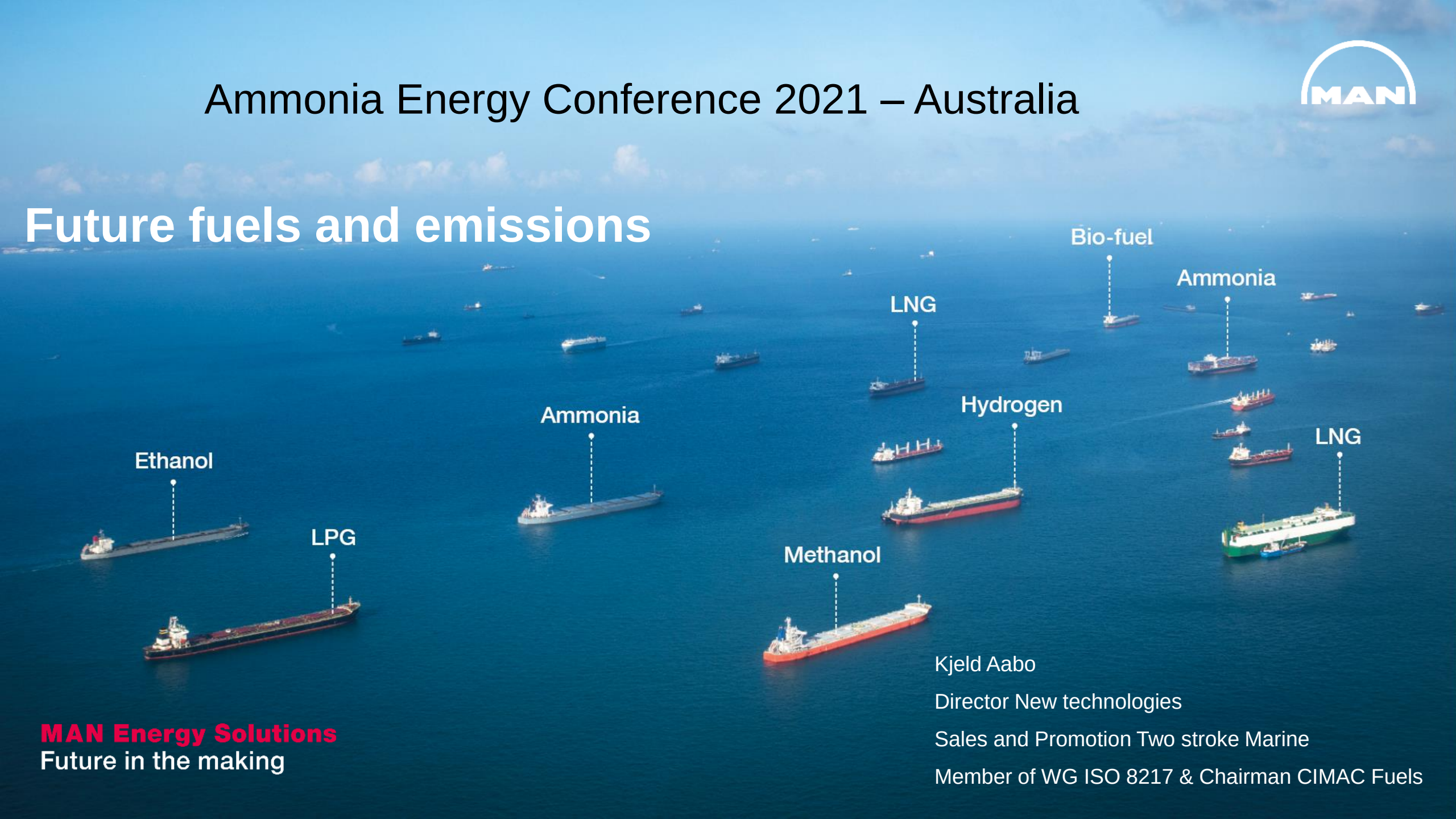
Ammonia Energy Conference 2021 – Australia

