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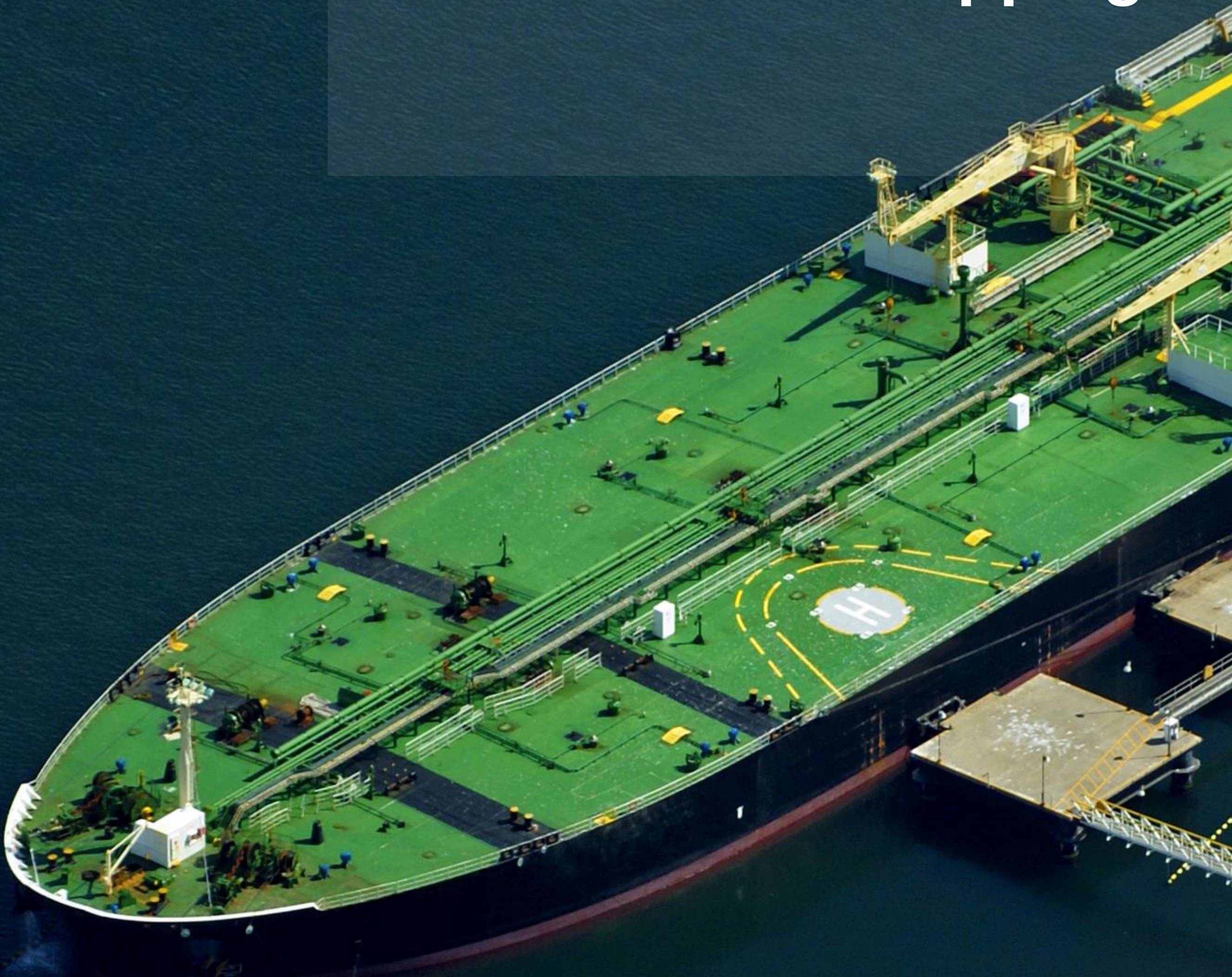
Supply-side and demand-side stranded asset risks in shipping



Marie Fricaudet, Nishatabbas Rehmatulla, Tristan Smith

Authors

Marie Fricaudet
Dr Nishatabbas Rehmatulla
Dr Tristan Smith

Acknowledgements

The report is supported by funding received by UCL from Oceankind and Kühne Foundation, for which the authors are very grateful. Kühne Foundation supported the study on demand-side risks, summarised in this brief. The views expressed are those of the authors.

Publication details

Publication date: 23 January 2025

Cite as: Fricaudet, M., Rehmatulla, N. and Smith, T. (2025), Supply-side and demand-side stranded asset risks in shipping, London, UK.

Contact details

If you require any further information on this report, please contact:
Dr Nishatabbas Rehmatulla, n.rehmatulla@ucl.ac.uk

About UCL Energy Institute

The UCL Energy Institute hosts a world leading research group which aims to accelerate the transition to an equitable and sustainable energy and trade system within the context of the ocean. The Shipping and Oceans Research Group's multi-disciplinary work on the shipping and ocean system leverages advanced data analytics, cutting-edge modelling, and rigorous research methods, providing crucial insights for decision-makers in both policy and industry. The group focuses on three core areas: analysing big data to understand the drivers of shipping emissions, developing models and frameworks to explore the path toward zero-emission shipping, and conducting social science research to examine the policy and commercial structures that enable the decarbonisation of the shipping sector.

