WHEN TRUST MATTERS

Future Fuels for Shipping

The Swedish Club Webinar

2 December 2025

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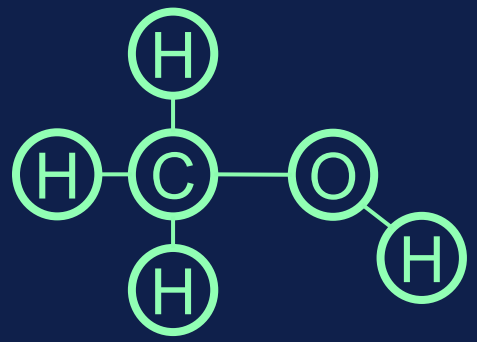
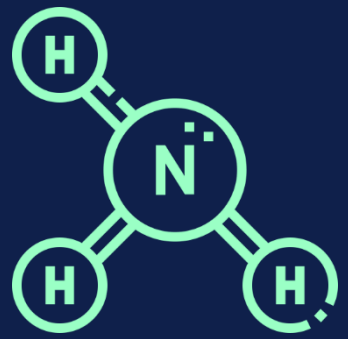
LNG



Methanol



Ammonia

Biodiesels

+ 65%

Passenger vehicles

+ 130%

Flights

+ 30%

Cargo tonne-miles

Decarbonization: Threat? Opportunity?

DNV

Decarbonization solutions and pahtways

Low-carbon & Carbon-neutral fuels
High uptake in NBs, availability and price are the main challenges.

Biofuels
Most popular short- and mid-term solution, reasonable price premium, challenge is availability of sustainable biomass.

Energy Efficiency
Large experience, many new developments, great enabler of new fuels.

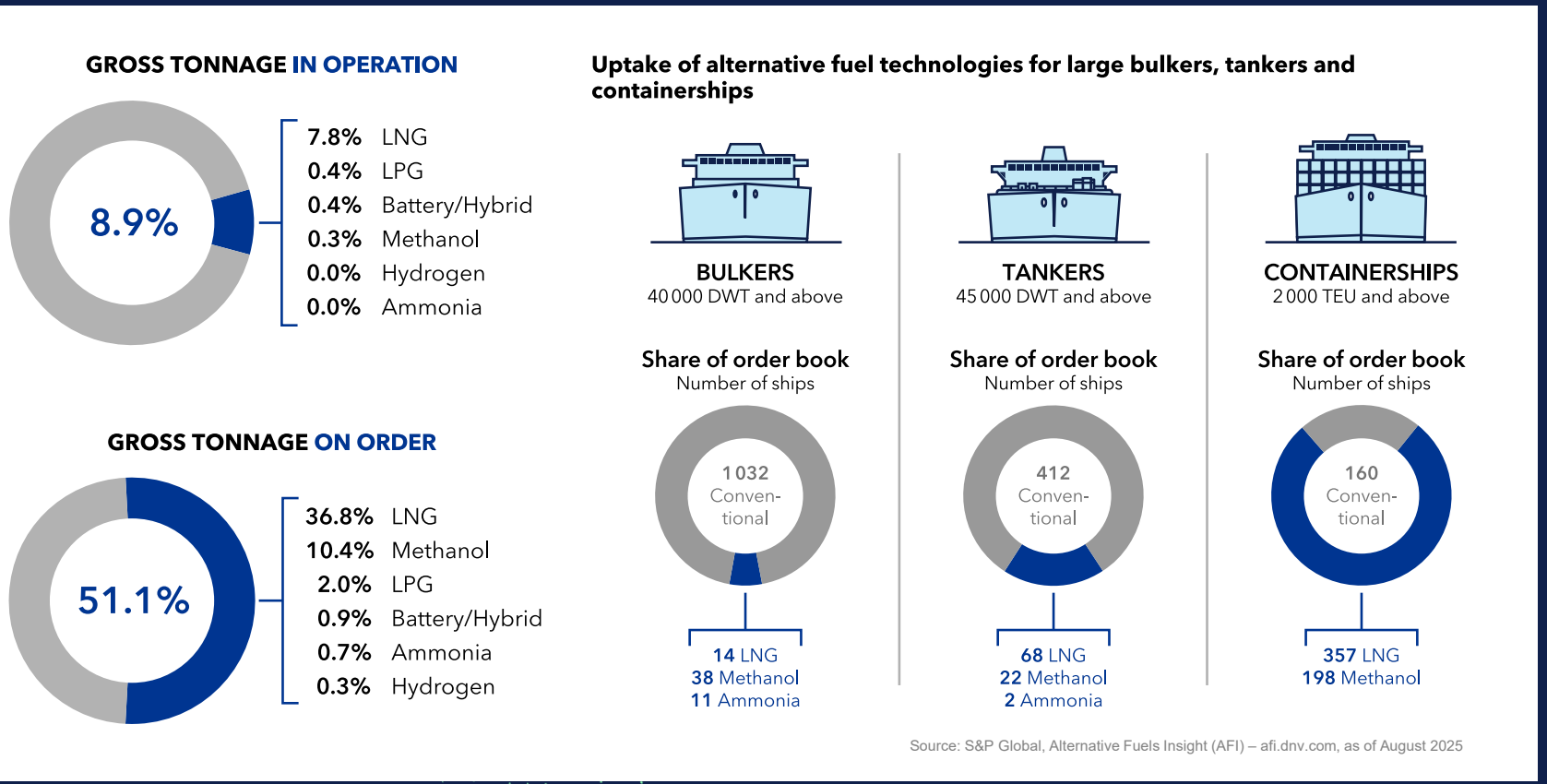
Fuel Cells
Already used in short-sea shipping. Challenging to scale up for oceangoing vessels but promising for auxiliary power.

Onboard Carbon Capture
Promising technology. Lack of maturity, regulatory framework and infrastructure.