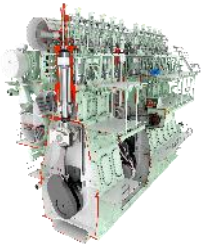
Future fuels and emissions



MAN Energy Solutions
Future in the making

Kjeld Aabo
Director New technologies
Sales and Promotion Two stroke Marine
Member of WG ISO 8217 & Chairman CIMAC Fuels

The world’s leading designer of two-stroke Diesel engines



Design of two-stroke engines

Production of spare parts

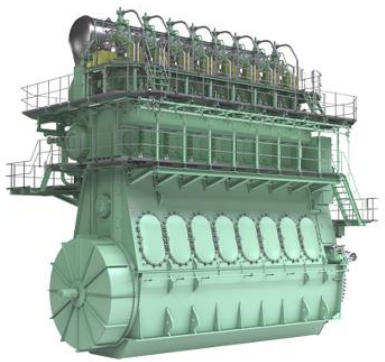
PrimeServ Academy

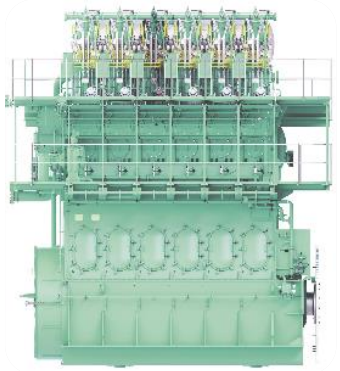
R&D Centre

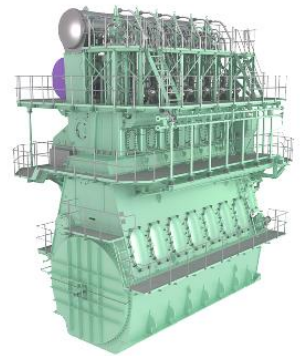
Diesel House

MAN B&W dual fuel portfolio

LNG		Ethane	Methanol	LPG	Ammonia
ME-GI 271	ME-GA 44	ME-GIE 25	ME-LGIM 27	ME-LGIP 101	→ 2024





