

MariNH₃

Clean, green ammonia
engines for maritime

Integrated Hydrogen and Ammonia Solid- State Stores for Maritime

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Cambustion



The
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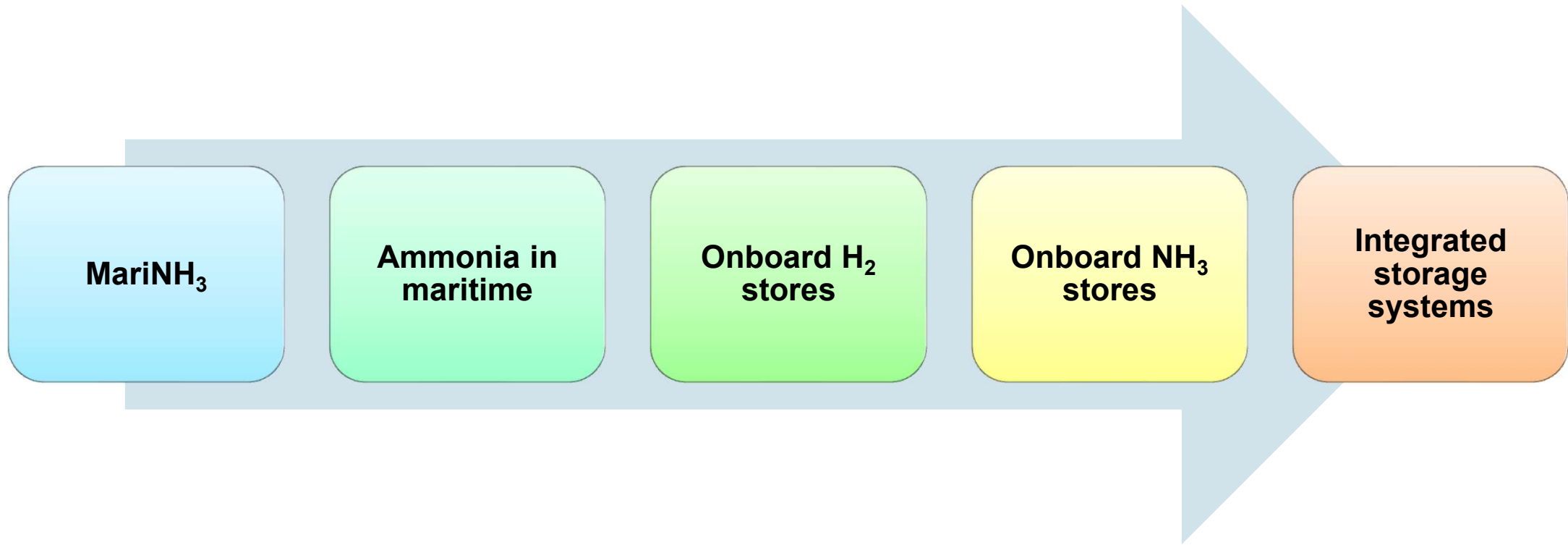
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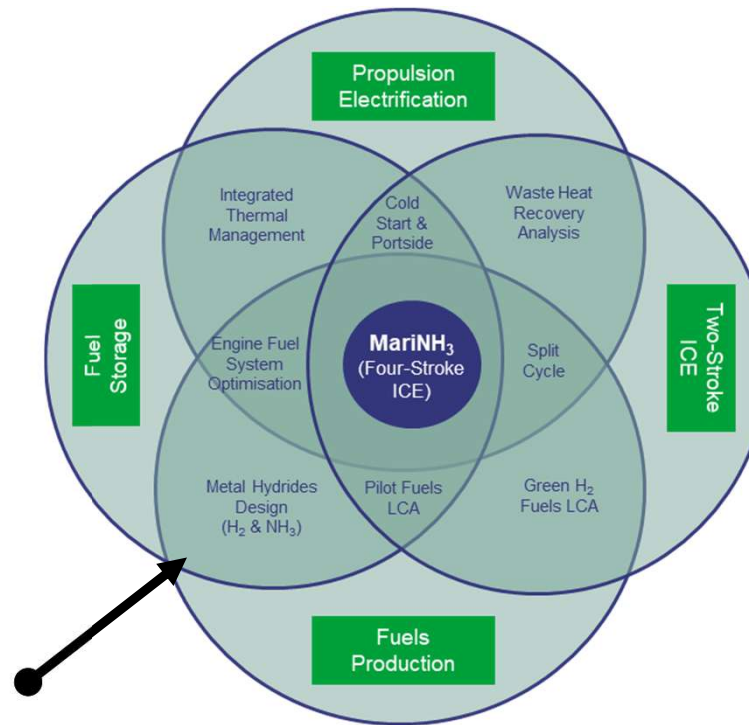
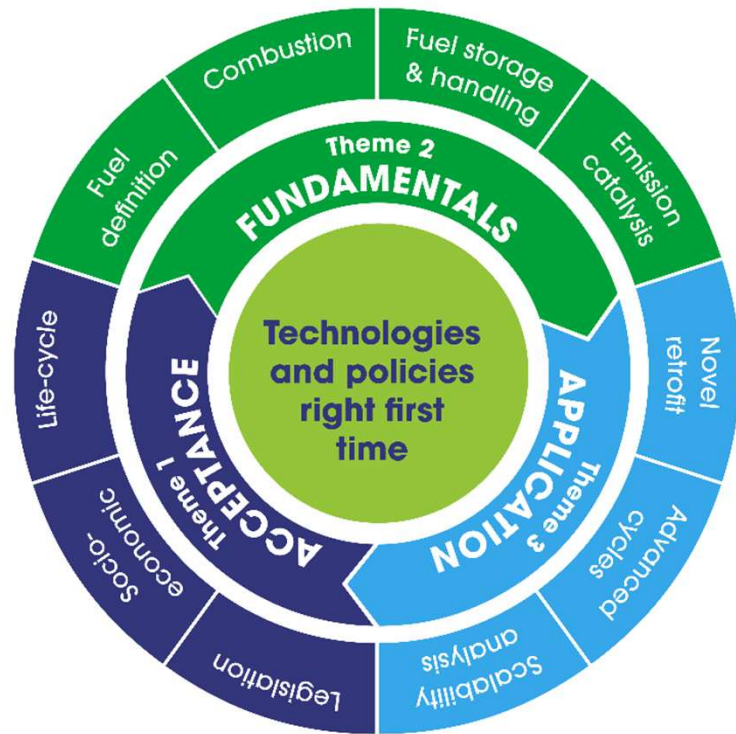
Outline



