

Navigating climate transition risks in global shipping

Managing interconnected decarbonization challenges

Executive summary

The global shipping industry stands at a critical inflection point. As decarbonization pressures intensify, maritime operators face a complex web of interconnected risks spanning litigation, policy, contracts, technology, and social expectations. These risks do not operate in isolation—they cascade through operations, amplifying vulnerabilities across the supply chain.

This whitepaper, drawing on recent research by Mosmans et al. provides industry leaders with a structured framework for understanding and managing these transition risks.¹ The key insight: siloed approaches to risk management are no longer sufficient. Success requires integrated strategies that anticipate how action in one domain may trigger consequences in others.

Why transition risks demand attention now

Climate change presents profound challenges for shipping. As a critical enabler of global trade, the industry faces risks spanning physical, technological, policy-related, legal, and social dimensions.² Climate risks fall into two broad categories: **physical risks**—direct damage from extreme weather, sea-level rise, and infrastructure disruption³—and **transition risks**, which relate to the costs, regulatory pressures, and market disruptions associated with moving to a

¹ Mosmans, H., Ebbesmeyer, S., Kruit, J., Martinez Romera, B., Rehmatulla, N., Fricaudet, N. (2026). Climate risks in shipping, *Journal of shipping & Trade*, 11, 17. <https://doi.org/10.1186/s41072-026-00233-7>

² Carlin, D., & Arshad, M. (2024). *Climate Risks in the Transportation Sector*. UN Environment Programme – Finance Initiative

³ Monasterolo, I. (2020). Climate Change and the Financial System. *Annual Review of Resource Economics*, 12, 299–320.

low-carbon economy.⁴ This whitepaper focuses on transition risks, though physical and transition risks are strongly interrelated.

The complexity of these risks is compounded by the heterogeneous nature of global shipping. Different business models face distinct challenges.⁵ While some shipowners—particularly larger companies with modern fleets—have made progress on GHG reduction, others have struggled to adapt.⁶ The presence of open registers adds further complexity, as varying regulatory standards and enforcement practices affect the industry's collective ability to address climate risks.⁷

While a growing body of literature addresses individual aspects of climate-related risks, such as work by Fricaudet et al.⁸ which focuses on stranded asset risks, a subset of transition risk, studies that bring together multiple categories of transition risks in shipping remain limited. The sector's global scope, multilayered regulatory environment, and reliance on complex contractual arrangements pose challenges that are often examined in isolation. This whitepaper addresses that gap by offering an integrated perspective on important known transition risks and their interconnections.

A framework for understanding transition risks

Building on established climate risk taxonomies from the Task Force on Climate-related Financial Disclosures (TCFD),⁹ the Network for Greening the Financial System (NGFS)¹⁰ and the Intergovernmental Panel on Climate Change (IPCC),¹¹ five interrelated categories of transition risk specific to shipping were identified:

⁴ Carney, M. (2015). *Breaking the Tragedy of the Horizon – Climate change and financial stability*. Speech given at Lloyd's of London.

⁵ Chua, A. (2024). Challenges of Sustainability, Energy Transition of Shipping Industry. *Maritime Fairtrade*

⁶ Jawara, L., & Matin Johansson, T. (2025). Climate emergency impacts and adaptations in shipping: Analogical policy formulation and recommendations. *Journal of International Maritime Safety, Environmental Affairs, and Shipping*, 9(1), 2428001; Stockbruegger, J., & Bueger, C. (2024). From mitigation to adaptation: Problematizing climate change in the maritime transport industry. *WIREs Climate Change*, 15, e894.

⁷ Munim, Z. H., Chowdhury, M. M. H., Tusher, H. M., & Notteboom, T. (2023). Towards a prioritization of alternative energy sources for sustainable shipping. *Marine Policy*, 152, 105579.

