ESTONIAN-LATVIAN HARBOURS JOINT STRATEGY SURVEY

Interreg Estonia – Latvia

Co-funded by the European Union

THE ESTONIAN-LATVIAN HARBOURS JOINT STRATEGY SURVEY

COMMISSIONED BY THE ASSOCIATION OF ESTONIAN MARINE INDUSTRIES

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EXECUTIVE SUMMARY

The Estonian-Latvian Harbours Joint Strategy Survey 2024 aims to provide a foundational analysis for the development of harbours in the Talsi, Saaremaa, and Hiiumaa municipalities, with an emphasis on integrating offshore wind farms into the marine areas of Latvia and Estonia. The study is part of the Harbours and PPP project, funded by the Estonia-Latvia Programme. The survey outlines the current state and future potential of blue economy activities, focusing particularly on maritime transport, fishing, tourism, aquaculture, and the emerging offshore wind sector around the Gulf of Riga, as well as the Saaremaa and Hiiumaa marine areas.

Key findings indicate a strong interdependence between harbour development and the broader maritime economy, with a significant emphasis on the transition towards a greener economy. Harbours are not only pivotal in facilitating the production of renewable energy but also must adapt to become more sustainable and resilient against climate change. The survey highlights the expected demand for harbour services as offshore wind farms expand, detailing the role that harbours will play in maintenance and logistics and local economic growth.

The survey also identifies existing challenges, including the need for significant investments in harbour infrastructure to accommodate the operational demands of offshore wind farms and aquaculture. It emphasizes the role of collaboration between Estonia and Latvia to optimize investments and development strategies for harbours, ensuring they can cater to both local, national and international needs.

In conclusion, the survey offers a roadmap for the synchronized development of harbours in Estonia and Latvia, outlining strategic visions, estimated investment requirements, and potential cooperation opportunities that could enhance economic growth and sustainability in the region. The findings will assist local and regional authorities in crafting actionable development plans that align with both environmental sustainability and economic viability.

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INTRODUCION

The aim of the survey is to provide basis for the harbours development plans in Talsi, Saaremaa and Hiiumaa municipalities, considering the development of wind farms in the LAT and EST marine area.

The baseline survey has to provide a vision for a synchronized/symbiotic development of small harbours in EST and LAT and to assist with the mandatory chapters of local/regional thematic development plans:

1) analysis of current situation and prerequisites for further development;

2) the vision for the required activities to implement the development plan, development objectives and the main strategies to reach the objectives.

The analysis is based primarily on strategic documents, public databases and maps, existing studies, and environmental impact assessment programs and reports of offshore wind parks and aquafarms in Estonia and Latvia. It also incorporates GIS analysis, similar studies from Denmark, and the UK, interviews with offshore windfarms developers (Saare Wind Energy/Van Oord, Utilitas Wind, Enefit Green, ELWIND project), and a harbours questionnaire.

Special thanks to Anni Hartikainen, Liina Härm, Ingrid Tilts, and Jaanis Prii for their critique, corrections, and advice.

TERMS AND ABBREVIATIONS

AIS – Automatic Identification System

EST – Estonia

EIA – environment impact assessment

CTV - Crew Transfer Vessel

EMODnet - European Marine Observation and Data Network

Harbour hinterland – the area of influence of the harbour, the land area served by the harbour from which and to which cargo flows are transported by land; the land area where the harbour sells its services and interacts with its users.

LAT – Latvia

O&M harbour - operation & maintenance harbour for offshore wind farm

OWF – offshore wind farm

OWT - offshore wind turbine

SOV - Service Operation Vessel

Small harbour - In Estonia and Latvia small harbours are defined differently by law. In Estonia small harbour is defined as a harbour or a part thereof that provides harbour services to vessels with a total length of up to 24 meters. In Latvia, however, the definition is based on primary activities such as fishing, fish processing, tourism, and the export and import of ecologically clean goods.

1. DEVELOPMENT TRENDS

1.1. Development trends of maritime economy

The development of harbours is closely linked to the development of the entire maritime economy. Without harbours, there is no maritime economy, and vice versa. Worldwide, there is a trend of the blue acceleration - a race among diverse and often competing interests for ocean food, material, and space.[1] Besides the traditional activities, new sectors are emerging. The latest Blue Economy report by the EU divides Blue Economy sectors into two categories - traditional and emerging sectors.[2]

The traditional Blue Economy activities, the "established sectors," are: marine living resources, marine non-living resources, marine renewable energy, harbour activities, shipbuilding and repair, maritime transport, and coastal tourism.

The emerging sectors, i.e., sectors that are either new (i.e., innovations) and have potential for further growth and expansion, are: ocean energy, blue bioeconomy and biotechnology, desalination, marine minerals, maritime defence, security and surveillance, research and education, infrastructure and maritime works (submarine cables, robotics, etc.).

The EU strategy Blue Growth identifies 5 sectors that have high potential for new jobs, promoting innovation and sustainable growth. These sectors are aquaculture (fish and shellfish farming), tourism, marine biotechnology, ocean energy and seabed mining.

According to various studies, national strategies and action plans and marine spatial plans, the following maritime economy sectors are particularly important in the context of the development of harbours in Western Estonia and Latvia:

- maritime transport/shipping;
- fishing — coastal fishing and trawling;
- maritime tourism;
- marine renewable energy, especially offshore wind farms (OWF);
- aquaculture, mainly fish farming.

Development trends of harbours in the context of Green Transition "Green transition" in general is the process of shifting from a traditional, fossil fuel-based economy to one that is more sustainable and environmentally friendly. Harbours participate in the green transition in two ways: firstly, by contributing to the production of green energy—primarily offshore wind energy today—and secondly, by becoming greener, more

[1] *The Blue Acceleration: The Trajectory of Human Expansion into the Ocean, https://www.sciencedirect.com/science/article/pii/S2590332219302751#fig1*

2 https://oceans-and-fisheries.ec.europa.eu/system/files/2021-05/the-eu-blue-economy-report-2021_en.pdf sustainable and adapted to climate change themselves.

By the new approach for a sustainable blue economy in the EU[3] beyond transshipment and logistics, ports future lies in developing their key role as energy hubs (for integrated electricity, hydrogen and other renewable and low-carbon fuels systems), for the circular economy (for collecting, transshipping and disposing of waste from ships and other port industries, and for decommissioning ships), for communication (for submarine cables), and for industry (as industrial clusters). A further aspect that helps achieve decarbonisation and zero pollution is the use of smart digital solutions and autonomous systems, as these optimize traffic flows and cargo handling in and around ports. Taking up these new roles will improve working conditions of operators and living conditions for surrounding communities.

Current situation, ambitions and possible developments of offshore windfarms In 2023, total offshore wind capacity in Europe was nearly 32 GW. Europe is set to build approximately 5 GW of offshore wind annually over the next three years. This is not enough to reach Europe’s climate and energy security targets. It adds to the need to install more offshore windfarms towards the end of the decade. European countries will need to build 24 GW a year in the period 2027-2030 to reach the 2030 targets.[4]

To ensure that offshore renewable energy can help to reach the EU's ambitious energy and climate targets for 2030 and 2050, the Commission published a dedicated EU strategy on offshore renewable energy (COM(2020)741) on 19 November 2020 which proposes concrete ways forward to support the long-term sustainable development of this sector. It sets targets for an installed capacity of at least 60 GW of offshore wind by 2030 and 300 GW by 2050.[5]

Estonia has a target to cover 100% of annual electricity demand with renewables by 2030 and to achieve climate neutrality by 2050.

Latvia has the goal to reduce total greenhouse gas emissions (without land use, land-use change and forestry) by 65% from 1990 levels by 2030 and to achieve net zero by 2050. Latvia has set a low ambition target of 400-500 MW for offshore by 2030 and even 2050[6].

Both Estonia and Latvia have established their own maritime spatial plans, designating areas for the development of wind energy (see figure 1). In Estonia, the implementation of these designated areas

3 Communication from the commission to the european parliament, the council, the european economic and social committee and the committee of the regions on a new approach for a sustainable blue economy in the eu transforming the eu's blue economy for a sustainable futuure. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:240:FIN

4 Wind Europe, https://windeurope.org/newsroom/press-releases/lots-of-good-news-in-offshore-wind-including-in-the-supply-chain/

5 Offshore renewable energy, https://energy.ec.europa.eu/topics/renewable-energy/offshore-renewable-energy_en

6 Baltic Wind, https://balticwind.eu/lwea-unlocking-the-potential-of-latvian-offshore-wind/

is managed through auctions organized by the Consumer Protection and Technical Regulatory Authority (CPTRA). In Latvia, no specific procedure for this is known to exist. As of September 25, 2024, one superficies license has been issued in Estonia, and seven superficies license proceedings are ongoing (table 1, figure 1). In Latvia, one superficies license is under review.

It is important to note that the actual size of the OWFs in the future may be significantly smaller than the initially requested area, as various exclusions may arise during the Environmental Impact Assessment (EIA) and studies. For example, in the case of the Saare Wind Energy OWF, areas filled with sediments on the seabed and partially the habitat type of reefs were excluded for the placement of wind turbines. There is no such data available yet for other OWFs, but exclusions could also be caused by birds, shipping, trawling and other factors.

TABLE 1. OWF DEVELOPMENT PROJECTS IN ESTONIA AND LATVIA (DATA: CPTRA, ELWIND)

Area	Developer	Capacity (MW)	Development Status	Production Timeline
Saare Wind Energy (Saaremaa)	Saare Wind Energy	1400	EIA approved	2033
Elwind (Saaremaa)	Estonian Republic	1000	EIA in progress	2033+
Elwind (Latvia)	Latvian Republic	1000	EIA in progress	2033+
Saare-Liivi (Gulf of Riga)	Utilitas Wind OÜ	1200	EIA in progress	2033
Liiv (Gulf of Riga)	Liivi Offshore OÜ	1000	EIA in progress	2033
Loode-Eesti (Hiiumaa)	Enefit Green	1000	EIA approved, in dispute in court	2033++
Liivi 1, Liivi 2 (Gulf of Riga)	UAB Ignitis renewables, Copenhagen Infrastructure Partners P/S (CIP)	2300	EIA in early phase	2033++
Saare 2.1., Saare 2.2. (Saaremaa)	Deep Wind Offshore AS	2400	EIA in early phase	2033++
Liivi Offshore OÜ 1 and 2 (Gulf of Riga)	Liivi Offshore OÜ	2010	EIA in early phase	2033++

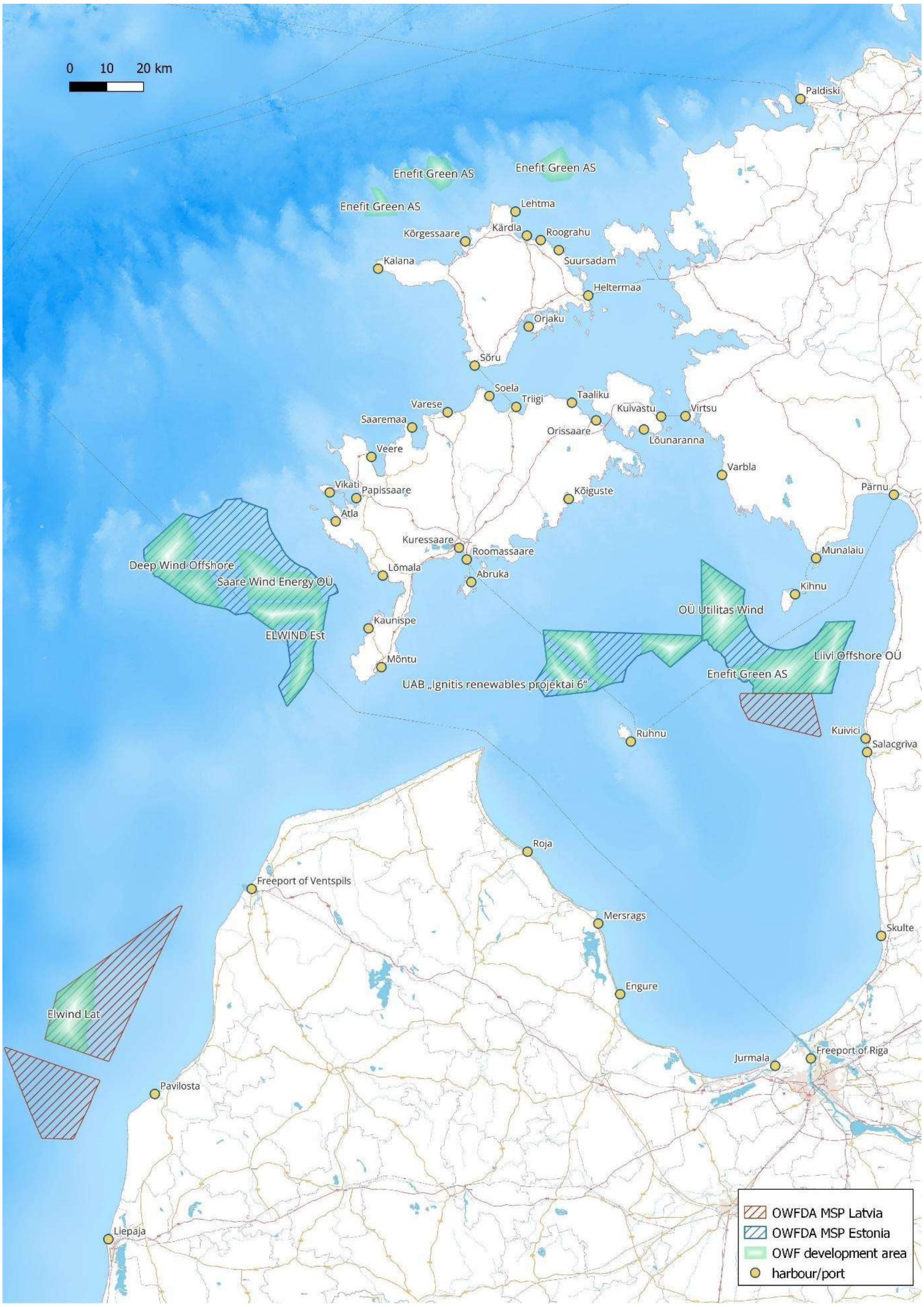


FIGURE 1. OWF DEVELOPMENT PROJECTS IN ESTONIA AND LATVIA (DATA: CPTRA, ELWIND)

2. LIKELY FUTURE DEMAND

2.1.1. The role of harbours in the value chain of offshore windfarms

Offshore wind farms are highly complicated systems. Many different enterprises with a variety of backgrounds, knowledge and technical know-how are involved depending on the phase of the process (Figure 2) [7]. Every new phase needs the decision about finances and partners in the project, including harbours that can enable the specific operations.