Contents

Highlights

- Over 40% of ships globally transport fossil fuels, and nearly all ships are fossil-fuelled.
- Existing ships and those on order would produce approximately double the emissions than that required under a 1.5°C-aligned carbon budget for shipping of 9.6 giga tonnes CO_2-equivalent
- To align with this carbon budget and avoid overshooting, ships representing over one third of the existing and ordered fleet, valued at just over 400bn USD, would need to quickly transition to zero-emission technologies or face premature scrapping.
- The transition away from fossil-fuels in the wider economy creates further risks of oversupply for fossil fuel carrying ships. In particular, liquefied gas tankers face oversupply, with 26–32% of fleet value at risk around 2030.
- Retrofitting and repurposing ships would reduce the amount of stranded assets but can still be a costly alternative.
- Uncertainty in future technology mix complicates planning but proactive management through optionality for example through dual fuelled vessels[1], of the supply-side risks of stranded assets remains necessary.
- Shipowners and financiers could manage or account for demand-side risks by avoiding investment in segments with uncertain future transport demand, investing in optionality for repurposing to other cargoes, and by factoring this risk into expected returns

Aims and objectives

Following the ambitious Revised GHG Strategy from the UN's International Maritime Organization (IMO) Marine Environment Protection Committee (MEPC) 80 meeting in July 2023, the global shipping industry, responsible for 2-3% of anthropogenic greenhouse gas (GHG) emissions[2], now has a clearer path close to aligning with a 1.5°C climate goal[3]. However, this strategy has come late in the timeline required to shift sector investments away from fossil fuels toward sustainable fuels, renew fleets, and optimized operations as ships are high-cost assets with operational lifespans of 20 to 50 years. The focus now is on transforming this ambitious but non-binding UN strategy into robust, equitable and legally binding policies, through "mid-term measures"[4]. With such policies, current carbon-intensive vessels could become less competitive compared to emerging fleet of ships, referred to in this brief as "supply-side risks"[5].

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[1] Where at least one fuel option is a scalable zero emission fuel, defined as a fuel which has net zero well-to-wake GHG emissions and has the potential to be produced at a competitive price compared to fossil fuels
over a long period of time, whilst also having the potential to be produced at the volumes necessary to meet a significant amount of global maritime demand. The total cost of operation of those fuels is provided in LR & UMAS (2020) Techno-economic assessment of zero carbon fuels

[2] Faber, J., Hanayama, S., Zhang, S., Pereda, P., Comer, B., Hauerhof, E., van der Loeff, W. S., Smith, T., Zhang, Y., Kosaka, H., Adachi, M., Bonello, J.-M., Galbraith, C., Gong, Z., Hirata, K., Hummels, D., Kleijn, A., Lee, D. S., Liu, Y., … Xing, H. (2020). *Fourth IMO GHG Study*.

[3] Bullock, S., Mason, J., & Larkin, A. (2023). Are the IMO's new targets for international shipping compatible with the Paris Climate Agreement? *Climate Policy*, *0*(0), 1–6. https://doi.org/10.1080/14693062.2023.2293081

[4] Smith, T., Fricaudet, M., Frosch, A., Stewart, J., Oluteye, D., & Chin-yee, S. (2024). *An overview of the discussions from IMO 's 17th Intersessional Working Group on GHGs*. https://www.shippingandoceans.com/post/imo-on-track-to-deliver-an-ambitious-package-of-policies-for-reducing-ghg-emissions

[5] Smith, T., Bracewell, T., Mulley, R., & Palmer, K. (2015). Stranded assets and the shipping industry. In *SCC2015: Shipping in Changing Climates Conference 2015*.

Simultaneously, meeting the climate targets outlined in the Paris Agreement requires a swift transition to a low-carbon global economy. This means replacing fossil fuels used across the energy, transport, and industrial sectors with renewable electricity and other low or zero-carbon energy sources. In its updated Net Zero by 2050 scenario, the International Energy Agency (IEA) projects that coal demand would drop by 90% to 500 million tonnes, oil by 75% to 24 million barrels per day, and natural gas by 78% to 900 billion cubic meters[6]. The anticipated decrease in fossil fuel trade would therefore lower demand for transporting these commodities, referred to in this brief as "demand-side risks"[7].

This policy brief provides an overview of the scale of both supply-side and demand-side risks for the shipping industry, building on previous research[8] and offering updated results based on the latest data. The aim is to raise awareness among industry stakeholders and financiers about the urgent need to assess their current investments and, where necessary, realign them to better respond to evolving market conditions and climate goals.

Approach

This brief provides a more recent and global quantification of the scale supply-side risks published previously[9]. The scale of supply-side risks is calculated by estimating emissions of the existing and ordered ships until they reach their scrapping age, based on latest observed operational conditions obtained from the 4th IMO GHG study and recent studies on energy efficiency trends[10] (see box 3) and comparing it to shipping's share of the carbon budget aligned with a 1.5°C trajectory (see box 2).

For demand side-risks, previous evidence published in Fricaudet et al. (2024) is used, which focuses on four shipping segments for their stranded assets risk in the transition towards meeting the 1.5°C climate target: bulk carriers for coal, oil tankers, liquefied natural gas (LNG) tankers and liquefied petroleum gas (LPG) tankers. The quantitative results reported below do not account for the fleets' limited ability to carry other cargos nor for an eventual decrease in supply, e.g., early scrapping as a response to a decline in transport demand; hence, the results indicate a maximum risk. The potential of fossil fuel carrying ships' ability to repurpose to carry other cargos is discussed qualitatively.

