

Workshop “Ammonia as an Energy Carrier”

Ammonia in the Maritime Sector



Agenda



- Maritime decarbonization targets
- Ammonia as energy carrier
- Ammonia as an engine fuel
- Outlook



Maritime Transport – Facts and Trends



→ The backbone of global trade

- About **100,000** oceangoing vessels
- Over **90%** of worldwide transport and over **90%** of EU foreign trade

→ Trend towards mega ships

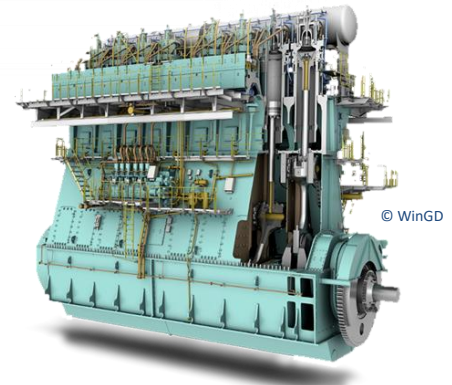
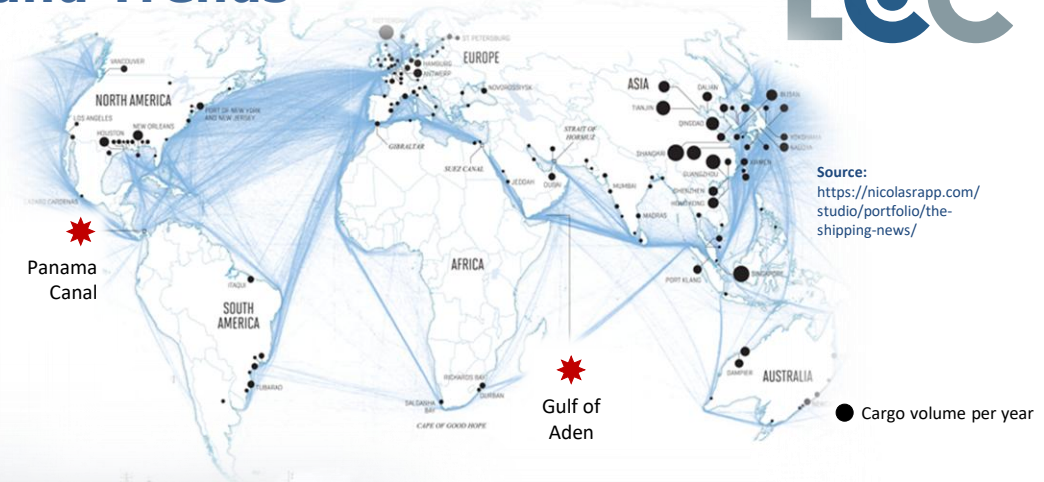
- Post Panamax, Post Suezmax, etc.
- Container vessels for shipping of more than **24,000 TEU**
- Cruise ships for over **7,000 passengers** (crew members not included)

→ Mainly IC Engine as prime mover

- Power output up to **80 MW**
- Almost exclusively **HFO** (Heavy Fuel Oil), **MGO** (Marine Gas Oil) and **LNG**

→ Retrofitting – a viable option?

- Investments of well-over **100 million dollars**
- **Lifetime** of vessels **25+ years**

