航运先锋 2023：

Green Shipping Pioneers 2023:

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Pioneers of Pollution and Carbon Reduction in Ocean-Going Vessels (China)

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When promoting pollution and carbon emission reduction in shipping, some leading ship operators play a pioneering role in exploring the pilot and large-scale application of green technologies and actively responding to and promoting the IMO's emission reduction strategies and initiatives to enhance the application of clean energy in their fleets. By analyzing the emission reduction measures taken by the top 20 ship operators (in terms of cargo-carrying capacity) participating in China's international maritime transportation in two aspects of technology and management, the report found that four container ship operators, three bulk carrier operators, and two oil tanker operators have engaged a high proportion of vessels equipped with energy-saving and environmentally friendly technologies in China's international maritime transportation. These operators have also taken the lead in ordering vessels using alternative fuels, showing a significantly better performance than the overall industry. *[1 This means that the general scores of the shipping companies in the four technology-based indicators and two management-based indicators are higher than the average scores of the industry by 1 standard deviation.]* Specifically, green pioneers in the container shipping sector include: HMM, Hapag-Lloyd, Yang Ming Marine, and CMA CGM; in the bulk shipping sector: Vale, RWE Group, and Fredriksen Group; and in the oil tanker shipping sector: Angelicoussis Group and Fredriksen Group.

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However, in this stage, it is not yet clear which alternative fuel may be the best choice for zero-carbon emission in the shipping industry. The application of alternative fuels still faces multiple challenges, such as technical feasibility, total ownership cost, green low-carbon fuel availability, and non-CO_2 GHG emission control. For example, in terms of technical feasibility, the use of ammonia as fuel in the shipping industry still awaits the production and application of ammonia-powered marine engines. In terms of the total cost of ownership, compared with traditional fuels or blue ammonia, grey methanol, etc., green low-carbon fuels, such as green ammonia, green methanol, and biofuels, do not show any cost advantage, and ships powered by alternative fuels may face additional costs for engines, storage tanks, and after-treatment systems. This makes cost control a key consideration for the choice of alternative fuels. As for the availability of green low-carbon fuels, ammonia still requires investment in and the construction of supply chain infrastructure, and the application of biofuels may encounter competition with other fields, such as the demand for decarbonization in the aviation sector. In addition, in terms of non-CO_2 GHG emission control, LNG-powered vessels may face methane escape, and ammonia-fueled ships face N_2O emission, which need more attention. Notably, in terms of the potential for global warming in 100 years, methane and N_2O respectively contribute 28 and 265 times more than CO_2.

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Progress in adopting clean energy varies among ships in different routes and berthed at different ports due to multiple factors, such as port infrastructure and the conditions of the routes in which they operate. According to analysis, although the installation rates of shore power-receiving facilities in ocean-going vessels are generally low, on some specific routes, such as the container routes between China and Singapore and between China and the United States (US), the proportion of voyages by vessels with shore power-receiving facilities is relatively high, reaching 18.9% and 14.2% for each respective route. However, as for the routes between China and Southeast Asian countries (including Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam), the proportion of vessels with shore power-receiving facilities is still low, ranging between 0%–4.3%.

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Among the key emission reduction pathways for alternative fuel, LNG or LNG-ready ships are among the current participants in China's international maritime transportation. With Shanghai Port and Shenzhen Port building comprehensive LNG refueling service capacities, a total of more than 100 vessels have adopted LNG as fuel among container ships berthed at these two ports. However, as the shipping industry devotes increasing attention and investment to methanol- and ammonia-fueled ships, ports also need to accelerate the deployment of diverse green low-carbon energy supply. For example, among the oil tankers participating in China's international maritime transportation, 13 tankers operated by methanol producer Methanex Corporation have adopted methanol as an alternative fuel and are calling at Guangzhou Port, Jiaxing Port, and Ningbo Zhoushan Port.

