A sea-going view of decarbonization of maritime transport

Richard Payne

Director EMEA Non-road Regulatory Affairs

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Development of alternative fuels and application for ship use

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About EUROMOT

- EUROMOT is the European association of internal combustion engine manufacturers, founded in 1991 in London
- Our scope
  - Interest representation for manufacturers of industrial combustion engines
  - International environmental requirements and related legislation such as product safety, certification and testing, fuels, standards,…
- Member companies from all over the world
- A non-governmental organization in consultative status at IMO

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Engines and System Integration

Marine Vessels of the future

Alternative fuels & technologies

- Gas / LNG
- Ethane, LPG
- Methanol
- Ammonia
- Hydrogen
- Power to Liquid/ Synthetic Fuels
- Fuel-Cell
- …

Efficiency & emission technologies

- Exhaust After Treatment
- Waste Heat Recovery
- Dynamic propulsion control (e.g. trim & fuel optimization)
- Propulsion System efficiency, through system integration
- Air lubrication
- Wind Rotors
- …

Electrification/ Hybridization & Intelligent Power Management

- Diesel-electric
- Hybrid
- Pure-e / battery electric
- Microgrid / Intelligent Power Management
- …

Automation, Digitalization & “Smart Ship”

- Automation incl. efficiency mgt.
- Connectivity
- Equipment Health Mgt./ Condition Based Maintenance
- Digital services (fuel performance, fleet / route optimization, EHM, hull cleaning)
- Remote & autonomous control
- …

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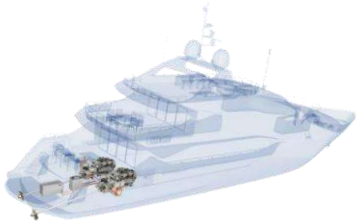
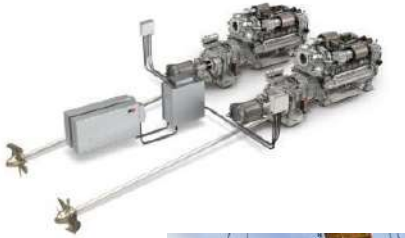
Hybridization and Intelligent Power Management

Improving Energy Efficiency

- Excellent short-term measure to improve energy efficiency of ships
- Technology with high maturity and wide range of available systems
- Application to new ships and retrofitting of existing ships
- Potential for further decarbonization
- High degree of system integration is key
- May be used with conventional marine fuels, low flashpoint diesel fuels or low/zero carbon fuels





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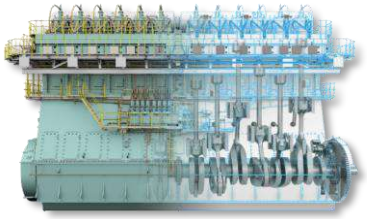
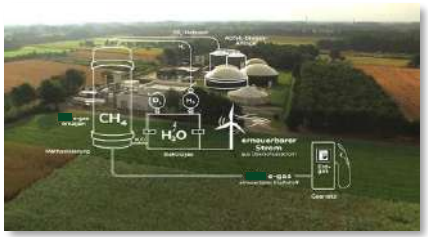
LNG, LPG, Synthetic- and Bio-Methane

Increasing share of synthetic and bio methane is used in a broad variety of gas- and dual fuel-engines

- Excellent short-term measure
- Ongoing technology development to minimize methane slip for pre-mixed engines
- Highly mature technology
- Application to new ships and retrofitting of existing ships is possible
- Wide range of available dual fuel and gas engines
- LNG/LPG as a transition to synthetic-/bio-methane and all other low flashpoint fuels





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Hydrogen and Hydrogen Admixture

- Adaptations to marine engine running on hydrogen is at an early development stage
- Max. 20 - 30% hydrogen admixture to LNG as a first development target
- LNG engines as transition technology to hydrogen
- Engines running with pure hydrogen are at an early research stage
- Technical challenges using hydrogen, e.g. a broad explosive range and impact on material
- Hydrogen needs to be liquefied in order to achieve comparable energy density





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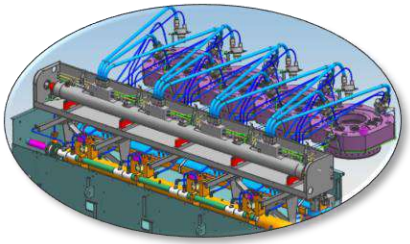
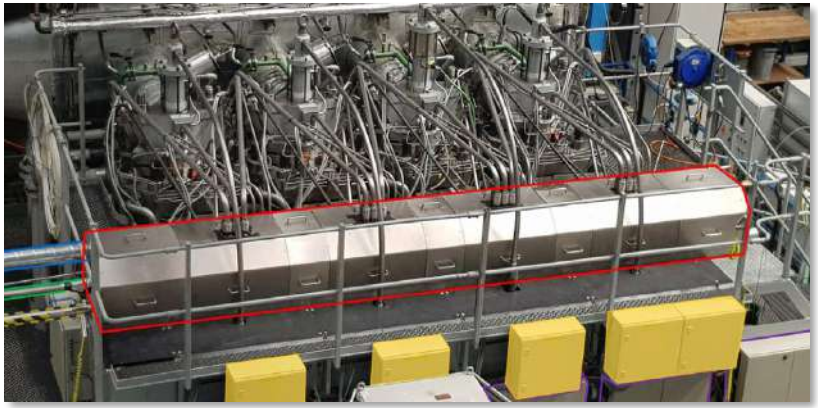
Methyl- / Ethyl-Alcohols (Methanol and Ethanol)

