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The international legal and practical development of shipping decarbonization: China's perspective

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The impact of climate change on the environment has led to increasing demands for the decarbonization of the shipping industry. The Climate Change Advisory Opinion has further drawn attention to the reduction of greenhouse gas emissions in various countries. As a major shipping nation, China's role in this process cannot be ignored. Despite international efforts, the extent to which China can and will contribute to shipping decarbonization remains a critical question. The paper provides a contemporary overview of several aspects of the decarbonization of the shipping industry, with a particular focus on China's position on certain national regulations, the International Maritime Organization (IMO), and the United Nations Framework Convention on Climate Change (UNFCCC). By examining legal developments and international practices in shipping decarbonization, this paper aims to demonstrate China's active participation and contribution to this global effort. Firstly, the paper reviews the IMO's progressive development of shipping decarbonization regulations and China's contribution to legislative practices. Secondly, it defines three main issues in shipping decarbonization and analyzes China's stance on these challenges. Finally, the article proposes potential solutions and discusses China's facilitating role in the international cooperation on shipping decarbonization.

KEYWORDS

decarbonization of shipping, green shipping, international cooperation, international law, the role of China

1 Introduction

The International Tribunal for the Law of the Sea (ITLOS) elaborated on the importance of greenhouse gas (GHG) emission reductions in its Advisory Opinion on Climate Change issued on 21 May 2024 ([Silverman-Roati and Bönnemann, 2024](#)). ITLOS recognized that, under the United Nations Convention on the Law of the Sea (UNCLOS), anthropogenic GHG emissions are regarded as a form of "pollution of the marine environment" and that States are obliged to prevent, reduce, and control such pollution. The opinion emphasized that article 194, paragraph 5, of the UNCLOS, read together with

article 192, imposes specific obligations on States Parties to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened, or endangered species and other forms of marine life from climate change impacts and ocean acidification ([International Tribunal for the Law of the Sea \(ITLOS\), 2024](#)).

Meanwhile, world shipping has been growing consistently for the past decades. Shipping remains the backbone of global trade, accounting for over 80% ([WTO, n.d.](#)). Also, from 1980 to 2013, the annual tonnage carried in the five main shipping trade sectors increased by 158% ([United Nations, 2017](#)). International ship emissions of nitric oxide (NO_x) and sulphur oxide (SO_x) were approximately 13% and 12% of global NO_x and SO_x total, respectively, over the 2007–2012 period ([IMO, 2015](#)). In 2018, shipping emitted 1,056 Mt of carbon dioxide (CO₂), accounting for about 2.89% of the total global anthropogenic CO₂ emissions for that year ([IMO, 2021a](#)). CO₂ could increase between 50% and 250% by 2050 if left uncontrolled ([United Nations Framework Convention on Climate Change \(UNFCCC\), 2018](#)). GHG emissions from ships, including exhaust gases, cargo emissions, emissions of refrigerants, and other emissions, have significantly contributed to global warming and climate change (IMO, 2009). By the early 1990s, it was becoming apparent that, in some parts of the world, emissions of GHG from ships were of concern. The ocean has undergone significant acidification through the absorption of CO₂ into the water column.

The only long-term way of tackling the climate change impacts on the oceans in the long-term is through the reduction of GHG emissions (e.g., CO₂, methane, and nitrous oxide) into the atmosphere although short-term impacts may be reduced through adaptation measures, which increase the resilience of marine ecosystems in the short-term ([Harrison, 2021](#)). Recognizing the need for climate action, the International Maritime Organization (IMO) has mandated emission reductions of 50% for all vessels by 2050 ([IMO, 2018](#)). Moreover, as GHG emissions reductions from shipping have a significant impact on global GHG regulation, States have a clear legal responsibility under international law to take measures to reduce GHG emissions from vessels flying their flag or of their registry in order to protect the marine environment and marine biodiversity. In this context, the need to reduce the pollution and climate change caused by the shipping industry becomes urgent, which leads to the emergence of shipping decarbonization, with the hope of using alternative shipping facilities to reduce the environmental damage and cost in maritime transportation ([Lee and Nam, 2017](#)).

This article focuses on the current legal regulation and future developments in the decarbonization of global shipping. Shipping decarbonization refers to “the use of resources and energy to transport people and goods by ship and specifically concerns the reduction in such resources and energy in order to preserve the global environment from GHG and environmental pollutants generated by ships” ([Lee and Nam, 2017](#)). With the emergence of shipping decarbonization, legal and technical standards have been introduced in various countries. On the international level, institutions like the International Maritime Organization (IMO) and the United Nations (UN) have issued instruments and guidance

to govern the international shipping decarbonization. Particular attention is given to the IMO’s 2025 Net-Zero Framework, which reshapes the legal and economic foundations of maritime decarbonization. Domestically, major maritime powers, such as the European Union (EU), China, the United Kingdom (UK), the United States (US), and Brazil, have enacted and implemented laws and regulations to promote shipping decarbonization.

As a major coastal State, China is rapidly emerging in the shipping industry as a leading actor. This is evidenced by the fact that its foreign trade maritime shipping volume has accounted for 30.1% of the global maritime shipping volume ([Transport Planning and Research Institute, Ministry of Transport, China \(TPRI\), 2025](#)), and approximately 95% of its import and export cargo volume is carried by sea ([National Development and Reform Commission \(NDRC\), 2024](#)). China formally joined the IMO in 1973. Subsequently, in 1983, China acceded to the International Convention for the Prevention of Pollution from Ships (MARPOL). China is also a Category A member of the IMO Council, representing one of the countries with the largest interest in providing international shipping services ([IMO, n.d.](#)). In this role, China participates in the IMO’s key decision-making processes and influences global shipping policy. As a result, China’s experience in shipping decarbonization offers an instructive case for the development of global regulatory approaches.

At first, in the Introduction, this article presents the rise of China’s shipping industry, explaining why China will play a leading and demonstrative role in shipping decarbonization. The next part summarizes the existing legal regulations related to decarbonization in shipping internationally and what corresponding policies and laws China has introduced, and examines their compatibility with those of other countries in the world. The third part of this article discusses the limitations and issues of these laws and regulations. Finally, solutions are proposed using China as an example, emphasizing the importance of international co-operation in reducing emissions from shipping. Specific recommendations include establishing a comprehensive legal regulation of decarbonization, encouraging developed countries to provide financial and technical assistance to developing countries, and developing green corridors globally.

2 International regulation of shipping decarbonization

The second part of this paper analyzes international laws and regulations related to shipping decarbonization, and focusing on China as a case study to assess the adaptability of China’s shipping decarbonization laws and regulations with relevant regulations of other countries and international organizations, and to identify common issues.

