



The Potential of Electric RoPax Vessels for Short-Sea Ferry Operations

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ARTICLE INFO

Special Issue:

11th International Conference on
Maritime Transport;
May 27-29, 2026.
Barcelona School of Nautical Studies
(FNB-UPC), Spain

Article history:

Received 27 May 2026;
in revised from 28 May 2026;
accepted 01 Jun 2026.

Keywords:

FuelEU Maritime, electric vessels,
short-sea shipping, RoPax electric
ferries.

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ABSTRACT

This paper studies the potential of electric RoPax vessels on the Helsinki–Tallinn route. This route is a busy short-sea shuttle route, with a crossing of the Gulf of Finland taking approximately 2–2.5 hours, depending on the vessel. One of the shipping companies operating in the region has announced plans for a possible investment in a fully electric vessel, with the objectives of significantly reducing emissions on the route, taking advantage of lower-cost electricity compared to many marine fuels, reducing costs associated with the EU Emissions Trading System (ETS), and ensuring compliance with FuelEU Maritime requirements. The vessel would be charged in port using shore-side electricity. This paper examines the energy requirements and reported emissions of four vessels currently operating on the route, based on EU MRV data, and estimates the electricity demand of a comparable electric vessel operating on the same service. Although the use of electricity in maritime transport presents several challenges, primarily related to battery technology, fixed short-distance routes of this kind may represent a viable application for fully electric vessels.

1. Introduction.

Efforts to reduce the environmental impacts of maritime transport are increasingly being driven by regulation (EU, 2023a; EU 2023b; IMO, 1997; IMO, 2020). Legislation and regulatory measures aimed at reducing air emissions have been implemented at both global and regional levels. To mitigate greenhouse gas emissions, the International Maritime Organization (IMO) has adopted a net-zero emissions target for international shipping, with the objective of achieving net-zero greenhouse gas emissions by 2050 (IMO, 2023). Within the European Union, the inclusion of maritime transport in the EU Emissions Trading System (EU ETS) directly increases the cost of fossil fuel use (EU, 2023a). In addition, the FuelEU Maritime Regulation encourages shipping companies to transition

towards non-fossil fuel solutions (EU, 2023b). Global limits on the sulfur content of marine fuels (IMO, 2016), together with restrictions on nitrogen oxide (NO_x) emissions, are intended to reduce the acidifying and eutrophying effects of these pollutants on the environment (Deng et al., 2021; Jutterström et al., 2021). Furthermore, the IMO has designated certain sea areas as Emission Control Areas (ECAs), including Sulfur Emission Control Areas (SECAs) and Nitrogen Emission Control Areas (NECAs), where emission limits for sulfur and nitrogen oxides are more stringent than elsewhere. The Baltic Sea is designated as both a SECA and an NECA (HELCOM, 2017). Environmental regulation within both the IMO and the European Union has been developed in a largely technology-neutral manner (Bach & Hansen, 2023; von Malmborg, 2024). As no clearly superior alternative to internal combustion engines and fuel oils has yet emerged that can meet the operational requirements of maritime transport, while offering superior environmental performance (Cullinane & Yang, 2022; Gilbert et al., 2018; IMO, 2020; Korberg et al., 2021), this approach is justified.

FuelEU Maritime necessitates a transition away from fos-

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sil fuels (EU, 2023b). The regulation defines this transition in a clear and prescriptive manner. In contrast to approaches that focus solely on tank-to-wake emissions, FuelEU Maritime also accounts for well-to-tank emissions (EU, 2023b), which are generated during the production and supply of the fuel or energy source (Chatzinikolaou & Ventikos, 2015). This differs significantly from another key EU regulatory instrument affecting maritime emissions, the EU Emissions Trading System (EU ETS) (EU, 2023a). While the EU ETS places a price on carbon dioxide emissions, it remains technologically neutral and does not prescribe or favor any propulsion technology. By contrast, FuelEU Maritime directly assesses the greenhouse gas intensity of the energy used on board vessels.