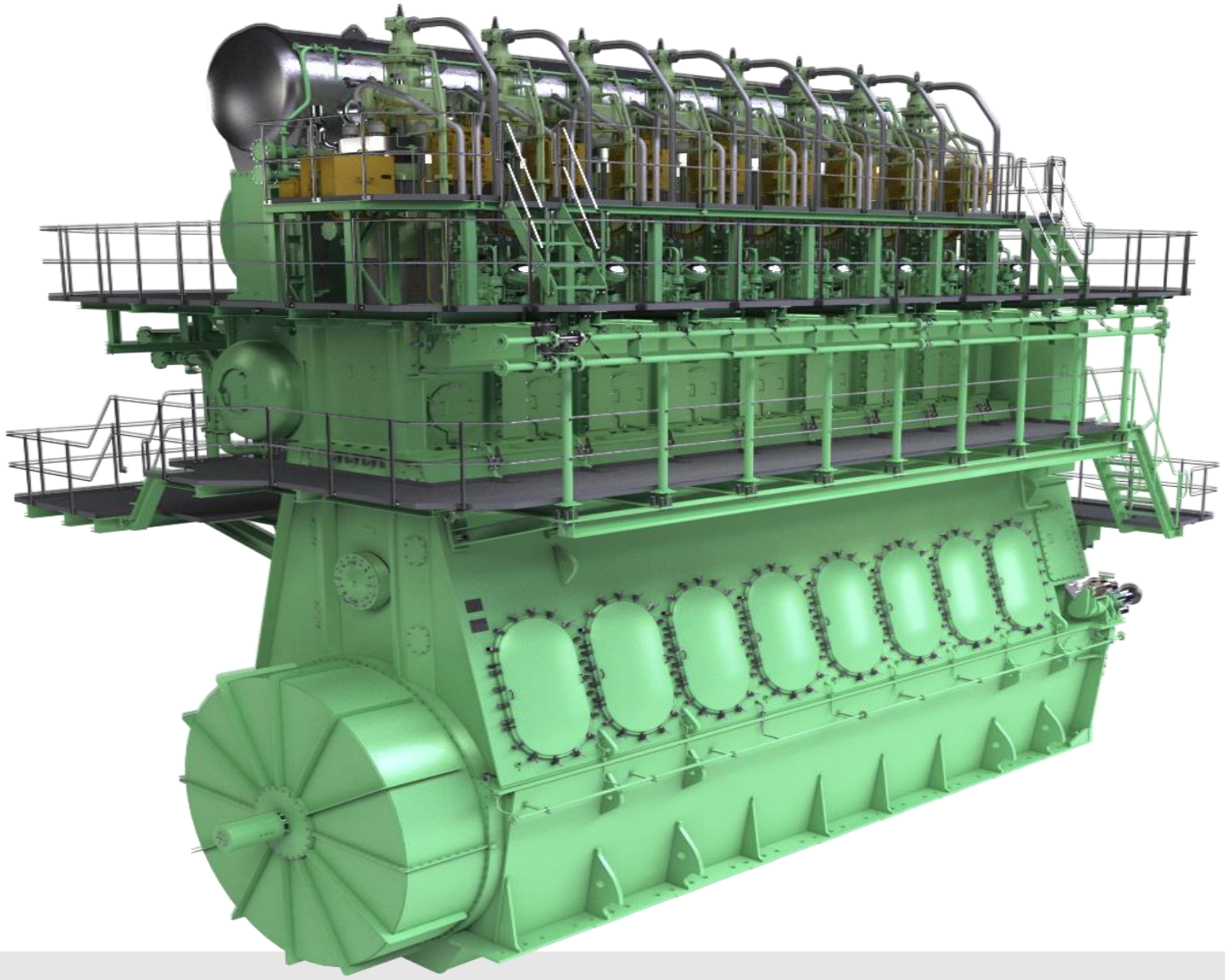


Powering sustainable shipping by opening clear pathways

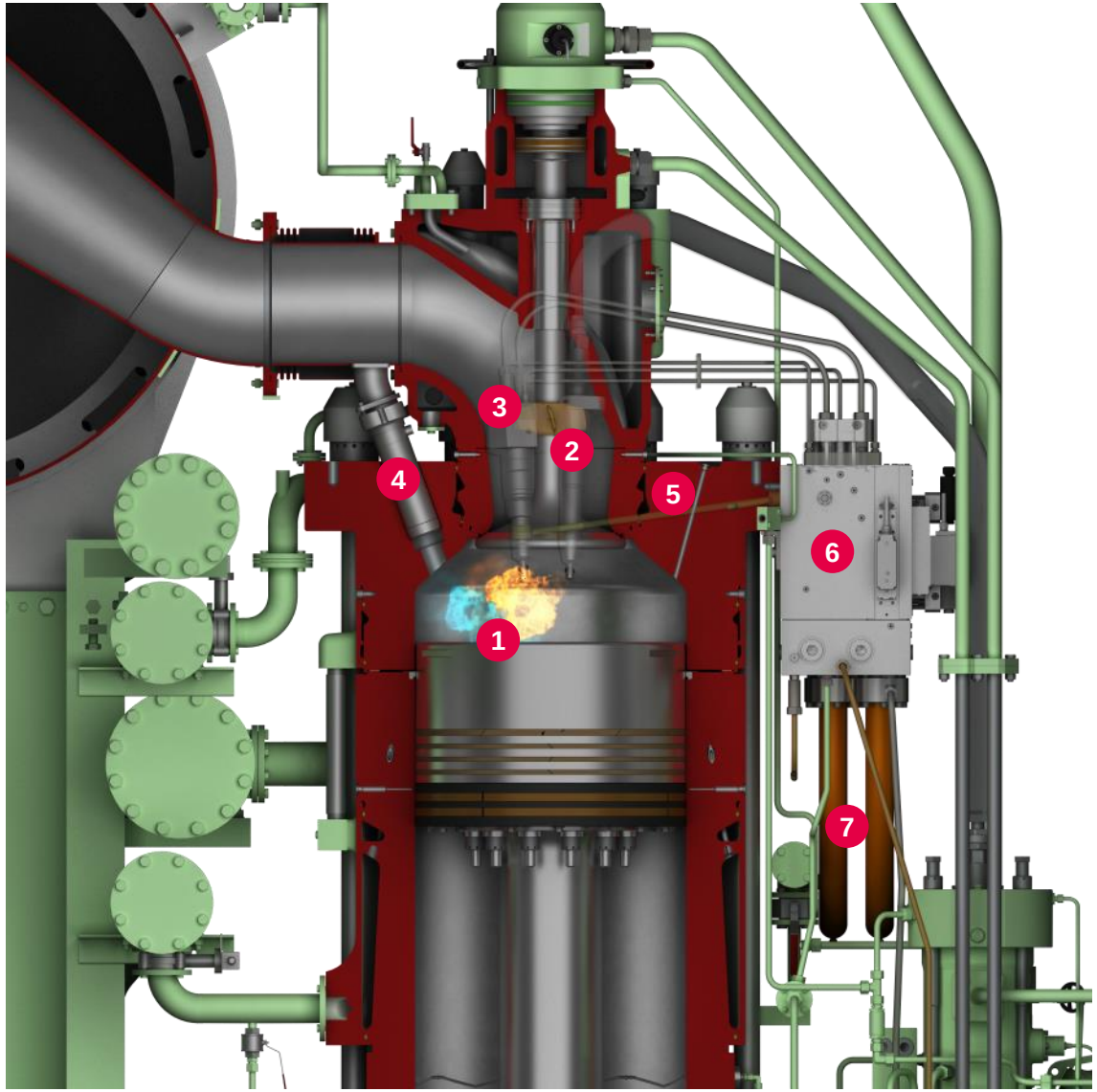
MAN Energy Solutions supports all

LNG	Ethane	Methanol	LPG	Ammonia
ME-GI 271 Engines	ME-GA 44 Engines	ME-GIE 25 Engines	ME-LGIM 27 Engines	ME-LGIP 101 Engines	→ 2024