Nuclear
Carbon-neutral energy. Challenges on various aspects; technical, regulatory, societal acceptance.

Three-quarters of the order book for container vessels above 2000 TEU have dual-fuel capability

- **Alternative-fuel capable ships set to almost double by 2028**
- **33,000 seafarers require training for alternative fuels over next 3-4 years**

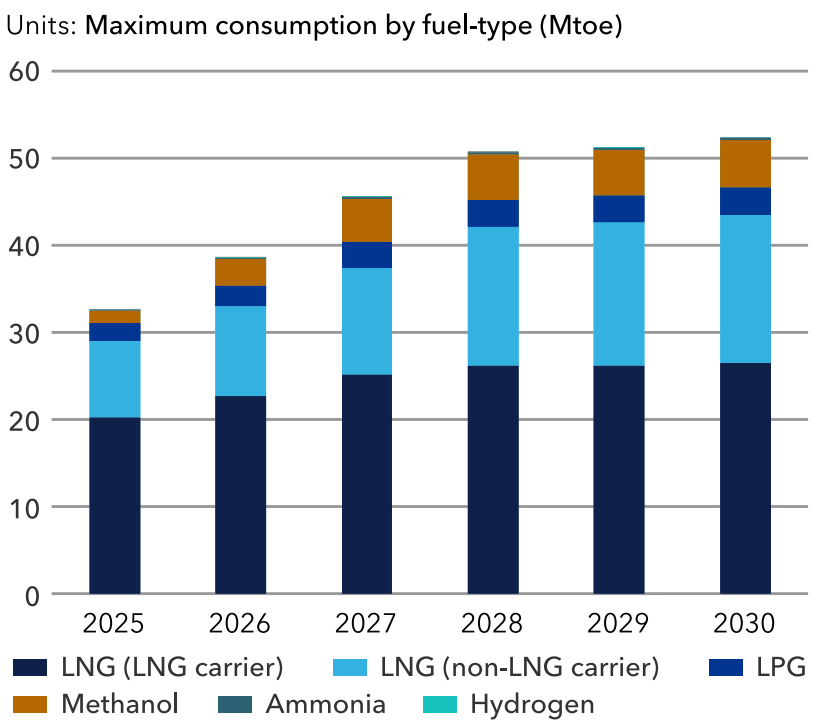


The world fleet can consume up to 50 Mtoe of non-oil fuels by 2030, dominated by LNG

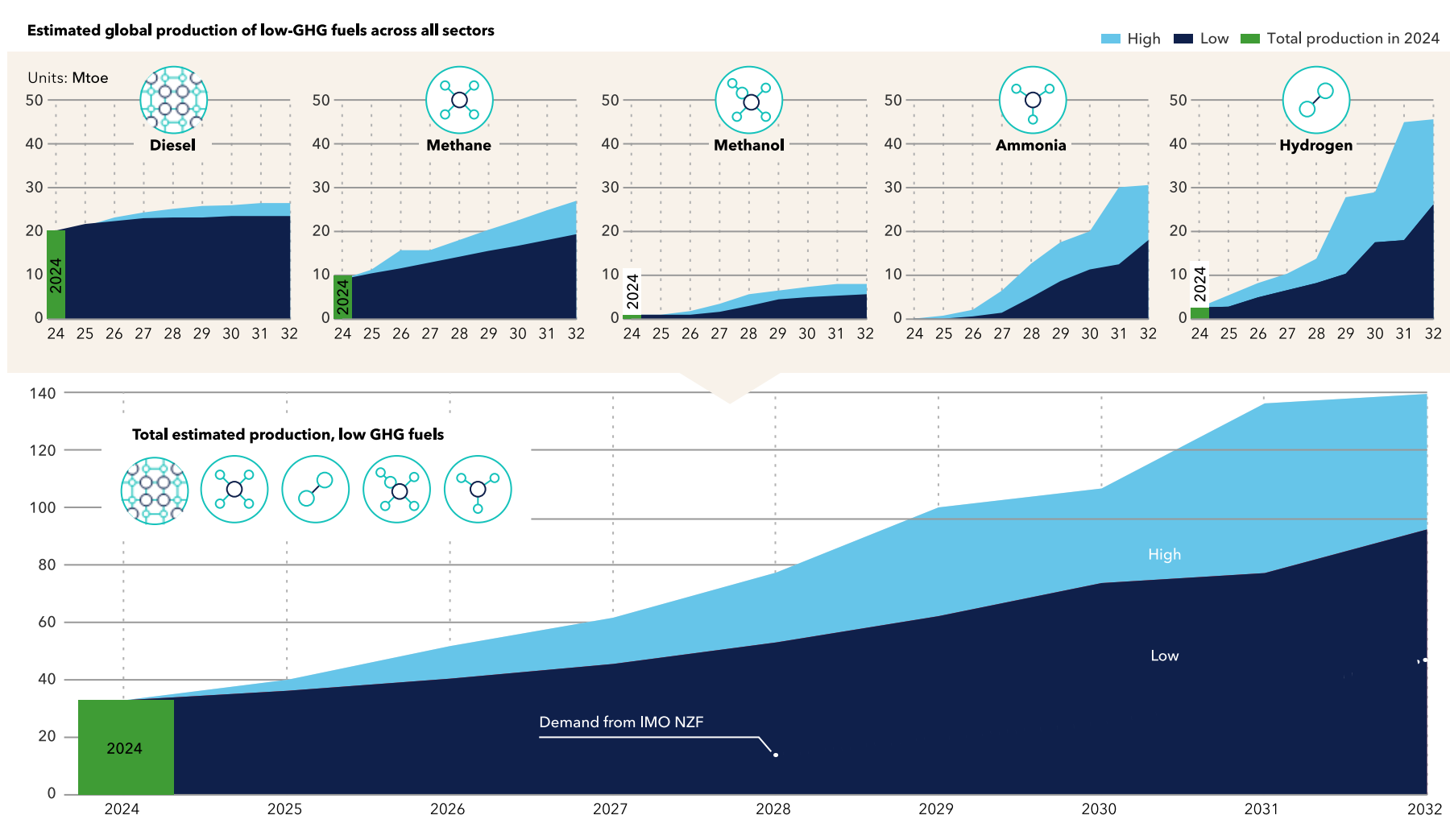
In 2030, sailing fleet with today's order book could potentially consume:

- **44 Mtoe LNG – 44/280 % of world fleet**
- **6 Mtoe methanol**
- **3 Mtoe LPG**
- **0.2 Mtoe ammonia**
- **0.04 Mtoe hydrogen**

Maximum consumption of LNG, LPG, methanol, ammonia and hydrogen for the world fleet and vessels in the order book. Powered by AFI – afi.dnv.com



Fuel production facing headwinds – IMO 2030 requires up to one third of global low-GHG fuel supply of 70-100 Mtoe



1 Biodiesels

2 LNG

3 Methanol

4 Ammonia

5 Hydrogen

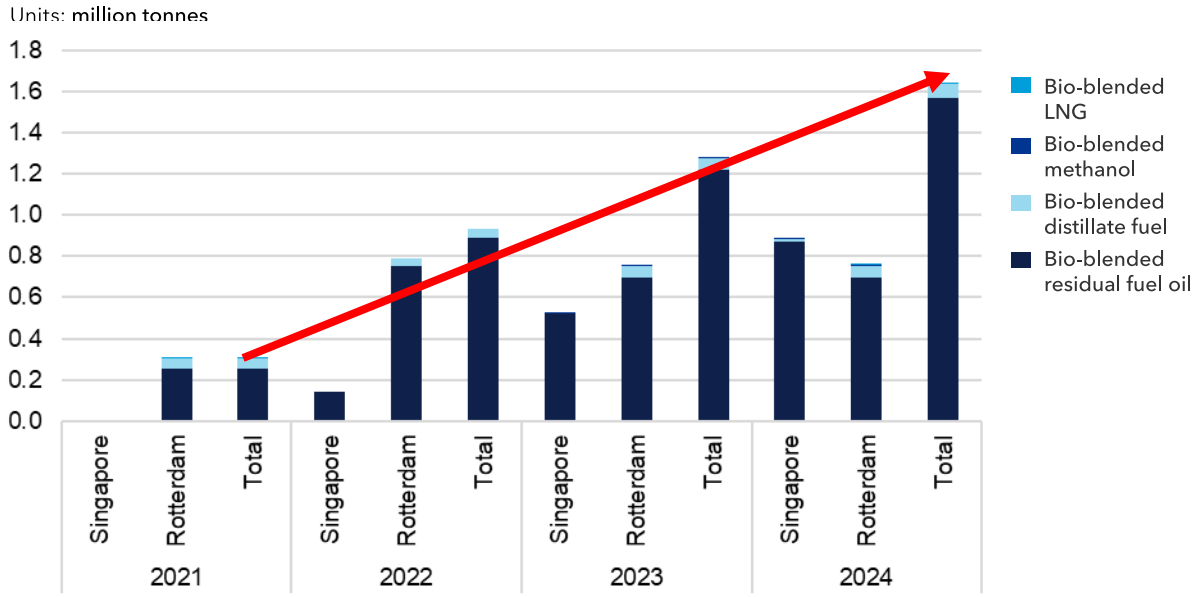
Biofuels – the quick fix

Enablers	Challenges
▪ Easier operation ▪ No/minimal retorfits required ▪ Same engines	▪ Cost ▪ Availability (especially based on sustainable biomass ▪ Operational issues

Engines readiness	• The use of biodiesel (FAME and HVO – both as blends and pure products – generally proceed without any problems
Green Credentials	• Biodiesels can significantly improve GHG compliance • The benefits depend on the certified GHG savings of the biodiesel • Sustainability and GHG saving criteria under IMO NZF still uncertain

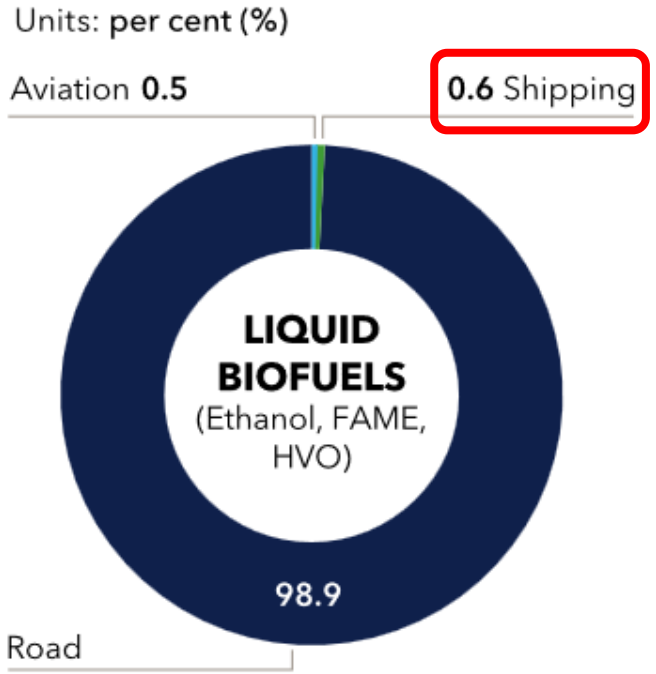
Bio-blended bunker market is increasing

Bio-blended bunker sales in Singapore and Rotterdam (2021-2024*)



