# ЕКОНОМІКА

UDC 656.033:502.175 DOI https://doi.org/10.33082/td.2024.4-23.01

## "GREEN" PORT DUES AS A TOOL FOR INVESTMENT IN THE DEVELOPMENT OF ECOLOGICAL TRANSPORT AND LOGISTICS SYSTEMS

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***Summary***

***Introduction.*** *The relevance of the topic of the article is conditioned by the negative impact of transport and logistics systems on the environment. The operation of ports and sea vessels is associated with significant emissions and environmental damage. On the other hand, greening of transport infrastructure is a developing world trend, which is reflected in the investments of ship owners and the system of port dues.* ***Purpose.*** *The article is devoted to the generalization of current practices and technologies that directly affect the environmental consequences of transport and logistics systems, the systematization of price incentives for "green" vessels in seaports, the identification of a special form of environmental investment of port enterprises to obtain an ecological effect, and the classification of the main criteria for port dues incentives.* ***Results.*** *The practical experience of selected environmental indices, initiatives and incentive schemes are generalized, as well as the features of using each tool. The practices and technologies that directly affect the environmental consequences of the transport and logistics systems are systematized. The main areas of influence from the side of ship owners, ports, maritime corporations and terminals are highlighted. A special form of environmental investment of port / port administrations in the form of price incentives for "green" vessels for obtaining an ecological effect for ecosystem of port cities has been identified. Various price incentives for "green" ships in some European, Asian and American ports are summarized. The main criteria for discounts from "green" port dues are classified.* ***Conclusions.*** *Participation in the global and local ecological programs gives seaports the opportunity to encourage the most environmentally friendly ships, reduce the negative impact on the environment, get an ecological effect, and ship owners – to receive discounts visiting such ports and invest in the greening of the fleet. The practices and technologies, that directly affect the environmental consequences of the activities of participants in transport and logistics systems, for ship owners include reducing greenhouse gas emissions, using more environmentally friendly engines, minimizing risk of oily discharges; for ports, maritime corporations and terminals – reducing of GHG emissions and air pollutants;*

*reducing underwater noise sources, cargo losses and waste generated during handling, transportation and storage of dry bulk, etc. Environmental protection measures in the form of price incentives for "green" vessels with the aim of obtaining an ecological effect for ecosystem of port cities can be considered as a special form of environmental investment of port enterprises. The main criteria for green port dues incentives include GHG labels for certified vessels, use zero carbon fuel, LNG as marine fuel, technologies for reduction of underwater noise, specialized types of vessels that meet certain environmental requirement, and port time duration.*

***Key words:*** *transport and logistics system, ports, pricing, "green" port dues, greenhouse gases, emissions, shipping, investments, ecosystem of port cities, ecological effect.*

## «ЗЕЛЕНІ» ПОРТОВІ ЗБОРИ ЯК ІНСТРУМЕНТ ІНВЕСТУВАННЯ У РОЗВИТОК ЕКОЛОГІЧНИХ ТРАНСПОРТНО-ЛОГІСТИЧНИХ СИСТЕМ

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***Анотація***

***Вступ.*** *Актуальність теми статті зумовлена негативним впливом транспортно-логістичних систем на навколишнє середовище. Робота портів та морських суден пов'язана зі значними викидами та екологічними збитками. З іншого боку, у світі набуває розвитку тенденція екологізації транспортної інфраструктури, що відображається на інвестиційних витратах судновласницьких компаній і системі формування портових зборів.* ***Мета.*** *Стаття присвячена узагальненню практик і технологій, які безпосередньо впливають на екологічні наслідки функціонування транспортно-логістичних систем, систематизації світового досвіду застосування цінових стимулів для «зелених» суден у морських портах, ідентифікації особливої екологічної форми інвестицій портових підприємств з метою отримання екологічного ефекту, а також класифікації головних екологічних критеріїв для знижок з портових зборів.* ***Результати.*** *Систематизовано практичний досвід застосування екологічних індексів, ініціатив та схем стимулювання судновласників, а також особливості застосування кожного інструменту. Узагальнено практики та технології, які безпосередньо впливають на екологічні наслідки функціонування транспортно-логістичних систем. Виділено головні напрями впливу з боку судновласницьких компаній, портів, морських корпорацій і терміналів. Визначено особливу форму екологічних інвестицій морських портів / портових адміністрацій у здійснення природоохоронних заходів у формі знижок з портових зборів для «зелених» суден з метою отримання екологічного ефекту для екосистеми портових міст. Узагальнено цінові стимули для «зелених» суден у деяких портах Європи, Азії та Америки. Класифіковано основні критерії знижок із «зелених» портових зборів.* ***Висновки.*** *Участь у глобальних і локальних екологічних програмах дає морським портам можливості заохочувати най-*