ME-GI and ME-LGI engines for future fuels



Combustion Principle - diesel cycle

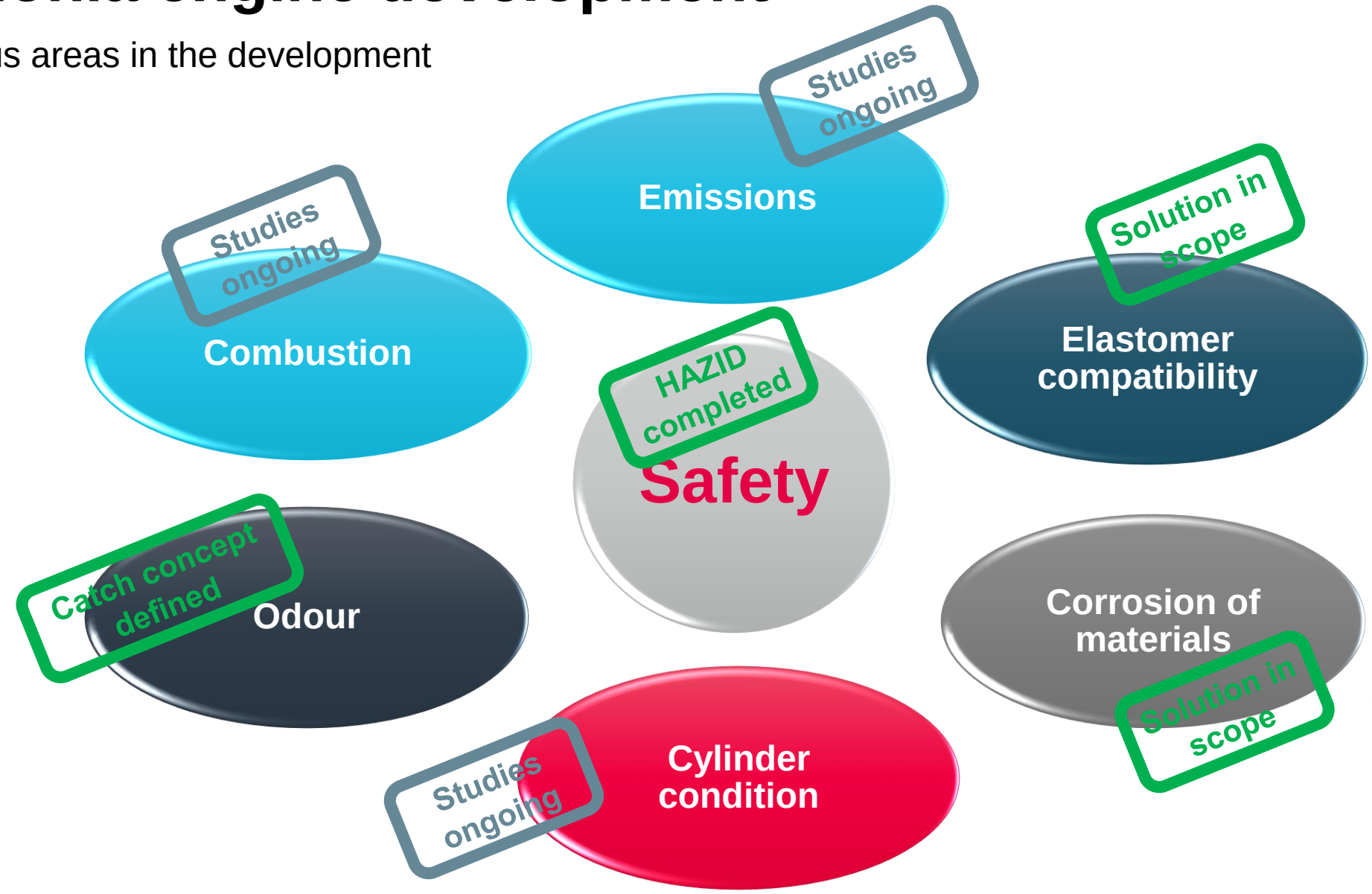


1. From actual footage (colorized)
   Yellow = pilot oil (0.5 to 5%* @100% load)
   Blue = fuel gas
2. Conventional slide fuel valve
3. Gas fuel valve
4. High pressure safety valve
5. Gas distribution channel (yellow)
6. Gas distributor block
7. Gas chain link double-walled pipes

*) based on main fuel selection

Ammonia engine development

Main focus areas in the development



Solutions for retrofitting to alternative fuels
- Now adding Ammonia (NH3)

Future-proof engine Technology.

MAN B&W ME-C engines are future-proof and can be retrofitted to use LNG, LPG, Ethane, Methanol and Ammonia as fuel.

Proven track record of engine conversions.