⁸ Fricaudet, M., Rehmatulla, N. and Smith, T. (2025), Supply-side and demand-side stranded asset risks in shipping, London, UK, available at <https://www.shippingandoceans.com/post/existing-ships-and-those-on-order-would-produce-twice-the-emissions>

⁹ TCFD. (2017). *Recommendations of the Task Force on Climate-related Financial Disclosures*.

¹⁰ NGFS. (2024). *Network for Greening the Financial System Scenarios*.

¹¹ IPCC (2022) Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056, doi:10.1017/9781009325844

Risk Category	Core Challenge
<i>Litigation</i>	Legal exposure from regulatory non-compliance, greenwashing claims, and commercial disputes
<i>Policy</i>	Regulatory uncertainty, fragmented implementation, and evolving decarbonisation targets
<i>Contractual</i>	Misalignment between existing agreements and new environmental obligations
<i>Technology</i>	Stranded assets, integration failures, and uncertainty over fuel pathways
<i>Social</i>	Shifting stakeholder expectations, workforce transitions, and reputational pressures

Table 1: Categorisation of Transition Risks affecting Shipping

Critical insight: Economic consequences are not a separate category, but flow through all others—regulatory changes generate compliance costs, technological innovations require capital investment, and litigation creates direct financial liabilities.

Risk category deep dive

1. Litigation Risks

Litigation exposure is growing as decarbonization pressures intensify. Multiple litigation risks were identified:

Sub-category	Potential Risks
<i>Regulatory non-compliance</i>	Fines, penalties, and detention of vessels
<i>Commercial litigation</i>	WTO disputes; contractual disputes; shareholder and investor litigation; product liability and technology failures
<i>Other litigation</i>	IP litigation; labor litigation; supply chain and third-party liability; greenwashing claims; defamation claims

Table 2: Potential Litigation Risks

Industry example: Under Article 16(11a) of the EU ETS Directive, companies face significant fines and potential vessel detention until compliance is restored. Beyond direct penalties, such measures can disrupt operations and can erode reputation. Greenwashing litigation is also accelerating. Opportunity Green's 2023 complaint to the UK Advertising Standards Authority against cruise operators—alleging misleading promotion of fossil LNG as "green" fuel—illustrates growing scrutiny of environmental claims in the shipping industry.¹²

2. Policy Risks

Regulatory uncertainty can create strategic paralysis. Companies making investment decisions amid unclear frameworks risk committing to technologies or strategies that may not align with future requirements. The following policy risks were identified:

¹² (Un)Sustainable from ship to shore, 2023, available from <https://opportunitygreen.org/climate-law/insights/asa-complaints-cruise-companies-lng-claims-greenwashing/>

Sub-category	Potential Risks
<i>Regulatory uncertainties</i>	Uncertainties of future regulations make it difficult to duly anticipate
<i>Implementation of policies</i>	Inconsistent adoption and enforcement of regulations
<i>Disturbed level playing field</i>	Regional vs global regulations creating market distortions
<i>Insufficiency of existing policy</i>	New technologies cannot be used safely under existing regimes
<i>More stringent decarbonisation targets</i>	Operational changes may be necessary, including fleet modifications

Table 3: Potential Policy Risks

Key concern: Existing regulatory frameworks often lag behind technological development. Alternative fuels such as ammonia or hydrogen require new safety and compensation regimes that do not yet exist.¹³ The current private liability and compensation regime does not adequately cover shipping incidents involving alternative fuels.¹⁴

3. Contractual Risks

The shipping industry is predominantly organized through contracts. Market risks materialize in this contractual reality, affecting charter parties, shipbuilding agreements, financing arrangements, insurance policies, and demolition contracts.¹⁵ The following contractual risks were identified:

Sub-category	Potential Risks
<i>All contracts</i>	Compliance with new regulations; increased costs; interpretation differences
<i>Charter party risks</i>	Increased fuel costs; route deviations; slow steaming disputes; force majeure ambiguity
<i>Shipbuilding contracts</i>	Technology specification risks; warranty and performance guarantees
<i>Financing and insurance</i>	Loan covenants linked to emissions; financing reluctance; higher premiums; coverage gaps
<i>Freight and cargo risks</i>	Emission-linked freight rates; cargo preferences; unlawful cargo
<i>Bunkering contracts</i>	Inadequate compliance/specification standards for alternative fuels
<i>Demolition contracts</i>	Recycling standard changes
<i>Certification and verification</i>	Emissions reporting and verification risks

Table 4: Potential Contractual Risks

¹³ Hjelm, R., Sidenvall Jegou, I., Henderson, N., & Howse, T. (2024). *A missing piece of the net-zero puzzle: Gaps in regulatory frameworks addressing the risks posed by alternative fuels*. Global Maritime Forum; Jang, H., Mujeeb-Ahmed, M. P., Wang, H., Park, C., Hwang, I., Jeong, B., Zhou, P., & Mickeviciene, R. (2023). Regulatory gap analysis for risk assessment of ammonia-fuelled ships. *Ocean Engineering*, 287, 115751.

¹⁴ Kruit, J., Mosmans, H., Gaskell, N., & Henderson, N. (2024). Liability and compensation regimes for incidents on board vessels involving the carriage or consumption of alternative fuels. In *CMI International Working Group on Maritime Decarbonisation 'Green Fuels' Workstream*. Comité Maritime International.

¹⁵ Zografakis, H., Henderson, N., Rigden Green, A., Mace-Kokota, D., & Turner, J. M. (2023). Decarbonize Shipping or Decarbonize International Maritime Trade. In M. Lind, W. Lehmacher, & R. Ward (Eds.), *Maritime Decarbonisation: Practical Tools, Case Studies and Decarbonization Enablers* (pp. 201–221). Springer

Practical challenge: ISO 8217:2010 does not cover biofuels, creating contractual ambiguity over quality and compliance.¹⁶ Loan covenants tied to the Poseidon Principles could expose shipowners failing emissions targets to higher interest rates or financing withdrawal.¹⁷

4. Technology Risks

Rapid innovation creates both opportunity and exposure. Companies face the danger that investments in current technologies could become stranded as cleaner alternatives emerge. Technology risks are categorized as follows;

Sub-category	Potential Risks
<i>Infrastructure and asset risks</i>	Stranded assets; integration challenges
<i>Operational risks</i>	Increased costs affecting modal competitiveness; cybersecurity vulnerabilities
<i>Innovation and development risks</i>	Disruption from rapid advancements; R&D failures
<i>Alternative fuel risks</i>	Uncertainty about fuel selection; infrastructure readiness

Table 5: Potential Technology Risks

Strategic dilemma: Heavy investment in hydrogen may become obsolete if ammonia is more widely adopted. The lack of clarity over which fuels will dominate complicates long-term planning.¹⁸

5. Social Risks

Societal expectations increasingly influence business outcomes. ESG factors now shape investor decisions, consumer preferences, and workforce dynamics, resulting in various social risks:

Sub-category	Potential Risks
<i>Market perception risks</i>	Changing consumer preferences; public opinion and social activism
<i>Stakeholder risks</i>	Investor and lender pressure; community resistance
<i>Human capital risks</i>	Labor and skill shortages; training and education needs
<i>Supply chain risks</i>	Increased local production; changing trade patterns
<i>Reputational risks</i>	Environmental performance scrutiny; CSR expectations

Table 6: Potential Social Risks

¹⁶ Collier, P., Lea, S., Lücke, V., Moussalli, M.-A., Volz, E., Datta, N., Kaperoni, M., Naumova, A., & Pilcher, R. (2024). *FuelEU Maritime Series – Part 6: Legal issues*. Clyde & Co.