*більш екологічні судна, зменшувати негативний вплив на навколишнє середовище, отримувати екологічний ефект, а судновласникам – отримувати знижки при заходах у такі порти та інвестувати у екологізацію флоту. Практики та технології, які безпосередньо впливають на екологічні наслідки діяльності учасників транспортно-логістичних систем, для судновласників включають зменшення викидів парникових газів, використання більш екологічних двигунів, мінімізацію ризику викидів мастильних матеріалів тощо; для морських портів, морських корпорацій і терміналів – зменшення викидів GHG і забруднювачів повітря, джерел підводного шуму, зменшення відходів, зменшення втрат вантажів та пилу, що утворюється під час переробки, транспортування та зберігання сухих вантажів. Надання знижок з портових зборів для «зелених» суден є особливою формою екологічних інвестицій портових підприємств у здійснення природоохоронних заходів з метою отримання екологічного ефекту для екосистем портових міст. Основні критерії надання знижок із зелених портових зборів включають певний рівень GHG для сертифікованих суден, використання пального з нульовим викидом вуглецю, використання LNG як пального, технологій для зменшення підводного шуму, спеціалізованих типів суден, які відповідають екологічним вимогам, а також тривалості часу стоянки.*

***Ключові слова:*** *транспортно-логістична система, порти, ціноутворення, «зелені» портові збори, парникові гази, викиди, судноплавство, екосистема портових міст, екологічний ефект.*

**Introduction.** The processes of greening the transport and logistics systems include implementation of innovative ecological technologies, types of fuel, improvement of energy efficiency, etc. There are many tools based on the use of ecological indices and environmental programs to attract environmentally friendly vessels to seaports that are not only transport hubs, but also an important component of transport and logistics systems. This makes it possible to use various port dues incentives for the vessels with required ecological characteristics. This trend is currently observed in many ports around the world. “Green” port dues contribute to the environmental protection and the energy efficiency of sea vessels.

**Formulation of the problem.** Environmental trends are not taken into account in the Ukrainian system of port dues. Analysis and generalization of the global experience of using environmental indices, initiatives and incentives schemes and green port programs are necessary for the further development of measures to green transport and logistics systems in Ukraine.

**Analysis of recent research and publications.** Features of pricing policy in the management system of port enterprises are considered in many scientific publications. The study by T. Notteboom, A. Pallis & J.-P. Rodrigue [1] indicates that pricing is an important issue of interaction between economic entities in the port industry. The port authority, state or municipal bodies or enterprises, and private companies are the three economic actors that offer services at the port. They are responsible for setting the pricing structure for port users. In the works by M. Acciaro [2, 3] an analysis of the scientific literature on port pricing was carried out, and the structure of port tariffs was considered. Special attention was paid to the issues of the formation of port

dues system and revenue management for the use of port infrastructure. In the paper by E.L. Musso, A.S. Bergantino & F. Porcelli [4] the methodological and empirical aspects of port management are considered. In particular, the authors researched the role of controlling in the activities of port enterprises, proposed a set of factors that should be taken into account when making management decisions. In the work of H. Meersman, S. Strandenes & E. de Voorde [5] the principles, structure and models of port pricing are considered, the classification of port tariffs and fees is given.