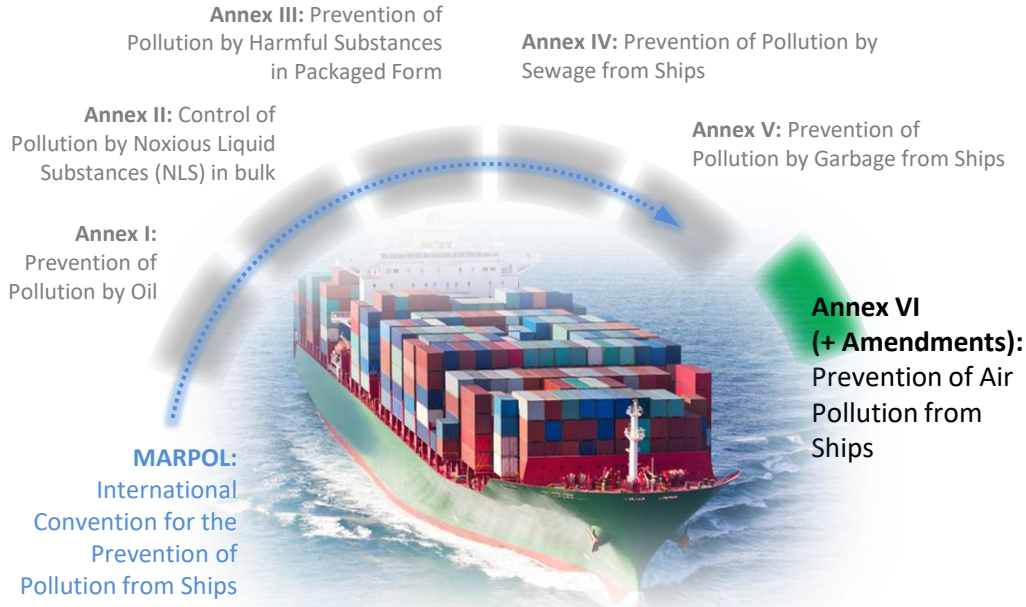


Source: https://maritimeoptima.com/public/vessels/pages/imo:9929429/mmsi:636022601/MS_C_IRINA.html

Maritime Transport – Emission Regulations



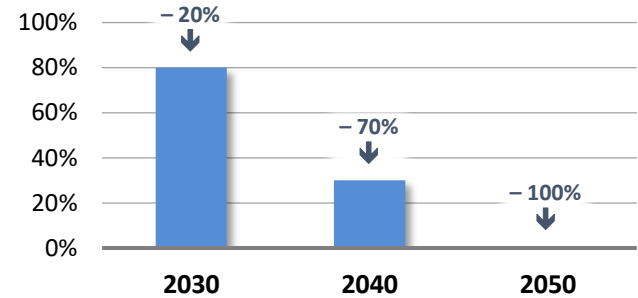
Specialized agency of the United Nations
176 countries / Headquarters London



Recently adopted / announced by IMO

2020 Limitation of the sulfur content in the fuel oil used on board ships operating outside designated emission control areas (ECAs) to 0.5 %

2023 Targeted reduction in greenhouse gas emissions from global shipping – base year 2008



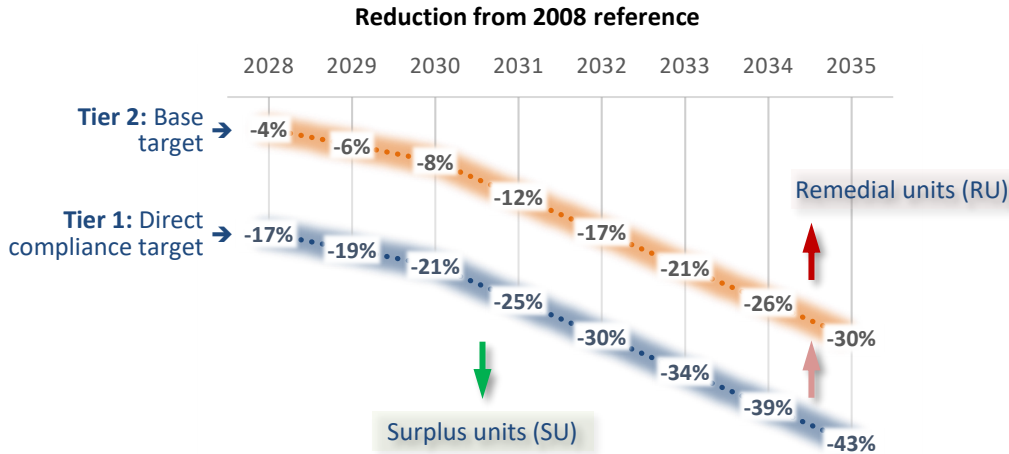
2025 Extension of Emission Control Areas to Mediterranean Sea (SO_x), Canadian Arctic (NO_x and SO_x) and Norwegian Sea (NO_x and SO_x)

