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The role of insetting in supporting shipping's energy transition

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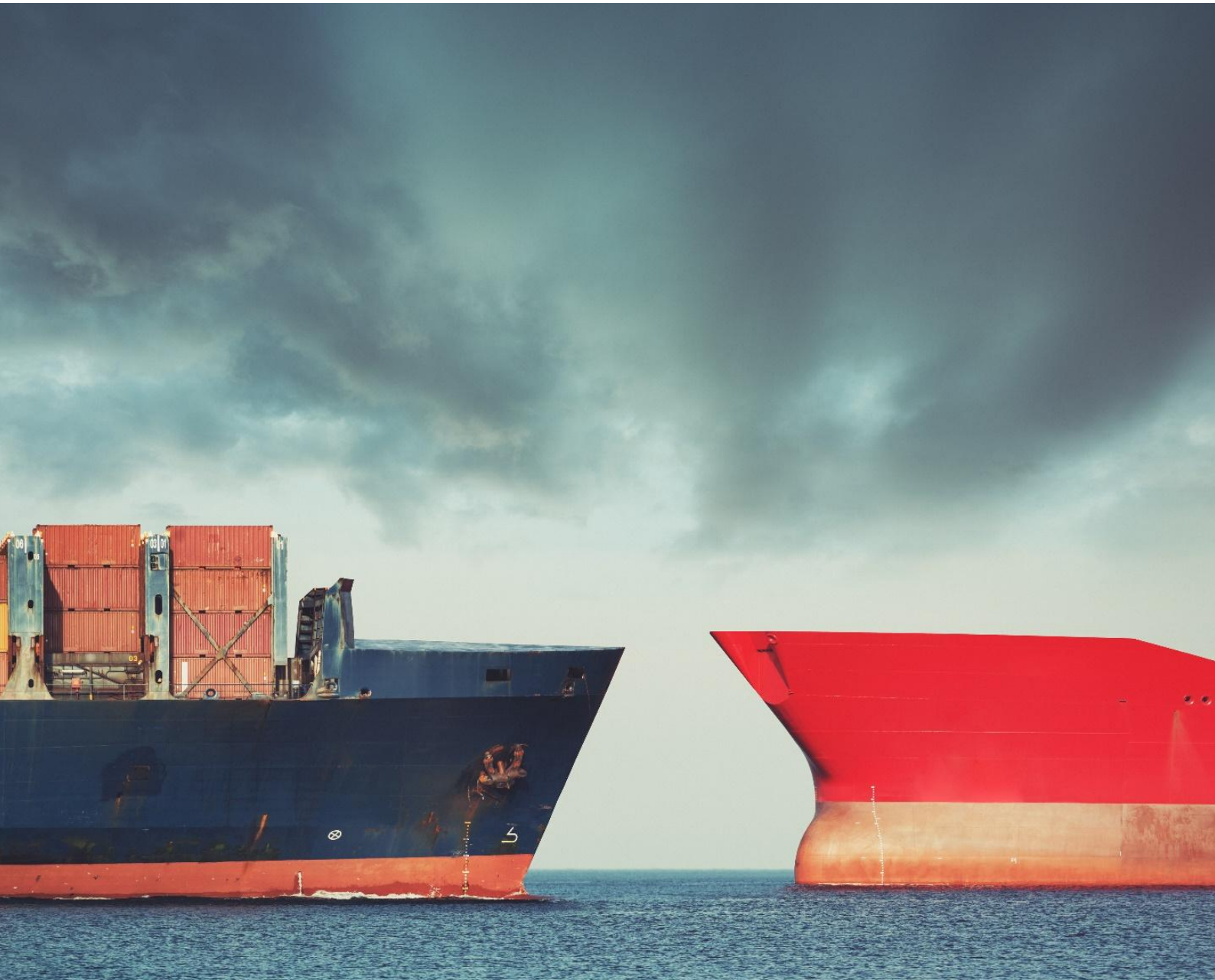

About UCL

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.

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About UMAS

UMAS is an independent commercial consultancy dedicated to catalysing the decarbonisation of the shipping industry. With our deep industry expertise, exceptional analytical capabilities and state-of-the-art proprietary models, we support our clients in navigating the complexities of this transition by providing groundbreaking data, analyses and insights. Internationally recognised for our work, UMAS delivers bespoke consultancy services to the maritime sector (including owners/operators, charterers, OEMs, and energy providers), alongside regulators, governments, and NGOs.

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Contents

List of Abbreviations

AFOLU	Agriculture, Forestry and Land Use
EU ETS	EU Emissions Trading Scheme
EEXI	Energy Efficiency Operational Index
GHG	Greenhouse Gas
GHGP	Greenhouse Gas Protocol
GLEC	Global Logistics Emissions Council
GO	Guarantee of Origin
IMO	International Maritime Organization
ISCC	International Sustainability and Carbon Certification
LCA	Life Cycle Assessment
LDC	Least Developed Countries
LNG	Liquefied Natural Gas
NZF	Net Zero Framework
RED	Renewable Energy Directive
RSB	Roundtable on Sustainable Biomaterials
SBTi	Science Based Targets Initiative
SIDS	Small Island Developing States
SMFC	Sustainable Maritime Fuel Certificates
SZEF	Scalable Zero-Emissions Fuel
TtW	Tank-to-Wake
VCS	Verified Carbon Standard
WtW	Well-to-Wake

Glossary

Additionality

A principle ensuring that emissions reductions or climate benefits result directly from a specific intervention that would not have occurred under a "business-as-usual" scenario. This is critical to proving the genuine impact of any form of emissions credit.

Book and claim

A chain of custody model that allows emissions credits to be purchased and claimed through a registry by a party that is not directly related to the organisation or activities generating the emissions credits, therefore decoupling. This model decouples the physical flow of materials flow from the associated emissions reduction claim.

Certification

A process through which emissions reductions or climate-related activities are verified against established standards by an independent third party, ensuring these activities meet required quality and credibility benchmarks.

Permanence

Refers to the durability of an emissions reduction or carbon sequestration effort over time.

Transparency

The clear, accessible, and accurate disclosure of information regarding emissions reductions, credits, methodologies, and impacts.

Verification

The process of independently assessing whether reported emissions reductions are accurate, valid, and comply with established standards or methodologies.

Voluntary actions

Actions from private sector organisations, non-governmental organisations and state actors (national action) which are in addition to or ahead of mandatory regulations.

Technological lock-In

A situation where reliance on currently viable but transitional solutions delays investment and development in scalable long-term solutions (e.g. SZEFs).

Scalable zero-emission fuels (SZEFs)

Alternative fuels, such as green ammonia, green methanol, and hydrogen, that produce no greenhouse gas emissions during use and can be sustainably scaled to meet the global energy demands of shipping. These fuels are key to the long-term decarbonisation of the maritime sector.

