NAVIGATING THE NET-ZERO TRANSITION

Insights and Concepts for Financing Shipping Decarbonisation

Environmental Defense Fund

The Decarb Hub LR

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DR. CARLO RAUCCI – Lloyd's Register Maritime Decarbonisation Hub, Director

"This report reflects the results of a strong collaboration that aims to advance shipping decarbonisation with innovative financing mechanisms. By evaluating such mechanisms - from new offtake models to blended finance mechanisms — we are helping to unlock investment, reduce risk, and build confidence in the fuels of the future. In doing so, the report brings the Decarb Hub theory of change to life: turning ambition into action. These insights are not a final answer, but a call to collaboration, providing practical pathways to scale fuel adoption and move the maritime sector closer to its net-zero future."

ANGIE FARRAG-THIBAULT - Environmental Defense Fund, Vice President

"While maritime sector has made progress in embedding decarb as a key factor in its sustainable future, financing the transition away from fossil fuels remains an enduring challenge. At the same time, we see significant learnings from the finance industry in de-risking clean-tech investments. Our aim with this work has been to highlight these opportunities, refine further for application to this sector, and connect stakeholders trying to accelerate the adoption and commercialization of more sustainable fuels and technologies. In doing so, it supports EDFs key objective of making sure the IMO's short and mid-term measures can be successfully implemented. We are grateful for the excellent collaboration across our networks in producing this research and report and welcome further engagement to bring solutions to scale."

From the authors:

DANA RODRIGUEZ - Lloyd's Register Maritime Decarbonisation Hub, Programme Manager

"Silos are holding back shipping's transition. Financiers remain cautious about one of the toughest industries to decarbonise, while scaling zero- and near-zero emission fuel projects demands huge CAPEX, in some cases up to $2 billion for infrastructure, storage and terminal facilities. These challenges are evident in the lack of communication between shipping and infrastructure finance, despite their interdependence. To overcome this, fuel procurement strategies must evolve, and bold collaboration across the maritime value chain is critical. Finance and shipping must meet in the middle to deliver a sustainable and affordable transition."

GUILLAUME MORAUW - Environmental Defense Fund, Senior Policy Analyst

"Without strong action, emissions from maritime shipping are projected to rise up to 130% of 2008 levels by 2050, putting the sector far off track of its climate targets. The sheer CAPEX intensity of ships and fuel infrastructure creates major financing needs to achieve the transition. That's why additional, innovative mechanisms to de-risk projects and channel capital at scale are essential. By backing energy-saving retrofits, the lending platform helps shipowners cut emissions and mitigate transition risks, while giving financiers a practical way to make impact and decarbonise their portfolios."

ACKNOWLEDGMENT

We would like to thank our teams at EDF and LR for their guidance and reviews, as well as all stakeholders who contributed to this study, including banks and investors, insurers and export credit agencies, shipowners and operators, industry associations, maritime experts, fuel producers and energy generators, and academics and non-profit organisations. We are especially grateful to the following experts for their valuable input to parts of this report: Ahila Karan and Dr. Charlie McKinlay (LR Decarb Hub), Marie Cabbia Hubatova, Jenny Mandel and Andrew Howell (EDF), Katrina Ross (UK Chamber of Shipping), Gerasimos Zolotas (EuroFin Group), Dr. Tristan Smith and Dr. Marie Fricaudet (UCL), Yves Kallina (Hamburg Commercial Bank), The Maritime Emissions Reduction Center (M-ERC), Joe Boyland (GMF), Jon Tarjei Kråkenes (Wallenius Wilhelmsen). Their contributions and reviews have greatly enriched this work. However, their participation does not imply endorsement of the analysis, findings, or conclusions presented in this report, which remain the sole responsibility of the authors.

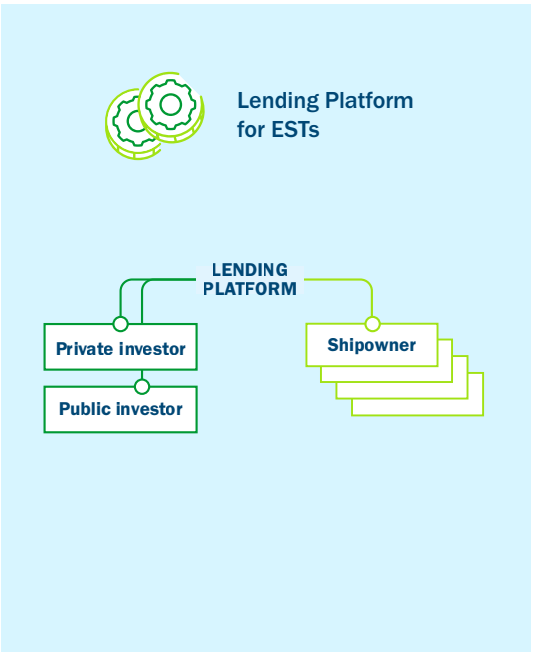
EXECUTIVE SUMMARY

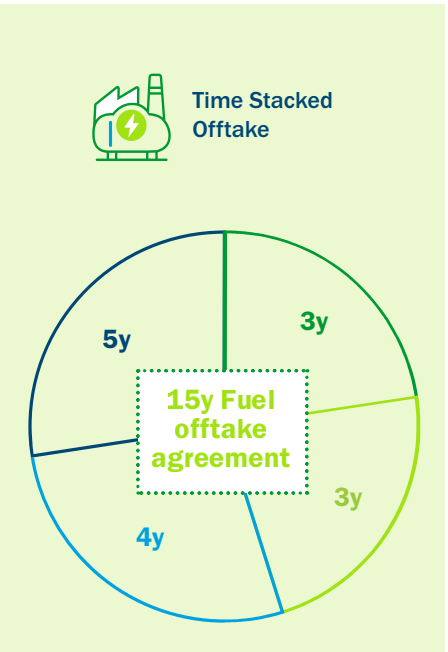
Global efforts to decarbonise maritime shipping by the mid-century will require innovative mechanisms to unlock capital and reduce risk for the transition to net-zero. This report examines three concepts that emerged during a *workshop* hosted by Environmental Defense Fund (EDF) and Lloyd's Register Maritime Decarbonisation Hub (the Decarb Hub) in 2024 as promising opportunities for further exploration to help address key barriers to financing shipping decarbonisation.

The energy transition of the shipping sector will require coordinated and swift action across various fronts, including:

- Improving the energy efficiency of the existing fleet
- Progressively replacing older vessels with zero and near-zero GHG emission (ZNZ) [1] capable ships
- Scaling up ZNZ fuel production and bunkering infrastructure

The workshop identified areas of nascent opportunity for both the finance and shipping sectors to contribute to the acceleration of maritime shipping decarbonisation. Aggregating expert insights from the workshop discussions and more than 40 one-on-one interviews, this report explores, evaluates, and critically examines three concepts that demonstrate potential to deliver systemic climate benefits, create a value proposition for shipping net-zero transition, and support shipping stakeholders and financiers in achieving their decarbonisation targets.





[1] ZNZ fuels are defined as per IMO MEPC 83/J/9 Regulation 39 and upcoming guidelines "ZNZs shall include technologies, fuels and energy sources and be evaluated on a well-to-wake basis, taking into account guidelines to be developed by the IMO. The GFI threshold for ZNZs shall be set at not greater than 19.0 gCO2eq/MJ for an initial period until 31 December 2034, and from 1 January 2035, the threshold shall be set at not greater than 14.0 gCO2eq/MJ taking into account LCA guidelines developed (MEPC.391(81)) and those to be developed by the IMO".

Maritime Multiplier Carbon Accounting

This tool measures and communicates the cross-sector benefits of investing in shipping decarbonisation. By reframing the value proposition of such investments, this tool can incentivise capital allocation to the sector's transition, help to align shipping with investors' ESG goals, and gives a clearer understanding of maritime exposure.

Target audiences include public and private banks, and investors who can use the tool to quantify "out-sector" benefits, integrate output metrics into sustainability reporting, and develop sustainable finance products.

Lending Platform for energy saving technologies (ESTs)

This platform channels public and private capital to offer loans to shipowners for ESTs and retrofit projects. This ensures sustainable access to finance, particularly for smaller shipping players, supports near-term emissions reductions from the existing fleet, and helps develop the maturity and scale of the EST and retrofit market.

Target audiences include smaller shipowners seeking capital, as well as banks, public investors, and funds looking for impact-oriented financing tools to support real-world decarbonisation.

Time Stacked Offtake

This model breaks long-term (10 to 15-year) ZNZ fuel offtake contracts into smaller tranches for multiple mid and downstream buyers. For fuel producers, it aggregates demand to unlock capital for new ZNZ projects. For offtakers it offers shorter contract periods and risk-sharing arrangements, increasing flexibility and lowering barriers to participation.

Target audiences include ZNZ fuel developers aiming for Final Investment Decision (FID) and mid and downstream players with limited long-term offtake commitments.

