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REISFER

REDUCING CO₂ EMISSIONS IN ISLAND FERRY TRAFFIC

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D.1.2.3

Sea-going staff's views on decarbonisation of island ferry traffic in the Central Baltic Region

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List of Acronyms

AX	2-letter regional Code for Åland
AxFerries	AxFerries is the marketing name of Åland’s primary island ferry operator. It is a 50/50 joint venture between the Government of Åland and Finferries Corporation. The company was formally established in autumn 2024 under the name Ålands Skärgårdsrederi Ab. In 2025, it reported a turnover of €17.3 million and employed around 90 staff.
CBR	Central Baltic (Sea) Region
CO ₂	Carbon Dioxide
EE	2-letter country code for Estonia
EU	European Union
EU ETS	EU Emissions Trading System
FI	2-letter country code for Finland
Finferries	Finferries is the marketing name of Finland’s fully state-owned operator of island and road ferry services. The company was officially established in 2010 as Suomen Lauttaliikenne Oy. In 2024, it reported a turnover of €73.8 million and employed approximately 400 staff. Its island ferry operations are managed through its subsidiary, Suomen Saaristovarustamo Oy.
GHG	Greenhouse Gases
GoA	The Government of Åland
GT	Gross tonnage
HVO	Hydrotreated Vegetable Oil
IMO	International Maritime Organization
Island ferry	A ferry operating on a route that is not part of public road network, typically linking islands in the archipelago to a mainland port and/or to some other islands
Road ferry	A ferry operating on a route that is part of public road network. These ferries typically carry 10 to 100+ vehicles and have capacity to take passengers
Ro-Pax (ferry)	A roll-on/roll-off (Ro-Ro) ferry that can take both passengers and vehicles
SE	2-letter country code for Sweden
Sunlines	The ferry operator Spinnaker OÜ operates under the Sunlines brand in Estonia

Keywords List

- Island ferry services
- Carbon emissions
- Decarbonisation
- The Baltic Sea
- Central Baltic Region

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REISFER as part of Interreg Central Baltic Programme

As part of the Interreg Central Baltic Programme, the 3-year REISFER project (2024–2027) aims to significantly reduce the carbon footprint of island ferry transport, a vital connector of mainland areas with islands across the Central Baltic Region (CBR) (Figure 1).

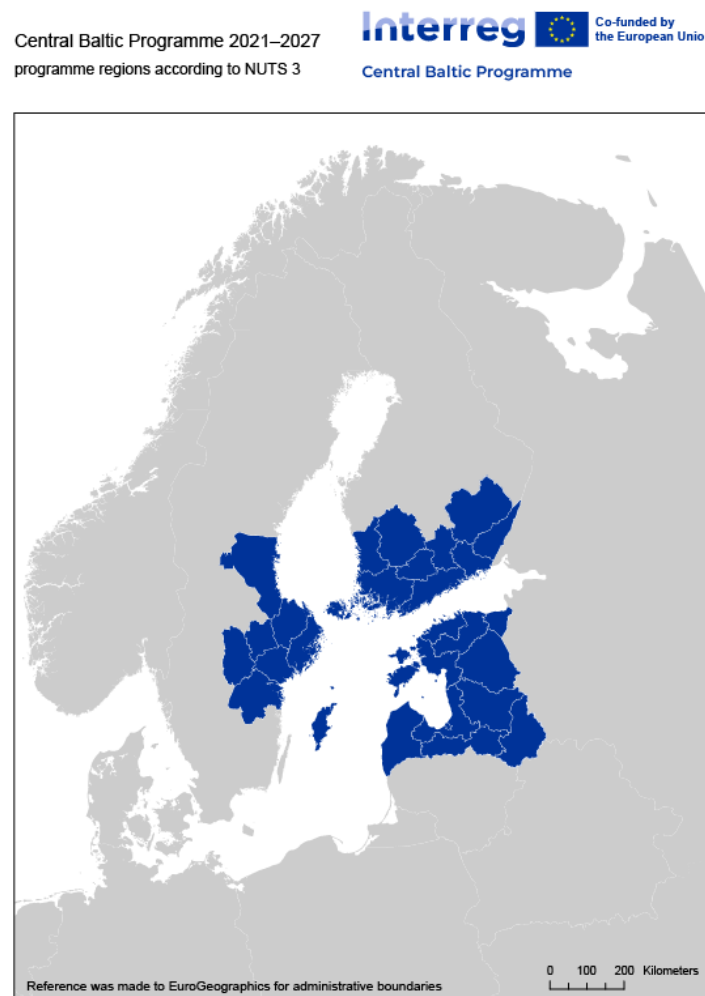


Figure 1. Participating regions in the Central Baltic Programme 2021–2027

The primary objective of the REISFER project is to achieve a 10–20% reduction in CO₂ emissions on selected ferry routes by introducing a combination of technological and operational innovations.

The project's work plan is divided into two work packages (WPs), each focused on delivering outcomes that contribute to lowering CO₂ emissions in key ferry transport areas:

1. **WP 1 – CO₂ reduction possibilities and potential in CBR island ferry traffic**
2. WP 2 – CO₂ emission abatement methods and technologies on ferries

This report falls under the WP 1 in the REISFER project.

Purpose and background of the report

The Baltic Sea, as one of world's busiest maritime areas, features a dense network of ferry routes connecting countries, islands and mainland ports. These ferry services are essential for both passenger and cargo transport, particularly in heavily trafficked areas like the Gulf of Finland and the northern Baltic Proper.

Ferry services are considered the backbone of transport in the Baltic Sea Region, with major routes experiencing constant, year-round demand. This includes large car-passenger vessels that carry over 15 million passengers and 3 million vehicles yearly in cross-border routes between Estonia, Finland and Sweden.

The REISFER project and this report focus on a less known, but equally important domestic and local road and island ferry services with smaller vessels in the Central Baltic Region, namely those between islands and/or the mainland along the coastlines.

While the REISFER reports D.1.1.1 (Bratkov et al., 2025), D.1.2.1 (Ojala et al., 2025) and D.1.2.2 (Joki-Korpela et al., 2025), available [here](#), offer cross-border analyses of the set-up, scale and governance structures of ferry services in the Central Baltic Region, this report provides insights obtained directly from the crews that actually operate the vessels and have gained valuable experience and knowledge from the everyday operational environment.

This report is the first cross-border study on the seagoing staff's views on decarbonisation of island ferry transport in the Central Baltic Region.

The study combines the views of 26 deck and machine officers who work on board island ferries on selected routes in Estonia, Finland – including the Åland islands – and Sweden (Figure 2).

The material was collected through interviews focusing on the work environment, environmental issues, key decarbonisation measures – eco-driving, voyage optimisation, and electrification – and future perspectives in the maritime transport sector.



Figure 2. Map of the study region and locations of the ferry routes this study concerns. (Map by M-L Ojala; basemap: Maptiler)

While the **University of Turku** is responsible for material collection in Finland (including Åland), the analysis and writing of the report, Kadi Kasepõld from **Tallinn University of Technology** (TalTech) and Petra Stelling from the **Swedish National Road and Transport Research Institute** (VTI) collected and translated the interview material from Sweden and Estonia and provided comments for the report. All authors and Mr. Markku Mylly participated in designing the interview guide.

In addition to TalTech and VTI, this study was made possible through the collaboration of all REISFER partners – **Blidösunðsbolaget**, **Estonian State Fleet**, **Finferries**, **the Government of Åland**, **Kihnu Veeteed**, **Suomenlinnan Liikenne** – as well as **AxFerries** in Åland and **Sunlines** in Estonia. We sincerely thank you all for your cooperation.

Most importantly, we want to express our gratitude to the crews for welcoming the researchers on board and for sharing their expertise and thoughts with us. As mentioned, your suggestions and concerns will be reported in more detail yet anonymously to the company in question. In case further studies, such as academic research articles, will be conducted based on the interview material, you will find this information from [the REISFER website](#). **We wish you safe travels and calm waters!**

Introduction

The European Union (EU) and its individual Member States have set ambitious emission reduction targets for the current and coming decades—and island ferry traffic is no exception. Reducing environmental impact is becoming increasingly important for both the companies providing ferry services and the authorities responsible for procuring, subsidising, and regulating the sector. In the Central Baltic Sea Region, cutting CO₂ emissions is rapidly emerging as a key priority for professionals engaged in island ferry operations.

As efforts to reduce emissions in the transport sector accelerate, it becomes increasingly important to evaluate the current state and near-term opportunities for emission reductions in the island ferry industry. There are essentially two primary ways for maritime vessels to reduce greenhouse gas emissions: decreasing fuel and energy consumption by operational optimisation or by switching to lower-emission fuels or electricity.

These emission reduction strategies are not implemented in isolation. Their success is influenced by a wide range of contextual factors, including the availability of infrastructure, economic incentives, customer behaviour, and even variability in weather conditions. Moreover, the new measures and procedures do not happen automatically. Instead, they need to be brought to practice, with seagoing staff playing a key role in this task.

To assess the feasibility of emission reduction measures in island ferry traffic, it is essential to understand the views and experiences of the seagoing staff who operate the vessels.

These crews have valuable first-hand experience and knowledge on the operational environment and how the emission reduction measures are implemented in practice.

This study answers the research question: “**how do the seagoing staff view decarbonisation of island ferry transport in the Central Baltic Region**”. The question is explored through key themes that focus on the main emission reduction methods in island ferry transport and on factors influencing employees’ performance and well-being when adapting to new procedures and technologies (e.g., Yuen et al. 2018; Eurofund 2020; Theotokas et al. 2024; Glaveli et al. 2025).

The themes of the cross-country interviews were as follows, along which this report is structured:

- Work environment, management support and safety
- Environmental awareness and attitudes
- Eco-driving and voyage optimisation
- Electrification of ferries
- Future perspectives

These issues were discussed in 26 interviews with the deck officers and chief engineers in Estonia, Finland including the Åland Islands and Sweden. The interviews resulted in over 300 pages of interview transcriptions and notes.

The interviews followed a semi-structured approach and were conversational in nature. The interview guide was constructed based on the above-mentioned themes, which allowed conducting thematic analysis of the interview transcriptions in each region and route. However, due to the semi-structured nature of the interviews, the discussions did not adhere to the predefined thematic limits. Therefore, iterative qualitative content analysis and revisiting the interview material through the different thematic lenses was applied.

Presenting the results reflects the same variety; although the themes are the same in each region, the structure of each section varies based on the emphasis and contents of the rather freeform discussions. Additional topics and themes emerged differently in each interview, and the most relevant of these are also presented in each section.

Before presenting the empirical results, Chapter 2 outlines the current operational and technical methods available for reducing emissions in island ferry traffic, while Chapter 3 describes the physical and natural environment of the Central Baltic Region. These two Chapters are based on or summarised from the previous REISFER studies D.1.1.1., D.1.2.1 and D.1.2.2, which are available in full length [here](#).

The main research question of this study is addressed in Chapters 4–7 through region-specific thematic descriptions based on qualitative content analysis, supplemented with information on the operational environment in each region. The findings are presented as descriptive summaries, and the analysis prioritises reported experiences over interpretive or theory-driven explanations.

A cross-border outlook and comparison of the interviews is provided in Chapter 8, and Chapter 9 concludes the report and links the findings to broader developments.

1 Emission reduction methods in shipping

The mission to reduce ferry emissions can essentially be approached from two primary directions: operational optimisation and alternative energy solutions. A summary of the emission reduction methods is presented in Table 1.

Operational measures, such as eco-driving and voyage optimisation, focus on improving efficiency and reducing fuel consumption through changes in driving practices, speed management, route optimisation and scheduling. Their main advantages are cost-effectiveness, immediate applicability, and the possibility of implementation without major technological modifications to existing vessels.

The second approach involves addressing the source of emissions: the fuel itself. By replacing fossil fuels with cleaner alternatives, or eliminating fuel use altogether through electrification and battery-powered propulsion, it is possible to achieve zero operational emissions.

Although alternative fuels and electrification offer clear environmental benefits, their implementation is often constrained by high investment costs, limited fuel availability, infrastructure requirements, and technical limitations specific to vessel type and route characteristics. In addition, lifecycle emissions, which encompass all emissions from fuel production to vessel decommissioning, need to be taken into account when evaluating them.

In this context, retrofitting existing vessels plays an important role, ranging from smaller efficiency improvements to extensive conversions such as hybridisation or battery-electric propulsion. Where retrofitting is not feasible or cost-effective, fleet renewal provides a longer-term solution, as modern vessels are typically designed with higher energy efficiency and lower emissions in mind.

The interviews conducted for this report focus on eco-driving, voyage optimisation, and the electrification of ferries, although other measures – such as alternative fuels and onboard energy-saving practices – were also discussed in some of the interviews.

Table 1. Emission reduction methods in island ferry traffic (Joki-Korpela et al. 2025)

Reducing fuel consumption	
Eco-driving	Reducing and optimising driving speeds and techniques and avoiding idle running of engines to reduce fuel consumption.
Voyage optimisation	Optimising routes and schedules to minimise total driving distance and/or engine hours leading to lower fuel consumption and emissions.
Energy systems of vessels	Efficient heating and cooling systems to reduce energy consumption, as well as the installation of energy-efficient lighting systems such as LEDs.
Blasting and painting	Appropriate application of antifouling coatings on vessels to reduce or maintain low water resistance, thereby decreasing energy and fuel consumption.
Replacing the use of traditional fuels with electricity and batteries or alternative fuels	
Electrification of ferries	Batteries are installed on board vessels and used as the power source of the ferry. The batteries are recharged in ports with electricity from the grid, similarly to bunkering. Ferries can be fully electrified or hybrid ferries that combine traditional diesel power and electric batteries.
Hydrogen and ammonia	Hydrogen and ammonia can be used to power vessels with a fuel cell. The fuel cell will create electricity that is used to power the vessel.
Biofuels, HVO	Biofuels are fuels produced from biomass and generally function in a similar manner to fossil fuels. In ferry traffic, Hydrotreated Vegetable Oil (HVO) is the most prominent biofuel, as it essentially serves as a renewable alternative to marine diesel.
Methanol	Methanol is an industrial alcohol that can serve as a sustainable marine fuel. Although it is a liquid fuel, it is not a drop-in replacement and therefore requires modifications to existing engines and infrastructure.
LNG	Liquefied Natural Gas (LNG) can be used as fuel and the use of LNG will lower emissions but not eliminate them. LNG is a fossil fuel and therefore cannot achieve carbon neutrality.
E-fuels	E-fuels are synthetic fuels designed to replicate the properties of conventional fossil fuels. From an environmental perspective, they represent a promising alternative, although large-scale implementation is still several years away.

1.1 Eco-driving and voyage optimisation

Eco-driving and voyage optimisation are among the most straightforward methods for reducing emissions.

Eco-driving refers to operating a vessel as fuel-efficiently as possible. A key component here is slow steaming, which involves sailing at reduced speeds. Since slower speeds require less energy, this directly decreases CO₂ emissions per nautical mile. However, the downside is longer travel times, which can reduce convenience for passengers and other end-users. Despite this, slow steaming remains a low-cost, immediately available strategy for emission reduction. Ultimately, adjusting vessel speed represents a trade-off between faster service and lower environmental impact.

Beyond slow steaming, vessels can be operated more fuel-efficiently by optimising routes and timing to take advantage of environmental conditions such as currents and tides. While slow steaming offers a straightforward approach, ferry crews can also be trained in more advanced eco-driving techniques. These methods help reduce fuel consumption and contribute to moderate emission reductions. An energy or fuel management system with related monitors installed on the bridge and reports support deck officers in engaging in eco-driving practices.

One of the key benefits of eco-driving is cost efficiency—using less fuel not only lowers emissions but also reduces operating expenses for ferry operators and contracting authorities.

Voyage optimisation is an operational strategy designed to minimise fuel consumption and emissions by optimising routes and schedules. This may involve selecting shorter or more efficient routes, reducing the frequency of underutilised voyages, or concentrating operations during peak travel times—daily, weekly, or seasonally.

Schedule optimisation is especially relevant in the context of island ferries in the Central Baltic Region, where some services may run with very few passengers solely because they are part of a fixed timetable. Additionally, voyage optimisation can include weather-based routing, although this approach is typically more applicable to long-distance, open-sea travel.

Voyage optimisation may concern a singular leg or rearranging a larger network of ferry routes anew. In densely populated archipelagos, for instance, the hub-and-spoke model is one approach for streamlining ferry operations. This model designates a central "hub" island with direct connections to the mainland, while smaller surrounding islands—the "spokes"—are served via connections to the hub.

1.2 Electrification of ferries

Electrification of maritime vessels refers usually to replacing traditional fuel entirely with batteries and electricity as the vessel's primary energy source. In hybrid systems, electric

motors operate alongside conventional combustion engines, allowing both to be used as needed. Full electrification results in a battery-powered ferry that produces zero emissions during operation, as no combustion of any fuel takes place.

Electrification offers many advantages, including cost-efficient operation, zero emissions if the electricity is produced sustainably, and a vessel that runs more smoothly and quietly compared to those with fossil fuel engines. It is nevertheless expensive and has certain limitations. The difficulty and cost of implementation are the limiting factors for fully battery powered vessels

Hybrid vessels are another option. Typically, a hybrid vessel combines electric and fossil fuel-based propulsion, allowing operators to benefit from batteries without being overly dependent on charging infrastructure. The emission reduction achieved by a hybrid vessel depends on how much the vessel uses each propulsion.

Furthermore, a hybrid vessel can also utilise alternative fuels, potentially making it a zero-emission vessel regardless of the propulsion source. The main drawback of a hybrid is that accommodating two energy sources increases both the vessel's weight and technical complexity. Overall, hybrid vessels are a practical solution for routes where full electrification is not feasible.

The true environmental benefit of battery-powered ferries is realised when they operate using renewable electricity, such as wind, solar, hydro, or emission-free nuclear power. These sources can make the operation nearly carbon-free. Still, it must be acknowledged that battery manufacturing is not an emission-free process and may involve significant lifecycle emissions. Therefore, while batteries combined with clean energy can significantly reduce emissions, they do not eliminate them entirely.

From an operator's perspective, transitioning to electric propulsion requires either:

- Purchasing new battery-electric ferries, or
- Retrofitting existing vessels with battery systems and supporting technologies.

However, electrification is not a universal solution. Batteries are heavy, require space, and are dependent on a reliable charging infrastructure, which introduces logistical and technical constraints—particularly in maritime environments. Electrification is best suited to short routes and lightweight vessels, which generally makes it well-aligned with island ferry traffic.

The feasibility of electric ferries is highly route-specific, depending on factors such as distance, port infrastructure, and financial capacity. Nevertheless, on routes where electrification is technically and economically viable, transitioning to battery-electric vessels offers an effective means to significantly reduce or even eliminate operational emissions.