Just and equitable transition

A framework to ensure that the benefits and costs of decarbonisation are distributed fairly, prioritising support for vulnerable populations, such as Least Developed Countries (LDCs) and Small Island Developing States (SIDS).

Executive summary

Purpose and scope

This study analyses the rapidly evolving landscape of voluntary insetting schemes, with particular focus on maritime sector applications. The objective is to synthesize existing literature on insetting to provide actionable recommendations that address identified risks and challenges. The analysis examines insetting schemes broadly rather than evaluating individual maritime insetting programs in detail.

Insetting schemes have a role in improving the energy efficiency and supporting the energy or fuel technology transition in shipping. The scope of this study is on the latter. The working definition used in this study for insetting schemes is that they generally require that investments go directly towards activities that reduce emissions in an organisation's own value chain, for example, investing in renewable energy generation to supply an organisation's own factory, investing in sustainable practices within a company's suppliers, etc.

Opportunities for insetting

In the context of a transition, voluntary action through insetting schemes can be a potentially valuable tool for catalysing shipping decarbonisation during the emergence phase or the critical period before regulation is driving key decarbonisation actions. The strategic utility of maritime insetting schemes includes their ability to stimulate value chain thinking and provide early market signals during this phase. Insetting schemes offer a mechanism to mobilise private investment into and aggregate demand for low/zero emission solutions during the narrow window before compliance-driven measures become dominant.

Organisations that take this early action can become innovators and early adopters, and so promoting this practice can enable subsequent mass market adoption of new fuels and technologies. Maritime insetting schemes can be seen as helpful if they manage to achieve this objective—i.e. successfully mobilise investment in solutions and produce strong standards that dovetail into regulation and therefore minimise stranded asset risks. With the right incentives in place, insetting schemes can help build momentum and confidence in industry. This response could provide regulators with firmer signals to design stronger policies.

With the approval of the IMO NZF in April 2025, there is a growing expectation that shipping's energy transition will be driven by regulation. If the LCA guidelines currently being developed at the IMO continue to limit compliance with the NZF to the physical fuels/energy used onboard ships, this would leave voluntary insetting schemes with a different basis to the accountancy of GHG emissions than used by the IMO. As a consequence, the industry may direct its efforts towards regulatory compliance, with the IMO NZF increasingly providing the clearest signal for investment by early adopters. In this eventuality, there would only be a small remaining time window for voluntary insetting schemes to play a clear additional role in incentivising the early adoption of long-term decarbonisation solutions, provided these schemes have sufficient guardrails to enable this.

Well-designed insetting schemes can support the business case of first movers, e.g. if technology or solution providers can show a functioning market for book and claim and sufficient demand for credits at the volume and value required for those solutions. At present, in the maritime sector, only a very small portion of shipping's energy use is covered by such schemes, making it difficult to give grounds for transformative investments, for example, multi-

million-dollar e-fuel production investments. Such schemes may yet grow to have a stronger effect, but in the meantime, they can provide a supportive market signal for first movers (fleet operators as well as fuel producers). Well-designed insetting schemes can still have a role in improving the uptake of energy efficiency measures, and could be used to overcome split incentives and lack of access to capital barriers.

Risks and challenges

As well as presenting opportunities, including in the case of maritime insetting, there are risks. These are discussed, along with the potential ways in which they can be managed, in order to provide specific recommendations that can maximise the success and value of maritime's use of insetting. There is growing literature indicating that private or non-state action is not leading to desired outcomes in various settings, whether it is tangible emission reductions, a lack of enforcement, or setting appropriate and effective environmental standards to feed into regulation. Voluntary actions can therefore face pitfalls, can be misguided and provide unhelpful distractions—all of which may be faced by maritime insetting schemes. Using the literature of wider experiences as a prompt, maximising positive and catalytic potential, maritime insetting efforts should ensure they address the following challenges:

***Inappropriate boundary setting**:* Whilst there are efforts to understand the importance of system boundaries, there is only emergent independent guidance or standards on the issue of boundary setting in general, nor in maritime insetting schemes. This stems from a more fundamental question on how to define value chain boundaries for an organisation. Each company will have its own interpretation of what its value chain is, which is compounded when multiple organisations are working to establish the same. The book and claim systems in existence have tended to be quite broad and opaque, e.g. covering the whole transport sector, with unclear methodologies for accounting and verification.

> ***Recommendation:*** Adopt GHG Protocol guidance on defining insetting boundary as only 'within the value chain, not adjacent to it'. In the case of maritime insetting schemes, adopt the SFC's Book & Claim Methodology, which recommends that transactions be restricted by mode. The appropriate boundary should therefore encompass the fuel supply chain, port infrastructure, vessel/cargo carriers (of different sizes and types), and cargo owners (bulk and containerised).

Incompatibility with broader regulation and additionality: If insetting is seen as a bridge to regulatory-driven energy transition, it needs to be a bridge to forthcoming regulations and not a dead-end or an expensive distraction, e.g. to avoid risks of further ratcheting up of policy creating stranded asset risks. For example, if there is an incompatibility between insetting and regulation (e.g. in GHG accountancy), the relative cost of different pathways/technologies may not be the same under insetting as under regulation – asset investments by early adopters to take advantage of insetting incentivisation may then become stranded. Where there are existing or anticipated regulations, insetting schemes should ensure compatibility/coherency with expected emissions accountancy practices, as well as additionality over any regulatory compliance strategy – this can be achieved if action is taken before regulations, e.g. before stricter intensity targets are enforced.

> ***Recommendation:*** Ensure all claimed emissions reductions exceed regulatory compliance requirements. Follow the latest available science in setting the standards. For example, adopt a full lifecycle emissions accounting (well to wake) approach and include all GHG emissions and emissions factors when using insetting schemes to decarbonise emissions from the fuel supply chain.

Verification standards: There are limited examples of transparent and universal standards or guidance for the certification and verification of the emissions reductions promised by insetting schemes. As a result, companies rely on frameworks and standards pulled from a similar pool of inconsistent standards or their own internal standards. These have varying stringency and scope, and are often criticised in the offsetting market as 'marking your own homework'. This has led to similar concerns around emissions accountancy integrity, additionality, permanence, transparency and double counting as well as accusations of some insetting schemes simply being offsetting under a new guise.

> ***Recommendation:*** Use independent third-party verifiers and transparently report the verification process used. Adopt GHG Protocol for Project Accounting to provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG reduction claims. Maritime insetting schemes should use existing structures for verification, e.g. Recognised Organisations such as classification societies.