In the article by T. Achmadi [6] port tariffs are considered as a component of logistics costs, and the pricing of port services should ensure the reduction of the complex cost of logistics. The author proposed a port pricing model that takes into account external factors and the level of port service quality. In the paper by Y.M. Bandara, H.O. Nguyen & S.L. Chen [7] the strategic pricing of port infrastructure services, taking into account the prices of competitors, was considered, and the impact of port tariffs on the demand for services of a particular port was investigated. In the article by R. Van Den Berg, P.W. De Langen & C.J. Van Zuijlen Paul [8] an analysis of various types of port administrations was performed. It was shown that pricing is often determined not only by commercial criteria. The main principles of port pricing, based on strategic value, were proposed. The greening of port dues and their differentiation based on environmental indicators were investigated.

H. Haralambides & G. Gujar [9] analyzed the Indian port industry and specific pricing approaches for port development and supply chain efficiency. The study by Mchizwa Nokuzola Ethel [10] identified the peculiarities of South African ports, the main factors of pricing, in particular, intra-port and inter-port competition. Author proposed an approach to pricing that takes into consideration not only costs, but also the goals of increasing efficiency for maritime trade and the country as a whole. The article of L. Vukić, I. Peronja & M. Slišković [11] is aimed at studying the need to modify port pricing in the North Port of Split based on the analysis of tariff systems in Croatian ports for specific categories of ships and types of cargo. The impact of port pricing on the competitiveness of seaports is shown. Authors paid attention to the port dues, which provides benefits for environmental protection and may be considered as an element of the port's development strategy.

The paper by S. Sköld [12] reviews "green" port dues, indices and types of incentives that have been developed by various stakeholders to reduce the environmental impact of sea vessels. The article by M. Burchacz & J. Piotrowicz [13] examines «green» port incentives in the European cruise industry and ports that increase competitiveness and attract activities of "green" cruise liners in Europe, including the Baltic Sea region. The article by M. Dooms & M. Geerts [14] examines the role of ports in climate change and the application of various port greening schemes, including incentives, "green" port dues, redistribution of funding, etc. Final report of a research project of the Swedish Environmental Research Institute [15] explored environmentally differentiated port charges and incentives to reduce the environmental impact of vessels. Ports are considered as a part of international transport chains that can influence the environmental efficiency of transport and use of "green" technologies and alternative fuels.

**Formulation of the goals of the article.** The goals of the research are to generalize the practices and technologies that directly affect the environmental consequences

of the operation of transport and logistics systems, the world experience in the application of "green" port dues, the classification of various types of benefits of "green" port programs, environmental indices and incentives schemes to achieve the goals of sustainable development seaports as transport nodes and a component of urban transport and logistics systems of port cities, as well as greening of supply chains.

**Presentation of the main research material.** Greening of the port industry is facilitated by the participation of seaports in international organizations that unite participants of the transport process, the use of environmental ship indices and the development of their own "green" port programs (Table 1).