Our role

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Clean, green ammonia engines for maritime



Facilities

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Clean, green ammonia engines for maritime



**Hydrogen and energy storage labs
Research Acceleration &
Demonstration (RAD) building,
University of Nottingham**



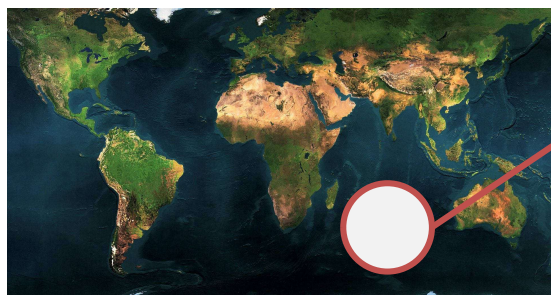
GC



Rig

Capabilities:
Ammonia storage
Ammonia cracking
Ammonia synthesis

Ammonia: clean fuel for maritime



“Shipping”

3% GHGs → **6th largest emitter > Germany**



Ammonia in engines (30-45% less)

- Hydrogen is harder to transport, requiring large volumes even when compressed or as a liquid at 20 K.
- Ammonia is convenient to transport as liquid.

- Zero-carbon emissions
- Storage and handling
- **Toxicity**
- **Lower energy density than conventional fuels (HFO/diesel etc.).**
- **Alternative combustion characteristics: NH₃ combustion generates harmful NO_x (global warming potential ~300x)**

Is compressed H₂ the right fit?