Compatibility with long-term solutions*:* Current insetting schemes predominantly rely on transitional fuel choices such as biofuels due to their immediate availability, relative ease of use as a drop-in fuel and cost-effectiveness, but face scalability constraints due to limited supply and competing demand from other hard-to-abate sectors. This focus on transitional fuels creates significant risks of technological lock-in and diverting investment away from Scalable Zero-Emissions Fuels (SZEFs) such as green hydrogen, ammonia, which are essential for long-term decarbonisation.

> ***Recommendation:*** Maritime insetting schemes should have clear guardrails that promote the uptake of fuels that are scalable and zero/close to zero emissions.

Compatibility with a just and equitable transition: An unrestricted insetting scheme will channel funds toward the most cost-efficient geographical areas, and there is a risk that this favours developed nations with good existing infrastructure and lower costs (e.g. costs of capital). Without safeguards, there is a risk of marginalizing the Least Developed Countries (LDCs), and Small Island Developing States (SIDS), most vulnerable to the negative environmental impacts of climate change. There is also a possibility that lowest cost energy production will occur in low-income countries, separated from those in higher-income countries with higher willingness to pay a premium for GHG emission reduction. If this is the case, and there are safeguards to ensure investment is genuinely 'just and equitable', there can be compatibility.

> ***Recommendation:*** Maritime insetting schemes could contribute to a just and equitable transition, e.g. through specific targeting at initiatives that enable the uptake of fuels that are scalable and zero/close to zero emissions in regions that are at risk of being priced out of shipping's transition opportunity. Monitoring of the beneficiaries of insetting, where the projects that they enable are located, can track whether or not this is the case, or if additional intervention is needed.

Concluding remarks

Insetting at its best can be a useful tool for creating a pathway for fully decarbonising shipping. It creates a lower 'cost of entry' for early adopters by aligning shipping operations, which might be able to pay price premia, with opportunities for the least cost use of future fuel/technologies. Particularly in a period in which regulation is anticipated but not yet in place, it can help companies to explore, learn and strategise to better prepare for a period of regulation. However, insetting has risks of unintended consequences, including because it helps to establish 'norms', and these risks can reduce its value. To maximise insetting's potential, schemes need to follow the latest available science, have effective governance from

reliable third parties, and promote long-term decarbonisation solutions without creating adverse impacts for countries most vulnerable to climate risks. The window of opportunity for maritime insetting schemes to demonstrate their catalytic potential is likely to be narrow but still significant. Their ultimate value will be measured not by the emissions credits they generate, but by their ability to rapidly accelerate the maritime industry's transition to a zero emissions future.

Introduction

International shipping is at the beginning of an energy transition that will reshape the sector, both its fleet and energy supply chains. There are various potential drivers for that reshaping, which can be identified both from the structures that govern shipping today, as well as looking at how transitions unfold more generally. One of the advantages of this global sector in relation to energy transition, is the existence of a multilateral governance regime in the form of the UN agency the International Maritime Organisation. This regulator can and does set policy to manage shipping's environmental impacts, including in relation to climate change. However, there are also sub-global governance regimes (including national and regional regulation) as well as private standards – voluntary standards adopted by 'coalitions of the willing', including to align with wider guiding objectives. The particular interplay and relative contribution of these various potential levers is constantly evolving. In 2021, a number of potential scenarios for their respective contribution (timing, effectiveness) were developed, in close discussion with many stakeholders from across shipping's value chain.[1] Some further clarity arose in July 2023 when IMO adopted its Revised Strategy for reduction of GHG emissions, and then in April 2025, when IMO approved in principle its Net Zero Framework, a policy development intended to drive energy transition.[2]

The increase in regulatory and public pressure on companies to commit to and implement emission reductions to meet decarbonisation targets has widened the breadth of options being considered to achieve this. Voluntary insetting is one option with a growing presence in the decarbonisation ecosystem, including the maritime space. While there is a growing body of information available regarding this emission reduction mechanism, there is a noticeable gap in critical analysis of the opportunities and challenges that insetting presents. This paper sets out to provide a detailed analysis of the rapidly developing insetting landscape with specific attention to applications in the maritime sector.

Insetting – a primer

Voluntary emissions insetting is when companies invest in emission reduction projects in their value chain. Insetting schemes enable investment in activities that prevent, reduce or remove emissions in exchange for the right to claim those emissions reduction attributes in some form. Although there is no universally accepted definition of insetting, the key distinction between insetting and offsetting is the restrictions governing the relationship between the activities generating the emissions reductions and the organisations investing in and, subsequently, claiming the emissions reductions (see Figure 1).

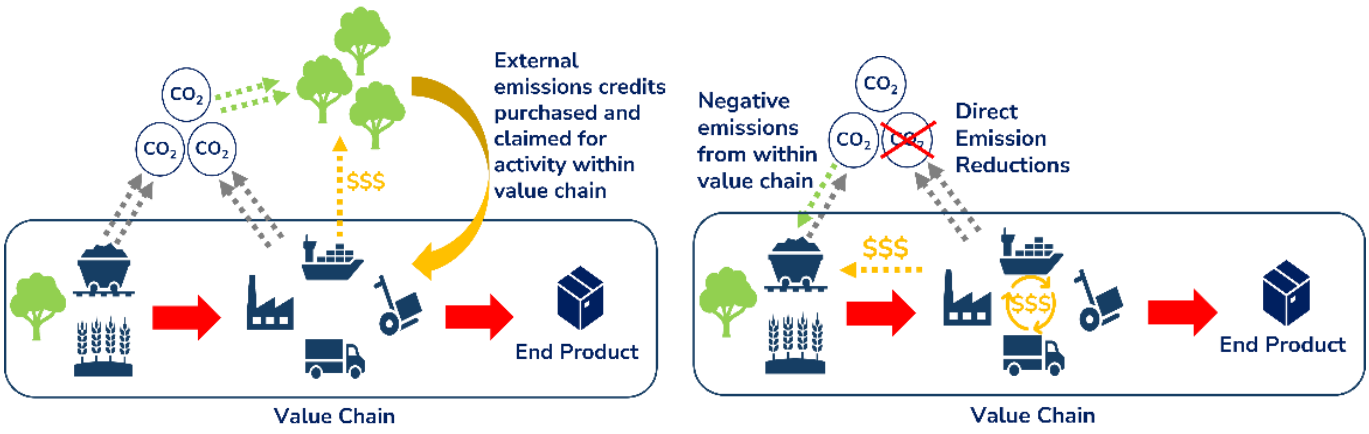

Figure 1. Infographic indicating the offsetting approach (left) and the insetting approach (right) to reducing carbon emissions

Emissions insetting schemes generally (though not necessarily in the case of maritime) require that investment is directed towards activities that reduce emissions in an organisation's own value chain (e.g. investing in renewable energy generation to supply an organisation's own factory, investing in sustainable practices within a company's suppliers, etc.). As the projects target emissions reductions within a company's value chain, emissions reduction attributes naturally feed through into the activities of the organisation investing in insetting projects. This is distinct from offsetting, where no such limitations are put in place as standard, and emissions reduction attributes (usually in the form of certificates or credits) can be exchanged and used freely between largely unrelated activities.