Just like traditional ferries rely on fuel and bunkering stations, electric ferries depend on an uninterrupted power supply and shore-side charging infrastructure. This includes:

- The charging station at the ferry terminal, and
- A stable connection to the local electricity grid.

Setting up this infrastructure typically requires collaboration with local authorities, grid operators, and sometimes national regulators. It is often a time-consuming and bureaucratic process, but an essential step. Without adequate charging infrastructure along a route, operating a battery-electric ferry is not feasible.

In conclusion, charging infrastructure is a critical enabler of ferry electrification. Its availability—combined with route characteristics, vessel type, and access to renewable energy—will determine the feasibility and success of emission reduction through electrification in the island ferry sector.

Despite its limitations, electrification is emerging as a key trend in the ferry transport industry, with several authorities in the Central Baltic Region increasingly leaning toward this solution. In neighbouring Norway, electric ferries have already become the industry standard, positioning the country as a global frontrunner in this field.

The growing popularity of electrification does not imply that all island ferries in the Central Baltic Region can or should be electrified. Some island routes in the Central Baltic Region are relatively long and connect remote islands, making the establishment of charging infrastructure both difficult and expensive.

1.3 Alternative fuels, energy systems and hull maintenance

Alternative fuels

Various alternative energy sources are emerging for maritime transport. According to the International Maritime Organization (IMO), industry experts estimate that by 2030, up to 15% of the global shipping fleet could be powered by alternative fuels. This means vessels would no longer rely on conventional high-emitting fuels such as heavy fuel oil (HFO), marine diesel oil (MDO), or electricity alone.

This section is a general summary of the available or possible alternative fuels for maritime transport. A more detailed description of these is found, for example, in REISFER Deliverable 1.2.2 (Joki-Korpela et al., 2025).

- **Hydrogen** is a chemical element with the potential to serve as a zero-emission energy source. In maritime applications, hydrogen must be converted into electricity using a fuel cell. While hydrogen is often cited as a promising energy carrier for the future, significant challenges related to its production, storage, transport, and safety remain. Hydrogen fuel can be produced in several ways, with vast differences in environmental impact and cost. **Green hydrogen** is produced via electrolysis using renewable electricity and it is low- or zero-emission but expensive. **Grey hydrogen**, produced from fossil fuels (e.g., natural gas), is significantly cheaper, but results in considerable CO₂ emissions.

- **Ammonia** (NH₃), a compound of nitrogen and hydrogen, can be used as a marine fuel and is easier to store and transport than hydrogen, while also serving as a potential hydrogen carrier. However, its high toxicity poses serious safety risks, and both ammonia and hydrogen present challenges related to flammability and leakage. Despite their zero operational CO₂ emissions and long-term potential, current technical, logistical, and economic constraints make them unsuitable for island ferry operations in the Central Baltic Region in the near term.
- **Biofuels** are a broad category of fuels derived from renewable biological sources, such as biomass, vegetable oils, or bio-waste. Like fossil fuels, they are burned in internal combustion engines to produce power. Among these, Hydrotreated Vegetable Oil (HVO)—also known as renewable diesel—emerges as one of the most suitable biofuels for island ferry operations in the Central Baltic Region.

HVO is a liquid biofuel that closely resembles marine diesel and is compatible with most existing diesel engines, often without any technical modifications. It offers substantial lifecycle emission reductions—up to around 80% depending on feedstock and production methods—while maintaining similar storage and bunkering characteristics to fossil diesel.

Already used on publicly procured ferry routes in Sweden, HVO stands out as a practical, near-term option for significantly reducing emissions in island ferry traffic, even though it is not a long-term net-zero solution. HVO presents a highly implementable option for rapidly reducing the carbon footprint of island ferry transport in the Central Baltic Region.

- **Methanol** is an industrial alcohol with strong potential as a sustainable marine fuel. Although its combustion produces some CO₂, lifecycle emissions can be close to zero depending on production methods. As a liquid fuel, it can be used in modified internal combustion engines. With moderate infrastructure needs and scalability, methanol offers a practical decarbonisation option for island ferries, provided that public-sector leadership supports supply development.
- **Liquefied Natural Gas (LNG)** is a cleaner alternative to conventional marine fuels but remains a fossil fuel with logistical and safety challenges due to its cryogenic storage requirements and methane leakage risks. It can reduce CO₂ emissions by around 25% compared to HFO or MDO, while BioLNG offers further lifecycle reductions but is costly and not carbon-neutral. Although LNG is a mature and commercially available option, it should be viewed only as a transitional fuel due to its limited emission-reduction potential and incompatibility with legacy engines.
- **Electrofuels (e-fuels)** are synthetic fuels produced using renewable electricity and captured CO₂, including options such as e-diesel, e-methanol, and e-ammonia. They are attractive for maritime decarbonisation because they could significantly reduce emissions without major changes to existing vessels or infrastructure. Most synthetic fuel technologies are still in early stages, and their production, distribution, and commercial use are several years away from maturity.

It is important to recognise that not all alternative energy sources have the same environmental impact. LNG and HVO, for instance, only reduce the amount of emissions rather than eliminate them completely. However, sustainably produced biofuels can achieve much greater emission reductions than LNG.

The more experimental alternative fuels—such as hydrogen, ammonia, methanol, and e-fuels—stand out for their potential to completely eliminate CO₂ emissions. Each of these fuels has unique applications, production capacities, and technical challenges, but they all currently face the same obstacle: the lack of an established supply network. Setting up bunkering stations for these fuels is equivalent to building charging infrastructure for electric ferries; without bunkering or charging, the vessels cannot operate.

Many alternative fuels are also difficult to adopt from a technical perspective. Hydrogen, ammonia, and methanol are not drop-in fuels, which means that they require designated vessels either through retrofitting or procurement. Some e-fuels, however, are drop-in fuels – a strong incentive for their development – but they are not yet widely available. HVO, in particular, is both readily available and technically suitable for diesel-powered ferries, but the rise in fuel costs is a limiting factor.

Energy systems

A ferry requires energy not only for propulsion but also for powering a range of onboard systems. Passenger ferries, in particular, consume energy for heating, cooling, lighting, and other amenities—functions typically supported by electricity generated from the vessel's engine. Installing energy-efficient systems can substantially lower the overall energy demand of these operations, resulting in reduced fuel consumption. As such, improving energy efficiency serves as an indirect yet impactful method for cutting emissions and operational costs.

Hull maintenance

The condition of a vessel's hull plays a significant role in its overall energy consumption. A smooth and well-maintained hull reduces hydrodynamic resistance, which in turn lowers the amount of force—and fuel—required to propel the vessel. Regular maintenance, including surface cleaning, blasting, and the application of specialised coatings, is essential for preserving hull efficiency and minimising fuel use. However, environmental concerns are associated with certain toxic hull coatings, as traditional marine paints can release harmful substances into surrounding waters and damage marine ecosystems. The use of such coatings should be avoided in favour of environmentally friendly alternatives, and some are already prohibited by IMO.

2 Physical and natural environments of the region

This report focuses specifically on island ferry operations in the Stockholm Archipelago, the Åland Islands, Turku Archipelago, ferry lines to islands near the capitals Helsinki and Tallinn, as well as ferry lines to islands Vormsi and Kihnu in the west coast of Estonia (Figures 2, 3). In this chapter, the physical and natural environments in the Central Baltic Region are described at a more general level.

A nearly continuous belt of tens of thousands of islands and islets stretches from the Stockholm Archipelago through the Sea of Åland to the Turku Archipelago, forming a region of complex topography and bathymetry (Figure 3). The inner archipelago zones are typically characterised by large islands separated by narrow and shallow straits. These gradually transition into dense clusters of smaller islands and sheltered waters, eventually giving way to the more open and deeper areas of the outer archipelago.

The average depth of the Archipelago Sea is approximately 23 meters, while the Sea of Åland reaches an average depth of 75 meters. Notably, along the fault line between Åland and Sweden, depths of up to 300 meters are reached closer to the shoreline.



Figure 3. Map of the study region and sea areas there. (Map by M-L Ojala; basemap: MapTiler)

In the Gulf of Finland, there are over 15,000 islands, and the transition from the inner to the outer archipelago is more abrupt compared to other areas. Rocky shores, underwater reefs, and canyons are also characteristic features of the region. The average depth of the Gulf is 37 meters, with the western parts being deeper as the seabed gradually becomes shallower toward the east. The deepest point, reaching 123 meters, is located off the north-western coast of Estonia.

Together, the western coast of mainland Estonia and the islands of Saaremaa, Hiiumaa, and Muhu enclose the Väinameri sea area, which is characterised by its shallow waters, where the average depth is less than 10 metres. The deepest part, reaching 22 metres, is located between Muhu and the mainland. In contrast, the outer coasts of Saaremaa and Hiiumaa are deeper and less sheltered.

As Figure 4 illustrates, the Baltic Sea region experiences significant seasonal variation in weather conditions due to its northern latitude and the combined influence of both temperate marine and subarctic continental climate zones. Westerly winds are the most common and tend to be strongest during autumn and winter, while summer is typically characterised by weaker overall wind intensity.

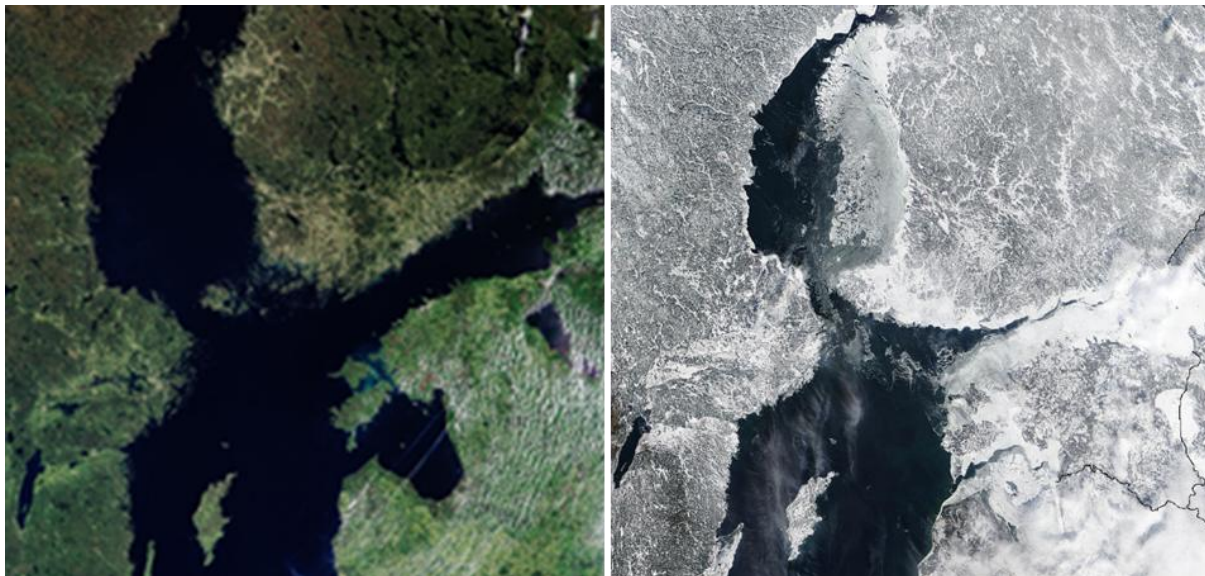


Figure 4. The Baltic Sea seen from Copernicus Sentinel-3 satellite in May 2021 (left; source: [ESA](#)), and in February 2003 seen from Terra Satellite (right; source: [NASA](#)).

In summer, average sea temperatures range from +13 to +20 °C, whereas in winter, they drop to between 0 and +5 °C. Over recent decades, both surface water and air temperatures have increased. At the same time, winter and spring precipitation have risen. In the past, the Gulf of Finland was normally covered by ice during the winter months. Nowadays, the sea typically remains largely ice-free, with only the more sheltered areas of the archipelago retaining ice cover.

The winter 2025–2026, however, was the coldest in more than a decade, which meant that there were rather large ice formations in February 2026, when most of the interviews for this study were conducted.

While open deep-water routes can enhance fuel efficiency under calm conditions due to reduced bottom friction, they are also more exposed to strong winds and waves. Such conditions increase engine load and fuel consumption. During storms, greater water depth can amplify wave energy, requiring vessels to exert additional power to maintain stability and course. In winter, these areas are often affected by fragmented drift ice, which demands continuous monitoring and careful navigation. (See Bratkov et al., 2025.)

More sheltered coastal routes are generally less affected by wind and wave conditions. However, during winter, these areas are more prone to developing uniform level ice, which increases engine power requirements and fuel consumption, and may result in slower transit times. Especially the routes in complex archipelago environments can experience rapidly changing ice conditions over short distances, requiring frequent navigational adjustments and contributing to further delays.

The Baltic Sea is a unique and sensitive marine environment, home to complex ecosystems and several endangered species. Despite the establishment of national parks and UNESCO World Heritage Sites, biodiversity loss remains a significant concern across all coastal regions. Eutrophication—driven by excessive nutrient inputs—is the primary threat to the sea’s ecosystems.

Efforts to reduce greenhouse gas emissions and minimise the risk of fuel spills help alleviate environmental pressures and contribute to the overall protection of the (marine) environment both locally and globally.

3 Estonia

3.1 Operational environment

3.1.1 Selected key data of Estonia

Estonia has a population of nearly 1.4 million, of whom over 30% live in the capital city of Tallinn by the Gulf of Finland (Statistics Estonia, 2025). While inland Tartu is the second largest city, much of the population is concentrated on the coastal areas, including cities Pärnu and Haapsalu and the large islands on the west coast of Estonia.

The inhabited Estonian archipelago comprises the three main islands – Saaremaa, Hiiumaa, and Muhu – and 17 smaller islands (Figure 2). Approximately 41,000 people inhabit these islands; Saaremaa is the most populous, with over 30,000 residents, followed by Hiiumaa (8,300 residents) and Muhu (1,600 residents). The smaller islands have tens or hundreds of residents, or even fewer.

Following the concentration of islands and population, ferry services are also focused on the west coast. The routes between Saaremaa, Hiiumaa and Muhu and mainland had almost 2.5 million passengers in 2025, and over 1.2 million vehicles were transported to and from these islands (TS Laevad OÜ, 2026). Two ferries serving the smaller islands of Kihnu and Vormsi transported around 80,000 passengers each in 2025 (See Figure 5).

In addition to permanent residents, domestic and foreign tourists, seasonal residents and enterprises form the clientele of the ferry services.



Figure 5. M/S Ormsö leaving Sviby port and Vormsi island, 2015. (Photo: [Tiit Tõnurist](#), [CC BY-SA 4.0](#))

Both inbound and domestic tourism have been growing steadily in Estonia. The number of accommodated foreign tourists grew from 1.4 million in 2008 to almost 2.3 million in 2019. The number dropped following the pandemic, but reached well over 1.9 million in 2025. Similarly, the number of domestic visitors registered in accommodations was 0.9 million in 2008, and reached over 1.7 million in 2025. (Statistics Estonia, 2026)

Many Estonians have a second home in the archipelago, and seasonal and multilocational living, including remote work, have become increasingly common in Estonia. Both tourism and the occupancy of summer houses are nevertheless highly seasonal, with a strong emphasis on summer period.

As inbound tourism is a key determinant of economic growth, the Estonian government aims to increase international tourism (Republic of Estonia, 2025). Promoting nature, sustainable travel, and easy multi-modal transportation are part of the strategy, aligning well with decarbonisation and other developments in the island ferry sector. Although Estonia's population is decreasing, the increase in both international and domestic tourism, as well as lifestyle changes toward multilocational living, continue to maintain and increase the demand for ferry services.

3.1.2 Legal, political and economic environment

Similar to other members of the European Union and the International Maritime Organization (IMO), Estonia is subject to a range of EU and international maritime regulations¹. These include participation in the EU Emissions Trading System (EU ETS) and compliance with IMO regulations on sulphur oxide (SO_x) and nitrogen oxide (NO_x) emissions.

In addition to these obligations, the Estonian government has shown strong political commitment to reducing CO₂ emissions in maritime transport. This is reflected in initiatives such as the Ministry of Climate's procurement of green ferries and Tallinn's designation as a TEN-T core port, which requires the Port of Tallinn to provide shore-power infrastructure for vessels by 2030.

Due to the relatively small size and capacity of these vessels, the EU ETS does not apply to Estonian island ferries. At the national level, Estonia currently has minimal regulation specifically targeting CO₂ emissions from island ferries, and emission levels are not yet a determining factor in the public procurement processes.

As a result, the current legal and political environment remains relatively permissive regarding CO₂ emissions from the perspective of island ferry operators. However, this situation is expected to change as environmental regulations are likely to become stricter in the near future.

The intensity of competition in the Estonian island ferry market is relatively low, and smaller operators typically lack the financial capacity to make significant sustainability-related

¹ IMO regulations, as well as most EU regulations, primarily apply to international shipping, whereas domestic waterway traffic, such as island ferry services, is regulated mainly at the national level.

investments. In contrast, the state-owned operator TS Laevad OÜ possesses considerably greater economic and administrative resources, enabling it to invest in environmentally sustainable technologies.

However, the market structure limits direct competition: TS Laevad OÜ operates only the two highest-volume routes—those connecting the islands of Saaremaa and Hiiumaa to the mainland—while smaller ferry routes are operated by private companies under public contracts. In some cases, these contracts include the use of state-owned vessels, further highlighting the strong role of the public sector in shaping the market.

The governance and market structure of Estonia's island ferry sector positions smaller operators under indirect but significant control by public authorities. These operators typically rely heavily on revenue from public service contracts, which limits their financial capacity for large-scale investments. When the public sector is responsible for both funding and providing the vessels, it follows logically that it should also carry the responsibility for major investments—such as retrofitting vessels with clean technologies or developing infrastructure for alternative fuels and shore power.

In contrast, under full-service contracts where operators own and operate their own vessels, smaller-scale sustainability investments may be more economically viable. Examples include eco-driving training or upgrading onboard systems for more energy-efficient heating, cooling, and lighting.

3.1.3 Technological environment in island ferry services

The structure of the Estonian island ferry market has created a technological environment largely controlled by the public sector. The Estonian State Fleet (ESF), a public body operating under the Ministry of Climate, is responsible for owning and procuring ferries and other vessels. Currently, the majority of Estonian island ferries are state-owned through the ESF, which will also oversee the acquisition of new vessels in the future.

AS Saarte Liinid is a state-owned company responsible for operating Estonia's small ferry ports. It operates under the Ministry of Climate, which holds 100% of its shares. Island ferry services, although provided by private companies, are publicly procured by the Estonian Ministry of Regional Affairs and Agriculture, as well as by several municipalities and regional authorities.

The country's largest ferry operator, TS Laevad OÜ, is a subsidiary of the publicly listed AS Tallinna Sadam (Port of Tallinn Ltd.), which is itself majority-owned (67%) by the Estonian state. Through these institutions and ownership structures, the technological and operational environment of Estonia's island ferry transport remains firmly under state control.