Compliance under FuelEU Maritime can be assessed either on an individual vessel basis or through vessel pooling arrangements (EU, 2023b). The pooling mechanism is specifically intended to support investments in exceptionally low-emission technologies (Christodoulou & Cullinane, 2022). Under this approach, compliance is evaluated at the pool level rather than at the level of individual vessels. Consequently, a vessel with a very low greenhouse gas intensity can substantially reduce the average emissions intensity of the entire pool. This allows conventionally powered vessels within the same pool to continue operating with little or no technological modification and without the need for significant investments in cleaner technologies. The rationale is straightforward. The regulation seeks to place considerable value on major environmental investments, recognizing that older vessels are expected to be phased out of the fleet over the coming decade. At the same time, shipping companies retain the flexibility to pursue a more incremental approach to emissions reduction, whereby each vessel is upgraded only to the extent required for compliance. Both strategies are, in principle, permissible under the regulation.

The available options include, e.g., biofuels and RFNBO (renewable liquid or gaseous transport fuels of non-biological origin) fuels, which allow ships to operate with lower carbon intensity (Aakko-Saksa et al., 2023; Christodoulou & Cullinane, 2022). A likely bottleneck for biofuels is the availability of sustainable feedstocks, as their production must not compromise food security or compete directly with food production (EU, 2023b; Hararap et al., 2023). Even where direct competition with food crops can be avoided, other land-use changes covered by the LULUCF (Land Use, Land-Use Change and Forestry) framework may have significant environmental impacts, particularly when they occur in tropical rainforest regions. The production of RFNBO (Renewable Fuels of Non-Biological Origin) fuels require substantial amounts of electricity and hydrogen. Furthermore, except for ammonia, fuel options commonly proposed for maritime transport (including methanol, methane, and synthetic diesel) also require carbon as a feedstock. As a result, the environmental performance of these fuels depends heavily on how the electricity and feedstocks, particularly hydrogen and carbon, are produced (Christodoulou & Cullinane, 2022; Gilbert et al., 2018; Hararap et al., 2023). At present, large-scale production of RFNBO fuels remains limited. Consequently, the widespread adoption of these fuels would require the development of an entirely new industrial sector and sup-

porting supply chains on a global scale.

In addition to these alternatives, fully electric vessels represent another pathway for reducing emissions from maritime transport (Guo et al., 2023; Nuchtaree et al., 2020). Electrification has gained significant momentum in sectors such as road transportation. The widespread adoption of electric propulsion in shipping remains constrained by the limitations of current battery technology. In particular, the lower energy density than conventional fuels, weight, and space requirements of batteries pose substantial challenges for many maritime applications, especially those involving long distances, high power demands, or extended operating periods. However, fully electric vessels can be an effective technology for reducing ship emissions as FuelEU Maritime classifies electric propulsion as a zero-emission technology (EC, 2023b). The emissions produced in the electricity generation process must be considered, meaning that the environmental impact of electricity produced in different countries can significantly affect the overall outcome.

Electric motors are inherently well suited for maritime applications. As pod thruster systems become increasingly common, electrically driven propulsion solutions are also becoming more widespread (Arish et al., 2024). Even in conventionally shaft-driven vessels, electric propulsion offers several advantages, including greater flexibility in engine room layout and the ability to integrate different fuel and/or energy sources for electricity generation through onboard generators. However, each energy conversion step inevitably reduces overall system efficiency. Converting fuel into electricity, and subsequently into mechanical propulsion, results in energy losses that would not occur if electricity were used directly. Consequently, when considering battery-electric vessels, electricity generated onshore can be utilized onboard with a very high overall efficiency, as only a limited number of energy conversion steps are required between power generation and propulsion.

The objective of this paper is to examine the potential for fully electric vessels to operate in short-sea shipping. The topic is highly relevant, as current regulations require a transition away from fossil fuels. In addition, a Finnish shipping company has recently announced plans to invest in rechargeable electric RoPax vessels. Although the broader deployment of fully electric vessels faces numerous challenges, they also offer distinct advantages, particularly from an environmental perspective.

2. The context and selected methods.

This paper examines the opportunities and limitations associated with introducing fully electric vessels into short-sea RoPax shipping. Fully electric vessels have only been deployed on a very limited scale globally, primarily in the form of very short-distance car ferries and similar low-range services. This analysis focuses on the operational feasibility of a fully electric RoPax vessel in the context of the Helsinki–Tallinn route. This case has been selected because a shipping company operating in the region has publicly announced plans to invest in a fully electric vessel intended for service on this route.