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1250 gal
265 psi
534 kg H₂

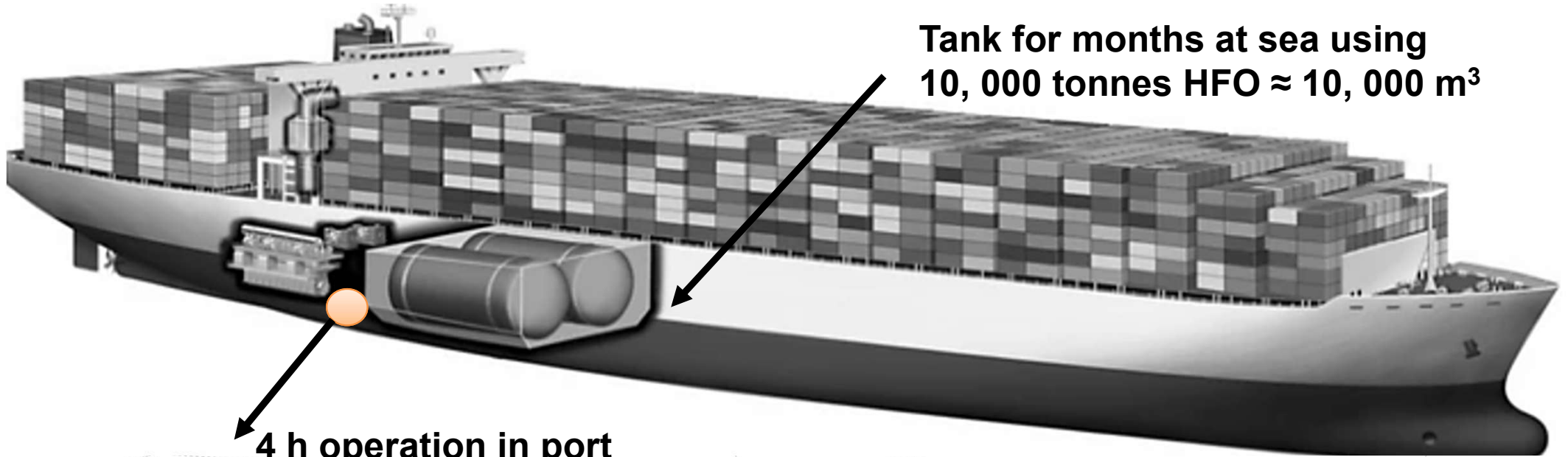
53%
more H₂



5800 gal
3200 psi
350 kg H₂

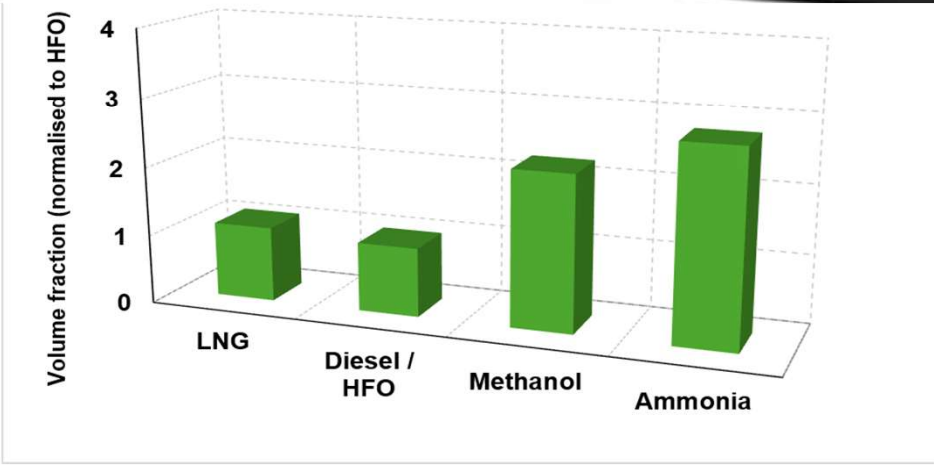
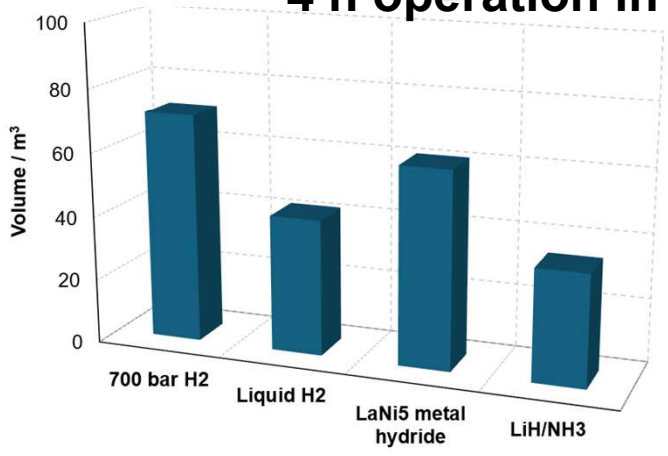
What hydrogen storage options are suitable?

- Ammonia as indirect hydrogen store.
- Additional ammonia store for capturing ammonia, which can be used onboard.
- **Extracting hydrogen from ammonia store via cracking (requires high temperatures).**
- **Extracting hydrogen from hydride stores (utilize ammonia and low-grade waste heat).**



