

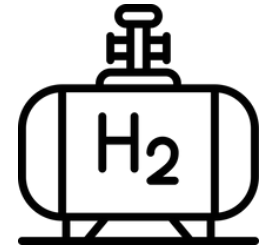
#H2OffThePress

Ammonia cracking

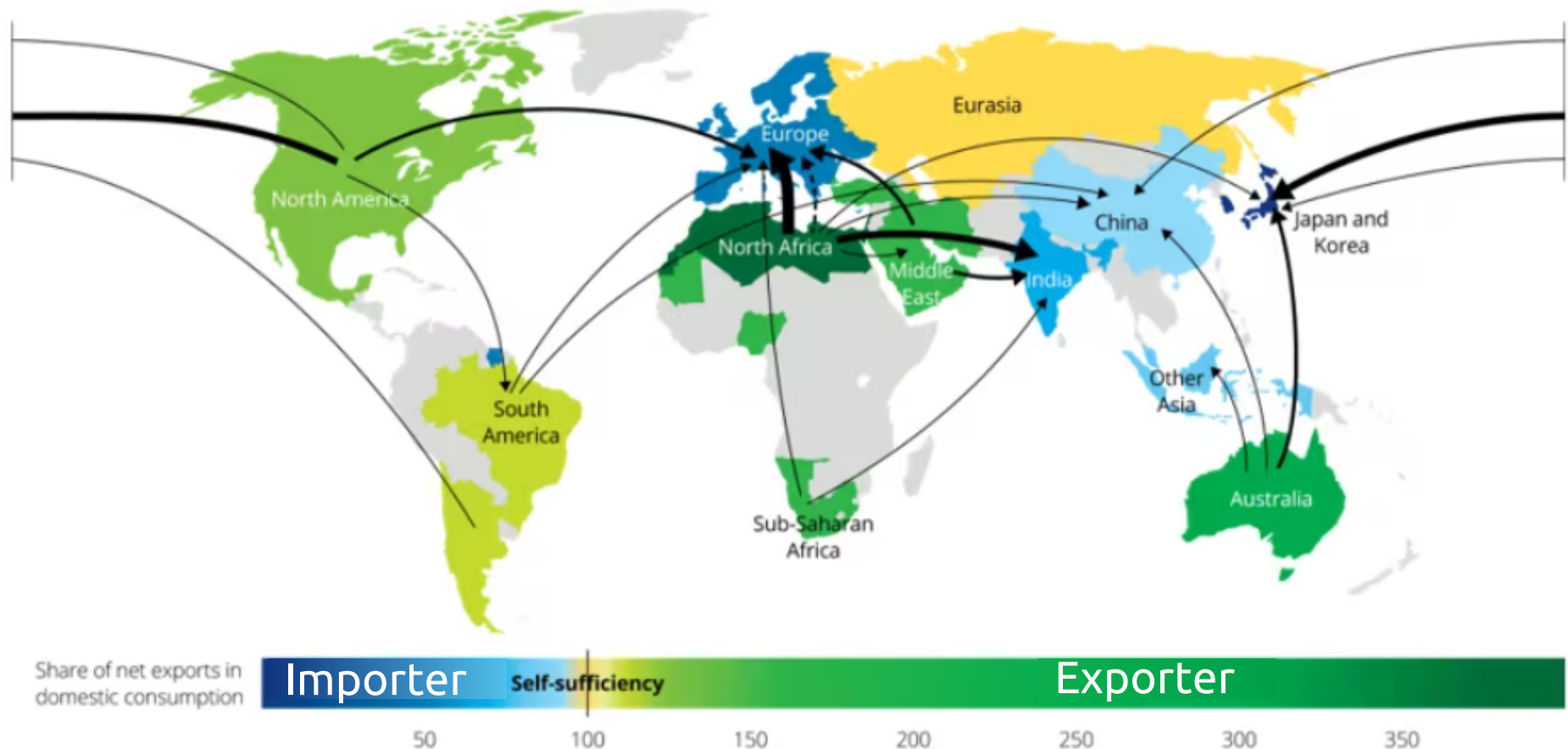
A gamechanger to satiate
hydrogen import demands



There is a growing need to find the best approach for hydrogen transportation

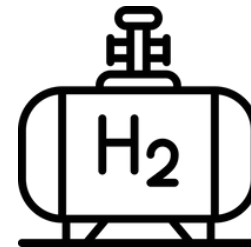


→ Ensuring a global competitive hydrogen market implies connecting the **production hubs** (low-carbon energy resources) with **demand centers** (industrial hubs)



Hence the need to transport hydrogen
How can hydrogen be transported?