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[6] IEA. (2023). *Net Zero Roadmap. A Global Pathway to Keep the 1.5°C Goal in Reach. 2023 Update.* https://www.iata.org/contentassets/8d19e716636a47c184e7221c77563c93/finance-net-zero-roadmap.pdf

[7] Smith, T., Bracewell, T., Mulley, R., & Palmer, K. (2015). Stranded assets and the shipping industry. In *SCC2015: Shipping in Changing Climates Conference 2015*.

[8] Fricaudet, M., Prakash, V., Sohm, S., Smith, T., & Rehmatulla, N. (2024). *Fossil Fuel Carriers and the Risk of Stranded Assets*. https://www.shippingandoceans.com/post/fossil-fuel-shipping-profits-could-decrease-by-30-as-we-move-to-decarbonisation;
Fricaudet, M., Rehmatulla, N., & Smith, T. (2022). Understanding the Scale of the Stranded Assets Risk in the Shipping Industry. *SSRN Electronic Journal*. https://doi.org/Preprint at 10.2139/ssrn.4036552

[9] Bullock, S., Mason, J., Broderick, J., & Larkin, A. (2020). Shipping and the Paris climate agreement: a focus on committed emissions [Article]. *BMC Energy*, *2*(5), 1–16. https://doi.org/10.1186/s42500-020-00015-2

[10] Faber, J., Hanayama, S., Zhang, S., Pereda, P., Comer, B., Hauerhof, E., van der Loeff, W. S., Smith, T., Zhang, Y., Kosaka, H., Adachi, M., Bonello, J.-M., Galbraith, C., Gong, Z., Hirata, K., Hummels, D., Kleijn, A., Lee, D. S., Liu, Y., … Xing, H. (2020). *Fourth IMO GHG Study*;
Smith, T., & Francis, H. (2024). *Transition Trends: International Shipping Emissions from 2018 to 2022*. https://www.shippingandoceans.com/post/international-shipping-emissions-return-to-peak-2008-levels-due-to-insufficient-energy-efficiency-im

Key findings

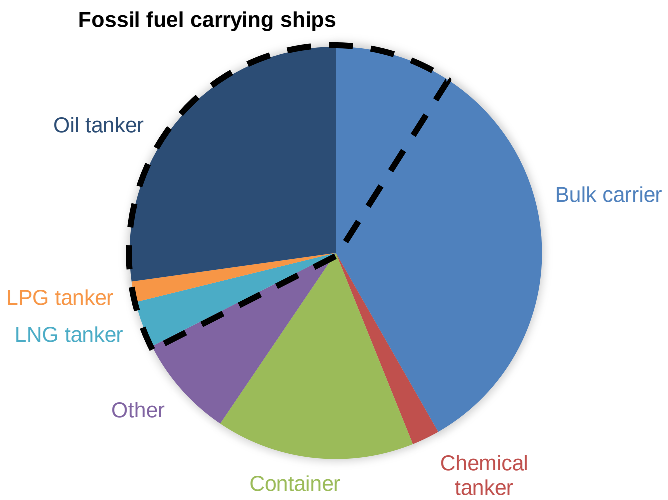
Over 40% of ships transport fossil fuels, and nearly all ships are fossil-fuelled

Today, nearly all existing and ordered ships are fossil-fuelled, and only a small share (2%) of the fleet is ready or capable to switch to scalable zero-emission fuels such as ammonia or methanol (Figure 1). Only a third of the existing and ordered fleet is equipped with at least one energy saving technology such as propeller ducts, bow enhancement or wind assistance, despite many of those technologies being mature and cost-effective[11]. The fleet therefore appears ill-prepared to cope with a supply-side shock resulting from future GHG regulations.

Regarding demand-side risks, over one third[12] of the global shipping capacity is used to transport fossil fuels (Figure 1). As of 2023, the value of existing and ordered oil tankers was USD 286 billion, containers for USD 264 billion, bulk carriers for 336, LNG tankers for USD 188 billion, LPG tankers for USD 67 billion[13] (Figure 2; box 1 for details on the method). As LNG tankers are much more expensive than other ships, the comparably small fleet has a high total value.

Box 1: Valuation of the fleet

The fleet's residual value is calculated for 2023 and annually through 2050 by estimating each ship's newbuild value, determined by design characteristics (deadweight, segment, fuel type, and engine size). This value is then depreciated linearly to its scrappage value over the ship's expected lifetime. Parameters used for linking ships' design characteristics and newbuild value are found in Fricaudet et al, 2024.



[11] Rehmatulla, N., & Smith, T. (2020). The impact of split incentives on energy efficiency technology investments in maritime transport. *Energy Policy*, *147*, 111721. https://doi.org/10.1016/j.enpol.2020.111721
[12] 41%: this calculation is based on the combined deadweight of the current and ordered fleets of liquefied gas and oil tankers, along with an additional 17% of the deadweight from the bulk carrier fleet, as recorded by Clarksons WFR on the 9th January 2024 (Clarksons Research, 2022). The 17% adjustment represents the proportion of coal trade within total bulk trade (measured in ton-miles), according to data from the Clarksons Shipping Intelligence Network (SIN) (Clarksons Research, 2023).
[13] Fricaudet, M., Prakash, V., Sohm, S., Smith, T., & Rehmatulla, N. (2024). *Fossil Fuel Carriers and the Risk of Stranded Assets*. https://www.shippingandoceans.com/post/fossil-fuel-shipping-profits-could-decrease-by-30-as-we-move-to-decarbonisation