With the growing issue of ocean acidification and sea-level rise caused by CO₂, the topic of ocean climate change has been drawing great attention. Zero-emission ships are expected to enter the market by 2030 and for shipping to be zero-emission by 2050 ([United Nations, 2021](#)). In this context, the international

community has developed a range of international laws and technologies to reduce the impact of ship emissions on ecosystems. These include international law treaties and conventions under customary international law, relevant maritime sectoral legislation, and shipping-specific treaties and conventions, which set out the relevant international law principles and rules for shipping decarbonization in general and in detail.

International law regarding marine environment pollution principally consists of two main categories and a new standard. The first is the international law centering on the UN. The second is the international law centering on the IMO.

2.1 UN-centered international law

The regulations governing shipping decarbonization under UN-centered international law are mainly principle-based, and lack concrete, enforceable mechanisms specifically addressing shipping emissions. The 1982 UNCLOS, in its Part XII, “Protection and Preservation of the Marine Environment,” sets out a broad obligation for States Parties to protect the marine environment (United Nations, 1982). In particular, Article 211 “Pollution from vessels” provides a foundational legal framework, allowing States and international organizations to jointly and individually develop rules to reduce and control marine pollution (United Nations, 1982). However, while this provision underpins regulatory efforts for both Flag States and Port States, it does not explicitly address GHG emissions from ships, leaving significant regulatory gaps.

Climate-focused treaties such as the 1992 United Nations Framework Convention on Climate Change (UNFCCC), the 1997 Kyoto Protocol, and the 2015 Paris Agreement refer to reducing the impact of GHG on marine ecosystems, but do not specifically regulate shipping decarbonization. The Paris Agreement, while not directly addressing the shipping sector, is still significant because it introduces the global temperature targets—“holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change” (United Nations, 2015a)—which has had an impact on other legal regimes. Specifically, the Kyoto Protocol calls for action by IMO on shipping emissions.

Given that international law remains largely treaty-based and heavily reliant on customary legal principles, its role in shaping shipping decarbonization has been indirect yet overarching, providing an overview of subsequent specialized maritime conventions, in particular, those relating to the marine environment.

While the UN-centered framework provides overarching principles and climate objectives, it lacks concrete sector-specific rules for international shipping. To operationalize these principles, the IMO has developed detailed regulatory instruments that directly target vessel-source emissions. The following section, therefore, examines IMO-centered law as the institutional counterpart that

translates general climate commitments into binding maritime rules.

2.2 IMO-centered international law

Mandated by the UNFCCC to address climate change in international maritime transport, the IMO is widely accepted, including within the global climate change framework, as the most suitable body for addressing GHG emissions from ships (Romera, 2016).

Firstly, the International Convention for the Prevention of Pollution from Ships (MARPOL), adopted in 1973 under the auspices of the IMO, is the leading convention for the prevention of pollution from ships (IMO, n.d.). A Protocol amending the MARPOL and adding a new Annex VI was adopted in 1997 and entered into force on 19 May 2005.

Annex VI Prevention of Air Pollution from Ships entered into force on 19 May 2005, which initially regulates the emission control of air pollutants such as ozone-depleting substances, NO_x, SO_x, and volatile organic compounds, as well as the criteria and procedures for designating NO_x and SO_x emission control areas (IMO, n.d.). With these treaties as the foundation, special areas have been designated in several parts of the world to enhance protection against pollution from ships by imposing discharge restrictions on oil, noxious liquid substances, sewage, and garbage.

It was not until 2011 that IMO incorporated maritime GHG emissions reduction into its regulatory framework, with the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) to regulate GHG emissions from ships and promote the adoption of more energy-efficient shipping facilities to reduce pollution (IMO, n.d.). This is the first-ever legally binding global regulations in controlling GHG emissions from ships (IMO, 2011b). The EEDI specifically requires a minimum energy efficiency level per capacity mile (e.g., tonne-mile) for different ship type and size segments.

Accordingly, Annex VI was amended to specifically address the reduction of GHG emissions from international shipping. The amended Annex VI applies to ships of 400 GT and above on international voyages where the keel is placed on or after 1 January 2013 and requires Contracting Parties to ensure that, from 1 January 2020, the sulphur content of ships’ fuel oil used for navigation in global waters does not exceed 0.50% m/m, or to implement other equivalent measures to prevent atmospheric pollution caused by SO_x (IMO, 2011c). From 1 March 2020, only ships fitted with exhaust gas cleaning systems (EGCS) will be allowed to carry non-compliant fuel oil and only for use on board (IMO, 2020). In 2021, there are 100 Contracting Parties to the MARPOL Annex VI (IMO, 2021b); the combined fleets of the Contracting Parties constitute over 96.65% of the gross tonnage of the world’s merchant fleet, meaning the global shipping industry is uniformly required to take more green measures, thereby promoting the global shipping decarbonization transition in the world.

Secondly, Amendments to MARPOL Annex VI, which came into force on 1 November 2022, were approved by the IMO Marine Environment Protection Committee (MEPC) at its 75th session (IMO, 2022). Regulation 20 of Annex VI, as amended, states that the goal of the relevant regulations is “to reduce the carbon intensity of international shipping, working towards the levels of ambition set out in the Initial IMO Strategy on reduction of GHG emissions from ships” (IMO, 2022). The amendments relate to the existing Ship Energy Efficiency Index (EEXI), the Annual Operational Carbon Intensity Indicator (CII), which includes a rating scheme (A to E) with mandatory elements, and the level of ship performance to be recorded in the Ship Energy Efficiency Management Plan (SEEMP) (IMO, 2022).

During the amendment process of MARPOL Annex VI, China has put forward and supported a number of important proposals and modifications to promote emission reduction and environmental protection in the global shipping industry. For instance, China proposed two clarifying suggestions: one on the application of EEDI phase requirements for five types of ships under Article 24 of MARPOL Annex VI, and another on defining “heavy cargo ships” in the Annex. Both proposals were reviewed and approved at IMO meetings, with their unified interpretations later included in Circular MEPC.1/Circ.795/Rev.9, effectively resolving inconsistencies in law enforcement standards for energy efficiency clauses among different flag states and enhancing the fairness of international maritime regulations.

Apart from these, China also backed practical revisions led by its domestic entities: The COSCO Shipping Group submitted a proposal titled Clarification on the Calculation of Ship Capacity in the CII G5 Guidelines, which addressed ambiguities in capacity valuation that caused deviations in CII calculations and unfair ship rating; this proposal was adopted to ensure accurate CII assessment for bulk carriers, LNG carriers, and ro-ro ships. Additionally, China’s maritime authorities contributed to regulatory enforcement: Ningbo MSA proposed revisions to the Port State Control Guidelines for MARPOL Annex VI, which incorporated inspection requirements for ship energy efficiency rules and were approved at the 5th session of the IMO Sub-Committee on Implementation (III5), providing unified guidance for all contracting parties’ port state control practices.

