BRIEF

Climate regulatory frameworks

Comparing internationally agreed schemes for air transport and maritime decarbonization

Introduction

In the global pursuit of net zero emissions, the transport sector stands out as both a major contributor to climate change and a critical area for innovation and policy action. The international air and maritime transport industries confront the complex challenges of decarbonizing while continuing to enable and support growth in global trade, mobility, and economic development. Although both industries operate across borders and are often compared, they diverge in technological constraints, regulatory frameworks, and available decarbonization pathways.

Both maritime and air transport are hard to abate in the sense that they rely on liquid fuels to meet performance and safety requirements, and viable alternatives, such as new propulsion technologies (electric, hydrogen, etc.), are not yet commercially available at scale. The challenge is, therefore, to find alternative renewable liquid fuels to the fossil-based fuels that are used today.

Fuels used in aviation have much tighter and more precise specifications than those for shipping because aircraft operate at high altitudes and extreme temperatures, and aircraft engines are highly sensitive. Quality control is more stringent as there is zero tolerance of engine failure, which could be catastrophic. Jet fuel specifications such as those defined by ASTM D1655 or Def Stan 91-091 (typically referred to as Jet A or Jet A-1) focus on achieving the tight range for mandatory characteristics such as energy density (around 43 MJ/kg), low freezing point (−47° C for Jet A-1), thermal stability, flash point, and purity (e.g., minimal particulates and water content). By contrast, marine fuels such as heavy fuel oil (HFO) and marine gas oil (MGO) are less refined and tolerate higher levels of sulfur, water, and ash. Marine engines are less exposed to extreme environmental conditions. Fuel standards such as ISO 8217 focus more on viscosity, sulfur content, and compatibility for blending, with recent emphasis on sulfur limits under IMO 2020.[1] Performance consistency is less critical than in aviation, making cost and availability the primary drivers.

There is a viable solution for replacing fossil-based jet fuel, in the form of Sustainable Aviation Fuel (SAF), i.e., liquid fuels made from non-fossil feedstock. In 2025, the supply of such fuels is expected to be less than 1% of current global jet fuel consumption, but it already adds USD 4.4 billion globally to aircraft operators' fuel bills.[2] Costs are nevertheless curtailed with regard to SAF due to its nature as a drop-in solution. It is compatible with the existing aircraft fleet, as well as current fuel storage, distribution facilities, and networks, eliminating the need for new infrastructure-it can simply be dropped in. This is not the case for hydrogen or electric aircraft, both of which will require additional and specific infrastructure investments. Yet, production of SAF is failing to ramp up

[1] The International Maritime Organization's regulation that caps the maximum sulfur content of marine fuels at 0.50% (by mass) globally, effective 1 January 2020.
[2] Policy Shortcomings Puts SAF Production at Risk, IATA, June 2025. Accessible here.

sufficiently because of a lack of investor interest and public support for new refining facilities, developing feedstock, and providing a regulatory framework that enables long-term planning and wider adoption of SAF.

The maritime sector benefits from a broader range of alternative fuels, such as green ammonia, methanol, and liquefied natural gas (LNG), allowing for a multi-fuel approach that may ultimately narrow, particularly for the deep-sea fleet.[3] Technological readiness and emissions reduction efficiency remain uneven, and each presents unique infrastructure and vessel modification challenges and associated costs. While LNG is relatively mature and recognized as a cost-effective solution,[4] most other alternative fuels pose problems, including bunkers' compatibility, high production costs, and scalability. For instance, although green ammonia offers significant emissions reductions, its high price,[5] safety limitations, and infrastructure requirements create substantial barriers. As with SAF, the maritime alternative fuels market is still in its early stages, and its successful development will require transparency and commitment from all supply-chain stakeholders, including fuel producers.[6] Nevertheless, shipping benefits from greater flexibility in operations, including speed reduction, which presents diversified alternatives for reducing emissions.