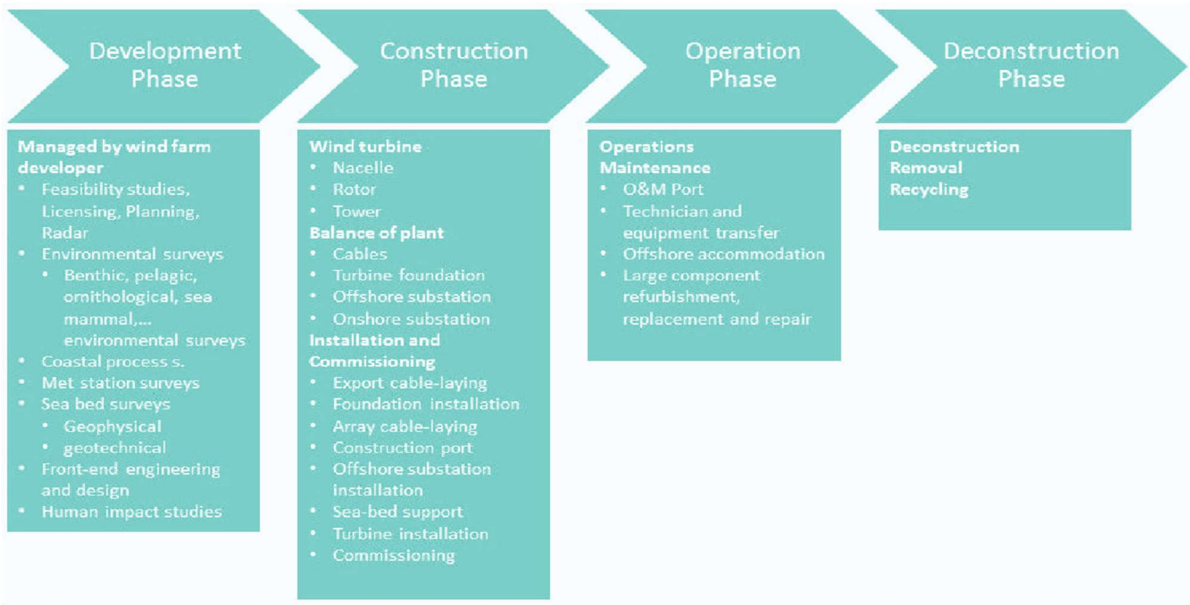


FIGURE 2. VALUE CHAIN OF THE OWF BY TASK

The development phase usually takes 4-6 years. During this time the project is managed by the wind farm developer. EIA including several surveys and studies are carried out to reach approval status. Nearby harbours are used for conducting environmental studies.

The construction phase takes 2-4 years. During this time, the wind turbines are constructed and installed. Many different components have to be put together. Substations are built and cables produced, to connect wind turbines and substations (offshore and onshore). At the same time the onshore substation and grid connection must be built (if missing). Construction is carried out from large construction

[7] *Weig, B., 2017. BONUS BALTSPACE internal project report: Spatial Economic Benefit Analysis.*

ports with construction vessels, assisted by CTVs from smaller nearby harbours.

The operation phase of offshore wind farms is limited to 30 years, with 5 years of possible extension. During operation, the performance of the wind farm has to be monitored, maintenance schedules have to be planned and customer and supplier interaction should be managed. Observation, service and repair are the main tasks to be done. A harbour nearby is usually chosen to function as operation & maintenance harbour, providing facilities. Technicians and equipment have to be transferred to the farm and accommodated in cases of longer stays.

The deconstruction phase - deconstruction, removal and recycling of offshore wind farm components. The need for harbours is similar as in the construction phase.

Offshore wind harbours play a crucial role in ensuring the cost effectiveness of an offshore wind project across the main stages of the project, from planning, production and pre-assembly, installation, O&M and decommissioning. The main types of harbours involved in the offshore wind sector are listed in Table 2.

> Offshore wind farms operate for 30 years, extendable by 5. Key tasks include performance monitoring, maintenance planning, and managing customer-supplier interactions, alongside observation, service, and repairs.

For countries which do not have local manufacturing capacity in offshore wind, the installation and O&M phase, by default, becomes the main driver of local economic benefits. Installation and O&M offers opportunities for domestic harbours and the hinterland of local suppliers, incl. seafarers, transport and logistics workers, technicians, and engineers. Although harbours themselves usually employ only few people directly, they play an important role in the local economy, generating substantial economic activity and local jobs in their hinterland.

TABLE 2. OWF HARBOUR TYPES[8]

Harbour type	Description
Installation and pre-assembly harbours	Preassembly and/or installation of main components which are received either by road transport or, increasingly, by sea from other harbours (via feeder- or base harbours). Often classified as large-component ports with significant space for storage and assembly of components.
Operation and maintenance (O&M) harbours	Act as local base harbours for the ongoing maintenance and repair of an offshore wind farm once commissioned. Requires less space and specialized capabilities than installation or production harbours.
Production harbours	Due to the increased size and weight of wind turbine components, some turbine and foundation manufacturers has started to establish manufacturing facilities within suitable harbours, following the example of offshore cable manufacturers where harbour production is well-established.
Import/export ports	Transactional ports involved in loading, unloading and storage of main components to/from the primary offshore wind manufacturing facilities.
Specialized ports	Ports which have specialized in e.g. decommissioning, re-powering, energy storage or in research and testing of offshore wind farm components.

2.2. The demand for harbour services by offshore windfarms

2.2.1. THE OPERATION PHASE

The operation phase of offshore wind farms lasts for 30 years, with an optional 5-year extension. During this period, the wind farm's performance must be monitored, maintenance scheduled, and interactions with customers and suppliers managed. Key tasks include surveillance, maintenance, and repair. A nearby harbour is typically designated as the operation and maintenance hub, providing necessary facilities (photo 1). Technicians and equipment must be transported to the site and accommodated for longer stays.

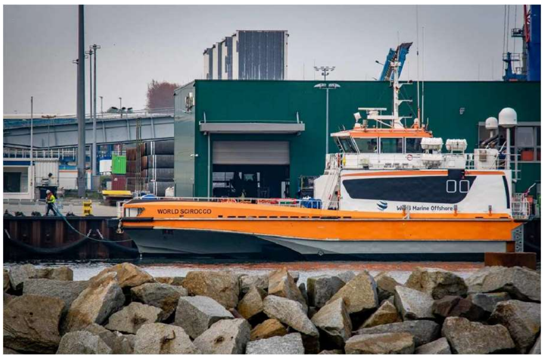


Photo 1. Operation Center and warehouse of Iberdrola with CTV in Sassnitz (Germany) (photo: Van Oord)

[8] *QBIS, 2020. Socio-economic impact study of offshore wind. Danish Shipping, Wind Denmark and Danish Energy with support from The Danish Maritime Foundation.*

During the warranty period, manufacturers typically manage wind turbine maintenance and decide whether to use CTVs or SOVs and which harbour to base O&M operations in.

Maintenance and repair are the primary focus during this phase. Only a few sectors are involved in these tasks, but logistics remain crucial, and periodic renewal of coatings and lubricants is necessary. Environmental monitoring is also mandatory throughout the wind farm's lifecycle. Insurances, legal consultancies, and research continue their roles, while investment firms and owners seek to recoup their investments. IT providers constantly check and improve systems, and project management ensures smooth operations.

O&M activities support the ongoing operation of wind turbines, balance of plant[9], and associated transmission assets. These activities begin once construction is complete and focus on safe operations, asset integrity, and optimizing electricity production. The wind farm owner manages site operations and oversees planned maintenance and fault responses. Wind turbines are typically under warranty for the first three to ten years, with suppliers offering maintenance and service agreements.

After the warranty period, maintenance may be handled by an in-house team, a specialist company, or through an arrangement where technicians transfer to the wind farm owner. O&M aims to maximize financial returns by balancing operational expenditure and turbine yield. By scheduling downtime during low wind speed summer months, high availability can be ensured during winter when wind speeds and energy outputs are higher. Contractual arrangements that reward energy production are becoming more common. Since all regular maintenance of the wind turbines must be carried out during the summer period, ice conditions in the harbours are not as critical.

Scheduling downtime in low-wind summer months ensures high availability during winter's peak wind and energy output. Regular maintenance in summer makes harbour ice conditions less critical.

In case a turbine requires emergency repairs outside the navigation season and access is hindered (e.g., due to ice), repairs are conducted using a helicopter, which does not mean that the harbour must have a helipad. If a helicopter is needed, it will come from its base and, if necessary, use the local airport.

In the Baltic countries, there are bigger ports who are interested in catering the

[9] *Balance of plant maintenance and service is focused on ensuring the operational integrity and reliability of all wind farm assets other than the wind turbines, including the substation(s), foundations, array cables, export cables, scour protection and corrosion protection systems.*

installation of offshore wind farms, which will need to have sufficient quay, depth, load bearing capacity, land clearance for warehousing, specialized local suppliers; the proper supporting infrastructure in the hinterland such as access roads, hospitals, helicopter access as well as accommodation, local transport services and more. In Paldiski, Liepaja and Klaipeda ports there are preparations ongoing to become installation ports for OWF-s.

Smaller harbours are unlikely to be able to handle the next generation of wind turbines without significant investments. It should also be noted, that unlike O&M harbours, the installation harbours might be abandoned during the operational phase. Therefore, harbours that have opportunities to find alternative uses during this period are in a better position.

Unlike O&M harbours, installation harbours may be abandoned during operation, making those with alternative uses more sustainable.

Smaller harbours near offshore wind farms play a crucial role during the O&M phase. The decision on which ports to use for installation and O&M is made in close collaboration between the offshore wind turbine (OWT) manufacturer and energy companies. As manufacturers typically handle wind turbine maintenance during the warranty period, they also decide which solution (CTV or SOV) and harbour will be used for O&M. Currently, there are only two offshore wind turbine manufacturers in Europe: Vestas and Siemens Gamesa.

For O&M harbours, distance to shore remains the key parameter due to the frequent shipping to and from the windfarms, which may favour smaller harbours (see chapter 1.5.2.).

The choice of O&M harbours for OWFs is crucial in determining the cost of electricity generated by the entire wind farm. This must be considered by the countries where offshore wind farms are located, the local governments in the region, and the developers and future operators of the farms. Although the operating costs of OWFs have been decreasing over the years, they still account for approximately 25% of the total cost of electricity from offshore wind farms.

An important aspect is the size of the wind turbines – all ongoing wind farm developments consider a maximum hub height of 350 meters above sea level, and the planned maximum capacity of one turbine ranges from 10 to 25 MW. However, in the Liivi 1 and 2 area, for example, the planned maximum capacity of one turbine is up to 25 MW, with a maximum hub height of up to 400 meters above average sea level. As turbine sizes increase, so do the challenges for O&M.

2.2.2. A SHORE-BASED OR AN OFFSHORE MAINTENANCE AND SERVICE STRATEGY

The choice of a suitable harbour derives from the wind turbines manufacturers decision whether to use a shore-based maintenance service (using crew transfer vessels) or an offshore maintenance service (using service operation vessels). This primarily depends on the wind farm's distance from the land. For efficiency, the first preference is always shore-based service solution (CTV) (photo 2).

Photo 2. CTVs in the Port of Helgoland (Germany) (photo: Van Oord)

According to literature and interviews with developers and the manufacturer Siemens Gamesa, the most important criterion for making the decision is the spatiotemporal distance. The journey from the harbour to the wind farm by CTV can take a maximum of 60-90 minutes, which generally corresponds to a distance of 30-40 km.