At present, Estonia lacks sufficient charging capacity to support widespread use of battery-powered ferries. AS Saarte Liinid, the state-owned operator of small ferry ports, has recently launched an initiative to establish charging infrastructure across the island ferry network. The objective is to install charging stations at the majority of island ferry ports, enabling the operation of battery-electric and hybrid vessels by 2027.

Currently, there is no large-scale use of hydrotreated vegetable oil (HVO) as a marine fuel in Estonia. However, a growing interest in hydrogen as a sustainable energy solution has been witnessed in the Baltic countries where a consortium of companies is actively working to develop the infrastructure and supply chain for green hydrogen.

Although uneven development of the supporting infrastructure continues to hinder the most innovative initiatives, the procurement of new, environmentally friendly vessels for Estonia’s island ferry services is advancing steadily. The ESF is committed to adopting cutting-edge, zero-emission technologies as the enabling infrastructure matures.

3.2 Setting of the interviews

In Estonia, three captains and two mates were interviewed. The interviews were conducted by Kadi Kasepõld in February and March 2026 as face-to-face interviews on board the island ferries. All interviews were recorded and later transcribed using automated speech transcription service tekstiks.ee designed for Estonian speech recognition (Olev & Alumäe 2024).

In the winter 2025–2026, the ice-conditions were tough making the voyages longer or in some cases cancelled until shipping conditions improved. Low water levels in combination with shallow harbours added to the difficult conditions, and weight restrictions were established on some routes.

The vessels and routes whose crew members were interviewed in Estonia are as follows:

- M/S Kihnu Virve: Kihnu – Munalaid – Manilaid, approx. 65 + 15 minutes
- M/S Ormsö: Rohuküla – Sviby, approx. 45 minutes
- M/S Wrangö: Kelnase (Prangli island) – Leppneeme, approx. 1 hour

All of the vessels are diesel-powered Ro-Pax ferries capable of carrying both passengers and vehicles (Table 2).

Table 2. The ferries, whose crew members were interviewed in Estonia, in numbers.

	Length (m)	Width (m)	GT	PAX	Cars	Built	Shipyard location	Age in 2026 (years)
M/S Kihnu Virve	45	12.48	924	200	30	2015	Nasva, EE	11
M/S Ormsö	45	12.48	924	200	30	2015	Nasva, EE	11
M/S Wrangö	24.7	7.06	139	97	2	2013	Loksa, EE	13

Kihnu Virve and *Ormsö* are sister ships and operated by Kihnu Veeteed in the West coast of Estonia (Figure 6). They are double-ended ferries able to transport up to 30 cars and 200 passengers. The ferries have two diesel-powered main engines and an ice class that enables winter navigation in ice up to 80 cm.



Figure 6. Sister ships M/S Ormsö (left) and M/S Kihnu Virve (right). (Photos: Kihnu Veeteed)

Kihnu Virve connects the islands Kihnu and Manilaid to mainland, while *Ormsö* travels between mainland and Vormsi island. These routes differ a lot. *Ormsö* operates in a rather closed environment, protected from the wind by mainland and islands, and *Kihnu Virve* navigates in a more open sea area heavily affected by wind and wave conditions, making the route more difficult to operate.

Depending on the season and weekday, both ferries make two to five daily return trips to Vormsi and Kihnu island.

Wrangö is single-directional ferry operated by Spinnaker OÜ under the Sunlines brand (Figure 7). It travels a one-hour line between Prangli island and the Leppneeme harbour, located approximately 15 kilometres northeast of Tallinn. The ferry operates year-round with up to three departures from each port.



Figure 7. *Wrangö* at Kelnase port in Prangli island in May 2025 (Photo: Minna-Liina Ojala)

Wrangö is capable of winter navigation in up to 20 cm of ice. It transports mainly passengers, but can transport two vehicles on board. As *Wrangö* is a rather light-weighted ferry, its navigation is strongly affected by maritime weather conditions as well as other circumstances on the route and at the ports.

3.3 Interview outcomes

3.3.1 Background and experience

The interviewees' seafaring experience ranged from slightly under three years to over thirty years. The two mates and two of the captains were under 36 years old and one captain over 50 years old. While the mates had worked in this role only on board the current ferry, the captains had more diverse professional backgrounds, including experience on various types of vessels ranging from conventional tugboats to fishing vessels and cargo ships. In addition to service on several ferries operating in Estonia, some captains had gained experience also from international routes.

The interviewees had received their formal education in Estonia. Most mentioned having studied at the Estonian Maritime Academy or its predecessor institution. In addition to their

formal navigation officer education, the interviewees have completed the standard safety and other necessary refresher trainings. Most had also received a separately organised training to use and interpret a fuel management system.

Currently, all interviewees work regularly on one specific vessel and route, and from here, their experience ranged from around six months to six years at the time of the interview. All of the vessels they have operated during their careers have been fuel-powered.

3.3.2 Work environment and safety

All deck officers considered their work environment to be rather stagnant, without frequent operational or technological alterations, and adaptation to change has not caused stress or dangerous situations. As an illustrative example, one captain recalled that the most recent significant change was the automation and renovation of port infrastructure around 2010.

However, a more recent change on board all vessels has been the installation of the fuel monitoring system with related displays, implemented less than eight months prior to the interviews. A couple of interviewees considered the instructions to use and interpret the system brief, but most had experienced a sufficient or even thorough session. Some of them described it interactional as well; the crew had suggested improvements on the spot and these were also acted upon.

Some deck officers expressed interest in more opportunities to educate oneself, and two interviewees expressed dissatisfaction about the current salary levels. Regarding the interaction and communication between the seagoing staff and management, some ideas for improvement were raised. While others had only minor suggestions, some considered a need for more major changes.

At Kihnu Veeteed, the captains collect the ideas and concerns of the crew and deliver them forward to the management. The communication happens mainly via e-mail. The captains considered it easy for them to give feedback and propose new suggestions. One interviewee also described how the crew has a certain level of autonomy to make decisions and changes on board the ferries.

One deck officer nevertheless reckoned that some relevant information remains missing from both sides. In addition, another hoped for clear reactions to the feedback they give. As a solution, a more consistent interaction and more face-to-face meetings, such as management visits to the ferries or presence at the captains' meetings, were hoped for.

Based on the interviews, there seems to be a good rapport among the crew members. One captain specifically mentioned how they value having everyone included in the discussions. Similarly, the mates considered that they can freely raise issues with the captains. Some interviewees hoped for more experience-exchange also between the crews from different vessels.

Across the interviews, the deck officers expressed high level of professional skills as well as confidence in their work. No significant safety or security issues were reported. However, one notion concerned certain pier configurations that could be improved as mooring requires constant and careful supervision from the captain there.

3.3.3 Environmental awareness and attitudes

Many interviewees were generally aware of the broader regulatory frameworks and policy developments in the maritime sector, while also noting limited detailed knowledge of these issues as they do not directly apply to small island ferry operations. Some nevertheless expressed interest in gaining a better understanding of the developments.

The interviewees reported supportive attitudes towards emission reduction, but the discussions on environmental issues remained rather brief. In general, the different emission reduction measures – such as eco-driving and voyage optimisation – were primarily associated with reduced fuel consumption and costs or improved operational efficiency, while environmental benefits were typically mentioned as accompanying outcomes.

While some merely agreed that environmental protection is important, one interviewee described themselves as a proper eco-driver and frequently referred to environmental aspects, while another expressed clear concern about environmental degradation. The latter explicitly mentioned regional environmental challenges, such as eutrophication, and noted that although progress has been made in emission reduction, further action is still needed.

To different degrees, the state and changes in the local natural environment – such as seal and fish populations, overgrowth, waste dumping, and altered seasonal patterns – were discussed in all interviews, which reflects the exposure to and awareness of the surrounding environment in the course of daily work at sea.

Responsibility for environmental protection was primarily attributed to authorities, fleet owners, and policymakers. Some interviewees also emphasised the importance of explaining the rationale and economic implications of environmental measures. According to these interviewees, clearer communication from authorities and company management could improve understanding and acceptance of such measures both among crew members and within the wider public.

In addition, a call for re-evaluation and rationalisation of some actions was expressed by one deck officer. In a similar vein, it was also noted how some passengers continue to smoke and throw cigarette butts in to the sea; since smoking is prohibited, no ash bins are made available.

When discussing motives behind emission reduction efforts at the organisational level, the interviewees presumed that it is foremost economic – not environmental – considerations that guide the company and government level decision-making. In addition, the ownership of vessels by the State Fleet and the relatively short operating contracts were mentioned as factors limiting long-term investments in low-emission technologies or procedures by the companies.

3.3.4 Eco-driving and voyage optimisation

Eco-driving was described as much integrated into daily ferry operations in Estonia, and practice-based learning was considered important. All the ferries discussed have been equipped with a fuel management system with the related display on the bridge for the deck officers. The digital monitors were in active use and considered greatly supporting the deck officers in optimising their work.

The system allows the monitoring of fuel consumption indicators and adjusting the driving behaviour through gradual power application, engine load optimisation, and avoidance of inefficient manoeuvres, such as excessive acceleration or abrupt braking, for instance. The interviewees also mentioned being able to compare their performance with previous trips, which was considered useful. Interest in having also a predictive fuel consumption feature was expressed.

Using and interpreting the system was described effortless and the configuration logical not requiring any advanced digital skills. There were some variations regarding the training to use it: some described the instructions very brief and others sufficient and interactive.

Altogether, the instalment has eased the deck officers' work load as previously many were calculating and estimating the fuel consumption and related data by their own means. Now, the same information is readily available for them.

While two interviewees estimated limited eco-driving knowledge prior to system installation, three described having already established efficient eco-driving practices prior the fuel monitoring system was introduced. Some of the latter noted that the system verified they had already been operating very close to the optimal ways. However, interest in attending a separate, profound eco-driving training was expressed by many.

At Kihnu Veeteed, the individual eco-driving performance is rewarded with a financial bonus, which was considered a good incentive. Based on the discussions it seems that all interviewees are also motivated by their intrinsic interest in optimising their performance. In addition, one described how the monitors add some playful competitiveness.

It was noted that if the data was monitored or compared with negative consequences, it would adversely affect employee well-being. However, no such practices are currently in place and the incentives for eco-driving were perceived as rewarding.

Across the interviews, and especially regarding the more weather-sensitive routes, contextual factors, such as marine weather, ice conditions and vessel design, were highlighted as defining the practical boundaries within which eco-driving can be applied. Therefore, there was also some critique towards the predefined fuel consumption target levels – to which the financial incentive is also based on.

Possibilities for voyage optimisation were recognised in almost all interviews. For instance, a 45-minute trip could be made in 60 minutes with a significant reduction in fuel consumption. In addition, it was noted how there are sometimes only a couple of passengers on board even

in the larger vessels. Suggestions to monitor the demand and reduce trips in low seasons were proposed.

The interviewees nevertheless noted that local residents would likely oppose such changes, as they want ferry services to operate at fixed intervals – even if the actual demand is low or non-existent. Similarly, since the local municipality requires to compensate the trips that are cancelled due to weather conditions or technical malfunctions, for instance, also voyages with little to no passengers are sometimes made only to comply with the schedule set in the service contract.

Some interviewees also described how various minor changes, such as switching to shore power faster and installing solar panels, could be done on board the ferries, but currently there is no additional motivation or incentive to complete them.

3.3.5 Future perspectives

Interviewees described that a shift in their job profiles has already taken place: both ship officers and mechanics are spending more time monitoring systems and less time performing manual tasks. It was widely anticipated that their role and requirements will continue to evolve toward greater digital and data interpretation competence.

Similarly, future training needs were closely linked to digital skills and general awareness of the developments in the maritime sector. In addition, a separate eco-driving training was welcomed by some. The form of the preferred training varied from onboard instruction to classroom-based, simulator learning and a hybrid model. Two interviewees also mentioned that greater environmental awareness could be particularly important for the crew to understand the underlying reasons behind some of the introduced procedures and requirements. It was also added that skilful and knowledgeable employees benefit the company, which would justify more investment in their expertise.

The interviewees did not have experience with electric or hybrid vessels, but the electrification of ferry operations was discussed with all deck officers. Interest in operating electric or hybrid vessels was consistently positive and even enthusiastic, although practical constraints to electrifying the archipelago ferries were emphasised. The limited grid capacity and charging infrastructure, as well as ice conditions, were identified as key challenges for fully electrifying the fleet. Several interviewees viewed hybrid solutions as the more realistic option in future. One interviewee nevertheless suggested that the electrification of island ferries is advancing faster than the development of emission regulations, potentially reducing the need for regulatory measures as emissions are already being eliminated.

Although automation is already widely used on board, the interviewees emphasised the need for human oversight in navigation and the ability to intervene if systems fail. Thus, fully autonomous operation was not seen as realistic. However, future changes in crew size received slightly mixed assessments. Some interviewees anticipated that increased automation could eventually reduce crew numbers through combined roles and more efficient processes, but others considered current crew levels already representing the minimum.

In some interviews, it was anticipated that since the companies do not own the vessels, they are unlikely to make large-scale investments in improving environmental performance; therefore, longer contract periods would allow companies to invest more in low-emission technology and other modifications.

4 Mainland Finland

4.1 Operational environment

4.1.1 Selected key data of mainland Finland

The Finnish population is highly concentrated in coastal areas. Helsinki metropolitan region by the Gulf of Finland, for instance, is home to over 1.2 million people. However, when the urban centres are excluded, the actual archipelago areas have approximately 130,000 residents, accounting for 2,4% percent of the whole Finnish population (Rannanpää et al., 2025).

Finland has more than 200,000 islands, and 1,050 of them are permanently inhabited (Rannanpää et al., 2023). The most populous islands are connected to the mainland with a bridge – or even a subway system in Helsinki. The smaller islands are accessed with ferry services and private vessels. About 470 of the inhabited islands are without fixed road connections, and these islands are home to approximately 8,800 people.

The maintenance and accessibility of archipelago areas relies on well-functioning transport connections, and road and island ferries are essential modes of transport in the Finnish archipelago. Route availability and passenger volumes reflect the distribution of permanent and seasonal populations as well as tourism activity, with the Archipelago Sea standing out as the busiest area (See Figure 8).

The Archipelago Sea has over 24,000 islands, covering 24% of total island land area in Finland, and hosts approximately 30,000 residents and over 32,000 seasonal houses. The largest municipalities are Parainen and Kemiönsaari, with a combined permanent population of approximately 22,000 people. With its unique nature and designation as a UNESCO Biosphere Reserve, the Archipelago Sea is also a popular tourist destination. The Archipelago Trails, for example, attract an estimated 50,000 visitors annually.

Similarly, the busiest road ferry routes in Finland are located in the Archipelago Sea: the Parainen–Nauvo ferries transported 566,000 vehicles in 2023, while the Nauvo–Korppoo route served approximately 280,000 vehicles (Rannanpää et al., 2025).

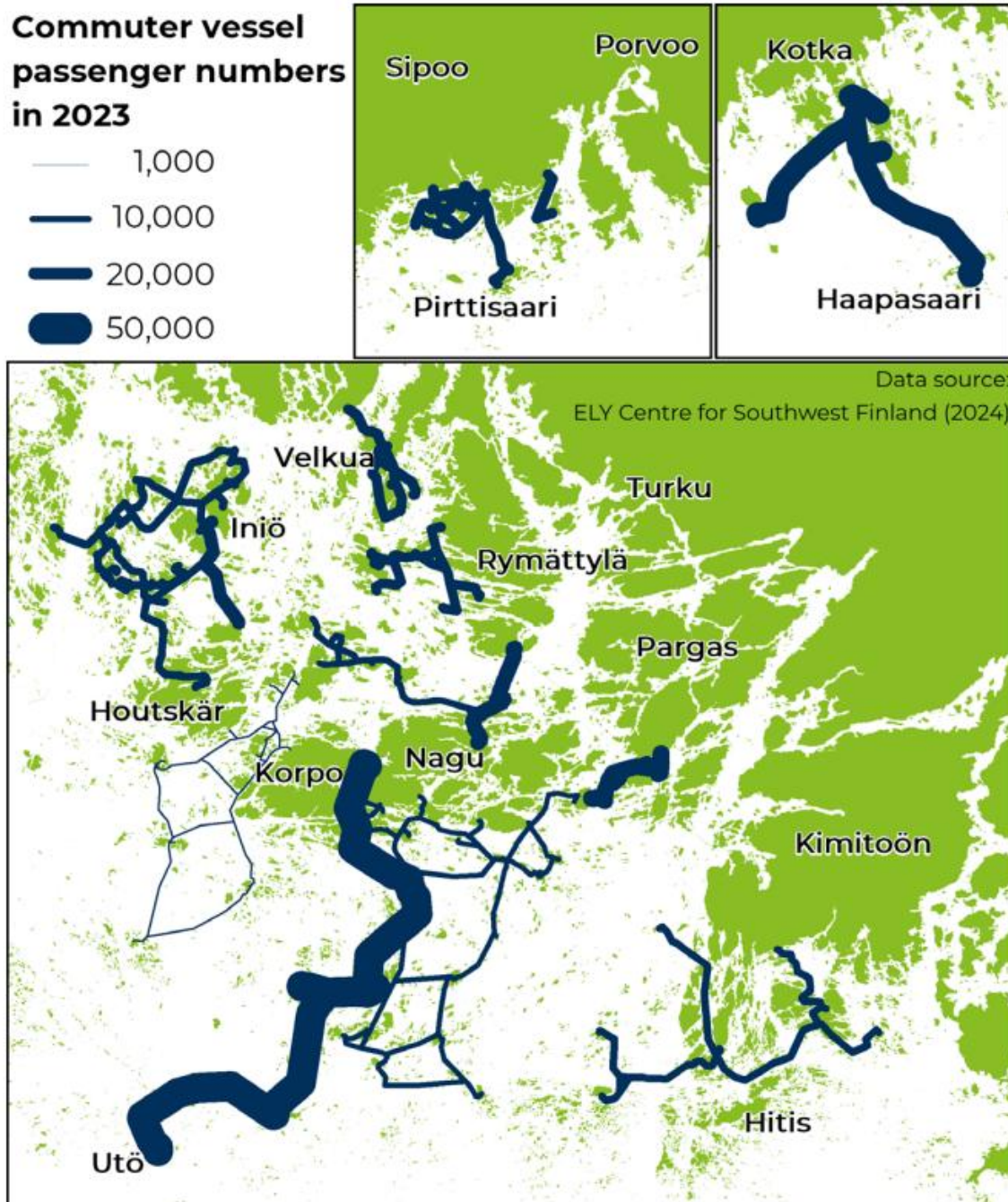


Figure 8. Commuter ferry routes and passenger numbers in Southern Finland. (Rannanpää et al., 2025)

The Gulf of Finland contains approximately 15,000 islands (See Figure 2). While the permanent coastal population is concentrated in the Helsinki metropolitan area and smaller cities, the more rural islands are primarily characterised by tourism and seasonal habitation. The most popular island ferry route connects mainland Helsinki with the fortress island of

Suomenlinna. This island is home to about 800 permanent residents, but as a UNESCO World Heritage Site, it attracts tens of thousands of visitors each month; Suomenlinna ferries carry over 2 million passengers a year.

