

ABS Assessment of Fuel Transition Pathways and Implications for Mid-Term Measures

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Overview and Context

This paper presents the results of an ABS data-driven assessment of fuel transition pathways in international shipping, with a focus on fuel availability, infrastructure readiness, and operational feasibility through 2030 and beyond. The analysis is framed in the context of ongoing IMO discussions on mid-term GHG measures, highlighting the importance of developing a globally applicable framework while recognizing that further technical refinement is required.

Deployment Dynamics Through 2030

The transition of the global shipping industry toward low- and zero-carbon fuels is progressing within a complex and evolving landscape. While IMO's GHG Reduction Strategy targets are clearly defined aiming for at least 20% reduction in greenhouse gas (GHG) emissions by 2030 and net zero by around 2050, the practical implementation of alternative fuels across the fleet remains uneven.

Current evidence suggests that the pace and form of fuel adoption are influenced by a combination of fuel availability, infrastructure development, trade patterns, and commercial frameworks. Rather than a single pathway, the transition appears to be developing slowly through multiple parallel approaches across different vessel segments and operating profiles.

Segment-Specific Dynamics in Fuel Adoption

Differences in vessel operating patterns are playing a significant role in shaping fuel transition pathways. Segments such as containerships, ferries, and cruise ships typically operate on predictable routes with repeated port calls, enabling coordination between fuel suppliers, ports, and operators. These characteristics support the development of localized fuel supply chains and structured procurement arrangements.

In contrast, vessels operating in tramp trades, including bulk carriers and tankers, face more variable routing and commercial structures. This variability can limit access to alternative fuels that depend on concentrated bunkering infrastructure and predictable demand. Approximately 10% of global fleet tonnage is alternative-fuel capable, with an additional 6% categorized as fuel-ready. These figures indicate that widespread adoption remains at an early stage.

LNG: Established Infrastructure and Continued Expansion

Liquefied natural gas (LNG) is currently the most established alternative fuel in shipping, supported by a relatively mature infrastructure network and operational experience. More than 220 ports have LNG bunkering capability, supported by over 50 dedicated bunker vessels, while by 2030, the LNG-capable fleet is projected to reach approximately 112 million gross tons (GT). This level of infrastructure has facilitated adoption, particularly in segments with regular trading patterns. At the same time, further expansion will be required to accommodate

increasing demand, including the integration of lower-carbon variants such as bio-LNG and synthetic LNG.

Methanol: Emerging Pathway with Supply Constraints

Methanol is developing as a second major pathway in the transition, benefiting from existing production, storage, and handling capabilities. Growth has been supported by vessel orders and infrastructure development at key ports. By 2030 projections support a methanol-capable fleet of approximately 16 million GT, while bunkering infrastructure will be available or under development in roughly 50 ports worldwide.

However, available supply remains a central consideration. While announced green methanol capacity is significant, realistically deliverable volumes are estimated at 6–13 million tonnes by 2030, representing about 13–29% of announced capacity. In energy terms, this corresponds to only a low single-digit percentage of global shipping demand, underscoring the importance of aligning fleet strategies with expected supply availability. Ethanol is also under consideration as a complementary fuel option, supported by existing global production of approximately 90 million tonnes annually, although its use in maritime applications remains limited.

Ammonia: Long-Term Potential with Near-Term Limitations

Ammonia is widely discussed as a potential zero-carbon fuel for shipping, particularly over longer time horizons. Its use could enable significant emissions reductions, particularly for long-distance transport. Nonetheless, near-term deployment remains limited. Despite a large global project pipeline, shipping-related uptake is expected to remain modest with a projected fleet of around 2.5 million GT by 2030 and limited bunkering infrastructure available. In energy terms, ammonia is likely to account for a small fraction of global marine fuel demand by 2030, with larger-scale deployment anticipated in subsequent decades.

Alternative Compliance Approaches

Given the current constraints on fuel availability, a range of alternative approaches to emissions reduction is expected to be applied across the industry. These include drop-in biofuels, energy efficiency technologies, and operational measures, including speed optimization and voyage planning. In addition, emerging technologies such as carbon capture are being explored, although they remain at an early stage of deployment.

Overall Transition Outlook

Looking toward 2030 and beyond, the overall fuel mix is expected to remain diversified with alternative fuels projected to account for approximately 17% of the total fuel mix while conventional fuels, including oil and biofuel blends, are expected to remain dominant at around 83%. This distribution reflects both the scale of the existing fleet and the time required to develop, finance, and deploy new fuel supply chains at a global level.

