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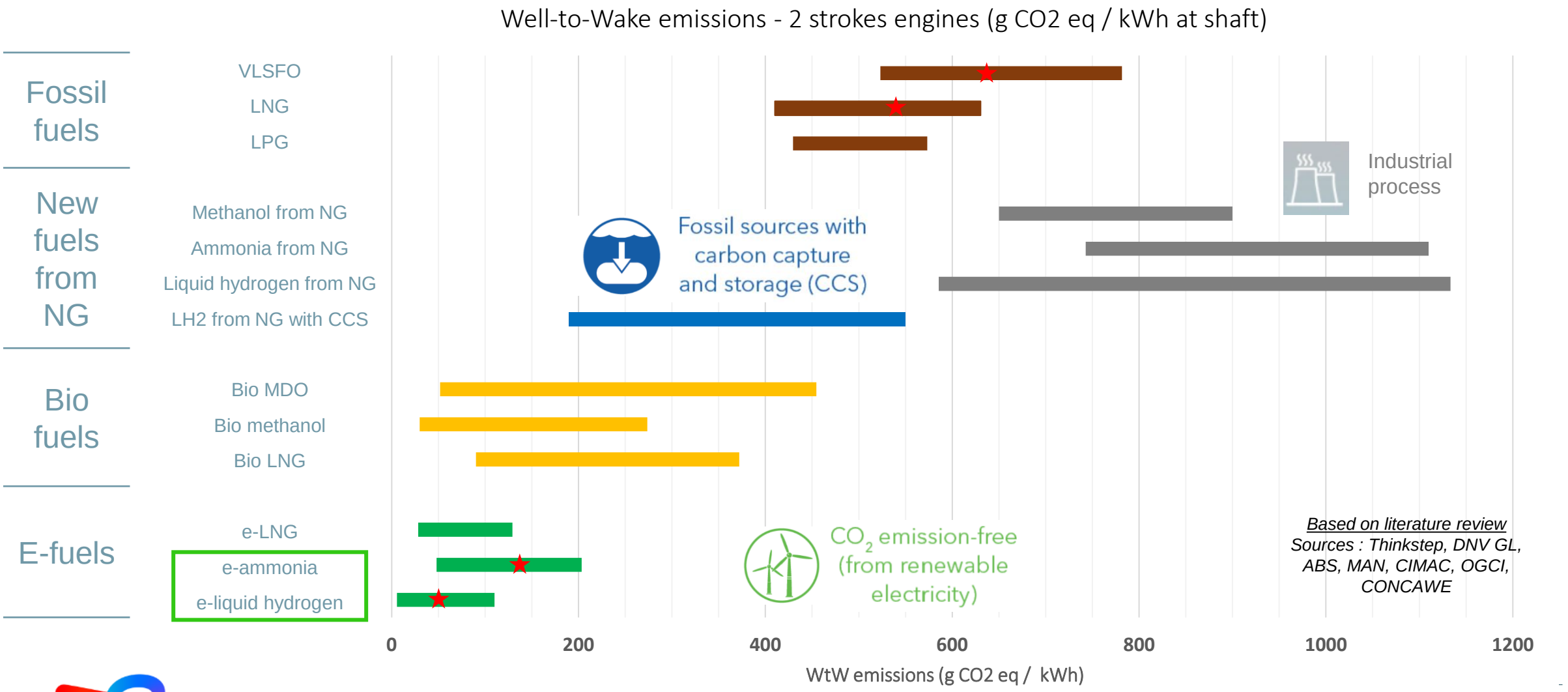
Ammonia Energy Conference 2021 - Australia

Advancing Ammonia as a Marine Fuel

27 August 2021

Alternative Marine Fuels: e-fuels have the highest abatement potential of GHG emissions (> 80% vs VLSFO).



Ammonia vs. Hydrogen For Shipping

	LIQUID AMMONIA	LIQUID HYDROGEN
STORAGE & TRANSPORTATION	Can be stored & transported as a liquid at a practical temperature of -33°C	Requires deep cryogenic temperature (-253 °C or lower)
INFRASTRUCTURE	Can be distributed using existing infrastructure	No existing infrastructure
ENERGY DENSITY	Low volumetric energy density, however 50% better than liquefied hydrogen	Very low volumetric energy density
SCALABILITY	Easily produced from H2 & N2 No CO2 needed	

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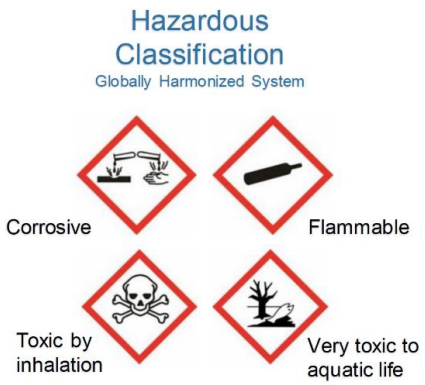
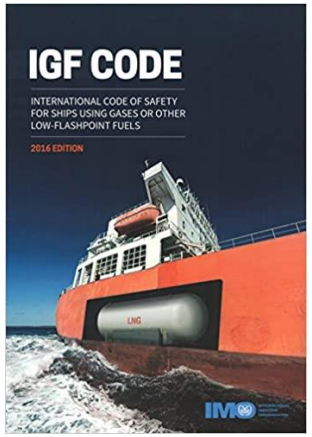
Short Term Challenges for Ammonia as a Marine Fuel



