Ammonia Europe

Advancing Ammonia as a Sustainable Maritime Fuel

Position Paper

October 2025

Key policy asks

This year was meant to mark a turning point for shipping, with the International Maritime Organization (IMO) expected to adopt its Net Zero Framework in October. However, the decision has now been delayed by twelve months, to October 2026 - prolonging **uncertainty at a critical time for the global transition**. While this postponement risks slowing international progress, it also underlines the **need for European leadership**. The European Union still has a unique opportunity to shape the future of maritime decarbonisation and ensure that shipping's clean fuel transition delivers industrial and climate benefits at home. To do so, **the EU must position itself as a leader in the maritime fuel of the future – ammonia**. Achieving this will require further effort. To establish clean ammonia as a central pillar of EU maritime decarbonisation, the EU must act decisively across the full value chain – from production to port to vessel – while safeguarding both safety and competitiveness. This includes**:**

1. **Fostering competitiveness and supporting the expansion of EU clean ammonia supply**
    - Recognise all clean production pathways in EU targets, swiftly simplify RFNBO/Low-Carbon Hydrogen delegated acts, provide robust CAPEX/OPEX support via Innovation Fund and State Aid, and ensure CBAM consistently covers all hydrogen-derived fuels.
2. **Establishing ammonia maritime as a lead market and stimulating demand**
    - Strengthen FuelEU Maritime by 2027 with ammonia multipliers/mandates, reinvest ETS maritime revenues into bunkering and first-mover vessels, and use the Hydrogen and the Industrial Decarbonisation Accelerator Banks, plus fiscal incentives, to bridge the green premium and secure long-term offtake contracts. Leverage Ammonia Europe certification to help bridge the 'green premium'.[1]
3. **Prioritising ammonia port infrastructure**
    - Make ammonia bunkering a priority in STIP and AFIR 2026, channel EU funding into TEN-T ports with shared infrastructure as PCIs/PMIs, and de-risk projects through AFIF/IPCEI status while mapping gaps via a modernised EU Ports Atlas.
4. **Supporting EU shipbuilding and propulsion technology leadership**
    - Deploy ETS Innovation Fund revenues to finance ammonia retrofits and newbuilds (including crew training and storage systems), expand R&D funding for ammonia engines and NOx control, and scale deployment through EU-led Green Shipping Corridors.
5. **Ensuring safe, harmonised deployment**
    - Align EU rules with IMO ammonia safety guidelines, establish EU-wide bunkering and emergency standards, avoid over-conservative storage rules, and ensure mutual recognition of safety protocols across Member States to enable cross-border operations.

Ammonia is already produced at industrial scale for more than 100 years | Ammonia is the 2nd most produced molecule in the world (200 million tons is produced yearly) | Ammonia is easy to store | 20 million tons is transported by ships around the globe | Already 120 x ports have ammonia terminals

[1] Ammonia Europe, "Certification" (Webpage, accessed 30 September 2025) https://www.ammoniaeurope.com/certification/

1. Introduction

Ammonia is emerging as a strategic **enabler of maritime decarbonisation** in the European Union. Traditionally used in fertiliser production and various chemical and industrial processes, ammonia is increasingly recognised for its potential as a zero-carbon marine fuel – particularly as the shipping sector faces mounting pressure to reduce emissions in line with EU and international climate goals.

While domestic ammonia production in Europe remains largely flat, demand is expected to grow significantly, particularly driven by maritime and energy uses. This growing mismatch implies a rising dependency on imports to meet the EU's growing needs. Despite these challenges, Europe's ammonia industry remains one of the **most energy-efficient globally**, with average emissions of just 1.7 tonnes of CO_2 per tonne of ammonia.[2] While over 70% of ammonia demand is currently linked to fertiliser production, the remaining 30% is linked to other industrial applications[3] – from chemicals and defence to clean energy and shipping amongst others.

As a maritime fuel, ammonia offers a highly scalable, zero-carbon solution that aligns with both the EU Green Deal and the IMO's forthcoming Net Zero Framework. It benefits from existing handling infrastructure and shipping experience, and it is more practical for long-haul shipping than other alternative fuels. Recent modelling by UMAS and University College London, supported by over 30 industry stakeholders, shows ammonia is expected to become the **most cost-competitive zero-emission fuel for shipping** by the mid-2030s.[4] Ammonia dual-fuel vessels are already being built today. On the other hand, conventionally-fuelled tonnage risks becoming uncompetitive, and LNG – as a fossil fuel – offers at best a temporary emissions reduction pathway.