It is important to note that the actual size of wind farm area in the future may be significantly smaller than the initially requested area, as various exclusions may arise during the Environmental Impact Assessment and studies. Therefore, it is not yet possible to determine the actual distance of most of the planned OWFs in Estonian and Latvian maritime areas from the harbours. Additionally, there may be situations where the distance is suitable, but it is still not possible to use CTVs due to shallow areas or restrictions for nature conservation.

To maximize local benefits, the onshore service model is preferred. "O&M harbour" typically refers to local harbours serving CTVs.

For the efficiency reasons the offshore maintenance service (SOV) (photo 3) is chosen only for shore-distant windfarms. In that case, the proximity of the port is not a key decision factor. Instead, other factors may become decisive, such as the depth, the need for investments and the rate of harbour fees. The availability and quality of the hinterland such as local services and supplies is only the third consideration when choosing between on-shore (CTV) and offshore (SOV) service models.

Photo 3. Service Operation Vessel 7017E, damen.com

Compared to CTV, the use of SOV significantly reduces the consumption of onshore services, as the crew lives on the ship. Consequently, there are also significantly fewer indirect and associated jobs and the socioeconomic positive impacts are significantly smaller. Therefore, for higher local benefits, the on-shore service model should be preferred.

Choosing the nearest port for an OWF is also financially advantageous. The CAPEX for establishing CTV ports is included in the broader OPEX of wind farm maintenance (figure 3). Costs are lower in countries where farms are closer to the shore and maintenance ports. For reasons described above, the term "O&M harbour" is usually perceived to refer to a local harbour providing services to CTVs. Table 3 provides a comparison of both strategies.

FIGURE 3. AVERAGE LIFETIME OPEX/MW/YEAR (KEUR) BASED ON COUNTRY AND DISTANCE FROM SHORE (REAL 2020) [10]

[10] *https://peak-wind.com/update-2022-opex-benchmark-an-insight-into-the-operational-expenditures-of-european-offshore-wind-farms/*

TABLE 3. COMPARISON OF CTV AND SOV BY CATAPULT[11]

	ON-SHORE SERVICE MODEL (CTV)	OFFSHORE SERVICE MODEL (SOV)
Function	CTVs provide access for technicians and contractors to the wind turbines from the onshore OMS base to turbine locations and substation. CTVs are the preferred access solution for projects closer to shore.	SOVs provide an offshore OMS base, with staff working from the vessel for periods of two to four weeks at sea. SOVs are the preferred way to maintain and service wind farms located far from shore.
Costs per 1 GB OWF	The charter day rate for a CTV is about 3000 EUR, depending on specification, availability and contract period. (Fuel is not typically included in the charter cost and there is an important emphasis on fuel efficiency of vessels.)	Charter costs around 30 000 EUR per day depending on size and fit out (excluding fuel).
Key facts	Vessels length is from 25 to 30 meters. Require a minimum draft from 2,5 to 3,5 meters. CTVs transport personnel to the wind farm on a daily basis and do not have overnight facilities. Robust vessels that can operate in adverse weather conditions. Wind farm operators typically use aluminium catamarans up to 30m long with capacity for 12 to 16 technicians. Vessel speeds can be up to 30kn (in average 15-25 kn) and are designed to transfer maintenance and service team members in comfort and safety to the wind farm ready to start work. CTVs may have fixed or controlled pitch propellers but operators may prefer the increased manoeuvrability of water jets. Vessels with a smaller draught (less than 2 m) may be used where harbours are more challenging to operate due to water depths. CTVs have a load capacity up to 30t for turbine components and consumables, as equipment.	Vessels length is from 80 to 100 m. Require a minimum draft from 5 of 7 meters. SOVs offer accommodation, mess and welfare facilities for wind farm technician staff, as well as workshop and spares storage. SOVs will stay at the wind farm for up to 2 weeks at a time, at which point they will return to home port to restock and change crews. Access to the wind turbines is achieved either by smaller crew transfer vessel, daughter craft, by helicopter, or directly from the SOV using a turbine access system. SOVs have operational speeds of up to 15kn. They are equipped with dynamic positions systems. SOVs can typically accommodate crew between 50 and 100, of which up to 50 may be wind farm workers.

[11] *Catapult https://guidetoanoffshorewindfarm.com/*

2.2.3. CRITERIA FOR THE O&M HARBOUR (SHORE-BASED STRATEGY)

The criteria for selecting O&M harbour do not differ much from the general criteria important for harbours overall. The main criteria are presented in table 4.

TABLE 4. CRITERIA FOR THE O&M HARBOUR

Determinants of Port Competitiveness in general[12]	Specific for O&M harbour by interviews and Catapult[13]
The geographical location.	The geographical location (distance from the OWF outer area not exceeding ca 30-40 km)
Physical and technical infrastructure.	Draft of no less than 2.5 m, accessible at all water levels throughout the navigation season. A 1 GW wind farm is likely to require up to 3-4 CTV s. CTVs use purpose-built concrete pontoons equipped with mooring, electrical, and water systems, as well as a fast fueling system capable of supporting a small crane with a lifting capacity of at least 100 kg. Refueling can be arranged using a fuel truck. Each CTV requires a berth of approximately 30 m for loading. The berths are expected to be constructed during the construction phase and later repurposed for operational use.
Efficiency, quality and costs of services (e.g. harbour dues)	Preferred are those harbours where the capital and operating expenditures ratio is optimal
Connectivity of the harbour on landside.	Good infrastructure in the hinterland, which must include access for trucks to transport wind turbine spare parts, as the supply for the maintenance harbour is carried out by land, and an airport nearby for the quick transport of workers and specialists. Accommodation possibilities nearby (max 20 min to drive).
Availability, quality, and costs of logistic value-added activities (e.g. warehousing).	Space for an 8000-10000 m2 warehouse next to berth which includes everything they need (workshops, showers etc). The loading of spare parts onto CTVs is done from the warehouse, requiring a small crane with a lifting capacity of at least 100 kg[14]. The operations base consists of office(s), warehousing, workshop(s) and car parking (photo 3).
Availability, quality, and costs of harbour community systems (PCS) and other digital solutions.	
Harbour security/safety and environmental profile of the harbour.	
Harbour reputation.	

[12] *Port Economics, Management, and Policy (PEMP) https://porteconomicsmanagement.org/pemp/contents/part5/inter-port-competition/#2_Geographical_and_Functional_Levels_of_Port_Competition*

[13] *Catapult https://guidetoanoffshorewindfarm.com*

[14] *In the case of a CTV, there is no need for a more powerful crane, as the CTV only transports smaller spare parts, which must be carried manually into the wind turbine at sea.*

3. CURRENT STATE OF HARBOURS

3.1. Natural conditions

Geology

One of the most significant differences in the area under consideration is geology, specifically the composition of the bedrock. In Hiiumaa and Saaremaa, this consists of Ordovician and Silurian limestones, whereas in Latvia, it is Devonian sandstones (figure 4). The composition and depth of the bedrock determine the depth and dredging possibilities of the harbours. Devonian sandstone is softer and easier to dredge. However, dredging harder limestone can be challenging and expensive, if not impossible.

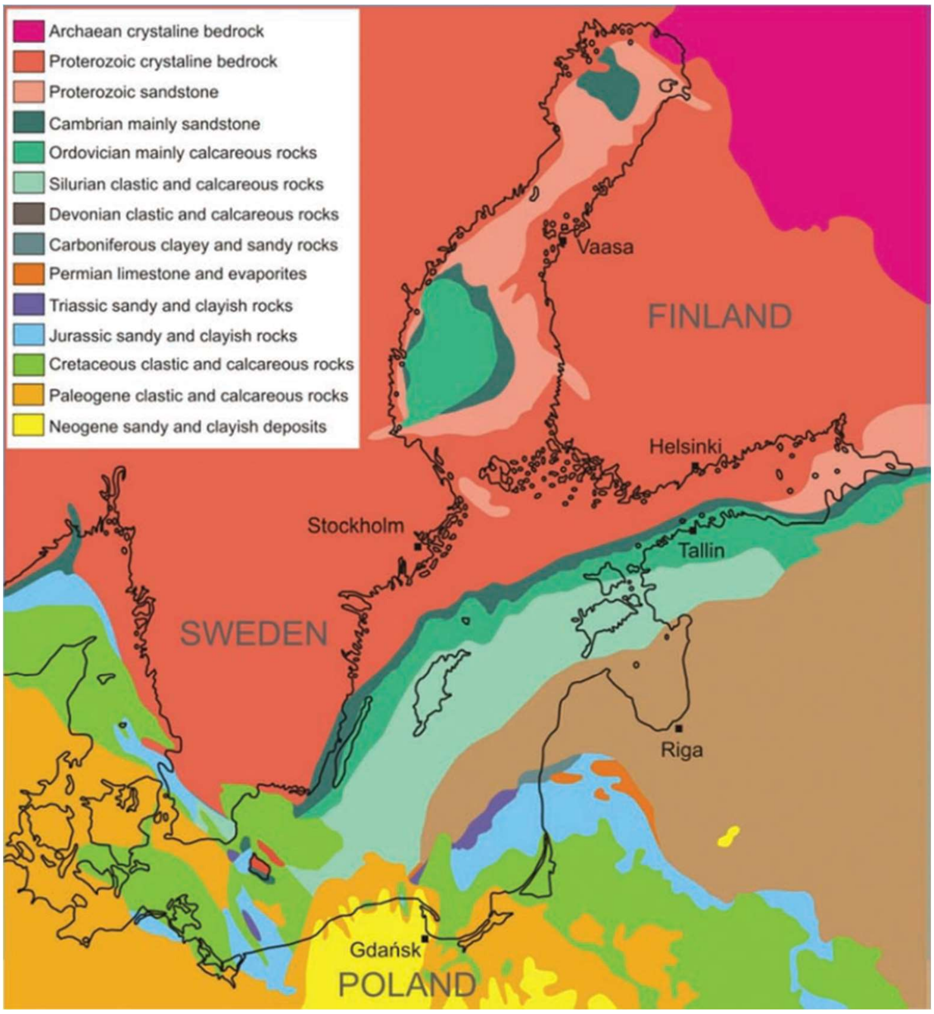


FIGURE 4. PRE-QUATERNARY GEOLOGY OF THE BALTIC SEA REGION[15]

[15] *The Baltic Sea Basin* https://www.researchgate.net/publication/318199123_The_Baltic_Sea_Basin

At the same time, Devonian sandstones are more susceptible to erosion (figure 5), requiring repeated dredging of the harbours. The dominant drivers of sediment transport, erosion, and accretion in the Baltic Sea are wave energy and direction. Factors such as Baltic Sea volume, storm surges, wave setup, the presence or absence of sea ice, and long-period wave energy from infragravity or edge waves mainly influence the duration and location on the beach profile where sediment can be mobilized and erosion may occur.

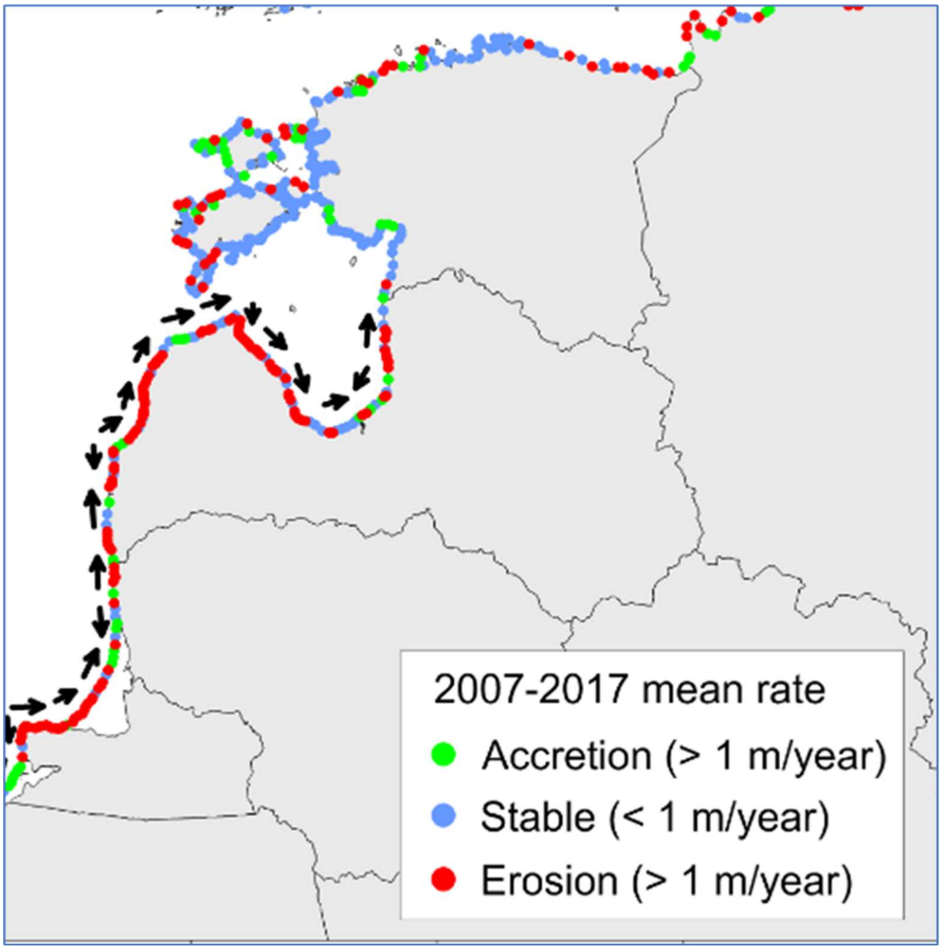


FIGURE 5. RATE OF MEAN ANNUAL COASTLINE CHANGE FROM 2007 TO 2017 IN THE BALTIC SEA. (BY THE BALTIC SEA BASIN. HTTPS://WWW.RESEARCHGATE.NET/PUBLICATION/318199123_THE_BALTIC_SEA_BASIN)

When planning the future of harbours, land uplift must also be taken into account, which in Hiiumaa can reach up to 4 mm per year (figure 6).