While permanent residence in the Finnish archipelago is declining and aging, the number of second homes continues to grow. Approximately 20,300 islands are used for leisure housing, with over 150,000 second homes located in archipelago areas (Rannanpää et al., 2023). Second-home occupancy is highly seasonal. This seasonality of island residence is further amplified by tourism, which is largely focused in the summer months.

The archipelago's rich cultural and natural heritage is widely recognised as a sales appeal for tourism, but the development has been fragmented and much of the potential unutilised. Therefore, *Archipelago and Coastal Area* is designated and developed as one of the main tourism areas in Finland. In 2019, tourists spent over 7.4 million nights in this region, with foreign visitors accounting for 15% of the total. The travel restrictions imposed during the Covid-19 pandemic led to a significant decline in these figures; however, the tourism industry has been recovering to pre-pandemic levels. (Visit Finland, 2019; 2025a; 2025b)

4.1.2 Legal, political and economic environment

In Mainland Finland, the key legal instrument governing island ferry traffic is the Finnish Archipelago Act (Finlex 1981/494)². The Act specifically concerns island ferry services and stipulates that all Finnish citizens permanently residing on coastal islands in Mainland Finland must be provided with a free public transport connection to a mainland port.

This means that the routing and scheduling of island ferry services in the archipelago of Mainland Finland must comply with the Archipelago Act and the transportation rights it guarantees to permanent residents of Finnish islands.

In practice, both island ferry services and road ferry services in Mainland Finland are free of charge for most users and funded by the Government. The authority currently responsible for the tendering and oversight of these services is the Economic Development Centre for South-Western Finland, located in Turku. Since 1 January 2026, these new Centres have replaced the former Centre for Economic Development, Transport and the Environment for Southwest Finland.

The Ministry of Agriculture and Forestry of Finland is currently (spring 2026) preparing an update to the Archipelago Act. However, based on the draft legislation currently under consideration in the Finnish Parliament, the reform is unlikely to have major implications for the organisation of island ferry services in Mainland Finland.

So far public procurement of Finnish island ferry services has been mainly price based. However, Finnish authorities are now planning to bring environmental criteria into future

² Due to regional autonomy, island ferry traffic in the Åland Islands is regulated by the regional authorities.

tenders, which highlights the political pressure ferry operators face to reduce CO₂ emission levels. The legal and political environment regarding island ferry traffic emissions in Finland is slowly, but inevitably, shifting towards increased environmental regulation.

Finland has set an ambitious goal of reaching carbon neutrality by 2035, which requires emission reduction across all industries including the transport sector. As significant emission reduction is required, even the small-scale transport like island ferries will be affected by the 2035 goal. Finnish island ferry operators should expect increasing environmental regulation and emphasis on emission reduction methods in public procurement within the next 10 years.

The level of competition in the island ferry market in mainland Finland is very low, with the state-owned company Finferries serving as the clear market leader. Its market share by revenue in the island ferry services is over 90%, and its share in road ferry services was about 75% in late 2025. This is not necessarily the intended outcome even for Finferries itself, as it has been the result of a number of separate events largely outside the company's influence.

Economically, both island ferry and road ferry services face a challenging operating environment, evidenced by several service providers having gone bankrupt or voluntarily terminated their public contracts due to financial constraints.

As a result, most ferry routes are now operated by the state-owned company. While this development has reduced competition and led to a decline in the number of small, locally based operators—which is not necessarily an ideal outcome—it also means that ferry service providers now have greater financial capacity to invest in technological upgrades and sustainability measures.

Since island ferry services in mainland Finland are primarily publicly procured and mostly free of charge for passengers, the economic viability of the sector is closely tied to public funding and the political decisions that guide it. Notably, the level of national public funding allocated to island ferry services decreased slightly between 2024 and 2025, which may impact future development and investment capacity within the industry.

In Helsinki, the public transport authority HSL is planning to raise ticket prices in 2026 in response to increasing operational costs and the need to fund new infrastructure projects. This has intensified the political debate on the issue, in which ticket prices of the few ferry lines in the HSL system are purely marginal.

At the national level, the incumbent Finnish government is pursuing a policy of reduced public spending, which may have broader implications for the island ferry sector.

Should public funding for island ferry traffic be reduced, it could delay or scale back major publicly funded infrastructure projects, such as the deployment of charging infrastructure for electrified ferries along the Finnish coastline. As a result, the transition to cleaner ferry technologies may face slower implementation timelines, despite growing environmental and political interest in lowering emissions from the maritime transport sector.

4.1.3 Technological environment in island ferry services

The technological environment for island ferry operations in mainland Finland is currently undergoing a transition. Historically, the sector has depended on aging vessels powered by conventional fossil fuels. However, reducing emissions is becoming an increasing priority, and electrification is increasingly seen as a viable solution—at least for specific routes. The state-owned ferry operator Finferries has already electrified several ferries and publicly committed to further reducing greenhouse gas emissions. Given Finferries' dominant market position and demonstrated success in implementing electrification, other operators may feel compelled to follow suit to remain competitive. Finferries also emphasises eco-driving training as part of its environmental initiatives.

The potential for electrifying Finnish island ferry routes depends largely on route characteristics. In general, road ferries operating short crossings are more suitable for electrification. In contrast, longer island ferry routes involving several hours of travel across open sea to remote islands present significant challenges. For these routes, full electrification is likely to remain unfeasible due to the impracticality and high cost of building charging infrastructure in remote locations. As a result, while electrification offers clear environmental benefits, it is not a universal solution for Finland's diverse ferry network.

In addition to Finferries, Suomenlinnan Liikenne Oy, operated by the City of Helsinki, has recently increased its use of HVO (hydrotreated vegetable oil). One of Finferries' vessels, Kökar, operates for Suomenlinnan Liikenne Oy in Helsinki and runs on HVO. Some larger Ro-Pax ferries operating between Helsinki and Tallinn have also begun adopting HVO, signalling a growing trend towards biofuel bunkering in the capital region.

Operators and authorities in mainland Finland are relatively well positioned to transition towards HVO, particularly because major Finnish companies such as Neste and UPM are among the leading global producers of renewable fuels. In the northern Baltic Sea, a bio-LNG/LNG-powered ferry also connects Vaasa, Finland, and Umeå, Sweden, further demonstrating the region's openness to alternative fuels.

Finland benefits from favourable conditions for transitioning to non-fossil energy sources. The country already has access to several sustainable alternatives, including HVO, LNG, and green electricity. Among ferry operators, Finferries has taken a leading role in pioneering both electrification and HVO adoption in island ferry traffic. However, Finland still lacks the large-scale charging and fuel infrastructure required for a broader systemic transition.

This infrastructural challenge is partly geographical. Unlike countries with a centralised ferry hub, such as Sweden's Stockholm region, Finland's ferry routes are widely dispersed across the country. The absence of a centralised ferry network limits economies of scale and complicates coordinated infrastructure investments. Consequently, the responsibility for shaping the technological trajectory of the sector does not rest solely with ferry operators. Public authorities will play a central role in steering the future of sustainable ferry transport in Finland through strategic investment, procurement policies, and infrastructure development.

4.2 Setting of the interviews

In mainland Finland, six captains and five chief engineers were interviewed during February and March 2026. The interviews were conducted by Minna-Liina Ojala on board three ferries operated by Finferries in the Turku Archipelago and one, operated by Suomenlinnan Liikenne, in Helsinki. All interviews were recorded. A secure and closed transcription service transcribe.utu.fi was used for the initial transcription of the recordings.

On the ferries operating in the Turku Archipelago, also other staff members – such as deck hands, visiting engineers or trainees – were occasionally present during the interview and joined the discussion. Some of their comments are incorporated into the results as well.

Besides one misty morning, all interview days were calm and bright winter days, with daytime air temperatures between –11 and +5 °C, and the vessels’ icebreaking capability was necessary to open the freezing fairways.

The vessels and routes included in the study are as follows. The first three are operated by Finferries and the fourth by Suomenlinnan Liikenne:

- M/S Altera: Parainen – Nauvo (Turku archipelago), approx. 10 minutes
- M/S Elektra: Parainen – Nauvo (Turku archipelago), approx. 10 minutes
- M/S Stella: Korppoo – Houtskari (Turku archipelago), approx. 30 minutes
- M/S Suomenlinna II: Helsinki Market Square – Suomenlinna island, approx. 15 minutes

On the interview day, *Elektra* was not in traffic and its crew operated another vessel. Otherwise, the ferries operated their lines without major disturbances, with the exception of turning back once to pick up an emergency vehicle.

While *Altera*, *Elektra* and *Stella* are road ferries and part of the public road network, *Suomenlinna II* is a more light-weighted vessel mainly transporting pedestrians. While the number of passengers varies a lot throughout the year and time of day, in peak seasons, the ferries’ carrying capacity is oftentimes used to the maximum in Turku archipelago (Table 3).

Table 3. The ferries of Finferries and Suomenlinnan Liikenne, whose crews were visited in February and March 2026, in numbers. Some data on e.g. vessels sizes may vary depending on the source.

	Length (m)	Width (m)	GT	PAX	Cars	Built	Shipyard location	Age in 2026 (years)
M/S Altera	104	15.2	1.339	375	92	2022	Gdynia, PL	4
M/S Elektra	97.92	15.2	1.275	375	90	2017	Gdynia, PL	9
M/S Stella	65.0	12,8	0.812	250	65	2012	Rauma, FI	14
M/S Suomenlinna II	33.8	8.5	0.329	395	2	2004	Gdynia, PL	22

All of the ferries are able to carry both passengers and vehicles (so-called Ro-Pax vessels; see Figures 9, 10). They are bidirectional vessels designed with identical bow and stern, allowing them to onboard passengers and vehicles at both ends of the line without turning around.

Finferries' *Elektra* and *Altera* are the first shore-powered battery-hybrid vessels in Finland, with *Altera* being the newer and improved version. These vessels share the same 1.6 km route in the Turku Archipelago. Their battery packs are charged from the local grid on both sides of the crossing. As a back-up source of energy, the vessels have also diesel-electricity generators on board. The draught of these vessels is 3.5 metres.



Figure 9. Left: Finferries' M/S Altera; Right: Finferries' M/S Stella with M/S Aura at Galtby harbour. (Photos: M-L Ojala)

Stella was built as a diesel-electric ferry in 2012 but it was converted into a hybrid vessel at the beginning of 2026. Four of its eight diesel generators are now replaced with battery packs that store energy, balance load, and enable the generators to operate at optimal efficiency. *Stella* operates Finferries' longest route (9.5 km) in the Turku Archipelago. *Stella*'s draught is 4.6 m.



Figure 10. Left: M/S Suomenlinna II by Helsinki Market Square; Right: The ferry approaching Suomenlinna island. (Photos: M-L Ojala)

Suomenlinna II, built 2004, is a diesel-electric ferry operating between Helsinki Market Square and the Suomenlinna fortress island, a UNESCO World Heritage site (Figure 10). It transports mainly pedestrians but has the capacity to carry two vehicles. The vessel is equipped with icebreaking electric Azipod propulsion units with substantial propulsion power (2×500 kW), ensuring reliable operation in icy winter conditions. The vessel's draught is 3.2 metres.

4.3 Interview outcomes

4.3.1 Background and experience

Most of the 11 interviewees were between 36 and 50 years old and had several years of experience in the maritime transport sector. Their work experience in their current company ranged from approximately two to more than 20 years. In addition to island ferries, many had previously worked on larger vessels operating international routes, including cruise and container ships, while others had focused primarily on ferry traffic in the Finnish archipelago. All had received their maritime education in Finland, although one interviewee had completed most of their studies abroad.

For most interviewees in both companies, the current route and vessel were the only ones they mainly operated at the time of the interview. In Helsinki, however, many had also worked on the *M/S Ehrensward* service vessel to Suomenlinna or on subcontracted ferries operating on the same route as *Suomenlinna II*. At Finferries, many employees occasionally work on other ferries as well, and those assigned to a regular route and vessel often also have previous experience from other island ferry routes in the Turku archipelago.

One of the interviewed captains and one chief engineer were substitute workers but both worked regularly on the routes in question. In addition, one interviewee had experience from both *Suomenlinna II* and different Finferries ferries, including *Altera* and *Elektra*.

4.3.2 Work environment and safety

Apart from the crew of *Stella*, the interviewees did not perceive many recent changes in their work. In both companies, one relatively minor change—though not recent in the case of Finferries—was the installation of an energy monitoring system, which will be discussed further in relation to eco-driving. In addition, the generator set of *Suomenlinna II* had been renewed and a marine urea solution system introduced, although the overall operating system remained largely unchanged.

The interviewed crew of *Stella* is experienced and had been involved in the project while the vessel was converted into a hybrid one at the dockyard. They had also worked on electric ferries before and were familiar with the battery systems. Thus, they had an easy transition and felt competent in manoeuvring the vessel, even though it had returned to service only recently. Since *Stella* still uses diesel generators, the work environment did not change much in terms of soundscape and procedures – except that the chief engineers must now understand and manage the battery systems as well.

There have not been any significant changes for *Altera* and *Elektra* since their launch. Compared to traditional and diesel-electric ferries, the work environment on an electric ferry was considered much more pleasant with less noise and vibration. The captains of *Elektra*, *Altera* and the newly renovated *Stella* noted that their work is essentially the same as on diesel-electric or traditional vessels and the more profound changes concern the engine room.

The chief engineers considered themselves competent with modern technology. Although new skills and procedures were needed, they recalled adjusting easily to the digital systems on board. While the onboarding training was sufficient, some hoped for more in-depth briefings and training possibilities also later on. It was also mentioned that not all colleagues are comfortable and willing to work on vessels equipped with the newest technology, and acquiring skilful substitutes for the electric ferries was considered challenging at times.

Suomenlinna II operates on a busy and rather narrow strait, which requires skill and caution. Regarding safety, some work ergonomic improvements – also discussed in relation to eco-driving later on – were proposed. Some captains proposed that the work shift arrangement and daily schedule could be slightly rearranged to allow proper recovery between shifts and more adequately timed breaks during the workday. Also, a wish to involve the employees more in decision-making and planning-process was expressed.

In general, the orientation training in both firms was considered sufficient and at times even extensive. However, past examples were also mentioned where crew members were simply handed a new system or vessel at the start of a shift. Similar instances on a smaller-scale still happen in both companies mainly due to information disconnection. While these surprises can cause frustration, they were generally regarded as part of the normal course of events.

The technical support system for chief engineers was nevertheless considered well-functioning in both firms.

The interviewees were confident in their skills and did not consider themselves in need of additional training to manage their basic tasks. At Finferries, two nevertheless hoped for more profound briefing after installation of new equipment. Most were very receptive for further training and new knowledge to improve themselves. Especially more first aid and other emergency training was commonly welcomed for all crew members. As the captain is steering the vessel, the skills of the deckhand in particular, and those of the chief engineer, were mentioned crucial in emergencies.

Although the companies are taking care that the mandatory safety requirements are filled, the criticism concerned the level of these requirements in domestic traffic. One explained that the transport authority has let the situation slip to a point in which the vessels meet extensive standards, but the crew necessarily does not. As a result, they have all kinds of equipment on board but the crew may lack sufficient skills to operate them effectively. These concerns over low proficiency requirements were common especially in the Turku archipelago, where the distance to mainland services is long.

4.3.3 Environmental awareness and attitudes

The interviewees were aware of the general developments in the maritime transport sector regarding emission reduction, although the exact terms and regulations, mainly concerning the larger-scale ships, were not familiar to all. Most follow these issues through mainstream news and other media, but some also actively seek information and read professional journals or newsletters on the topic – or have even focused on it in their further studies.

While most of the interviewees were at least somewhat concerned about climate change – mainly as parents thinking about the future of their children – almost half expressed strong environmental awareness and dissatisfaction with current developments. While the former group highlighted the responsibility of the largest countries and felt content with the measures taken in Finland, most in the latter group clearly stated that not enough is being done to address the crisis in Finland either. Instead, some described climate change as the greatest threat to humankind and current actions as inadequate. They too highlighted the role governments and other larger-scale actors have in setting the framework for others, but also smaller-scale mitigation acts were of importance to them.

Despite the varying level of environmental concern, emission reduction, also in the island ferry traffic, was supported by all, and especially the chief engineers were interested in emission reduction solutions and technologies. Some working on board *Suomenlinna II* would have hoped that the vessel had already been converted into an electric or hybrid vessel. Two pointed out the contradiction between *Suomenlinna II* and the carbon-neutral and zero-emission strategies of the City of Helsinki and HSL Helsinki Region Transport for 2030 and 2035. One of the interviewees agreed that operating a fossil-fuelled vessel conflicts with their values.

In some interviews, littering, eutrophication, emission trading and sulphur emissions were also discussed, and the mariners were aware of the poor state of the Baltic Sea. This awareness was emphasised by providing examples of historical measurements, environmental legislation and their own observations. On all routes, the views and occasional entertainment – such as spotting eagles or seals – provided by nature were appreciated.

4.3.4 Eco-driving and voyage optimisation

To guide the captains in monitoring and improving their energy consumption performance, both firms have installed energy monitoring systems.

Many Finferries ferries have a driver display with a software that integrates background and real-time data. This tablet shows a real-time energy-consumption curve against the median, along with wind direction, crossing time, and a forecast of expected consumption. It also allows the captain to view statistics on both their personal and vessel-level energy consumptions.

Although the driver display was not in active use by the interviewed captains – the one in *Altera* was out of order, a similar display had not yet been installed for the renovated *Stella*, and the reserve ferry for *Elektra* lacks the system – the captains had previously used the tablet and it had helped them and their colleagues to experiment and establish more sustainable navigating habits. According to one, everyone's consumption dropped after some time the display had been introduced.

At Suomenlinnan Liikenne, the instalment of a similar energy monitoring display – with Marfle Fleet Management system – is more recent and the captains are not actively engaging with it yet. At the time of the interviews, their driver profiles and baselines were being formulated and the main focus was on collecting data on energy consumption during ice navigation. The captains showed interest of having more interaction with the display and data.

All captains consider themselves to have intermediate or advanced understanding of eco-driving principles. At Finferries, the firm offers captains two 3-day eco-driving courses. How intensively they are implementing eco-driving in practice varies. At least the interviewed captains denied wasting power or fuel unnecessarily. Instead, it is mainly the circumstances and timetables that define how much they can engage in eco-driving.