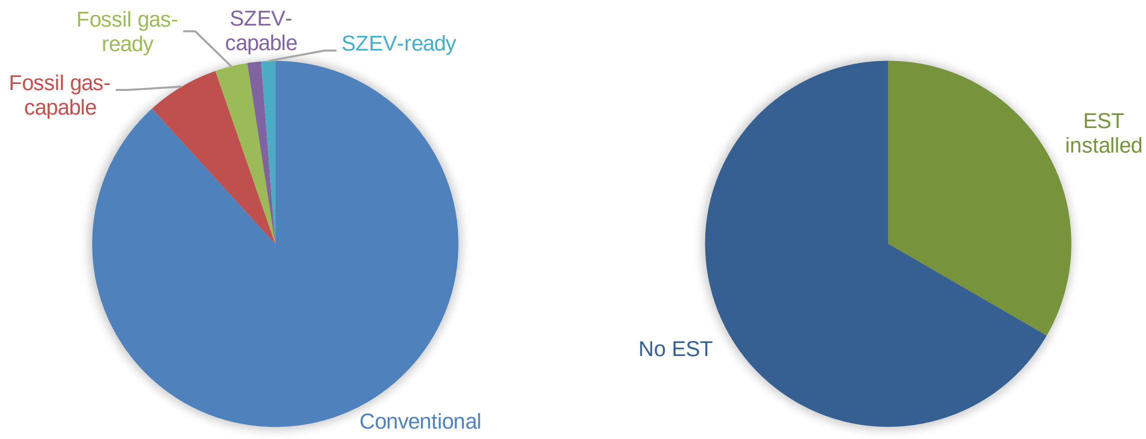


Figure 1: Existing and ordered deadweight, by sensitivity to stranded asset risk[14]

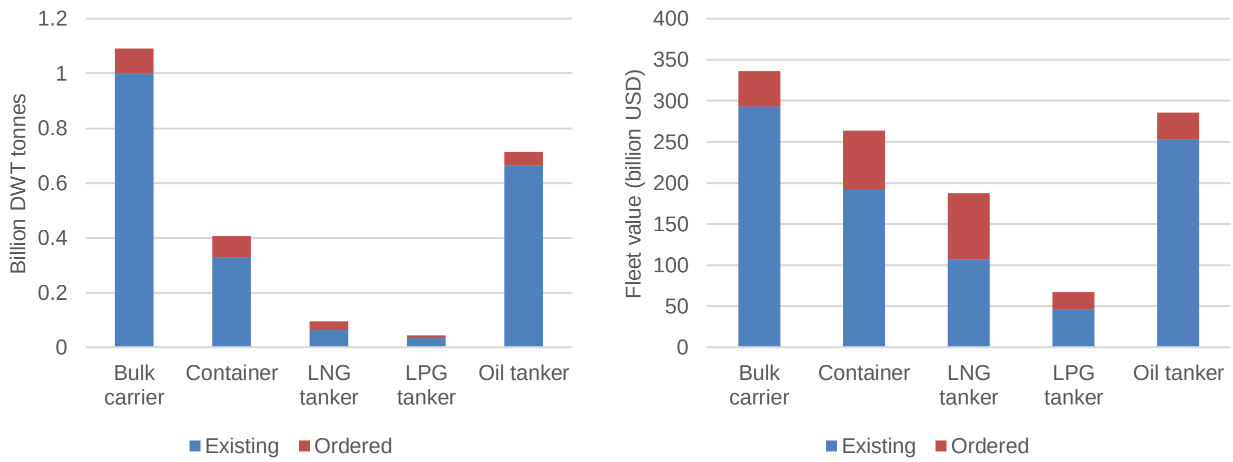


Figure 2: Existing and ordered fleet in selected segments as of 2023

[14] Calculated using Clarksons WFR collected on the 9th January 2024
SZEV refers to scalable zero emission vessels capable of using scalable zero emission fuels (SZEF) as defined in page 3
EST refers to Energy Saving Technologies such as bow enhancements, propeller ducts, wind technologies

Existing ships and those on order would result in approximately double the emissions than that required under a 1.5°C-aligned carbon budget[15]

In 2023, the existing and ordered fleet's committed emissions – emissions that the ships are expected to produce throughout their remaining lifetime if they continue operating as their historical average – were estimated at 18.3 billion tonnes of CO_2-equivalent[16] (Figure 4). Most of the committed emissions are embedded in the largest shipping segments in terms of activity, namely container ships, bulk carriers, oil tankers, and liquefied gas tankers, which together represent around three quarter of the fleet's committed emissions. Younger ships tend to have higher committed emissions, as they have a longer lifetime. However, the high level of ordering of ships after 2010, in particular in the bulk carrier and container segments, means that there is a large amount of committed emissions associated to that generation of ships (Figure 3). They also represent a large share of the capital sunk in those two segments. On the other hand, the splurge of ordering in the container and the liquefied gas tanker segment means that a significant amount of emissions and capital is linked to the recently built ships and in the orderbook (Figure 2).

Box 2: Calculating shipping carbon budget

The carbon budget for shipping is calculated as the product of the share of shipping in global GHG emissions and the global carbon budget at the start of 2023. The first is taken from the IMO 4th GHG (2.89%). The remaining carbon budget from the start of 2018 consistent with a 50% chance of limiting the warming to 1.5°C is estimated at 580 billion tonnes of CO_2-e[16]. Of this estimate, 100 billion tons of CO_2-e should be subtracted to account for permafrost thawing and the potential release of methane from wetlands in the future[16], as well as 4.1 billion tonnes of CO_2-e of shipping emissions from 2018 to the start of 2023, calculated using the IMO's 4[th] GHG study and Smith & Francis (2024).