Table 1

**Selected environmental indices, initiatives and incentives schemes**

| Index or incentive scheme | Description of scheme | Source |
|---|---|---|
| Environmental Ship Index (ESI) | ESI identifies seagoing ships that perform better in reducing air emissions than required by the current emission standards of the IMO – emissions to air (NOx, Sox, CO2). | The Environmental Ship Index, 2024 |
| Green Award | A Green Award certificate, which can be obtained by ships that go above and beyond the industry standards in terms of safety, quality and environmental performance, acts as a quality mark and brings benefits to its holders (emissions to air and water, health safety and security for the crew). Examples of incentives: discount on the port dues; discount on services, discount on products, special extra service / product, promotion | Green Award, 2024 |
| Clean Shipping Index (CSI) | CSI estimates vessels' environmental performance. Vessels are scored on the following parameters: SOx, NOx, CO2, chemicals, water and waste, particulate matter. Registered vessel is assigned a class from 1 to 5 based on environmental performance parameters defined by the CSI | American Bureau of Shipping, 2024 |
| Green Marine | Incentives for ship owners, ports and terminals include: reducing greenhouse gas (GHG) emissions, minimizing NOx emissions, sulphur oxides and particulate matter, risk of oily discharges, reducing the effects of ship recycling, underwater noise, ship generated garbage, the risk related to ballast water discharges and biofouling, etc. | Green Marine, 2024 |
| Blue Angel Eco-friendly ship design (DE-UZ 141) | The requirements include the installation of an emergency towing system to measures for air pollutant reduction and fuel tank protection (double hull); requirements for onboard waste and wastewater treatment | German Federal Government, 2024 |
| The Maritime Singapore Green Initiative: Green Port Program (GPP) | Port dues incentives to GPP registered vessels that use LNG as marine fuel in the port, or low or zero carbon fuel, etc. | Maritime and Port Authority (MPA) of Singapore, 2024 |
| The Green Flag Program | The vessel operators can earn dockage rate reductions in the Long Beach port for speed reduction to 12 knots or less within 40 nautical miles | The Port of Long Beach, 2024 |
| The Green Ship Incentive (GSI) Program | The GSI Program provides the greatest monetary incentive for Tier III ships of any seaport. Participants must register with the Port and with ESI in order to receive incentives under the new program | |

The Environmental Ship Index (ESI) program identifies sea vessels which have a better performance in reducing air emissions than required by current IMO emission standards. All maritime stakeholders can use ESI as a mean of improving their environmental performance and a tool to achieve their sustainability goals. With over 7000 registered vessels, ESI has become the standard tool used by ports worldwide to reward and incentivize ship owners that meet and exceed IMO emissions standards [21]. In 2024 ESI was entering a new phase with revised and expanded modules and formulas, as well as the introduction of new greenhouse gases and innovative modules. By 2026, the revised and expanded ESI will take into account a range of potential emissions, introduce a new methodology for greenhouse gas emissions, and reward innovation and the application of zero-emission methods on board ships.

The Green Award is a global, independent organization dedicated to certifying vessels and ship managers which exceed industry standards for safety, quality and sustainability. It works closely with maritime authorities and classification societies and provides data to database containing information on the safety of the world's merchant fleet. Green Award participants include more than 30 countries in Europe, Asia, the Middle East, Africa, Australia, South and North America, with more than 1500 registered certified river and sea vessels and more than 200 incentive providers, including ports and maritime service companies. Green Award participates in the development of corporate social responsibility tools for ports and companies [20]. Green Award certified ships have GHG labels (CO2 and/or CH4 – methane); ports from 16 countries are offering incentives to the certified seagoing ships; 110+ service providers and equipment suppliers are offering incentives.

One more example of ecological index is The Clean Shipping Index (CSI) that is an independent system for assessing vessels' environmental performance. It serves as a practical tool for differentiating port dues and fees. Vessels are scored on the following parameters: SOx, NOx, CO2, chemicals, water and waste, particulate matter, harmful for the human respiratory and cardiovascular systems [22]. Once registered, the vessel is assigned a class from 1 to 5 based on environmental performance parameters defined by the CSI. The maximum score for vessels is 150 points – 30 points for each of 5 different parameters.

The Green Marine global environmental initiative is managed by the non-profit organization Green Marine International, established in 2024 to oversee two programs – Green Marine and Green Marine Europe. Management is carried out by the board of directors, which includes top managers of American, Canadian and European companies [23]. Green Marine encourages its members to adopt practices and technologies that directly impact the environmental footprint of their operations.