The tight schedules – such as the 10–15-minutes crossings with 5 minutes turnaround in Suomenlinna and the Parainen–Nauvo line – do not allow much finetuning. If a departure is delayed, the captains must try to make up the lost time while en route. The longer the delay has been, the longer they need to disregard eco-driving principles in order to catch up with the schedule. Delays and time pressure are more common in summer – the busiest season on all routes – as passenger onboarding often takes more time. It was also noted that captains sometimes increase speed to secure a short break at the quay, and, at times, fatigue prevents focusing on eco-driving.

The short lines with compact schedules do not leave much possibilities for finetuned eco-driving, but some captains are still actively finessing their navigation. On the Suomenlinna

lane, one had calculated that they can arrange extra 30 seconds en route to save fuel in certain circumstances. At Finferries, one mentioned how he had noted that some captains can combine speed with eco-driving even on the shortest routes.

Although keeping to the schedule is the overarching objective, ensuring safety and maintaining secure command of the ferry remain the first priorities. After these determinants, prevailing conditions – such as ice or delays in onboarding – dictate how much the captains can engage in eco-driving. On an individual level, skills, professional and environmental motivation, and alertness vary between captains and from one workday to another.

It was commonly agreed that direct monetary rewards, or competition and surveillance among captains, would not be good incentives for eco-driving, as they would likely create an unhealthy work environment and encourage risk-taking. It was nevertheless noted that since the energy savings translate into financial savings, these should benefit operational-level staff as well. Many also felt it would be useful for others to see how the most efficient captains operate the ferry. At the same time, it was acknowledged that the same techniques do not necessarily apply to other vessels or routes.

Instead of the crew pinching the crossing time by seconds or a minute or two, a more straightforward and effective option would be voyage optimisation by relaxing the schedule – or even leaving out a departure or two. Adding to the crossing time would not only save energy but also allow the captains to better compensate occasional delays without rush and related cognitive stress. Similarly, it would allow them to have an additional short break if needed.

Voyage optimisation was considered valid also for the longer Finferries' routes where – as some interviewees have roughly estimated – a five-minute slowdown, meaning a drop of about one knot, could yield to around 30 percent fuel saving. It was also noted that the overcapacity is enormous in some lines and there appears to be room for fewer departures in many of the timetables. Although the service level would naturally drop, leaving out a departure or two would not conflict much with the demand that is sometimes very low (e.g., one car) or even non-existent.

Recently, all night-time departures on the Parainen–Nauvo route were converted to an on-demand service that must be booked 20 minutes before the scheduled departure time. Although this was generally regarded as an improvement, some interviewees suggested that there is realistic potential to reduce departure frequencies even further or expand the on-demand model to other routes as well.

The ferry routes are already relatively straight. However, on the route to Suomenlinna, some interviewees noted that removing a couple of rocks could straighten the route even further. While this would generate only minor fuel savings, the more significant benefit would be improved maritime safety, as the crossing area used by cruise ships and other vessels would become wider. The interviewees were unsure whether environmental protection regulations or simply a lack of awareness had prevented the removal of these rocks.

4.3.5 Transition to electric ferries

Whereas *Suomenlinna II* is a diesel-electric ferry, *Elektra* and *Altera* – with diesel engines as a back-up – are designed to operate fully electric, and, in early 2026, the diesel-electric *Stella* was converted into a hybrid by replacing half of its diesel generators with battery packs.

Those who have worked on *Elektra* and *Altera* appreciate the work environment as noise levels, vibration, smell and the number and form of machinery are minimal. Especially the engine room but also the bridge and passenger space are considered much more comfortable in electrified ferries. One described these ferries as spaceships, and another compared the difference in the work environment to that between a tank and a Rolls Royce – not wanting to go back to the former (See Figure 11). In hybrid vessels, such as *Stella*, these benefits do not materialise as the diesel engines are still in function.



Figure 11. Part of *Altera*'s engine room (left); Newly installed battery packs on board *Stella* (right).
(Photos: M-L Ojala)

Although the captains have to understand the basics of the vessel's battery systems, they did not feel that their work had changed in significant ways. Charging, for instance, is a rather simple process from their perspective: "you press a button and that's it." The management of charge levels is nevertheless a key aspect of their work and they need to balance with the circumstances.

The technology in an electric ferry is different from combustion engines and related apparatus, but the chief engineers recalled that there had not been considerable difficulties in accustoming to the new systems. Many also enjoyed the simplicity and cleanliness of the digital instruments – although some still missed the tangibility of the old tools.

It was noted that although operational reliability is quite good, it is not the same as with the more traditional vessels that run as long as there is fuel. One said that disturbances related to batteries and charging – such as power cuts and false alarms – are rather common. In addition, careless driving habits and charging routines were mentioned to cause disruptions to the engineers' work. The maintenance of electric ferries is also more complex when compared to vessels using fuel, but much of this work is outsourced to specialists.

Over all, working on an electric ferry was nevertheless considered an improvement. While electrification streamlines and simplifies some parts of the engineering work, in hybrid vessels, the engineers need to understand and manage both systems.

Those who had not yet been operating an electric ferry were interested in trying one. However, many of them doubted whether the power capacity would be enough to manage their route, especially in winter.

Those who were familiar with operating an electric ferry, were confident that the vessels' electric system is sufficient – even for the longer lane *Stella* sails. In fact, even though *Stella* is not intended to operate fully electric, a trial to cross the 9.5 km line by using only battery power was performed successfully. Based on calculations, even the return would have been possible without recharging.

Instead of the vessels' capacity, the crew members underlined that the main challenge is the reliability of the supporting infrastructure, including power transmission from the shore and the availability of spare parts, for instance.

4.3.6 Future perspectives

Whereas two interviewees were enthusiastic also about the possibilities with hydrogen, all considered electrification being the way forward for island ferries, especially in the shorter routes.

The idea of having fully-electric ferries was nevertheless rejected by many in both companies. They agreed that there should always be at least a subsidiary power source as a back-up. In addition, some were not convinced of the power capacity in electric vessels – although those operating an electric or a hybrid ferry were more positive about the reliability of operation. Overall, different sorts of hybrid solutions were considered worthwhile.

However, as one chief engineer reminded, whether electric vessels are the more sustainable choice depends on the energy source and the entire life-span and supply chain, including construction and the procurement of batteries.

It was also noted that reducing the dependency on fossil fuels is important also for self-sufficiency and security reasons in addition to emission reduction.

In both firms, some interviewees noted that state-owned companies – such as Finferries – should act as forerunners in investing in electrification and other cutting-edge solutions, as the risk is much higher for small private operators. One message to management was to ensure the new vessels and conversions are designed carefully to avoid costly corrections. At

Suomenlinnan Liikenne, a wish to involve the employees more in decision-making and planning was expressed.

There was a clear consensus across the interviews that although some tasks may be automated, full automation would be too risky for the archipelago routes. Especially some chief engineers pointed out that while automation may already be advanced enough to manoeuvre island ferries in theory, it still lacks the ability to make ethically acceptable decisions in busy and complex archipelago traffic.

Additionally, given the frequency of malfunctions even on vessels equipped with the latest technology, the presence of the crew was considered essential. The automation of a short and simple cable-ferry line was seen more realistic. Overall, automation was not viewed as a major threat to employment in the near future.

Regarding their career and professional development, most captains appeared content with their current positions. Although the watch arrangements were not always ideal, the fixed work location – and the fact that they did not have to spend nights, or at least not multiple nights, at sea – suited the current life situation of many. The engineering side seemed a bit more dynamic. While one captain was interested in expanding their skills into engineering, a couple of chief engineers had already begun to further their studies.

In both firms, many employees welcomed more opportunities to develop their skills and expertise. Many were interested in learning about eco-driving, electrification, current developments in maritime transport in, as well as the potential artificial intelligence brings to their field, for instance. In particular, at Finferries there was a clear desire for more safety and emergency preparedness training and requirements.

Concerning the external operational environment, some projected that, due to climate change, the increase of weather extremes is likely and it will have an effect also on the everyday operation of the island ferries. In addition, in Helsinki, the increasing constructions and maritime traffic in the harbour area was mentioned as a possible nuisance from maritime safety perspective.

6 Stockholm County

6.1 Operational environment

6.1.1 Selected key data of Stockholm Country

Stockholm County in Sweden comprises 26 municipalities – of which only five are landlocked – and is home to approximately 2.5 million residents. The Stockholm Archipelago consists of roughly 30,000 islands, of which around 200 are inhabited (Länsstyrelsen Stockholm, 2019). Even the City of Stockholm itself spans multiple islands, interconnected by bridges, a subway system, and a well-developed ferry network.

Stockholm attracts millions of tourists annually. In 2024, accommodations in Stockholm County recorded nearly 8.4 million tourist arrivals. July and August remain the busiest months, while January and February see the lowest visitor numbers. In 2024, about 32% of tourists were international, with the remaining 68% being Swedish residents. Around 20% of tourists visit the archipelago during their stay. (The Swedish Agency for Economic and Regional Growth, 2025; Visit Stockholm, 2023.)

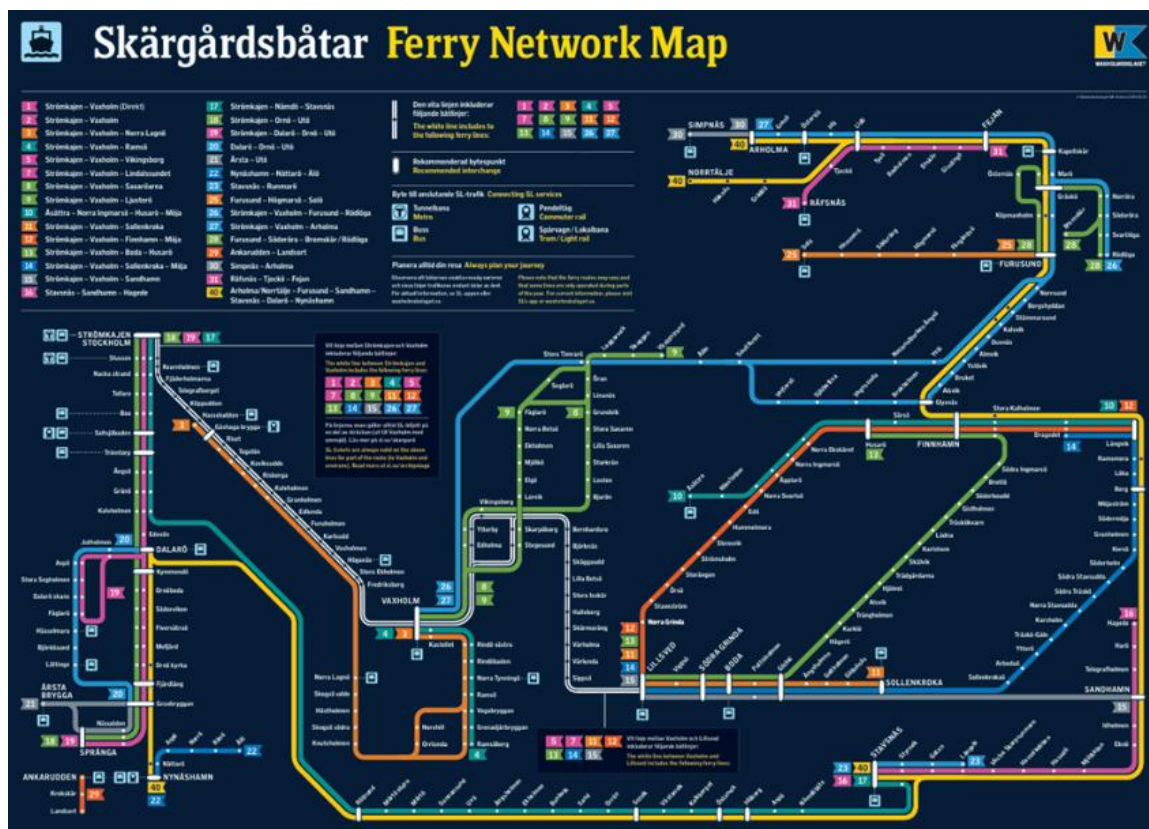


Figure 12. Stockholm County has well established ferry connections as illustrated by the ferry network map. (Source: Waxholmsbolaget)

The public transport system includes four ferry commuter routes in central Stockholm, which carried over 4.8 million passengers in 2022. The archipelago ferries, operating across a broader area from Arholma in the north to Landsort in the south (See Appendix 1; Figure 12), serve around 1.5 million passengers annually—an average of 4,100 boardings per day. (SL, 2023.) In addition to island ferries, road ferry routes connect several of the largest islands to the mainland.

In Stockholm County, approximately 9,000 residents live on islands that lack a bridge connection to the mainland (SCB, 2023). While most of these islands are served by road connections, several inhabited islands have neither a road ferry nor a bridge. Instead, the islands are accessed by archipelago ferries, taxi boats, and private vessels (See Figure 13).



Figure 13. Aerial view over the northern parts of the Stockholm archipelago showing the ferry route to Husarö on the right. Mainland can be seen on the horizon. (Photo: [Belola80](#), [CC BY-SA 3.0](#))

Fourteen of the islands with limited access have been designated as Core Islands (kärnöar) and prioritised in regional planning as service hubs for surrounding islands and tourism. The regional standard for Core Islands includes daily, year-round ferry access. These islands are home to approximately 1,500 permanent residents. However, the regional aim is to strengthen infrastructure and services, thereby increasing their capacity for both permanent settlement and business development (Region Stockholm, 2025).

Most Core Islands are also included in another regional development initiative: the Stockholm Archipelago Trail, launched in 2024. This trail covers 20 islands and offers 270 km of hiking routes, all accessible via the public ferry network.

6.1.2 Legal, political and economic environment

Sweden is subject to the same EU and IMO regulations as Estonia and Finland. Previously, the public procurement of island ferry services has been price-focused, but the procuring authority will consider environmental criteria in the future.

Authorities in Stockholm County have demonstrated a strong will to reduce emissions from the public transport services they provide by arranging charging infrastructure for not only island ferries, but also for larger ferries, such as those heading to Gotland, Finland, and Estonia. These policies are in line with Sweden's national emission reduction goal of reaching net zero GHG emissions by 2045.

The regional governing body of the Stockholm County is called Region Stockholm, which is responsible for healthcare, public transport, culture and regional development within the county. Island ferry traffic is a part of the county's public transport network and one of Region Stockholm's main responsibilities. The Core Islands, which are being developed according to the hub-and-spoke model, are one example how regional planning directly shapes how the island ferry transport is organised.

Region Stockholm owns a shipowner company Waxholms Ångfartygs AB (also known as Waxholmsbolaget, WÅAB) and procures ferry services from private companies. The role of WÅAB is to own vessels and govern contracted operators, not to operate the vessels itself. WÅAB has a fleet of 25 vessels, which are not enough for the high demand of island ferry services in the Stockholm County. Thus, Region Stockholm is also procuring ferry services from companies operating their own vessels.

The economic and competitive environment for island ferry services in Stockholm County can be described as robust and dynamic, particularly when compared to other regions within the Central Baltic. The market is competitive, with multiple operators actively involved in providing services, and financially capable of investing in environmentally sustainable technologies, including the electrification of vessels.

Unlike regions such as mainland Finland—where a single dominant operator (Finferries) holds a significant market share—Stockholm County does not have a monopolistic market structure. Although Blidösundsbolaget AB (BBAB) is currently the market leader, several other companies operate in the region, ensuring healthy competition in public tenders.

One notable competitor is Ballerina Rederi AB, a well-established company that possesses the operational capacity and financial resources to compete effectively with BBAB for contracts. The presence of multiple capable operators contributes to an innovative business environment, fostering progress in sustainable ferry operations.

6.1.3 Technological environment in island ferry services

The technological environment in Stockholm County is currently slightly more advanced in terms of emission reduction when compared to other regions in this study. HVO is commonly used by island ferries in Stockholm County, and a supply network for ferries is in place. The main issue is cost, as the fossil option, Diesel MK1 (a mixture of fossil and biodiesel), can be purchased at roughly half the price of HVO. Island ferries in Stockholm County are predominantly HVO-compatible, which means the technological preconditions exist for a complete biofuel transition.

There are also a few electric ferries and hybrids operating in Stockholm County. Blidösunbolaget AB (BBAB) is the largest ferry operator in the region and leading the way regarding electrification. BBAB recently converted a 50-year-old vessel, M/S Silverö, from fossil fuels to fully electric. The old engine and all fuel-powered appliances and systems were removed, and the vessel is now fully powered by batteries, emitting zero emissions in operation. This project serves as an example of what is possible, but also highlights regional limitations. M/S Silverö was selected due to being a lightweight and suitable vessel for retrofitting, and it operates a route that provides access to sufficient shoreside power for charging in Vaxholm island.

Another example of technical novelty in Stockholm is The Candela P-12 shuttle, Nova, a fully electric hydrofoil passenger ferry serving commuter traffic. The cutting-edge hydrofoil technology lifts the vessel above water and allows it to drive faster, use less energy and create less sound or wake when compared to a traditional ferry.

Stockholm County faces similar issues to those on the mainland Finland regarding electrification, as the ferries need to cover a vast archipelago. For the broader electrification of Stockholm County's ferries, a more extensive network of charging stations would need to be established. The strategic locations of the City of Stockholm and Vaxholm, for instance, where many of the region's ferry routes lead, is an advantage, but the archipelago is too large for ferries to make voyages far into the islands and back without recharging (See Appendix 1).

The local authority, Region Stockholm, will play a key role in allowing or setting up sufficient charging infrastructure across the archipelago. The technology and know-how to convert a vessel to use batteries exist, albeit at an expensive cost to the operator.

6.2 Setting of the interviews

The interviews in Stockholm County were conducted by Petra Stelling on board four ferries on a partly cloudy day in February 2026 with ice on the fairways. The interviews were recorded, and an offline transcription service aTrain was used to aid in transcription (See, Haberl et al. 2024).

Stelling interviewed four captains on board four passenger ferries: *M/S Solöga*, *M/S Sandhamn*, *M/S Waxholm I*, and *M/S Nämdö* (See Figure 14). Three of the interviewees

mentioned that instead of operating a regular vessel and route, they work on different vessels depending on the season and scheduling needs. Consequently, they have also reflected on their experiences on other vessels and routes when discussing their current experience. The interviews concern mainly the following vessels: *M/S Nämndö*, *M/S Sandhamn*, *M/S Saxaren*, *M/S Silverö*, *M/S Solöga*, *M/S Waxholm I* and *M/S Yxlan* (Table 4).



Figure 14. Left: *M/S Solöga* (Photo: Petra Stelling), Right: *M/S Saxaren* (Photo: M-L Ojala)

All of these ferries are operated by Blidösundsbolaget. *Silverö* is owned by Blidösundsbolaget and other ferries by Waxholmsbolaget, a shipowner company owned by Region Stockholm. The ferries are passenger ferries with seating lounges and most are equipped with a small cafeteria. They are single-directional vessels with a differently designed bow and stern, meaning that they need to turn around at the terminal for the return trip.