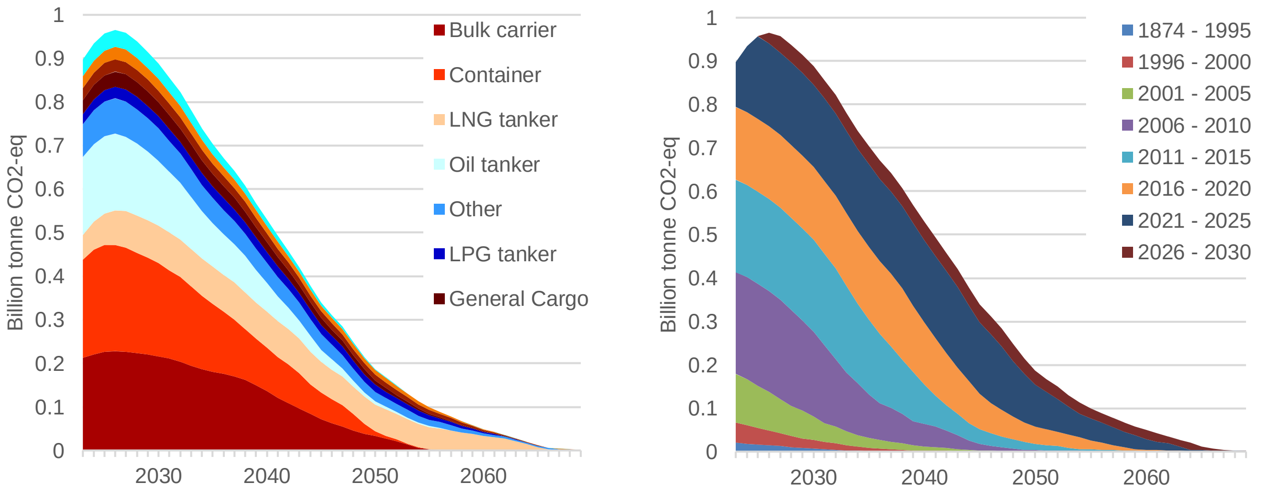


Figure 3: Committed emissions of the existing and ordered fleet each year from 2023 to 2070

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[15] This is expressed in CO_2-equivalent and therefore include other gases than CO2 which have a greenhouse potential.
[16] Rogelj, J., Shindell, D., Jiang, K., & Fifita, S. (2018). Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In *Global warming of 1.5°C. An IPCC Special Report on the impact of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,* (p. 2).

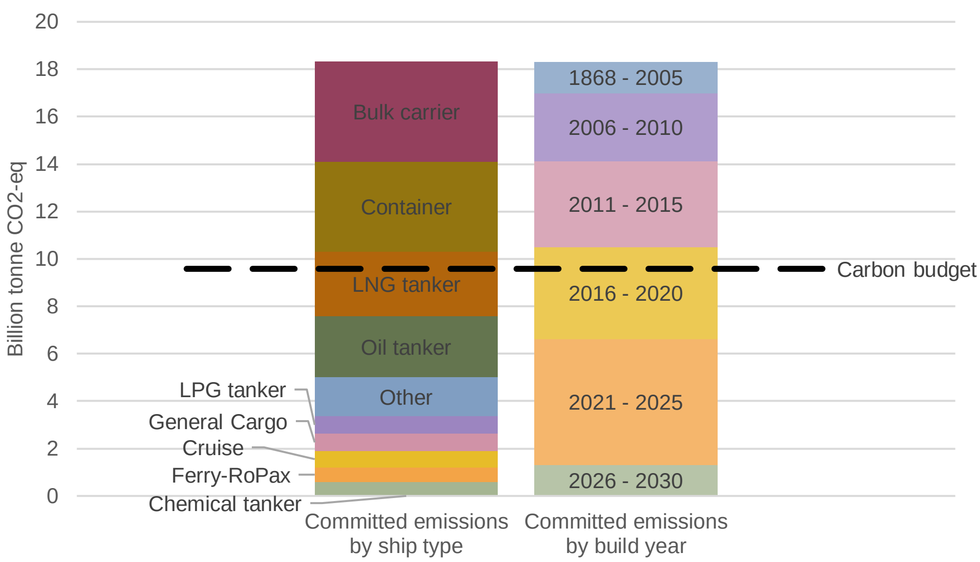

Figure 4: Committed emissions of the existing and ordered fleet up to their scrapping age, and remaining carbon budget in 2023

Even if no new conventionally powered ships were ordered from the start of 2024 onward, 48% of the emissions exceed the carbon budget allocated to the shipping sector (around 9.6 billion tonnes of CO_2-equivalent) and must be avoided if the sector is to stay within its 'fair share' emissions limit (Figure 4). This implies that, to comply with the carbon budget, a fleet representing around half of committed emissions would need to either retrofit to scalable zero-emission technology or be scrapped and replaced with zero-emission vessels immediately.

To grasp the magnitude of the challenge, this is equivalent to only ordering zero emission vessels as of today, and immediately replacing by or converting to zero emission vessels all ships built before 2016. To understand the scale of capital at risk, the report focuses on the four main segments, for which the fleet value can be estimated (see box 1). If the market is efficient in realising and minimising the amount of stranded value, that is, assuming that the ships with the highest committed emissions over residual value are stranded first, ensuring that 48% of the committed emissions are not emitted requires that ships worth USD 411 billion stop emitting any GHG from 2024 onward. This represents 36% of the fleet's residual value. Those ships would either need to be retrofitted immediately, or be scrapped altogether., If the market is less than efficient in realising and minimising this significant stranded asset risk, and ships with higher committed emissions compared to their residual values keep on operating, the value at risk would increase even further. Furthermore, any fossil-fuelled new order adds to the committed emissions of the fleet while any additional emissions from ships for example through increased level of activity than that estimated would further reduce the remaining carbon budget available.