Sources: MPA Singapore (2025). MPA Singapore. Retrieved from Maritime Performance: https://www.mpa.gov.sg/who-we-are/newsroom-resources/research-and-statistics; Port of Rotterdam (2025). Port of Rotterdam. Retrieved from BUNKER SALES PORT OF ROTTERDAM 2021–2024: https://www.portofrotterdam.com/sites/default/files/2024-10/bunkersales-2021-2024.pdf

End-use of biofuels by sector (2023)

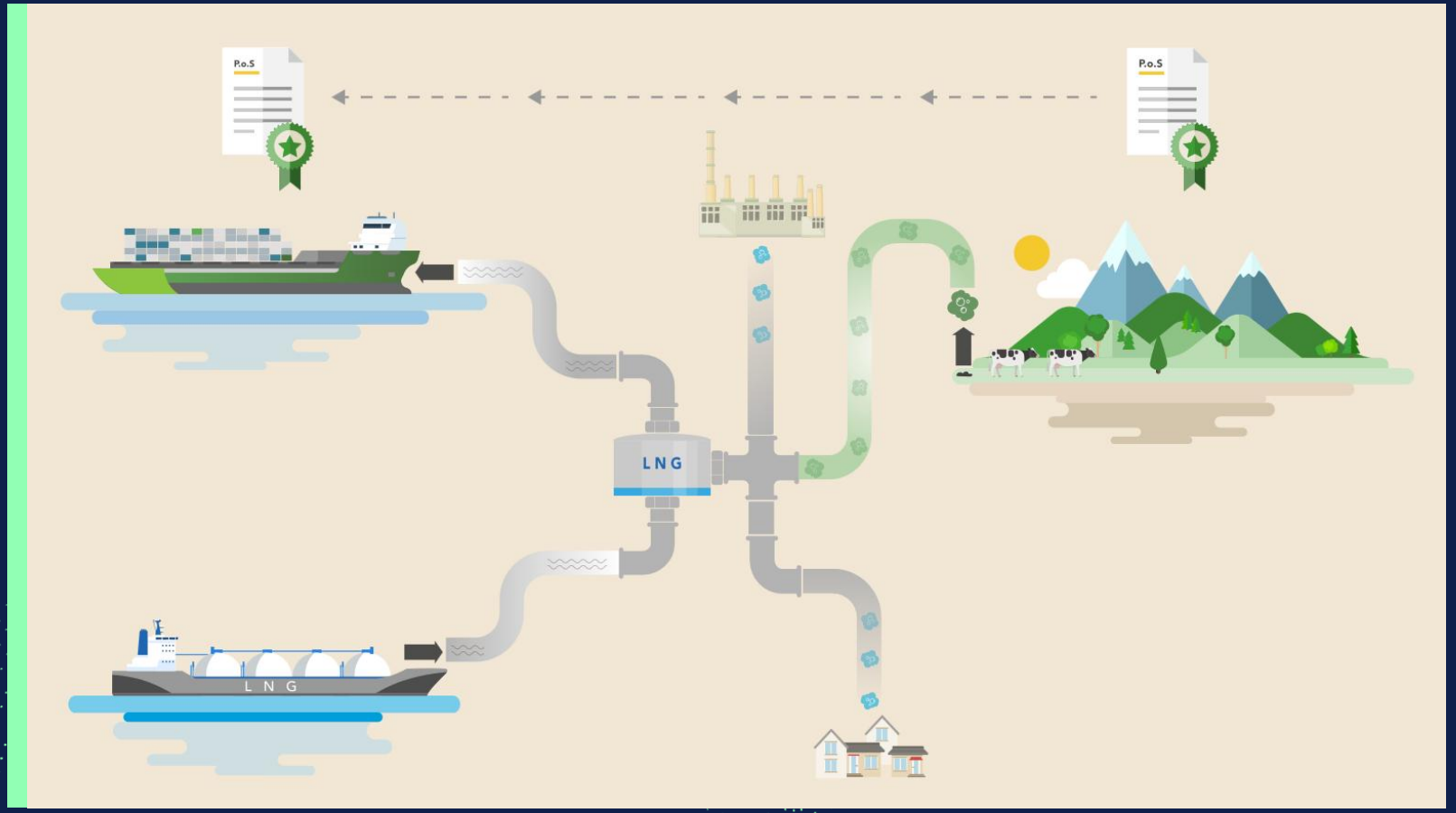


Biofuel bunkering operations have taken place in more than 60 different ports since 2015

Flexible chains of custody can accelerate uptake of bio-methane and other low-GHG fuels in shipping

Flexible chains of custody:

- **Increases availability** by reusing existing infrastructure
- **Reduces cost**, energy, and emissions
- **Incentivizes production** of low-GHG fuels