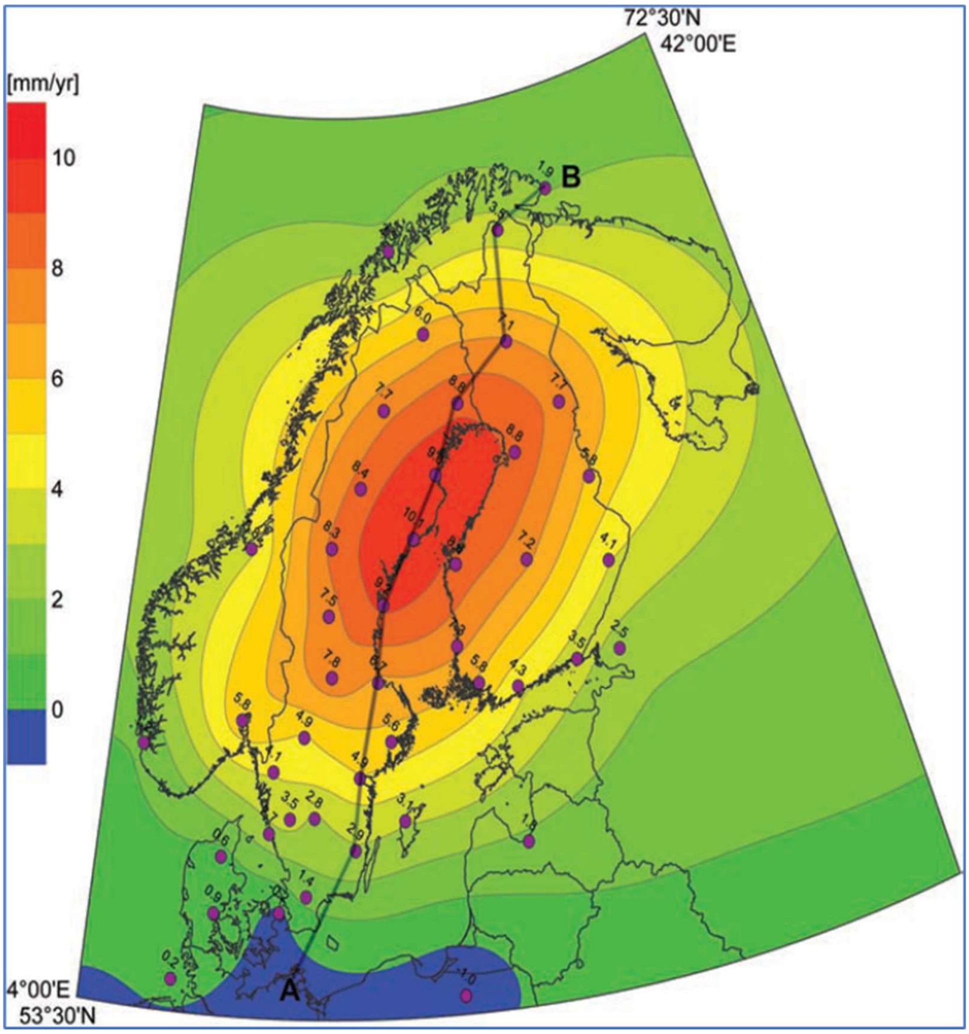


FIGURE 6. INTERPOLATED SURFACE OF PRESENT-DAY CRUSTAL UPLIFT RATES (IN MM/YEAR) [16]

Water temperature

In winter, the surface water temperature approaches zero. The absolute minimum surface water temperature in the Gulf of Riga ranges from -0.18 °C to -0.45 °C, while in the open sea, it ranges from -0.4 °C to -0.6 °C. Water begins to warm in April, occasionally in March. The monthly average water temperature peaks in July, reaching +16 °C to +18 °C. The highest surface water temperature generally occurs two weeks after the peak air temperature. In the Gulf of Riga, the maximum surface water temperature can reach +26 °C to +28 °C, typically in July, but along the Baltic

[16] *The Baltic Sea Basin https://www.researchgate.net/publication/318199123_The_Baltic_Sea_Basin*

Sea coast, it peaks in August. Cooling starts at the end of August and continues until early December, reaching +1 °C to +3 °C.

Wind

The prevailing wind directions are from the west, southwest, and south. The longstanding average ground-level wind speed on the coast ranges from 3.4 to 4.6 m/s, while the average wind speed at sea is higher. The annual average wind speed in the West Estonian Archipelago and open coastal areas of the Baltic Sea, measured 10 meters above ground level, is 6–7 m/s. Winds are stronger in autumn and spring due to high cyclonic activity.

At a height of 150 meters, the average annual wind speed in the sea areas west of the islands ranges from 8.5 to 9 m/s, with gusts exceeding 30 m/s. In the open middle part of the Gulf of Riga, the average annual wind speed is 8 to 8.5 m/s, with gusts between 26 and 28 m/s. The number of days with storm winds (>15 m/s) and strong winds decreases rapidly from the coast towards inland areas. Offshore and windy coasts experience up to 40 storm days per year. However, in the transitional coastal zone, there are usually 10-20 storm days per year, both over the sea and up to 10-20 kilometers inland, where there are mostly fewer than 10 storm days.

Waves and currents

Currents in the Baltic Sea are influenced by wind direction and strength. Water flow along the coast in an eastern direction is more common. Strong western winds raise the water level, while eastern winds lower it. Extreme fluctuations can be 2–2.5 meters above and 1.2 meters below the mean water level. Typical wave heights are 1-2 meters, but during storms, offshore wave heights can reach 5-6 meters, and up to 10 meters during exceptional western storms. Temporary changes in water levels depend on coastal topography and local wind conditions, with the smallest changes occurring on the offshore coast.

The characteristic current velocity in the surface layer of the Estonian marine area is 10–20 cm/s, but currents are highly variable and dependent on local wind. Maximum current velocities exceeding 1 m/s have been recorded during strong coastal jets in straits (e.g., Suur Strait) and along the coast.

Sea ice

The variability of sea ice formation, duration, and breakup is extremely high, making every winter unique (figure 7). The freezing point of seawater in the East Baltic Sea area is approximately -0.4 °C due to low salinity, and even higher near river mouths discharging fresh water into the sea.

In extremely mild winters, ice is only found in Pärnu Bay and the Gulfs of Väinameri. In harsh winters, the entire Estonian sea area is covered with ice, even on the west coast of Hiiumaa and

Saaremaa, and the west coast of Latvia, where ice can be present for 30 days. Ice formation in the Gulf of Riga usually intensifies in February, facilitating the freezing of the bay and influencing the functioning of the Gulf ports. In temperate winters, the coastal waters of the Gulf of Riga and the Irbe Strait are covered with stationary ice by late February. In harsh winters, the entire Gulf of Riga is covered with ice by mid-January, but in mild winters, the bay does not freeze. The high seas of the Baltic Sea usually do not develop an ice blanket in winter.

Drifting ice occurs mainly in areas with shorter average ice cover duration, such as the open part of the Gulf of Riga and the western coast of Saaremaa. The movement of drift ice causes the formation of hummock ice, making navigation difficult for ships in winter. Hummocks form mainly at the edges of fast ice, where drift ice is piled up by wind and currents. In severe winters, hummocks can occur in most marine areas of Estonia, with Pärnu Bay and Väinameri being the most affected.

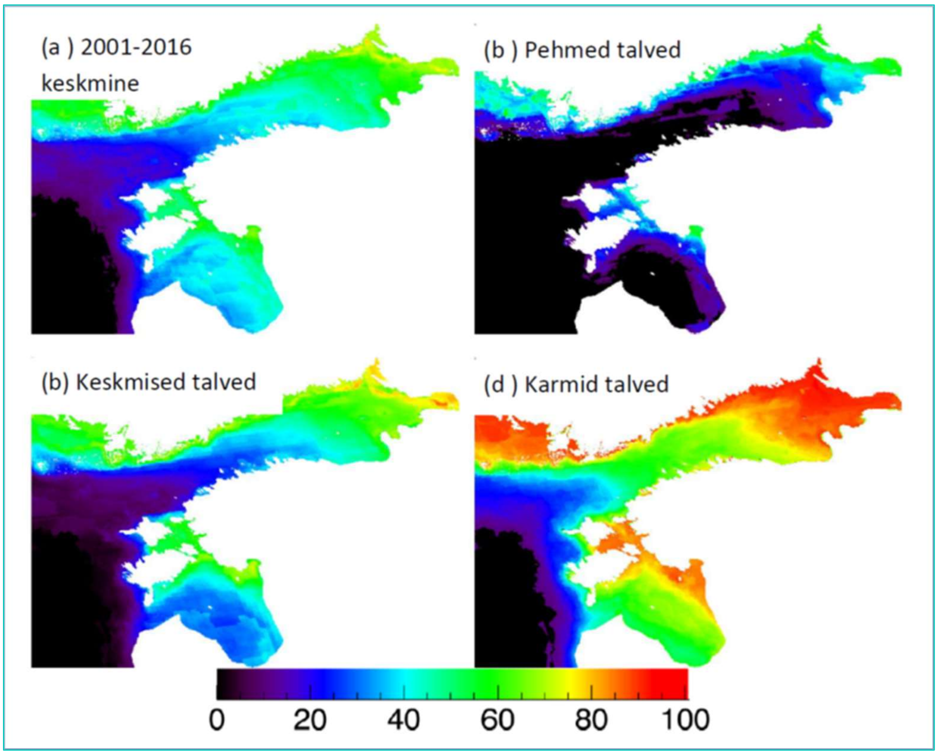


FIGURE 7. THE FIGURE SHOWS THE PROBABILITY (%) OF ICE OCCURRENCE AT EACH POINT OF THE SPACE DURING THE PERIOD 2000-2016. THE LIKELIHOOD OF ICE OCCURRING IN DIFFERENT WINTER SCENARIOS: (B) MILD WINTERS, (C) AVERAGE WINTERS, AND (D) SEVERE WINTERS. [17]

[17] *TTU Institute of Marine Systems, 2016*

3.1. The scope of the survey

The scope of the survey includes small harbours in Latvia and Western Estonia, specifically focusing on Gulf of Riga, Kurzeme, Saaremaa and Hiiumaa.

In Estonia and Latvia small harbours are defined differently by law. In Estonia small-craft harbour is defined a port or a part of a port where port services are provided to water craft with an overall length of 24 metres and less[18]. In Latvia, however, the definition is based on primary activities such as fishing, fish processing, tourism, and the export and import of ecologically clean goods[19].

While Latvian harbours are primarily economic units aimed at providing services, generating revenue and contributing to regional economic development, the main focus of Estonian small harbours has been on maritime tourism and providing services to the local community, including coastal fishing. This is also reflected in the density of vessels traffic - while all Latvian harbours have active vessels traffic, in Estonia there are harbours rendering public services where AIS data shows very sparse or non-existent vessels traffic (Figure 8).

In Latvia, harbours are typically owned by the state and/or local municipalities. State and municipal land and water areas are managed by the port authority, which acts on behalf of the landowner. Practically all small ports in Latvia operate according to the so-called 'landlord' model. In Estonia, aside from harbours owned by state (operated by AS Tallinna Sadam and AS Saarte Liinid), other harbours are privately owned or owned by local municipalities and leased to NGOs managing the harbours.

In this particular survey, we address harbours of regional or national level public interest, primarily due to their role in the maritime economy sectors mentioned in chapter 1.1, either currently or in the future. Therefore, the criteria for selecting the harbours are as follows:

- Maritime transport/shipping, including passenger transport – harbours which are used for cargo or passenger transport according to AIS and official statistics;
- Fishing – harbours which are used for commercial fishing with fishing vessels (i.e., trawling) according to landing sites and AIS data, since virtually all harbours and landing locations are suitable for coastal fishing;
- Tourism – harbours that, according to small harbor visitation statistics, have been visited in the last 5 years or visited by yachts and recreational boats according to AIS data;
- Marine renewable energy – harbours with the potential to become offshore wind farm O&M harbours (not necessarily already established as such);

[18] Ports act, https://www.riigiteataja.ee/en/eli/ee/518102024016/consolide/current

[19] https://likumi.lv/ta/en/en/id/57435

- Aquaculture – harbours currently or potentially associated with offshore aquaculture.