Both industries have a vested interest in ensuring that international transport remains safe, cost-effective and, increasingly, sustainable. Through their respective United Nations specialized agencies—the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO)[7]— both have established climate policy frameworks aimed at emissions reductions. These agencies provide the forum for States to reach consensus on complex cross-jurisdictional challenges, ensuring the continued development and maintenance of these essential transportation networks within and across the global economy.

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), developed under the auspices of ICAO, and the IMO's recently adopted Net Zero Framework reflect each industry's global approach to decarbonization. While both initiatives mark significant steps forward, they differ substantially in terms of adoption timelines, policy instruments, and implementation readiness.

This brief compares the two frameworks and their role in aligning global transport with long-term climate goals.[8]

A comparison of the various design elements of the two schemes is included in the Appendix.

CORSIA: An early-adopted and operational global framework

In 2016, just one year after the Paris Agreement, the ICAO Member States adopted CORSIA to address CO_2 emissions from international air transport.[9] This historic decision marked the first time that an industry agreed to a global market-based measure (MBM) to address its climate impact. CORSIA establishes a baseline for CO_2 emissions from international air transport at 85% of 2019 emissions. Airlines are obliged to purchase CORSIA eligible emissions units or CORSIA eligible fuels to compensate for any emissions above the baseline. The States also agreed that CORSIA should be the only MBM to address international air transport emissions and

[3] Indeed, some experts consider that, as the industry matures, standardization around a smaller set of fuels is likely to emerge among high-volume operators to streamline crew training, ensure consistent fuel supply, and build technical expertise at scale.
[4] Shipping industry decarbonization: Fuel choice and the costs of achieving regulatory compliance, SEA-LNG, November 2024. Accessible here.
[5] Prices of Alternative Fuels, IMO, April. Accessible here.
[6] S&P Global Commodity Insights supported this study with its expertise on marine fuels. Find the latest insights on the marine fuel market here.
[7] Art 2.2 of Kyoto Protocol.
[8] The observations contained in this document rely on current provisions in the regulatory frameworks and available data, aiming to inform and foster deeper understanding.
[9] Including both cargo and passenger services.

emphasized the necessity to avoid any patchwork of regional or national MBMs, levies, or taxes. The exclusivity of CORSIA was reaffirmed in the most recently adopted ICAO 41st Assembly Resolution.[10]

The implementation of CORSIA commenced in 2019, with Monitoring, Reporting, and Verification (MRV) obligations for aircraft operators. Implementation of CORSIA offsetting requirements started from 2021.[11] The growing commitment of States to CORSIA is evident, with the number of volunteering States reaching 129 as of January 2025, up from 81 in 2021.[12] Currently, it is estimated that about 60% of international air transport emissions are covered by CORSIA participants[13] and CORSIA is projected to cover more than 85% of international air transport emissions from 2027 onwards.

Increasing fuel efficiency has long been a priority for airlines, driven by financial self-interest aligned with sustainability goals, as fuel accounts for approximately 25-30% of airline operating costs on average. Since 1990, the industry's fuel efficiency has improved by 53%. Combustion CO_2 intensity has improved by 37%, from 1,370 gCO_2 per revenue tonne kilometre (RTK) in 2000 to 863 gCO_2/RTK in 2023.[14] Airlines have invested over USD 1 trillion in 19,000 more efficient new-technology aircraft since 2009 and have improved capacity utilization through higher load factors and other operational measures. The development and implementation of a global MBM (i.e., CORSIA) is not intended to replace in-sector efforts such as the investment in fuel-efficient aircraft, the use of SAF, and the improvement of operations and infrastructures. However, CORSIA is an indispensable lever in air transport's decarbonization, and it establishes a harmonized and unified approach across the global industry.

IMO Net Zero Framework: A bonus-malus system expected to be implemented from 2028

The IMO's revised greenhouse gas (GHG) strategy[15], adopted in July 2023, is a global framework aiming to reduce GHG emissions from international shipping to net zero by or around 2050. It covers both CO_2 and other greenhouse gas emissions, with interim checkpoints (2030 and 2040) to guide the sector's decarbonization. In April 2025,[16] the IMO adopted a regulatory framework to support the strategy, which includes a dual-tier GHG pricing mechanism, fuel standards based on carbon intensity, and a bonus-malus system tied to compliance levels.