These concepts lay the groundwork for scalable investment, but are not intended to provide exhaustive or prescriptive solutions for the complex transition of maritime shipping. Rather, they aim to inform and advance the conversation, highlighting opportunities for collaboration, experimentation, and learning. **EDF and the Decarb Hub welcome engagement from industry, financiers, policymakers, and technology providers to refine these concepts, co-create pilots, and accelerate the sector's decarbonisation.**

INTRODUCTION
Setting the scene

Maritime shipping is crucial to the global economy, transporting around 80% of global trade and accounting for 3% of global greenhouse gas emissions (GHGs). In 2023 the International Maritime Organization (IMO) adopted the 2023 IMO Greenhouse Gas Strategy signalling the sector's ambition to reach net-zero by, or around, the year 2050. Translating goals into regulation, the IMO approved the IMO Net-zero Framework (NZF) in April 2025 – a first-of-its-kind set of regulatory measures including the introduction of a global fuel standard and a price on GHG emissions. Upon adoption in October 2025, the NZF will make maritime shipping the first sector to regulate GHG emissions globally. It will come with a redistribution of revenues mechanism that rewards the use of zero and near-zero GHG emission fuels and technologies (ZNZs) [2]**, while promoting a just and equitable transition.**

The pace of maritime decarbonisation is slow due to the high costs of emerging technologies, an aging global fleet, and persistent uncertainty around future fuel pathways and regulatory direction. Fully decarbonising the sector is estimated to require USD $1.5 trillion [3]. Developing a ZNZ-capable fleet and the supporting fuel infrastructure demands significant investment, driven by high capital and operational costs, risks associated with emerging technologies, and fluctuating fuel

[2] ZNZ fuels are defined as per IMO MEPC 83/J/9 Regulation 39 and upcoming guidelines - "ZNZs shall include technologies, fuels and energy sources and be evaluated on a well-to-wake basis, taking into account guidelines to be developed by the IMO. The GFI threshold for ZNZs shall be set at not greater than 19.0 gCO2eq/MJ for an initial period until 31 December 2034, and from 1 January 2035, the threshold shall be set at not greater than 14.0 gCO2eq/MJ taking into account LCA guidelines developed (MEPC.391(81)) and those to be developed by the IMO".

[3] The UNCTAD, Review of Maritime Transport 2023 estimated the cost for global fleet renewal to range between USD $8-$28 billion and fuel infrastructure costs to range between USD $28-90 billion per annum.

availability and pricing. The IMO NZF represents a critical milestone, but without decisive implementation and a significant scale-up of investments in decarbonisation solutions, shipping emissions could reach between 90% and 130% of 2008 levels by 2050.

Meanwhile, the financial sector also faces a complex and evolving set of expectations regarding climate risk and real-world decarbonisation. Regulatory frameworks, such as the European Union's (EU) Corporate Sustainability Reporting Directive (CSRD), and initiatives like the International Sustainability Standard Board (ISSB) Sustainability Disclosure Standards and the Partnership for Carbon Accounting Financials (PCAF), push banks and investors to disclose their climate-related risks and financed emissions. These pressures are uneven across markets and institutions, and coexist with other challenges – including fiduciary duties, data limitations, and concerns about short-term financial performance that shape climate considerations and how they are integrated into investment decision-making. Nonetheless, despite ongoing challenges, public and regulatory pressures prompt financial institutions to address climate risk, reduce their financed emissions, and contribute to the transition of the real economy.

Innovative and pragmatic approaches to financing, as well as cross-sector collaboration between shipowners, fuel producers, ports, cargo owners, and financiers, are key to catalyse and sustain the maritime shipping sector's transition to net-zero. Traditional approaches to financing the maritime shipping sector will not be sufficient to meet the scale of the challenge. Strong and sustained public-private cooperation, greater mobilisation of private capital, and innovative financing mechanisms will be critical to sufficient capital flows across the full range of ZNZ shipping solutions.

From plans to pathway

Recognising that capital mobilisation is essential to achieving climate goals, EDF and the Decarb Hub see opportunities for bold collaboration between the shipping and finance sectors to accelerate the maritime industry's transition to net-zero and unlock broader climate benefits. Delivering this transition will require swift, coordinated action across three interdependent fronts:

- Improving energy efficiency of the existing fleet through energy saving technologies (ESTs) and retrofitting,
- Replacing aging vessels with ZNZ-capable ships,
- Scaling production and bunkering infrastructure for ZNZ fuels to enable their widespread uptake.

Each of these pillars presents untapped opportunities for both the shipping and finance sectors to benefit from shipping's net-zero transition. The EDF–Decarb Hub partnership aims to incubate innovative concepts that can bridge investment gaps and channel capital towards this complex, capital-intensive transition.

Building on EDF landscape assessment of maritime shipping finance, a workshop was held at the International Maritime Organization (IMO) gathering over 30 experienced industry professionals, financiers and policymakers to pool their expertise and identify promising ideas and concepts, new or pre-existing, to accelerate and unlock finance for shipping decarbonisation solutions. The session sparked valuable connections among stakeholders and collaborative brainstorming on how to overcome long-standing challenges to financing the sector's transition.

This report explores the most promising concepts that were discussed during the workshop:

- A maritime multiplier carbon accounting approach
- A lending platform for ESTs and retrofits
- A Timed-Stacked Offtake model for ZNZ fuel procurement

Building on existing literature and following a series of interviews with over 40 experts – including shipping companies, public and private financial institutions and investors, academics and non-profit organisations – this study assesses the viability of and appetite for the proposed concepts. It offers initial insights into their potential design and highlights both the opportunities and limitations associated with bringing these concepts to implementation and achieving impact.

Findings do not intend to be exhaustive nor prescriptive in addressing the complex transition of the international maritime shipping sector, which will require a combination of policy, technological and financing tools beyond those described here. Rather than proposing definitive answers, this report seeks to inform and advance the conversation and inspire further collaboration and experimentation across the public and private sectors as well as with key stakeholders.
We invite the audience to feed back on the concept analysis and engage with us in their further development and implementation.

INCUBATED CONCEPT

Maritime Multiplier Carbon Accounting Approach

The issue

Growing expectations from regulators, business partners and civil society for companies' sustainability performance intensifies both the pressure and opportunity for investors to address the climate footprint of their portfolios. However, investing in maritime shipping can frequently be perceived as misaligned with decarbonisation goals. High baseline emissions for shipping, long asset lifespans, and currently a limited availability of zero-emission technologies means maritime investments can increase a financial institution's reported emissions in the short-term, even if those investments enable long-term decarbonisation [4]. This creates a misalignment between "green finance" ambitions and actual capital flows. Financial institutions could favour allocating capital to already "green" sectors with low reported emissions rather than sectors like shipping where investment is needed for climate progress. Public policy and financial regulation such as Basel IV capital requirements [5] may further constrain banks' willingness to finance shipping, especially when shipping assets are seen as riskier or less compliant with sustainability objectives.

Together, these factors contribute to weak investor sentiment toward the sector. A recent survey by Woodrow found that 64% of UK senior finance professionals consider divesting from maritime sectors due to ESG-related reputational or regulatory risk. This underlines the urgency, also expressed by interviewed experts, of reframing the value proposition of shipping decarbonisation investments from an isolated economic activity and source of emissions to a cross-sector enabler where decarbonisation unlocks broader benefits, including more resilient and sustainable trade.

For greater political will, regulatory attention, and capital allocation, experts indicated the need to support policymakers, industry and financiers in better understanding and assessing the direct and indirect economic and climate impact of their exposure to maritime shipping. Maritime shipping is essential for energy distribution, food supply chains, industrial operations, and regional development. However, the role of strategic enabler for other sectors is at times overlooked, limiting the capital and policy support needed by the maritime sector for its transition.