Table 4. The Swedish archipelago ferries discussed in the interviews in numbers.

	Length (m)	Width (m)	GT	PAX	Cars	Built	Shipyard location	Age in 2026 (years)
M/S Nämndö	31.30	8.72	364	280	-	2009	Uusikaupunki, FI	17
M/S Sandhamn	39.90	10.30	686	500	-	2000	Kolvereid, NO	26
M/S Saxaren	37.39	7.78	247	340	-	1999	Mandal, NO	27
M/S Silverö	22.54	5.4	86	151	-	1970	Östhammar, SE	56
M/S Solöga	27.53	7.2	221	180	-	1978	Nacka, SE	48
M/S Waxholm I	36.31	9.02	387	344	-	1983	Ramvik, SE	43
M/S Yxlan	27.00	7.5	256	150	-	2018	Riga, LV	8

Silverö was built in 1970, and it is recently, in June 2025, retrofitted into an electric vessel. The old engine and all fuel-powered appliances and systems were removed, and the vessel is now fully powered by batteries, emitting zero emissions in operation. *Silverö* is not ice-strengthened, and therefore it is not operated in winter.

Silverö is not assigned to a single fixed route. Instead, it connects Vaxholm island with several nearby islands and serves as an important intermediate link for other lines in the archipelago. The length of these individual legs varies between 4 and 55 km. The vessel has a charging station at Rindö island next to Vaxholm where it is charged during night and longer breaks in the daily schedule.

Yxlan is the first ice-going hybrid passenger vessel of Waxholmsbolaget. The hull of *Yxlan* has Swedish-Finnish ice class 1A and it is able to keep a speed of two knots through 40 cm of ice. The ferry operates with a battery pack and two 405kW diesel generators. The batteries are used in parallel with the diesel generators but have also enough capacity to be used independently.

Saxaren and *Solöga* are fuel-powered vessels. While *Solöga* is ice-strengthened and operational throughout the year, *Saxaren* is a more light-weighted aluminium ferry and not used in winter season. *Nämdö* and *Waxholm I* are powered by diesel engines. *Nämdö* has Azimuth thrusters whereas *Waxholm I* has continuous pitch propeller and straight shafts.

In Stockholm County, many ferry lines – especially those heading further towards outer archipelago – are long and include several stops. The routes vary from a few kilometres up to almost 200 km.

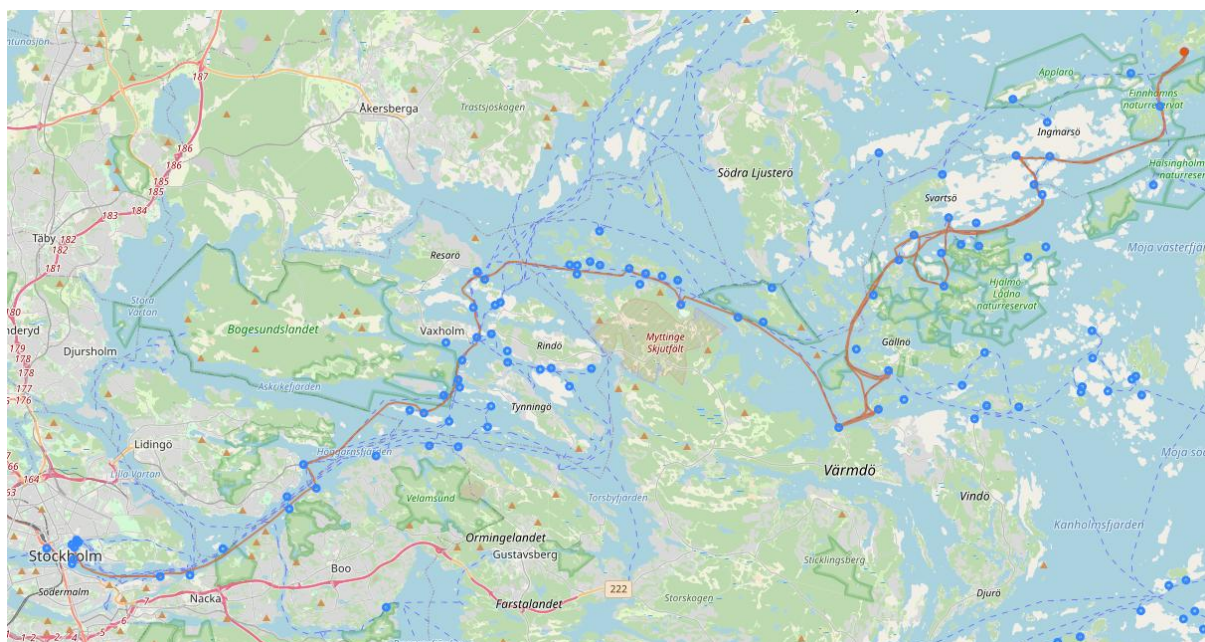


Figure 15. The route of M/S Sandhamn as an example of a typical line at the Stockholm Archipelago. (Source: Blidösbolaget)

As a result, a single shift and line encompasses often a variety of crossings with different lengths, natural environments and piers (See Figure 15). Therefore, it is not uncommon that one work day does not entail many or even a full tour along the specific route. In addition, the crew also sleeps on board the ferry during several of the journeys.

6.3 Interview outcomes

6.3.1 Background and experience

All interviewed captains have extensive experience from different vessels and routes especially in the Stockholm archipelago. Three of them have worked in maritime transport from 15 to 30 years, and as a captain they had served for more than ten years – one interviewee did not specify their background. In the current company, the three captains had worked between 7 to 20 years. Before this recruitment, one had sailed also on coastal tankers, and another had worked on smaller sightseeing vessels as well as Cinderella ferries that take excursions in the archipelago.

One interviewee had completed a four-year maritime officer programme and the others had completed a two-year professional education to become an archipelago captain. In addition to their formal education, the captains have participated in the recurring safety and refresher trainings. Two mentioned having participated also on an eco-driving course and one in a more intensive simulator training as part of their studies.

While one of the captains reported working on a single regular vessel and route, the others operate different vessels depending on the season and scheduling needs – not all ferries can operate in winter, for instance. One of the captains has also experience working on *Silverö* after its conversion to an electric ferry, and another has served on *Yxlan*, a hybrid ferry with a battery system supporting two propulsion units.

6.3.2 Work environment and safety

Overall, interviewees expressed satisfaction with the interaction and communication between seagoing personnel and company management, as well as with the general functioning of the organisation. Most captains noted that the current state of smooth cooperation had nevertheless taken years to develop.

All captains reported that they feel free to contact management when they wish to suggest an idea, request clarification, or raise a concern. At the same time, it was noted that some colleagues may not feel equally comfortable initiating such contact. In addition, their perspective does not always receive priority in decision-making. The captains nonetheless stated that they feel listened to. It was regarded as an advantage that the management includes individuals with seagoing experience.

The interviewees also stated that additional support and training are readily available when needed. One captain highlighted that the company communicates its priorities clearly: safety is always the primary consideration. In situations where an employee does not take the initiative to request training, management typically guides them toward the appropriate courses.

Onboarding to new vessels was described as well-structured, and the captain who has worked with the electrified *Silverö* noted that the office played an active role in that transition.

Aside from the electrification of *Silverö*, no major recent organisational or operational changes were identified. Although machinery and other vessel components are upgraded every now and then, these updates were not considered particularly significant in terms of daily work.

One captain nevertheless mentioned that introductions to new equipment are sometimes brief, and another pointed out that certain types of information – such as briefings to new IT systems or organisational changes – may occasionally be lost when the initial people receiving information pass it forward or if their role changes. The interviewee added they can always reach out for clarification when necessary.

Interviewees also emphasised the value of on-site events, including trainings and the more informal staff gathering. These occasions were seen as important not only for completing the required exercises but for discussing work-related matters with colleagues. Practical onboard exercises were highlighted as especially beneficial, and some captains expressed a desire for increased opportunities for peer-to-peer mentoring as well.

In general, the captains reported no major safety concerns related to vessel operations or communication with management. Instead, the safety issues mentioned were the growing intensity of maritime traffic and possible slippery quays during winter.

Although the work environment in the company was considered good, one interviewee noted that the company's limited negotiating power, combined with what they perceived as a declining level of competence within the transport authority, affects the firm's performance. According to the interviewee, some higher-level initiatives are not grounded in operational realities.

6.3.3 Environmental awareness and attitudes

One of the captains was not particularly worried about climate change, and the discussion about environmental issues remained limited with them. They nevertheless viewed emission reduction as a positive development, also from the perspective of nature.

The other three captains expressed greater concern about climate change or other forms of environmental degradation, such as biodiversity loss and waste dumping.

Two of them considered that efforts made in a small country like Sweden – one referring to climate-change mitigation and the other to plastic waste – have no significant impact. The other said they would have been more worried in the past, but now some of their hope has already faded. Still, this interviewee believes that emission reduction, including with Swedish island ferries, does matter.

The latter also noted that Hydrotreated Vegetable Oil (HVO) is already widely used in Sweden, and its share will soon rise from 50 to 90%. In addition, AdBlue – an aqueous urea solution – is used to reduce nitrogen oxide (NOx) harmful emissions from diesel engines. Even though they were pessimistic about the impact of these efforts in a larger scale, they considered that setting an example might encourage progress also elsewhere.

The fourth captain acknowledged being deeply concerned about climate change and reflected on it in more detail and from multiple perspectives. They mentioned global warming projections and the implications for sea levels, ecosystems, ocean currents, and the prevalence of extreme weather events. They had also paid attention to changes in algae blooms, fish presence, and water quality in their local environment.

According to this captain, more can and should also be done in Sweden and in island ferry operations. As examples, they pointed to some ferries operating with only a few passengers and to the political paradox of simultaneously seeking both a vibrant archipelago and the achievement of emission reduction targets. In practice, the latter would require reducing traffic volumes rather than increasing them.

6.3.4 Eco-driving and voyage optimisation

Emission reduction was viewed positively by all captains, and all have been engaging in eco-driving practices in their work. Two had already participated in eco-driving training, and two were looking forward to attending it. Blidösundsbolaget was seen as actively supporting eco-driving, which one captain summarised by noting that fuel savings benefit the company, the environment, and ultimately the public.

The installation of the Blueflow energy-management system further supports captains in this task. One noted that even the electronic nautical charts introduced in the late 1990s, which display the route, position, and estimated time of arrival, enabled captains to adjust their speed to save fuel rather than arriving at the jetty ahead of time at full throttle. Blueflow has made this work considerably easier by providing additional information and guidance.

Blueflow records and displays real-time fuel consumption, vessel position, speed, and other relevant data. Captains also receive regular consumption reports to help improve their practices. Captains at Blidösundsbolaget can access and compare each other's performance, which allows them to view individual voyages completed by other captains in comparable ice conditions, for instance.

Three captains reported using Blueflow very actively in their daily work. Its basic functions were considered straightforward and intuitive. However, using the system more extensively – such as for report generation or parameter analysis – would require additional training, and two captains expressed clear interest in receiving such advanced training.

The interviewees acknowledged that there are notable differences between captains. According to one, fuel-consumption differences can exceed one cubic metre per week. Regular training, combined with opportunities to exchange experiences, was therefore considered important. One captain also noted that more information on the environmental reasons behind green practices would help employees better understand their purpose.

In addition to differences in skills, obstacles to eco-driving include the need to maintain schedules and the delays caused by weather, traffic, or passenger boarding, for instance. As one captain succinctly put it: safety first, timetable second, and after that comes eco-driving. In addition, it was noted that, for new captains, eco-driving should only be an additional and final layer of developing their professional competence.

The main incentive for eco-driving appears to be intuitive professional skills. However, one captain said that environmental reasons also motivate them to save energy. For another, fine-tuning eco-driving techniques is partly a way to counteract boredom as well. Overall, eco-driving was seen as something that should become an integral part of work culture, much like safety is.

Direct financial rewards were not considered suitable, as they might lead to competition, compromised safety, and questions of fairness and privacy. However, one captain suggested that fuel savings should be used for benefiting the company as a whole, including the seagoing staff.

In addition to eco-driving, all interviewees saw significant potential to reduce energy consumption through voyage optimisation in the island ferry traffic in Stockholm County. While one captain simply noted that fixed timetables and operational constraints limit such savings, others discussed the issue in more depth.

One captain pointed out that some practices persist merely out of tradition, and that with dialogue between captains and planners, the timetables could be revised for better efficiency. As an example, they described schedules that force unnecessary full-power segments followed by long idle periods.

In general, adding more time to the schedules would allow operating the ferries slower and counter delays. For instance, onboarding of passengers is not always efficient and the time varies a lot depending on their number and whether assistance is needed. Weather is another external factor that may cause delays. One captain suggested that even ten minutes could be

added to certain timetables and it would allow them to engage more consistently in eco-driving.

Stockholm archipelago ferries are single-directional vessels, meaning that they need to turn around at the terminal for the return trip. Thus, manoeuvring the ferries to and from the jetty with low RPM ranges was emphasised separately as the most wasteful part of the crossing throughout the interviews – even if the vessel doesn't use much fuel overall. Here, hybrid propulsion could be used to save energy.

A further point concerned fuel types and regulations set by the transport authority. One of the captains noted that, currently, 50 percent of annual fuel use must consist of HVO. Once this quota is reached, operators switch back to diesel because it is cheaper. Ideally, political decision-makers would incentivise the continuous use of HVO for environmental reasons.

6.3.5 Electric ferries

One of the interviewed captains had worked on Silverö after its conversion into a fully electric ferry. According to them, the transition went smoothly. Their tasks and decision-making processes did not fundamentally change, although some differences did emerge. In addition, they consider receiving good support and training.

From the crew's perspective, one of the main improvements concerns the work environment: noise and vibration levels decreased significantly, and there are no longer fumes or oil handling on board. The captain added that the latter has also eliminated the risk of oil leaks into the environment.



Figure 16. Left: Silverö at the Rindö charging station; Right: Monitors at the bridge. (Photos: M-L Ojala)

The electrical and digital systems, associated equipment, and their maintenance are more complex than on fuel-powered ferries. This complexity, however, affects the captain's work only slightly: the number of monitors increased, and the battery charge levels must be monitored more frequently than fuel levels (Figure 16).

The electric propulsion has also changed the way the vessel behaves and responds to commands, which has required some adjusting and experimenting.

As with fuel-powered vessels, approaching and departing the jetty remain the most wasteful and inefficient parts of the journey. The interviewee had nevertheless noted that electric propulsion allows for more precise and energy-efficient manoeuvring.

The route and schedule are partly designed based on the grid and charging capacity. The captain described how, with the electric ferry, there is no similar energy buffer as with fuel-powered vessels. A delay cannot be made up by increasing the speed as easily as with diesel vessels that are supplied with a plentiful amount of fuel. In addition, low running charge levels – typically after the longer or otherwise higher-demand parts of the route – can be stressful.

In general, the captain nevertheless considers that the transition has been smooth without any considerable problems. Initially, they were even surprised by how well the battery capacity works. The captain also considered that there was – and still is – enough and easily-accessible support from both the management and the manufacturers of the battery and charging systems. All in all, the interviewee feels confident with the new technology and routines on *Silverö*.

The three other captains interviewed in this study had no experience with fully-electrified ferries, although one of them was familiar and shared their experience with operating the hybrid ferry *Yxlan*.

Yxlan has battery packs that would allow limited zero-emission operation, but in practice they are primarily used to support the diesel engines during high-demand situations. Even this use leads to substantial emission reductions; for example, during manoeuvring one of the engines can be turned off. According to the captain – and echoed by the other interviewees – hybrid systems represent a more suitable solution for archipelago ferry operations.

Indeed, despite the success with *Silverö*, none of the four captains believes that the technology, supporting infrastructure, or the maritime sector, more broadly speaking, are ready to accommodate longer, high-demand routes with pure electric ferries.

In addition to the study at hand, four captains with experience from the electrified *Silverö* have been interviewed by VTI in 2025. The captains shared a highly consistent view on the electrification, which aligns with the experience outlined above. The perceived experience of the electrification was very positive. Although some range anxieties were there in the beginning, it soon became clear there was no need to worry; *Silverö* has been reliable in operation and the timetable tailored to the battery and charging requirements.

These four captains described the improved working environment with less noise and vibrations, less maintenance and smooth charging process. According to these interviews, the biggest difference operating an electric vessel is not in the operations itself rather in the mindset. They all reported improved awareness about fuel consumption and driving style, particularly on the importance to plan ahead and to avoid speeding.

6.3.6 Future perspectives

In general, the captains had a positive outlook on technological development and new innovations in island ferry traffic.

Full automation, however, was rejected by the three captains with whom it was discussed. They emphasised that the complex and constantly changing conditions – such as weather, ice, narrow passages, and unpredictable traffic – require continuous human judgment and situational awareness. While automated systems like autopilot or route steering were

considered useful supportive tools, the interviewees agreed that automation cannot replace human decision-making in the Stockholm archipelago.

Only one of the captains had experience operating the fully electric *Silverö*, but all four held rather similar views on the electrification of ferry transport. They mentioned that especially batteries' limited energy-storage capacity and the lack of charging infrastructure prevent larger-scale electrification of the longer archipelago routes. The captains anticipated that the potential for electrification will improve, but with current technology it is not feasible to fully electrify the archipelago traffic in the near future.

However, the captains considered different hybrid systems to be highly suitable for the Stockholm archipelago.

In addition to environmental benefits, one interviewee added that replacing fuel with electricity improves the country's self-sufficiency as well.

Some interviewees proposed eco-driving to be embedded in the work culture in much the same way that safety currently is. As discussed earlier, all captains also believe there are significant opportunities to further support eco-driving, for example by adjusting schedules and increasing the number of hybrid ferries.

Several captains noted that the volume of island ferry traffic has been increasing in Stockholm. Two captains seemed delighted about the revitalisation of the archipelago ferry traffic. One was more critical towards this development and implied that the new departures shouldn't merely duplicate road connections when there is no real demand for both.

As mentioned previously, one captain hoped that the ferry operator would strive for a stronger negotiating position toward the transport authority. Two interviewees also noted the importance of policy adjustments to support more environmentally friendly options.

7 Åland Islands

7.1 Operational environment

7.1.1 Selected key data of Åland

The Åland Islands is a self-governing and demilitarised province of Finland. This sparsely populated and geographically diverse archipelago consists of approximately 6,760 islands (1,556 km²) and has a population of 30,650. Around 60 of the islands are permanently inhabited (ÅSUB, 2025a). The main island, Fasta Åland, is home to 93% of the population and includes the capital city, Mariehamn (population approx. 11,800), along with nine other municipalities.