The Blue Angel is the ecological label of the German Federal Government. This is an independent label that sets stringent standards for environmentally friendly products and services. Eco-friendly ship design (DE-UZ 141) is implementation of environmental standards during vessels construction. The aim is to implement as many environmental innovations as possible for reducing emissions into the marine environment already during the planning phase for a sea-going ship. Requirements range from the installation of an emergency towing system to measures for air pollutant reduction and fuel tank protection, and also include stringent requirements for the treatment of on-board waste and wastewater [18].

The Green Port Program (GPP) is one of the programs under The Maritime Singapore Green Initiative (MSGI) to promote environmental sustainability among ocean-going vessels calling at the Port of Singapore and vessels licensed by the Maritime and Port Authority (MPA) of Singapore [25].

The Green Ship Incentive (GSI) Program is a voluntary clean-air initiative targeting the reduction of smog-causing nitrogen oxides of Port of Long Beach. The GSI Program rewards carriers committed to environmental and operational excellence through the use of cleaner fuels, vessel modifications, or on-board technologies [25]. The Port's Green Flag Program is a vessel speed reduction program that rewards vessel operators for slowing down to 12 knots or less within 40 nautical miles of the entrance to the harbor. Because the ships emit less when they travel more slowly, the program has been highly successful in reducing smog-forming emissions and diesel particulates from ships. More than 90% of vessels coming into the port participate in the program. The ship operators can get dockage rate reductions in the Long Beach port [25].

The practices and technologies that directly affect the environmental consequences of the operation of transport and logistics systems are classified in two groups – for ship owners and for ports, seaway corporations and terminals (Figure 1).

Rotterdam has become the first port in the world to start offering Green Award-certified LNG tankers a 6% port dues discount [26]. This is in line with the policy of the Port of Rotterdam to support sustainable shipping. In addition, the Port of Rotterdam has been involved in the development of the Environmental Ship Index from the very beginning.

Another example is the port of Riga, where discounts on port dues can be granted to ships that have a Green Award Certificate in the amount of 5% of the canal and pilotage dues, and ships using LNG, methanol, ammonia, hydrogen – in the amount of 10% of canal and pilot dues [17].

The port dues system of the Port of Singapore takes into account the port's greening aspirations through «green» port dues in accordance with The Green Port Program (GPP). Discounts on port dues up to 30% take into account various criteria, including the desire to green the port within the framework of GPP [19].

The article by J. Gedeon [16] examines the experience of applying port fee rebates in the Canadian port of Milwaukee for owners of "green" vessels. The StewardSHIP initiative was developed during International Great Lakes Navigation. Shipowners are granted a 10% discount on port dues if the company meets one of the StewardSHIP criteria.

Table 2 generalizes the various price incentives for «green» vessels in some ports.

The proposed classification of criteria for port dues incentives includes: certified vessels having GHG labels – CO2 and/or methane (CH4); use zero carbon fuel; use LNG as marine fuel; technologies for reduction of underwater noise; specialized types of vessels (crude oil tankers, product and chemical tankers and LNG carriers) that meet certain environmental requirement; and port time duration (Figure 2).

Some criteria may be applied simultaneously, for example, use of specialized types of vessels and GHG labels as in the Port of Hamburg, or certain ecological requirements for vessel and port time duration as in the Port of Singapore.