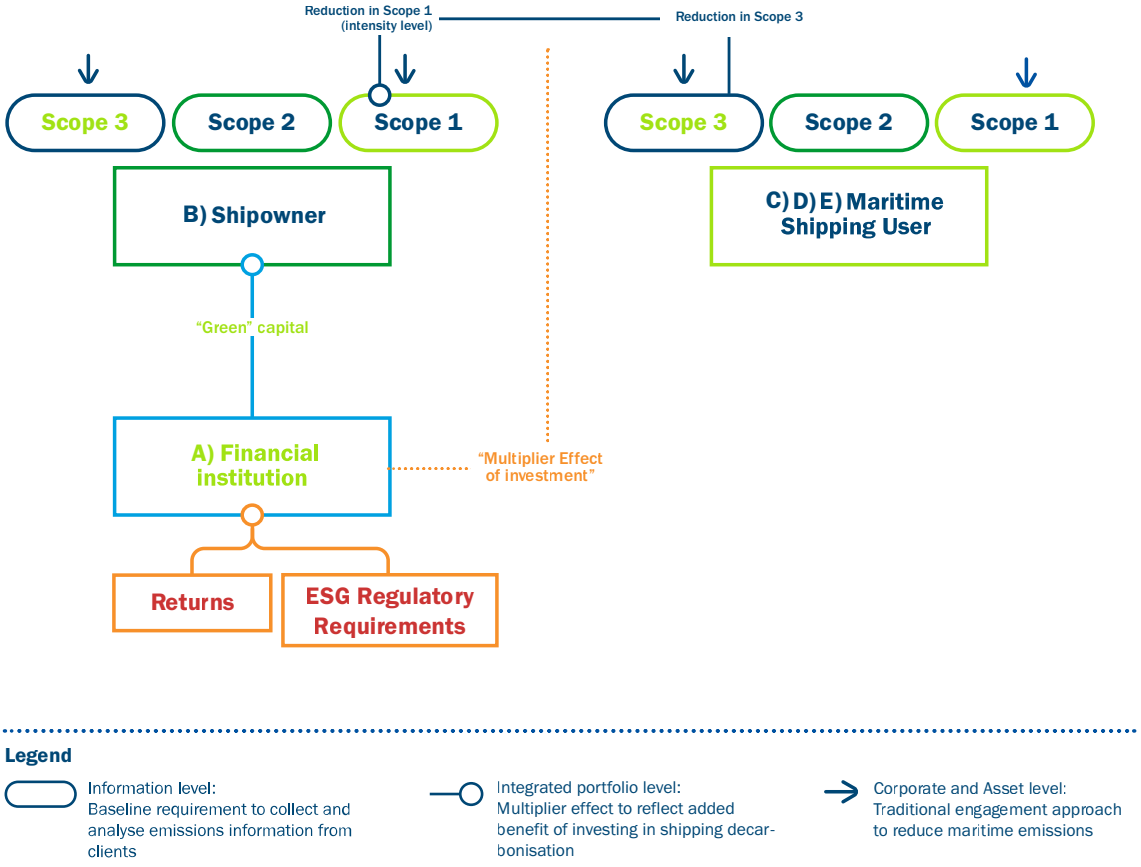
[4] Example: new financing for the acquisition of a dual-fuel vessel which will sail on conventional fuel at first before eventually switching to ZNZ fuels means that absolute financed emissions will increase at least until the vessel sails on ZNZ fuels.
[5] The Basel Accords are international banking regulatory frameworks developed by the Basel Committee on Bank Supervision (BCBS) that provide guidelines on how banks should manage capital risk, market risk, and operational risk. Their goal is to ensure that financial institutions maintain sufficient capital reserves to absorb unexpected losses and safeguard financial stability.

Concept: The Maritime Multiplier Carbon Accounting Approach

Investing in shipping decarbonisation is not just about reducing the sector's own GHG emissions (Scope 1), even if that remains critical. It is also about enabling the broader low-carbon transition, including through reduced supply chain emissions (Scope 3). From agricultural inputs like fertilisers to manufactured consumer goods, decarbonising shipping translates into lower embedded emissions in traded products. These Scope 3 emissions may appear marginal at the individual product or company level, yet cumulatively they represent a climate risk and opportunity at the portfolio level.

Because of this far-reaching impact, investments in shipping decarbonisation may deliver outsized ESG benefits per dollar spent, extending beyond the sustainability performance of individual investees. To help capture these broader economic and environmental gains, this study explores an innovative concept: **the Maritime Multiplier Carbon Accounting approach (MMCA).**

This tool is designed to help investors quantify and communicate the cascading benefits of their investments in shipping decarbonisation. By helping investors integrate this narrative into their climate disclosures should enable them to move from a defensive stance in which high-emitting sectors must be avoided, to a proactive and strategic one in which capital is deployed where it can have the greatest real-economy decarbonisation impact.



Simplified example of the MMCA in action:

1 — Bank A provides a loan to Shipowner B to finance the acquisition of ZNZ vessels. These vessels replace older, conventional-fuel ships, and — if operated efficiently and/or using ZNZ fuels — result in lower Scope 1 emissions for Shipowner B.

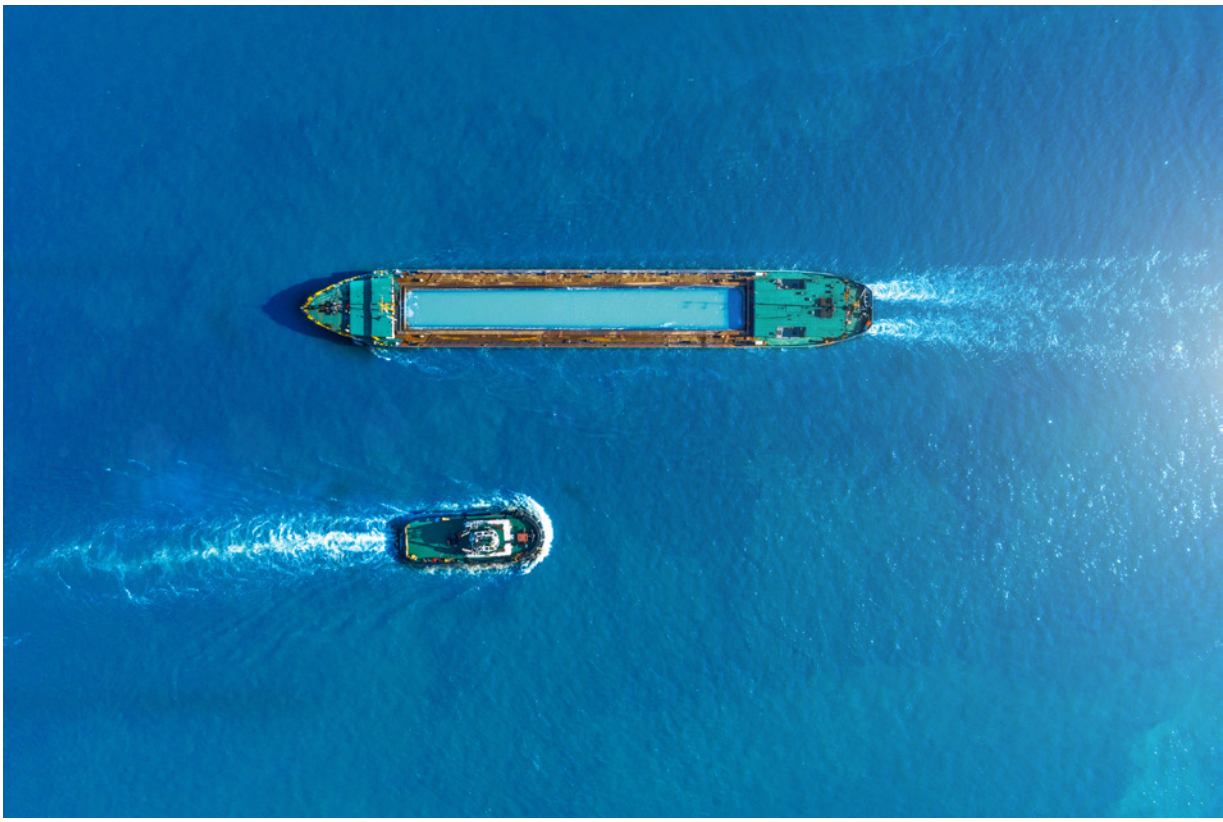
2 — These new vessels are then deployed on trade routes serving multiple clients, for instance a fertiliser producer (C), an agricultural exporter (D), and a consumer goods retailer (E). Because these clients now use lower-emissions shipping services, Scope 3 emissions associated with the transport of their goods decrease, and the overall carbon footprint of those goods, reduces accordingly.

3 — The MMCA would model and quantify these interconnected emissions impacts. Using GHG accounting frameworks, trade flow data, supply chain analysis, and economic modelling, impact would be converted into investor-relevant indicators such as avoided emissions across the value chain (i.e. Scope 1, 2 and 3), reduced financed emissions at the portfolio level, or enhanced sustainability performance as disclosed in climate (such CSRD or ISSB) reports.

4 — If Bank A also finances any of the downstream actors (C, D, or E), then its initial shipping investment may indirectly improve climate performance across multiple parts of its portfolio. This may increase the strategic value of shipping loans within the bank's broader decarbonisation strategy. In effect, a single investment (the initial loan of Bank A to Shipowner B) may produce compound climate benefits across the bank's entire portfolio, amplifying its contribution to financed emissions reductions and the real economy transition. Bank A could actively trigger such cascading effect by encouraging collaboration between its shipowner clients and its cargo owner or end-user clients.

MMCA design should balance methodological robustness with practical feasibility. Maintaining flexibility and data integrity are key to the tool's usability, credibility, and value across diverse investor and lender profiles. Depending on data availability, the tool could offer a tiered approach - a 'measured' or 'estimated' pathway. The 'measured' pathway would use proprietary emissions or cargo data disclosed by shipowners and clients for high-integrity results. The 'estimated' pathway would rely on modelled assumptions, publicly available datasets, industry averages and trade route-level emissions factors for indicative results where primary data are unavailable.