The six island municipalities – Brändö, Föglö, Kumlinge, Kökar, Sottunga, and Vårdö – have a combined population of close to 2,000 (See Figure 18). Approximately 30% of the 8,500 summer cottages are located on these islands, with the remainder situated on Fasta Åland (ÅSUB, 2024a).

Tourism is Åland's largest export industry and makes a significant contribution to the local economy. It employs 20% of the private sector workforce and relies heavily on maritime transport, including both large car-passenger ferries and smaller inter-island ferries. In 2023, tourist-generated land-based consumption was estimated at EUR 107 million, rising to over EUR 700 million when sea-based tourism is included (ÅSUB, 2024b).

Recent statistics show approximately 1.3 million annual inbound tourists, although this figure includes cruise passengers who do not disembark in Åland. Accommodation data – covering hotels, guest houses, cottages, and campsites – provides a more realistic view: in 2024, nearly 200,000 guests arrived, staying an average of two nights. Tourism is highly seasonal, with about 4,000 monthly arrivals in winter, over 33,000 in June and August, and nearly 60,000 in July.

More than half of the guests were from Finland, while about one-third were from Sweden. Fewer than 40,000 passengers arrived or departed via Mariehamn Airport, underscoring the importance of maritime transport (ÅSUB, 2025b).

In addition to tourism, shipping and ferry services, as well as the processing of agricultural and fish products are key economic sectors in Åland. These industries are partially dependent on reliable ferry services.

The dispersed population, mosaic-like geography, and strong tourism industry make island ferry services vital for Åland. Ferries connect the smaller islands to Fasta Åland and also provide links to the Turku Archipelago in Finland (See Figure 18).



Figure 17. AxFerries' M/S Vigen of the Southern line in Galtby (mainland Finland) loading for Långnäs in Åland in February 2026. (Photo: Lauri Ojala)

In 2025, there were four main free-moving ferry routes: the Northern Line, Cross Line, Southern Line, and Föglö Line. In 2024, they served 422,000 passengers and 248,000 vehicles in 2024. Additionally, six shorter cable ferry routes carried nearly 570,000 passengers and 380,000 vehicles (ÅSUB, 2025b). In total, the volume was 1 million passengers and over 600,000 vehicles.

Skärgårdstrafikens körtider | Saaristoliikenteen matkustusajat
Archipelago-traffic traveltimes

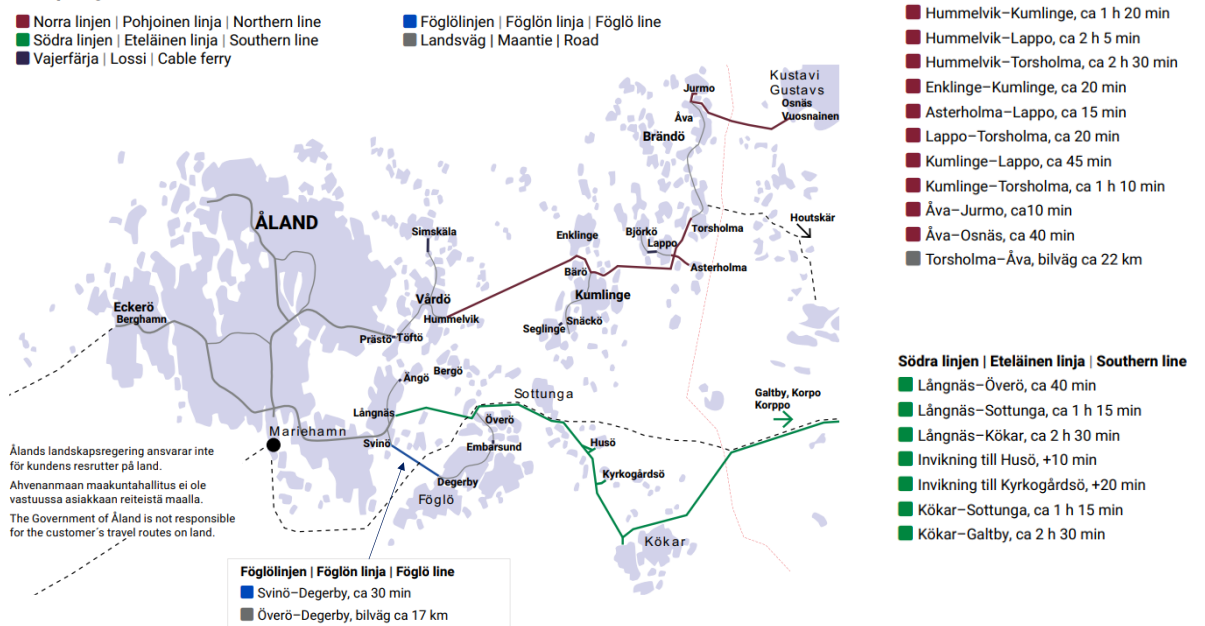


Figure 18. Map of the main ferry lines in Åland Islands in 2026. (Government of Åland)

As from 2026, however, the so-called Cross line linking Långnäs on the main island with Sottunga and Snäckö in Kumlinge was discontinued. These services were replaced by shorter island-to-island connections, which in many cases meant somewhat longer travel times.

7.1.2 Legal, political and economic environment

The legal and political environment in the Åland Islands is primarily shaped by the incumbent regional government. The Finnish Archipelago Act does not apply to Åland, and due to its autonomous status, the regional authorities are responsible for setting policies related to island ferry services. The Åland Islands constitute Finland's only autonomous region, a status that dates back to a settlement under the League of Nations in 1920.

The composition of the Government of Åland (GoA) may change following elections, potentially leading to adjustments in policy priorities. However, the fundamental importance of ferry services to the region remains consistently high, as reliable connections are essential for residents regardless of political orientation.

Beyond political dynamics, a pivotal development for island ferry services occurred in 2024, when a key ferry operator declared bankruptcy and ceased operations almost overnight. In response, the Government of Åland (GoA) was required to act swiftly to ensure the continuity of ferry services and to reorganise their provision. This led to the establishment of Ålands Skärgårdsrederi Ab, operating under the marketing name AxFerries—a 50/50 joint venture between the GoA and Finferries Corporation. AxFerries was formally established in autumn 2024.

A key factor behind the GoA's decision to partner with Finferries was the company's proven expertise in ferry operations, including the electrification of its fleet. The partnership signals that both AxFerries and the GoA are positioning themselves towards a more technologically advanced and environmentally sustainable future in ferry transport.

AxFerries now operates the majority of the vessels previously owned by the GoA and has become the dominant operator in the regional ferry market. Despite the strategic importance of these services, overall market competitiveness remains limited.

In December 2025, AxFerries won the GoA procurement for ferry traffic on four main routes in Åland waters. Unlike previous procurements, this time the tender procedure covered several routes simultaneously. The contract period covers the years 2025–2026, with an option to extend for 2027. The agreement applies to the following four routes in Åland traffic:

- Åva–Osnäs (from January 9, 2025)
- The Föglö route (from January 9, 2025)
- The Southern route (from January 9, 2025)
- Hummelvik–Torsholma (from September 1, 2025)

AxFerries' bid of over 22 million euros per year was the lowest among those approved by the GoA, which has not disclosed how many bids were submitted. One bid was rejected because it was deemed not to meet the conditions of the tender procedure (YLE, 2024).

Looking ahead, AxFerries is well positioned to secure a strong advantage in future public tenders for ferry services. It operates on market terms without ongoing owner funding, while benefiting from deep regional expertise and robust operational resources—factors that together provide a clear competitive edge over potential rivals.

7.1.3 Technological environment in island ferry services

Island ferry traffic in the Åland Islands is currently characterised by an ageing fleet, with many vessels expected to be replaced or retrofitted with new technologies in the coming years.

Given the essential role of ferry services and the importance of the archipelago environment to local residents, the Government of Åland (GoA) has clearly committed to a transition towards electrification. This shift is already underway, as evidenced by the launch of a tender for a new electric cable ferry.

In terms of the broader technological environment, a significant initiative is currently in the planning and feasibility stage. The project—known as Mega Green Port (Mega Grön Hamn in Swedish)—involves key stakeholders such as OX2, a renewable energy developer, and the Bank of Åland (Ålandsbanken), among others.

The project aims to transform the Port of Långnäs, located on the eastern side of mainland Åland, into a Nordic hub for green energy. As a central node in the region's ferry network, Långnäs plays a critical role in connectivity, and its development into a green port would facilitate the adoption of zero-emission energy carriers, including hydrogen, e-fuels, and renewable electricity.

If implemented, the Mega Green Port would create highly favourable conditions for the transition of Åland's ferry traffic towards emission-free operations. However, no final investment decision has yet been made, and even under optimistic assumptions, the port would remain several years away from becoming operational. Nevertheless, the seriousness with which the project is being pursued underscores Åland's strong commitment to a green energy transition and the advancement of sustainable maritime transport.

7.2 Setting of the interviews

The interviews were conducted by professor Lauri Ojala in February 2026 from Sunday noon to late Monday evening on three lines and four vessels, all operated by AxFerries. He was travelling with his own car to enable a smooth transition from one ferry to another.

In addition, he met with Ms. Ida Mann, Government of Åland (GoA) and MD Per Ringsby, AxFerries on Monday in Mariehamn, and discussed on issues related to island ferry operations, but not, for example, on issues regarding the tendering process being prepared by the GoA.



Figure 19. M/S Alfågeln manoeuvring to the pier in Hummelvik in icy conditions. (Photo: Lauri Ojala)

During the voyages, the weather was extremely beautiful with about -10 degrees centigrade – with some exceptional features:

- The Archipelago Sea had a historically low water level mainly due to extended high air pressure: initially at -70 cm compared to mean sea level. During the weekend the situation eased to around -50 cm to -40 cm, which was still an unusually low level
- This caused some heavy goods vehicle restrictions on ferries and to occasional problems loading the ferries in some ports, which did not directly affect the visited ferries
- The Archipelago Sea had its most intensive ice formation during the past 10+ years. For AxFerries this meant that those vessels without an ice class could not be used. All of the four ferries have a Finnish-Swedish ice class IA, and they could operate normally (See Figure 19 and Figure 20).

The vessels and routes visited were as follows, all operated by AxFerries:

- M/S Viggen from Galtby to Långnäs on Southern line, approx. 5.5 hours
- M/S Skarven b/w Svinö and Degerby on Föglö line, approx. 30 minutes
- M/S Alfågeln from Hummelvik to Torsholma on Northern line, approx. 2.5 hours
- M/S Knipan from Åva to Osnäs on Northern line, approx. 40 minutes

All are traditional diesel-powered ferries, with conventional technologies both in the bridge and in the engine room with a single Wärtsilä main engine. The oldest of them is over 40 years, and the newest one 17 years in 2026. (Table 5)

Table 5. The four AxFerries ferries visited in February 2026 in numbers.

	Length (m)	Width (m)	GT	PAX	Cars	Built	Shipyard location	Age in 2026 (years)
M/S Viggeren	53.50	12.25	1,512	250	58	1998	Uusikaupunki, FI	28
M/S Skarven	65.30	13.40	2,285	250	65	2009	Klaipėda, LT	17
M/S Alfågeln	52.88	12.02	1,469	250	56	1990	Flekkefjord, NO	36
M/S Knipan	48.49	10.51	471	157	22	1985	Turku, FI	41

Their draught is approximately 4 meters (3.9 to 4.1 m), and they were all built for GoA traffic, in which they have remained since their launch. All of the four ferries have a Finnish-Swedish ice class IA, which means that they were capable of operation also in these somewhat unusually harsh ice conditions (see Figure 20).



Figure 20. M/S Alfågeln heading for Torsholma on the Northern line. (Photo: Lauri Ojala)

Compared to newer double-ended island ferries used by Finferries, for example, the loading and unloading of some of the visited vessels is done from either bow or stern only. This requires time and energy consuming manoeuvring when approaching to piers along the routes. M/S Skarven, however, is a double-ended ferry.

Some of the piers, such as the one in Degerby, are constructed so that the vessel has to turn 90 degrees just when approaching the pier. The pier in Degerby is also subject to occasional currents that make the manoeuvring more complicated than in most other harbours.

The way the single diesel main engine vessels and some of the piers in Åland are constructed may cause additional costs of several hundred thousand euros per annum due higher fuel consumption to compared to double-ended vessels and more straightforward approaches to the piers. These constraints are, in other words, “given” and reduce the scope of what could be achieved by eco-driving practices, for example.

7.3 Interview outcomes

7.3.1 Background and experience

The four Captains were very experienced seafarers typically in their 50s or 60s, with a long career in merchant marine on large cargo, passenger and/or cruise vessels in Baltic, European and worldwide trades before taking their positions in island ferries. All had received a Master Mariner education, and had been working as Captains, Bridge Captains and 1st Officers in merchant marine.

They had been Captains for island ferries for about 5 to 15 years, typically on the same ferry, so they were very experienced in this traffic and the routes. This means that they had been working on island ferries operated by predecessors of AxFerries, founded in 2024.

The two Chief engineers had had careers in various type of merchant marine vessels before joining the crews of island ferries, where they had been working for five to ten years. They too had been working on island ferries operated by predecessors of AxFerries. Their educational background was that of Marine engineer.

All had received their maritime education in Åland in Swedish language. For Marine engineers, Åland³ is the only place in Finland, where teaching is in Swedish. Swedish is the only official language in Åland, and the interviewed persons all had Swedish as their native tongue. All were Finnish citizens, while not necessarily native islanders of Åland.

7.3.2 Work environment and safety

Given their extensive experience on various types of vessels, including very large ships, all respondents expressed confidence in their professional ability to operate and manoeuvre these relatively small, conventional, and aging vessels in confined domestic trades.

In addition to regular dockings, no major overhauls have been made to these ferries, all with their original Wärtsilä diesel main engines in place. Very few new pieces of equipment or technologies have been installed to these 28 to over 40 years old vessels.

The only noteworthy recent exception of relevance for this study is the instalment of Blueflow equipment during the past two years or so, which monitors the fuel consumption of the vessels on a real-time basis. It also generates accurate statistics of fuel consumption, which can be analysed also afterwards, if need be.

These systems had been installed in three of the four ferries, but in one of them, the Blueflow monitor was available only in the bridge. During the interview the fourth ferry had no means of following its fuel consumption other than by measuring manually the amount of fuel being consumed. It turned out that very little, if any training had been provided to use, follow and analyse the data provided by the Blueflow system so far. Even though the system is said to

³ Now called Alandica Shipping Academy as part of Åland University of Applied Sciences (<<https://asa.ax/>>)

store the collected operational data into a centralised server, the crews did not have access to this data history of their vessels.

AxFerries is a relatively small company, employing around 90 people in early 2026. Given its size, employees tend to know each other well and often have long-standing working relationships. It is therefore unsurprising that the company appears to foster a work environment that supports open and candid communication with management as well as across the land-based organisation.

7.3.3 Environmental awareness and attitudes

The interviewed were generally well aware of the current and emerging EU and IMO emission regulations, which mainly concern large ships with a gross tonnage of over 5,000, including terms such as Fit for 55, EU ETS – EU Emissions Trading System, and FuelEU Maritime Regulation. However, they do not apply to small vessels in domestic trades.

Both the captains and the marine engineers were well informed about the possibilities and constraints associated with retrofitting these aging vessels with newer propulsion systems and technologies.

There was a clear consensus that converting the vessels to fully electric propulsion would be impracticable. Similarly, the use of newer alternative or synthetic fuels was not considered a feasible solution under current conditions. The option most widely regarded as viable was the adoption of diesel-electric systems combined with battery storage, which could reduce fuel consumption in specific operational contexts.

Such a configuration would be particularly beneficial during manoeuvring to and from piers. With the current single main engine configuration, only a fraction of the available engine power is required in these situations, even though the main engine operates at a nearly constant load.

The route alignments are generally already optimised for minimum distance, leaving limited scope for reducing sailing distances further. However, elements of the existing route network, vessel design, and pier configurations at certain locations impose operational constraints that limit opportunities to minimise fuel consumption.

The most significant improvement in this respect has been the relaxation of timetables on the longer routes from January 2026 onwards. This adjustment has enabled a reduction in operational speeds of approximately 1 to 1.5 knots, resulting in fuel savings of 20–30% compared to the previous schedules.

During operations in heavy ice conditions—as was the case at the time of the interviews—fuel consumption may increase to 300 litres per hour and occasionally even reach 400 litres per hour. In open-water conditions, consumption is typically around half of these levels or lower.

7.3.4 Eco-driving and voyage optimisation

Exposure to eco-driving training—or even opportunities to participate in such training—has been limited, if available at all. This can be partly explained by the fact that the current operator, AxFerries, has existed for less than two years, while its predecessors were smaller and not particularly active in this area. However, eco-driving training is planned for AxFerries' seagoing staff in the future.

At the same time, experienced captains demonstrated a strong awareness of how manoeuvring practices in different operational situations affect fuel consumption. They also showed consistent attentiveness to maintaining optimal speeds whenever operational conditions allowed.

7.3.5 Future perspectives

Compared to the somewhat tumultuous experiences in Åland's island ferry operations in the early 2020s—when a key operator went bankrupt and ceased operations almost overnight—the current outlook is considerably more stable.

AxFerries, established as a 50–50 joint venture between the Government of Åland and Finferries, benefits from access to Finferries' broader technical, operational, and commercial expertise. This is likely to result in more consistent safety standards and operational procedures across the Åland ferry network and its routes.

The new operating model also supports continued efforts to reduce vessel energy consumption through various measures, including the adoption of eco-driving practices and the optimisation of route structures and timetables where feasible.

In this regard, the most significant development has been the relaxation of timetables on the longer routes from January 2026 onwards. This adjustment has enabled a reduction in operational speeds of approximately 1 to 1.5 knots, resulting in fuel savings of 20–30% compared to previous schedules.

A potential minor operational adjustment would be to require advance booking for stops at less frequently used piers on the Northern and Southern routes (see Figure 18). In practice, however, the need to call at some of these piers may arise at short notice, and such a requirement could be perceived as a reduction in service quality. Nevertheless, it would be useful to quantify the additional costs—and fuel consumption—associated with a 10–20-minute detour from the main route to serve these piers.

One of the main concerns for the foreseeable future is that the current fleet, while still technically in relatively good condition, is ageing and relies on single diesel main-engine propulsion. However, the use of newer alternative or synthetic fuels was not considered a feasible solution under current conditions.

Retrofitting these vessels to diesel-electric systems is technically feasible; however, given their remaining economic lifetime, such an undertaking would be costly and its financial justification needs to be considered carefully. In addition, this transition would require

investments in shore power infrastructure and upgrades to the electricity grid, both of which entail significant costs.

It is therefore likely that a full transition to diesel-electric propulsion through fleet renewal may take a decade, if not longer, should such a decision be made. In any case, the payback period for diesel-electric retrofitting must be assessed carefully, particularly as declining battery costs and technological advancements may improve its economic viability over time.