These in-sector measures, set to be formally adopted in October 2025 before entering into force in 2028, will become mandatory for large ocean-going ships of over 5,000 gross tonnage, which emit 85% of total CO_2 emissions from international shipping. From 2028 onwards, they will be required to measure their greenhouse gas fuel intensity (GFI) against a benchmark consisting of the 2008 levels of 93.3 gCO_2eq per megajoule, and they will need to meet two levels of mandatory emissions reduction targets (a base target and a direct compliance target). Ships emitting above GFI thresholds will have to pay penalties or acquire remedial units to compensate, while those meeting the targets or using zero or near-zero GHG technologies will be eligible for financial rewards.

IMO will likely rely on the IMO's Data Collection System (DCS), which, since 2019, mandates ships to report fuel oil consumption but does not ensure open access to this data for all stakeholders, limiting transparency. In contrast, ICAO's MRV system, launched in the same year under CORSIA, requires aircraft operators to report CO_2

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[10] Operative Paragraph 18, ICAO Assembly Resolution A41-22.
[11] With the updated baseline of 85% of 2019 emissions, the projected offsetting obligations started on 1 January 2024.
[12] Versions of the ICAO document – CORSIA States for Chapter 3 Sate Pairs, CORSIA Central Registry.
[13] According to data from the CORSIA Central Registry.
[14] Tracking Aviation Efficiency, Waypoint 2050, Factsheet, ATAG, October 2024. Accessible here.
[15] Implemented through MARPOL Annex VI regulations.
[16] Consensus was reached with 63 nations voting in favor, 16 against and 25 abstaining.

emissions to the State authority, with data published annually in the CORSIA Central Registry (CCR),[17] ensuring data transparency and forming the basis for calculating offsetting requirements applied from 2021 to 2035.

The IMO Net Zero framework sets out ambitious long-term goals. However, key operational and technical details, including the modalities of remedial unit trading and the funding disbursement criteria, are still under development. Upcoming negotiations will notably need to define the roles of States, the IMO, and external experts and auditors in managing the scheme. These challenges add to the practical uncertainty surrounding the availability of sufficient and affordable alternative fuels. All are key factors that will determine the IMO Net Zero Framework's robustness, efficiency in driving emissions reductions, and overall viability.

Climate finance approaches

Both frameworks incorporate climate finance dimensions, but with distinct structures and implications.

Under CORSIA, aircraft operators need to purchase and cancel CORSIA eligible emissions units (EEUs) generated from the CORSIA eligible programs to fulfill their compliance obligations. In other words, the climate finance under CORSIA is achieved through aircraft operators' compensating for their emissions by financing a reduction in emissions elsewhere. CORSIA EEUs are sourced from projects based primarily in developing countries and have to comply with a comprehensive set of sustainability criteria. In addition to generating CO_2 abatement, the projects also generate social and economic benefits, including employment, rural development, biodiversity conservation, and technology transfer. Thanks to their high quality, CORSIA EEUs are sought after in the carbon market, and thus contribute to the maturity and integrity of that market globally, bringing wide-ranging benefits.

The IMO Net Zero Framework provides for the establishment of a fund that aims to support an array of activities. The fund will reward low-emitting ships, finance research and innovation projects, support just-transition efforts in developing countries, fund training and capacity building, and provide compensatory support to vulnerable States, such as Small Island Developing States and Least Developed Countries. The International Chamber of Shipping (ICS) estimates that the proposed fund could generate a minimum of USD130 billion between 2028 and 2030.

As of now, this one-of-a-kind UN fund remains largely conceptual, with contracting States expected to negotiate the detailed governance and operational framework in the coming months. The effectiveness and robustness of the IMO's Net Zero Fund will be contingent upon its governance structure, transparency standards, and allocation criteria—all still under negotiation. Among the most contentious elements are the composition of the Fund's Board and the provisions designed to prevent conflicts of interest while ensuring that no country is left behind.