¹⁷ Poseidon Principles. (2024). *About the Poseidon Principles*. <https://www.poseidonprinciples.org/finance/about/>

¹⁸ Wang, Q., Zhang, H., Huang, J., & Zhang, P. (2023). The use of alternative fuels for maritime decarbonization: Special marine environmental risks and solutions from an international law perspective. *Frontiers in Marine Science*, 9, 1082453; Fricaudet, M., Sohm, S., Smith, T., & Rehmatulla, N. (2024). *Fossil Fuel Carrying Ships and the Risk of Stranded Assets*. The Bartlett Energy Institute and Kühne Foundation.

Workforce challenge: Decarbonization requires new technical skill sets. The World Maritime University highlights threats to operational continuity from insufficient supply of crew trained in alternative fuel operations.¹⁹

The cascade effect: How risks interconnect

Perhaps the most critical insight from the research is that these five risk categories form an interconnected system. Action—or inaction—in one domain triggers consequences in others.

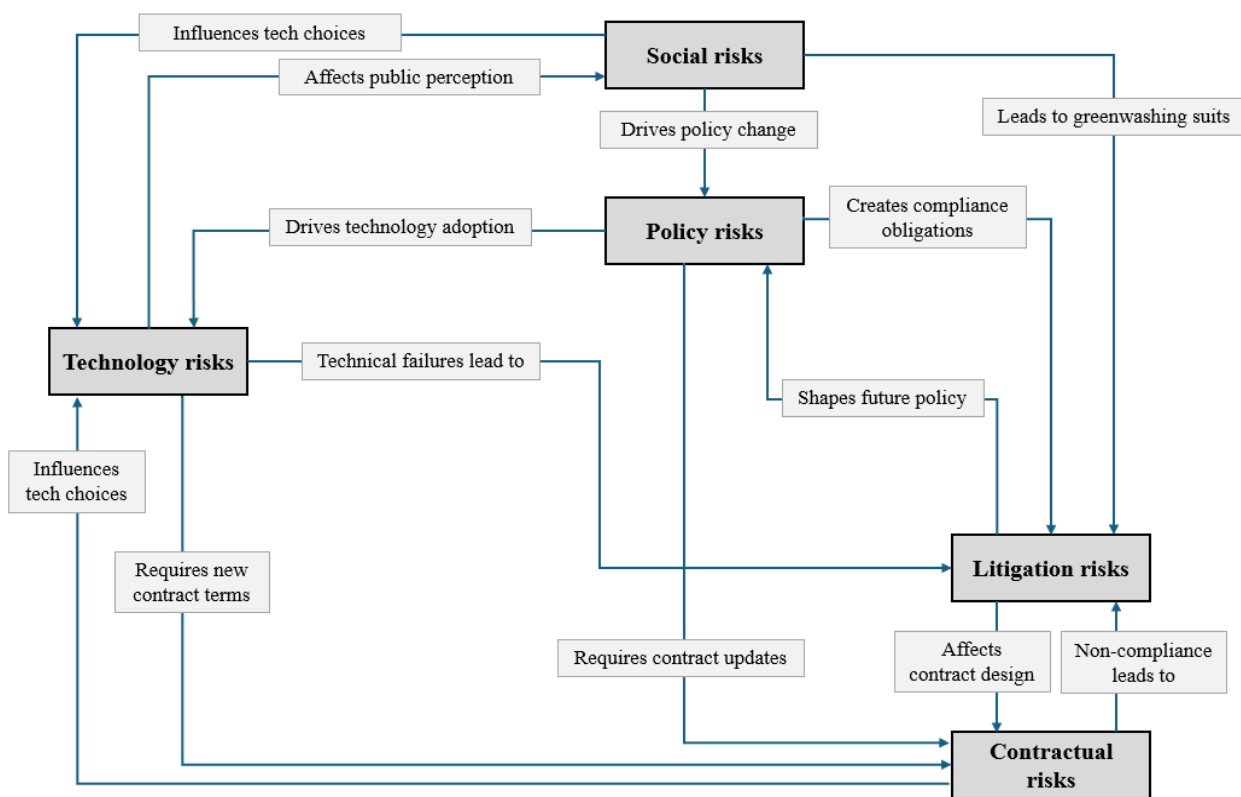


Figure 1: Interconnectedness of Climate Risks for the Shipping Industry

Source: Adapted from Mosmans et al. (2026)

Policy changes frequently trigger technological adaptations, which in turn generate new contractual disputes and legal exposures, while social pressures often catalyse regulatory shifts, intensifying both compliance and litigation risks.