Maritime Transport – Emission Regulations



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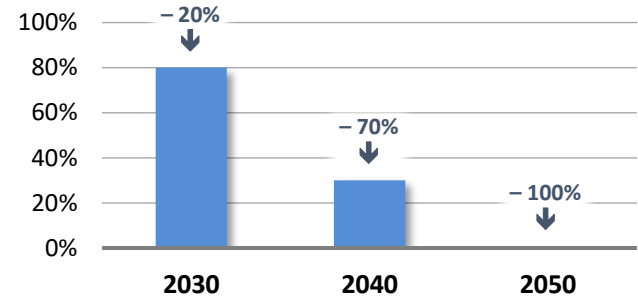
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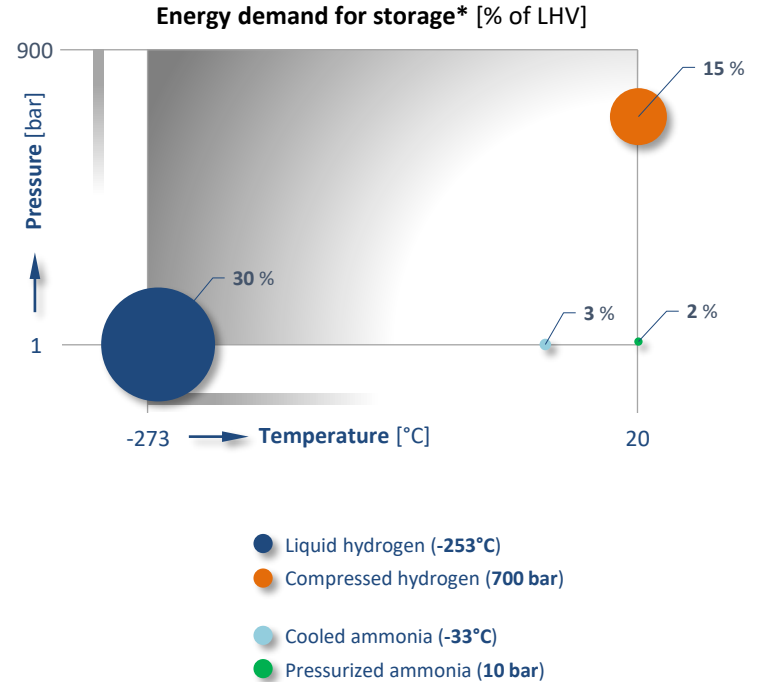
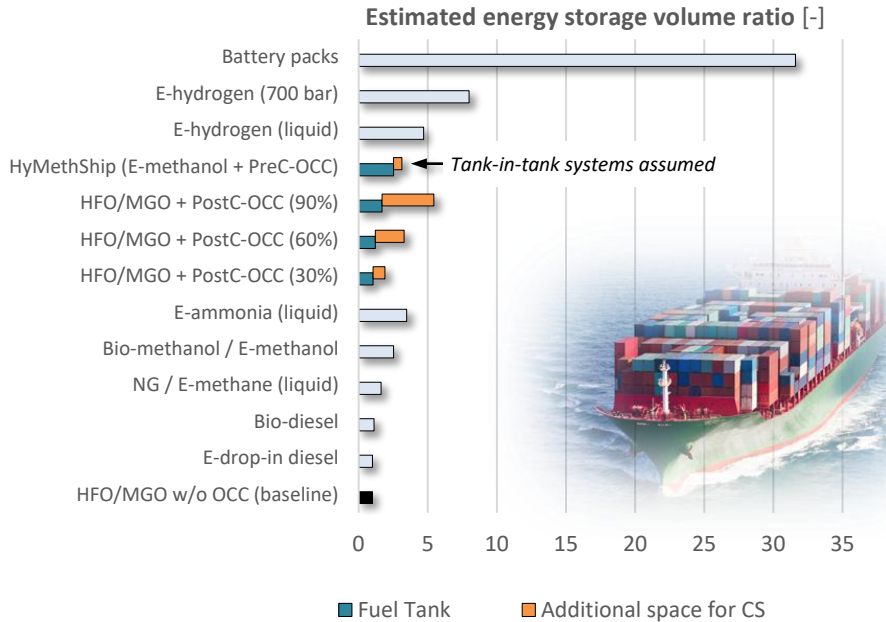
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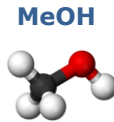
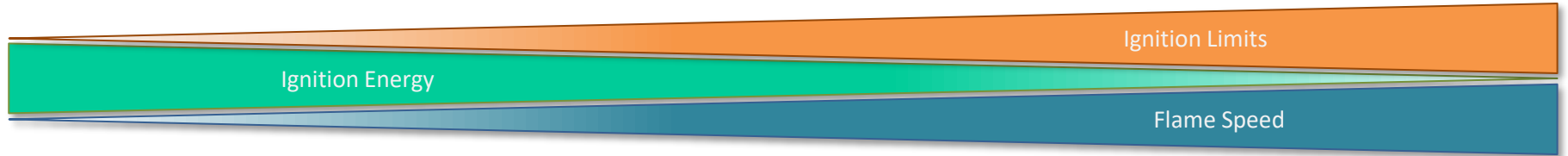
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2025 Net-Zero Framework – New requirements on greenhouse gas (GHG) fuel intensity, in combination with a pricing and reward mechanism, taking effect from 2028