For example, trade flow data could be used to approximate the volume and type of goods transported on a decarbonised vessel. Input-output economic models or lifecycle emissions factors would estimate the resulting Scope 3 emissions reductions across sectors in the value chain such as agriculture, retail and manufacturing.



Challenges

Expert interviews recognised the MMCA as a conceptually promising tool to reframe the value of shipping decarbonisation. However, several challenges and limitations must be addressed prior to deployment to ensure credibility, practicality and stakeholder uptake.

Data collection burden and methodological complexity:

The heterogeneous nature of the shipping industry, and the many sectors it intersects with, make comprehensive data collection challenging. Accurate implementation would require consistent, high-quality data across a wide range of supply chain actors, many of whom may have limited data availability or lack readiness for Scope 3 emissions reporting. Even where relevant data exists, enabling ongoing cross-sector data sharing and standardising inputs could prove difficult to operationalise.
As a result, it may be necessary to take a phased or targeted approach. Initial efforts could focus on trade segments where data quality is higher and coordination among stakeholders, such as large global container lines working with regular corporate customers, or vessels transporting a single type of cargo within vertically integrated supply chains where data flows more easily. Leveraging data from Book & Claim [6] platforms, such as Katalist, could also prove valuable as these platforms collect emissions-related information along the maritime supply chain.

Low readiness and prioritisation:

The net-zero agenda has recently encountered growing resistance, and many investors show limited interest in Scope 3 emissions. While impact accounting can be a strategic tool for climate risk management and investment decision-making, it is currently not often prioritised. Several experts noted that the perceived effort of data collection and analysis required by the MMCA may outweigh the perceived benefits for investors.

Greenwashing and double counting:

There is a risk that emissions reductions could be claimed multiple times along the value chain, including Scope 3 emissions credits sold through a Book & Claim scheme, unless clear allocation rules and safeguards are developed.

Perceived low impact materiality:

Maritime shipping emissions often appear immaterial at the level of a single traded good or corporate client, limiting their perceived relevance in individual financing decisions. However, this perceived immateriality masks the system-wide benefits that become visible only when impacts are aggregated at the portfolio level. This underscores the importance of providing portfolio-wide insights to demonstrate the true scale of impact.

[6] A Book & Claim system in maritime shipping enables companies to claim emissions reductions from the use of sustainable fuels, even if their cargo is not directly transported by vessels using those fuels. By separating the environmental benefits, such as lower GHG emissions, from the physical movement of goods, the system helps overcome challenges related to physical fuel availability and cost.

Next steps & Recommendations

Amid growing expectations from regulators, business partners, and civil society to assess and act on the climate impacts of financial portfolios, shipping remains an often-overlooked sector in sustainable finance. Despite being essential to the global economy, maritime investments are frequently perceived as incompatible with climate goals. Financial institutions must avoid deprioritising or divesting from the sector solely based on reported emissions and instead prioritise investment decisions that reflect the sector's systemic impact.

Many banks, insurers, and regulators are testing tools, frameworks, and metrics to better align climate goals with investment decisions. Various frameworks already define what constitutes a 'green shipping' investment' [7], but there is currently no widely adopted method for assessing, measuring and disclosing the broader system-wide impacts of those investments. A complementary framework like the MMCA could fill this gap to help further attract and scale sustainable finance in this space. For some stakeholders, the tool may serve as a strategic lens to better understand their portfolios' climate impact, guide engagement with clients and influence capital allocation strategies across interdependent sectors. For others, it may support enhanced disclosure or internal target-setting.

To succeed, it must be grounded in credible data and supported by collaborative action.

- **For investors:**
  They can initiate a foundation for the MMCA by working with investees to establish data-sharing protocols and clear expectations for their investees to report on emissions reduction-related information along the value chain, including emissions savings that are already claimed[8] to mitigate double counting risk. This would encourage greater transparency and foster collaboration across the maritime value chain.

- **Regulatory and disclosure bodies:**
  They are encouraged to explore how the MMCA could complement or integrate existing climate disclosure and portfolio alignment standards.

- **For any interested stakeholder:**
  EDF and the Decarb Hub invite interested stakeholders to co-develop pilot applications of the MMCA. Working with selected financial institutions, shipping companies, and cargo owners, these pilot projects will help test methodologies and data collection processes, validate assumptions, and refine metrics to ensure the tool meets practical needs.

[7] For example, the Climate Bonds Initiative, the Poseidon Principles, Loan Market Association, the European Union's Taxonomy Regulation.
[8] For example, through credits sold under a book and claim scheme (e.g. ZEMBA), or via the IMO surplus units trading mechanism (as part of the IMO NZF which allows ships outperforming the targets to generate tradable surplus units).

Lending platform for energy saving technologies and retrofit projects

The issue

Deploying ZNZ-capable vessels is constrained by technological, economic and political factors, including limited shipyard capacity and low availability of ZNZ fuels. Since global fleet turnover has a decades-long time horizon, some experts emphasised that retrofitting existing vessels and installing energy saving technologies (ESTs) [9] are a most immediate and scalable lever to reduce emissions across the global fleet in the nearer term, especially for small and medium sized companies.

ESTs and retrofits can deliver dual value. First, they enable vessels to operate more efficiently under existing propulsion systems, thereby generating OPEX savings through reduced fuel consumption [10]. Second, they support compliance with increasingly stringent climate regulations. For shipowners, these upgrades represent a practical way to extend the viability of existing assets, limiting transition risk exposure, and preserve operational flexibility and competitiveness as the industry transitions toward ZNZ fuels and technologies. For the financial sector, this points to a rising need for targeted capital to EST deployment and retrofit projects. Doing so will help meet evolving regulations and protect the long-term value of maritime portfolios from the risks of stranded assets. Without action, ships could face premature devaluation or be scrapped sooner as climate rules tighten [11].

Despite their value, investments in ESTs and retrofit projects face several barriers that prevent financial institutions and shipowners from engaging more proactively. These barriers arise from a combination of market dynamics, perceived investment risks, and structural challenges within the industry, and are particularly prominent for smaller players.

[9] For the purpose of this report, we define energy saving technologies (ESTs) and retrofits as the upgrades of existing vessels to improve their efficiency or compatibility with low-emission operations. This can include the installation of ESTs such as air lubrication systems, hull modifications, or wind-assist technologies. For example, air lubrication systems reduce friction between the hull and the water by creating a layer of air bubbles along the vessel's bottom. According to SilverStream Technologies, a manufacturer such systems, this technology can reduce fuel costs and deliver emissions reductions of up to 5-10% depending on vessel type and operating profile. This can include the installation of ESTs such as air lubrication systems, hull modifications, or wind-assist technologies. For example, air lubrication systems reduce friction between the hull and the water by creating a layer of air bubbles along the vessel's bottom. According to SilverStream Technologies, a manufacturer such systems, this technology can reduce fuel costs and deliver emissions reductions of up to 5-10% depending on vessel type and operating profile.

[10] For the purpose of this report, we define energy saving technologies (ESTs) and retrofits as the upgrades of existing vessels to improve their efficiency or compatibility with low-emission operations.

[11] Research conducted by the UCL Energy Institute on supply-side and demand-side stranded asset risks in shipping indicate that existing and ordered ships are expected to emit nearly twice the 1.5 °C-aligned carbon budget for shipping (9.6Gt CO2e). To stay within this limit, over a third of the fleet, worth more than USD400b, must rapidly adopt zero-emission technologies or risk early scrapping.

Core barriers identified in interviews with financial institutions and industry stakeholders include:

Opportunity cost of downtime

Taking vessels offline for upgrades means lost revenue from downtime, especially during boom periods with high freight rates. This causes shipowners to postpone retrofits until market conditions deteriorate, ironically when financing becomes harder to secure.

Uncertain economics

ESTs CAPEX must be balanced against OPEX savings, which vary with factors such as vessel type, route, and usage profile. This variability makes it difficult to predict payback periods and adds investment risk, especially for newer or less widely adopted technologies. In addition, the limited large-scale deployment of ESTs to date results in insufficient performance data to verify their effectiveness and build a strong business case. As a result, many shipowners remain cautious, often opting to operate vessels without upgrades until end-of-life, and instead investing in newer and more efficient ships at replacement.

Split incentive

There is a misalignment between CAPEX costs and OPEX savings, in particular for ships operating under short-term contracts. The shipowner bears the cost of energy efficiency upgrades, but the charterer, who leases and operates the vessel, reaps the benefit in the form of fuel savings.