There are five methods of transporting hydrogen



Ammonia (and Cracking)
Hydrogen (H_2) combines with Nitrogen (N_2) to form ammonia (NH_3). Ammonia can be “**cracked**” back to H_2

LOHC

Liquid Organic Hydrogen Carrier (LOHC) absorbs and releases H_2 through a chemical reaction

Liquefaction

H_2 is liquified at $-252.9\text{ }^{\circ}\text{C}$ into a liquid for transportation

Compression

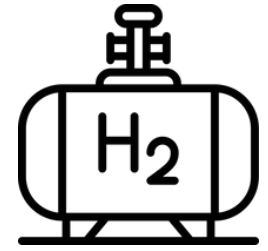
Compressing H_2 to 350 or 700 bar in tube trailers

Pipeline

Gaseous H_2 can be transported via pipelines

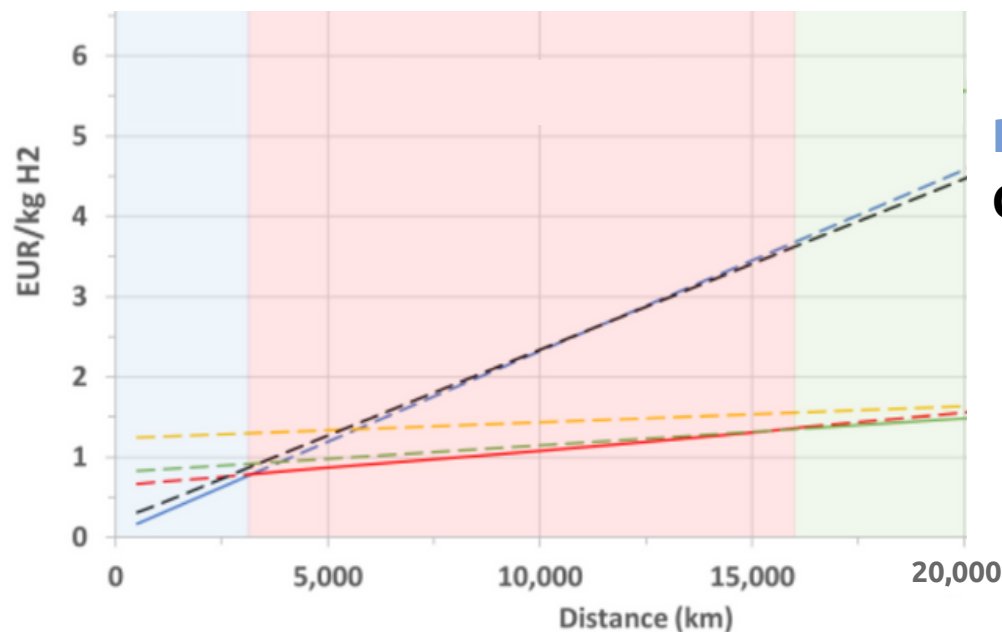


Ammonia, the natural candidate for long distance H₂ transport



Considering the constraints with transporting H₂ and the cost over long distances, using **ammonia as a carrier and then cracking it back to H₂** serves as a promising option to make H₂ a global commodity

H₂ delivery costs depending on the transport distance



Pipeline
Compression

Ammonia, LOHC and
Liquefaction
*Preferred carriers for
long distances*

Other advantages of ammonia for long distance H₂ transport



Existing global commodity with 120+ ports with ammonia terminals

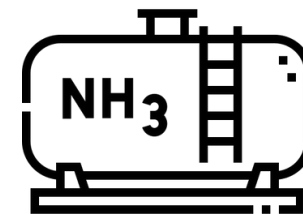


Ammonia has multiple uses such as green fertilisers and precursor to multiple industries