Increased maritime demand for clean ammonia can also support broader decarbonisation across EU industries. Scaling up production for shipping can reduce costs, reinforce supply chain resilience, and ensure sustainable ammonia is available for agriculture, energy, and defence sectors. As such, **shipping** is not just a demand driver but also an **enabler for** wider **clean ammonia market** development and EU strategic autonomy.

Ammonia can also be integrated into **Power-to-X systems**, where surplus renewable electricity is converted into a storable and transportable fuel. In ports, this allows ammonia to be produced, stored, and bunkered alongside other alternative fuels, while also functioning as a hydrogen carrier. This provides a link between renewable energy generation, maritime fuel supply chains, and port infrastructure, supporting the development of Europe's hydrogen economy.

However, to realise this potential, **strong policy support will be essential** to secure industrial competitiveness, create first-mover advantages, and cement the EU's leadership in global maritime decarbonisation.

With that in mind, this document sets out the key requirements for establishing ammonia as a central pillar of EU maritime decarbonisation. It begins with an overview of ammonia production and market dynamics, then outlines the policy measures needed to scale clean ammonia supply. It goes on to examine the infrastructure required to support fuel deployment, the readiness of ship technologies, and the safety protocols necessary for secure handling. As such, it covers the entire ammonia value

[2] Abdurahman Alsulaiman & Kong Chyong, *The Economics of Decarbonising Europe's Ammonia Industry: Policy, Pathways, and Trade-offs in a Hard-to-Abate Sector* (policy paper ET-43, Oxford Institute for Energy Studies, March 2025), p.1

[3] Timur Gül et al, *Ammonia Technology Roadmap: Towards more sustainable nitrogen fertiliser production* (technology report, IEA, Paris, October 2021), p.8

[4] Femke Spiegelenberg & Deniz Aymer, *IMO policy measures: What's next for shipping's fuel transition?* (insight brief, Getting to Zero Coalition / Global Maritime Forum, 27 May 2025), p.5

chain – from production to port to vessel – emphasising the coordinated action needed across sectors to unlock ammonia's potential in the maritime transition.

2. EU Ammonia Availability and Affordability

2.1 EU ammonia production and market outlook

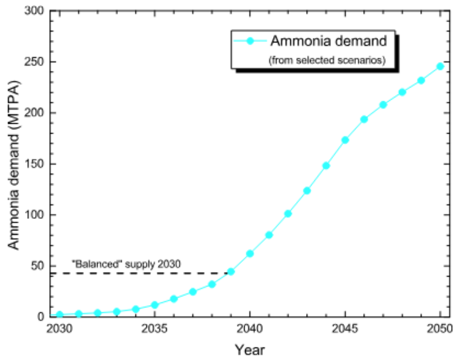

Figure 1- Demand for ammonia as a maritime fuel according to the DNV Pathway model; for both green and blue ammonia contributions.

As ammonia gains momentum as a maritime fuel, the EU must move swiftly to expand its clean production capacity and secure a competitive role in a rapidly growing global market.

Europe's annual ammonia production capacity is currently at approximately **18 million tonnes**.[5] Yet, a large majority is still produced using **fossil** fuels – with only a very limited amount produced using renewable electricity. As a result, to meet maritime demand and broader decarbonisation goals, the EU must significantly and rapidly scale up renewable and low carbon ammonia production.

According to a study commissioned by the European Commission and conducted by DNV, global demand for clean ammonia as a **maritime fuel** is set to rise from **2.3 million tonnes in 2030** to 245 million tonnes by 2050.[6] This exponential growth presents the EU with a strategic opportunity – provided it can scale infrastructure, production, and policy support in time.

Still, high production costs remain a key barrier to producing clean ammonia, which is generally produced via two pathways:

- Blue ammonia made via SMR or ATR with carbon capture.
- Green ammonia made via electrolysis powered by wind, solar, nuclear, or grid mix.

Steam Methane Reforming (SMR)
SMR remains the dominant hydrogen production method globally, including ammonia synthesis. By combining SMR with CCS emissions can be reduced more than 90% depending on capture efficiency and storage availability. According to the International Energy Agency, SMR accounts for approximately 70% of global hydrogen production.

Autothermal Reforming (ATR)
While ATR is largely similar to SMR, it produces syngas by partially combusting natural gas with steam and oxygen inside the reformer, generating heat internally. This results in higher CO_2 concentrations, making carbon capture more efficient. While more thermally efficient and better suited for CCS, ATR is still an emerging and costlier technology.