Barriers for smaller players

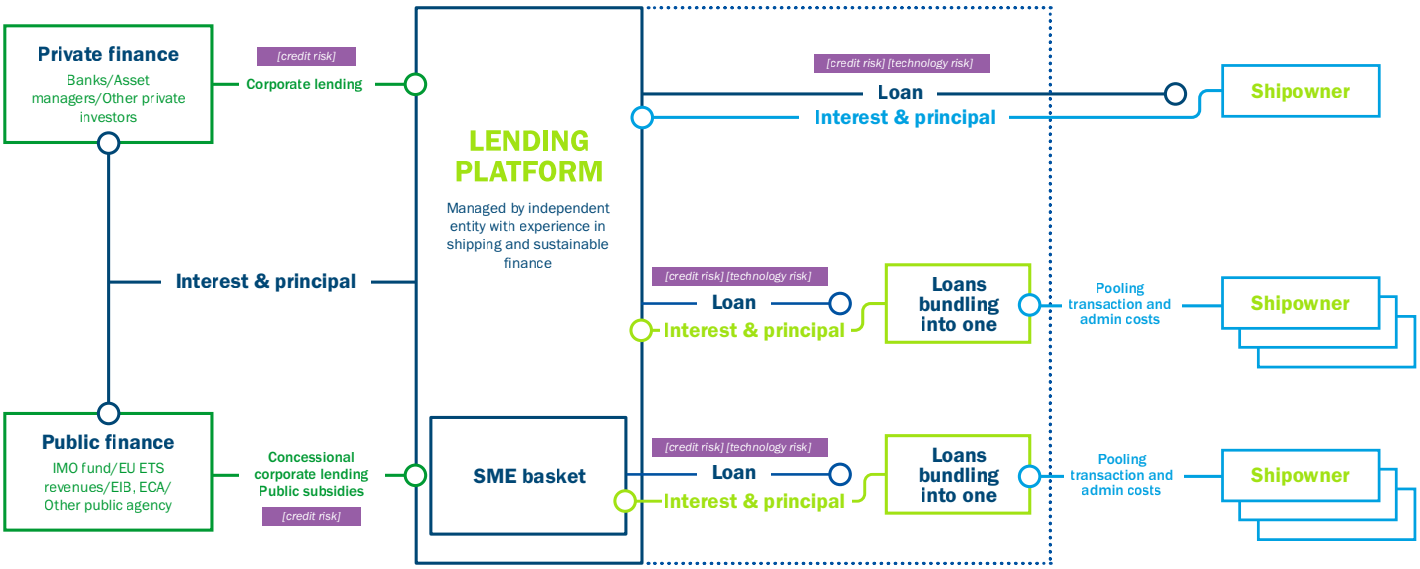
Smaller shipowners typically lack the financial strength and credit history of larger peers and are often excluded from capital markets. Even when creditworthy, lenders often prefer larger clients and deals that offer higher volumes and better margins. Public funding schemes, meanwhile, often involve burdensome application processes including high technical thresholds and extensive documentation requirements – challenging for smaller players that lack the time, expertise, or internal capacity to navigate. As a result, they can be left relying on more expensive and less flexible forms of financing, despite representing a significant share of the global shipping fleet and playing an essential role to achieving decarbonisation at scale.

Despite these barriers, participants to the EDF and the Decarb Hub workshop agreed that the outlook may shift rapidly. Tightening climate regulations will trigger growth in demand for capital to finance energy efficiency projects and financial institutions must prepare to offer adequate financial support at scale, particularly during downturns in the shipping cycle. Meanwhile, many shipowners, especially larger and top-tier players, have benefited from strong cash flows in recent years and now hold healthy balance sheets, giving them greater leverage to negotiate favourable financing. This creates a window of opportunity to design and deploy financing tools that can ensure sustainable, affordable access to capital, especially for smaller shipowners, to secure ESTs and retrofit projects.

Concept: a dedicated lending platform for ESTs and retrofit projects

At present, shipowners looking to invest in ESTs or retrofit projects typically rely on a limited set of financing options: using internal cash reserves, leveraging existing loans secured by first-ranked mortgages, taking out new term loans from their existing banking relationships, or accessing vendor financing for equipment. As the demand for capital to decarbonise the existing fleet grows, these options alone might not be sufficient, particularly for smaller players and project sizes.

At the EDF and Decarb Hub workshop, a working group focused on energy efficiency identified an opportunity to complement existing financing tools. As ZNZ fuels and infrastructure scale-up, a dedicated **lending platform** could ensure that capital for ESTs and retrofits is, now and in the future, available, accessible and affordable. Acting as an intermediary between shipowners in need of capital for ESTs and retrofits projects, and investors seeking to fund shipping decarbonisation, the platform would aggregate EST and retrofit projects into a diversified portfolio and channel public and private capital to offer affordable loans to shipowners, especially smaller ones, for these projects.



Capital stack and ROI

The platform would be capitalised through a blended finance structure, combining:

- Public capital (e.g., coming from the IMO Net-Zero Fund [12], EU climate funds [13], development banks, or regional public subsidies) offering concessional or first-loss capital to absorb early-stage risks and enhance commercial appeal to private investors. This initial public contribution would be critical in the platform's early stages to demonstrate its viability and build a track record of successful investments that can attract private capital at scale.
- Private investment from banks, institutional lenders and impact investors in the form of senior or mezzanine debt [14], depending on risk appetite. Returns would be generated from shipowners' loan repayments, with public funds absorbing potential early losses or accepting lower returns to de-risk the investment proposition.
- A partial equity contribution from shipowners could also help align incentives.

To maintain investor confidence and attract participation over time, it will be important to define clear investor engagement strategies, including potential exit options aligned with investor expectations. For example, while building a portfolio of performing loans, securitisation could be used to issue ('green') asset-backed securities, enabling capital recycling, scaling up lending, and enhancing liquidity and risk distribution across a broader investor base.

Governance and operational structure

To build trust and ensure transparency, the governance model should be carefully designed to avoid conflicts of interest and mitigate the risk of adverse selection. Experts recommended establishing a central coordinating entity, such as a specialised asset manager or development bank, to serve as the main interface between borrowers and investors. This entity would oversee project origination, due diligence, loan structuring, performance monitoring and reporting. A transparent and consistent credit assessment process, factoring in vessel age, retrofit type, and projected cash flow improvements, would support consistent decision-making. Overall, this governance structure would promote portfolio consistency, accountability, and transparency to build investor confidence.

In addition, the coordinating entity could play a facilitation role for smaller players to access public and concessional finance. By centralising and redistributing public support, or helping borrowers navigate application processes, the platform would act as a bridge between available funding and smaller-scale projects. Shifting the administrative burden from shipowners to the platform entity would lower the threshold for access, enabling broader participation in the energy transition.
The platform could also serve as a hub for knowledge sharing, helping shipowners identify cost-effective and high-performing ESTs and retrofit solutions tailored to their vessels and operations, and thereby stimulate investor appetite. As the platform

[12] IMO Net-Zero Fund will distribute revenues to reward ZNZs, which include ZNZ fuels and ZNZ technologies (IMO Net Zero Framework; Regulation 39 and 41).
[13] Such as the EU Innovation Fund
[14] Mezzanine debt occurs when a hybrid debt issue is subordinate to another debt issue from the same issuer.

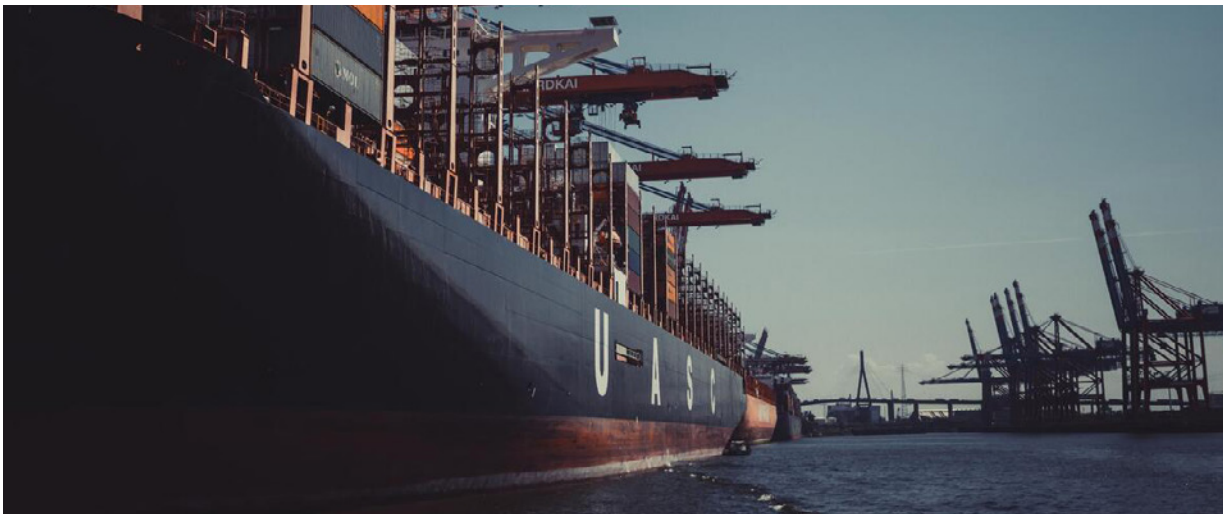
enables the improved energy efficiency of vessels, lower voyage expenses create opportunities for new contractual arrangements, realigning incentives between shipowners and charterers. Such realignment could take the form of performance-based charter party terms or higher charter rates for more efficient vessels, allowing cost savings to be shared across stakeholders.