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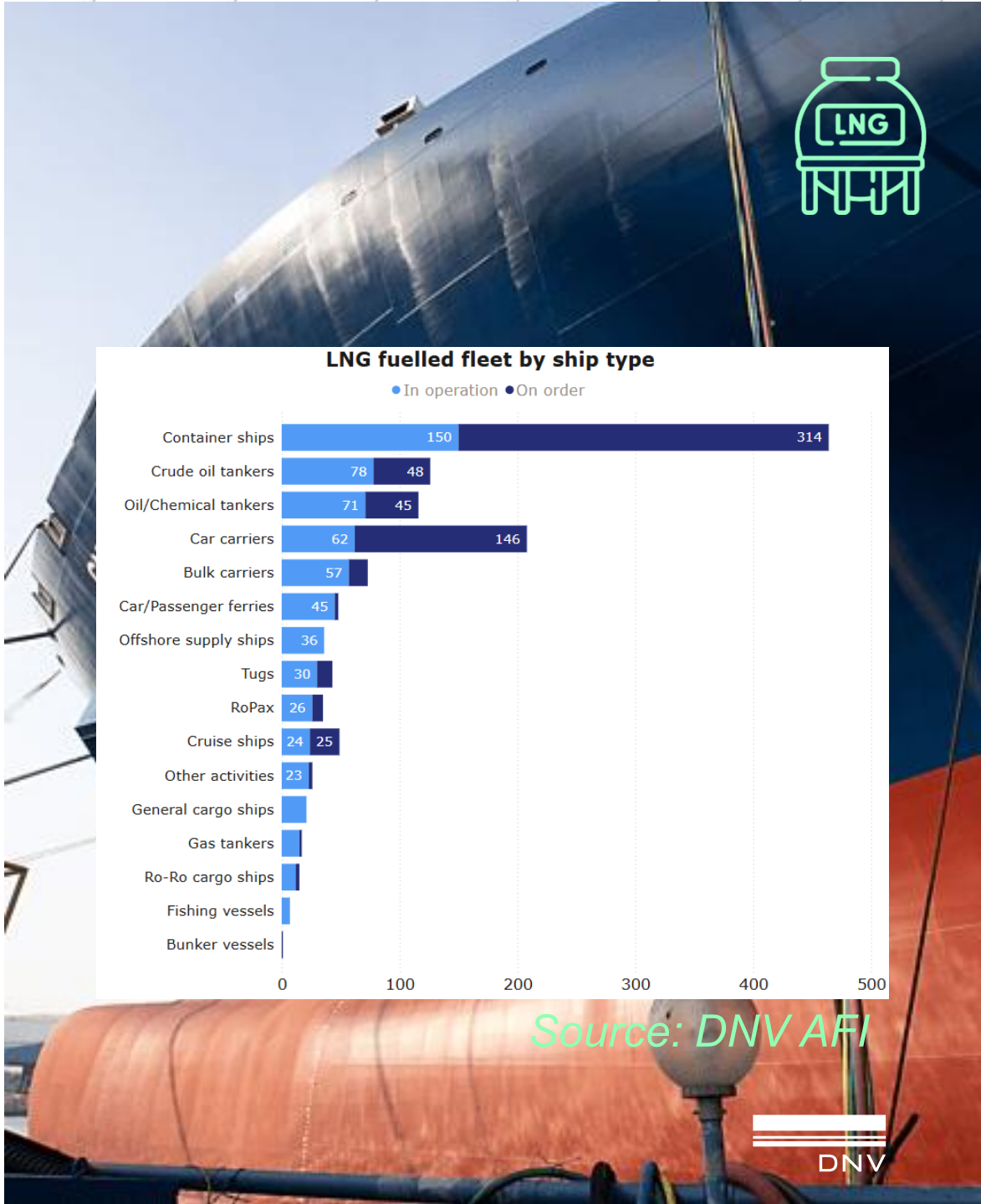
LNG – leads the way

Enablers	Challenges
▪ Mature technology and industry experience ▪ Wide infrastructure and availability ▪ Can receive benefit even from today ▪ Allows for BioMethane pathway	▪ Cost and complexity ▪ Fossil-based LNG does not provide long-term compliance ▪ Methane slip (makers focus on reduction)

Engines readiness	• Engines are available and in operation • Methane slip can pose a challenge
Green Credentials	• Reduction in well-to-wake GHG up to 23% • Bio-LNG can further reduce the well-to-wake GHG by at least 70% (depending on production pathway) • Methane slip from engine will impact WtW



LNG bunkering infrastructure is being developed to supply the growing fleet

In operation

Decided / under discussion

Note: In the above maps, we only include dedicated bunkering infrastructure (bunker vessels and tank-to-ship)

Source: Alternative Fuels Insight (AFI) - afi.dnv.com, as of September 2025

LNG-capable tankers and bulk carriers are trading globally

1 Biodiesels

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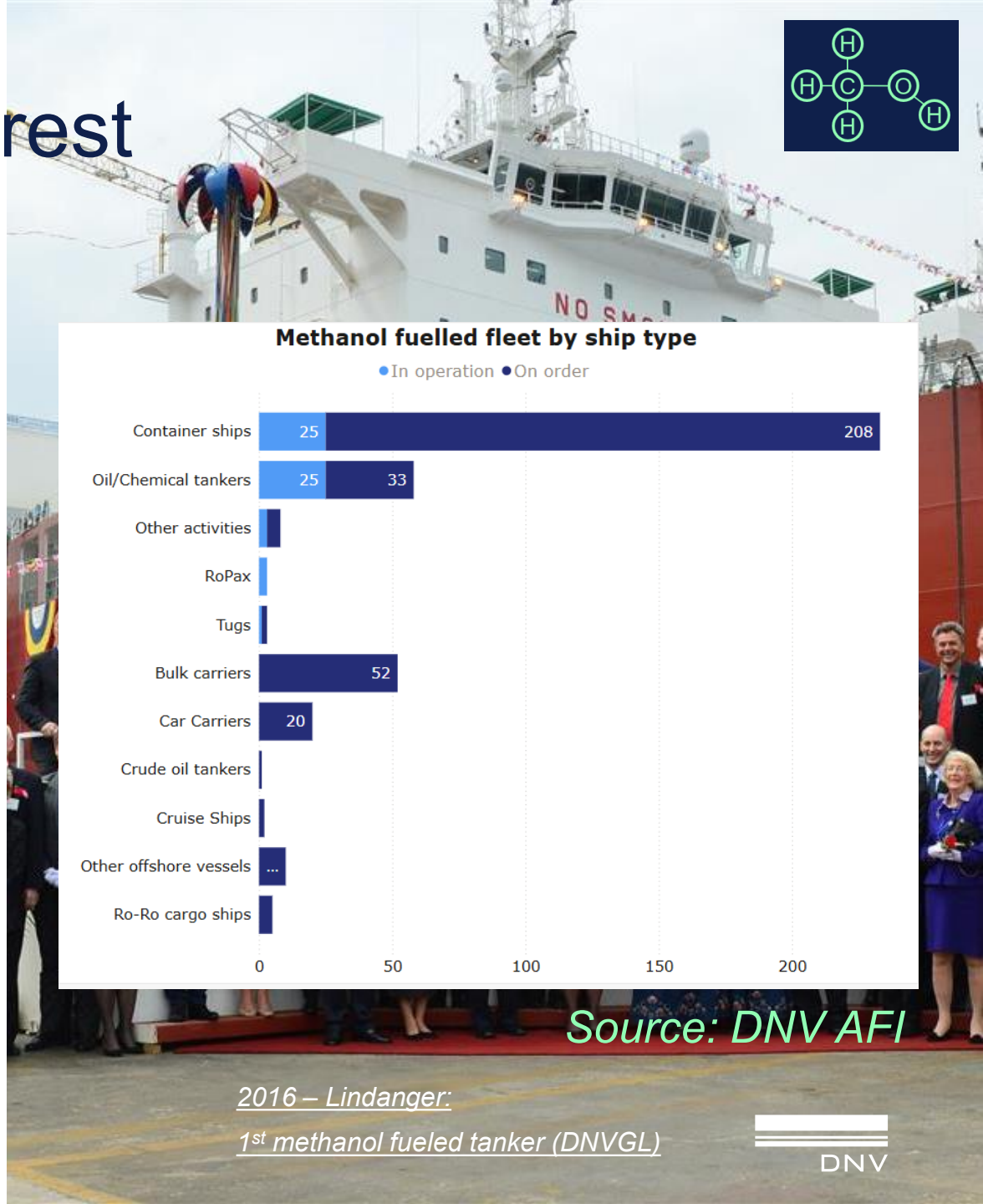
Methanol – Keeps getting interest