Historically, the distinction between offsetting and insetting has been quite clear. However, evolution in the design and ring-fencing of voluntary markets for emissions credits has seen the emergence of schemes that have elements of both, including projects in the maritime sectors. Critical examination of the degree to which projects in these new forms can access the potential benefits of insetting, whilst avoiding the historical pitfalls of offsetting, is important in guarding against new forms of greenwashing and misdirection of funds for decarbonisation. Most of these new schemes are based on a book and claim chain of custody model for emissions accounting.

Chain of custody models

Specific chain of custody models underpin insetting practices, providing accounting frameworks that establish standards for the certification, ownership and transfer of emissions reduction attributes between parties. In all cases, an independent body will typically certify emissions reduction attributes under a specific standard (e.g. Verified Carbon Standard (VCS)[3], Gold Standard[4], International Sustainability and Carbon Certification (ISCC) EU[5], etc.), which aims to quantify and validate the quality of the emission reductions achieved by a project and/or the emissions attributes of material throughout the supply chain. The robustness of the processes and standards for certifying emissions reductions is critical to the utility of a chain of custody mechanism and the ultimate value of an insetting or offsetting scheme. The credibility of any scheme collapses if the materiality of emissions reductions (e.g. additionality, permanence, transparency) is not guaranteed through a transparent process of assessment by a third party. The major chain of custody models are described below.

Segregation & identity preservation

In identity preservation chain of custody models, certified and non-certified feedstocks remain physically separate throughout the supply chain, maintaining their distinct qualities and origins. This ensures that products derived from certified sources can be traced directly to their specific sustainable origins. A segregation chain of custody model requires the certified product from a certified site to be kept separately from non-certified sources but allows mixing of certified products or feedstocks that have the same characteristics. Emissions reduction attributes associated with certified low-emission feedstock can be assigned to the consumer or user of these segregated products. The key difference between segregation and identity preservation is that the former allows mixing of materials if they are certified under the same standard, whereas the latter requires no mixing of materials throughout the supply chain.[6]

> ***Example of identity preservation:*** *A shipping company completes a spot charter voyage using certified biofuel.* A cargo owner specifically requests the use of *certified biofuel for their shipment for the entire voyage (and pays the resulting cost premium). The emissions reduction attributes associated with the use of biofuel are assigned directly to the cargo owner.*

Mass balance

Certified and non-certified feedstocks may be mixed and/or blended, with their exact quantities tracked throughout the supply chain. This model enables the renewable or low-emission qualities of the certified feedstock to be attributed proportionally to the final product, allowing precise claims regarding the volume or percentage of certified low-emission feedstock. Attributes corresponding to the proportion of certified low-emission feedstock can then be allocated to the consumer or user of the feedstock and transferred along the supply chain. These attributes can also be distributed unequally between end users, provided the total emissions reduction claim does not exceed the volume of certified feedstock used.[6]

> ***Example 1 of mass balance:*** *A shipping company uses a certified blend of biofuel and conventional marine fuel for a spot charter voyage. The emissions associated with the biofuel portion are calculated, and emissions reduction attributes equivalent to that can be allocated to the cargo owner(s). The maximum quantity of emissions reduction attributes that can be claimed corresponds precisely to the proportion of biofuel used during the voyage. These attributes can be allocated fully to an individual cargo owner or distributed (equally or unequally) across multiple cargo owners involved in the voyage.* These attributes can be allocated fully to an individual cargo owner or distributed (equally or unequally) across multiple cargo owners involved in the voyage.

> ***Example 2 of mass balance:*** *A certified volume of bio-LNG is injected into a shared LNG supply network and emissions reduction attributes associated with the volume of fuel are calculated. One or more vessels fuelling with LNG at ports connected to the same LNG supply network can claim emissions reduction attributes against their fuel use up to the quantity associated with the certified volume injected into the network.*

Book and claim

Certified emission reductions from specific projects or activities are documented in a registry as emissions credits/certificates. These emissions credits can be purchased and claimed by other organisations to reduce emissions from their own unrelated activities. This system allows flexibility in reducing emissions across different activities and breaks the need for a physical connection between the origin of the emissions credits and the activity being offset.[6]

> ***Example of book and claim:*** *A shipowner conducts a voyage whilst burning a certified biofuel and generates emissions credits associated with the low-emissions transport work, which it registers on a book and claim marketplace. A cargo owner that uses a vessel fuelled by conventional marine fuel purchases some of the certified emissions credits from the* book and claim *marketplace. These credits are then used to report reduction in the direct emissions from the cargo owner's voyage. In selling the credits, the seller relinquishes the right to claim the emissions reduction associated with the credits, despite their use of low-emissions fuel.*

In its purest form, insetting is founded on the principles of mass balance, segregation or identity preservation. Through these mechanisms, emissions reductions are funded within an organisation's value chain and have a physical connection to the activities of the organisation. This allows organisations to make a tangible emissions reduction claim in relation to their activities. The book and claim framework breaks this requirement for a physical connection between the activity producing the emissions reduction and the organisation investing/purchasing, and subsequently claiming, the generated credits. This is what enables its application as the basis for emissions reductions. It is worth noting that mass balance, segregation or identity preservation models will often underpin the initial certification of emissions credits that are then allowed to be traded under a book and claim framework.