Electrolysis
Powered by renewable and/or nuclear electricity, electrolysis is widely regarded as the most sustainable long-term solution for hydrogen production. However, its economic viability is heavily influenced by time-matching regulations, which require electrolysers to align their operations with renewable electricity availability to demonstrate additionality.

Blue ammonia is produced by combining a conventional SMR facility with CCS – capturing around 70% of CO_2 emissions cost-effectively – or via ATR, a newer and more efficient process capable of capturing up to 98%. By contrast, electrolysis-based green ammonia is fully decarbonised but remains the most expensive option, primarily due to high electricity and electrolyser costs. According to data projections on global ammonia prices from Maersk-Moller-McKinney [see figure 2], zero-carbon green ammonia will cost approximately 30-43 $/GJ while low-carbon blue ammonia ranges less, around 22-25 $/GJ by 2030 – which is broadly similar to the cost of high-emitting grey ammonia at ~25.8 $/GJ and

[5] Bernd Haveresch and Thor Gallardo, *Europe Ammonia: Navigating the Energy Transition* (industry insight report, KBR, October 2024), p.1

[6] Hendrik Brinks, Oleksii Ivashenko and Tomas Tronstad, *Availability of green and blue ammonia in 2030 to 2050* (white paper, DNV, 19 April 2024), p.21

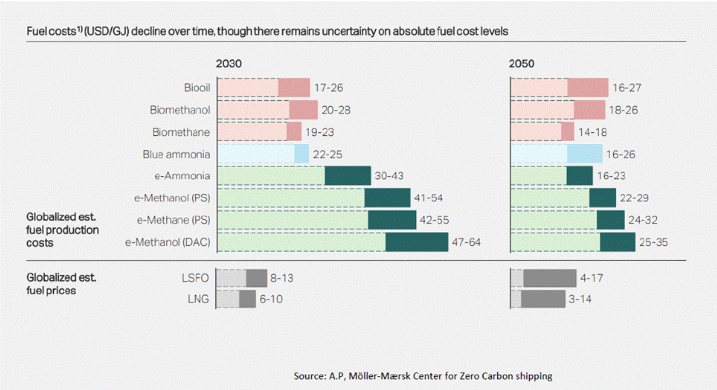

Figure 2 -According to September 2025 data from the Møller-Mærsk Center for Zero Carbon Shipping

conventional methanol at 23 $/GJ in Europe in 2025.[7][8] While green ammonia is the ultimate long-term solution, blue ammonia – with the right policy support – can offer a practical and competitive pathway to rapidly decarbonise maritime shipping, while leveraging largely existing facilities and technologies. In fact, with the right support, projections indicate that up to 32 million metric tons of green ammonia per year could be available to shipping by 2030, thereby keeping prices competitive – compared to only 3.5 million metric tons of green methanol for example.[9]

As a result, with the right mix of policy instruments, market signals, and investment frameworks, costs for both green and blue ammonia can fall enough to become the go-to fuel of choice for maritime decarbonisation. Early action to support both green and blue clean ammonia is therefore important to enhance industrial resilience and accelerate progress toward the EU's climate objectives.

2.2 Policy recommendations

To unlock ammonia's potential as a maritime fuel and ensure EU industry remains globally competitive, the following policy actions should be considered to ensure clean ammonia availability and affordability in the EU:

- **Reducing ammonia production costs and ensuring a level playing:**
    - **Recognition of different pathways:** Recognise multiple decarbonisation pathways in the revision of the Renewable Energy Directive (RED) and Refuel EU Maritime (including blue ammonia with CCS, green ammonia from renewables, and low-carbon ammonia produced under long-term nuclear power purchase agreements) as eligible for meeting 2030, 2040 and 2025 targets.
    - **Simplify relevant delegated acts:** Harmonise definitions and simplify requirements under the RFNBO Delegated Act and proceed with the proposed Low-Carbon Hydrogen Delegated Act to reduce administrative burden, resolve inconsistencies, and improve investor certainty.
    - **Funding support:** Increase CAPEX financial support for SMR, ATR with CCS and electrolysis technologies, as well as OPEX for electrolysis to scale up clean ammonia supply. Support could be channelled through the Innovation Fund and coordinated State Aid, with provisions for cumulative funding and explicit linkages between the EU Sustainable Transport Investment Plan (STIP) and the IMO fuel-transition objectives for maritime transport.
    - **Carbon Border Adjustment Mechanism (CBAM):** Implement CBAM with limited adjustments to address inconsistencies in the treatment of hydrogen-derived fuels which lead to uneven competition among alternative maritime fuel options (for