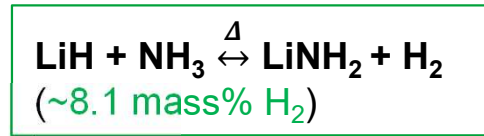
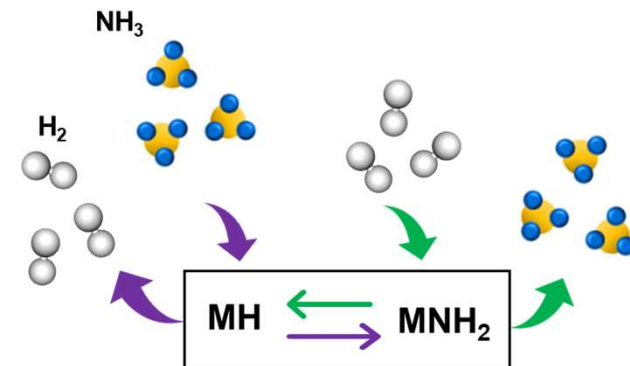
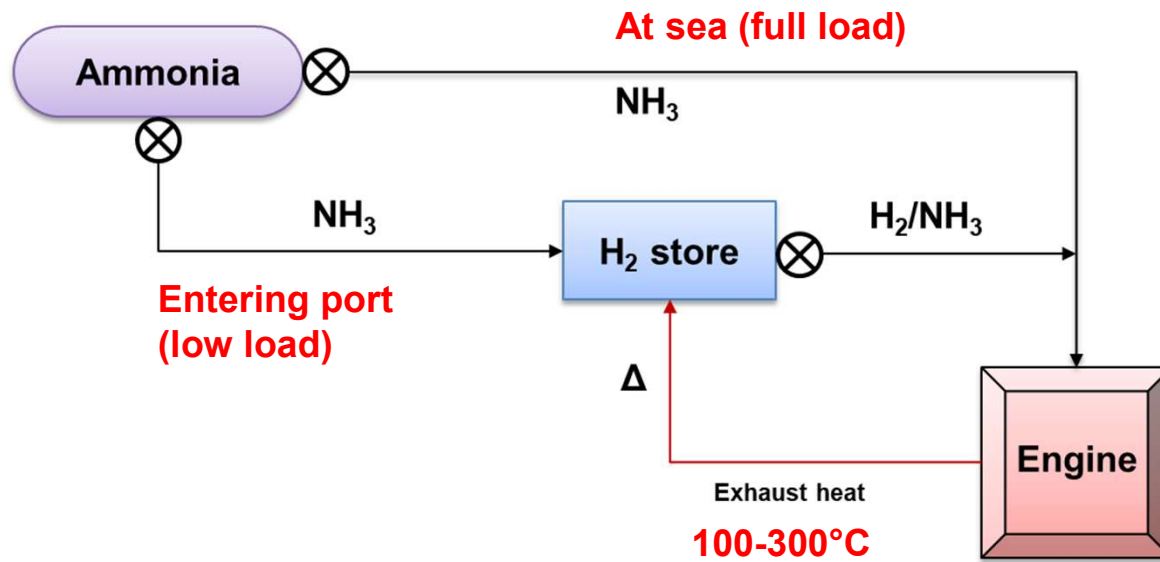
Tank for months at sea using
10,000 tonnes HFO \approx 10,000 m³

4 h operation in port



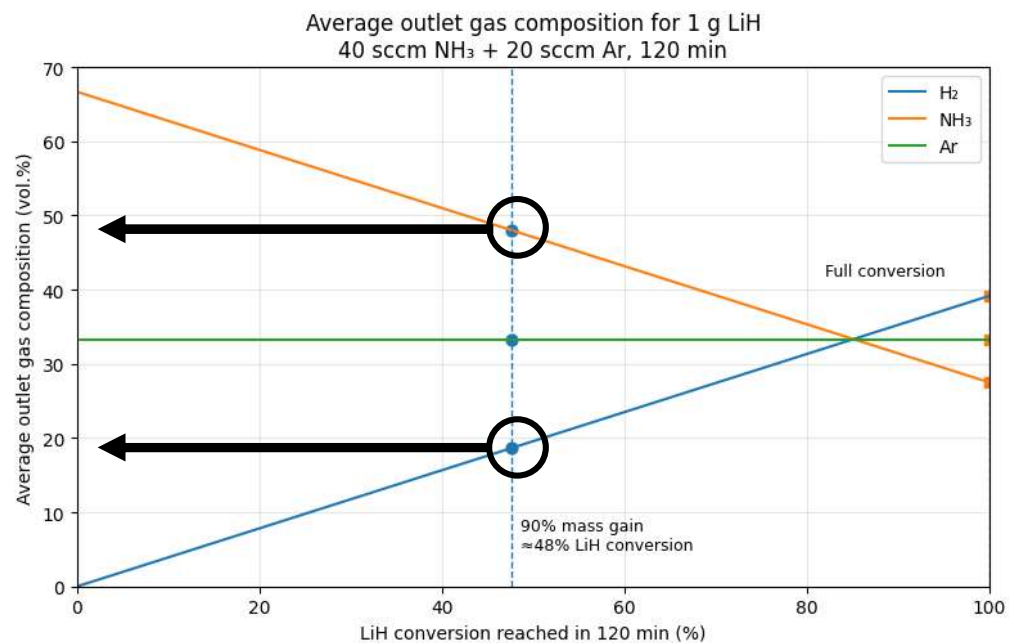
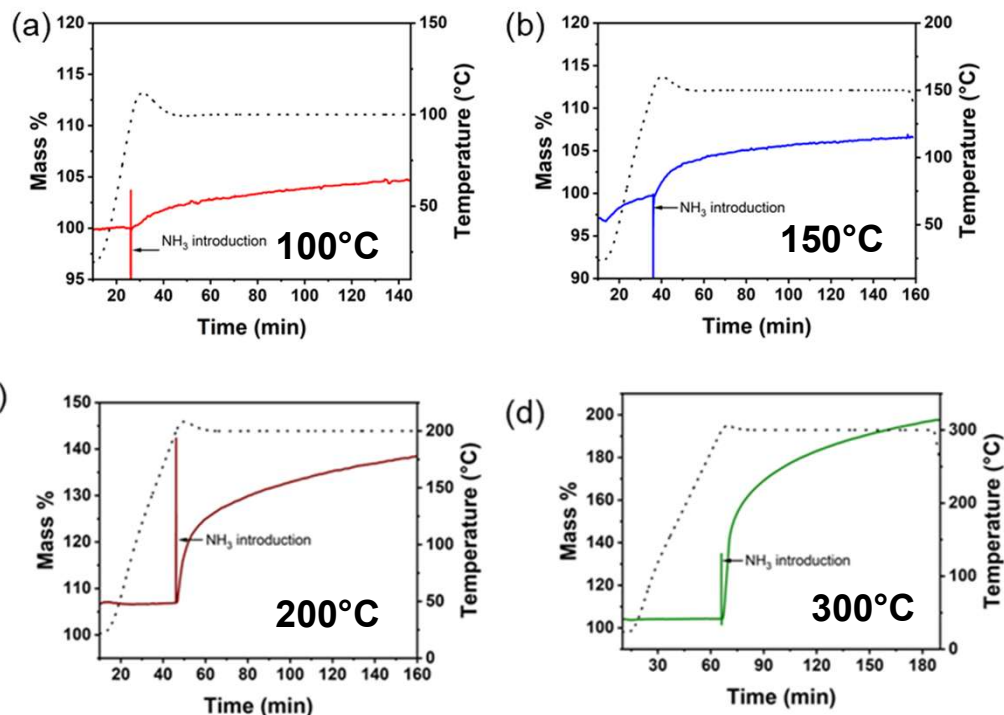
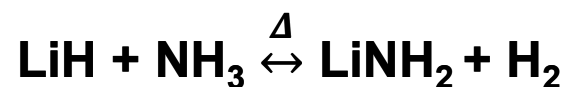
For onboard H₂ supply, LiH-NH₃ is a potential “Just-In-Time” solution