There are only seven small harbours in Latvia: Skulte, Mersrags, Salacgriva, Roja, Engure, Pavilosta, and Jurmala. Currently, Baltic Sea and regional cargo transportation are handled from the harbours of Skulte, Mersrags, Salacgriva, and Roja, which also serve as bases for fishing vessels and yacht services. Engure and Pavilosta harbours are primarily for fishing and yachting, while Jurmala harbour functions exclusively as a marina for leisure boating.[20] Besides small harbours in Latvia, there are big multifunctional ports: Liepaja, Ventspils, and Riga. Therefore, all the Latvian harbours are within the scope of the survey.

In Estonia, according to the Harbour Register, the specified region of Estonia – Saare, Hiiu, and Pärnu Counties – has a total of 113 harbours. The majority of them are so-called community harbours, which means they primarily provide services for local inhabitants and fishermen. There are 32 harbours of broader, public interest, 11 of which belong to the state and are operated by the state-owned enterprise AS Saarte Liinid.

The usage of the harbours is analyzed in more detail in chapter 2.3. The list and map of the harbours within the scope of this survey are provided in Annex 1 and Annex 2.

[20] *Project "Baltic Loop" Dialogue between different transport actors. Recommendations for small port services and vision of future cargo flows development in Riga region / metropolitan area*

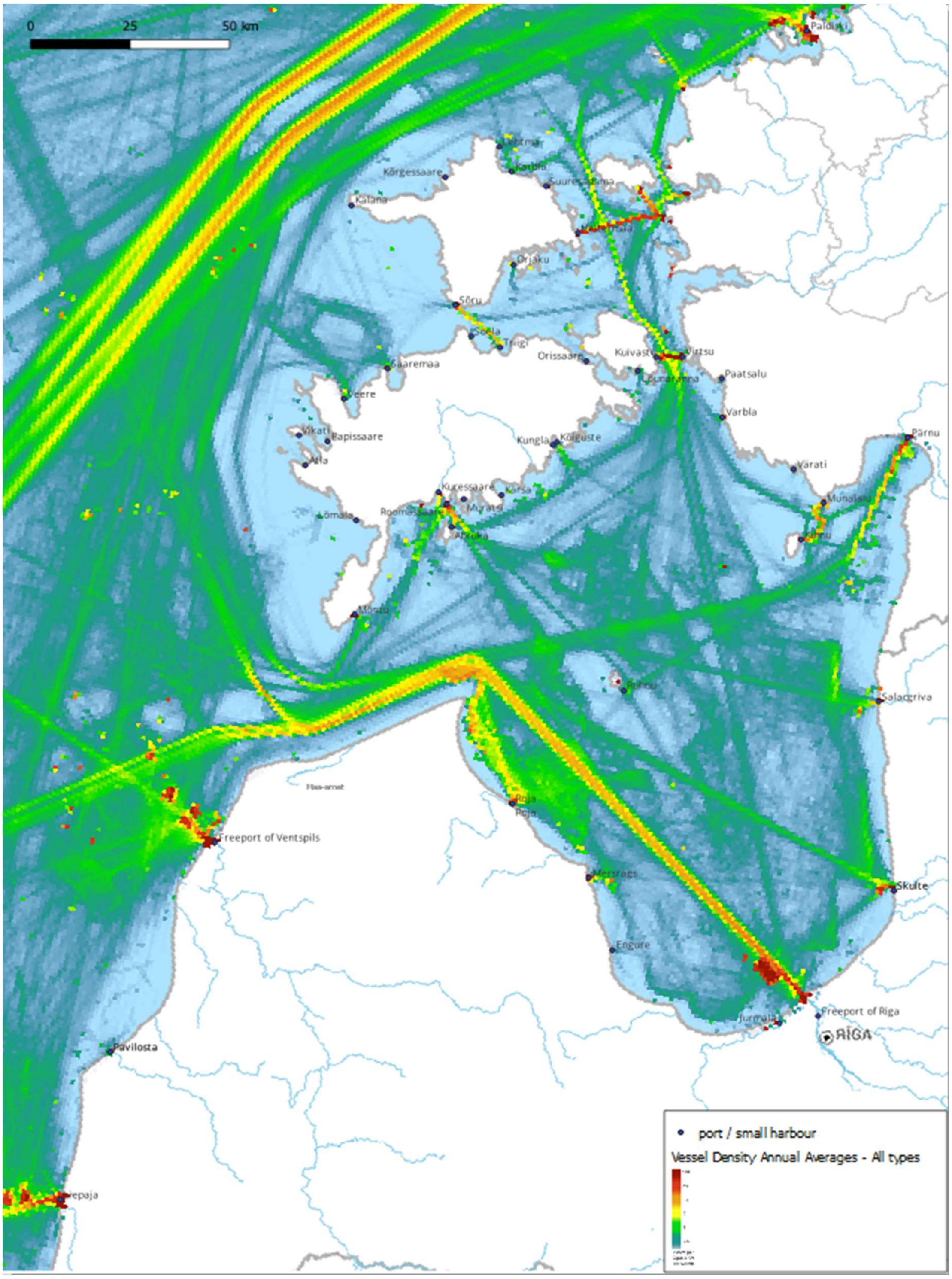


FIGURE 8. THE AVERAGE ANNUAL DENSITY OF ALL VESSELS 2017-2023 BY EMODNET. THE MAP IS BASED ON AIS DATA AND SHOWS SHIPPING DENSITY IN 1X1KM CELLS.

3.2. Mapping of the situation

3.2.1. MARINE TRANSPORT

Transport encompasses both goods and passenger transport. Western Estonian harbours serve regular ferry lines between the islands and the mainland. There are 12 of such harbours in the survey sope area (Virtsu, Kuivastu, Heltermaa, Kihnu, Ruhnu, Munalaiu, Manilaiu, Papissaare, Vikati, Sõru, Triigi, Abruka). These harbours are owned by the state and managed by AS Saarte Liinid.

In Latvian harbours, there are no regular local ferry lines and cargo transport is predominant. Latvian small harbours – Skulte, Mersrags, Salacgriva, Pavilosta, Roja – account for 5.7 percent of the total cargo turnover of all Latvian ports[21]. From the harbours in Western Estonia and Latvia, the main exports are fire wood, pulp log, woodchips and wood pellets, peat, limestone chips, and other building materials. The volumes of cargo transport are determined more by the overall economic situation than by the capacity of the harbours. Also, in Saaremaa and Hiiumaa the volume of cargo transport in harbours is significantly limited by the size of their hinterland. Therefore, a significant increase in cargo transport is not expected. Cargo volumes from the harbours in the region are presented in the table 5.

Figure 9 shows the ports involved in passenger or cargo transport.

TABLE 5. CARGO TURNOVER 2019 -2023[22]

Port/harbour	2018	2019	2020	2021	2022	2023
Riga	36431,9	32762,2	23712,1	21498,8	23519,9	18794,4
Ventspils	20325,9	20456,8	12902,1	11081,4	14746,4	10418,4
Liepaja	7537,6	7334,2	6603,2	7056,7	7608,6	7232,2
Pärnu	2100,0	2200,0	1700,0	1800,0	1700,0	2000,0
Skulte	998,5	1005,6	969,0	1098,1	1204,4	1119,3
Mersrags	456,8	468,2	402,4	504,1	551,7	556,1
Salacgriva	351,0	301,8	303,5	421,3	369,0	456,6
Roomassaare	393,1	320,4	318,6	365,4	351,6	420,0
Virtsu	361,8	350,5	398,5	414,9	320,6	281,4
Saaremaa	61,7	94,8	144,3	170,6	277,2	62,7

21 VIA Latvia https://www.transport.lv/en/ostas/satistika/

22 Datas: https://www.transport.lv/en/ostas/satistika/, https://www.ts.ee/investor/pohinaitajad/, AS Saarte Liinid, annula reports of AS Pärnu Sadam

Port/harbour	2018	2019	2020	2021	2022	2023
Heltermaa	143,8	116,2	95,3	125,5	144,7	91,2
Roja	70,2	47,1	58,1	70,3	78,3	78,2

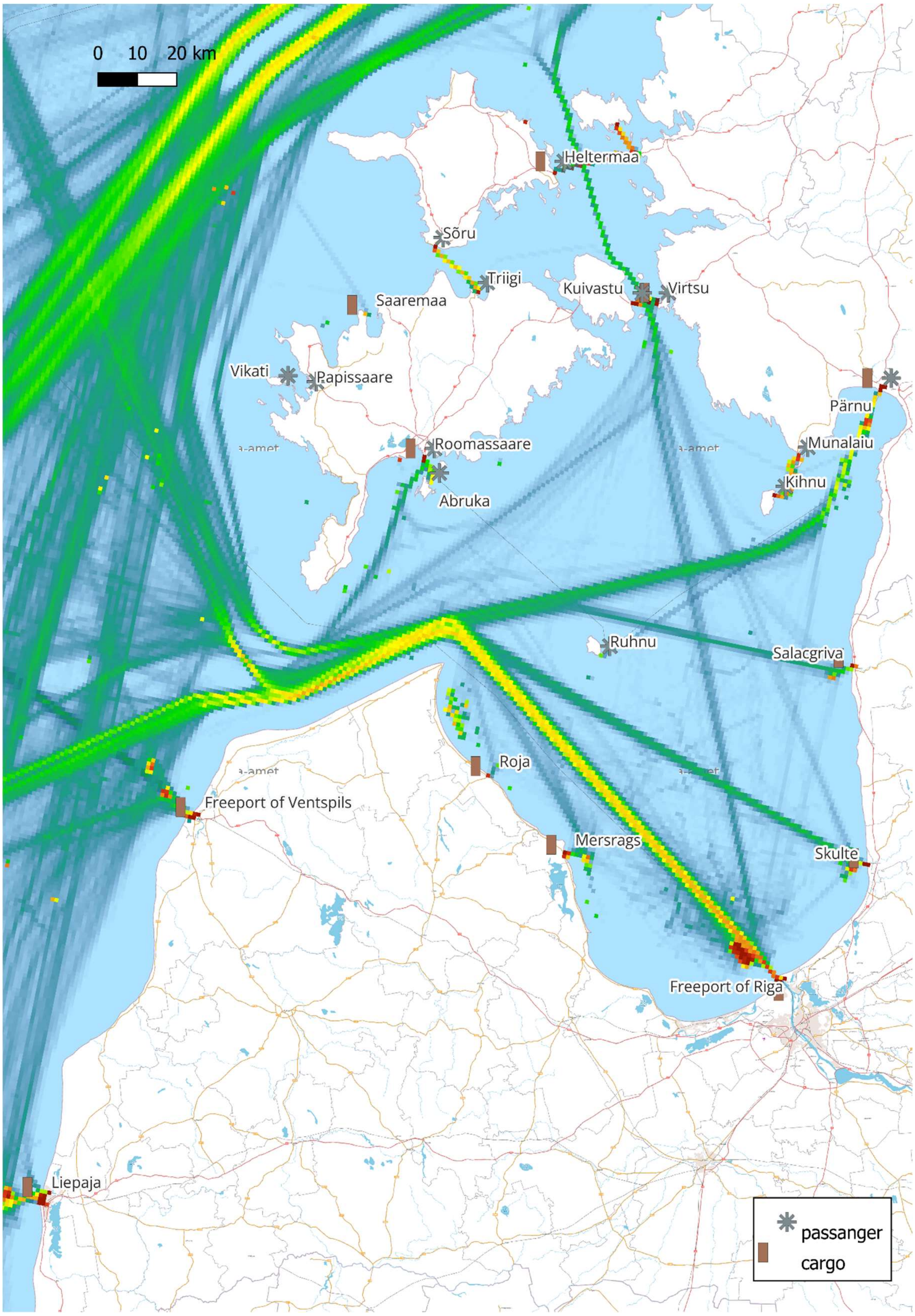


FIGURE 9. THE AVERAGE ANNUAL DENSITY OF CARGO AND PASSENGER VESSELS 2017-2023 BY EMODNET. THE MAP IS BASED ON AIS DATA AND SHOWS SHIPPING DENSITY IN 1X1KM CELLS.

3.2.2. FISHING

Fishing has historically been one of the most common functions of harbours. This analysis focuses on trawling. Trawling is permitted only in marine areas with a depth of more than 20 meters.

e dominance of Latvian harbours in fish unloading is due to the location of the main trawling areas near Ventspils, Roja, and Salacgrīva, as well as the presence of fish factories in ports. Estonian fishing vessels also partially unload their catch in Roja and Salacgriva.

Currently, trawlers primarily unload their catch at 11 harbours, 6 of which are in Latvia and 5 in Estonia (Table 6, Figure 10). The most important fishing port is Ventspils, where about one-third of the total catch is unloaded. Th

Fish unloading does not take place from May to August. The most intensive fishing occurs in November, when the largest amount of fish is unloaded.

The trawling has been relatively stable in recent years. Since fishing is regulated by quotas, no significant changes are expected, including in the location of fishing harbours.