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Background and Objectives

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As international and regional regulations continue to tighten the requirements for GHG emission reduction in shipping, the general trend has geared toward the industry's green and low-carbon transition. In July 2023, the 80th session of the Marine Environment Protection Committee (MEPC 80) of the IMO adopted the "2023 IMO Strategy on Reduction of GHG Emissions from Ships" (hereinafter referred to as the "2023 IMO GHG Strategy"), which put forward more stringent targets than the "Initial IMO Strategy on Reduction of GHG Emissions from Ships" (Table 1). In particular, the target for reducing total GHG emissions from international shipping has been tightened from “50% by 2050 compared to 2008” to “net-zero emissions around 2050.” Two “indicative checkpoints” have been set: to reduce total annual GHG emissions from international shipping by at least 20%, striving for 30%, by 2030 compared to 2008 and reduce total annual GHG emissions from international shipping by at least 70%, striving for 80%, by 2040 compared to 2008. In addition, in January 2024, the European Union Emissions Trading System (EU ETS) will be extended to cover shipping, and all passenger and cargo ships (with 5,000 gross tonnage or above) entering EU ports *[2 This includes EU member states, Iceland, Liechtenstein, and Norway.]* will be required to monitor and report their emissions and pay a certain amount of carbon allowances for each tonne of carbon dioxide equivalent (tCO_2e) emission *[3 The computation involves 100% of emissions in intra-EU voyages (between two ports in the EU) and in ports and 50% of emissions in extra-EU voyages (between a port in the EU and a port outside the EU).]*. Increasingly stringent regulations mean that the shipping industry must act proactively to improve the energy efficiency of ships through technical and operational measures and accelerate the adoption of zero- and near-zero-emission technologies and energy sources.

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The green and low-carbon transition of shipping will contribute to the sustained improvement of China's air quality and the realization of its dual-carbon goals. In China, a major country in the realm of ports, emissions in shipping are among the most major sources of air pollutants. NOx emissions from ocean-going vessels within inland waterways and coastal and contiguous zones (24 nautical miles beyond the baseline of the territorial sea) accounted for 14% of mobile sources in 2021 (Ministry of Ecology and Environment 2022). Port cities are even more significantly affected. Atmospheric pollutant emission inventories at port cities, including Guangzhou, Hong Kong, Shanghai, and Shenzhen, indicate that emissions from vessels account for 20%–40% of urban atmospheric pollutant emissions. Currently, China has not achieved solid air quality improvement and faces the demand and pressure for continuous improvement. China's carbon emission reduction is still in the initial stage, and the dual-carbon goals are a pressing and arduous challenge. In this context, the shipping industry is accelerating its green and low-carbon transition, which will become an important booster for China's pollution and carbon reduction.

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To promote the green and low-carbon transition of China's international maritime transportation, CAA has launched the Green Shipping Pioneers project, which focuses on international container ships, bulk carriers, and oil tankers entering and leaving coastal ports of China. It analyzes the process and challenges involved in their pollution and carbon reduction and provides a reference for decision-makers, insiders, and upstream and downstream industry chains. Based on the research report "Green Shipping Pioneers: A Study on the Progress of Reducing Pollution and Carbon Emissions in Shipping" published in 2022, the project has established an objective and fair evaluation system to encourage more shipping companies to adopt leading pollution and carbon reduction initiatives and engage "cleaner" ships in China’s international maritime transportation by identifying pioneering fleets already making such actions. It also urges port enterprises and relevant authorities to provide incentives to these pioneers, thus reducing the impacts of ocean-going vessels on China's air quality and climate and protecting public health.

联合国秘书长古特雷斯（António Guterres）在 MEPC 80 的视频发言中表示，将全球气温上升限制在 1.5 摄氏度仍有可能，但需要全球付出巨大的努力并采取即刻的行动，其中，占全球排放 3%的航运业将起到关键作用。

His Excellency António Guterres, Secretary-General of the UN, said in his video message to the MEPC 80, "It is still possible to limit global temperature rise to 1.5 degrees Celsius. But it requires an immense and immediate global effort. And shipping, which accounts for almost three percent of global emissions, will be vital."