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The highest capacity amongst lightweight hydrides

Ammonia to hydrogen



Up to 90% yield at 300 °C in 2 h under ammonia.

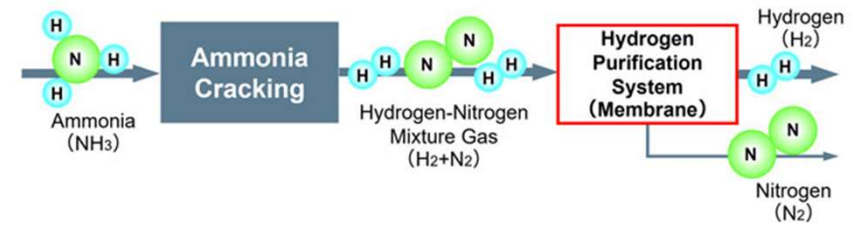
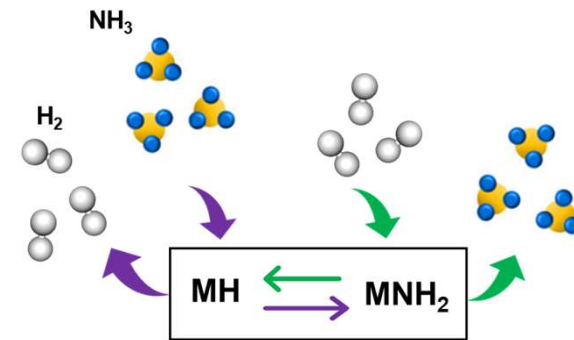
H₂ : NH₃ = 1 : 2.5 [average composition in 2 h at 300°C]

More energy efficient than the cracker?