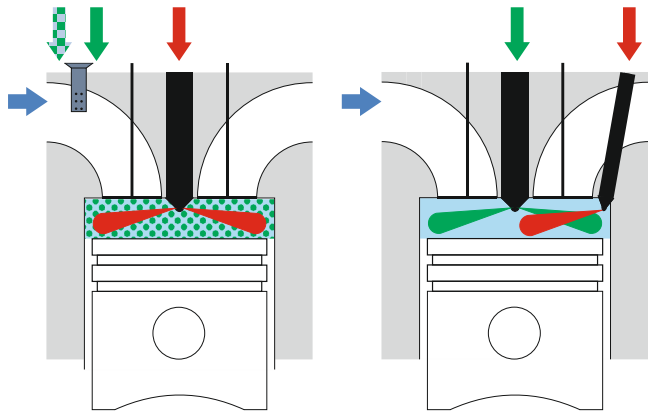
Additional Storage Space (Lost Cargo)



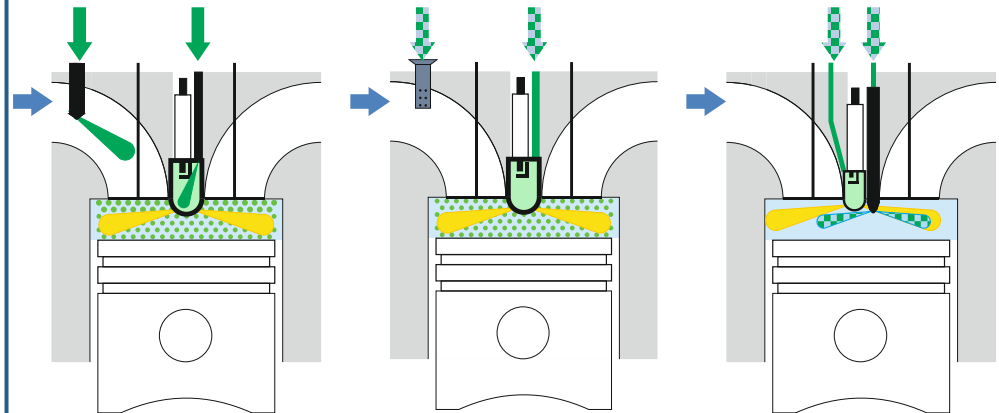
Ammonia properties and combustion concepts