[7] S&P Global Commodity Insights, Interactive: Ammonia Price Chart, August 2025 https://www.spglobal.com/commodity-insights/en/news-research/latest-news/energy-transition/051023-interactive-ammonia-price-chart-natural-gas-feedstock-europe-usgc-black-sea
[8] Methanex, Methanol Price Sheet, July 30, 2025, https://www.methanex.com/wp-content/uploads/Mx-Price-Sheet-July-30-2025.pdf
[9] Global Maritime Forum, Oceans of opportunity: Supplying green methanol and ammonia at ports (report, April 2024)

example methanol). To ensure fair market conditions, CBAM and ETS policies must address sectoral inconsistencies and adopt harmonised, technology-neutral methodologies that create a true level playing field.

- **Implementing and enhancing current clean fuel maritime legislation to create demand**
  - **FuelEU Maritime:** Ensure effective implementation of FuelEU Maritime, which sets fuel intensity reduction targets of 2% by 2025 and 80% by 2050. During the 2027 revision, go beyond the current framework by introducing ammonia-specific fuel mandates and incentives to provide certainty for shipowners and fuel suppliers. At the same time, raise overall FuelEU targets in line with the IMO's forthcoming Net Zero Framework, ensuring Europe sends a clear demand signal to clean fuel suppliers.
  - **EU ETS – Maritime:** Use revenues from the inclusion of maritime transport in the EU Emissions Trading System to support the deployment of clean ammonia bunkering infrastructure and early-mover vessels, aligning funding with FuelEU Maritime targets.
  - **Transposition of RED III transport targets:** Paired with incentives to create the right conditions, ensure full and timely Member State transposition of RED III transport targets—specifically accelerating the ramp up of renewable energy—to create a clear market signal for clean fuels.
  - **Lead market for clean fuels:** Position clean ammonia as Europe's maritime fuel of choice by combining regulatory certainty, targeted financial support, and port infrastructure rollout, all aligned with the IMO's Net Zero Framework to unlock investment at scale.
- **Covering the green premium and increasing ammonia uptake in the maritime sector**
  - **Funding:** Use the EU Hydrogen Bank to provide targeted offtake support for clean ammonia as a maritime fuel across both RFNBO and low-carbon production pathways. This can bridge the green premium and enable long-term supply contracts. Future funding rounds should go beyond the €200 million already earmarked for maritime fuels, while the forthcoming EU Competitiveness Fund / Decarbonisation Bank could explore Contracts for Difference (CfDs) and double-sided auctions as additional tools.
  - **Fiscal incentives**: Introduce fiscal incentives, such as VAT exemptions for low carbon ammonia, to stimulate early demand and improve the competitiveness of clean ammonia in shipping. This could help create predictable market signals, helping scale up and deliver large-scale decarbonisation projects within the EU.
  - **Recognition of ammonia certification schemes:** Ensure EU recognition of credible ammonia certification schemes, such as those from Ammonia Europe, to guarantee traceability and facilitate cross-border market trust.[10]

3. Ammonia maritime Infrastructure

3.1 Port Infrastructure readiness and bunkering requirements

While over **30 EU ports** currently **handle ammonia**, this is primarily for chemical and industrial applications. Nonetheless, with the required storage and handling infrastructure already in place, the challenge lies not in building capability from scratch, but in redirecting and **scaling this infrastructure towards maritime bunkering** operations to meet the rising demand from the shipping sector.

[10] Ammonia Europe, "Certification" (Webpage, accessed 30 September 2025) https://www.ammoniaeurope.com/certification/

Enabling the widespread use of clean ammonia as a maritime fuel will therefore require ports to evolve from passive cargo transit points into **active nodes in the fuel supply chain** – integrating production, storage, distribution, and refuelling within a coordinated network. This ties directly into the so-called 'green corridor' concept in which dedicated low-emission shipping routes are supported by end-to-end infrastructure, from hinterland supply to port bunkering and vessel operations.