TABLE 6. FISH UNLOADING BY ESTONIAN AND LATVIAN FISHING VESSELS (INCLUDING ESTONIAN FISHING VESSELS IN LATVIA)

Harbour	2018	2019	2020	2021	2022	2018-2022
Ventspils	29363,1	26637,8	24541,8	25878,7	26370,8	132792,2
Roja	9030,9	11682,8	10770,7	12907,4	14242,9	58634,6
Liepaja	12957,2	10328,1	7190,6	5426,9	6449,2	42351,9
Skulte	5582,0	7280,2	8059,5	7077,5	7252,5	35251,6
Veere	7259,5	4675,8	4217,2	3675,6	2735,6	22563,7
Salacgriva	2887,7	2930,0	2730,7	3954,9	4183,6	16686,9
Mersrags	2540,7	3044,4	3282,5	4127,8	3359,8	16355,2
Mõntu	1884,8	3962,4	3442,1	2172,0	4199,5	15660,9
Virtsu	2415,8	2525,7	3017,6	2110,0	5589,3	15658,4
Roomassaare	1746,3	2337,7	2038,1	2979,1	4388,2	13489,4
Saaremaa	2616,6	1695,6	801,0	2178,6	3512,0	10803,8
Pavilosta	2712,0	3283,6	2027,4	0,3	0,2	8023,4
Lehtma	0,0	0,0	0,0	1457,7	0,0	1457,7
Riga	321,3	1,5	4,2	3,0	2,5	332,5

Harbour	2018	2019	2020	2021	2022	2018-2022
Pärnu	0,0	0,0	0,0	0,0	131,7	131,7
Heltermaa	0,0	0,0	11,6	0,0	0,7	12,3
Sõru	0,0	0,0	0,0	0,0	0,6	0,6
All	81317,7	80385,5	72135,0	73949,5	82419,1	390206,8

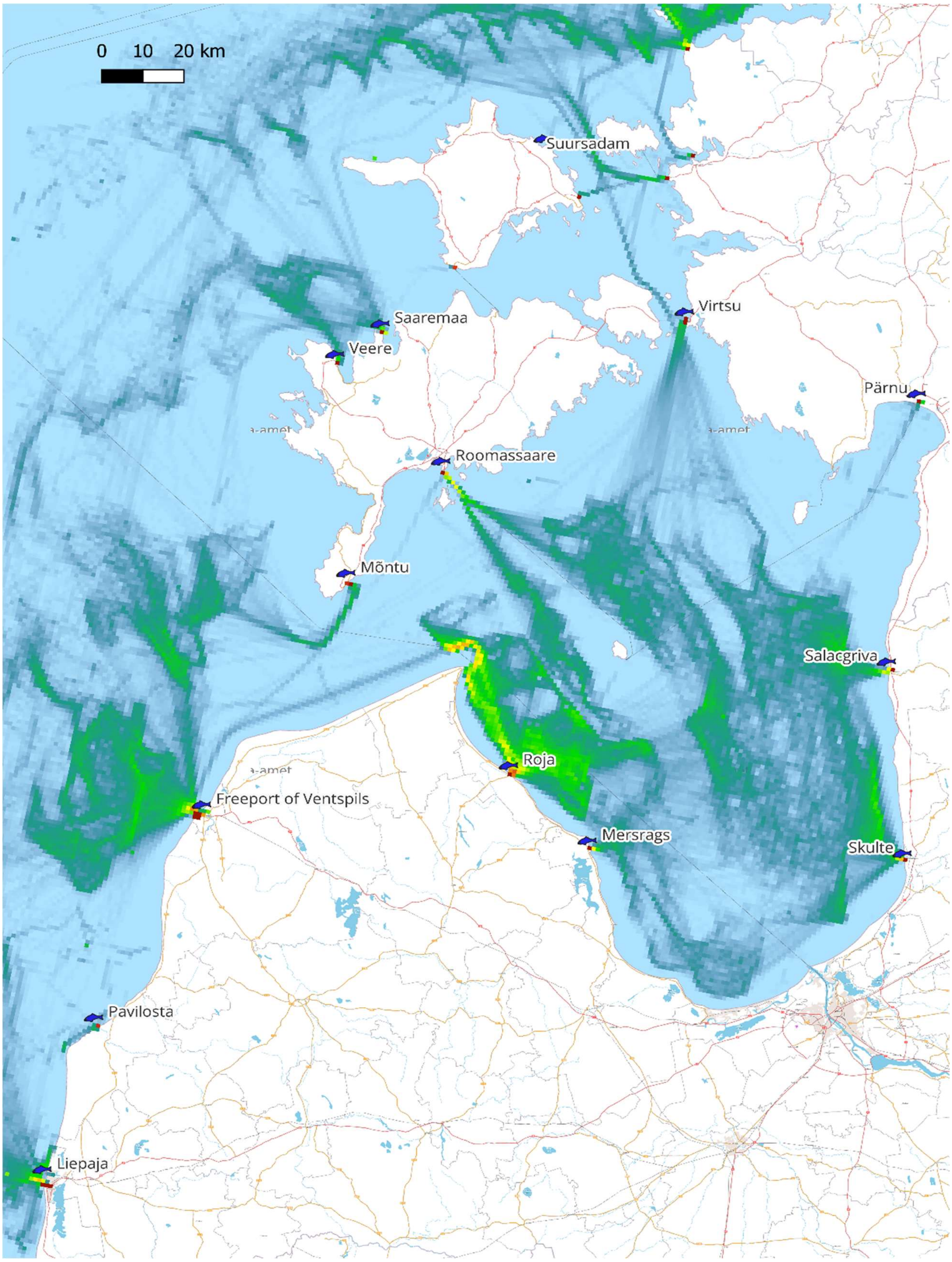


FIGURE 10. FISHING HARBOURS AND THE AVERAGE ANNUAL DENSITY OF FISHING VESSELS 2017-2023 BY EMODNET. THE MAP IS BASED ON AIS DATA AND SHOWS SHIPPING DENSITY IN 1X1KM CELLS.

3.2.3. MARITIME TOURISM

Maritime tourism is the most widely spread function of harbours in the observed area. The western coast of Latvia, the Gulf of Riga, and the Väinameri Sea are actively used by sailors (see figure 11). The sea area west of Hiiumaa and Saaremaa is less utilized, primarily due to the lack of sheltered harbours.

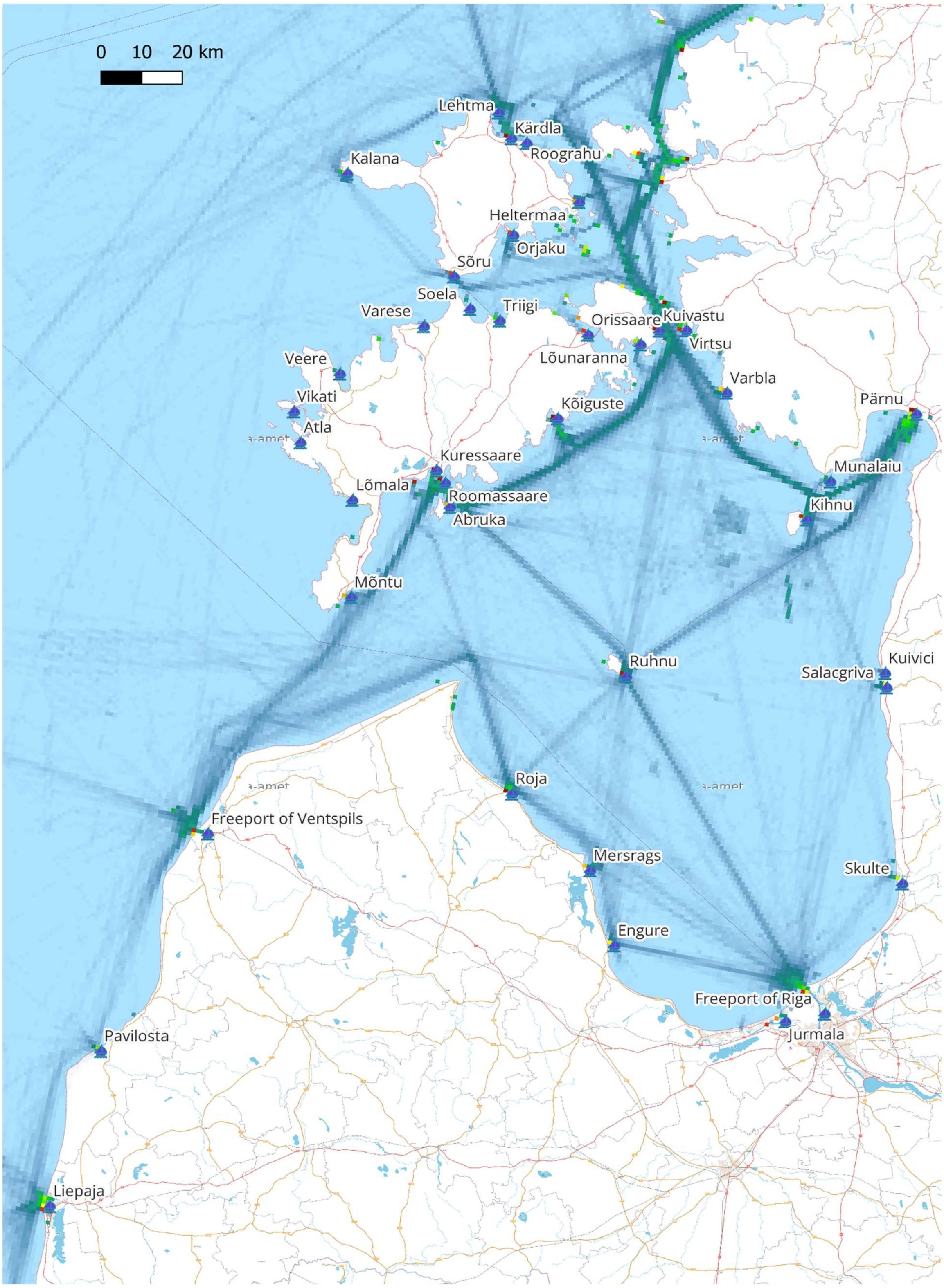


FIGURE 11. THE AVERAGE ANNUAL DENSITY OF YACHTS AND PLEASURE CRAFTS 2017-2023 BY EMODNET. THE MAP IS BASED ON AIS DATA AND SHOWS SHIPPING DENSITY IN 1X1KM CELLS.

In the Baltic Sea, there are several so-called maritime traffic loops (see figure 12), where certain routes can be covered by small boats within a single navigation season. From the perspective of maritime tourism, the large Baltic Sea loop includes the route: Germany - Poland - Lithuania-Latvia-Estonia (through Väinameri)-Finland-Sweden-Denmark-Germany. Entry into the ring of Latvian and Estonian harbours from the larger loop typically occurs from the southwest direction (Denmark, Germany, Poland, Lithuania, Latvia) due to the prevailing winds.

In the Gulf of Riga, there are two alternative routes – along the southern coast of Saaremaa or through Latvian harbours on the coast of the Gulf of Riga, to Riga, and then through Kuiviži to Pärnu and Kihnu. In the middle of this, the harbour of Ruhnu serves as a shortcut. According to visit statistics, the harbour of Ruhnu is one of the most visited harbours by yachts in the region (see table 7).

FIGURE 12. THE AVERAGE ANNUAL DENSITY OF YACHTS WITH MARITIME TRAFFIC LOOPS[23]

[23] *Sustainable Boating 2030 - Making leisure boating in the Baltic Sea fit for the post-pandemic boating tourism market https://interreg-baltic.eu/project/baltsusboating-2030/*

TABLE 7. VISITING YACHTS BY HARBOURS 2019-2023

Harbour	2023	2022	2021	2020	2019
Kuivastu	711	751	595	827	1149
Kihnu	689	740	586	558	552
Ruhnu	688	649	697	681	667
Kärdla	695	575	587	668	888
Kuressaare	617	407	273	275	478
Abruka	306	348	359	346	280
Ventspils	359	300	184	227	502
Roomassaare	109	198	104	117	493
Roja	232	180	107	179	190
Heltermaa	192	170	121	179	192
Orjaku	147	164	172	96	260
Sõru Jahisadam	83	127	61	65	83
Salacgriva	0	118	89	74	66
Lõunaranna		105	118	157	224
Munalaiu	105	94	145	65	40
Triigi	81	75	79	60	44
Roograhu	13	21	27	11	18
Skulte	50	16	17	0	20
Varese	-	10	-	-	-
Atla	-	2	-	-	-
Manilaiu	5	2	6	11	5
Vikati	1	2	-	-	-
Kõiguste			271	124	164
Lehtma	-	-	-	14	24
Mõntu	135	-	83	96	207
Orissaare		-	-	106	
Pärnu Jahtklubi	205	-	341	278	412
Soela		70	-	54	
Varbla	163	-	181		
Veere		-	2	7	14
Riga		181	171	133	249
Liepaja	228	200	175	175	370
Mersrags	20	72	25	44	135
Jurmala	7	0	0	30	14
Pavilosta	163	138	178	172	352

In maritime tourism, Estonian-Latvian cooperation in harbour development has been the most successful. An example is the East Baltic Coast project[24], which resulted in the creation of a portal that provides sailors with up-to-date information about harbours and routes. As shown in Figure 12, Estonia and Latvia form a shared sub-destination, and Estonian-Latvian cooperation in jointly marketing maritime tourism should continue, including finding new ways to develop maritime activities, particularly considering the planned offshore wind farms.