Compared to MARPOL Annex VI (2011), the revised version has higher requirements for EEDI, and the start date of EEDI Phase 3 has been brought forward from 1 January 2025 to 1 April 2022. As a result, the energy efficiency of ships (with keel laid) constructed on or after that date must meet the minimum requirements. At the same time, the scope of application of EEDI has been expanded to cover more types of ships, such as container ships, large gas carriers (>15,000 DWT), general cargo ships, LNG carriers, and cruise passenger ships with non-conventional propulsion.

In addition, the amendments include the requirement for competent authorities to report the required Energy Efficiency Design Index (EEDI) for ships, the calculated value of the EEDI obtained and related information to IMO.

The new EEDI regulations can be found to better assist the shipping industry in achieving its decarbonization goals. On the one

hand, EEDI regulations incentivize ship designers and builders to adopt more advanced energy-efficient technologies and design solutions, driving their technological innovation. On the other hand, by improving the energy efficiency of ships, EEDI directly reduces the fuel consumption of ships, which in turn reduces the emission of GHG such as CO₂. In terms of fuel, EEDI encourages ship operators to consider the use of low-carbon or zero-carbon fuels, such as liquefied natural gas (LNG), hydrogen fuels, and electricity. These fuels have lower carbon emissions compared to traditional heavy fuel oil.

Thirdly, the 2023 IMO Strategy for Reducing GHG Emissions from Ships is one of the most recent developments in international shipping. Under the mandate of the 1997 Kyoto Protocol (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997), the IMO has been pursuing a strategy to minimize emissions from maritime transport as soon as possible. In 2018, the 72nd session of the IMO Marine Environment Protection Committee, by resolution MEPC.304(72), adopted the Initial IMO Strategy on Reduction of GHG Emissions from Ships. This strategy proposes a reduction in global maritime carbon emissions intensity of at least 40% by 2030 compared to 2008, with efforts to achieve a 70% reduction by 2050 and a reduction in total annual GHG emissions of at least 50% by 2050. In July 2023, IMO adopted the 2023 IMO Strategy on Reduction of GHG Emissions from Ships in accordance with the agreed program of follow-up actions (IMO, 2023a), in which two indicative calibration points, 2030 and 2040, have been set out in the emission reduction strategy to test the effectiveness of the phased reduction of GHG emissions from international shipping.

As for the specific measures, The Intersessional Working Group on Reduction of GHG Emissions from Ships (ISWG-GHG 16) has made proposals on technical and economic measures on GHG governance (IMO, 2024a). Technical measures include EEDI, SEEMP, and new fuel standards. Economic measures refer to the exploration and progressive implementation of a carbon-pricing mechanism for GHG emissions to incentivize the shipping industry to reduce emissions and use cleaner energy. In considering GHG emissions pricing mechanisms and associated revenue collection and distribution, all delegations that spoke reiterated their commitment to the development of an economic element as part of the basket of mid-term measures. The group noted that the candidate economic elements would be assessed observing specific criteria, to be considered in the ongoing comprehensive impact assessment, with a view to facilitating the finalization of the basket of mid-term measures.

Meanwhile, short-term GHG emission measures are also noteworthy. It includes (a) a review of mandatory target-based technical and operational measures aimed at reducing the carbon intensity of international shipping (short-term GHG abatement measures), which should be completed by 1 January 2026, in accordance with MARPOL Annex VI Articles 25(3) and 28(11), and (b) a decision may be made by the Commission to initiate a review of other short-term measures listed in Annex I.

The adoption of the IMO Net-Zero Framework in 2025 marks the most transformative regulatory milestone in maritime

decarbonization since the 2023 Strategy (Global Maritime Forum, 2025). In April 2025, the IMO Marine Environment Protection Committee (MEPC 83) adopted a landmark amendment to the MARPOL Annex VI, introducing the IMO Net-Zero Framework—the first globally binding regulation integrating mandatory fuel lifecycle greenhouse gas intensity (GFI) standards with a market-based pricing mechanism. Under the framework, ships $\geq 5,000$ GT must meet progressively stricter GFI targets from 2028 onward, using a well-to-wake (WtW) approach. Compliance is enforced through a two-tier system: a base target and a direct compliance target, with flexibility via surplus units (SUs) and remedial units (RUs). Ships exceeding targets may buy RUs priced at USD 100/tCO₂eq (Tier 1) or USD 380/tCO₂eq (Tier 2), while early adopters of zero- or near-zero emission fuels (ZNZs) receive financial rewards from the IMO Net-Zero Fund (IMO, 2025a). The framework is expected to generate USD 30–40 billion annually by 2030, earmarked for decarbonization support, especially for developing countries and small island states. If formally adopted in October 2025, it will reshape maritime regulation and intensify the debate over CBDR and NMFT principles.

It could be concluded that the IMO-centered international law has provided detailed requirement for states to promote shipping decarbonization. In addition to the principle-based provisions, there are also a number of conventions that regulate individual emissions from ships. For instance, MARPOL, as aforementioned, primarily discharges standards regulating the release of operational and non-accidental pollutants from ships into the marine environment (IMO, 2024a).

While it is fair to say that the regulatory situation for vessel-source pollution is both relatively clear and reasonably well settled, it remains far from legally settled or free from controversy (Ringbom, 2023). Uncertainties persist at multiple levels, which will be further examined in the following section.

3 Current issues regarding the development of shipping decarbonization

Here, we analyze China's shipping decarbonization laws and regulations with relevant regulations of other countries and international organizations around the world and identify common issues. Although the international regulatory frameworks under the UN and the IMO provide important legal foundations, their effectiveness in practice is constrained by persistent challenges. These challenges fall into three interrelated categories: conflicting principles between CBDR and NMFT, stagnation of market-based mechanisms, and divergences in national standards. Together, these issues explain why global consensus and coordinated implementation on shipping decarbonization remain elusive.

By analyzing existing relevant policies and legal practices, three principal barriers can be identified to global shipping decarbonization: the tension between the CBDR and NMFT principles, the halting of market mechanisms, and the large differences in legal regulation between countries. Differences in

laws between countries lead to different problems in the implementation of shipping decarbonization, which will be addressed in the succeeding section, with China as an example.

3.1 The conflict between CBDR and NMFT principles

International concern about the contradiction between common but differentiated responsibilities (CBDR) and the principle of No More Favorable Treatment (NMFT) gradually increased in the early 2000s, particularly in the context of the IMO's promotion of GHG abatement measures. Now, with the emergence of energy efficiency standards such as EEDI and CII, national discussions on the allocation of responsibilities and economic impacts are heating up.