SAFETY

ENGINES

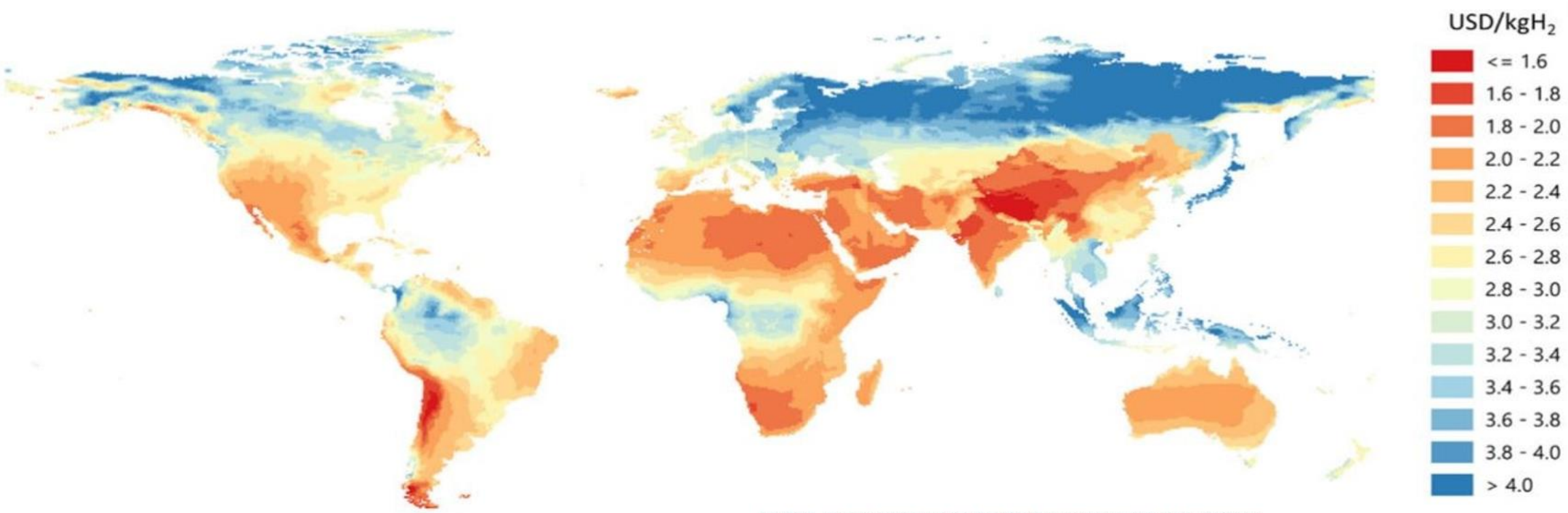


SHIP DESIGN REGULATIONS

BUNKERING & SHORE INFRASTRUCTURE

Challenge of Scaling e-Ammonia Production

Hydrogen costs from hybrid solar PV and onshore wind systems in the long term



IEA (2019), The Future of Hydrogen, IEA, Paris https://www.iea.org/reports/the-future-of-hydrogen

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Speeding Up Ammonia Marine Fuel Development

RESEARCH & DEVELOPMENT

JOINT INDUSTRY PROJECTS

SUPPORTIVE POLICIES

CO2 PRICING

- **Joint study with 34 companies across diverse industries** on ammonia as an alternative marine fuel
  - TotalEnergies embarks on Singapore ammonia bunker study
- **Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping** to assess the technical, financial and environmental potential of converting existing vessels to future fuel solutions and technology, such as ammonia
- **TotalEnergies Partners with Novatek**; explores new opportunities for developing decarbonized hydrogen & ammonia

MOL, Total and Pavilion join Singapore ammonia bunker study

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New project to look into converting existing ships to zero-carbon fuels

RESEARCH & DEVELOPMENT

May 14, 2021, by Naida Hakirevic Prevljak

A.P. Moller – Maersk, ABS, MAN Energy Solutions, Mitsubishi Heavy Industries, NYK Line, Seaspan Corporation and Total are joining forces through the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping to assess the technical, financial and environmental potential of converting existing vessels to zero-
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DOW JONES NEWSWIRES

Russia: TotalEnergies Partners with Novatek on LNG Decarbonization, Hydrogen and Renewables

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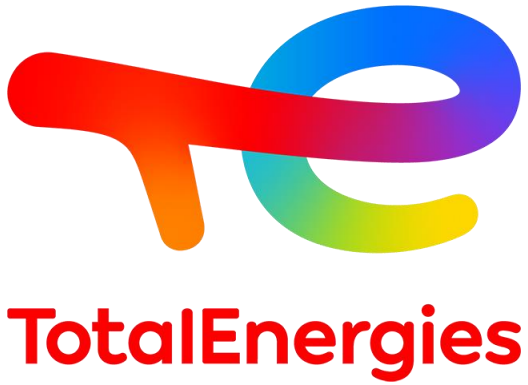

Thank You!