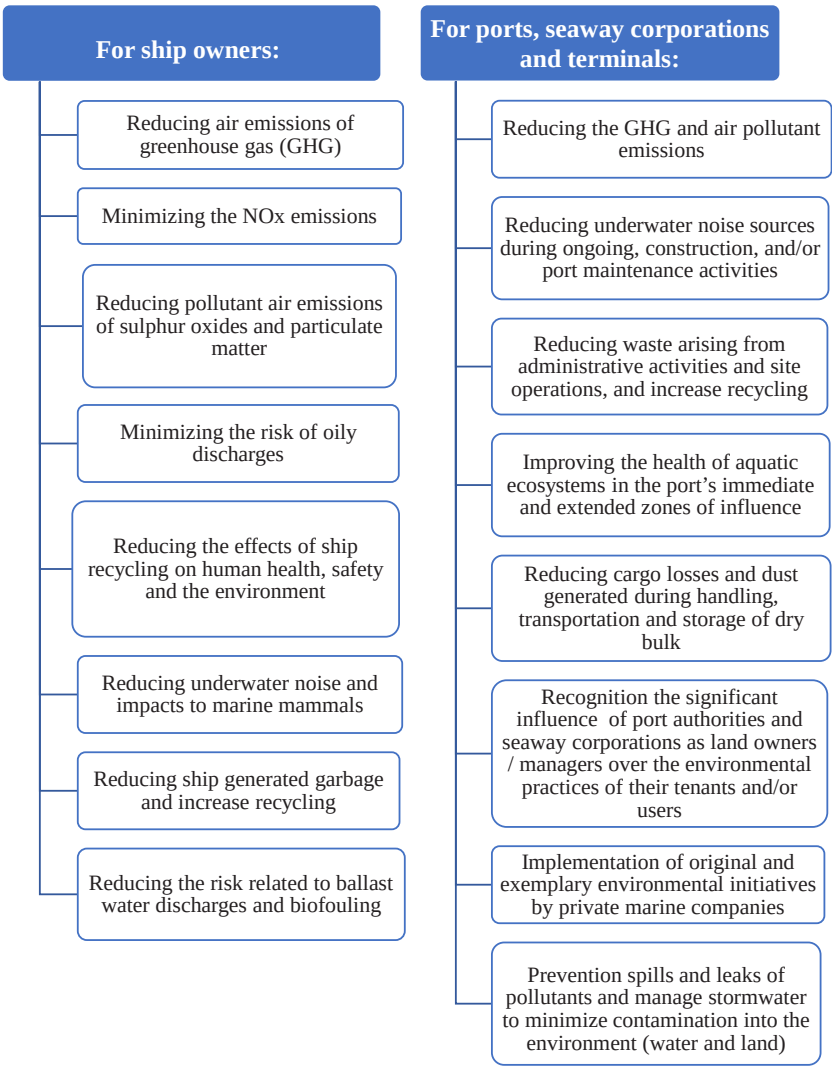


*Fig. 1. Classification of the practices and technologies that directly affect the environmental consequences of the activities of participants in the transport and logistics systems*