Current insetting practices

As has been the case for offsetting, insetting is most attractive to companies in hard-to-abate sectors with high economic, technological or social barriers to direct emissions reductions. For example, insetting has long been used in sectors linked to agriculture, forestry and land use (AFOLU) (e.g. cosmetics, food and drink, clothing, etc.), with many organisations directing funds towards nature-based solutions related to the activities at the base of their supply chain (e.g. reforestation, agroforestry, biodiversity conservation, etc.).[7] Similarly, companies in the cement and steel manufacturing industries have implemented insetting schemes in the form of investment in technologies that reduce emissions during their manufacturing process (e.g. carbon capture, renewable feedstock replacements). [8,9]

As a potential means of delivering more tangible emission reductions than conventional offsetting and realising the importance of investing in an organisations own value chain, insetting has gained traction in these sectors, with many organisations pointing towards its potential to stimulate deep decarbonisation within a supply chain.[7,10] Much like offsetting, there remains no universal standards or guidance for the certification and verification of the emissions reductions promised by insetting projects. As a result, companies rely on frameworks and standards pulled from a similar pool of inconsistent standards, or their own internal standards, of varying stringency and scope that are often criticised in the offsetting market. This has led to many of the same concerns around emissions accountancy integrity, additionality, permanence, transparency and double counting as well as accusations of some insetting schemes simply being offsetting under a new guise.[11,12]

It is worth noting that in the context of AFOLU, Science Based Targets Initiative (SBTi) and GHG Protocol (GHGP) have both issued guidance (or draft guidance in the case of GHGP) allowing for the use of forms of insetting as part of a net-zero strategy.[13] However, in all other contexts, SBTi and GHGP use a case-by-case evaluation of the legitimacy and effectiveness of insetting schemes as part of a long-term emissions reduction strategy. Neither organisation currently offers a clear definition of the insetting practice – a recognition of the varying levels of credibility in current insetting claims.[14–16] Less attention has been paid to emergent schemes in the freight transport sector that appear to merge the ethos of insetting with book and claim-based frameworks.

Insetting in the maritime context

In the maritime sector, the limited availability and high cost of SZEFs, along with the substantial upfront expenditure required for related infrastructure and onboard technologies to use these fuels, is a hindrance to emissions reduction efforts. As a result, some organisations are now looking to programs like insetting as a potential strategy to reduce costs, cost-effectively reduce emissions in a sector that represents 3% of global emissions and forms part of the Scope 3 emissions of a huge variety of organisations. Maritime emissions reduction can be delivered in many ways (e.g. energy efficiency technologies[17], operational efficiency improvements[18], etc.), however, recent attention has focused on the replacement of conventional fossil-based marine fuels with low-emission substitutes.

Different types of organisations within the maritime sector have established a variety of insetting-like schemes in recent years and a tentative assignment of these into three categories is provided below. All three categories of initiatives rely heavily on a book and claim chain of custody model, which allows the transfer of emissions reduction attributes in the form of certificates or credits from one organisation to another. Despite not meeting the requirements of some definitions of 'insetting', schemes of these kinds are often labelled as such due to the boundaries that are placed around the book and claim systems. In general, this involves restrictions on the organisations eligible to exchange emissions credits (e.g. in-sector actors only) and limits on the types of activities that can be booked and claimed against (e.g. transport activities within the same transport mode).

Existing maritime insetting schemes

As a product by logistics companies/freight forwarders

Several logistics companies offer a product which allows purchasers of freight transport to access a proprietary emissions insetting scheme at a premium. Emissions reductions are generally created (and 'booked') on activities within the maritime transport network of the logistics company or a partner organisation by supplying a vessel with low-emission marine fuel (most commonly biofuel). The emissions reductions can then be claimed against the vessel and voyage of their customer, regardless of whether biofuel was used on their specific voyage, using a book and claim chain of custody model.

These schemes use a variety of certification standards and methodologies for the certification of low-emission fuels and the emissions savings they create. Most use an independent certification standard for selecting fuels (e.g. CISCC, RSB, etc.) and have some form of third-party verification in place to audit emissions reduction claims against the reported emissions accounting framework (e.g. GLEC Framework). Some companies (e.g. DFDS) also offer alternatives that use a mass balance chain of custody model, which can improve the likelihood that emissions reductions are achieved using low-emission fuels on the specific vessels/voyages conducting the customer's trade. However, it is often the case that there is no obligation for reporting to verify the physical matching of fuel use on a particular voyage, or a monitoring mechanism built in for tracking at this level of granularity.

Examples: *GoodShipping*[19]*, GoGreen Plus (DHL)*[20]*, Insetting Light (Forto)*[21]*, Decarbonised Solutions (DFDS)*[22]

As a product by shipping companies

Several shipping companies offer emissions insetting as a premium product, whereby emissions reductions generated by burning low-emission fuels can be claimed against the transport activities of the customer using a book and claim methodology. These schemes utilise various certification standards and methodologies for certifying low-emission fuels and the emissions savings they create. Most adopt independent certification standards for fuel selection (e.g., ISCC, RSB, etc.) and incorporate third-party verification to audit emissions reduction claims against established emissions accounting frameworks (e.g., GLEC Framework). Similar to the previous example, the obligation to verify or date to track at this level of granularity is not automatically a feature of these examples.

Examples: *ECO Delivery (Maersk)*[23]*, Ship Green (Hapag-Lloyd)*[24]*, Sail for Change (UECC), Norden (via 123Carbon)*[25]

As part of a book and claim platform/community/marketplace

Book and claim marketplaces/communities provide a central platform with a shared accounting methodology and standards where emissions credits can be registered and exchanged between organisations. The platform or community generally sets standards for certification of emissions reduction credits, auditing/verification of emissions reduction claims, as well as restrictions on which organisations and in relation to what kinds of activities emissions credits can be exchanged. There are examples of these platforms operated by both for-profit and not-for-profit organisations.

Examples: *123Carbon Book & Claim Platform*[26]*, RMI-MMMCZCS Platform Katalist*[27]

Opportunities for maritime insetting

Fundamentally, book and claim schemes in the maritime sector increase access to low- and zero-emission fuels, create markets for deployment of SZEF and have the potential to positively impact total GHG emissions as a result. By widening access to the lowest-cost emissions reduction solutions, platforms of this kind have the potential to mobilise capital from organisations that might otherwise be unwilling or unable to pay the cost of direct emissions reductions. This is particularly attractive in a sector like shipping, where there is significant variation in the cost of abatement for actors based on the specifics of their operations and geographical variations in the availability of different fuels.

In the face of the estimated nearly $4 trillion required by 2050 to fully decarbonise shipping, the mobilisation of private investment in low-emission shipping solutions early on is undoubtedly positive.[28] The increased accessibility and demand aggregation that is facilitated by such platforms has the capability to channel funds from a range of private actors within the sector towards the development and commercialisation of these technologies.[29,30]

Before a compliance-driven regime is established through the enforcement of the IMO NZF, schemes of this type could encourage behaviour changes and provide near-term demand signals. This, in turn, could help accelerate the development of the production and distribution infrastructure required to seed the near-term adoption of scalable zero-emission fuels (SZEFs).[29] The same could be said of the proprietary insetting schemes offered by particular shipping and logistics companies, but to a lesser extent due to the reduced level of demand aggregation. Schemes based on book and claim insetting could also serve as fruitful proving grounds for business model innovation and development of robust emissions reduction mechanisms that could feed into future regulation.[29]

Gaining Momentum

Most of the proprietary schemes from freight forwarders and logistics companies offering insetting as a premium service based on book and claim or mass balance models have entered into force post-2020. Open book and claim communities and platforms are an even more recent development with the blockchain-based multi-modal book and claim platform, by 123Carbon, launched in 2023, and Katalist, the only schemes currently in full operation. The 123Carbon scheme uses the Book & Claim Methodology published by the Smart Freight Centre (SFC) in 2023.