Eligibility and scope

In terms of project eligibility, the platform would need to strike a careful balance between environmental integrity and accessibility. Experts stressed that, to maximise uptake, especially among smaller players, the platform must minimise administrative burdens on shipowners. Emissions reductions and tracked fuel savings would be valuable, but defining a baseline is challenging due to varying vessels operations. The assumption underpinning the platform is that investments in ESTs and retrofits aim at reducing GHG emissions now or in the near- to mid-term and therefore constitute a valuable contribution to maritime shipping decarbonisation. The design of the platform would then take a flexible, technology-neutral stance to allow the financing of both established and emerging solutions, avoid penalising shipowners for factors beyond their control (such as operational routes), and support pragmatic progress in the absence of mature ZNZ fuel alternatives.

Impact disclosure

Because the proposed platform would exclusively fund energy efficiency improvements, it presents a compelling opportunity for lenders seeking to meet sustainable investment targets. Experts suggested that, if eligible, investors could credibly classify their participation as contributing to climate transition objectives. Further research could explore the eligibility of the platform's investments with recognised frameworks such as the EU's Sustainable Finance Disclosure Regulation (SFDR) under Article 8 ("environmental characteristics") or Article 9 ("sustainable investment") [15]. This alignment could enhance investor appeal to invest in the lending platform, particularly for those with sustainability mandates or ESG integration requirements.



Challenges

Despite its potential, the analysis and expert insights revealed several challenges the platform must overcome to become mature and scalable, including:

Technology risk

Although it could offer some risk diversification among the selected financed technologies, pooling technologies into a single portfolio does not eliminate the underlying technology performance uncertainty which must be considered by the lending platform in its loan financing conditions. Without reliable, verifiable data, both financiers and insurers struggle to assess and price the risk accurately, thereby limiting their appetite to get involved in such deals.

Unsecured lending

The vessel being retrofitted is usually already pledged as collateral for an existing loan. First-ranking lenders may require prior consent for major retrofits, especially if the upgrades affect the value of the collateral. Where the EST or retrofit does increase asset value, the benefit accrues mainly to the bank holding the original mortgage on the vessel, not the platform. As a result, the lending platform cannot secure a first-ranking claim on the asset and would need to provide unsecured financing which typically carries higher risk and cost of capital. However, alternative forms of collateral could be explored, such as escrow accounts, performance guarantees from insurers or ECAs, or corporate guarantee from the shipowner's parent company.

Public funding trade-offs

Setting up and running the platform requires substantial upfront investment in legal, technical, and operational infrastructure, including loan origination, monitoring, reporting, and coordination across multiple stakeholders. From a policy perspective, the allocation of limited public finance presents a strategic dilemma. Some policymakers and donors may prefer prioritising investments in ZNZ vessels and fuels given their long-term relevance to decarbonisation. However, while ESTs and retrofits alone will not deliver net-zero by 2050, they play a role in the near-term emissions cuts as well as in the long-term by improving the economics of ZNZ fuels and vessels, therefore decreasing the volume of ZNZ fuels needed, lowering OPEX of ZNZ vessels, and easing supply infrastructure needs.

Next steps & Recommendations

The lending platform aims to support short- and medium-term emission reductions from the existing fleet as ZNZ fuels and associated infrastructure scale. By supporting shipowners in investing in ESTs and retrofit projects, the platform helps mitigate their exposure to climate transition risks while enabling financiers to manage and decarbonise their shipping portfolios.

The following are important considerations for different stakeholders to ensure further refinement of the lending platform concept:

- **For all shipping and finance stakeholders:**
  To realise its potential and secure buy-in from policymakers, industry stakeholders and investors, EDF and the Decarb Hub welcome stakeholder collaboration for a deeper investigation to determine how the platform should be structured and demonstrate its added value [16]. Such analysis should account for the potential emissions reductions impact, but also projected financing volume over the next years, costs to launch and manage the platform, and the amount of private capital that can be leveraged per euro of public funding. Clarifying the platform's regulatory classification, whether as a fund, special purpose vehicle, or another structure, as well as the jurisdiction under which it operates, will also be critical to streamline the setup and ensure compliance with relevant regulatory and licensing requirements.

- **For public finance:**
  In practice, experts [17] suggested the lending platform would likely need to be launched first at a small scale and with public money as a major part of its capital stack. This "proof-of-concept" phase would aim to demonstrate the commercial viability of the model, build a pipeline of successful transactions, and thereby attract private investors over time. Public funding would play a key role in absorbing early risks, reducing the cost of capital, and creating enabling conditions for blended finance. Establishing a strong track record will be critical to secure broader buy-in from the market.

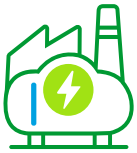
- **For financial institutions:**
  Over time, this tool could catalyse a more mature and efficient market for EST and retrofit projects, helping investors view these projects as credible, lower-risk climate investments, and progressively standardising financing. Banks could act as key partners by referring clients to the platform in cases where traditional financing proves difficult, such as in cases with relatively small ticket sizes, high loan-to-value ratios limiting further secured borrowing, or where retrofit costs exceed the estimated increase in asset value. In such situations, the platform could offer a complementary financing option, to help ensure viable projects are not left unfunded.

- **For de-risking agents:**
  Enhancements to the platform's financial structure could also be evaluated. Export

[16] Including its market positioning and complementary with initiatives such as PROW Capital Green Shipping Fund, Eurazeo Sustainable Maritime Infrastructure Fund, or eShipFinance.
[17] As well as a study produced by Marine Capital on potential funding models in the UK domestic market including an asset leasing platform which would address issues of access to finance and credit quality for smaller shipowners.

credit agencies (ECAs) could offer guarantees or long-term financing, while insurers could offer credit or technology performance risk coverage. Although appetite for underwriting such risks remains limited, especially for newer technologies with limited data, developing partnerships with these actors could expand the platform's ability to attract capital and reduce risk exposure for both lenders and borrowers.

Finally, while the research focused on ESTs and retrofit projects, further analysis could explore extending the platform to other decarbonisation measures, such as the acquisition of ZNZ fuelled ships or scaling ZNZ fuel production. This would allow the platform to remain relevant as the industry progresses toward full decarbonisation, offering a scalable and flexible financing solution that evolves alongside market needs and regulatory ambition.



Time Stacked Offtake Model

The issue

Most projections forecast that the ZNZ fuel market share will need to be at more than 50% to meet the shipping sector's decarbonisation goals [18]. To ensure sufficient ZNZ supply for future shipping demand, existing fuel procurement strategies must be rethought in ways that incentivise the near-term offtake, scaling and production of these fuels.

As regulations such as the IMO NZF, the EU Emissions Trading Scheme (ETS), and FuelEU Maritime begin, pricing shipping emissions and green shipping corridors [19] help aggregate cross-sector [20] ZNZ fuels demand [21]. ZNZ fuel projects are hitting a near-term "feasibility wall" [22] due to high project costs, uncertain fuel pathways, and constrained fuel procurement strategies. The business case behind near-term scaling of ZNZ fuels, as with any investment, hinges on the ability for projects to deliver clear and predictable returns. This is not always the case for ZNZ fuel projects: first mover costs, fuel supply constraint, technology readiness and market demand risk are elements contributing to "first mover loss" [23] or uncertain payback for developers [24]. These risks are especially acute in an industry like shipping where current fuel procurement strategies [25] are not yet aligned with the near-term development of ZNZ fuels nor their market entry.

Scaling ZNZ fuel projects, especially new build projects, requires an estimated CAPEX cost of up to USD $2 billion for infrastructure, storage and terminal facilities, depending on project size and location. Consequently, ZNZ fuels will be costly [26] in the early stages and require long, multi-year, offtake commitments to advance production. While ZNZ fuel project announcements have been rising, the transition

[18] The Decarb Hub estimates that, collectively, the hydrogen necessary for maritime ammonia production could represent approximately 50% of the total hydrogen dedicated to the production of ammonia as fuel by 2030.
[19] Green shipping corridors are defined by the Global Maritime Forum as the routes where the feasibility of zero-emission shipping is catalysed by public and private action, and by the Maersk Mc-Kinney Møller Center for Zero Carbon Shipping as the routes where commercial vessels operate using alternative, low-emission fuels, or other means of low-carbon propulsion, like electricity.
[20] Ports, shipowners, fuel producers, cargo owners, financiers, and governments.
[21] Private initiatives also exist, such as the Zero Emission Maritime Buyers Alliance (ZEMBA) which is a buyers group aggregating customer demand for clean energy shipping solutions.
[22] Feasibility wall is referred to the point where the cost gap inevitably pushes project timelines back or forces a downscaling of ambition (GMF).
[23] First-mover loss refers to the financial disadvantage or risk faced by companies that ZNZ technologies and fuels ahead of the market. While being a "first mover" can bring reputational and strategic benefits, it often comes with higher costs and greater uncertainty, especially in the context of shipping decarbonisation.
[24] For example, Fortescue has faced heavy losses, with its green energy division losing over US $2.1 billion across four years with lack of commercial returns, largely due to high electricity costs and supplychain challenges. Budget cuts and project delays across its hydrogen and ammonia ambitions reflect the uncertain payoff profile of these earlystage investments.
[25] Spot market when fuel is purchased on an as-needed basis prevailing market prices, supply agreements where fuel producers give medium or long term (6-24 months) fixed volume and/or price structured contracts, vertical integration or co-investment where a downstream player like a shipowner has equity stake in a production project, or fuel hedging where fuel-intensive operators use of financial derivatives like swaps or futures to hedge against fuel price fluctuations.
[26] Expert interviews estimated ZNZ fuels to be 2 to 4 times more expensive in the near-term than the conventional fuels.

from announcement to FID [27] remains slim due to bankability bottlenecks [28]. To reach FID, ZNZ fuel developers need creditworthy offtake clients committed to lifting 50–70% of project volumes. This demonstrates reliable revenue and positive cash flow projections.