Vessels operating on this route are large RoPax ferries. They are typically around 200 meters in length and can carry, de-

pending on the vessel, from just under 2,000 to approximately 2,800 passengers. These ships can transport hundreds of passenger vehicles and freight trucks. The business model is also closely linked to onboard retail, including tax-free sales, and this is strongly reflected in the interior design of the vessels. In many respects, they resemble floating shopping centers. Crossing the Gulf of Finland typically takes about two hours one way, service speed being about 22–23 knots. The distance is approximately 43–44 nautical miles. Turnaround times in ports are relatively short, approximately one hour, including loading and unloading. This means that when the ferry departs from Helsinki, after three hours, it is scheduled to depart from Tallinn. To make operating possible on this kind of shuttle route, operations must run smoothly, and both ports are equipped with automated mooring systems. A vessel operating in shuttle traffic typically makes six crossings of the Gulf of Finland within a 24-hour period, which corresponds to three port calls in both Helsinki and Tallinn. These ferries do not operate during the night. In addition, overnight cruise vessels also operate on the route, but these constitute a separate service category.

This route combines high frequency, predictable schedules, and fixed distances. For this reason, shipping companies and port operators have also been willing to invest in terminal infrastructure, as evidenced by the adoption of automated mooring systems. These features are favorable when assessing the feasibility of electric propulsion. If the routes operated vary, determining the required battery capacity would become significantly more challenging. In addition, shore-based battery charging would require a new type of charging infrastructure, the design of which would depend heavily on the implementation of the charging system and battery infrastructure.

In the summer of 2025, one of the shipowners operating in the area issued a press release outlining plans to invest in a fully electric RoPax vessel for this route (Viking Line, 2025). According to publicly available information, this concept vessel would be approximately 195 meters long and 30 meters wide, with a fully electric powertrain. The announced battery capacity is in the range of 85 to 100 megawatt-hours, with charging power exceeding 30 megawatts. The target service speed is around 23 knots, with capacity for around 2,000 passengers, 650 cars, and significant freight volume. According to current plans, the vessel is intended to operate primarily on electricity charged from shore. It is likely that the vessel will also be equipped with onboard generators to provide auxiliary power, if needed. However, no information has been published regarding their intended fuel type.

Electric vessels have previously operated in Finland, but only on a very small scale. In 2017, Finferries introduced a battery-electric ferry operating in the Archipelago Sea (Finferries, 2017). This car ferry “Elektra” (IMO number 9806328) operates with a battery capacity of around one megawatt-hour and maximum propulsion power of 1,800 kilowatts. In practice, the vessel can operate entirely on electricity and recharge while moored, and during normal operation, it follows this principle. The diesel generators serve only as a backup system. However, it is important to note that the route is extremely short, only about 1.6 kilometers, with a crossing time of roughly eight min-

utes. The vessel’s sister ship, “Altera”, was commissioned in 2022. Compared to these electric ferries (Finferries, 2017), the size of this fully electric Ropax vessel would be significantly larger (Viking Line, 2025), with a battery capacity roughly 100 times greater. Fully electric vessels of this scale have not yet been realized.

The EU Monitoring, Reporting and Verification (MRV) Regulation requires ships of more than 5,000 gross tonnage (GT) operating within the European Union to report their annual fuel consumption and calculated greenhouse gas emissions to the EU MRV database (EU, 2015). Carbon dioxide (CO₂) is the most significant reported emission, but methane (CH₄) and nitrous oxide (N₂O) are also considered and used to determine CO₂-equivalent emissions. Unlike the International Maritime Organization’s Data Collection System (DCS), the EU MRV database is fully public, allowing the performance of individual vessels to be examined. The reported data also serve as a basis for regulatory instruments, such as the EU Emissions Trading System (EU ETS). This transparency has improved the overall visibility of the maritime sector. The open database makes it possible to identify major emitters, both in absolute terms and relative to their transport activity, thereby providing policymakers with a stronger evidence base for designing and targeting environmental regulations.

In this paper, the EU MRV database is used to examine the energy consumption reported by the RoPax ferries currently operating on the Helsinki–Tallinn route (EU, 2015). The analysis is based on data from 2024, which represents the most recent annual data set available at the time of writing this paper. The study includes four vessels operating in shuttle service on the route. In terms of size and operational profile, these vessels are broadly comparable to the previously announced electric vessel concept.