Box 3: Estimating committed emissions

To calculate committed emissions, each ships remaining lifetime is multiplied by its annual emissions - corresponding to the average emissions of the shipping segment and size published in the IMO 4th GHG study and updated for the segments covered in Smith & Francis (2024) to 2022 data.

The detailed description of methods and results can be found in Fricaudet et al, 2022, although slightly more recent input for emissions and fleet from Clarksons World Fleet Register and Smith & Francis (2024) were used for this policy brief.

Aligning shipping demand with a 1.5°C carbon budget will mean the gas tanker market will face substantial oversupply, leading to approximately 30% of the fleet value being written off by around 2030

If the demand for fossil fuel transport aligns with a 1.5°C carbon budget by 2050, liquefied gas tankers are likely to face significant oversupply. The LNG and LPG fleets are relatively young, averaging around 7 years for LNG tankers and 15 years for LPG tankers, leaving them with a remaining operational lifespan of approximately 20 to 30 years. Additionally, new orders are substantial, representing 55% and 28% of the current fleet's capacity, respectively. The combination of a young fleet and significant new capacity projected to enter the market suggests an oversupply that could persist through the mid-2040s (Figure 5). At its peak, this oversupply means that 26 to 32% or USD 52 to 63 billion of the fleet value[17] is left idle, and potentially at risk of being stranded.

In contrast, demand for transporting dry bulk goods, such as iron ore, steel products, grains, forestry goods, and minerals, is projected to increase. This growth is expected to more than offset the anticipated drop in coal transport demand. If no additional capacity is added to the dry bulk fleet, there could soon be a shortage in transport capacity to meet demand.

Box 4: Modelling of transport demand

In the modelling approach, projected future demand for fossil fuel transport is taken from the 4th IMO GHG Study. Since these projections were based on scenarios developed in 2018, the model was updated to reflect a 2024 perspective. The original forecast for total transport demand from 2018 to 2050 is kept constant but annual demand over the 2018-2023 period is adjusted to align with actual observed demand, which exceeded the initial 2018 projections, while keeping cumulative demand across the 2024-2050 period equal to the 4th IMO GHG Study 2020's. For more details, see Fricaudet et al, 2024

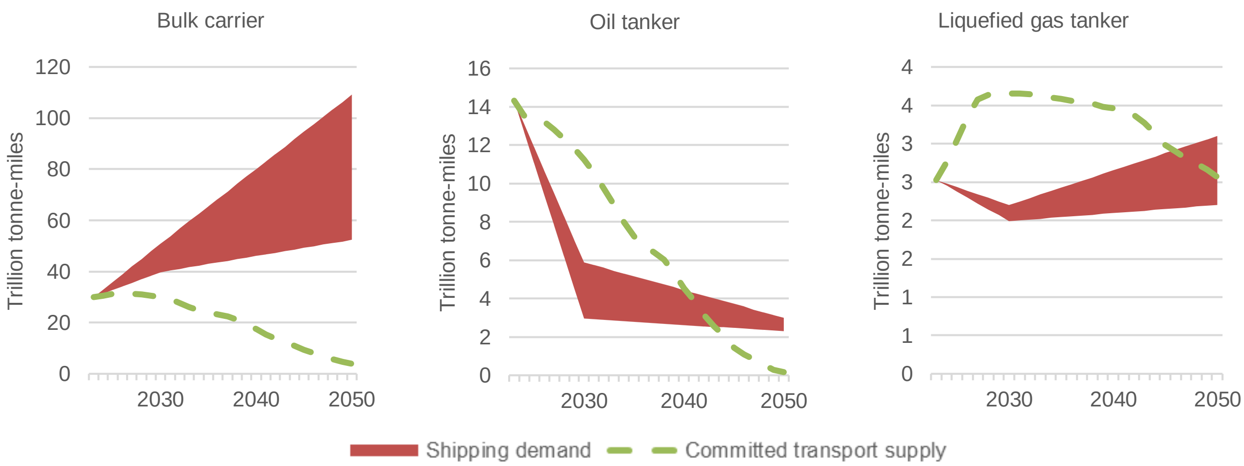

Figure 5: Committed supply of the existing and ordered fleet and projected demand aligned with a 1.5°C carbon budget [18]

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[17] The range corresponds to the range of scenarios on shipping gas demand in the IMO 4th GHG study.

[18] Fricaudet, M., Prakash, V., Sohm, S., Smith, T., & Rehmatulla, N. (2024). *Fossil Fuel Carriers and the Risk of Stranded Assets*. https://www.shippingandoceans.com/post/fossil-fuel-shipping-profits-could-decrease-by-30-as-we-move-to-decarbonisation

The oil tanker fleet is relatively old, with an average age per size category ranging from 10 to 30 years and an estimated remaining operational life of about 10 years, while new orders make up only 7% of the current fleet's capacity[19]. For oil tankers, supply and demand are set to decrease in tandem, as the aging fleet depreciates rapidly and the order book remains modest, although oversupply is still possible in the short term (Figure 5).