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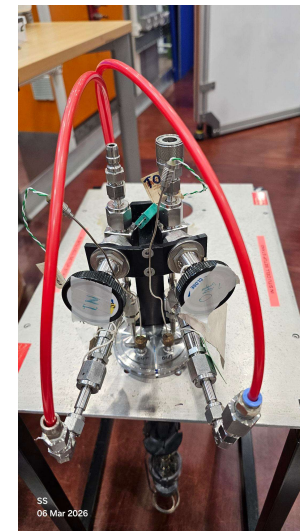
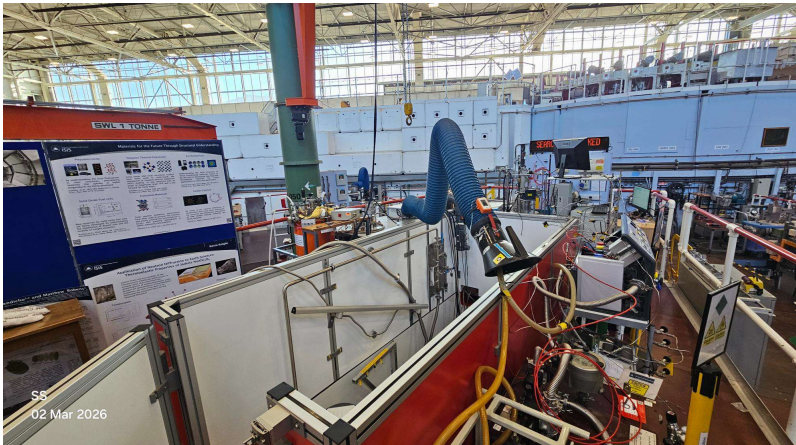
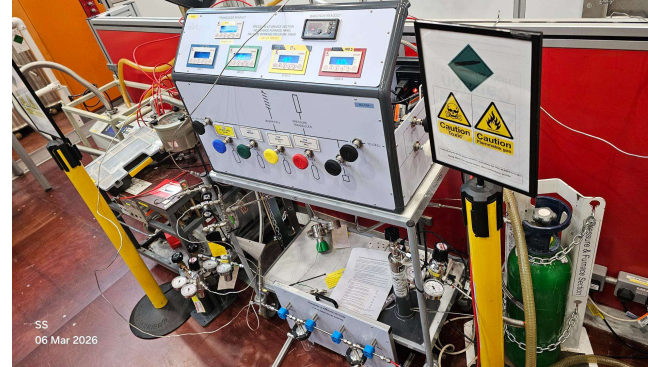
Parameter	LiH-NH ₃	Cracking
Operating temperature	100-300 °C	>600°C
Waste heat utilisation	Ideal for marine engine	May require supplemental heating
Energy for H₂ Prod.	Exothermic	Endothermic
Main product	H ₂	H ₂ + N ₂
Byproducts	No byproduct	N ₂
Space	Compact solid storage	Cracker + separator + gas buffer
Cost	Lower (no precious catalysts)	High



Polaris beamline at ISIS Facility (UK)

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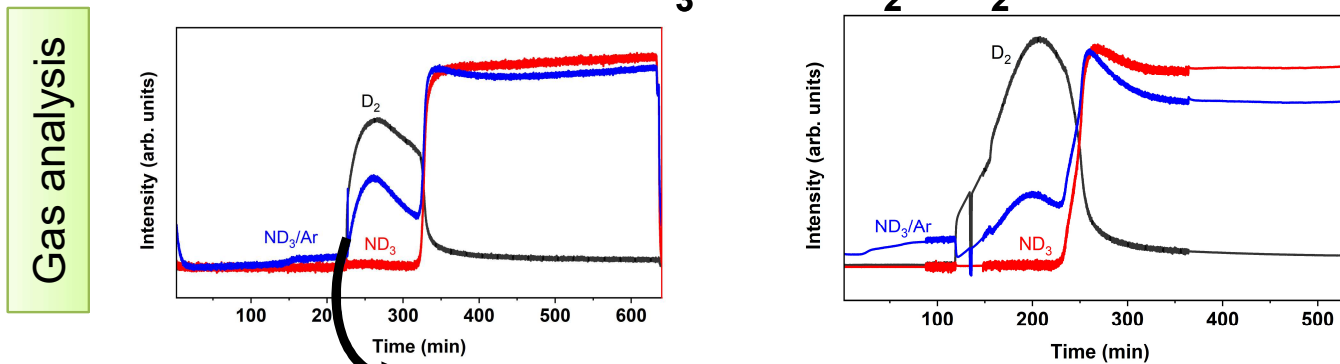
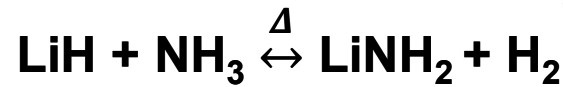
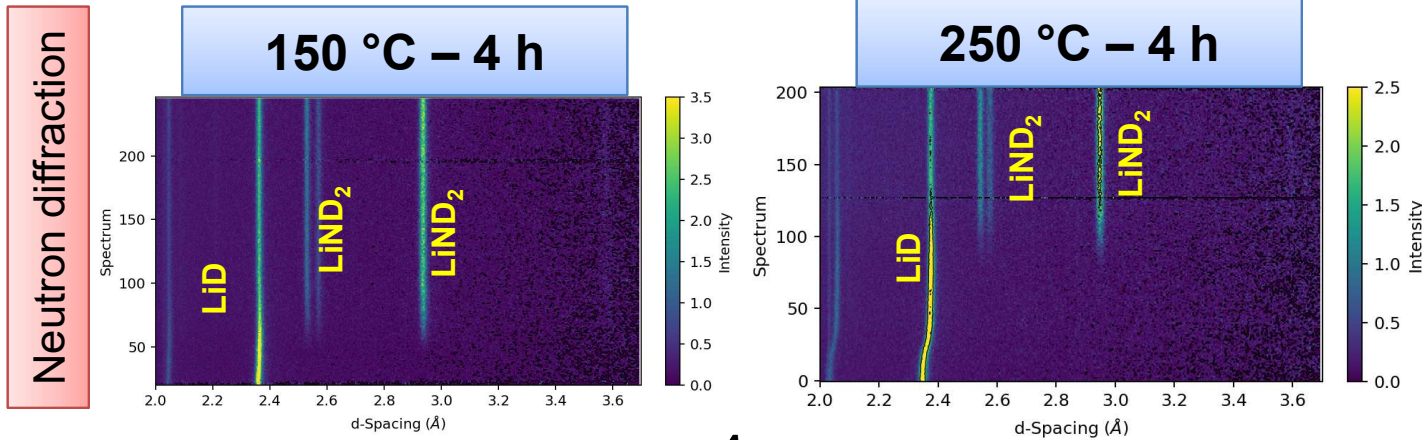
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Structural evolution under ammonia