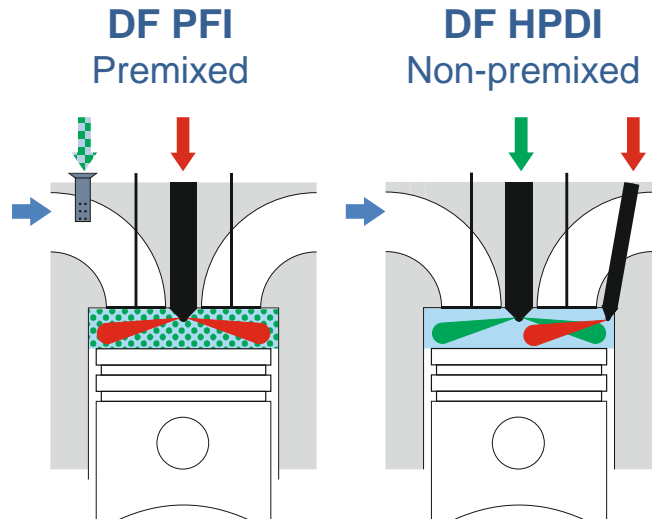
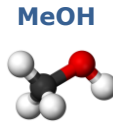
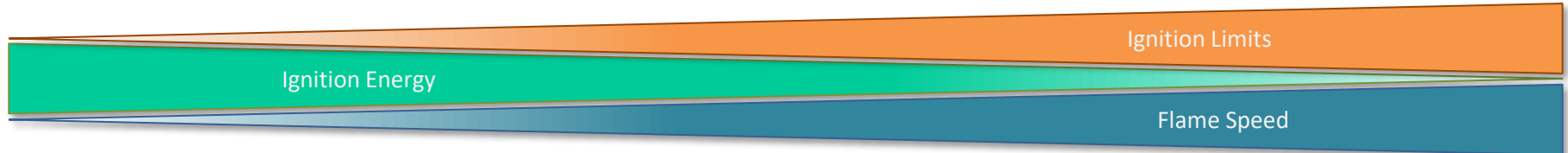
CI combustion concepts