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Focusing on the major container routes (Note 1), it can be seen that there is a certain proportion of shore power vessels on the China-US, China-Australia, China-Singapore, China-South Korea, and China-Japan routes (Figure 2.4), but the proportion of sailings with shore power vessels on the routes between China and the Southeast Asian countries (including Vietnam, the Philippines, Malaysia, Thailand, and Indonesia) is still relatively low, ranging from 0% to 4.3%.

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Among the fleets entering and leaving China’s coastal ports, the proportion of Chinese-flagged vessels is about 2.8%, mainly from COSCO Shipping and SeaLead Shipping. It means that the current Chinese policy related to promoting the construction and retrofitting of shore power-receiving facilities on Chinese-flagged vessels (Note 2) will produce very little effect in promoting the retrofitting of shore power facilities on these ocean-going vessels. A positive signal is that container ship operators have already promoted the installation and utilization of shore power facilities through voluntary action programs, initiatives, etc., which may be effective solutions to the problem of the low utilization rate of shore power at container terminals.

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Bulk carriers are less equipped with shore power-receiving facilities than container ships. Among the bulk carriers participating in China’s international maritime trade, the number and cargo-carrying capacity of vessels with shore power-receiving facilities accounted for 2.0% and 3.5%, respectively. Among the 20 bulk shipping companies included in the analysis, only five had a certain proportion of vessels using shore power, three of which were COSCO Shipping, China Merchants Group, and Shandong Marine Group (Figure 2.5). In addition, Vale, which had the top cargo-carrying capacity, participated in China’s international maritime transportation with 40.6% of its fleets equipped with shore power facilities, making it far ahead in the bulk shipping market.

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In terms of the major bulk shipping routes, a certain proportion of bulk carriers on the China-Brazil, China-South Africa, China-Indonesia, and China-Australia routes can use shore power (Figure 2.7). However, the proportion of shore power vessels voyaging on routes between China and the US, Japan, and other routes is relatively low. At present, the bulk shipping market still lacks voluntary actions to enhance shore power utilization rate. The relevant departments of the Ministry of Transport are suggested to take the lead in organizing the participation of bulk shipping companies and port terminals in the demonstration and promotion of shore power use. For major ports with frequent bulk calls, such as those in the Bohai Rim region, major trading ports can sign an industry agreement with shipping companies to promote shore power use at both bulk terminals and in bulk carriers.

Figure 2.5: Proportion of the Capacity of Bulk Shipping Companies Participating in China's International Maritime Transportation and Proportion of the Capacity of Shore Power Vessels

Figure 2.6: Proportion of Shore Power Vessels of Bulk Shipping Companies Calling at China's Ports

Figure 2.7: Proportion of the Vessel Times of Shore Power Vessels on Major Bulk Shipping Routes

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The NOx emission control of ocean-going vessels follows the requirements of Annex VI of the "International Convention for the Prevention of Pollution from Ships" (MARPOL), which stipulates that NOx emission reduction should be achieved by tightening the diesel engine emission limit standards for newly built vessels. At present, the NOx emission limits are divided into three categories: NOx Tier I, Tier II, and Tier III. These depend on the shipbuilding year and sailing areas. Among them, Tier III has the most rigorous NOx emission control restrictions. When activating the denitrification unit of a vessel in this tier, the NOx emission is 74%–76% more stringent than Tier II limits. However, Tier III is only applicable to ships navigating in IMO NECAs and that are built after IMO-NECAs came into effect.

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At present, four IMO-NECAs have taken effect, including the North American ECA (NAECA) and the US Caribbean ECA (CECA), which both entered into force on January 1, 2016, as well as the North Sea ECA (NSECA) and the Baltic Sea ECA (BSECA), which both entered into force on January 1, 2021. Under IMO-NECA policy, the NOx emission of a portion of global marine vessel engines has already reached Tier III, but the proportion of global fleets meeting Tier III is still low at 4.8% due to the limited number of regions where Tier III is in force and the fact that it only applies to newly built vessels.