Enablers	Challenges
▪ Mature technology and industry experience ▪ Easier and less expensive than LNG ▪ Safer for environment in case of leakage ▪ Lower cost demand for infrastructure development	▪ Green methanol availability (hard on spot market) ▪ Maritime bunkering infrastructure is not well developed ▪ Lower energy density than HFO (2-2.5x) ▪ High FuelEx

Engines readiness	• Several sizes available and in operation • Limited crew training requirements
Green Credentials	• Fossil Methanol is worse than MGO in terms of WTW GHG emissions. • Green Methanol (e-/bio) can provide compliance to 2050 • 8-9% improved EEDI compared to Fuel oil



Source: DNV AFI

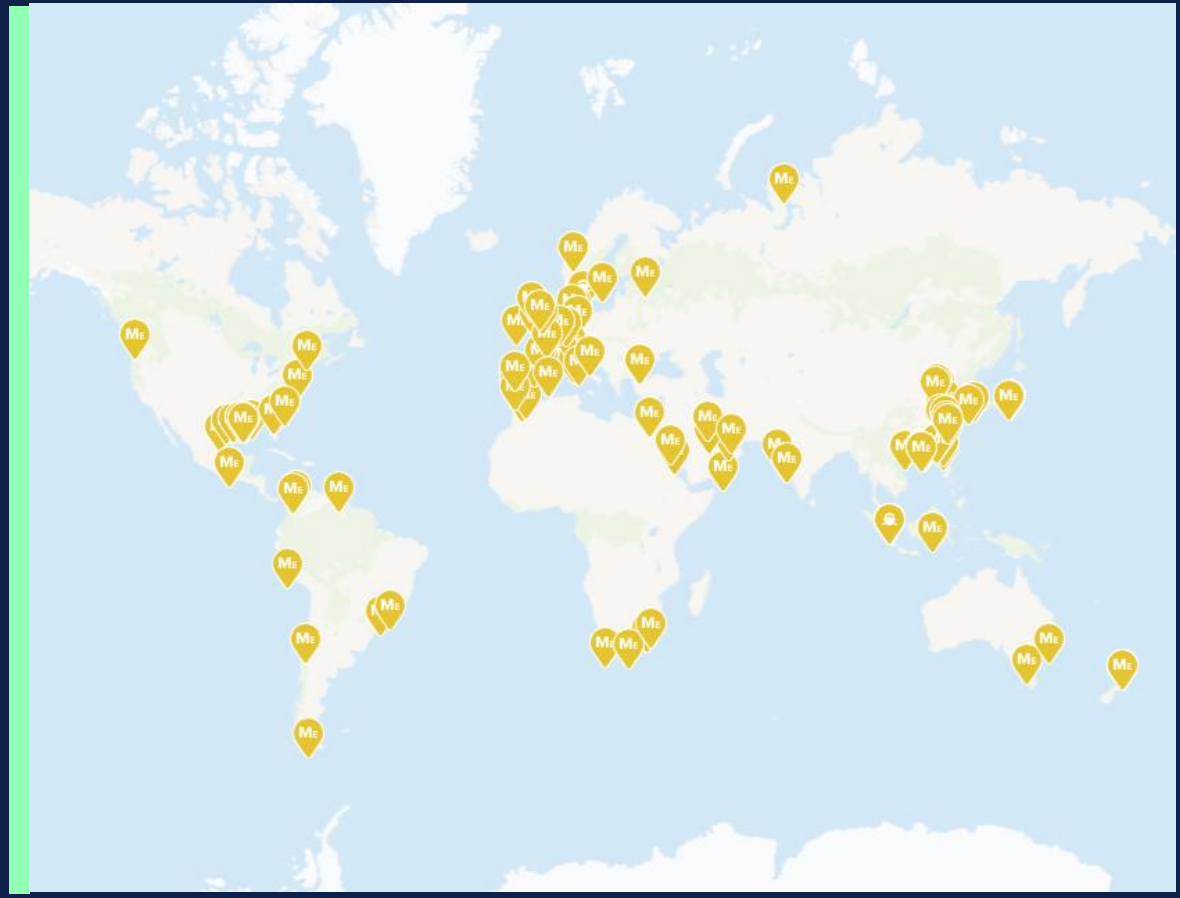
2016 – Lindanger:

1st methanol fueled tanker (DNVGL)

Methanol bunkering infrastructure is being developed to supply the growing fleet

Dedicated bunkering infrastructure

All methanol terminal infrastructure



Source: Alternative Fuels Insight (AFI) - afi.dnv.com, as of September 2025

Methanol-capable tankers and bulk carriers (mostly methanol tankers) are trading globally

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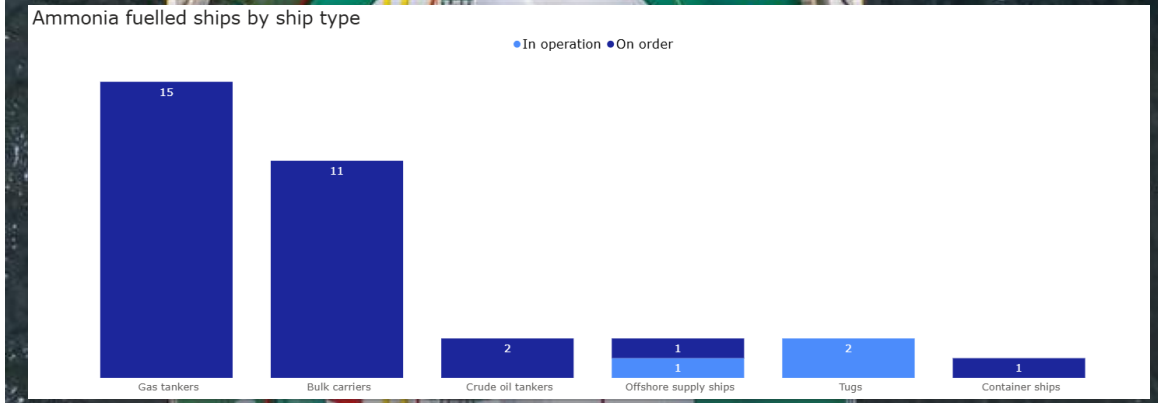
Ammonia – getting ready

Enablers	Challenges
▪ Zero carbon fuel ▪ Large producers focus on ammonia – Will be available for land usage ▪ Good energy carrier (for Hydrogen)	▪ Toxic and corrosive (unmanned ER, double piping) ▪ Lower density => ~3-4 x conv. fuel tanks ▪ N2O, potent GHG ▪ Crew training for ammonia

Engines readiness	• 2 stroke Engines are developed and tested • 1st engine in 2026 (‘26-’30 test period)
Green Credentials	• NH3 does not contain carbon – hence is a zero-carbon fuel TtW • Grey Ammonia is worse than MGO WtW • N2O slip – a possible challenge

- ✓ First orders placed early 2024
- ✓ 1st engine in 2026 (‘26-’30 testing period)
- ✓ **IMO Interim Guidelines approved in CCC10**



Source: DNV AFI

Ammonia bunkering infrastructure is being developed to supply the growing fleet

Dedicated bunkering infrastructure

All ammonia terminal infrastructure

Source: Alternative Fuels Insight (AFI) - afi.dnv.com, as of September 2025

Only three ammonia-capable vessels are in operation (1 offshore vessels and 2 tugs)

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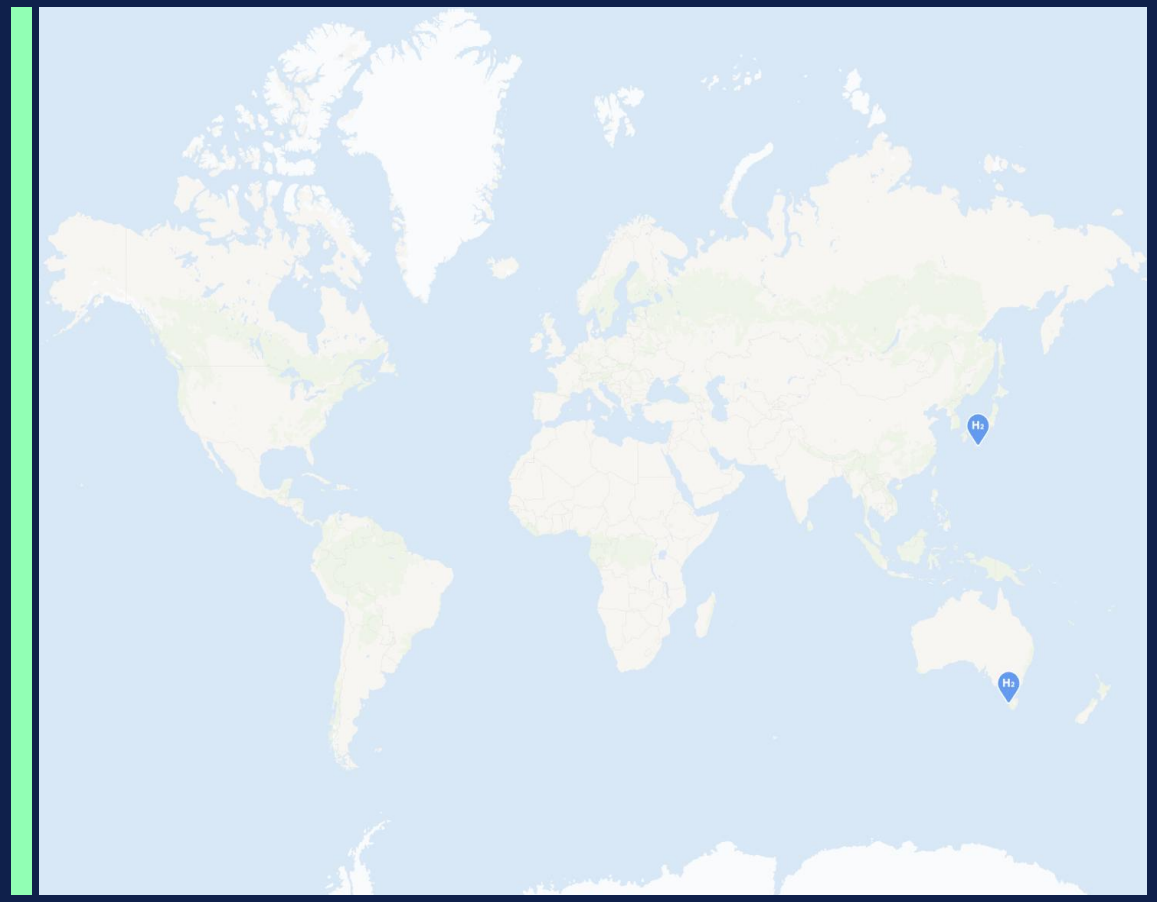
Hydrogen – the long term fuel