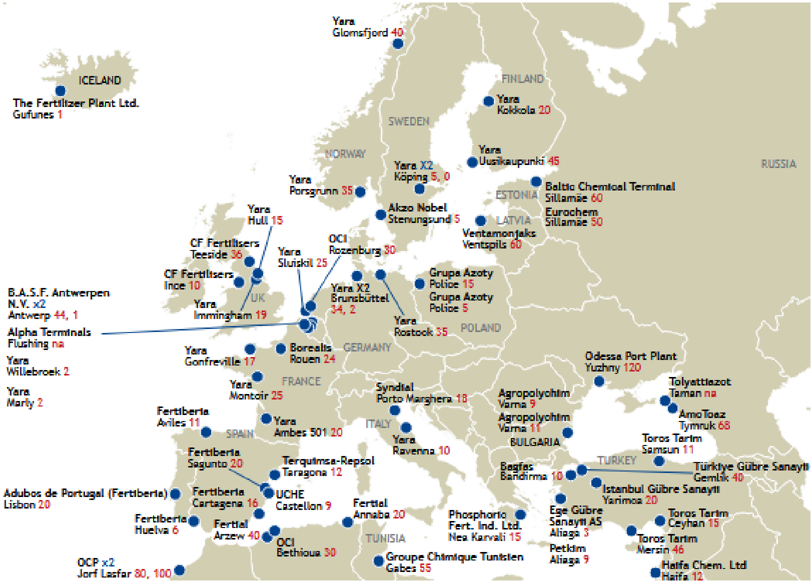

Figure 3- Ammonia terminal locations and capacity - Argus.

Once ammonia reaches the port, **dedicated fuel infrastructure is essential**, including purpose-built refrigerated storage tanks, safety-compliant transfer systems, and bunkering solutions; such as ship-to-ship, truck-to-ship, and shore-to-ship transfers. Technology demonstrations are already underway: in April 2025, the Port of Rotterdam successfully conducted its first ship-to-ship ammonia bunkering, building on earlier pilots in Singapore, Yokohama, and Dalian.

Beyond fuelling vessels, clean ammonia can contribute to the decarbonisation of port operations. Onshore power supply (OPS) systems could be powered via **ammonia cracking** units—already under development in ports like Rotterdam – providing clean electricity to berthed ships and replacing diesel generators.

Whatever the case, for the maritime transition to succeed, port **infrastructure development** must proceed **in parallel with ship technology deployment**. Coordinated investments across the ammonia value chain, underpinned by clear safety standards and regulatory alignment, will be critical to ensuring the fuel is available where and when needed. Finally, improved hinterland connectivity – via rail, pipelines, or barges – will also be essential to guarantee stable, efficient, and cost-effective delivery to and from bunkering hubs.

3.2 Policy recommendations

To enable port readiness and accelerate ammonia infrastructure development, the following actions are recommended as part of initiatives such as the European Port Strategy, the Alternative Fuels Infrastructure Regulation (AFIR), and the Sustainable Transport Investment Plan (STIP):

- **Prioritise ammonia infrastructure in STIP and AFIR for bunkering:** Ensure the Sustainable Transport Investment Plan (STIP) and the next AFIR review (by 2026) explicitly prioritise targeted measures and funding to support ammonia bunkering facilities and strengthened infrastructure linkages with nearby industrial clusters.
- **Ensure clean onshore power:** EU Fuel maritime (2027) and AFIR (2026) should be updated to require that onshore power generation is sustainable.
- **Target key TEN-T ports:** Focus investment on major TEN-T ports that serve both maritime bunkering and industrial uses to maximise shared infrastructure. Projects which maximise shared infrastructure should be included as Projects of Common Interest (PCIs) and Projects of Mutual Interest (PMIs), enabling better coordination and fast-tracked support from Connecting Europe Facility and other EU funding instruments.

- **De-risk investments through subsidies and instruments:** Use funding tools like AFIF to support the high CAPEX of ammonia infrastructure and attract private capital.
- **Streamline permitting and designate ports as acceleration areas:** Fast-track permitting for key port infrastructure projects by granting IPCEI status to strategic ammonia hubs.
- **Establish a modernised EU Ports Atlas:** To support better coordination, use existing tools like TENtec and the European Alternative Fuels Observatory (EAFO) to develop a new comprehensive EU-wide tool which maps current and planned infrastructure for alternative fuels, with a greater focus on ammonia infrastructure.

4. Ammonia Propulsion Technology and Ship Readiness

4.1 Retrofitting and new builds

While ammonia has long been **transported by ship (20 Mt/year)** [11] and is used extensively in industry, its application as a marine fuel is relatively new. Nevertheless, recent research confirms that ammonia holds significant promise as a zero-carbon fuel for shipping, combining scalability with an established global production and trade network. As such, modelling shows that ammonia is likely to become the most cost-competitive zero-emission fuel pathway for deep-sea shipping by the mid-2030s.