- Mature engine technology, derived from LNG-dual fuel engines
- Short-term availability
- Application to new ships and retrofitting of existing ships possible
- Moderate technical adaptations needed to ensure safe storage and use on board
- Requires adaptation of safety concepts due to physical and chemical properties
- Fuel feedstock needs consideration (land-use)





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Ammonia

- Engine technology derived from LNG-dual fuel engines
- Ongoing development, engines anticipated to be available in a few years
- Application to new ships and retrofitting of existing ships is possible
- Moderate technical adaptations needed to ensure safe storage and use on board
- Requires adaptation of safety concepts due to toxicity
- Exhaust after treatment for NO_x and N_2O will be adapted when required

Start	+1 year	+2 years	+3 years	+4 years	+5 years
Pre-Study	**Project Kick-off**	**1st engine test**	**Emission specificiaton**	**Full Scale Engine test**	**1st engine delivery to yard**
• NH_3 combustibiity investigation	• Test engine received as platform for the Ammonia engine development • Workshop on engine concept	• 1st engine confirmation at R&D facilities • Engine basis concept defined based on engine tests • Ammonia supply & auxiliary systems specified	• Specification of emission after-treatment systems done	• Full scale engine test at R&D facilities completed	• Ammonia engine in engine programme • 1st ammonia burning engine to be installed at yard

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Future Fuels for Shipping

Deployment of low/zero carbon fuels is necessary to achieve IMO GHG reduction targets in the longer term

- Biofuels may play a role in a transitional period
- Electrification/hybridization may play a bigger role in short-sea and inland shipping with lower power demand
- **Hydrogen based fuels with zero carbon footprint are key for marine and other applications with higher power demand**

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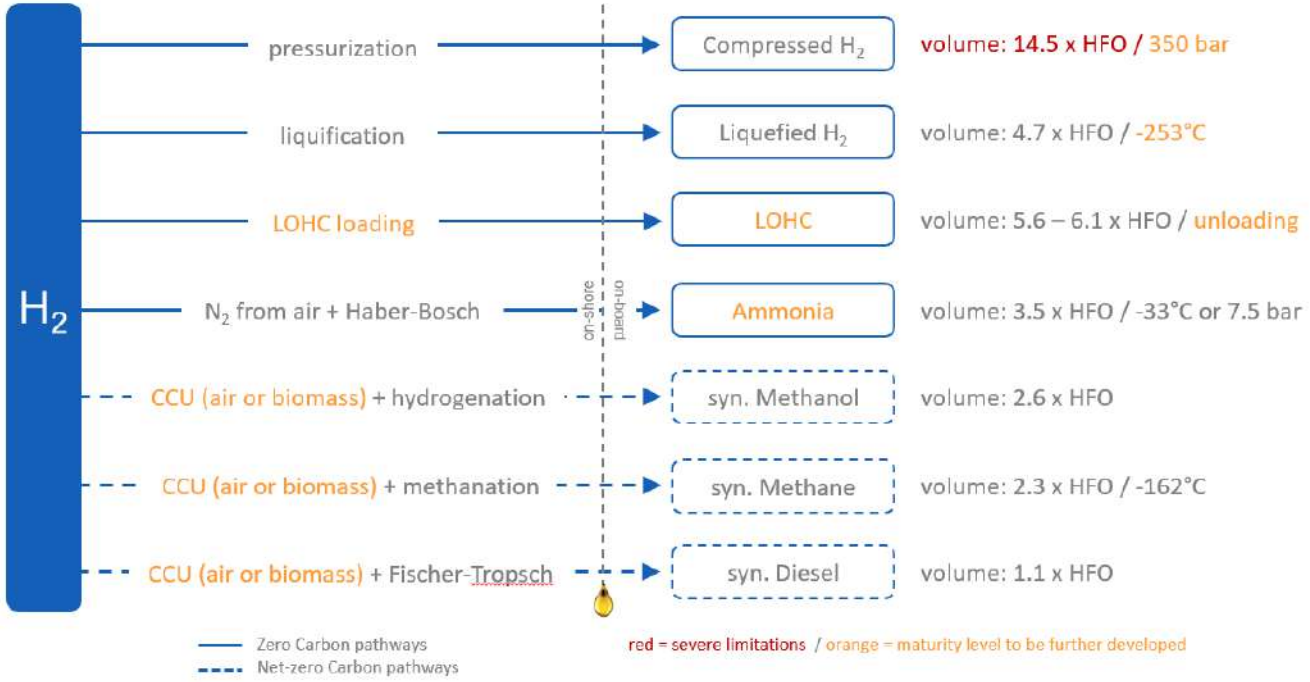
Production Pathways – Hydrogen Based Fuels



https://www.cimac.com/publications/publications350/cimac-ghg-strategy-group-position-paper-and-white-papers.html

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Maritime Energy Transition – Prerequisites to make it happen

- Combustion engines combine an outstanding endurance with high energy density which is key as well for the use of future marine fuels
- IMO MSC and CCC (Sub)Committees need to speed up development of the IGF-Code. More resources to be provided especially to CCC
- Regulations have to be developed in a technology-neutral way under consideration of state-of-the-art risk assessments
- GHG-intensity of fuels has to be considered in a well-to-wake approach
- The future share of presented fuel options is at the time being unpredictable
- Therefore, manufacturers are advancing the development of engine technology and systems for all presented fuel options
- Sustainable production of marine fuels, reliable supply to ships to affordable prices is the challenge of the maritime energy transition

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For further question and comments pls contact the EUROMOT Secretariat under secretariat@euromot.eu

EUROMOT aisbl · Rue Joseph Stevens 7 · 1000 Brussels · Belgium

Tel: +32 2 893.21.42 · E-Mail: secretariat@euromot.eu

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