
Ammonia

Could it replace HFO/LSFO?

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November 13th, 2019



Lloyd's
Register

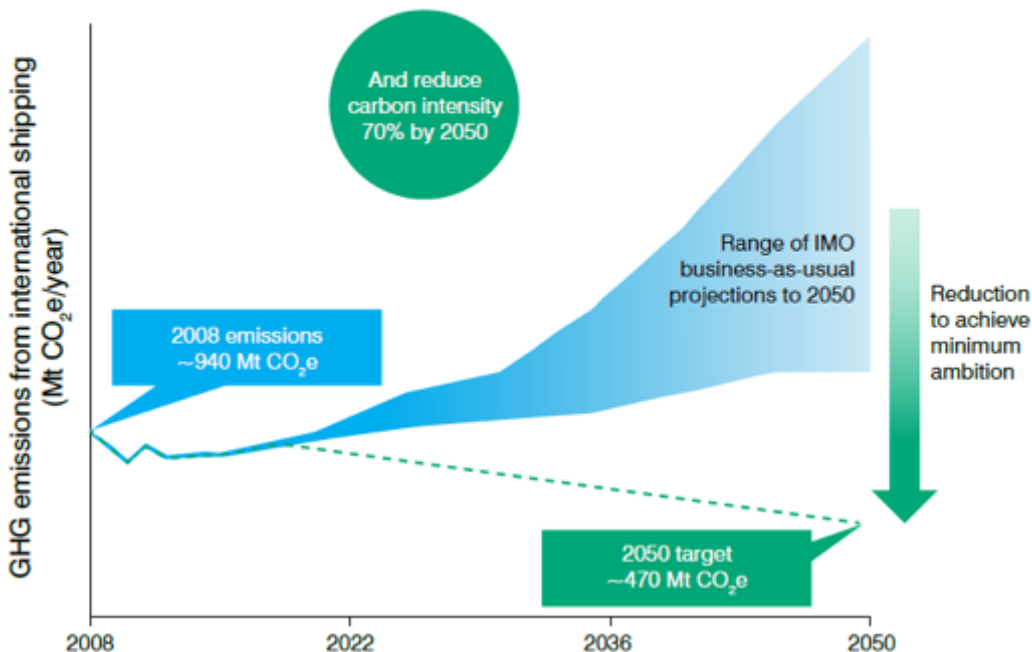
What will be discussed?

- **Classification society overview of the adoption pathways of new maritime fuel**
 - Overview: Alterations
 - Overview: Zero-carbon fuels
- **Ammonia as a fuel**
 - Fuel characteristics
 - Safety and Risks
 - Hurdles & Actions to be taken
 - Decarbonization
- **Conclusion**
 - Lloyd's Register & Sustainability

Overview

To achieve an absolute reduction in GHG of at least 50% by 2050

Reduction required to meet the IMO's absolute emissions reduction target



Source:
Nick Ash - Ricardo Energy & Environment
Tim Scarbrough - Ricardo Energy & Environment
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- This equates to around **85%** reduction in carbon intensity
- Efficiency and renewables are not enough to reach the goal
- Zero-emission vessels need to be entering the fleet from 2030
- This will not happen without policy intervention and a fundamental change to the incentives scheme

Overview: Alterations

Up to 2030s

2020 – 2030 is the most significant decade stressing the urgency for early action.

- A significant change in the energy supply market
- Full-scale prototypes and pilots now
- Easy to store zero-carbon fuels may be more attractive now
- Batteries play an important role
- Development of policy, standards and rules
- First adopters driven by consumer pressure



The 2030s

Scaling up of zero-carbon fuels.

- A clear signal on the evolution of the energy system
- Availability of cheap renewable electricity
- Consolidation of dominant technologies onboard
- Price, machinery costs and revenue loss will be better understood
- Fundamental change to ship's operating profile
- LNG assets will need to find a way to remain competitive



Up to 2050s

May experience more than one dramatic fuel switch.

- The likelihood is very difficult to assess
- A growing share of biofuels in the 2030s
- A major shift to electro-fuels in the 2030s & 2040s
- Consolidation of the market with an end fuel mix dominated by one family of fuels

Overview: Zero Carbon Fuels

To achieve an absolute reduction in GHG of at least 50% by 2050

	Zero-carbon fuels				
Energy source	Methanol	Gas oil	Hydrogen	Ammonia	Electricity
Natural gas with CCS			NG-H ₂	NG-NH ₃	
Biomass	bio-methanol	bio-gas oil			
Renewable electricity	e-methanol	e-gas oil	e-H ₂	e-NH ₃	batteries





Ammonia (NH₃): Fuel Characteristics

- Ammonia is a colorless, flammable, highly toxic and corrosive gas
- Flame speed is low (0.07 m/s)
- Formation of NO_x during consumption
- Highly soluble in water
- Ammonia has low flammability (15-28%)
- Latent heat of evaporation is high, meaning no reliquification would be required
- Liquification at -34°C



Ammonia (NH₃): Safety & Risks

1. Non-highly flammable
2. Toxic when inhaled
3. Corrosive when handled
4. Gas explosive (when stored in confined spaces)
5. High mortality rate when spilt in water or released in air