The principle of CBDR in climate change law recognizes that while all countries contribute to the problem of GHG emissions, their responsibilities may vary based on their social and economic circumstances, as not all countries have contributed equally to the problem. In other words, developed countries shall bear the primary responsibility, as they have contributed the most to historical and current GHG emissions. This principle was further developed in the UNFCCC framework with the addition of the concept of 'respective capabilities', leading to the more nuanced principle of common but differentiated responsibilities and respective capabilities (CBDR-RC), which guides the relevant international climate change mechanisms under the Convention (Wang and Gao, 2018).

Despite this, the international treaty instruments developed by the IMO are guided by the principle of non-discrimination and equal treatment and NMFT to all ships, regardless of their flag. This NMFT principle is recognized as one of IMO's major principles (IMO, 2009b). The NMFT principle is to enlist ships flying the flags of states that are not party to the convention, especially flag of convenience, to have a fair standard, rather than to weaken the sovereignty of states that are not party to the respective convention (Reiling, 2019). In April 2008, the 57th meeting of IMO's Marine Environment Protection Committee (MEPC) began to address the issue of the legal framework for GHG emission reduction in international maritime transport, stressing that the emission reduction mechanism should be "equally applicable to all flag States," which essentially means that the principle of "equal emission reduction" for ships under the framework of the Convention should be applied without discrimination. Most developing countries consider that this idea runs counter to the principle of CBDR and imposes conditions that are not in line with the principle of fairness on developing countries regarding shipping decarbonization.

In fact, the debate on the interpretation and application of the principle of CBDR in international shipping rules runs through the entire legislative process between developed and developing countries. Mandatory technical and operational measures were eventually adopted, but by majority vote rather than consensus. Conflicts between the two groups of countries center on the allocation of responsibilities and economic impacts.

In terms of responsibility allocation, developed countries want all countries to assume the same responsibility for emission reduction, while developing countries emphasize historical responsibility and capacity differences and demand differentiated responsibilities. As for economic impacts, developing countries are concerned that stringent emission reduction standards may increase their shipping costs and weaken their international competitiveness. Developed countries, on the other hand, are concerned that failure to impose the same standards on all countries could lead to “carbon leakage” and unfair competition. Nevertheless, developing countries account for approximately 80% of the registration of all merchant vessels engaged in international trade (United Nations Conference on Trade and Development (UNCTAD), 2020), indicating that they contribute more actively than developed countries in reducing GHG emissions from the shipping industry, following the NMFT-based regulations (Chen, 2021).

The divergence between developed and developing countries over the principles of CBDR and NMFT has long hindered legislative efficiency and delayed consensus on regulating GHG emissions from international shipping. However, recent scholarship and policy initiatives have sought to reconcile this divide. Chen and Cheng (2025) proposes a model of phased implementation, tailored to specific countries and timelines, makes compliance and enforcement more feasible, thus maintaining universal objectives while acknowledging capacity differences. Similarly, the IMO (2024b) has incorporated the concept of “Just and Equitable Transition” into its GHG Strategy objectives and supports the Maritime Just Transition Task Force. In addition, the draft Net-Zero Framework (IMO, 2025a) specifies that revenue should be allocated to support a just transition, capacity-building, and seafarer training, emphasizing technical and financial assistance as key to equitable implementation. These developments indicate a gradual shift from abstract principle conflict toward pragmatic differentiation. Yet, the tension continues to affect regulatory design in practice—the same normative imbalance complicates the creation of fair and workable market-based mechanisms, as discussed in the following section.

3.2 Stagnation of international market-based mechanisms

The Organisation for Economic Co-operation and Development (OECD) explains that MBMs seek to address the market failure of “environmental externalities” either by incorporating the external cost of production or consumption activities through taxes or charges on processes or products, or by creating property rights and facilitating the establishment of a proxy market for the use of environmental services (Organisation for Economic Co-operation and Development (OECD), 2007). The IMO has developed a range of market-based mechanisms for reducing emissions from shipping, designed to promote reductions in GHG emissions through economic incentives.

These mechanisms include carbon pricing, emissions trading systems, and fuel standards, aiming to provide the polluters (ship owners and ship operators) with an economic incentive to reduce their GHG emissions. However, at present, aside from MBMs having proven to be the most controversial, a combination of factors has made it difficult to advance their use in reducing emissions from the shipping industry, thereby hindering the global response to climate change.

At first, a number of states and nongovernmental organizations (NGOs) have submitted proposals to the IMO outlining seven distinct types of MBMs, such as GHG Fund, Port State Levy, Efficiency Incentive Scheme (EIS), Ship Efficiency and Credit Trading (SECT), Global Emissions Trading System (ETS), Penalty on Trade and Development and, Rebate Mechanism for a market-based instrument. Nevertheless, some states oppose the adoption of any MBM (Shi and Gullett, 2018). Significant differences in the design and implementation of market mechanisms such as carbon pricing and emissions trading systems exist between countries, making international coordination more difficult. Each country has different economic conditions, policy environments and stages of development of the shipping industry, resulting in different levels of acceptance of market mechanisms and capacity to implement them. Developed and developing countries are more divergent in the distribution of responsibilities and economic burdens for emission reductions. This conflict of interest hinders the advancement of the harmonized market mechanism. The discussions of MBMs have been suspended since 2012 due to deep disagreements between developed and developing countries over the above two conflicting principles (IMO, 2012). At the 65th MEPC meeting in May 2013, the IMO decided to suspend its discussion on MBMs in order to consider a proposal by the US on enhancing the energy efficiency of ships (IMO, 2013). It argued that the IMO should prioritize improving the energy efficiency of ships through technical and operational measures rather than MBMs.

Despite its suspension, MBMs never disappeared from IMO’s planning. It is becoming clear that the EEDI and the SEEMP, without additional mechanisms in support, will be unable to yield the necessary emissions reduction because of the future growth in international seaborne trade and world population (IMO, 2011a). Under this condition, the IMO has revived the discussion on MBMs. At the 70th MEPC meeting in 2016, the IMO discussed whether the approach adopted by the International Civil Aviation Organisation (ICAO) for the international aviation sector could be replicated for the international shipping sector (IMO, 2016). Both the IMO and the ICAO derive their GHG reduction mandates from Article 2(2) of the Kyoto Protocol (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997). However, the situation in international maritime is significantly more complex than in international aviation, including multiple shipping routes, a large number of ship types, a different composition of personnel and a complex mixture of countries spanning a ship’s owner, operator, and register. It remains to be seen whether the IMO will succeed in overcoming the regulatory challenges that have thus far prevented it from following the ICAO’s example and adopting MBMs for the international shipping sector.