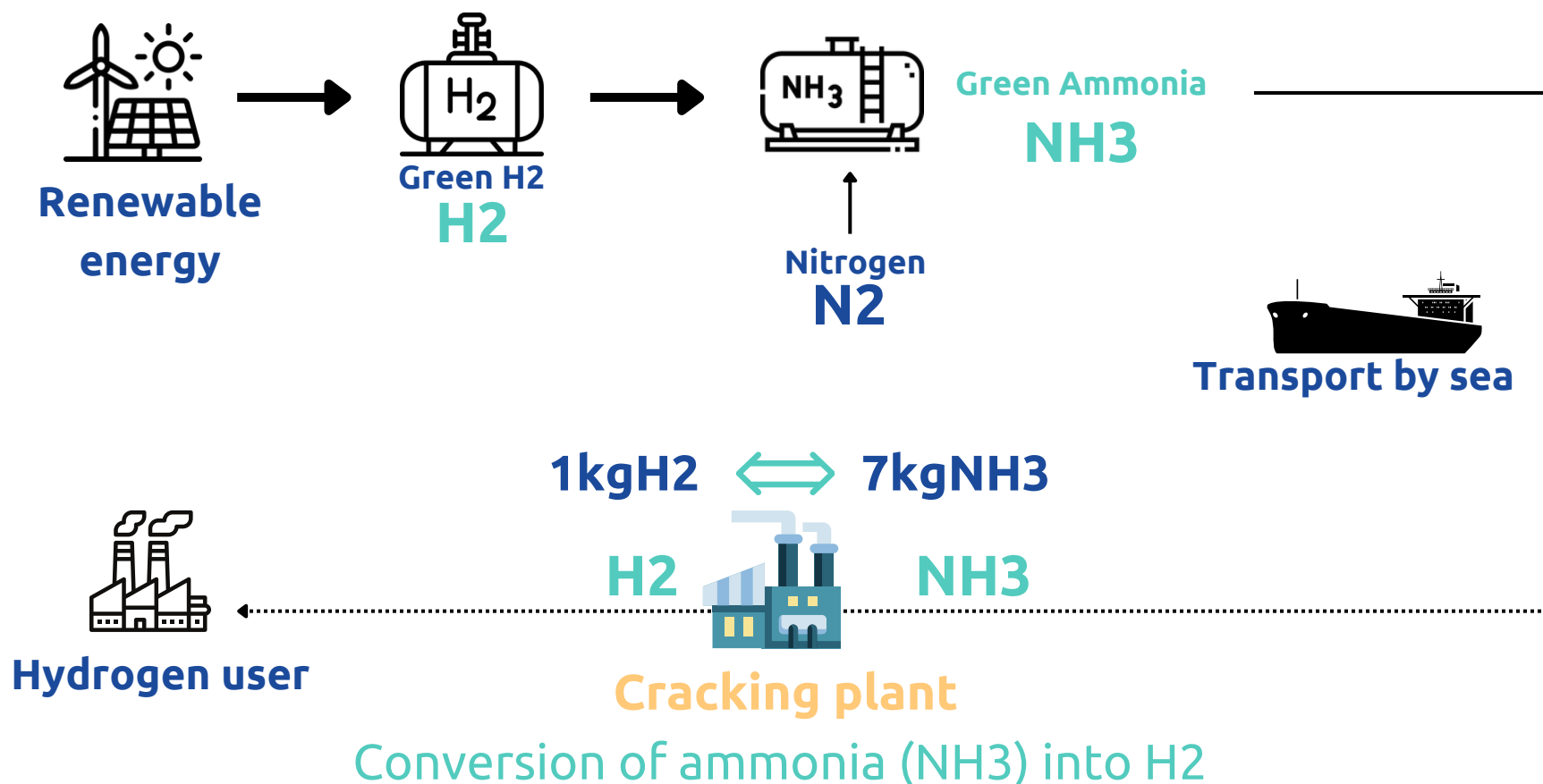


Ammonia can be used as a marine fuel, decarbonizing the shipping industry

What is cracking and when is it used?



