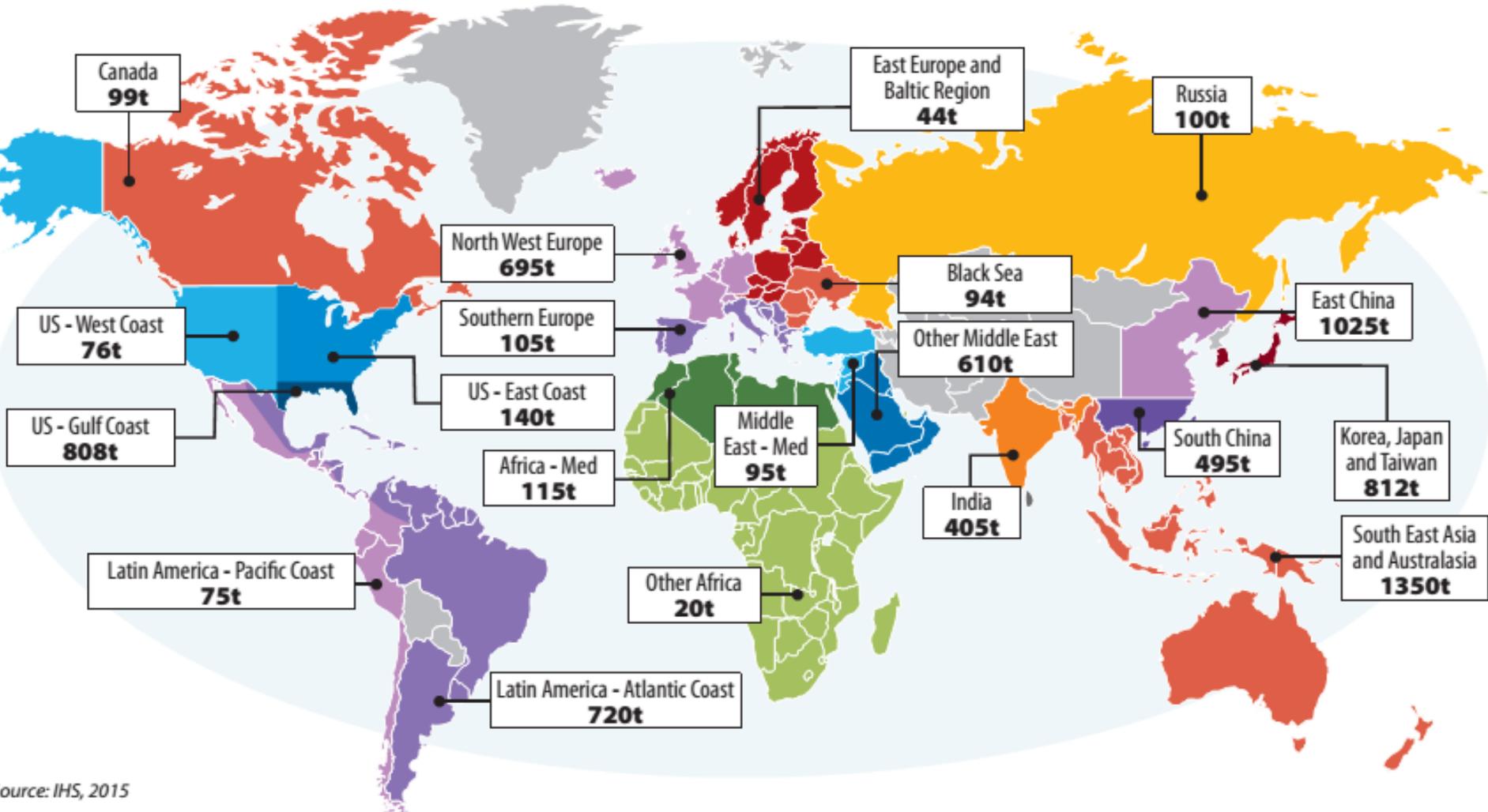
As part of Germany's Pa-X-ell project ship builder Meyer Werft installed a Serenergy high temperature PEM 90-kW methanol fuel cell system demonstrator on board the Viking *Mariella*



Modular units form basis of a highly efficient and decentralized network on board.



Available in many ports around the world



Methanol storage capacity estimates (thousand tons)

Source: IHS, 2015

Methanol is widely available and 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's biodegradable



Recent Studies



EU Joint Research Centre

LNG and Methanol “Most Promising” alternatives to bunker fuel.

May 2016



European Maritime Safety Agency

Investment costs for retrofits and new builds for methanol same range exhaust gas after treatment and less than LNG.

June 2016



European Sea Ports Organisation

Methanol shows promise as an emissions solution for the shipping industry.

July 2016

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



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