Retrofitting and repurposing is possible for certain fossil fuel carrying and carbon-intensive ships but can be a costly alternative

Repurposing fossil fuel carriers to transport alternative products and fossil-fuelled ships to energy efficiency technologies and/or alternative fuels could reduce stranded asset risks, although there are costs, technological and market limitations to consider.

Regarding the supply-side risk, retrofits to scalable zero emission fuels such as methanol and ammonia will be available from 2025 and 2027 respectively[20]. Retrofitting to alternative fuels might be technologically possible if sufficient space is available for storing the alternative fuel and the equipment onboard[21], and for ammonia and methanol, if vessels are equipped with electronically controlled engine, are sufficiently large and sufficiently young[21] If retrofitting is not feasible due to technical limitations, lack of financing solutions or lack of shipyard capacity, the entire value of the ship is at risk.

However, even when retrofitting is a less expensive alternative to scrapping it still leads to fleet devaluation due to retrofitting costs as well as to competition between the existing fleet and newbuilds. To illustrate this argument, take an example of a conventional 8-year old ship, worth ~16 million USD, which needs to retrofit to a zero-/low-emission technology to remain competitive and meet GHG regulations (for example to ammonia) (Figure 6). This ship would be in competition with ammonia-fuelled ships with similar design specifications (e.g. size, cargo carried), which are slightly more expensive. An ammonia dual-fuel newbuild of the same specifications would be worth USD 36 million, and an 8-year-old one around USD 22 million (step 1). However, the 8-year-old conventional-fuelled ship also needs to bear the cost of retrofitting (approximately 14 million USD, step 2), so that its residual value is USD 22 – 14 = 8 million. Step 3 shows the resulting value stranded, i.e. 16 – 8 = 8 million USD. As a consequence, even if all fossil-fuelled ships could technologically retrofit, a large share of the fleet value would still be stranded: for example, around a quarter of the LNG-fuelled fleet value might become stranded by 2030 if it needs to retrofit to ammonia to stay competitive[22]. The same rationale would likely apply to fossil fuel-carrying ships retrofitting to alternative cargoes.

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[19] Fricaudet, M., Prakash, V., Sohm, S., Smith, T., & Rehmatulla, N. (2024). *Fossil Fuel Carriers and the Risk of Stranded Assets*. https://www.shippingandoceans.com/post/fossil-fuel-shipping-profits-could-decrease-by-30-as-we-move-to-decarbonisation

[20] Lloyd's Register. (2023). *Engine retrofit report 2023: Applying alternative fuels to existing ships*.

[21] Yalamov, D., Georgiev, P., & Garbatov, Y. (2023). Economic Feasibility of Retrofitting an Ageing Ship to Improve the Environmental Footprint. *Applied Sciences (Switzerland)*, *13*(2). https://doi.org/10.3390/app13021199

[22] Fricaudet, M., Taylor, J., Smith, T., & Rehmatulla, N. (2022). *Exploring methods for understanding stranded value: case study on LNG- capable ships*.

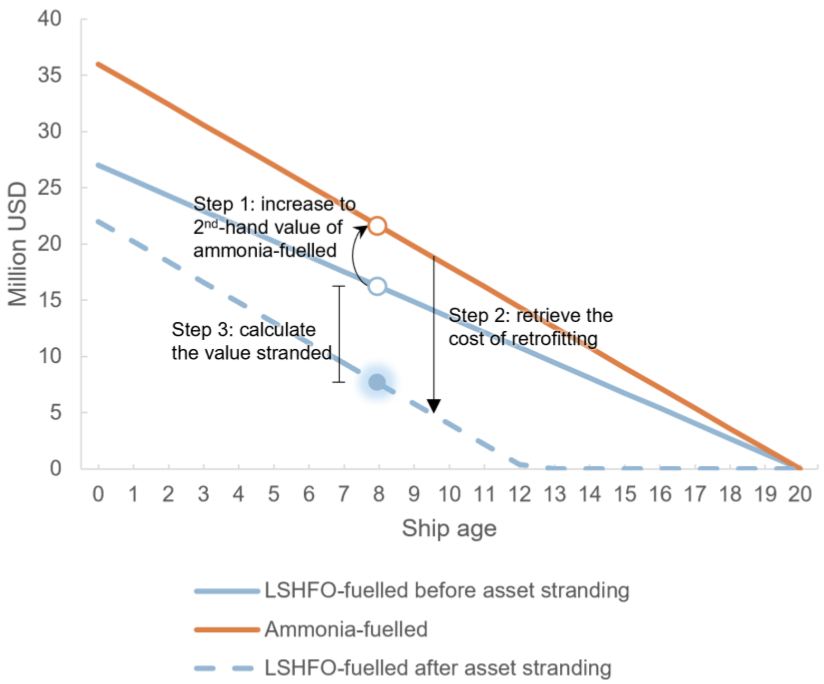

Figure 6: Asset stranding when retrofitting[23]

In terms of demand-side risks, several commercial challenges exist to retrofitting, including uncertain demand for alternative cargo types, the adaptability of markets, compatibility with port infrastructure, and design restrictions onboard ships[24] (Table 1). Converting oil tankers to carry chemicals or biofuels is promising but would require adjustments to handle the smaller volumes typical of these commodities compared to oil. LPG tankers could be adapted for ammonia transport, but this shift would require stringent safety upgrades across vessels, port facilities, and for personnel handling the cargo. LNG tankers face even greater challenges for ammonia conversion, involving costly modifications to tank membranes and other equipment. Unlike tankers, coal carriers might adapt more readily to other dry cargoes, posing a lower risk of becoming stranded assets.