3. Results.

The vessels operating on the Helsinki–Tallinn shuttle route are subject to MRV reporting requirements (EU, 2015). Currently, four RoPax vessels operate on the route under three different shipowners. Two of the vessels are LNG powered, while the other two operate on low-sulfur MGO (below 0.1% sulfur content). LNG vessels use MGO as pilot fuel, but the amounts are small in relation to total fuel consumption. In addition, one of the vessels is a modern LNG vessel that can also be started in gas mode. The gas used, at least during the reporting period, has been fossil natural gas. The LNG-vessels do not have any emission abatement technologies, but one of the vessels (ship 3) is equipped with catalytic converters.

The annual emissions and fuel consumption reported for these vessels in the MRV database (EU, 2015) for 2024 are listed in Table 1 (European Maritime Safety Agency, 2025). The reporting includes CO₂, CH₄, and N₂O emissions, which are used to calculate CO₂-equivalent emissions. In addition, the MRV-reporting includes annual fuel consumption and annual time spent operating at sea. Based on the data, the average fuel consumption per nautical mile has been calculated. The vessels do not operate at night, but during the daytime, port calls are

short (approximately one hour long), and traffic is continuous. This results in a high annual time spent at sea even though the vessel is often in port due to its operating profile.

Table 1: Emissions from RoPax vessels operating on the Helsinki–Tallinn route.

Ship	Fuel type	CO ₂	CH ₄	N ₂ O	CO ₂ eq.	Total fuel consumption	Average fuel consumption per distance	Annual time spent at sea
		t/a	t/a	t/a	t/a	t/a	kg/NM	h/a
Ship 1	LNG	43,384.77	422.46	1.85	55,703.83	15,832.46	167.87	4,870
Ship 2	LNG	41,980.44	409.40	1.79	53,917.59	15,323.30	160.02	4,962
Ship 3	MGO	41,521.80	0.65	2.33	42,157.71	12,951.28	166.13	4,354
Ship 4	MGO	51,350.85	0.80	2.88	52,137.30	16,017.11	186.96	4,766

Source: Authors.

The LNG vessels in Table 1 belong to the same shipping company and operate on identical schedules. Ship 1 was commissioned in 2017 and ship 2 in 2022. Although ship 2 has been in service at sea for a slightly longer time, it is somewhat more fuel-efficient and lower-emitting than ship 1. The engine technology differs between the vessels, but both use an electric-powered shaft propulsion system. Ship 3 operates under a different shipping company, and its schedule differs slightly from ships 1 and 2. This is reflected, among other things, in less time spent at sea, which in turn results in lower annual total emissions and fuel consumption. The ship was commissioned in 2008 and is powered by conventional internal combustion engines running on marine gas oil. Ship 4 is the oldest vessel on the list, having been commissioned in 2001. It was technically upgraded in 2026, including the installation of a battery system enabling hybrid operation for reducing emissions. However, since the data in Table 1 is from 2024, the vessel was still a conventional ship, equipped solely with diesel engines at that time.

Table 2 shows the energy consumption for the voyage, calculated based on the data presented in Table 1. The calculation is based on fuel consumption per distance unit and the lower heating values of the fuels, which are set at 13.8 kWh/kg for LNG and 11.8 kWh/kg for MGO. The amount of pilot fuel used in LNG mode is not considered, as its quantity is negligible. Based on these parameters, energy consumption is calculated per unit of distance and per single crossing of the Gulf of Finland. These are averages derived from annual reporting data and do not account for variations in weather conditions, loading, or other operational factors affecting performance. The total available energy from fuels ranges between 78 and 93 MWh per voyage.

Internal combustion engines have been considered relatively inefficient, but modern four-stroke compression-ignition marine engines can achieve efficiencies of 35–40%. However, determining efficiency in marine operations is not straightforward. In the simplest terms, efficiency can be assessed only for the main engines driving the propellers, but particularly in passenger vessels, there are many additional energy-consuming systems. These include heating and air conditioning in the hotel compartments, lighting, and other onboard services. The vessel's hydraulic and pneumatic systems also require an en-

ergy source. Waste heat from exhaust gases can be utilized via exhaust gas boilers, and waste energy from cooling water can be recovered through heat exchangers, which improves the vessel's overall efficiency. Since this paper addresses the topic at a general level, and more detailed information on vessel systems and energy balances is not available, the efficiency of the vessels is assumed to be 40%. Based on this assumption, the energy demand per voyage is obtained as shown in Table 2. Depending on the vessel, energy requirement per voyage varies between 31 and 37 MWh.

Table 2: The energy consumption of ships per voyage.