In April 2024, the Zero Emission Maritime Buyers Association (ZEMBA) announced that the winner of their first tender Hapag-Lloyd would use the Katalist, a nonprofit book and claim platform to generate, verify and transfer the Sustainable Maritime Fuel Certificates (SMFCs) to its participating members associated with moving the equivalent of more than 1 billion TEU-miles per year using waste-based biomethane in 2025 and 2026.[27] In March 2025, SBTi released the draft Net Zero Corporate Standard v2 that (for the first time) supports the use of environmental attribute certificates as a part of companies' commitments to abate scope 3 emissions only.[1] These latest endorsements for insetting in the form of book and claim provide a strong indication of stakeholders' desire to engage with projects of this type.

[1] The draft standard (v2) has just closed the window for public consultation and guidance is expected to be finalised in the coming months. SBTi confirms that as with the current version (V1.2) of the standard, V2 does not propose allowing offsetting. Final guidelines around how environmental attribute certificates can be applied will be revealed when the final version of the standard is published.

Potential Risks and Risk Management

While maritime insetting schemes present certain opportunities, there are also significant risks that have the potential to undercut their positive impact. Some of these risks, as well as suggested management strategies, are described in this section in order to provide specific recommendations that can maximise the success and value of maritime's use of insetting.

Inappropriate boundary setting

The restrictions placed around which entities and relating to what activities emissions credits can be exchanged in a book and claim-based offsetting system are often vague. In general, the boundaries that are placed around eligibility refer to allowing only the exchange of credits based on often vague references to an organisation's "supply chain", "value chain", "sector" or "activities". In their purest form, insetting schemes do not face this issue as emissions reductions are naturally passed through a supply chain by a mass balance, segregation or identity preservation style chain of custody model. However, the book and claim-based systems emerging in the maritime sector require boundaries to be set as the necessity for a physical connection between the emissions reduction attributes and the transport activity is removed.

Without robust standards, the issue of appropriate boundary setting is left open to interpretation in the maritime context. If not defined appropriately, this can negate many of the potential benefits of the insetting practice in the sector. For example, if emissions credits claimed by actors in the shipping sector originate from low-emission fuels used in other transport modes or renewable energy used for port operations, the argument that investment is being recycled into expanding sustainable technologies for ships loses much of its weight.

Currently, clear and independent guidance or standards on the issue of boundary setting are largely missing from the dialogue. There are a number of initiatives that have attempted to define where the boundary for insetting schemes should lie, for example the GHG Protocol considers insetting to only include activities within a company's value chain, whereas the International Platform for Insetting (IPI) and International Carbon Reduction & Offset Alliance (ICROA) consider insets to be activities within and around a value chain, and the AIM Platform has also attempted to define.[31]

It should be noted that the GHG Protocol is currently developing new Land Sector and Removals Guidance, due to be released in Q4 of 2025, which will contain frameworks for reporting emissions and carbon removals from Agriculture, Forestry, and Other Land Use (AFOLU) sector activities – including insetting, while SBTi currently maintains a policy of case-by-case assessment and will provide further guidance and clarity in the upcoming Corporate Net Zero Standard V2. [15]

As of 2025, the foremost guidance is the multi-modal Book & Claim Methodology published by SFC in 2023, which is used by the 123Carbon Book & Claim Program, and aims to align with current GHGP guidance.[32] SFC's Book & Claim Methodology recommends transactions be restricted by mode (i.e. credits generated by low-emissions shipping activity only be claimable against the emissions of ships), due to the significant variation in the availability, maturity and cost of solutions across different transport modes. The Katalist book and claim methodology and platform provides an additional benchmark for other schemes.[33] However, neither of these guidelines nor the SFC methodology represents an independent, universal, or enforceable standard for the definition of best practice on boundary setting – something that is critical to the long-term credibility of these schemes.

Recommendation: Adopt GHG Protocol guidance on defining insetting boundaries as only 'within the value chain, not adjacent to it'. In the case of maritime insetting schemes, adopt the SFC's Book & Claim Methodology, which recommends that transactions be restricted by mode. The appropriate boundary should therefore encompass the fuel supply chain, port infrastructure, vessel/cargo carriers (of different sizes and types), and cargo owners (bulk and containerised).

Incompatibility with broader regulation

On a fundamental level, there remains a question about whether IMO regulatory-driven energy transition will recognise emissions reductions achieved through both mass-balance and book and claim-type methodology (e.g. accountancy of GHG emissions, including what counts as a sectoral emission reduction). Whilst insetting should be additional and not duplicate regulation, if insetting cannot hand over a set of 'norms' to be further built on as regulation increasingly drives transition, there is a risk of incompatibility with the decarbonisation strategies and any norms created by insetting.

At present, there is a mix of approaches to how insetting is playing a role in existing or proposed regulations:

- Existing adopted IMO emissions standards (Energy Efficiency Design Index, Carbon Intensity Indicator) regulate actual/direct emissions only, depending on the specifics of the fuel used on a ship; therefore, insetting is not included. The emissions accountancy is tank to wake, however, there is an approximation of upstream emissions included to recognise the contribution of biofuels to GHG emission reduction.

- EU regulation of international shipping is built from the Renewable Energy Directive (RED), which includes the issuance of Guarantees of Origin (GOs) for renewable transport fuels produced in the EU. RED III's renewable energy targets, EU ETS and FuelEU Maritime therefore allow the use of 'mass balance', but only for the subset of fuel production and use within the jurisdiction of the EU regulation (e.g. it does not extend to allow mass balance outside of the EU energy system).

- The current IMO lifecycle assessment guidelines (Resolution MEPC.391(81)) are specifically limited to calculating well-to-wake emissions of the physical fuel used onboard a ship and do not include any form of insetting. The IMO's approved Net Zero Framework establishes each ship's GHG Fuel Intensity according to those guidelines, again without any reference or inclusion of any form of insetting. Compliance with target GFI can be managed through the use of 'units' of GHG emission reduction obligation (residual and surplus units) that can be purchased and, to a limited extent, traded.