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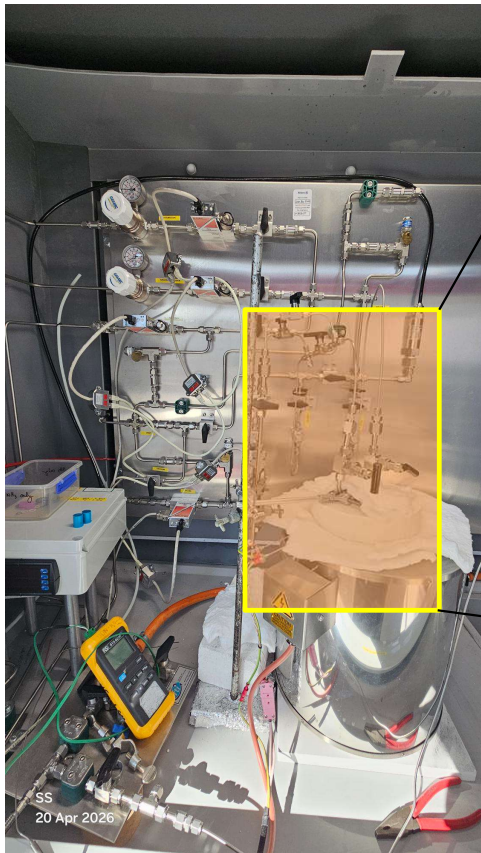


Onset of hydrogen with ammonia

LiH-NH3-H2 regeneration demonstrator

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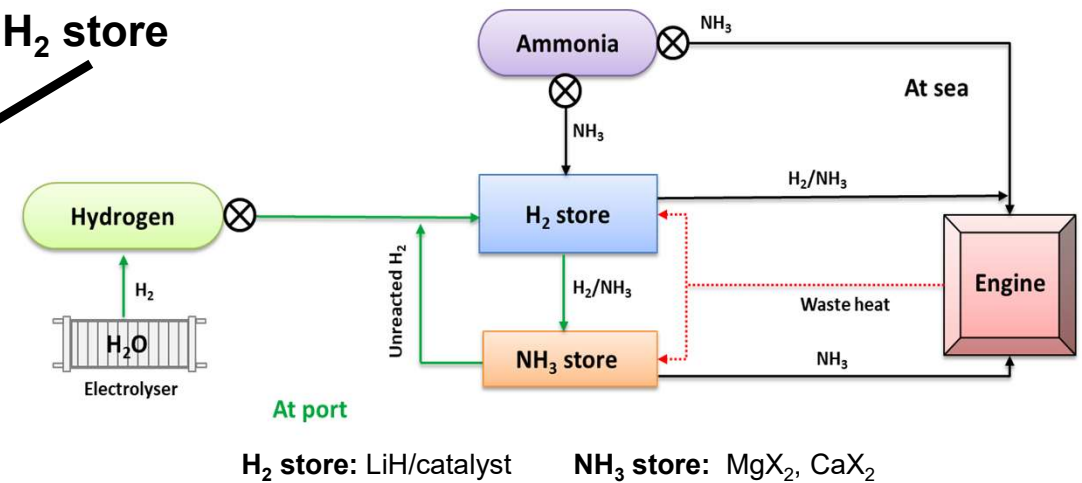
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H₂ store