Ammonia propulsion technology is **already technically feasible**. Dual-fuel two-stroke and four-stroke engines that can run on both ammonia and conventional fuels have reached high technology readiness levels and are being tested at full scale. This dual-fuel capability offers operational flexibility during the early stages of the transition. Early trials indicate that NOx emissions meet international limits, with compliance to the strictest standards achieved by fitting Selective Catalytic Reduction (SCR) systems. Work is also progressing on **onboard ammonia cracking** systems to produce hydrogen for fuel cells, though these are at an earlier stage of development. These propulsion systems can now either be deployed by retrofitting existing ships, or via new builds.[12]

Retrofits are currently being developed for a range of vessel sizes, from smaller coastal ships to large bulk carriers and tankers. **For very large gas carriers** (VLGCs) of about 50,000 DWT, equipped with 10–16 MW two-stroke engines, retrofits are estimated to cost approximately **€10–15 million** – roughly half to two-thirds of the cost of a comparable new build – and can extend the vessel's operational life by 15-20 years.[13] Everllence (formerly MAN Energy Solutions) is currently developing ammonia retrofit packages available for commercial vessels, [14] and C-Job Naval Architects/Wärtsilä plan to fit a retrofit package to a 300-metre-plus container ship belonging to shipping company MSC.[15] Nonetheless, there do still remain bottlenecks linked to limited shipyard capacity for complex retrofits, as well as linked to integrating safe ammonia storage within existing hulls and ensuring that crews are trained in ammonia handling.

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[11] Abdurahman Alsulaiman & Kong Chyong, *The Economics of Decarbonising Europe's Ammonia Industry: Policy, Pathways, and Trade-offs in a Hard-to-Abate Sector* (policy paper ET-43, Oxford Institute for Energy Studies, March 2025), p.9

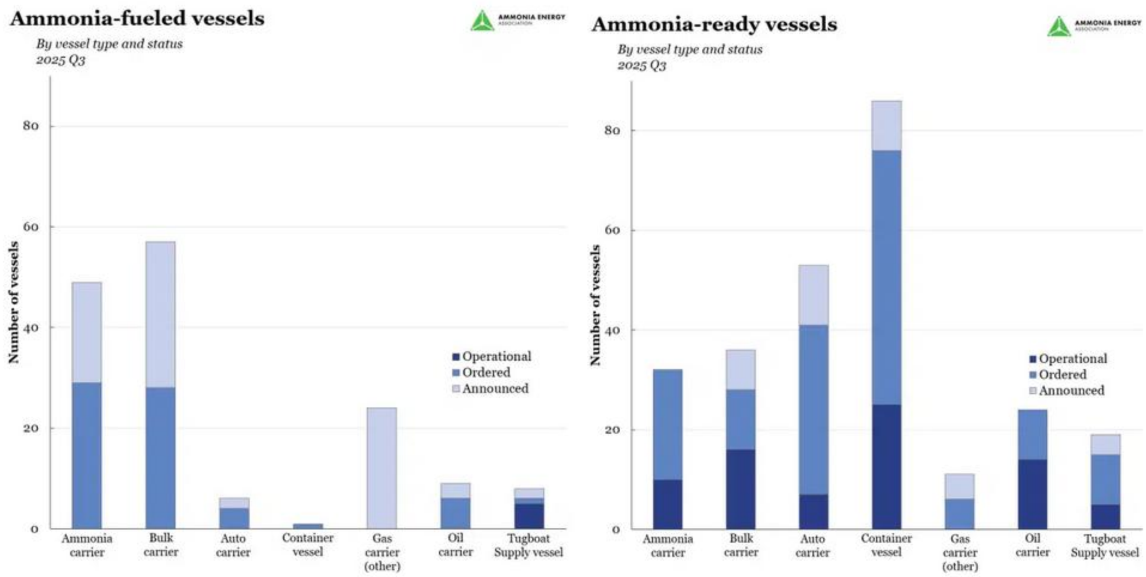
[12] European Maritime Safety Agency, *Potential of Ammonia as Fuel in Shipping* (report, EMSA, 2023), pp. 44–49, 125–126.

[13] European Maritime Safety Agency, *Potential of Ammonia as Fuel in Shipping* (report, EMSA, 2023), p. 56–57.