Enablers	Challenges
▪ Zero Carbon ▪ Land-based infrastructure	▪ Cost ▪ Fuel availability ▪ Readiness of fuel technologies ▪ Safety and immature safety regulations (flammability and low boiling point)

Engines readiness	• Mainly smaller engines for ferries, tugs, crew, etc. • Internal combustion engines or Fuel Cells.
Green Credentials	• H2 does not contain carbon • Grey Hydrogen is worse than MGO WtW

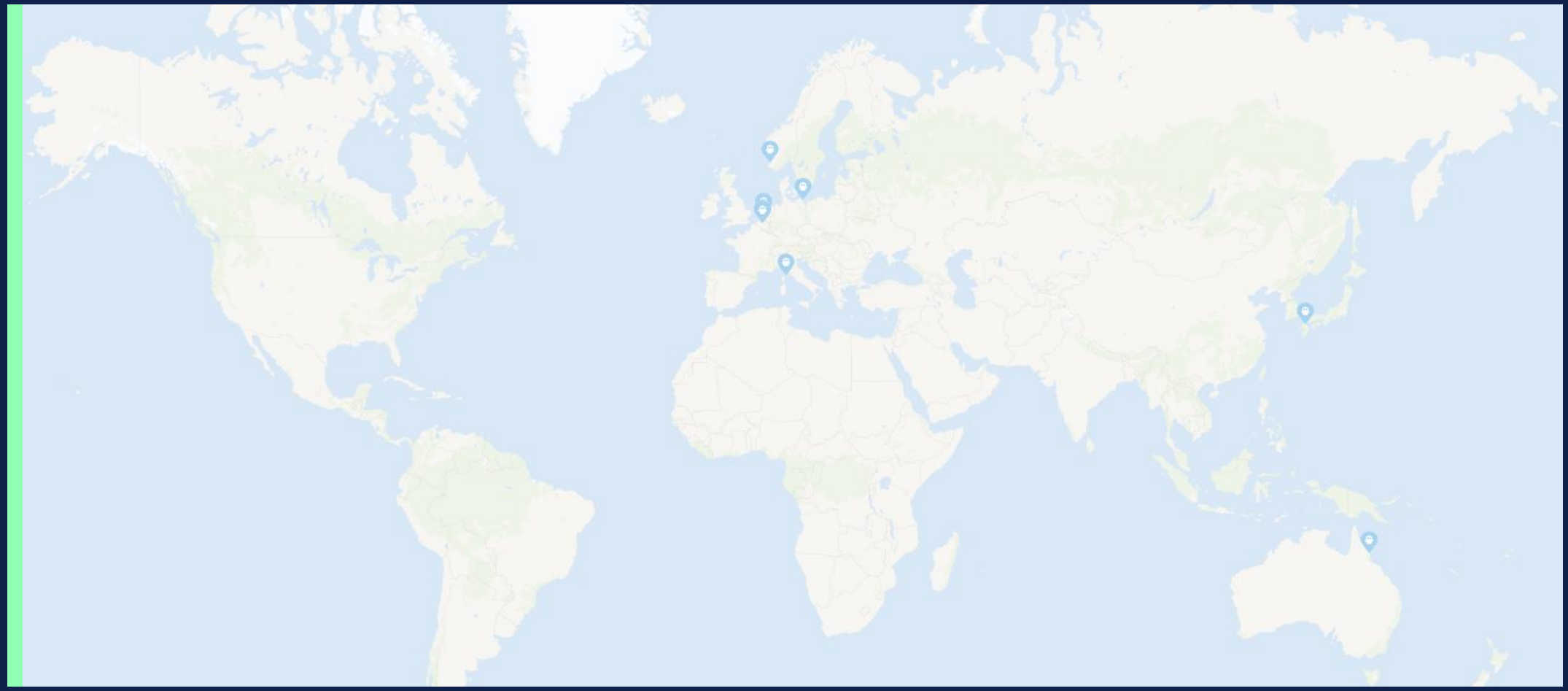
Hydrogen bunkering infrastructure is at very early stage

Dedicated bunkering infrastructure



Source: Alternative Fuels Insight (AFI) - afi.dnv.com, as of November 2025

Only eight hydrogen-capable vessels are in operation (smaller vessels), while many designs are currently being developed



Key takeaways

Short-Term

- Containerships, Car Carriers, and Cruise ships have very high uptake.
- Majority of bulker and tanker newbuildings opt for fuel-ready solutions (e.g., LNG-ready, ammonia-ready, methanol-ready)
- Biodiesels and bio-LNG is likely to be the most accessible low-GHG fuels due to existing infrastructure and production capacity

Long-Term

- Looking ahead, a broader range of fuel options will likely become available.
- The pace of adoption will vary depending on vessel type and trade routes.
- As low-GHG fuels remain relatively expensive, their use will strengthen the business case for implementing energy efficiency measures.

Thank you!

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