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The analysis found that ocean-going vessels entering and leaving China's coastal ports are mainly ships newly built on or after January 1, 2010, whose engine emission meets the Tier II requirements (Figure 3.1). There is also a portion of ships meeting Tier I requirements built before 2010 and still in operation. They show poorer performance in terms of NOx emission control. In addition, some of the international ships sailing in and out of China's coastal ports cover routes included in IMO NECAs. Therefore, their engine emission standards meet Tier III requirements. However, as China's waters have not been included in the IMO NECAs, and there is no need to meet Tier III requirements for entering and leaving China's sea area, these ships may not activate their denitrification units within China's waters to reduce operational energy consumption and costs.

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Among the 20 container ship operators included in the analysis, there are significant differences in the composition of the NOx emission phases of the fleets of different shipping companies participating in China's international maritime transportation (Figure 3.2). The number of Tier II ships and capacity of some shipping companies account for even less than 50%, while CMA CGM, Evergreen Marine, Hyundai Merchant Marine, and the Islamic Republic of Iran Shipping Line Group already have more than 10% of their fleets as Tier III vessels, which already have the infrastructure capacity to maintain a lower level of NOx emissions in China's waters.

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Tier III container ships accounted for 2.6% of ships berthed at China's ports in 2022, mainly at ports in the PRD and YRD of China, such as Shenzhen Port (25.3%) in the PRD and Shanghai Port (21.8%) and Ningbo Zhoushan Port (18.6%) in the YRD (Figure 3.3). If these ports provide incentives for Tier III ships or reach an agreement on NOx emission reduction with shipping companies, it will encourage the latter to activate their denitrification units or other NOx emission reduction measures in China's waters, continuously contributing to the improvement of air quality in port cities. For example, Norway launched the NOx Fund in 2008 to provide financial support for companies applying NOx emission reduction technologies through agreements with business organizations, under which the 2008–2010 and the 2011–2017 environmental protection agreements brought about NOx emission reductions of 18,000 tons and 16,000 tons, respectively.

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The ESTs analyzed in this report are mainly divided into shaft-driven generators, propeller-related ESTs, hull-related ESTs, waste heat recovery technologies, and renewable energy technologies. The first three ESTs account for more than 90% of the total and have a wider scope of application; renewable energy technologies, such as wind propulsion technologies, have certain requirements for the environment of the ship's navigational area, deck space, and cargo loading and unloading conditions, and their applications are still in the initial stage.

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Among the vessels participating in China's international maritime transportation, the cargo-carrying capacity of container ships and oil tankers that apply ESTs is relatively high, both of which exceed 40% (Figure 4.1), while the capacity of bulk carriers with ESTs is relatively low at 28%. The report makes the proportion of vessels that apply ESTs an indicator of technology-based emission reduction, which is used to evaluate the difference in EST application progress among different shipping companies.

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In 2022, among the bulk carriers that participated in China's international maritime transportation, 27.9% of the cargo-carrying capacity used ESTs, significantly lower than that of container ships and oil tankers. This means IMO's short-term measures are more likely to affect the bulk shipping market. If there is an insufficient number of energy-efficient bulk carriers complying with EEXI and CII requirements, these carriers will need to comply by, for example, slowing down their sailing, affecting the operating efficiency of the bulk shipping market. In terms of the cargo-carrying capacity of bulk carriers using ESTs, most of them used shaft-driven generators (37.4%), propeller ducts with propeller optimization technology (19.9%), rudder bulbs (12.5%), bow enhancement (8.1%), and propeller boss cap fins (6.0%), as shown in Figure 4.4.

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The alternative fuel pathway selection of shipping companies will have an impact on the supply and structure of green and zero-carbon fuels in the future. With the increasing pressure for decarbonization, the shipping industry is beginning to pay attention to alternative fuels with zero carbon emissions, such as methanol, ammonia, biofuels, etc. According to Alphaliner data, from January–September 2023, the cargo-carrying capacity of container ships using alternative fuels accounted for 83% of the total, with methanol-fueled ships accounting for 52%, already surpassing the proportion of LNG-fueled ships. Other shipping companies opted for alternative fuel-ready ships, which allowed for the transformation of a vessel to use certain alternative fuel types at the design stage, reserving the space to realize decarbonization in the future.

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