As a result, the former and latter group (IMO's Net Zero Framework) does not recognise the kinds of indirect reductions (e.g. upstream in the energy system related through a mass balance chain of custody model, as shown in example two of mass balance) that can be claimed under some of the maritime insetting initiatives (e.g. Katalist). The IMO, unlike the EU, does not have jurisdiction over the upstream of an energy system (e.g. production and supply chain), which makes it much harder for the IMO to set up and regulate in a way that is equivalent to how the EU has applied mass balance for renewable transport fuels produced in the EU. The longer-run utility of book and claim-based insetting schemes in a decarbonisation-driven-by-compliance outlook is therefore not assured. However, even as a completely voluntary measure with no contribution to compliance, there are significant risks of GHG accountancy misalignment relating to the compatibility/incompatibility of such schemes with broader forms of regulation.

Issues of potential misalignment between these schemes and different policy instruments apply to virtually all aspects of the scheme design, including boundary setting (as discussed in the previous section), emissions scope (e.g. TtW, WtW, CO_2, CO_2e, etc.), emissions accounting frameworks (e.g. emissions factors, etc.), as well as approved certification, verification and auditing standards. These are just some of the design parameters that could represent points of difference between insetting schemes of this kind and any form of regulation. Notably, both the EU ETS and FuelEU Maritime currently require a mass balance chain of custody model for verifying the sustainability and GHG performance of renewable fuels. With the extension of the EU ETS to include maritime activity since 2024 and Fuel EU Maritime entering into force in 2025 and the IMO NZF recently approved and expected to enter into force in 2027, the policy landscape is set to become increasingly complex.

> ***Recommendation:*** Use independent third-party verifiers and transparently report the verification process used. Adopt GHG Protocol for Project Accounting to provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG reduction claims. Maritime insetting schemes should use existing structures for verification, e.g. Recognised Organisations such as classification societies.

Additionality

Related to this is the issue of defining and ensuring 'additionality', which will be key to understanding the interaction of any of these schemes with different forms of regulation. As a minimum, alignment will be required on technical aspects of insetting systems with relevant regulations – something that will be further complicated by the likely variation in approaches between intersecting regulatory frameworks (e.g. IMO CII/EEXI regulations use CO_2 TtW, whereas EU regulations use CO_2e WtW). However, as regulations enter into force in the maritime space, the 'baseline scenarios' against which additionality is judged will become increasingly important. Demonstrating additionality will likely require practices and standards that are consistent between insetting schemes and aligned with the broader regulation defining the compliance regime, and the technical intricacies therein (e.g. pooling, banking, etc.), defining the new 'baseline scenario'.[34–36]

An assessment of 'additionality' could also vary between jurisdictions and schemes. The creation of a methodology that works seamlessly between jurisdictions will be a significant challenge as regional and international regulatory environments change in the coming years. The degree to which any methodology could be future-proofed against the likely details of emerging regulations is questionable, but the potential as an existential threat that regulation poses to schemes of this type should not be understated. Especially, in the face of a potential decrease in willingness to pay in the coming years due to compliance-driven spending on emissions reductions.

> ***Recommendation:*** Ensure all claimed emissions reductions exceed regulatory compliance requirements. Follow the latest available science in setting the standards. For example, adopt a full lifecycle emissions accounting (well to wake) approach and include all GHG emissions and emissions factors when using insetting schemes to decarbonise emissions from the fuel supply chain.

Accusation of it being "rebranded offsetting"?

One of the most common criticisms of offsetting is that it allows companies to outsource direct emissions savings to unrelated activities, which undermines the effectiveness of emissions reduction efforts and directs investment away from the in-sector solutions needed to decarbonise hard-to-abate sectors like maritime. Appropriate and consistent boundary setting

is the key to distinguishing between offsetting and book and claim-based insetting, as was discussed earlier.

However, even with appropriate boundary setting, many of the issues that have led to criticism of offsetting as greenwashing also apply to insetting schemes.[11,12] Concerns such as questionable additionality, lack of universal regulation and standards, potential rebound effects, and double-counting across frameworks are prevalent in both approaches. Proprietary insetting programs offered by shipping and logistics companies with internal practices are also particularly vulnerable to criticism of a lack of transparency.[11] Although verification and monitoring might be easier in a maritime context due to existing emissions monitoring, reporting, and verification protocols, insetting schemes still face significant barriers to building trust and participation.[37] Addressing these issues is crucial for distinguishing insetting schemes from the offsetting programs that have been largely discarded by the industry as greenwashing.

> ***Recommendation:*** Use independent third-party verifiers and transparently report the verification process used. Adopt GHG Protocol for Project Accounting to provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG reduction claims. Maritime insetting schemes should use existing structures for verification, e.g. Recognised Organisations such as classification societies.

Compatibility with long-term decarbonisation solutions

As a 'drop-in' alternative to traditional fossil-based marine fuels, biofuels generally offer the lowest abatement cost out of the available solutions for reducing emissions in the maritime sector at this point in time (alternative fuels such as ammonia or methanol are still emerging, with only initial small volume use of low GHG emission methanol currently). As a result, the emissions credits traded in most maritime insetting systems are primarily created by vessels burning fuels derived from biogenic feedstock. However, the long-term viability of decarbonisation of international shipping activities through the use of biofuels is complicated by concerns around the scalability of production and potential rising prices in the face of competition from other hard-to-abate sectors and limited supply.[38,39] These fundamental concerns about the role of biofuels in the maritime sector are in addition to existing questions about production standards, local environmental impacts and certification fraud.[40,41]

Scalable zero-emissions fuels (SZEFs), such as green hydrogen, green ammonia and other e-fuels, are considered by many to be the only viable option for the long-term decarbonisation of the shipping industry and adherence to international emissions targets. UMAS and UCL have estimated that SZEFs must reach at least 5% penetration of the maritime sector by 2030 to enable decarbonisation in line with the Paris Agreement.[42] This target has since been codified as the minimum ambition for uptake of zero or near-zero GHG emissions technologies in international shipping in the 2023 IMO Revised GHG Study.[42,43] However, these solutions carry significantly higher abatement costs in their current form. The costs will only be brought down through development and demonstration of new or retrofitted vessels capable of burning SZEFs, as well as the necessary fuel production and distribution infrastructure.[44] By currently pushing investment towards emissions reduction solutions that currently offer the lowest cost of abatement, emissions insetting schemes could serve to create technological 'lock-in' that entrenches reliance on short-term solutions or 'transition fuels'. This carries the risk of slowing the transition to technologies and fuels that represent better long-term prospects for maritime decarbonisation and increasing the risk of stranded assets.

An example of how these particular risks can be managed is provided by the ZEMBA initiative. In recognition of these risks, ZEMBA shortened the contract period of their first tender to just two years and intentionally selected a project with no requirements for new LNG-specific infrastructure or vessels when selecting a biomethane-based solution as the winner of their first tender.[27] ZEMBA has also committed to explicitly encourage solutions based on e-fuels in their second tender.[33] However, this may be a special case, and in general, book and claim marketplaces (e.g. 123Carbon Book & Claim Platform) are unlikely to be compatible with the same focus on high-level direction that could steer investment toward specific technologies (e.g. long-term decarbonisation solutions).