[14] Julian Atchison, "MAN Energy Solutions: testing begins on two-stroke marine ammonia engine" (article, Ammonia Energy Association, 7 July 2023), accessed 30 September 2025, https://ammoniaenergy.org/articles/man-energy-solutions-testing-begins-on-two-stroke-marine-ammonia-engine/

[15] Mariska Buitendijk, "Ammonia as marine fuel is becoming reality" (news article, SWZ|Maritime, 12 June 2025), accessed 30 September 2025, https://swzmaritime.nl/news/2025/06/12/ammonia-as-marine-fuel-is-becoming-reality/

New builds designed for ammonia allow optimal integration of fuel storage, safety systems, and propulsion technology. Orders range from small feeder vessels to very large crude carriers (VLCCs) above 300,000 DWT, with designs approved by major classification societies. The cost premium for an ammonia-fuelled deep-sea vessel of this scale – such as a 210,000 DWT Newcastlemax bulk carrier or a **300,000 DWT VLCC** – is estimated at **10% to 25 % above the total build cost of a conventional vessel**, similar to methanol and slightly less than hydrogen fuel-cell vessels.[16] While new builds offer efficiency and long-term compliance advantages, most construction capacity is concentrated in East Asia, and port bunkering infrastructure must expand in parallel to avoid fuelling bottlenecks.



Nonetheless, the maritime sector is moving forward at an increasingly rapid pace, with **154 ammonia-fuelled vessels and 261 ammonia-ready vessels ordered and announced** – including gas tankers, bulk carriers, oil/chemical tankers, and a container vessel. As of September 2025, 77 ammonia-ready vessels are operational, up from just one ship in 2022, indicating a clear and accelerating market shift.[17]

Despite this potential, much of the **innovation** around ammonia propulsion systems is increasingly occurring **outside Europe**. While EU maritime stakeholders possess valuable expertise and emerging ship designs are being developed, the pace of development and retrofitting is accelerating elsewhere. If this trend continues, Europe risks missing a critical opportunity to turn its maritime innovators into global champions of maritime decarbonisation.

4.2 Policy recommendations

To address the EU's need for greater strategic autonomy in propulsion technology and ship readiness, the **EU Maritime Industrial Strategy** should include the following:

- **Fund ammonia propulsion systems:** Use ETS Innovation Fund revenues and other EU instruments to help cover the higher costs of fitting ammonia engines.[18] Support should cover

[16] European Maritime Safety Agency, *Potential of Ammonia as Fuel in Shipping* (report, EMSA, 2023), p.151

[17] Ammonia Energy Association, "LEAD: Ammonia-Fueled Vessels" (web page / LEAD data briefing, Ammonia Energy Association, accessed 30 September 2025), https://ammoniaenergy.org/lead/vessels/

[18] **European Maritime Safety Agency**, *Potential of Ammonia as Fuel in Shipping* (report, EMSA, 2023), pp. 55–57, 151

shipyard upgrades, safe fuel storage, and crew training for retrofits, as well as early orders for EU-built ammonia-ready ships.

- **Expand R&D support:** Increase targeted Horizon Europe and Waterborne Technology Platform funding for ammonia propulsion, safety, and performance improvements – focusing specifically on better engine efficiency, NOx control systems, and onboard ammonia-to-hydrogen technology.
- **Accelerate deployment via Green Shipping Corridors:** Use Green Shipping Corridors to test and scale ammonia propulsion on real-world routes. Combine vessel funding with port bunkering investments through AFIF. Back demonstration projects on key trade routes, both within the EU (e.g. Spain–Rotterdam) and linking the EU to major partners such as Singapore, Egypt, Australia, Namibia, and India.

5. Safety Protocols and Guidelines

5.1 Enhancing safety and sector expertise

Ammonia's toxicity and corrosiveness are well understood, and its handling is governed by a **mature safety culture** developed over more than a century[19]. Both the chemical and shipping industries have extensive experience managing ammonia safely as a bulk cargo, with established protocols for containment, leak prevention, and crew protection.

Ammonia (NH_3) is widely used in agriculture, industry, and household applications.

Ammonia has a strong odour, allowing people to detect it at very low concentrations.

Ammonia is a natural part of the nitrogen cycle, produced by soil bacteria and decomposing organic matter. It breaks down quickly in the environment, preventing long-term contamination.

Ammonia safety systems and standards have been proven effective for over 50 years, particularly in industrial, agricultural, refrigeration and marine applications.

Ammonia production and handling are highly regulated, with strict safety protocols proven through decades of industrial use.

Ammonia in shipping was already used in the 19th century. It was one of the first refrigerants used in marine refrigeration systems for food preservation on cargo and passenger ships.