Table 1: Challenges for repurposing fossil fuel carrying ships to other selected cargos[24]

	Toxicity and safeguarding	Structural changes	Trading, cargo size, and port restrictions	Costs and return on investment	Cargo optionality
Oil tankers to chemical including methanol or bio-products	Low-medium	Medium	Medium-High	Medium.	Medium
LPG tankers to ammonia	Medium	Low	Medium	Low-Medium	Medium-High
LNG tankers to ammonia	Medium	Medium-High	Medium-High	Medium-High	Medium-High
Coal carriers to other dry cargo like iron ore or other minerals	Low	Low	Low-Medium	Low-Medium	Low

[23] For clarity, the numbers plotted and quoted in this example are illustrative, residual value at scrapping age is assumed to be 0 and the lifespan of the ship is assumed to be 20 years. The average observed scrapping age and the residual value at scrapping age are tailored to ship size in the remaining of the report (see box 1).

[24] Fricaudet, M., Prakash, V., Sohm, S., Smith, T., & Rehmatulla, N. (2024). *Fossil Fuel Carriers and the Risk of Stranded Assets*. https://www.shippingandoceans.com/post/fossil-fuel-shipping-profits-could-decrease-by-30-as-we-move-to-decarbonisation

Implications and recommendations

Growing evidence suggests that economic actors, particularly shipowners and financiers, are not anticipating a highly ambitious transition[25]. In the short term, transition risks, such as those related to policy, litigation, and technology, do not appear fully credible to them. As a result, these risks are not being adequately factored into their investment decisions, thereby exacerbating transition risk.

Shipping's transition has never been just about what happens at the IMO, however, 2025 is a key year in the international regulator's calendar as it will approve policies, a global fuel standard, a carbon price, and lifecycle analysis (LCA) guidelines, which will particularly crystallise the supply-side risks. Anticipating an ambitious outcome on these and following the latest available science is the least risky strategy, particularly because, as has been evidenced, the ambition will ratchet up over time as the IMO continues to bridge the gap between policy and the latest available science, for example from the IPCC.

Shipowners and financiers could manage or account for demand-side risks by avoiding investment in segments with uncertain future transport demand, investing in optionality for repurposing to other cargoes, and by factoring this risk into expected returns.

Although uncertainty persists regarding which technologies will dominate the future fuel mix, proactive planning remains essential despite its complexity. Shipowners and financiers can manage these risks by prioritizing investments in ships that are adaptable to future retrofits and incorporating anticipated retrofitting costs into current ship valuations. Furthermore, energy efficiency provides a degree of resilience in all scenarios by:

- Enabling fossil-fuel-powered ships to comply with climate regulations and lower emissions for an extended period, allowing time for the fuel mix to stabilize.
- Reducing the size requirements for tanks and engines while maintaining the same level of transport capacity, thereby enhancing operational flexibility and efficiency.

The process by which the risk of stranded assets—such as underutilization or premature scrapping—would impact various economic actors, including shipowners, charterers, banks, shareholders, and government finances, remains unclear. This uncertainty is increased by the fragmented nature of the ownership market. It is not evident which parties would ultimately bear the costs of asset stranding or whether they could transfer these costs to others, such as banks. As a result, the environment becomes unpredictable, making it challenging to quantify, anticipate, and effectively price in transition risks.

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[25] Fricaudet, M., Parker, S., Ameli, N., & Smith, T. (2024). Lower margins are tied to companies' climate performance rather than to low-carbon assets. *Cell Reports Sustainability*, *1*(8), 100155. https://doi.org/10.1016/j.crsus.2024.100155; Fricaudet, M., Parker, S., & Rehmatulla, N. (2023). Exploring financiers' beliefs and behaviours at the outset of low-carbon transitions: A shipping case study. *Environmental Innovation and Societal Transitions*, *49*, 100788. https://doi.org/10.1016/j.eist.2023.100788

Limitations

The methods employed in this policy brief have several limitations, as detailed in Fricaudet et al, 2024. Key limitations include:

- **Preliminary estimates**: The initial assessment of stranded assets relies on peer group averages to evaluate committed supply and emissions, resulting in findings that are preliminary and simplistic. Furthermore, the approach taken is normative and top-down, and although it is helpful to understand the misalignment of the current fleet with climate objectives, it is silent on the bottom-up drivers of asset stranding, such as regulation, evolution in technology costs of low-/zero-carbon shipping, customer pressure. Estimates of the scale of stranded assets further do not quantitatively incorporate the possibility nor the cost of retrofitting, although this was qualitatively discussed.
- **Narrow scope of demand-side risks**: The analysis considers only one aspect of demand-side risk and focuses on three shipping segments—bulk carriers, liquefied gas tankers, and oil tankers. However, additional factors linked to low-carbon transitions could further affect future transportation demand. For example, a global shift away from fossil fuels would likely reduce offshore activities tied to fossil fuel extraction. Similarly, trends like increased regionalization of trade and demand for local products could shorten shipping distances and reduce activity overall [26]. Conversely, potential growth in transporting new commodities such as biofuels, CO_2, and hydrogen-derived fuels is not accounted for, which could offset some of the decline in fossil fuel transport.
- **Omission of recent trade dynamics**: The demand projections used to evaluate demand-side risks do not reflect recent developments in global trade. For instance, the impacts of the conflicts in Ukraine and Gaza, such as increased shipping distances, shifts from pipeline to ship transport, and reduced gas consumption due to rising prices, are not incorporated into the analysis.

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