3.2.4. AQUACULTURE

Only two harbours are associated with aquaculture at the moment. Veere harbour serves one fish farm located in Tagalaht and potentially another fish farm planned for the mouth of Tagalaht. Service for the fish farm is provided daily by a workboat from the harbour from April to September. Through Taaliku harbour on Saaremaa, seaweed *Furcellaria lumbricalis* is transported to Saaremaa for further processing at the Est-Agar factory.

The potential for aquaculture lies primarily in Estonian waters around of Hiiumaa, where entrepreneurs have submitted applications to establish fish farms according to the marine spatial plan of Hiiu County and northwest of Saaremaa (figure 13).

According to the Latvian marine spatial plan, marine aquaculture facilities on the coast of Latvia are limited by natural conditions – the impact of waves and winds, fluctuating temperature and oxygen concentration regimes, and relatively low water salinity. The most suitable areas for aquaculture are in the high seas of the Baltic Sea, which provide a relatively stable temperature and oxygen concentration regime and a salinity of no less than 8‰. Meanwhile, the appropriate temperature and oxygen concentration regimes for growing algae and shellfish are found both in the Gulf of Riga and in the high seas of the Baltic Sea. However, the southern part of the Gulf of Riga is not suitable due to salinity levels below the physiological resistance limits of species suitable for aquaculture.

Both Estonian and Latvian maritime spatial plans do not determine specific locations for the development of aquaculture at sea. Each development opportunity is assessed individually, depending on the technology to be used and following the recommendations in the MSP for the compatibility of aquaculture with other types of marine use. Since marine spatial plans do not define specific locations for aquaculture (except for the Hiiu marine area plan), it is challenging to determine the prospects

24 *https://www.eastbaltic.eu/*

of other harbours in relation to aquaculture.

Cabinet of ministers Latvia 13.08.2024. designated two permit areas in the Gulf of Riga in the Baltic Sea for the establishment and operation of facilities necessary for aquaculture: "Roja" (area - 3,69km2; 2,20 nautical square miles from the coast) and "Mērsrags" (area - 1,97km2; 2,61 nautical square miles from the coast). The designated areas will be available for the development of aquaculture projects by tender.[25]

25 On the determination of two areas in the Gulf of Riga of the Baltic Sea for the installation and operation of equipment necessary for aquaculture operations https://tapportals.mk.gov.lv/structuralizer/data/nodes/4e1f6728-4b50-4d3b-950a-aa8eb7d623aa/preview

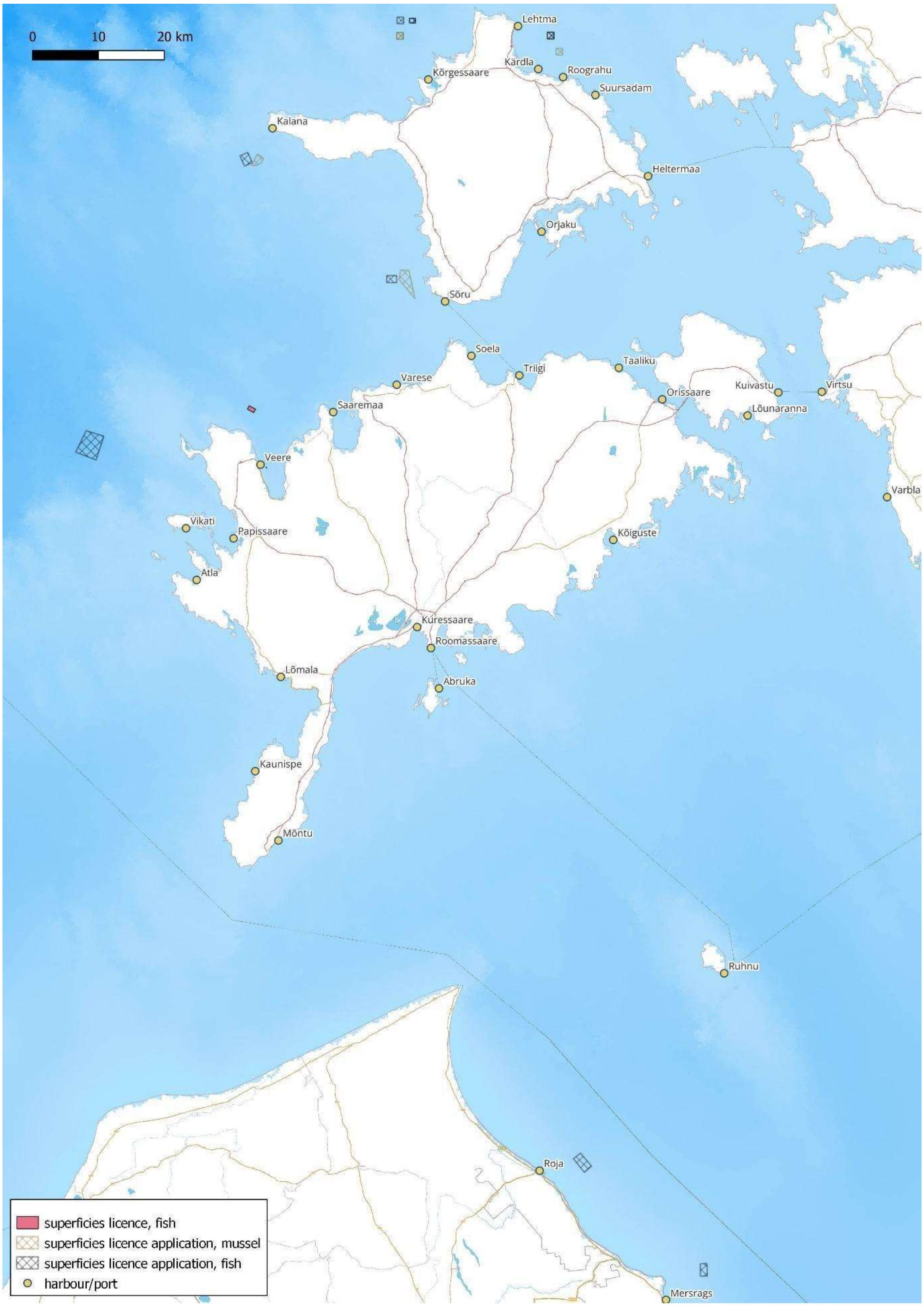


FIGURE 13. AQUACULTURE POTENTIAL

4. OFFSHORE WIND FARMS POTENTIAL IMPACT

4.1. Changes in the future demand compared to current harbour services

While so far, small harbours have been primarily regarded as necessary for island connections, maritime tourism, fishing, and local communities, offshore wind farms and aquaculture open up new opportunities for small harbours as well. However, unlike maritime tourism or fishing, offshore wind farms and aquaculture areas are located in specific regions, and not all harbours are suitable for serving them. Consequently offshore wind farms will not transform harbours and harbours network to the extent or in the locations that may be expected. The use of CTVs and the harbours that render respective services must meet specific criteria, primarily geographical ones, which cannot be offset by lower harbour fees or service prices. If the necessary criteria for CTVs cannot be met, maintenance based on SOVs is chosen (see Chapter 1.5).

Of the currently known offshore wind farm developments, those suitable for a shore-based strategy include SWE and ELWIND on the western coast of Saaremaa, ELWIND in Latvia, and Enefit Green's developments in the Gulf of Riga (figure 14). In the future, also Enefit Green's development on the northern coast of Hiiumaa. This means one CTV harbour on the western coast of Saaremaa (most likely Lõmala), one CTV harbour on the northern coast of Hiiumaa (Kõrgessaare or Lehtma), and 1-2 harbours in Latvia (Salacgriva, Kuiviži). The wind farm areas: Saare-Liivi (Utilitas), Liivi 1 and Liivi 2 (Ignitis), as well as Saare 2.1 and Saare 2.2 (Deep Wind Offshore), will most likely choose an offshore (SOV) strategy.

Latvian harbours have a significant opportunity to benefit from servicing SOVs for wind farms located in Estonia's maritime area, raising the question of what Saaremaa and Estonia's benefit would be and what potential cooperation between Estonia and Latvia could look like.

Based on current knowledge, there are no suitable harbours for servicing SOV vessels on Saaremaa and Hiiumaa, primarily due to the lack of necessary depth. Virtsu and Pärnu in Estonia, as well as Skulte, Ventspils, and Liepaja in Latvia, could compete for servicing SOVs. It is important to keep in mind, that broader socio-economic benefits are primarily brought by CTV harbours, as in such cases, the entire workforce lives onshore consuming onshore services regularly. In contrast, with SOVs, the personnel lives on the vessel and only comes ashore for crew shift changes. However, for harbours, SOVs also provide revenue through additional harbour fees, rent, or other sources. Latvian harbours have a significant opportunity to benefit from servicing SOVs for wind farms located in Estonia's maritime area, raising the question of what Saaremaa and Estonia's benefit would be and what potential cooperation between Estonia and Latvia could look like.

Harbours suitable for CTVs are needed already during the construction phase, as many tasks are performed from CTVs, given that the working time of construction vessels is very expensive. The first offshore wind farms in Estonia probably will begin construction in 2030-2033. It may be necessary to use other harbours for construction as well, as it is not practical to invest in a single harbour for a short period.

Aquaculture superficies licences and applications are located in the northwest of Saaremaa and the northern coast of Hiiumaa. Veere Harbor on Saaremaa is already involved in aquaculture, and this will likely increase in the future. Aquaculture offers new opportunities in Estonia primarily for the harbours of Sõru, Kalana, Kõrgessaare, Lehtma, Saaremaa and Varese, while in Latvia, for the harbours of Roja and Mērsrags.

Thus, new functions are emerging primarily in regions where maritime tourism and small harbour development have been relatively modest, thereby strengthening the existing small harbour network.

> Harbours suitable for CTVs are needed already during the construction phase, as many tasks are performed from CTVs, given that the working time of construction vessels is very expensive. The first wind farms will begin construction in 2030-2033.

There is a noticeable trend in the development of guest harbours, where the growth of the hinterland as a tourist destination has led to incentives to develop the harbour itself. Examples of this can be seen in Kõiguste, Kõrgessaare and Orissaare. Additionally, the harbours of Kalana, Suuresadam and Kaunispe have shown interest in developing guest harbours.

Figure 14 shows the areas where changes are expected in the next 10-20 years: offshore wind farms O&M, aquaculture, and sailing (guest harbours).

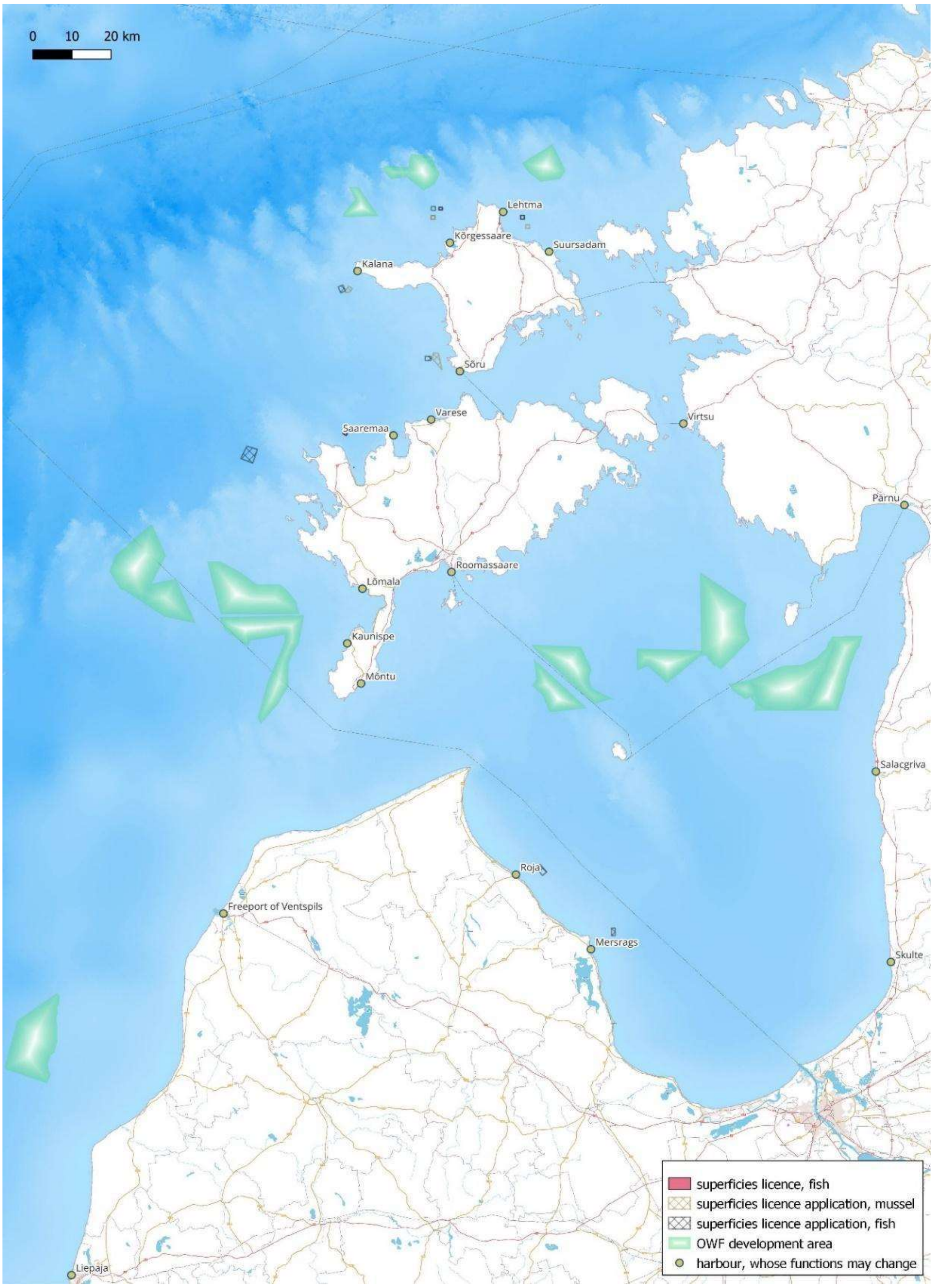


FIGURE 14. THE HARBOURS WHOSE FUNCTIONS MAY CHANGE IN RELATION TO OWFS, AQUACULTURE, AND SAILING IN THE NEXT 10-20 YEARS.