HAZARD PICTOGRAM REQUIRED	
No	
Yes	
Yes	
Yes	
Yes	

Hurdles

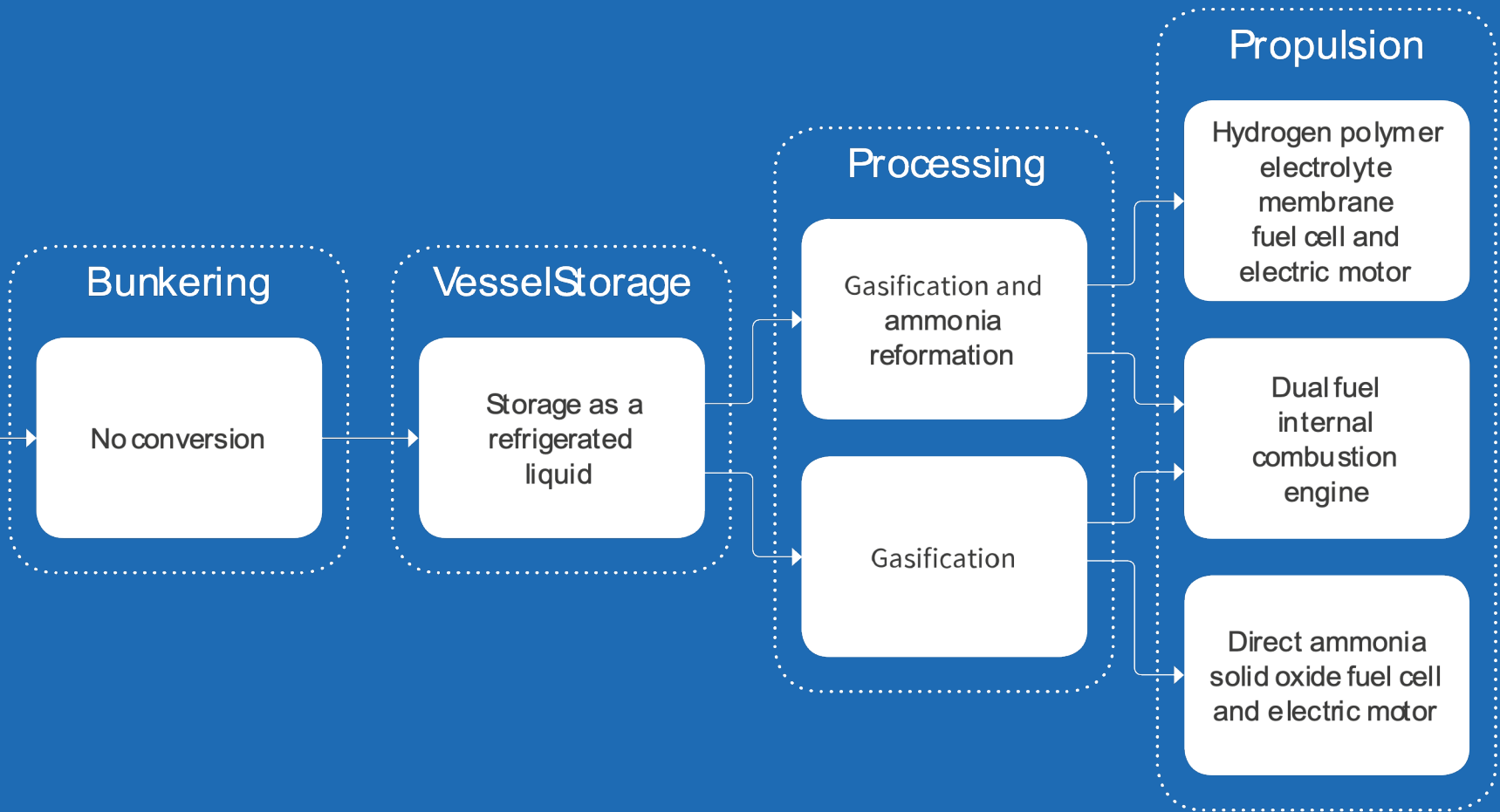
- **Regulatory – IMO**
Toxic cargoes not permitted to be used as fuel
- **Bunkering**
Has not been bunkered before
- **Consumers**
Machinery makers have not reached the stage of complying with ammonia as a fuel

Actions to be taken

- Amendments to the IGC code following support from administrations
- Bunkering procedures and fuel quality standards to be adopted
- Makers need to adopt (re-design) their equipment to accommodate ammonia as a fuel



Ammonia (NH₃): Decarbonization



Conclusion

- ❑ Are there risks?
- ❑ Are they manageable?
- ❑ Do we have the regulatory framework as well as the technology to achieve the required results?

Is it worth it?



Conclusion: Lloyd's Register and Sustainability

- ❖ Aim to help our clients meet their own sustainability challenges
- ❖ Demonstrate our own commitment to working towards a cleaner, safer and more sustainable world.
- ❖ Stakeholders are investing and innovating for a sustainable future
- ❖ No single government, nor any one sector, can make the changes alone
- ❖ Long-term operations

What we do today will have an impact tomorrow.

We should all work together towards it!



Thank you

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