Ship	Fuel consumption per distance unit	Lower heating value	Energy consumption per distance unit	Energy consumption per voyage	Estimated efficiency	Energy requirement per voyage
	kg/NM	kWh/kg	kWh/NM	kWh/voyage	%	kWh/voyage
Ship 1	167.87	13.8	2,164.22	93,061.48	0.4	37,224.59
Ship 2	160.02	13.8	2,065.28	88,806.96		35,522.78
Ship 3	166.13	11.8	1,814.20	78,010.46		31,204.18
Ship 4	186.96	11.8	2,026.12	87,123.12		34,849.25

Source: Authors.

Electric vessels have higher efficiency than conventional compression ignition engines. Electric motors designed for marine use often have efficiencies above 90% (Nuchturee et al., 2020). However, if electricity is generated from fuel - using gensets, overall efficiency is lower than in directly shaft-driven vessels, even though the generators themselves typically operate at similar efficiencies. The efficiency of battery systems varies depending on the battery type (e.g., including charging capability, cooling requirements, self-discharge, etc.); but in general, they are much more efficient compared to gensets. In electric vessels, waste energy is unlikely to be sufficient to meet hotel load requirements, and the chosen technical solutions determine how this energy demand is met. Depending on the ship concept (e.g., the efficiency of engines and batteries, installed engine systems, and other onboard energy needs), the required electric energy increases accordingly. However, a lot depends on how the vessel is technically designed and configured.

The main challenge for fully electric vessels is onboard energy storage (Guo et al., 2023; Nuchturee et al., 2020). The absolute amount of energy required by vessels is large, and it must be stored in batteries for the entire voyage. This is not surprising, as the data presented in Tables 1 and 2 show, even a single crossing of the Gulf of Finland requires a significant amount of energy (31–37 MWh). If a vessel had a 100 MWh battery system with an energy density of 0.1 MWh/t, the mass of such a battery would be 1,000 tons. In terms of absolute mass, this is comparable to the fuel oil tank capacity of vessels of the same size class, but there is a major difference in range. If this battery were used in operation for only a few hours, and assuming fuel oil consumption being for example 3 t/h, the equivalent operating time would be approximately two weeks. So, when considering electric vessels, especially battery capacity, investment costs and the space available onboard also impose significant practical limitations.

Battery technology has made significant technological ad-

vances over the past 20–30 years, and it is reasonable to assume that this development will continue (Guo et al., 2023). Heavy battery systems are being developed for both transport applications, particularly road transport, and industrial use. As the energy system increasingly shifts toward renewable energy sources, such as wind and solar power, there is also a growing need to develop solutions that balance energy systems. All of this supports the expectation that more energy-efficient battery systems will likely become available for marine applications in the future, enabling the wider adoption of at least hybrid vessels, and potentially also fully electric ships in short-sea operations.

Battery technologies suitable for maritime applications include lithium iron phosphate (LFP) and lithium nickel manganese cobalt oxide (Li-NMC) batteries (Brandt et al., 2022; Chen et al., 2024). The advantages of LFP batteries include better fire safety compared to conventional lithium batteries and a long service life, typically consisting of thousands of charge cycles (Chen et al., 2024). This battery technology also enables high discharge currents, which is particularly important during port maneuvering. The energy density of LFP batteries has typically been around 0.1 kWh/kg, which is lower compared to many other lithium battery technologies. However, because of ongoing product development, LFP battery systems with energy densities of 0.15–0.2 kWh/kg have entered the market. It is possible that even higher energy densities will be achieved in the future.

Lithium nickel manganese cobalt oxide (Li-NMC) batteries (Brandt et al., 2022) offer a higher energy density compared to LFP batteries (typically around 0.15–0.2 kWh/kg depending on the configuration, with significantly higher energy densities observed in more advanced solutions). Li-NMC batteries have been used, among other applications, as an energy source in electric vehicles. Such as LFP batteries, they can withstand thousands of charging cycles. In terms of safety, LFP batteries are generally superior. However, Li-NMC battery systems also offer an acceptable level of safety when properly designed and operated as intended.