Various factors contribute to making an offtake contract bankable. Recent findings from the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping's Fuel Demand Aggregation point to five key factors:

- Credit standing of the offtaker, assessed through a combination of public rating and/or lender's own due diligence
- Tenor of contract, which must match or exceed the tenor of the debt
- Volume certainty, with clearly defined amount, quality and delivery specifications
- Price certainty, either a fixed price, or linked to reputable index
- Limited termination clauses, with robust take-or-pay terms and no option for unilateral termination

Offtake bankability is not only a bottleneck for projects aiming for FID but reflects a deeper scalability challenge for ZNZ shipping fuels, rooted in the sector's fragmented and spot-market dependent fuel procurement strategies. Nascent ZNZ fuel project developers need bankable, 10-15-year long-term offtake agreements. However, the shipping sector is not fully willing to deliver, in part, because long-term pricing commitments are deemed risky in the absence of regulatory clarity and robust price benchmarks for ZNZ fuels. So, for ZNZ fuels to meet the future demand required for the international shipping sector to reach net-zero , the shipping sector must transform the way it buys fuel, and the energy sector must innovate the way it sells fuel. And the finance sector must evolve the way it supports the development of ZNZ fuel infrastructure.

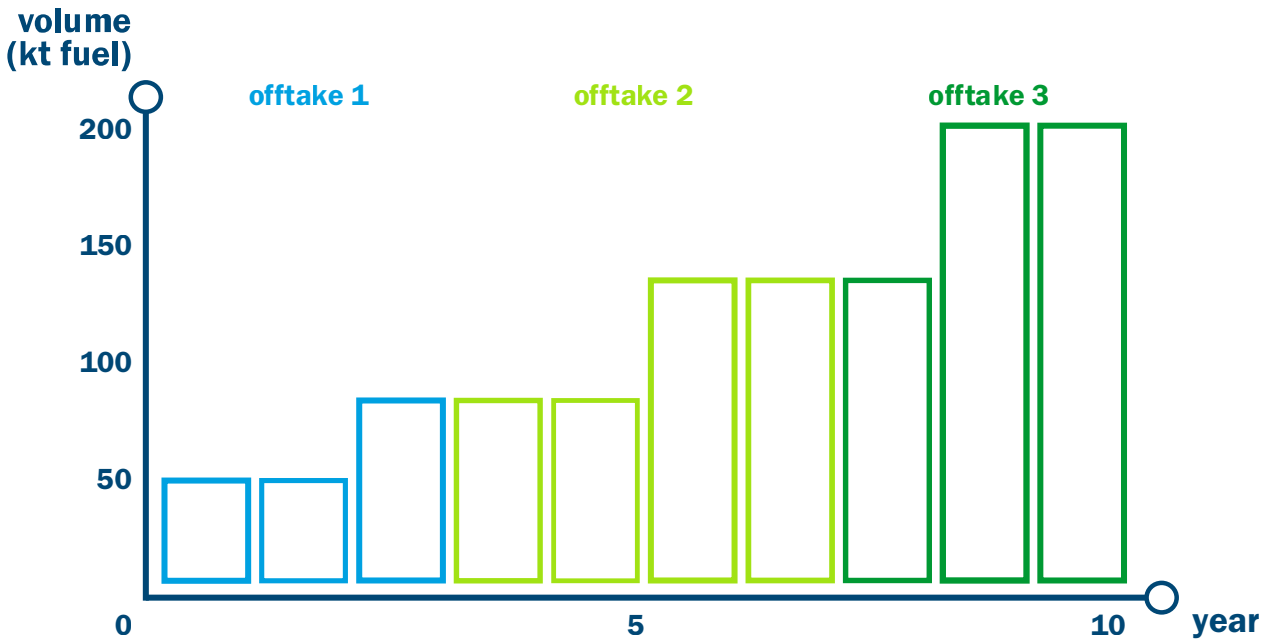
[27] Final Investment Decision (FID) marks the stage in a project's development when the company owning and/or operating the project has secured funding and is approving capital investments to start construction. According to the World Economic Forum, it currently takes four years or more to reach FID, followed by an additional two to five years before fuel production can begin.
[28] The International Energy Association estimates that only 4% of announced low-emission hydrogen production projects FID.

Concept: The Time-Stacked Offtake Model

There is an opportunity to innovate existing fuel procurement strategies to meet the needs of the emerging ZNZ fuel market. This report explores how to increase ZNZ fuel offtake appetite from downstream and midstream stakeholders by examining the "Time-Stacked Offtake" (TSO) concept, first introduced by the Global Maritime Forum's demand aggregation insight brief, and further incubated through industry expert input at the workshop. The study assesses the concept's viability, potential impact, and limitations through a review of existing literature and insights from 12 expert interviews.

A TSO consists of breaking up a long-term (10-15 year) offtake agreement into smaller and shorter-term tranches that can be taken up by various, potentially cross-sector, offtakers. The TSO concept pools demand for ZNZ fuels, allowing offtakers to join an offtake agreement without taking on all the risks of a long-term contract. Bundling multiple offtakers into a single contract with a ZNZ fuel developer balances offtakers' appetite for shorter-term contracts with developers' need for reliable volumes.

For mid- and down-stream offtakers [29][30], particularly those with smaller balance sheets and weaker credit standing, the TSO concept could offer the flexibility of shorter contract periods and risk-sharing arrangements amongst the mid- and downstream players in the TSO. Shorter contracts reduce exposure to long-term



[29] Announced projects are projected to supply 0.14 – 0.9 EJ of blue and green ammonia, and by 2030 the average demand for green ammonia in shipping will be 0.32 EJ and 0.47 EJ for blue ammonia. The Decarb Hub's Future of Maritime Fuels Report highlights that although the expected supply may currently meet the demand, it will be necessary to increase the supply of ammonia to meet the demand for clean ammonia in a net-zero future.
[30] DNV's Maritime Forecast to 2050 estimates the shipping demand for carbon-neutral fuels based on IMO's 2030 ambition of 20% GHG emission reduction compared to 2008. The cumulative capacity for ongoing or announced carbon-neutral production capacities for 2030 is between 44-63 Mtoe. Shipping's share of global energy use is 280 Mtoe and estimated demand from shipping for carbon-neutral fuels in 2030 will be between 7-48Mtoe, meaning that shipping will need between 10% - 100% to reach the IMO targets.

price fixing and regulatory uncertainty. This flexibility increases the appetite from mid- and down-stream offtakers to commit to lifting a smaller percentage of the required ZNZ fuel. The TSO concept would mobilise ZNZ fuel procurement from players not engaging in ZNZ fuel offtake agreements due to the current complexity, commitment, and high cost associated with scaling ZNZ fuel in the near-term.

For upstream players, like ZNZ fuel developers, the TSO concept offers an innovative way to secure volume lifting. Large-scale projects need offtake agreements for volume lifting of almost 650,000 tonnes per year in the case of green ammonia [32]. The TSO concept allows developers to have a wide range of offtakers to secure volume lifting amidst offtake uncertainty. The TSO concept could be a key element to ensure new-build ZNZ fuel projects reach FID. Applying the TSO to existing fuel projects may present opportunities for pilot testing the concept before implementation for new build value creation. If delivered strategically, the TSO concept could serve as a tool to secure offtake certainty and give projects £a predictable positive cash flows to ensure FID, without needing a single large buyer to commit to one long-term offtake agreement [33].

[31] For the purposes of this study, offtakers can encompass shipping companies, operators, logistics providers, cargo owners, or other down-stream or mid-stream players.
[32] The study from the Global Maritime Forum highlights an offtake example, where a 300,000 tonnes per year methanol plant may need to secure 65% offtake certainty (195,000 tonnes) through one or two offtake agreements. A one million tonnes per year ammonia plant on the other hand may need to secure 650,000 tonnes through three offtake agreements to reach FID.
[33] Experts noted that there are similar mechanisms in place where long-term contracts are split into two 5-year contract periods. While the first contract period is easier to secure offtake, there are limitations that include price-predictability and regulatory certainty preventing offtakers from engaging in the later 5-year contract.