Cascade Example 1: Policy → Contractual

The inclusion of shipping in the EU Emissions Trading System (policy risk) drives operational adjustments such as slower speeds and route optimisation, which in turn generate contractual

¹⁹ World Maritime University. (2023). *Transport 2040: Impact of technology on seafarers – The future of work*.

risks. These may include disputes over performance obligations, the allocation of fuel and carbon costs, insurance coverage for extended voyages, and the adequacy of financial covenants linked to vessel earnings. At the same time, the largely private and flexible nature of contractual arrangements in shipping creates scope for redistributing these transition risks across the contractual chain. However, without clear allocation and sufficient transparency, this may lead to uncertainty and imbalance, highlighting the need for standardised clauses or regulatory guidance to ensure a fair distribution of decarbonisation-related burdens.

Cascade Example 2: Social → Policy → Litigation

Public environmental concerns trigger stricter regulations (policy risks e.g. due to increasing compliance obligations and implementation uncertainties), which in turn spark various litigation forms—not only non-compliance claims, but greenwashing allegations and shareholder suits over inadequate climate risk disclosure. However, an alternative pathway exists: public concerns about rising consumer prices may lead to regulatory hesitation, creating an uneven playing field when regulations are not uniformly adopted across jurisdictions.

Implications and recommendations

Climate transition risks in shipping are not isolated challenges but form an intricate web of interconnected issues cutting across legal, regulatory, technological, contractual, and social dimensions. The identification and categorization of these risks reveals their complex nature and the way they cascade through different aspects of maritime operations.

These interdependencies underscore that responses framed within a single risk are insufficient—a genuinely holistic approach is required.²⁰ The analysis further highlights the dynamic and evolving nature of these risks. As demonstrated through the examination of risk cascades, the interaction between different risk categories can either accelerate or impede the industry's transition toward decarbonization. This suggests that risk management strategies must be adaptive and forward-looking, considering not only immediate challenges, but also potential future developments.

The market players in the shipping industry have far-ranging freedom to define and shape their mutual relationships through contracts. This creates significant potential for allocation of transition risks within the contractual chain. However, effective risk management requires transparency and clear delineation of responsibilities—potentially through standard clauses or guidelines that help ensure financial and operational burdens are fairly distributed.²¹ Regulators may need to proactively consider which parties should bear specific risks, especially those

²⁰ Van Maanen, M., & Kruit, J. (2021). Sustainable Transport. In H. J. De Kluiver (Ed.), *Duurzaam ondernemen en Sustainable Transport, Preadviezen Koninklijke Vereeniging 'Handelsrecht' 2021*. Paris Legal Publishing.

²¹ Zografakis et al., fn 13.

related to decarbonization, in a timely manner that allows contractual relationships to accommodate these public law obligations.

For industry practitioners, several priorities emerge from this analysis: coordinated regulatory frameworks that minimize jurisdictional fragmentation, adaptive contractual arrangements that anticipate evolving requirements, and proactive engagement with stakeholders across the supply chain.²² Understanding and addressing these interconnected risks—and setting priorities accordingly—will be essential for maintaining efficient, sustainable, and resilient maritime operations as the sector continues its transition toward decarbonization.

²² Koning, I., Van der Veen, J., Lambooy, T., Ochquee, P., Stekelenburg, A., & Van Hattum, B. (2023). *De Rol van Recht en Handhaving in de Verduurzaming van Logistieke Ketens*. Boom criminologie.

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