Geographical and operational heterogeneity is a fundamental aspect of the international shipping sector.[45] Actors in the sector also operate within a diverse range of economic and regulatory circumstances. As a consequence of this, the shipping sector has a very broad range of abatement costs as well as willingness and/or ability to pay those costs between different organisations, segments, and regions.[46] An apparent advantage of insetting schemes, e.g. book and claim, is the levelising effect of actors being able to purchase emissions reduction credits that are not directly related to their own activities. However, this heterogeneity and the higher cost of abatement in parts of the sector is an intrinsic part of the cost of decarbonisation in the shipping sector. Operations that will be more costly to decarbonise will likely require the highest levels of investment. Shielding organisations with a higher cost of abatement or a lower willingness to pay based on their specific circumstances could slow down the decarbonisation of the sector as a whole in the long term. Unless, as is the case in maritime, there is a clear expectation of forthcoming regulation that would help to mitigate this risk.

Insetting schemes without appropriate guardrails in place may have the opposite impact and instead funnel funding away from these harder to abate areas and towards the lowest cost emissions reduction solutions the sector can offer. The extent of this issue is largely dependent on the limits that are placed on how the low emissions shipping activities that produce emissions credits can be related to those that are being offset by the organisation purchasing the credits. There is recognition of this in SFC's Book & Claim Methodology, which defines 'transport operation categories (TOCs)'. These TOCs further disaggregate different freight operations beyond transport mode and are based on aspects such as asset type, asset size, load factor, and geography of operation.[32] A framework of this kind could ensure that capital spent on emissions reductions represents the cost of abatement within an organisation's conditions of operation and stimulates further emissions reductions in the same sub-segment. However, trading only within an organisation's TOC is currently recommended voluntary practice within the SFC Book & Claim Methodology, and it is unclear why an organisation would voluntarily opt to do so at a higher cost.

> ***Recommendation:*** Maritime insetting schemes should have clear guardrails that promote the uptake of fuels that are scalable and zero/close to zero emissions.

Compatibility with a just and equitable transition

Without any safeguards relating to ensuring a just and equitable transition, insetting schemes can be expected to lead to financial resources flowing towards the parts of the sector where they yield the greatest cost efficiencies. This approach is likely to advantage large organisations possessing substantial capital as well as richer nations equipped with existing infrastructure or the means to support their development. Small operators, Least Developed Countries (LDCs) and Small Island Developing States (SIDS) could be disadvantaged and marginalised by systems without preventative mechanisms built into their fundamental framework. There is also a possibility that the lowest cost energy production will occur in low-

income countries, separated from those in higher-income countries with higher willingness to pay a premium for the GHG emission reduction.[47] If this is the case, and there are safeguards to ensure investment is genuinely 'just and equitable', there can be compatibility.

The higher cost of abatement per person, less-developed infrastructure, remote geography and more limited access to financial resources required to make long-term investments in decarbonisation solutions could serve to exacerbate existing inequality within the sector – leaving behind the nations that are most sensitive to increased costs in the shipping sector and most vulnerable to the negative environmental impacts of climate change.[48–50] There is a reasonable argument that although insetting schemes may initially drive capital towards certain actors in the sector over others, the trickle-down effects of stimulating the development and scaling of low-carbon technologies could benefit all actors in the sector by establishing best practices and reducing costs. Nevertheless, a strategy of this kind that could lead to LDCs, SIDS and smaller operators becoming laggards would be broadly inconsistent with the vision of the IMO, which has put justice and equitability at the heart of its GHG Strategy.[43]

> ***Recommendation:*** Maritime insetting schemes could contribute to a just and equitable transition, e.g. through specific targeting at initiatives that enable the uptake of fuels that are scalable and zero/close to zero emissions in regions that are at risk of being priced out of shipping's transition opportunity. Monitoring of the beneficiaries of insetting, where the projects that they enable are located, can track whether this is the case or if additional intervention is needed.

Conclusion

Insetting is an increasingly widespread tool discussed and used as an aid to decarbonisation. Within the maritime sector, maritime insetting schemes, particularly those utilising the book and claim methodology, have gained traction as part of decarbonisation strategies in the shipping sector. These schemes can potentially increase the accessibility and use of low- and zero-emission technologies and fuels, mobilise private investment, and provide aggregated demand signals to help stimulate the deployment of low- and zero-emission technologies and fuels onto the market, perhaps for the first time. In the near term, book and claim-based insetting practices have the potential to stimulate emissions reductions and alleviate some immediate environmental impacts.

With the approval of the IMO Net Zero Framework, the expectation of a clear regulatory incentivisation of energy transition has now increased. If the LCA guidelines currently being developed at the IMO continue to limit compliance with the Net Zero Framework to the physical fuels/energy used onboard ships, this would leave voluntary insetting schemes with a different basis to the accountancy of GHG emissions used at the IMO. The consequence may then be an industry aligning its efforts to be compatible with regulatory compliance, with the IMO NZF providing the clearest basis in the incentivisation of early adopters. In this eventuality, there would then only be a small remaining time window for voluntary insetting schemes to play a clear additional role in incentivising early adoption of long-term decarbonisation solutions, provided the insetting scheme has sufficient guardrails to enable this.

However, there are significant challenges and risks associated with these schemes. One key concern is the lack of robust, universal standards for boundary setting and transparent emissions accounting, which can lead to inconsistencies and potential misuse of emissions credits. The current state of these issues creates a concerning parallel with offsetting practices that have continually failed to build trust and credibility. The current reliance on biofuels in many of the existing examples which currently offer lower abatement costs than long-term solutions, but face scalability and sustainability issues, also raises questions about the long-term impact of these schemes on the transition to scalable zero-emissions fuels (SZEFs) like green hydrogen and ammonia.

With care, one role book and claim-based insetting schemes can have is the potential to serve as an interim solution before compliance regimes are fully implemented (e.g. clearly driving early adoption and/or mass market energy transition). At present, in the maritime sector, only a very small portion of shipping's energy use is covered by such schemes, making it difficult to give grounds for transformative investments, for example, multi-million-dollar e-fuel production investments. Such schemes may yet grow to have a stronger effect, but in the meantime, they can provide a supportive market signal for first movers (fleet operators as well as fuel producers). Their long-term effectiveness and credibility depend on addressing key challenges: the establishment of robust, universal standards for boundary setting and emissions accounting, compatibility with regulation (e.g. additionality as well as compatibility with GHG emission reduction accountancy), and alignment with the long-term technological transition of the sector.

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