Limitations of a Fuel-Only NZF Approach

The findings of the ABS assessment, based on comprehensive data analysis of fleet composition, fuel availability, and infrastructure readiness, corroborate the concerns expressed by Member States regarding the NZF framework. In particular, a fuel-only compliance mechanism presents structural limitations that may constrain its effectiveness and global applicability:

- **Distortions due to supply constraints:** A compliance model driven exclusively by fuel switching is highly sensitive to the availability, geographic distribution, and price volatility of low- and zero-carbon fuels. Given the limited and uneven development of supply chains, such an approach risks creating competitive distortions between trades, regions, and vessel segments.
- **Restricted compliance pathways under a tightening GFI trajectory:** The progressively stringent GFI curve is likely to narrow compliance options toward fuels that are not yet available at scale. This creates a misalignment between regulatory ambition and industrial readiness, increasing the risk of non-compliance.
- **Risk of a “pay-to-pollute” outcome:** In the absence of sufficient alternative fuel availability, the mechanism may default to financial compliance rather than actual emissions reductions, weakening its environmental integrity.

Collectively, these challenges underscore the need for a more balanced regulatory design that reflects real-world constraints while maintaining decarbonization ambition.

Relevance of MEPC 84 Alternative Proposals

The ABS analysis reinforces the relevance of the alternative proposals submitted at MEPC 84, each of which reflects specific dimensions of the regulatory challenge. Saudi Arabia et al (MEPC 84/7/30) emphasize flexibility, consensus, and technological neutrality to reflect diverse transition pathways across shipping segments. The United States (MEPC 84/7/41) opposes levies and IMO-managed funds due to concerns over governance, economic impacts, and redistribution effects. Japan (MEPC 84/7/49) proposes removing the IMO fund and adjusting targets to better align with transport demand, efficiency improvements, and fuel availability. Liberia et al (MEPC 84/7/38) advocate for a revised GFI-based system linked to real-world availability, affordability, and scalability of marine fuels.

While the Liberian and Japanese proposals have attracted particular attention due to their technical sophistication, the ABS assessment also identifies inherent limitations in these proposals. The Liberian proposal, while responsive to fuel availability, due to the removal of the IMO remedial units may result in a compliance risk in scenarios where neither compliant fuel (e.g. for tramp sector operators) nor surplus units are accessible. The Japanese proposal, although addressing supply-demand imbalances, relies on mechanisms such as SUs

adjustment factors and voluntary contributions in maritime projects, which may introduce regulatory uncertainty and dilute incentives for emissions reductions.

Role of Energy Efficiency and Carbon Credits in Bridging the Gap

A central outcome of the ABS study is that energy efficiency represents the most immediate, scalable, and cost-effective pathway for emissions reduction in the maritime sector. An estimated 20–35% additional efficiency potential remains achievable in the short to medium term. Measures such as slow steaming and voyage optimization, air lubrication and wind-assisted propulsion may be deployed across a wide range of vessel types

These findings highlight that significant, near-term emissions reductions can be achieved independently of fuel switching, thereby providing a critical bridge to the large-scale availability of zero-carbon fuels. In this context, the provision included in the Regulation 31 of the Liberian draft MARPOL Annex VI (*Circular letter No. 5213*) creates a strategic opportunity to integrate energy efficiency carbon credits within the GFI framework, enhancing both flexibility and effectiveness.

Conclusion

The transition to low- and zero-carbon fuels in shipping is progressing slowly, shaped by a range of interdependent factors. Fuel availability, infrastructure readiness, vessel deployment patterns, and commercial arrangements all influence the pace and distribution of adoption. Current evidence indicates that alternative fuels can be deployed primarily where supply chains are established efficiently, however supply constraints remain a key consideration in the near term while different vessel segments follow distinct transition pathways

The ABS assessment demonstrates that fuel availability and infrastructure readiness will remain the principal constraints shaping maritime decarbonization. Under these conditions, a purely fuel-based compliance mechanism is unlikely to deliver emissions reductions in a manner that is cost-effective, equitable, and globally implementable.

A more balanced and practically oriented approach is therefore needed. In this context, a refined GFI framework drawing on elements of the Liberian and Japanese proposals combined with the introduction of carbon credits for energy efficiency, may provide a robust and forward-looking pathway.

Such an approach would remove reliance on an IMO-managed fund, while placing greater emphasis on mechanisms aligned with fuel availability, transport demand, and technological progress. It would also preserve the role of transitional fuels such as LNG within a technology-neutral framework and support the development of compliance pathways that are realistic, achievable, and cost-effective, based on continuous improvement across both fuel and operational performance.

The integration of carbon credits for energy efficiency within the GFI structure would create incentives for compliance, rewarding early adopters of efficiency technologies and operational best practices, provide a well-designed flexibility mechanism, reducing the risk of compliance gridlock in scenarios where low-carbon fuels are unavailable and deliver immediate emissions reductions, bridging the gap until zero and near-zero GHG fuels are available, enabling a more resilient and adaptive regulatory framework. Collectively, this combined approach offers IMO a pathway that is technically robust, economically efficient, and globally viable. It supports a transition that is not only environmentally effective but also grounded in real-world constraints, ensuring that decarbonization progresses in a structured, inclusive, and globally applicable manner.