In addition, the implementation of the market mechanism requires long-term policy stability, since policy uncertainty increases the operational risk of enterprises, making it difficult for them to accept the MBMs in the short term. Hence, to accelerate the process of emission reductions, there is a need to strengthen cooperation at the global level, to promote fair and efficient market mechanisms, and to achieve technological innovation and policy coordination.

Nowadays, with the implementation of 2023 IMO Strategy on Reduction of GHG Emissions from Ships, discussions on MBMs are back in the hot seat, with a particular focus on the ship carbon tax. However, developing countries have strongly opposed the introduction of such a tax in the maritime GHG negotiations, mainly due to concerns over economic burdens and development imbalances. They believe that the carbon tax will exacerbate their economic challenges, especially by increasing transport costs. Shipping plays an important role in the economies of many developing countries and is a key link in their exports and international trade. The imposition of a carbon tax will raise logistics costs and ultimately affect the competitiveness of their goods. According to statistics, one of the main sources of GHG is energy consumption, and the burning of fossil fuels is the main source of emissions (World Intellectual Property Organization (WIPO), 2025). However, these developing countries generally rely heavily on fossil fuels, making the cost of reducing emissions especially high. The implementation of the 2025 IMO Net-Zero Framework has further intensified these tensions by introducing a mandatory global carbon price, challenging developing countries' ability to comply without differentiated support.

Beyond the design of global market mechanisms, another obstacle lies in the fragmentation of national and regional standards, which further hampers international coordination and creates compliance burdens for shipping companies. This divergence will be analyzed in the following subsection.

3.3 Differences in national standards affect co-operation

The high mobility and inherently transboundary nature of international shipping operations mean that limiting GHG emissions from ships cannot be effectively achieved through national measures alone, but requires globally accepted standards (Gritsenko, 2017). While the IMO has set global emission reduction targets and measures, specific legislation or other forms of action are left to regional and national discretion, which, judging from the variability of legal provisions introduced by countries, may hinder further harmonization of regulations. On 25 July 2023, the Regulation of the European Parliament and of the Council on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC (FuelEU Maritime) was adopted by the Council of the European Union and will enter into force on 1 January 2025 (European Union, 2023). In contrast to the responsibility of the registered owner under the EU ETS, the

FuelEU Maritime regulation states that the DoC holder of the vessel (i.e., potentially the ship management company) is responsible for ensuring compliance with the regulation (European Union, 2023). Under FuelEU, depending on whether a ship's total GHG intensity in each reporting period (i.e., calendar year) is below or above the target intensity ratio set out in the regulation, the ship's compliance balance will be either positive (generating a surplus) or negative (generating a deficit) (European Union, 2023). Crucially, if a ship incurs a deficit in the reporting period, it will pay a FuelEU penalty (calculated according to the formula in the FuelEU regulation) unless it is pooled with other ships that have a surplus (pooling) (European Union, 2023).

Another example is the US, which has established emission control areas (ECAs) in North America and the United States Caribbean (IMO, 2008). Ships traveling within these areas are required to use low-sulphur fuels, and the sulphur content of fuels in the ECAs is limited to 0.10% (IMO, 2010), which is significantly lower than the global standard limit of 3.50%. Meanwhile, the Renewable Fuel Standard program implemented by the United States Environmental Protection Agency sets annual renewable fuel use targets covering biodiesel, ethanol, and other advanced biofuels. Moreover, under the Vessel Fuel Oil Consumption Reporting rule, all ships over 5,000 GT on international voyages are required to submit annual fuel consumption reports to the EPA (Lundy, 2018). This measure helps track and reduce GHG emissions.

The UK has adopted comprehensive measures to combat GHG emissions from ships, including the promotion of technological innovation and economic incentives through domestic laws and regulations and international cooperation. The UK Climate Change Act sets a target of reducing UK GHG emissions to at least net zero by 2050 (United Kingdom Government, 2008). To achieve the 2050 net-zero emissions vision, the Clean Shipping Programme has set out a detailed roadmap with a number of milestones: a target of 2025 for all ships operating in UK waters to maximize the use of energy-efficient options, for newly ordered ships to have zero-emission propulsion capability, and for zero-emission commercial ships to operate in UK waters (United Kingdom Government, 2023). By 2035, the UK will have multiple clean shipping clusters, low- or zero-emission fuel refueling options, and a Ship Registry that continues to serve as a global leader in clean shipping (United Kingdom Parliament, 2024).

For the US and the UK, decarbonization targets for shipping under international law are easier to achieve, aided by detailed target schemes under domestic law. The same is happening in China, where the goal of decarbonizing shipping can be achieved step by step in law and policy. As for China, it has regulated the requirements for ships' facilities, list of hazardous materials for ships, low-carbon emission reduction, energy efficiency of ships, shore power, emission control areas, etc., through both the transformative application and the direct application of policies from international conventions such as the BWM Convention (United Nations Treaty Collection (UNTC), 2004) and the 2009 Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (IMO, 2009a).

While these examples from the EU, the US, and the UK illustrate the leadership of developed economies in maritime decarbonization, they represent only part of the global picture. In addition to the practices of developed economies, several developing countries and regional organizations have recently advanced ambitious decarbonization frameworks that provide valuable comparative insights.

In 2023, the [Association of Southeast Asian Nations \(ASEAN\) Maritime Outlook \(2023\)](#) addressed collective efforts toward alternative fuel infrastructure, digitalized port operations, and equitable technology access across member states. In 2024, India further advanced its maritime decarbonization agenda through new green infrastructure projects at Visakhapatnam Port, including smart monitoring systems and low-emission cargo handling facilities. These initiatives, launched under the Maritime Amrit Kaal Vision 2047, illustrate India's shift from policy planning to concrete implementation of port-level sustainability and emission-reduction measures ([India Shipping News, 2025](#)). In Northern Brazil, the Brazil–Norway collaboration on a green shipping corridor reflects the country's move toward decarbonizing inland waterways through regional cooperation and biofuel/alternative fuel deployment ([Hakirevic Prevljak, 2025](#)). These initiatives demonstrate that developing economies are increasingly shaping the global maritime decarbonization agenda, offering alternative governance models that complement China's own approach to balancing environmental ambition with developmental needs.