Translating this expertise to its use as a maritime fuel is both feasible and already underway. Key risks – such as exposure to leaks, material degradation, and toxic emissions – can be effectively managed through **proven measures**, including advanced leak detection systems, ventilation technologies, corrosion-resistant materials, and comprehensive crew training. The latest report from EMSA did HAZID exercises upon the use of ammonia as fuel in specific ship designs and this work will be vital to further understanding of the safe use of ammonia as fuel.[20]

Regulatory developments are also progressing. The IMO's Human Element, Training and Watchkeeping (HTW) sub-committee has adopted draft interim guidelines for training seafarers working with alternative fuels. Building on this, specific **safety and training protocols** for ammonia-powered ships

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[19] *Note: Covered by regulations such as REACH EC 1907/2006 and CLP EC 1272/2008 and the BREF Ammonia, Acids & Fertilisers LVIC-AAF*

[20] European Maritime Safety Agency), Study Investigating the Safety of Ammonia as Fuel on Ships (technical report, published 10 July 2024; updated 30 July 2025)

are now being developed, following the release of the IMO's Interim Guidelines for the Safety of Ships Using Ammonia as Fuel (MSC.1/Circ.1687).

Additionally, a review of the current literature examined the production of N_2O emissions for ammonia used as fuel with both direct measurements and numerical simulations showing promising mitigation of emissions.[21]

To accelerate uptake, the EU must support the development and mutual recognition of **harmonised safety and bunkering standards** across member states. The safety frameworks being developed by the Port of Rotterdam's authority[22], from their bunkering pilots, and similar pilots taking place worldwide like in the Port of Singapore[23], should be the basis for harmonised EU and global protocols for ammonia handling at ports, training standards and emergency response coordination and are needed to enable safe, large-scale deployment.

While safety must remain a top priority, it is essential that regulation strikes a balance with efficiency and pragmatism, particularly in the context of ammonia storage for maritime fuel. Overly conservative approaches, such as those seen in the new Dutch PGS 12 guideline, risk creating unnecessary barriers to deployment by imposing impractical requirements that go beyond what is needed for safe operation. To enable a viable and scalable transition, safety standards should be grounded in **risk-based assessments, industry expertise, and real-world operational experience**, avoiding overregulation that could stall progress. While ammonia's risk profile demands careful management, it is not unfamiliar. The foundational expertise and regulatory momentum already in place provide a solid platform for enabling its safe and widespread use as a maritime fuel. What is now needed is clear EU-level alignment to support harmonised adoption, training, and port-level implementation.

5.2 Policy recommendations

To enable safe and harmonised deployment of ammonia fuels:

- **Adopt and align with IMO guidelines:** Ensure full EU alignment with MSC.1/Circ.1687 and forthcoming IMO safety and training protocols.
- **Support harmonised EU safety standards:** Build on pilots in the Port of Rotterdam, Singapore, and others to establish EU-wide bunkering and emergency response standards for ammonia.
- **Ensure that safety regulations are risk-based and proportionate:** Safety Regulations, including ammonia storage guidelines should adopt EU-wide risk-based safety standards for ammonia storage, aligned with IMO guidelines, to replace fragmented national rules.
- **Facilitate cross-border safety coordination:** Develop mutual recognition systems across Member States to reduce regulatory friction and build trust in ammonia safety protocols.

[21] Pacific Environment, Clean Shipping Coalition & EDF, Review of current literature on tank-to-wake nitrous oxide emissions from ammonia-fuelled engines (MEPC 83/7/23 working paper, submitted 31 January 2025)

[22] Port of Rotterdam, "Port of Rotterdam takes important step in making shipping more sustainable: pilot prepares port for safe bunkering of ammonia" (news release, 14 April 2025), accessed 30 September 2025, https://www.portofrotterdam.com/en/news-and-press-releases/port-rotterdam-takes-important-step-making-shipping-more-sustainable-pilot

[23] Energy Market Authority (EMA) & Maritime and Port Authority of Singapore (MPA), "EMA and MPA shortlist two consortia to further study viability of ammonia for power generation and bunkering" (media release, 25 July 2024), accessed 30 September 2025,https://www.mpa.gov.sg/media-centre/details/ema-and-mpa-shortlist-two-consortia-to-further-study-viability-of-ammonia-for-power-generation-and-bunkering

About Ammonia Europe

Ammonia Europe is the voice of the European ammonia industry and its value chain with the mission to advance the decarbonisation of the industry and its pivotal role in the transition towards a climate-neutral economy.

By 2050, we envisage a decarbonised ammonia industry and uptake of clean ammonia across various sectors of Europe's climate neutral and resilient economy.

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