In Service

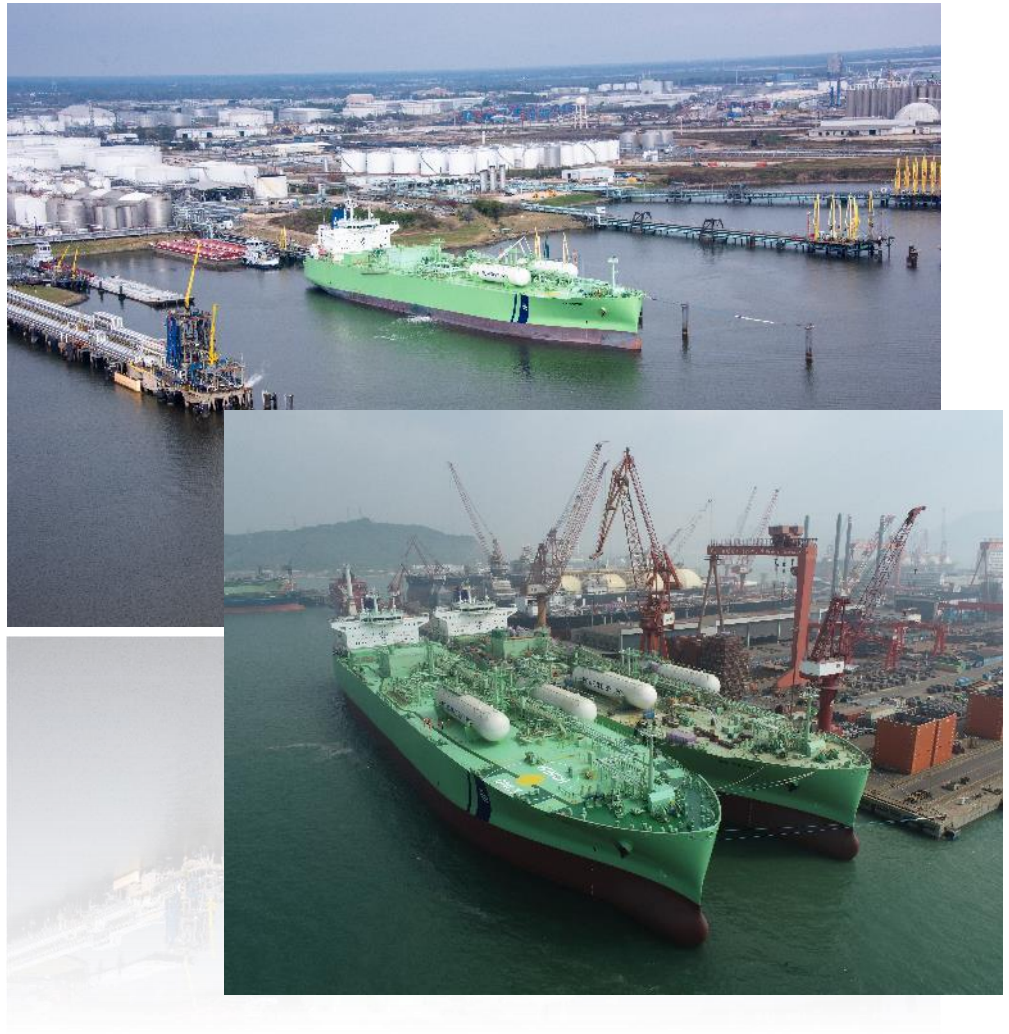
– ME-GIE: 1

– ME-GI: 3

– ME-LGIP: 4

In process and on order

– ME-LGIP: 11



*Pictures courtesy of BW Gas. 15 VLGCs will be retrofitted to LPG propulsion with MAN B&W engines.

Two-stroke ammonia engine development schedule

2019

Pre-study

- ✓ NH3 combustibility investigation

2020

Project kick-off

- ✓ 4T50ME-X test engine received as platform for the Ammonia engine development
- ✓ HAZID workshop on engine concept
- ✓ Combustion chamber 1st evaluation

2021

Engine concept R&D

- Engine basic concept defined based on R&D and simulations
- Ammonia fuel supply & Auxiliary systems specified and established in RCC

2022

Engine combustion and emission

- 1st engine confirmation at Research Centre Copenhagen (RCC)
- Specification of emission after-treatment done

2023

Full scale engine test

- Full scale engine test at RCC evaluated for 1st commercial design

2024

1st engine delivery to yard

- Ammonia engine in engine programme.
- 1st ammonia fueled engine delivered to yard

All data provided in this document is non-binding.
This data serves informational purposes only and is especially not guaranteed in any way.
Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.

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Thank you very much