Against this broader backdrop, China's approach to shipping decarbonization can be better understood not in isolation from developed economies, but as part of a wider movement among emerging maritime nations seeking to reconcile environmental responsibility with developmental priorities. China has developed a GHG trading mechanism to mitigate GHG emissions. On 19 October 2023, the Ministry of Ecology and Environment of the People's Republic of China issued the Measures for the Administration of GHG Voluntary Emission Reduction Trading (Trial) ([Ministry of Ecology and Environment of the People's Republic of China \(MEEPRC\), 2023](#)). Generally, the measures require the Ministry of Ecology and Environment to organize the establishment of a unified national voluntary GHG emission reduction registry, a trading body or system, and the formulation and release of technical specifications on the methodology of voluntary GHG emission reduction projects. These will serve as the basis for project validation and implementation in the relevant fields, as well as the accounting and verification of emission reductions.

Although there are detailed and applicable regulations for decarbonization of ships within each country, the incompatibility of emission reduction norms between countries due to differences in national legislation will have a far-reaching impact on emission reduction actors. On the one hand, compliance with the requirements of developed countries, such as the US, the UK, and the EU, will increase the operating costs and reduce the benefits of emission reduction actors. On the other hand, a large number of routes intersect with the above countries, and disregarding their norms will inevitably affect the operation of ships. Therefore, in a

situation where ships can easily move between different registries, international regulation and international co-operation show their advantages and importance.

4 Solution: taking China's role as an example and international shipping decarbonization cooperation

In the context of globalization, public concern about environmental issues such as resource depletion and pollution caused by shipping activities is rapidly increasing. Accordingly, environmental protection and resource conservation have been widely discussed by business and political leaders in various countries, and there has been a proliferation of research dedicated to addressing related issues. Many shipping companies around the world have also begun to address environmental issues and achieve green operations through shipping decarbonization practices. In this context, further international cooperation is crucial and imperative for the promotion of decarbonization in the shipping industry. A feasible example in cooperative frameworks to shipping decarbonization may include the following aspects: firstly, establishing comprehensive legal regulation of decarbonization through negotiation; secondly, persuading developed countries to provide financial and technical assistance to developing countries; and thirdly, vigorously developing green corridors.

In the context of globalization, shipping decarbonization requires not only ambitious targets but also practical pathways for implementation. Existing international initiatives introduced earlier in Section 2.2 have already provided important frameworks for collaboration. However, to translate these global initiatives into effective and inclusive action, China's role as both a major shipping power and a representative of developing countries is critical. Building on this dual identity, three interrelated solution pathways are particularly relevant.

4.1 Establish comprehensive legal regulation of decarbonization through negotiation

International law often materializes as an international cooperation mechanism in the areas of technology, politics, and finance. At present, under the IMO's initiative, States are collaborating to develop more comprehensive international legal provisions by renegotiating ship operations' energy efficiency programs, finalizing accurate baseline and intensity measurement indicators for energy efficiency, and further promoting market mechanisms for emissions of various substances ([IMO, 2023b, 2025b](#)). However, the level of ambition in setting such standards remains a contentious issue. If the standards are set too high, they may pose significant economic challenges for developing countries, potentially creating market distortion and leading to trade barriers. Conversely, overly lenient standards may fail to achieve the intended decarbonization targets. Therefore, global cooperation

and inclusive negotiations are essential to establish a global standard that is enforceable across all jurisdictions while balancing the interests of developed and developing countries.

Therefore, to make the proposal of comprehensive legal regulation more feasible, several elements require clarification. First, the IMO should remain the central platform for negotiation, while enhancing coordination with the UNFCCC and regional blocs such as the ASEAN and EU. Second, to balance the CBDR and NMFT principles, differentiated implementation timelines could be introduced, allowing developing countries transitional space without undermining overall ambition. Third, establish a dedicated coordination mechanism such as an IMO–UNFCCC joint working group that could help reconcile disputes over responsibility allocation between developed and developing states. Finally, special attention should be given to ensuring that small island developing states (SIDS) and least developed countries (LDCs) have substantive participation in negotiations, preventing their marginalization in the rule-making process.

At the domestic level, the priority should be to enhance their inclusiveness, rather than reiterating existing IMO strategies. China can play a facilitating role in bridging the divide between developed and developing states in ongoing IMO negotiations. For example, in the revision of MARPOL Annex VI, China has emphasized the economic feasibility of technical standards for developing countries while supporting a higher ambition in long-term decarbonization goals. Going forward, China could advocate for differentiated implementation timelines, ensuring that developing economies are given transitional space without undermining the overall effectiveness of global regulations. In this sense, China contributes not only as a participant but also as a mediator, shaping the balance between environmental ambition and developmental equity.

4.2 For developed countries to provide financial and technical assistance to developing countries under the CBDR principle

Although in the analysis of the challenge for shipping decarbonization, we have argued that the CBDR principle in climate change law conflicts with the NMFT principle advocated by IMO, possibilities exist for coordination between the two. The latest theory of the CBDR principle states that the differential treatment “has become an essential element of any international environmental agreement and should form the basis for the adoption of environmental measures” (Cullet, 2016). Reconciling the two principles can be quite challenging and requires innovative thinking, but is considered possible and feasible (Hackmann, 2012).

For instance, the Paris Agreement represents an evolution of the CBDR principle from differentiation entitlements specifically listed in the Annexes to the UNFCCC to a regime of flexible self-differentiation (Bultheel et al., 2015), an important shift that will undoubtedly have an impact on the reduction of GHG emissions from international shipping. More importantly, as one of the guiding principles, the CBDR principle was re-acknowledged by

IMO in the Initial Strategy for considering the future measures of controlling GHG emissions from ships. Both acknowledgments send a clear signal that the CBDR principle under the UNFCCC framework is and will continue to be respected and reflected in the development of regulations related to GHG emissions from international shipping. At the national level, developing countries are also gradually endorsing the harmonization of the two principles. In March 2017, China and India submitted a joint proposal in regard to the Comprehensive IMO Strategy on the Reduction of GHG Emissions from Ships (IMO, 2017). Echoing the Paris Agreement, the proposal incorporates both the CBDR and NMFT principles.

It can be concluded then that the two principles can still be complementary in practice: CBDR emphasizes equity and capacity, ensuring that developing countries have sufficient support and time to implement emission reduction measures; the principle of NMFT ensures that the implementation of emission reduction measures does not lead to market distortions and unfair competition. Combining the principles of both in the process of decarbonizing the shipping industry can achieve equitable transition, coordinated policies, and joint efforts in shipping decarbonization.

Accordingly, when setting global emission reduction targets and measures, the international community should consider the different development stages and capacities of countries, and provide technical and financial support to ensure a fair transition. As for the coordinated policies, when implementing carbon pricing and market mechanisms, globally coordinated policies ought to be adopted to avoid market distortions and unfair competition, while fair competition ought to be ensured among countries in the process of emission reduction. Finally, this process can lead the joint efforts in shipping decarbonization, promoting technology transfer and capacity building through international co-operation, thereby achieving common but differentiated emission reduction targets and fostering the sustainable development of the global shipping industry.