Ammonia cracking is a process for converting ammonia back to hydrogen at scale

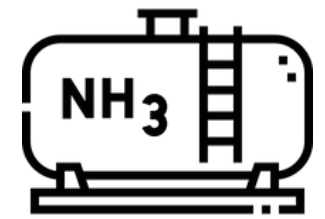


Up to 80% efficiency

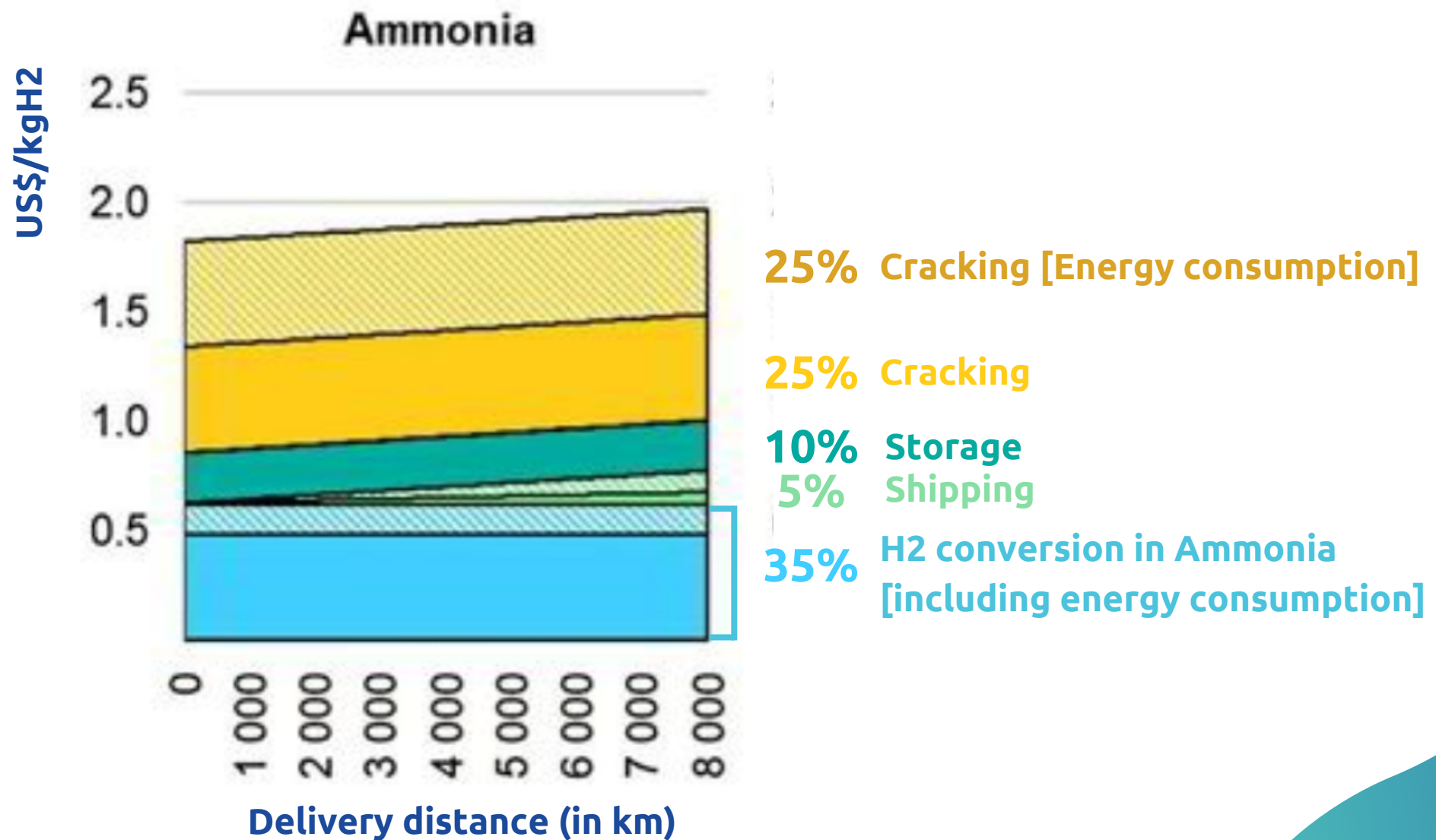
No CO₂ emissions
Green ammonia used at heat source

99.9% molH₂
50 barg H₂
output

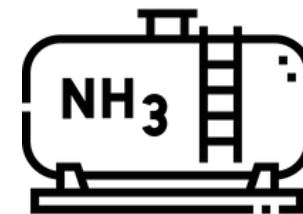
How much does cracking cost?



→ Market data show a delivery cost for the ammonia & cracking solution of
~US\$ 2/kgH₂



How mature is the technology?



→ Market announcements reveal a **good momentum** for the technology

ACE Terminal, in Rotterdam, emerges as the hottest hub in Europe



Cracking capacity 1 mn tons of H₂/yr
Status Feasibility Study conducted (May 2023)

Other top-tier players have announced to be working on the technology



→ Industrial-scale cracking is expected to become **operational by**
2028

References

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Deloitte, 2023 Green hydrogen: Energizing the path to net zero

S Giddey et.al, 2017 Ammonia as a Renewable Energy Transportation Media