Financial constraints and political realities need be taken into account too. In recent years, the net cost of island ferry operations for the Government of Åland has been approximately €20 million annually, after accounting for ticket revenues of around €1.5 million. With a total annual government budget of roughly €400 million, ferry services represent about 5% of public expenditure.

By comparison, the cost of a new diesel-electric ferry of the size and ice class required in Åland is estimated to be in the range of €25–40 million. In addition, such vessels would require shore power installations in multiple harbours. While estimating the cost of these installations—and any necessary grid reinforcements—is challenging in an archipelagic setting, the total investment could easily exceed €10–20 million if fully implemented.

Given that the ferries constitute a critical component of Åland's infrastructure and must remain operational under all conditions, fully electric solutions may not be a feasible option at present. In addition, the length of the Southern route, for example, is over 50 nautical miles (over 80 km), which pose an additional challenge to use fully electric ferries. This remains the case even if future technological developments were to reduce the costs of vessel procurement, as well as the required grid and charging infrastructure.

8 Comparison between EE, FI, SE and AX

This report presents the first cross-border study examining seagoing staff's views on the decarbonisation of island ferry traffic in the Central Baltic Sea region.

Consequently, the material was collected through in-depth interviews with a relatively small number of participants in each study region. The interviews were semi-structured and discussion-like and conducted in three languages by four different researchers. The type of vessels and routes that were discussed vary greatly between and within the regions included in this study. In some of the interview sessions, other crew members were also present and participated in the discussion, and in Finland (incl. Åland) also chief engineers were interviewed in addition to captains and mates.

As a result, detailed cross-country comparisons are not feasible, and the findings cannot be generalised to represent entire occupational groups in the companies or regions. Instead, this report provides valuable qualitative insight into seagoing staff's perspectives and experiences related to the decarbonisation of island ferry traffic. This chapter synthesises results from the different regions and presents some regional highlights and comparisons where feasible.

8.1 Views on emission reduction in island ferry transport

8.1.1 Environmental awareness

Instead of differing from each other, the interviewed crews seem to resemble each other in their variation when it comes to environmental awareness and attitudes. The depth of concern, the framing of responsibility, and the perceived relevance of environmental action varied between the interviewees in each region.

Across all four regions, the interviewees demonstrated at least a basic awareness of the overall mitigation strategies and regulations in the maritime transport sector. While many acknowledged not knowing about the details, some demonstrated even high-level familiarity with the mitigation strategies and mechanisms. Some interviewees in each region expressed interest in updating their knowledge regarding these developments. While a few did not express any particular worry over climate change, many mentioned being slightly concerned, and some were seriously concerned. The latter often demonstrated a deeper familiarity with climate change and other environmental issues.

In **Mainland Finland**, environmental awareness was rather high, and some interviewees demonstrated a relatively broad perspective, considering lifecycle emissions and energy sources alongside emission reduction itself. Most were moderately and some deeply concerned about climate change. The latter expressed strong dissatisfaction with current mitigation efforts at all levels. In addition, a contradiction between slow development with electrification and municipal carbon-neutrality strategies was presented. The chief engineers

were typically more interested in the different green transition measures and their linkage to the drivers behind climate change.

In **Sweden**, the need for emission reduction was widely acknowledged. Environmental attitudes were nevertheless slightly heterogeneous – and at times marked by pessimism. The significance of mitigation efforts undertaken by a small country was also questioned. Despite this scepticism, emission reduction was seen as worthwhile, even as a means of setting an example. One interviewee articulated deep environmental concern, connecting global climate projections with local developments. They also highlighted a political paradox between maintaining a vibrant archipelago and achieving emission targets.

In **Estonia**, discussions of environmental issues were generally briefer and more pragmatic. Interviewees supported emission reduction but primarily framed it in terms of fuel savings, cost efficiency, and operational optimisation, with environmental benefits seen as secondary outcomes. Limited contract durations and state ownership of vessels were seen as barriers to long-term environmental investments by the ferry companies. Clearer communication about the rationale behind environmental measures was also requested.

In **Åland**, environmental concerns or attitudes were not discussed in-depth, but the interviewed were generally aware of the current and emerging emission regulations even though they mainly concern larger ships with a gross tonnage of over 5,000. In addition, the crew members were knowledgeable and engaged in optimising their fuel consumption and considered it important.

In all regions, many interviewees mentioned local environmental degradation, such as eutrophication and littering, as problematic. Those who expressed greater concern about environmental issues also provided concrete examples of these developments, drawing on various sources and their own experiences. In addition, an appreciation of and interest in observing the surrounding nature as part of daily work were clearly evident across the regions.

Despite the variation, all crews in all regions conceived emission reduction and the related measures and innovations positively. It was nevertheless widely reckoned that the driver behind many decarbonisation measures by the companies and governments is foremost economic than ecological.

8.1.2 Eco-driving and voyage optimisation

All crew members **in all regions** demonstrated motivation and engagement to operate energy efficiently, but the degree of institutionalisation, use of monitoring systems, training practices, and incentives had some variation between the regions and companies.

In **Estonia** and **Sweden**, the interviewees were actively using the energy and fuel monitoring systems as part of their daily work. In both regions, some of the more experienced skippers nevertheless noted that similar information was also available before but required combining information from different sources. Now, the relevant information is readily available, and it is also possible to compare different journeys done by other captains and in certain

circumstances. All the interviewees considered that the monitors support them in their work and in engaging in eco-driving practices.

In **Sweden**, half of the interviewees mentioned having attended to a separate eco-driving training, and the rest were looking forward to it. In Stockholm County, the ferries are single-directional vessels and the carefulness and energy-inefficiency of manoeuvring them to and from the jetties was mentioned more often than in other regions. The energy management system had helped the skippers in experimenting the optimal ways.

In **Estonia**, two of the lines are strongly affected by winds and waves, which was highlighted in the interviews also when discussing eco-driving. Unlike in other regions, Kihnu Veeteed in Estonia offers the deck officers a financial reward for eco-driving performance and fuel-savings. The employees considered this as an important and good incentive to optimise their performance. However, it was also noted how the target does not sufficiently take into consideration the varying weather conditions.

At Finferries, in **Mainland Finland**, eco-driving was well supported through advanced energy monitoring systems introduced already years ago and a separate multiday training offered for the captains. Although energy management displays were temporarily unavailable, prior experience suggested measurable reductions in energy consumption after their installation. At SLL in Helsinki, the fuel monitoring system had been installed only recently and it was not yet functional for the captains. Some of them were eager to access the information it provides.

All the ferries discussed in **Mainland Finland** are bi-directional not requiring specialised manoeuvring when approaching and leaving the pier. Two of the ferry lines are also short, rather sheltered, and optimised to 10–15 minutes' crossing times. Although there are not much possibilities or need for engaging in various different eco-driving practices, some interviewees demonstrated that eco-driving can be applied and energy efficiency improved even on these routes.

In **Åland**, eco-driving practices were primarily experience-based rather than systematised. Exposure to formal training had been limited, reflecting recent organisational changes and the relatively young operator. A fuel management system with the related displays had been installed on many of the Axferries ferries, but it was not yet in active use by the captains. Despite this, the captains were experienced and demonstrated strong knowledge of how manoeuvring and speed selection affect fuel consumption. Following the progress in other regions, it is likely that the driver's monitors will be considered useful also by the captains in Åland.

In all regions, the main motivation to engage in energy-efficient navigation seemed to be professional intuition and motivation to improve one's performance. The readily available information from the displays was also mentioned as a catalyst to optimise one's behaviour. In addition, some were very motivated to reduce energy consumption due to their environmental awareness and concern. Experimenting with eco-driving was also mentioned as a way to counteract boredom and engage in playful competition.

While the financial bonus was appreciated in **Estonia**, in **Sweden** and **Finland**, the interviewees were cautious of direct financial reward as it might lead to risk-taking. However, also in these regions, it was considered that the economic savings generated by their performance should be used for collective benefits for employees.

The hindrances to eco-driving were largely agreed upon **across all regions**. Safety was consistently described as the highest operational priority, followed by adherence to timetables, while energy savings through eco-driving was an additional priority. Given this hierarchy, and the highly contextual nature of island ferry operations, several factors can hinder eco-driving. These include the changing and partly unpredictable marine weather, passenger volumes and boarding processes, traffic, and other exceptional situations. If a delay occurs, the optimised schedule should be caught up without compromising safety.

In addition, some acknowledged that fatigue affects their engagement in eco-driving and, at times, they need to secure a short break by speeding up to the pier. The interviewees also mentioned that engagement in eco-driving varies between the deck officers and explained this by the variation of skills or knowledge and personal motivation.

Potential for **voyage optimisation** based on the number of passengers was identified in **all regions**. While the routes were already rather optimal, timetable redesign was considered possible. Slow steaming could be allowed by relaxing the schedules from a couple of minutes to even half an hour depending on the route. A more radical method, yet still based on the real demand of the ferry services, was to reduce the number of departures. This option was considered feasible especially during low season and certain times of a day when only a few or no passengers at all use the ferries.

8.1.3 Electrification of ferries

Three captains and four chief engineers in **Finland** and two captains in **Sweden** had experience from operating a fully electric or a hybrid ferry. They shared largely similar views on the electrification of ferries.

The interviewees regarded electrification as a clear improvement over conventional diesel-powered vessels, particularly in terms of energy efficiency and the work environment. Those who had worked on fully electric ferries highlighted the substantial reduction in noise, vibration, fumes, and oil handling, which markedly improved comfort in engine rooms, on bridges, and in passenger areas. The elimination of oil handling was also seen as reducing environmental risks, such as oil spills. Overall, the change in working conditions was often described as significant, and many interviewees expressed a reluctance to return to traditional vessels.

The transition to electric propulsion was widely perceived as smooth and supported by sufficient training. Core tasks and decision-making processes for captains did not change fundamentally, although new technical emphases emerged. The number of digital interfaces increased, and monitoring battery charge levels became a central responsibility. The charging procedures themselves were described as straightforward, but energy management required rather constant awareness, especially on longer or more demanding route segments.

In **Stockholm County**, the captain noted how electric propulsion altered vessel response characteristics, requiring some adaptation, but it also enabled more precise and energy-efficient manoeuvring, particularly during approaches to and departures from jetties.

In **Turku archipelago (FI)**, the electric vessels are large bi-directional road ferries and it had also already been a while since the captains first started operating them, and similar issues were not reported.

The interviewed engineers had generally adapted well to the new digital systems and appreciated their cleanliness and relative simplicity, even though some missed the tangibility of traditional mechanical equipment. Although operational reliability was regarded as generally good, it was not considered fully equivalent to or as straightforward as that of conventional fuel-powered vessels.

Battery-related disturbances, such as power interruptions and false alarms, were mentioned. Maintenance of electric ferries was also perceived as more complex, with a reliance on external specialists. It was also noted that hybrid vessels require an understanding of both electric and diesel systems, and that not all colleagues find it equally easy to adapt to new technology.

In all regions, all interviewees considered electrification as a viable option for maritime transport. Those without direct experience with electric ferries expressed interest in operating them. They often expressed more concerns about power sufficiency and vessel performance, particularly under winter conditions. In contrast, those with hands-on experience were more confident in the capacity of electric systems.

Rather than vessel performance, the reliability of supporting infrastructure emerged as the primary concern, and this was acknowledged by all interviewees. Shore-side power supply, grid capacity, and disturbances requiring specialised maintenance were identified as critical constraints especially in the complex archipelago. It was acknowledged that not all routes – particularly the longer, more remote and high-demand ones – are suitable for electrification. Instead, hybrid solutions were widely seen as better suited to archipelago routes.

8.2 Work environment, management support and safety

Because the working environment was perceived as relatively stable and largely unchanged across **all regions**, organisational or technological changes were not considered to require significant adaptation, cause stress or hinder work performance. The most substantial changes were the conversion of Finferries' *Stella* into a hybrid vessel in **Finland** and the electrification of *Silverö* in **Sweden**, to which crews reported having adapted well and received sufficient support.

The introduction of energy or fuel management systems was another recent change in most vessels; these were generally regarded as simple to use and providing useful information. At

the time of the interviews, the captains in **Helsinki (FI)** and **Åland** had not yet interacted directly with the system.

In **Mainland Finland**, training and management support were generally considered sufficient, but some issues of fragmented information flow, shift arrangements and a concern over the level of general safety requirements raised concerns, particularly in remote archipelago operations.

In **Sweden**, the interviews highlighted a strong organisational culture centred on communication and the exchange of experience. Captains emphasised open dialogue with management, clear prioritisation of safety, and well-structured onboarding procedures for new vessels. Risks were primarily perceived as external, including increasing traffic density and, at times, what interviewees considered irrational higher-level decisions by authorities and policymakers.

In **Estonia** communication between seagoing staff and management was generally functioning, but some suggestions were also presented. Some interviewees desired more regular and face-to-face interaction between the management. Crew cohesion and professional confidence were strong, and no major safety issues were expressed. However, the salary levels were criticised by some.

In **Åland**, a fairly recent organisational change was experienced as the previous key operator went bankrupt and Axferries was established. Otherwise, the work environment was described very stagnant with minimal technological modernisation or other changes. Crews expressed strong confidence in their work, and the small size of the organisation fostered close relationships and open, candid communication with management.

In all regions, the interviews demonstrated a high degree of professional confidence in handling the vessel in various conditions. While the peak seasons and keeping up with the schedules were reported as the most stressful times of their work, these circumstances were considered part of normal everyday work. The need and appreciation of both Informal and formal gatherings, peer learning, and onboard exercises were regarded as important strengths supporting safety, learning and work satisfaction throughout the interviews.

8.3 Future perspectives

Across all four regions, interviewees expressed a generally forward-looking outlook on and preparedness to adapt to the future developments of island ferry operations. There was a broad consensus that technological development will continue, but that progress must remain grounded in operational realities of the complex archipelagic environments.

Electrification was widely seen as a key long-term direction in maritime transport, especially on short routes in the Central Baltic Region. Most interviewees nevertheless shared similar views on the limits of battery technology and charging infrastructure, particularly for longer and remote archipelago routes. However, those who had experience with electric ferries were

more confident in the electric ferries' performance. Hybrid systems were nevertheless widely regarded as the most suitable near-term solution in **all regions**.

Some **Swedish** and **Finnish** interviewees also linked electrification to national self-sufficiency as it reduces dependence on imported fuels. Especially the **Finnish** interviewees noted that state-owned companies should act as the forerunners in green transition. In **Sweden**, some interviewees noted the importance of policy adjustments to support environmentally friendly options, and one urged the ferry operator to strive for a stronger negotiating position with the transport authority. In **Estonia**, longer contract periods were highlighted as a prerequisite for meaningful investments in emission reduction by the companies.

The interviewees had already experienced a digital shift in their job profiles and anticipated that future roles will increasingly involve more automation, data interpretation, and digital competence. Although some saw increased automation to replace some human workforce, most did not consider automation a threat to their employment in the near future. Full automation was consistently rejected in all regions. The interviewees in **all regions** emphasised that ethical judgment, situational awareness, and the ability to respond to failures require a continuous human presence in the archipelago routes.

In terms of careers, crew members appeared generally content with their roles but many expressed strong interest in further training and other possibilities for professional development. Some also noted how competent workers benefit the company as a whole, and some highlighted the importance of engaging employees more in planning and decision-making.

9 Conclusion

This report presents the first cross-regional study examining seagoing staff's experiences and perceptions of the decarbonisation of island ferry traffic in the Central Baltic Region.

Although the vessels, routes, companies and operating environments discussed in the interviews differ substantially across and within the studied regions, the findings point to a high degree of commonality in everyday work and how decarbonisation is understood and approached in ferry operations. Importantly, differences in many perspectives were found to be more pronounced within national groups and companies than between these administrative or organisational boundaries. This suggests that the practical real-life operational context and professional and personal backgrounds play a great role in how decarbonisation measures and practices are received.

Overall, seagoing staff demonstrated strong professionalism and confidence in their skills and a well-grounded, practical understanding of the complex and constantly changing operating environment in which island ferries are operated.

The everyday work of the seagoing staff requires continuous situational assessment of safety, schedules, technical systems and the varying passenger flows and environmental conditions. As a result, the crews expressed valuable practice-based knowledge and understanding of how emissions can be reduced in practice and the ferry operations and their work environment improved further.

Among the interviewed crew members, attitudes and preparedness toward emission reduction and other new developments in the sector were broadly positive. Interviewees were generally interested and receptive to the changes that support more efficient and sustainable operations.

Electrification, especially hybrid solutions, was seen as the future for ferry operations and eco-driving and voyage optimisation as important instruments for emission reductions.

Economic, practical and ecological benefits were nevertheless much intertwined in the discussions, which also highlights the advantage of coupling emission reduction with other benefits. Eco-driving was commonly perceived as an extension of good seamanship, and new technologies, such as the energy management systems and autopilot, were considered and welcomed as supportive tools, for instance. Where electric ferries had been introduced, the crew members had experienced notable improvements in their work environment as noise levels, vibration and oil handling had decreased.

The importance of management support, proper training, and effective communication with management were seen as prerequisites for both the successful implementation of new practices and employee wellbeing and performance. Some also called for greater employee involvement in decision-making. Face-to-face meetings, including management visits on board the ferries and opportunities for peer dialogue and experience exchange, were

especially valued across all regions. Where these elements were weaker, their strengthening was viewed as a key development need.

These notions align with existing research showing that involving employees in decision-making and prioritising their well-being leads to improved performance at both the individual and organisational levels. (e.g., Yuen 2018; Eurofund 2020; Glaveli et al. 2025).

Notably, some critique expressed by the crews was directed not at employers but at authorities and political decision-makers who are more detached from the everyday realities of ferry transportation. Similarly, clear potential for major emission reduction through slow steaming and reduced departures was identified in all regions, but opposition from regional decision-makers and residents was reckoned as a barrier to these measures.

Indeed, the operational environment the crews navigate is formed in the cross-pressure between multiple forces: variable marine weather conditions and traffic; responsibility for safety; schedules; rules and regulations set by authorities and operators; passenger expectations and behaviour; seasonality; and personal well-being. Changes in one dimension can often lead to changes in other dimensions.

The results also highlight how the archipelago ferries are rather exceptional, independent and mobile workplaces, detached from the management or policy-makers' offices at the shore. Based on the interviews, it seems that some of the practice-based knowledge the crews hold has not reached – or is not taken into consideration – by related stakeholders in the island ferry sector.

This qualitative study yielded rich insights into the perspectives and experiences of a limited number of participants in the island ferry sector in the Central Baltic Region. To gain a better understanding of the findings of this study and improve the generalisability and comparability of the results across groups, regions, and organisations, further research with a more standardised approach and involving a larger sample of crew members per region would be beneficial.

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Appendices

Appendix 1: Stockholm’s archipelago map with ferry routes in 2020 ([Skärgårdstrafiken, 2020](#))