Challenges

The interview series and desk research show the TSO, at its theoretical foundation, is a promising way to help bridge the gap between energy/infrastructure project financing and shipping fuel procurement by enabling the scaling of high CAPEX projects through volume lifting from players used to a spot-market world. However, limiting factors for upstream as well as down- and mid-stream players must be addressed for the concept to materialise into feasibility and implementation. These factors include, but are not limited to:

Limitations in managing fuel offtake contracts

Issues may arise when upstream players manage a multitude of short-term offtake contracts, most significantly managing the risk associated with a weaker credit standing offtaker. While the TSO offers benefits to down- and mid-stream players through diversification of risk and shorter offtake time commitments, it introduces a management and risk barrier to the upstream provider that could be solved by a tertiary managing entity.
Additionally, the TSO analysis shows that unless offset by tools, like a Contracts for Difference (CfDs), or supported by de-risking agents like ECAs, the price and volume risk may threaten the viability of the entire TSO.

Need for credit worthiness of offtake contracts

Project financiers believed the fragmentation of offtakers may not fully guarantee the bankability of a project, especially if offtakers have exit clauses at later stages. With or without the application of the TSO concept, projects must have positive cashflows to be deemed bankable. Underlying credit, technology or other risks at nascent stage may not be eliminated through the TSO concept alone. That risk is spread through the diverse offtakers. For the TSO to function as a tool to increase ZNZ offtakes from smaller mid- and down-stream players, it would benefit from the support of a de-risking agent like an Export Credit Agency (ECA) or insurer that can absorb part of the downstream risk.

Lack of reliable pricing benchmarks and price bridging tools

Nascent fuels suffer from a lack of price-predicting benchmarks offering transparency, stability, and risk management in emerging markets. These benchmarks are foundational for scalable, investable, and bankable fuel procurement, enabling fair contracting and financial planning. ZNZ fuel price uncertainty presents limitations to downstream and midstream players who may be unwilling to offtake the later parts of the TSO contracts (e.g., years 9, 10, 11). The complex relationship between shipowners and charterers also introduces hesitation in committing to a ZNZ offtake agreement. Supplier delivery risks alongside existing fuel procurement strategies favour conventional fuels, and do not incentivise ZNZ fuels that are not yet available.

Next steps & Recommendations

The TSO concept offers an opportunity for large and small balance sheet players to be included in the ZNZ fuel procurement conversation. In this theoretical assessment, the TSO concept aims to unlock capital for new build ZNZ projects by increasing ZNZ fuel offtake appetite from various down- and mid-stream players [34]. However, given the challenges and limitations identified, there remains scope to better refine the concept's commercial maturity with the help of key industry actors.

- **For policy makers and governments**
  There is an opportunity to combine catalytic funding with innovative fuel procurement strategies, like the TSO concept, to help smaller downstream and midstream players transition to ZNZ fuels. Given the price and volume risks of ZNZ fuels, in the near-term the feasibility of the TSO model can be further studied in conjunction with public incentives and price bridging tools like Contracts for Difference (CfDs). These tools can offer revenue certainty and stabilise prices for upstream players, encouraging supply even in the face of uncertain demand or volatile prices. This would create a more stable environment to pilot and refine the TSO model.

- **For de-risking agents like Export Credit Agencies (ECAs), Insurers, or Third-Party Aggregators**
  These stakeholders can help close finance gaps and build investor confidence to support the near-term scaling and uptake of ZNZ fuels. Clarifying the role of de-risking entities, such as underwriting or backing later-stage offtakes (e.g. in years 9-11), could strengthen the commercial viability of the TSO model.

  To address contractual management and risk-diversification challenges, including legality, it is essential to better assess the role of third-party aggregators [35], like H2Global's HintCo, in advancing the TSO concept. These aggregators can reduce the creditworthiness burden on upstream players and promote the ZNZ fuel project's bankability.

  Public incentive mechanisms, when combined with innovative fuel procurement strategies, may be able to ensure the sustainable and near-term uptake of ZNZs. Public support, either through government backed funding or ECA support can help ZNZ fuel projects securing FID, as seen with European Energy's Kasso Project, which won EUR €1.5 million from the European Investment Bank and close to EUR €50 million in construction financing from EIFO, the Danish ECA.

[34] The TSO aims to increase appetite for ZNZ fuel offtake for various mid- and down-stream players; not limited to only Tier 1 clients.
[35] The recent findings from the Maersk McKinney Moller Centre for Zero Carbon Shipping's Fuel Demand Aggregation study introduce varying designs of demand aggregation networks, ranging from low-obligation to high-obligation in strength of involvement. These findings highlight a "sweet spot" in demand aggregation, where a third party, as an intermediary, can be included to enable or facilitate the sourcing or purchasing of the ZNZ fuels and take up most of the risk. The Global Maritime Forum's study on demand aggregation analyses the H2Global instrument Hintco.

- **For price benchmarking agents**
  The TSO concept could help to create ZNZ cost models and synthetic indices using data from TSO price commitments. It could also complement existing Bunker Adjustment Factor (BAF) models while the ZNZ market matures.

  The BAF is a contractual surcharge used by carriers and shippers giving them transparency on fuel costs and that each party pays a fair share, while reducing exposure to volatile fuel prices. In the context of the TSO, there could be an opportunity to explore how emerging BAFs that include ZNZ fuel mixes may be better priced thanks to price lock-ins that come with TSO. For example, the Wallenius Wilhelmsen's BAF 2.0 integrates multiple fuel types into one charge, helping customers predict costs during the ZNZ fuel transition. Exploring how TSO interacts with BAF 2.0 could help ensure greater price transparency and surcharge accuracy.

- **For midstream and downstream players**
  Emerging regulations affecting international shipping emissions will impact all players. The TSO aims to give all mid- and down-stream players the ability to contribute to near-term ZNZ fuels market scalability. For viability and to pilot the TSO, we invite midstream and downstream players to further refining the concept and offer insights on offtake willingness. By assessing the most appetising offtake contract structures, the TSO concept can be applied commercially.

- **For upstream players**
  Applying TSOs to existing fuel projects, not just newbuilds, could open opportunities for pilot testing of the concept. We invite upstream players to work with us in further refining how they can apply and test the TSO in a commercial setting.

Upon adopting regulatory measures, the international shipping sector will need the near-term scaling of ZNZ fuel projects to meet their long-term decarbonisation demands. In an environment where all players can transition to ZNZ fuels, there is an opportunity to scale-up the nascent solutions in the shorter, rather than longer term.

CONCLUSION

Accelerating the decarbonisation of maritime shipping hinges on innovative financial mechanisms that make transition investments visible, viable, and scalable. This report outlines three complementary concepts designed to overcome key barriers to financing the sector's transition:

Maritime Multiplier Carbon Accounting approach:

A tool to quantify the cross-sector benefits of investments in shipping decarbonisation, enabling investors to measure the cascading effects of these investments across global supply chains and incorporate these insights into disclosures.

Lending Platform for energy saving technologies:

A financial instrument leveraging pooling mechanisms, blended finance, and standardised processes to ensure access to affordable finance to deploy energy saving technologies, particularly for smaller shipowners.

Time Stacked Offtake model:

A flexible ZNZ fuel procurement mechanism that aggregates demand, shares risk and enhances project bankability.

Each concept calls for follow-on work to enable implementation. For example, exploring appropriate governance frameworks, de-risking instruments (such as ECAs and insurance), and catalytic public capital. Early pilot projects will be critical to demonstrate viability and attract private investment.

These concepts have the potential to create the foundations for scalable investment. EDF and the Decarb Hub welcome any constructive dialogue and active collaboration from industry, financiers, policymakers, and technology providers to refine these concepts, co-create pilots, and accelerate implementation across the maritime sector.

Together, we can mobilise capital at scale, reduce transition risks, and increase the finance and maritime sectors' leadership in global climate action.

This report was prepared by the Environmental Defense Fund and the Lloyd's Register Maritime Decarbonisation Hub

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The Lloyd's Register Maritime Decarbonisation Hub (commonly known as the Decarb Hub) is an independent, non-profit initiative established through a partnership between Lloyd's Register Foundation — a global charity with a mission to engineer a safer world — and Lloyd's Register Group, a global provider of maritime professional services with over 260 years of heritage.

This partnership brings together the Foundation's public benefit mandate and focus on societal resilience, with the Group's deep technical expertise and trusted relationships across the maritime industry. Positioned at the intersection of these two organisations, the Hub is uniquely equipped to accelerate the safe, sustainable, and human-centric decarbonisation of global shipping — combining neutrality with influence, and research with real-world application.

For more information, go to www.thedecarbhub.org.