Therefore, a financial mechanism to support developing countries in fulfilling their obligations to reduce GHG emissions from ships can be considered an effective way to enhance the application of the CBDR principle in international shipping. However, it must be based on the following conditions: first, developed countries should bear most of the financial burden in accordance with the law; second, developing countries should not bear additional financial burden; third, the funds raised should be used to support developing countries in enhancing their capacity to implement policies from the Convention.

Accordingly, the specific forms of funding mechanisms for ship GHG emission reduction can be divided into two, and each has its own focus:

1. External funding. The financial mechanism established under the framework of the UNFCCC comes mainly from the contributions of developed countries. Given that the global emission reduction targets stipulated in the Paris Agreement also cover international shipping, establishing a financial mechanism related to the reduction of GHG

emissions from ships should be a top priority for international shipping. This means that the financial mechanism established under the framework of the UNFCCC can also provide support for international shipping, thereby promoting the low-carbon transition of the global shipping industry. Notably, at the time of the adoption of the Paris Agreement, developed countries have pledged to continue to support developing countries by \$100 billion per year by 2025 after 2020 (United Nations, 2015b). Additionally, in the ISWG-GHG's 16th meeting ahead of the MEPC 81, all delegations that spoke reiterated their commitment to the development of an economic element as part of the basket of mid-term measures, on the basis of a maritime GHG emissions pricing mechanism as included in the 2023 IMO GHG Strategy, which aims to "effectively promote the energy transition of shipping and provide the world fleet a needed incentive while contributing to a level playing field and a just and equitable transition." It can therefore be argued that if external financing related to climate change can be brought to the international shipping industry through the IMO, support for developing countries can be a powerful manifestation for the differentiated responsibilities of developed countries.

2. Internal funding. GHG related funds in the international shipping sector could vary depending on the source of funding and could be public, private, multilateral, bilateral, etc. At the very least, priority should be given to the establishment of an internal fund, under the full control of the international shipping industry and legally binding on the contributions of developed countries, similar to the Green Climate Fund and the Special Climate Change Fund established under the framework of the UNFCCC. Such an internal fund, with the contribution of developed countries as an obligation, not only ensures the stability of the source of funds, but also reflects the differentiated responsibilities of developed countries compared with developing countries.

Admittedly, while the Green Climate Fund (GCF) has been identified as a potential source of support, its current allocation to maritime projects remains marginal—less than 5% since 2020. To address this gap, China could advocate within the IMO and UNFCCC for earmarked maritime funding windows, while simultaneously leveraging its Belt and Road maritime cooperation platforms to mobilize additional resources. Such dual-track efforts would enhance the availability of financial and technical assistance specifically dedicated to shipping decarbonization.

At the political level, States could provide the shipping industry with general guidance. Currently, corporations in different industries tend to preserve the current shipping system instead of spontaneously pursuing shipping decarbonization. In this regard, States' policies like tax exemption and financial subsidies play a crucial role in stimulating multi-industrial cooperation. Also, the top-level design of green

shipping corridors in each country can systematically establish relevant policy support and legal regulation. Further, countries could seek ways to synergize the promotion of green shipping corridor initiatives into intergovernmental and interregional agreements. Meanwhile, given its indirect impact on emission reduction and its role in mitigating uncertainties arising from unforeseen events, knowledge sharing has become a crucial element in the shipping industry's emission reduction efforts (Liu et al., 2023).

Calls for financial and technical assistance have long been part of the IMO agenda, but implementation remains limited. In this process, China's approach combines external advocacy and internal experimentation. Internationally, China has argued within the IMO that developed countries should fulfill their climate finance commitments to maritime projects, including through the Green Climate Fund. Domestically and regionally, China has initiated South–South cooperation projects, offering port infrastructure upgrades and shore power technology to partner States along the Maritime Silk Road. This dual strategy reflects China's attempt to operationalize CBDR in practice: pressing developed countries to take primary responsibility, while simultaneously providing alternative channels of support to ensure that developing countries are not left behind.

4.3 Actively promote the construction of green corridors

The Green Shipping Corridor is an innovative cooperation mechanism aimed at promoting the low-carbon transition of the shipping industry. This concept drives sustainability across the industry by achieving low carbon/zero emissions targets on specific routes established between two or more ports (Global Maritime Forum, n.d.). In these corridors, ports, shipping companies and fuel suppliers will work together to achieve significant reductions in GHG emissions through new fuels, technological innovations, and management innovations. To actively promote a low-carbon transition in the global shipping industry, 22 countries, including the UK, the US, Germany and France, signed the Clydebank Declaration at the 26th Conference of the Parties (COP26) in November 2021. This declaration addresses the development of green shipping and proposes the establishment of at least six green shipping corridors between two or more ports by 2025, with a further expansion of the number of corridors by 2030, until shipping decarbonization by 2050 (Global Maritime Forum, 2023).

This is of great significance for shipping decarbonization. According to the Annual Progress Report On Green Shipping Corridors 2023, the number of global green corridor initiatives has increased from 21 to 44, and existing corridor projects have matured significantly, with several corridors entering the implementation phase, deciding on their priority fuels, and setting operational targets. The representative green shipping corridors include the Shanghai–Los Angeles green shipping

corridor ([Shanghai Free Trade Zone \(SHFTZ\), 2023](#)), the Australia–East Asia iron ore green shipping corridor, the Asia–Europe container green shipping corridor, and the European port green shipping corridor.

China could initiate cooperating mechanisms with other States through green corridors. East and Southeast Asia cover many important shipping points like the Port of Shanghai and the Strait of Malacca, making the region crucial in global shipping. China emphasized the importance of solidarity, cooperation, openness, and win–win situations and demonstrated that it could support the strengthening of cooperation in the areas of transportation, energy and resources, the continuous upgrading of the level of soft infrastructure links, the promotion of green development, and the promotion of scientific and technological innovation ([Ministry of Ecology and Environment of the People's Republic of China \(MEEPRC\), 2023](#)).

Although China is not a State Party to the Clydebank Declaration, it has actively participated in multiple green shipping corridor initiatives, including the Shanghai–Los Angeles/Long Beach, Guangzhou–Los Angeles, and Tianjin–Singapore corridors. Among these, the Shanghai–Los Angeles/Long Beach Green Shipping Corridor represents the world's first trans-Pacific zero-carbon corridor and connects the busiest ports in Asia and North America, jointly accounting for approximately 25%–30% of total trans-Pacific container traffic ([Ni, 2025](#)). The corridor's 2023 Implementation Plan Outline sets the target of achieving zero-emission shipping by 2030, and its 2024 Annual Progress Report shows that implementation has entered a structured phase, with three thematic working groups—Energy Supply, Carriers, and Ports—responsible for advancing key tasks ([Shanghai Municipal Transportation Commission, 2024](#)).