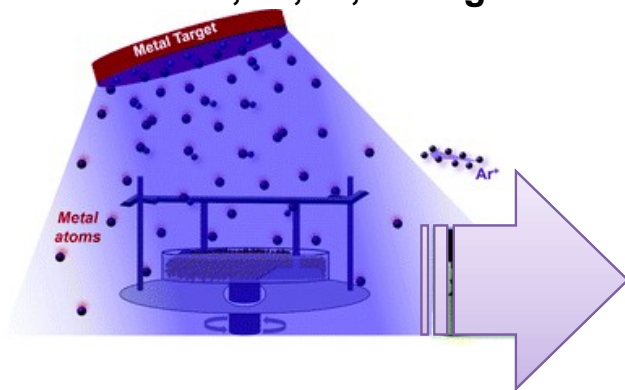
NH₃ store

Demonstrator

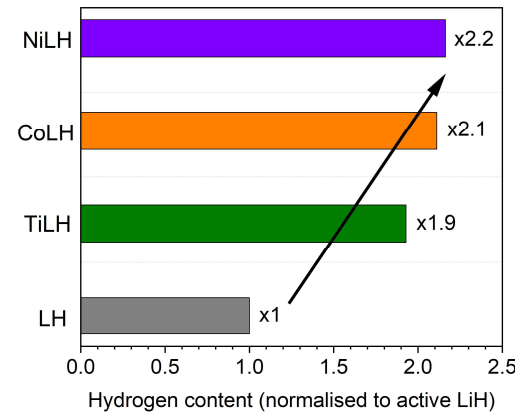


Novel LiH-TM systems for improved hydrogen yield

Co, Cr, Ni, Ti targets.



CoLH 1.5 wt.%
CrLH 1.2 wt.%
NiLH 1.9 wt.%
TiLH 1.2 wt.%



Hydrogen content estimated from integrated area in MS. NH₃/Ar flow for 4 h at 300 °C

Active metal catalysts are needed for faster kinetics and regeneration of spent material back to lithium hydride by reacting it with hydrogen.

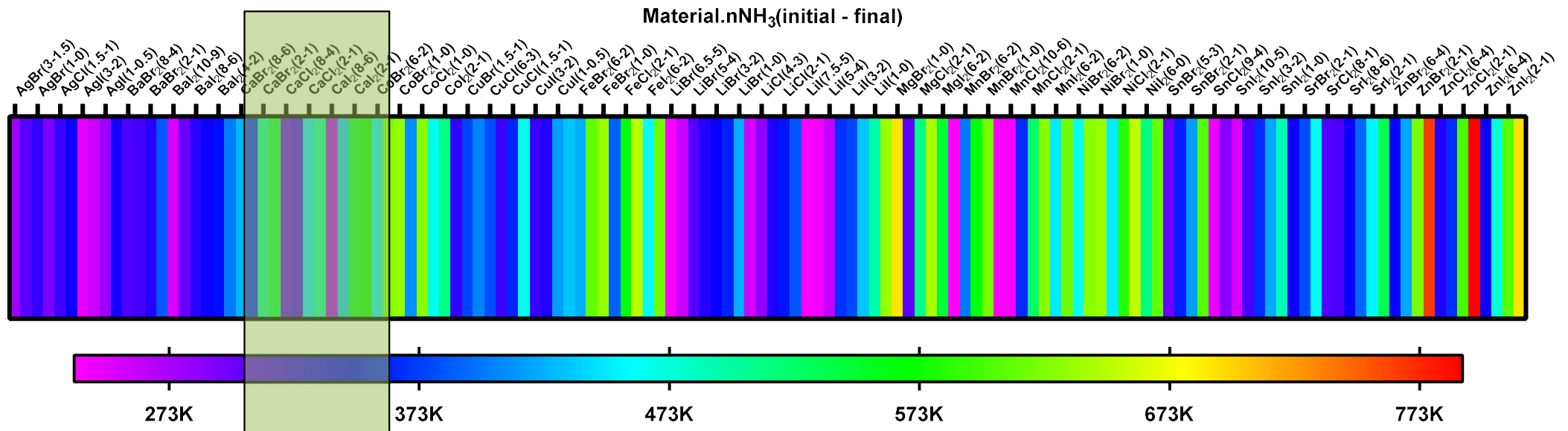
TiLH= 1.2 wt.% Ti

CoLH= 1.5 wt.% Co

NiLH= 1.9 wt.% Ni

- Transition metals showed enhanced hydrogen release under ammonia
- Trend: Ni=Co > Ti > LiH
- The mass gain confirm the enhanced conversion in the presence of catalysts

Potential materials for capturing ammonia during regeneration



Summary

- Hydrogen in ammonia stream onboard helps combustion and lowers NOx.
- Lightweight metal hydrides can utilize engine's waste heat to generate hydrogen near ports.
- LiH/NH₃ with high energy density may be a potential candidate to compete with conventional H₂ storage.
- On-demand hydrogen release with ammonia below 300 °C may compete with existing ammonia cracking technologies
- Regeneration at port (or at sea) requires efficient ammonia storage in absorber such as halides.

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Thank you for listening



The partnership



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