SI combustion concepts



Ammonia properties and combustion concepts



Dual Fuel (DF) Combustion concepts

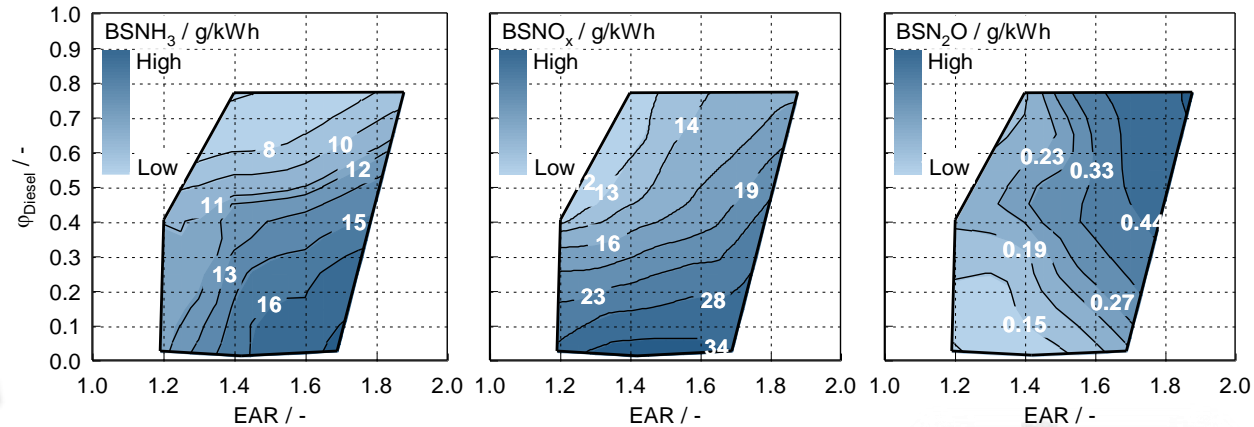
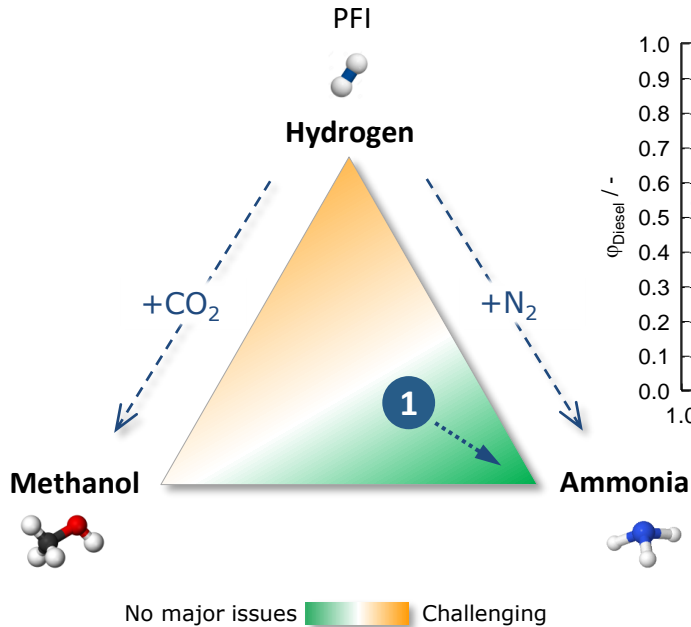
- Robust combustion concept for marine propulsion systems
- Allows for fast switch to pure Diesel operation in case of emergency

Ammonia combustion and emissions

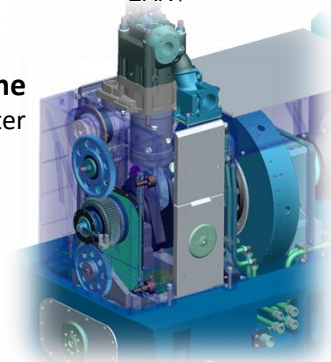
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- Ammonia-Diesel Dual Fuel combustion
- Low-energetic diesel fraction
- 90+ % GHG emission reduction (w/o exhaust gas aftertreatment)

Premixed combustion



Single cylinder research engine
Swept volume appr. 15 liter



Combustion concepts with green fuels



Premixed combustion

PFI



Hydrogen

+CO₂

+N₂

Methanol



Ammonia



No major issues Challenging

Non-premixed combustion

HP-DI



Hydrogen

+CO₂

+N₂

Methanol



Ammonia



- The **green transformation** of the marine sector is underway
- The **speed of the transformation** process is largely determined by the **availability of renewable fuels**
- The question of **fuel type** is very much **linked to** the question of which **energy carrier** will be used to store and transport renewable energy in the future
- Whether **retrofitting** will play a **decisive role** - either **with OCC or the conversion to new fuels** - remains an open question

Number of ships powered by **alternative propulsion systems**
(status: June 2024)



Thank you for your attention!

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Evolutionary Green Energy

and Transport Systems

for a Sustainable Tomorrow

Dipl.-Ing. Dr.techn.

Univ.-Prof. Dr.-Ing.

Contact:

Thomas Jauk
CEO

Email: thomas.jauk@lec.tugraz.at
Tel.: +43 316 873 30063

Nicole Wermuth
CSO

Email: nicole.wermuth@lec.tugraz.at
Tel.: +43 316 873 30087

LEC GmbH – Large Engines Competence Center
Inffeldgasse 19 | 8010 Graz, Austria

www.lec.at

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