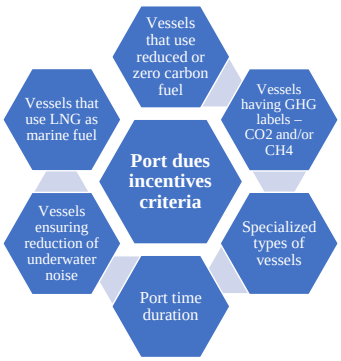


*Fig. 2. Classification of main criteria for port dues incentives*

Table 2

**Price incentives for "green" vessels in some ports**

| Port / Port Authority | Basis for price incentives | Price incentives |
|---|---|---|
| Port of Rotterdam | For all Green Award certified ships, for vessels that hold ESI | 10% discount on port dues |
| Maritime and Port Authority (MPA) of Singapore | Applicable to Green Port Program (GPP) registered vessels that engage an LNG-fuelled harbor craft for operations, or are serviced by low or zero carbon fuelled MPA licensed harbor craft. Port stay does not exceed 4 days | 10% discount on port dues |
| | For GPP registered vessels that use LNG as marine fuel in the port, or low carbon fuel, The Energy Efficiency Design Index (EEDI) reduction exceeds the IMO Phase 3 EEDI requirement by 10% or more. Port stay does not exceed 4 days | 25% discount on port dues |
| | For GPP registered vessels that use zero carbon fuel in the port. Port stay does not exceed 4 days | 30% discount on port dues |
| Hamburg Port Authority | For crude oil, product and chemical tankers and LNG carriers of any size that hold the Green Award certificate | 3% discount on port dues |
| Freeport of Riga Authority | For all Green Award certified vessels<br><br>For vessels that use liquefied natural gas (LNG), methanol, ammonia, hydrogen as fuel | 5% of the canal due and pilotage due<br>10% on the canal due and pilotage due |
| Administração do Porto de Lisboa | For all Green Award certified ships | 5% reduction on Tariff for Port Use |
| Administração do Porto de Setúbal | For all Green Award certified ships | 3% reduction on Tariff for Port Use |
| Administração do Porto de Sines SA | For all Green Award certified ships | 5% reduction on Tariff for Port Use |
| Administração dos Portos do Douro e Leixões | For Crude oil / Product Tankers, for all Green Award certified ships | 3% premium on Tariff of Port Use |
| Barcelona Port Authority | For all Green Award certified ships | 5% discount on port dues |
| Elefsis Port Authority S.A. (Port of Elefsina) | For all Green Award certified ships | 15% discount on port dues |
| Centre Port Wellington | For bulk carriers and oil tankers, for all Green Award certified ships | 3% of the port's Marine Services Charge |
| Gibraltar Port Authority | A 5% reduction in tonnage dues for all Green Award certified vessels entering British Gibraltar Territorial Waters and calling at the Gibraltar Port | 5% reduction in tonnage dues |
| Port of Long Beach | By the Green Flag Program vessel operators can earn a 25% reduction on dockage fee if they slow from 40 nm; or a 15% reduction for slowing from 20 nm.<br>By the Green Ship Incentive Program vessels with with certain ESI score is eligible for 3000–6000 USD incentive payment for each ship call. Each vessel that has a verified IMO Tier III Main Engine is eligible for an incentive of $3,000 per vessel call, regardless of the vessel's ESI score. The ESI and Tier III incentive may be stacked | 15-25% reduction in dockage fee<br><br>Reduction in port dues from 3000 USD to 6000 USD per ship call |
| Port of Milwaukee | For companies meet one of the criteria of the StewardSHIP initiative: participates in environmental programs (e.g. Green Marine), uses strategies and technologies to reduce emissions and impact on the environment and/or underwater noise technologies | 10% discount on port dues |

**Conclusions.** The ability to monitor environmental indicators and vessels impact on the environment is a key element in reducing emissions and improving the ecosystem of port cities. Participation in the Environmental Ship Index, Green Award and Green Marine programs gives seaports the opportunity to encourage the most environmentally friendly vessels, reduce the negative impact on the environment, and for ship owners – to receive price incentives in such ports and invest in the greening of their fleet. Such tools as the Clean Shipping Index, the Blue Angel, The Maritime Singapore Green Initiative and others have a positive impact on regional ecosystems.

The practices and technologies that directly affect the environmental consequences of the activities of the transport and logistics systems for ship owners include reducing GHG emissions, integrating new engines, reducing pollutant air emissions of sulfur oxides and particulate matter, minimizing risk of oily discharges, etc.; and for ports, seaway corporations and terminals this tools are aimed at reducing air pollutant emissions, underwater noise sources, construction and port maintenance activities, reducing waste arising from administrative activities and site operations, and increasing recycling, reducing cargo losses and dust generated during handling, transportation and storage of dry bulk, etc. For seaports / port administrations the implementation of environmental protection measures in the form of price incentives for "green" vessels can be determined as a special form of environmental investment aimed at obtaining an ecological effect. The main criteria for "green" port dues incentives are GHG labels for certified vessels – CO2 and/or methane (CH4), use zero carbon fuel; use LNG as marine fuel, technologies for reduction of underwater noise, specialized types of vessels (crude oil tankers, product and chemical tankers and LNG carriers) that meet certain environmental requirement, port time duration.

The practical value of the research lies in the possibility of using results for greening port pricing in Ukraine to protect the environment and ecosystems of port cities during the post-war renewal. However, the introduction of port dues incentives in Ukrainian ports is possible simultaneously with a fundamental change in the methodology for calculating port dues, taking into account the quality of services and the level of transport costs of clients in competing ports.

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