The Energy Supply Working Group has compiled data on alternative fuel demand and supply, developed fuel preparation and delivery schedules, and initiated studies on low- and zero-carbon fuel standards under the corridor framework ([North Bund Forum, 2024](#)). The Carriers Working Group formulated confidentiality and compliance policies consistent with the competition laws of participating jurisdictions and collected decarbonization roadmaps from individual shipping companies, including COSCO Shipping, Maersk, and CMA CGM. The Ports Working Group implemented pragmatic measures tailored to each port's resources and development stage. Shanghai Port strengthened its hub layout and improved port electrification and clean-fuel bunkering capacity, while the Ports of Los Angeles and Long Beach engaged U.S. fuel suppliers and retrofitted infrastructure to meet corridor requirements.

Despite these advances, economic and operational challenges remain significant. China's ports still face limited zero-emission fuel availability—particularly green methanol and ammonia—higher fuel costs compared to conventional options, and the absence of a unified standard across corridor partners ([Wu, 2025](#)). The Shanghai–Los Angeles/Long Beach 2024 report also identifies the need for coordinated monitoring and verification systems. In

response, a new metrics and monitoring group was established to standardize carbon accounting methods and develop technical standards for clean fuels.

Encouragingly, China's domestic policy progress has begun to reinforce these initiatives. The Action Plan of Shanghai Municipality for Accelerating the Advancement of Green and Low-Carbon Transition (2024–2027) sets a target of 100,000 t of green methanol consumption by 2027 for ocean-going vessels ([Shanghai Government, 2024](#)). Shanghai Port has become one of the few global ports capable of both LNG and methanol bunkering, achieving in April 2025 its first large-scale domestic green methanol refueling operation, using fuel produced in Ordos by Towngas China ([Ni, 2025](#)). Meanwhile, projects such as the Alxa 500,000-t-per-year green methanol plant, expected to reduce 750,000 t of CO₂ annually, are strengthening China's upstream supply chain ([Ni, 2025](#)). Collectively, these developments suggest that while the Shanghai–Los Angeles/Long Beach Corridor has made tangible progress, its long-term success will depend on overcoming fuel-supply constraints, narrowing cost gaps, and achieving standard alignment through sustained international coordination.

Additionally, there is also evidence of progress in establishing zero-emission fuel supply chains in areas relevant to corridors. For example, ground has been broken at the Port of Gothenburg on 50 kt of e-methanol production, which will be online from 2025 ([Hakirevic Prevljak, 2022](#)). In addition, many corridor ports are working to increase their readiness for zero-emission bunkering. For example, Singapore, Rotterdam, and Gothenburg have all completed ship-to-ship methanol bunkering trials ([MPA, 2023](#)), while Singapore, the Pilbara, Rotterdam, Antwerp, Houston, and Korean ports are undertaking safety and feasibility assessments for ammonia bunkering. In addition, some ports have begun harmonizing bunkering standards through corridors.

The Green Corridor provides the global shipping industry with specific paths and practical cases to achieve the goal of decarbonization, and provides valuable experience and inspiration for the extensive implementation of green shipping corridors in the future. However, the construction of a green shipping corridor is a long and complex process, which requires the full cooperation of governments, enterprises, scientific research institutions, and international organizations. By taking full advantage of these development opportunities, the Green Shipping Corridor has the potential to become a key force driving the sustainable development of the shipping industry.

5 Conclusion

In the context of the growing problem of climate change, the development of shipping decarbonization is being promoted worldwide by international organizations, shipping powers, and private actors. Currently, the international law centered on the UN governs shipping decarbonization in a broad manner, while the international law centered on the IMO is not fully comprehensive

on related matters. The regional legislation centered on the EU, while being innovative and progressive, may lack adequate support mechanisms for the promotion of shipping decarbonization. In addition, current technologies pose challenges to the development of shipping decarbonization, such as the high cost of low-carbon fuels and long lead times for equipment replacement. Despite certain shortcomings, existing international law and technologies provide a framework for the development of shipping decarbonization. Within the existing framework, various stakeholders of shipping decarbonization can further promote international cooperation on technology sharing, financial support, and political mutual trust.

Take China as an example. As a major shipping country in the world, China has been elected as a Category A member of the International Maritime Organization for the 18th consecutive term and remains actively engaged in global efforts to decarbonize shipping. Domestically, the revised Marine Environmental Protection Law (2023) ([National People's Congress of the People's Republic of China, 2023](#)) and the Measures for the Administration of GHG Voluntary Emission Reduction Trading (Trial) (2023) provide the legal foundation for regulating vessel emissions and promoting voluntary carbon trading.

As of 2024, China has made notable progress in advancing port electrification and low-emission infrastructure. According to the Ministry of Transport, several coastal provinces—such as Guangdong—have achieved over 88% berth coverage with shore-power facilities, reflecting a significant expansion of port-level decarbonization capacity ([Chinese Shipping, 2024](#)). In the carbon-trading domain, the 2023 Measures for the Administration of Greenhouse Gas Voluntary Emission Reduction Trading (Trial) established the institutional basis for China's voluntary carbon market ([Ministry of Ecology and Environment of the People's Republic of China \(MEEPRC\), 2023](#)).

Looking ahead, the interaction between China's voluntary trading system and the IMO's forthcoming Net-Zero Framework ([IMO, 2025c](#)) will be critical. Without coordination, Chinese carriers could face dual regulation—participating in a national voluntary market while also complying with the IMO's mandatory carbon pricing scheme. To prevent duplication, China could align its monitoring, reporting, and verification (MRV) standards with the IMO's GFI methodology, recognize IMO compliance instruments as eligible domestic offsets, or negotiate a transitional equivalence mechanism that links both systems. Through such coordination, China's domestic initiatives can complement rather than conflict with international regulation, ensuring that national emission-reduction efforts contribute directly to global decarbonization goals.

China's newly implemented Marine Environmental Protection Law and Measures for the Administration of GHG Voluntary Emission Reduction Trading (Trial) aim to regulate ships under its jurisdiction. Additionally, through its foreign policy and financial support programs, China seeks to support global efforts in the development of shipping decarbonization within the framework of international cooperation.

Author contributions

WW: Conceptualization, Formal Analysis, Funding acquisition, Supervision, Visualization, Writing – original draft, Writing – review & editing. KZ: Formal Analysis, Validation, Writing – review & editing. CL: Formal Analysis, Validation, Writing – review & editing.

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