Many lithium-based battery technologies depend on various critical raw materials (e.g., lithium, cobalt, copper, nickel), which creates a range of challenges (Brandt et al., 2022; Chen et al., 2024). The availability of these raw materials, as well as the environmental impacts of their production, represent key issues associated with the wider adoption of battery technologies. This is also relevant from a security-of-supply perspective, since, like fossil oil, the production of many critical metals is highly geographically concentrated. At present, China holds a very strong position as a producer of many of these materials. However, battery technology is developing rapidly, and sodium-ion batteries offer a technological alternative that could reduce dependence on these critical raw materials (Arvidsson et al., 2026).

In addition to batteries, the charging of electric vessels must also be addressed (Karimi et al., 2020a; Karimi et al., 2020b; Kumar et al., 2022). Shore power systems are currently being built in many ports, but they are primarily designed to provide shore power to vessels in port so that they can shut down their

auxiliary engines. For fully electric shipping, battery charging can be implemented based on three main principles. One method involves exchangeable batteries, where batteries are charged onshore at a slower rate. This solution reduces the need to invest in high-capacity port grid infrastructure and provides flexibility in the choice of applicable battery technologies. A second option is direct charging from the national electricity grid. However, this requires significant port grid capacity, especially if fast charging is intended. Nevertheless, the power levels involved are not so high as to make this solution infeasible compared with industrial energy consumption in general. A third option is a stationary battery system located in the port, which is charged according to the capacity of the electricity grid. The vessel is then charged by transferring energy from this shore-based battery to the ship's onboard batteries. This solution may be particularly beneficial in situations where the port's grid capacity is insufficient and investments in a stronger grid are not feasible or not planned.

Although these vessels are described as fully electric ships, they are expected to be equipped with generators to ensure safe operation and sufficient onboard power availability. This is also the case with the previously mentioned car ferry “Elektra” (Finferries, 2017). The choice of fuel type and installed genset capacity depends strongly on the design philosophy. One key question is whether the vessel is intended to be fully operable on genset power, or whether a lower maximum speed is accepted in such situations, thereby reducing investment and maintenance costs. Another consideration is whether to invest in multi-fuel solutions for the gensets, such as methanol–MGO capability, or whether to select a simpler single-fuel configuration (MGO) for cost efficiency.

4. Discussion.

The environmental impact of electricity depends on the emissions associated with its generation. This varies significantly between countries depending on electricity generation. In Finland, CO₂ emissions from electricity production are remarkably low (Fingrid, 2024), averaging only 33 g/kWh (compared with specific emissions of more than 600 g/kWh for a diesel engine running on MGO). In electricity markets, customers also have the possibility to purchase electricity from a chosen supplier. Therefore, if low-emission energy capacity is available on the energy market, customers can also make procurement decisions that take this aspect into account.

FuelEU Maritime regulation (Eu, 2023b) requires the greenhouse gas intensity of energy used on board ships to be reduced progressively through 2050. Electricity is one potential solution, as when generated from low-carbon sources, it can make a vessel readily compliant with FuelEU Maritime requirements throughout the entire compliance period. FuelEU Maritime allows shipowners to comply through pooling, in which the carbon intensity target is assessed across a group of vessels. A very low-emission vessel can lower the pool's average carbon intensity, allowing older and higher-emission ships to remain in operation if the pool meets the regulatory limit. This promotes

the adoption of the cleanest possible solutions and could potentially also provide the investing shipowner with opportunities to generate business through vessel pools.

For fixed shuttle routes, such as the Helsinki–Tallinn route, experimental solutions of this kind are likely to be easier to make economically viable. This is because the investments that electric vessels are likely to require in ports, and other shore-side infrastructure, can be more readily justified if the vessel is expected to operate on the same route for the next 15–20 years. The same principle applies to other novel technologies as well. Vessels operating on non-fixed routes generally need to rely on widely available technologies to ensure operational flexibility and the ability to call at a wide range of ports.

In addition to technological and regulatory considerations, economic factors are always of major importance to shipping companies. Capital investment costs are one aspect, operating costs are another, but the vessel's resale value also plays an important role in investment decisions. If a vessel is designed in such a way that transferring it to another route would be difficult, this will inevitably have a negative impact on its resale value. On the other hand, if the vessel can generate significant benefits through regulation mechanisms, such as FuelEU Maritime pooling or by utilizing low-cost electricity, this can enhance its resale value. These considerations can also be addressed during the design phase by ensuring that the vessel is structurally configured in a module-based way that allows technical modifications to be implemented relatively cost-effectively if required in the future. This may be particularly prudent when adopting experimental or novel technologies, as it provides greater flexibility while reducing both technical and commercial risks.

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