The overall compliance costs for shippers under the forthcoming IMO Net Zero Framework remain to be determined, considering obliged parties will pay USD 380 per tonne of CO_2eq emitted in excess of base targets, and USD 100 per tonne of CO_2eq emitted in excess of direct compliance targets. For airlines, based on projected price ranges for CORSIA-eligible emissions units (EEUs), the cumulative cost of compliance during the first phase of CORSIA (2024–2026) is estimated to range between USD 1.9 billion and 6.3 billion, excluding the costs associated with the use of CORSIA eligible fuels.[18]

[17] CORSIA Central Registry, ICAO. Accessible here.
[18] IATA's updated CORSIA Sectoral Growth Factor Forecast, September 2024.

Appendix: Comparison of design elements

Comparison of design elements of the internationally agreed CORSIA and the pending IMO Net Zero Framework, considering public information as of June 2025

	CORSIA	IMO NET ZERO STRATEGY AND FRAMEWORK
Long-term decarbonization target	Net Zero CO_2 emissions by 2050 through the Long-Term Aspirational Goal (LTAG)	Net Zero GHG emissions (both CO_2 and other greenhouse gases) by or around 2050
Adoption year	2016	2025 (October, pending)
Implementation start	2019: Monitoring, Reporting, and Verification (MRV) 2021: Offsetting requirements	(2019: Reporting of ship fuel oil consumption) 2028: Global fuel standard targets + GHG pricing mechanism (pending)
Ambition	Stabilize CO_2 emissions at the level of 85% of 2019 international air transport emissions	Two tiers of carbon intensity reduction targets up to 2040
Obliged party	Aircraft operators' international operations[19]	Large ocean-going ships over 5,000 gross tonnage engaged in international trade[20]
Building blocks of the mechanism	Baseline: 85% of 2019 international air transport emissions Monitoring, Reporting, and Verification (MRV) - implementation commenced 1 Jan 2019 Offsetting Requirements: On a route-based approach,[21] airlines are required to purchase carbon credits to offset emissions that exceed the baseline level (85% of 2019) established for international air transport since 1 January 2024	Baseline: GFI 2008: 93.3 gCO_2eq/MJ (WtW) Two targets: Base targets GFI and Direct compliance targets GFI from 2028 to 2040: - The Base Target requires a 4% GFI reduction in 2028, scaling to 30% by 2035, and a cumulative 65% by 2040. - The Direct Compliance Target demands stricter reductions: 17% in 2028, 43% by 2035, with details beyond 2035 to be finalized
Compliance mechanism	Compliance through national legislation	Two tiers of targets deficit: Obliged parties pay USD 380 per tonne of CO_2eq emitted in excess of base targets; obliged parties pay for USD 100 per tonne of CO_2eq emitted in excess of direct compliance targets Rewards: obliged parties will be rewarded for exceeding the direct compliance targets, or for using zero and near zero-emissions fuels. Further details are expected to be negotiated within the coming months

Source: IATA Sustainability and Economics

[19] Except for humanitarian, medical, and firefighting flights.
[20] Except for ships solely engaged in voyages within waters subject to the sovereignty or jurisdiction of the State the flag of which the ship is entitled to fly; ships not propelled by mechanical means, and platforms including FPSOs and FSUs and drilling rigs, regardless of their propulsion; and semi-submersible vessels.
[21] Paragraph 10 of the Assembly Resolution A41-22 defines the coverage of the CORSIA offsetting on the basis of routes between States, with a view to minimizing market distortions between aeroplane operators on the same routes. For this purpose, the approach is to provide equal treatment of all aeroplane operators on a given route. When an aeroplane operator calculates its CO_2 emissions covered by the CORSIA offsetting in a given year, it needs to take into consideration emissions from its operations on all the routes covered by the scheme, as outlined in paragraph 10 of the Assembly Resolution. It should be noted that the applicability of CORSIA offsetting requirements and the applicability of CORSIA monitoring, reporting and verification (MRV) requirements are not the same. Even if an international flight is not covered by the offsetting requirements, it is still covered by the MRV requirements.