4.2. Socio-economic impacts of expected changes

In countries without offshore wind manufacturing, OWF installation and O&M drive local economic benefits. They create opportunities for harbours and local suppliers, while generating significant economic activity and jobs in the hinterland. According to a Danish study, a 1 GW offshore wind farm during the O&M phase (in the case of a shore-based strategy) creates 45 direct jobs: service technicians, administrative personnel, etc., some of whom may live near or in proximity to the harbour, thereby bringing new jobs to the local area. For example, the SWE wind farm would create around 60 direct jobs (FTE). For Saaremaa, this would equate to a medium-sized enterprise, which our population and labour market could support without significantly negative effects (e.g., labour poaching or wage pressure) on other companies in similar sectors.

In addition to direct jobs, there are also indirect and related jobs and businesses. Local O&M harbour also creates opportunities for local suppliers and workers within the harbour region itself, ranging from local shipyards, steel manufacturers and electricians to local restaurants, hotels and catering companies (table 8).

It is important to note that not all O&M harbours will be able to generate the same share of local turnover/jobs from a specific offshore wind investment, especially within the primary and secondary sectors. O&M harbours with limited primary sector involvement in the offshore wind sector, the main source of local value added for local suppliers is likely to occur within the tertiary and secondary sectors.

Tertiary sector impacts will occur in any O&M project but may vary depending on how much of the work takes place within the harbour area. As an example, the longer an installation or O&M organization stays within a given harbour, the more services are required from local companies in tertiary sectors.

Local O&M harbour also creates opportunities for local suppliers and workers within the harbour region itself, ranging from local shipyards, steel manufacturers and electricians to local restaurants, hotels and catering companies.

The value that occurs within a harbour municipality's secondary sectors is more uncertain and depends largely on the availability, competitiveness and proactiveness of local subcontractors. The experiences captured by local suppliers in the secondary sector are nonetheless critical to foster the spin-off and spillover effects that can contribute to transforming local harbour-services dependent business ecosystems over time.

TABLE 8. TYPES OF LOCAL JOBS BY O&M HARBOUR[26]

Type	Classification	Examples
Primary offshore wind suppliers / direct jobs	Suppliers for the core activities involved in O&M of an offshore wind farm. Often highly specialized businesses with a substantial part of their turnover generated from offshore wind.	CTV suppliers, local turbine inspection suppliers, specialized O&M suppliers etc.
Secondary sector suppliers / indirect jobs	Suppliers in other sectors than offshore wind whose services may be required by the offshore wind developers and/or their primary offshore suppliers.	Local shipyards, equipment companies, electricians, cleaning and inspection services, fuel suppliers, etc.
Tertiary sector suppliers / induced jobs	Suppliers with no direct or indirect involvement in the core activities of an offshore wind farm. These suppliers may cater to the staff of offshore wind developers and their primary and secondary suppliers.	Local catering companies servicing O&M vessels or operations, taxi companies, hotels, restaurants, shops, cinemas, bakeries, etc.

The Danish study[27] indicates that a 1 GW wind farm can generate around 0.5 million EUR annually for the harbour. This covers docking fees for CTVs (or SOVs) and rent for space and facilities used by the wind farm operator's local O&M operations. Calculations based on current docking fees in Estonia and Latvia show that harbours income from servicing CTVs would be significantly lower here[28]. Considering the high costs of marine infrastructure (including dredging, quays, etc.), a single offshore wind farm is not enough to justify large-scale investments in harbour infrastructure. In addition to servicing offshore wind farms, harbour should have other functions and sources of income.

High marine infrastructure costs make a single wind farm insufficient to justify large-scale harbour investments. Harbours need additional functions and income

[26] *QBIS, 2020. Socio-economic impact study of offshore wind. Danish Shipping, Wind Denmark and Danish Energy with support from The Danish Maritime Foundation.*

[27] *QBIS, 2020. Socio-economic impact study of offshore wind. Danish Shipping, Wind Denmark and Danish Energy with support from The Danish Maritime Foundation.*

[28] Calculations made by Liina Härm and Kaspars Timofejevs, October 2024.

4.3. Changes occurring in connection with the development of offshore wind farms

The socio-economic impact of developing offshore wind farms includes effects on shipping, fishing, and marine tourism. In the maritime spatial planning of both Estonia and Latvia, existing maritime activities have been considered when designating areas for wind farms, with additional conditions set to accommodate these uses. For instance, Estonia's maritime spatial plan requires a minimum 2 km wind turbine-free zone between offshore wind farms.

As of now, only two Environmental Impact Assessment (EIA) reports for wind farms have been approved (Saare Wind Energy west of Saaremaa and Enefit Green north of Hiiumaa), which means there is insufficient knowledge to assess the cumulative impact of all proposed offshore wind farms on other maritime economic sectors.

The impact of offshore wind farms on shipping is expected to be minimal, as the needs of shipping have already been considered in maritime spatial plans.

OWFs in the middle of the Gulf of Riga may affect yacht routes, as the wind farms influence wind patterns and yachts cannot sail through them. This could result in an increase in visits to some harbours and a decrease in others. It may happen that yachts will no longer prefer to cross the Gulf of Riga via Ruhnu Island, but will instead sail along the coast of Saaremaa or the Latvian-Pärnu coastline. Currently, there is no precise data on the number and location of wind turbines in the Gulf of Riga OWFs, making it impossible to predict their impact on harbours.

Impact to the fishing can be either direct or indirect. Direct impacts occur when wind farms are established in areas previously used for trawling. Indirect impacts arise if the construction of the wind farm negatively affects fish stock reproduction. Generally, efforts are made during Environmental Impact Assessments (EIA) to avoid both types of impacts and to find solutions that are favourable for fish populations and fisheries.

In Estonian marine area, if offshore wind turbines affect a fishing enterprise, the enterprise is compensated with an environmental disturbance fee under the Environmental Charges Act, which is derived from the fee for producing electricity from wind energy[29]. To claim

[29] The fee for producing electricity from wind energy is set at 0.5 percent of the product of the following two indicators: 1) the total amount of electricity produced by the wind power plant in a quarter in megawatt-hours, but not less than 70 percent of the nominal capacity of the wind power plant multiplied by 1000; and 2) the arithmetic average market price of electricity in the Estonian price area of the next-day market for the respective quarter. For offshore wind farms, 90% of the revenue is distributed among the local government units within a 20 km impact area of the wind farm based on their share points, and 10% is directed to the state revenue account for compensating fishing enterprises.

this compensation, the reduction in fish catch due to the operation of offshore wind farms must be demonstrated according to the procedure established by the Government of the Republic.

For example, for a 1000 MW offshore wind farm producing approximately 1 TWh of electricity per quarter at an average market price of 100 €/MWh, the total amount of fee would be about 2 million € per year, of which 10% is 200,000 €. This 200,000 € would be distributed among the fishing enterprises operating in the area.

Harbours do not receive compensation, and it would adversely affect them if compensation were paid to trawlers instead of allowing trawling.

Conflicts between wind farms and fishing mainly occur in the Gulf of Riga, which is the primary baltic herring trawling area for both Estonia and Latvia. However, this is likely to affect primarily Estonian harbours, such as Roomassaare and Virtsu, since trawlers from Latvian harbours primarily fish near the Latvian coast, where no OWS-s is expected (Figure 14).

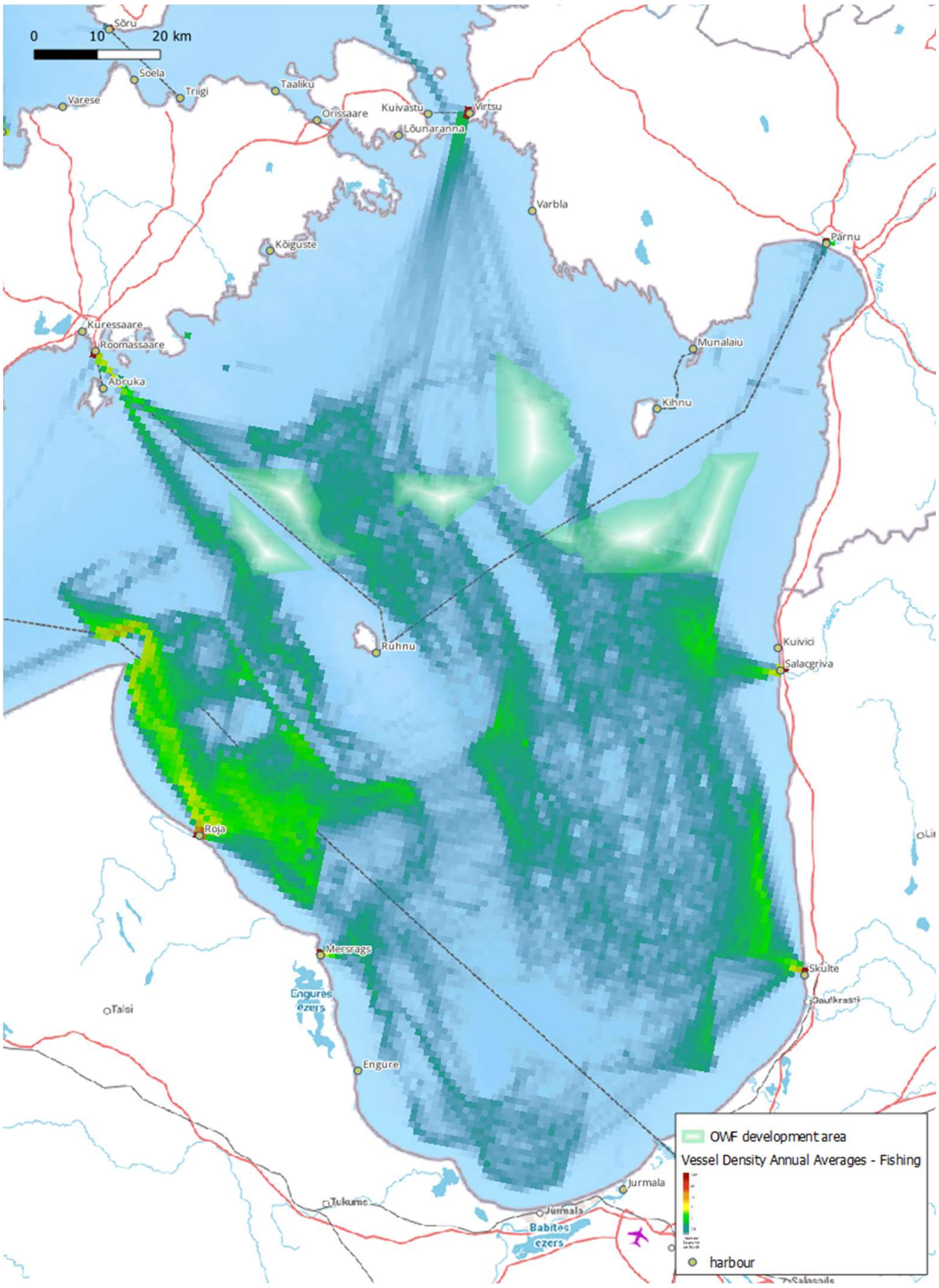


FIGURE 15. POTENTIAL OWFS AND TRAWLING IN GULF OF RIGA

4.4. Relevant uncertainties

Despite ongoing offshore windfarms construction planning, there remain uncertainties that could impact the future of the harbours:

Actual size of OWFs: The future OWFs may be significantly smaller than initially planned, as exclusions may arise during Environmental Impact Assessments (EIAs) due to geological, avian, habitat, cumulative impacts and other factors. Therefore, the actual distance of most planned OWFs from harbours in Estonian and Latvian maritime areas is yet to be determined.

Main grid connections: All wind farms require main grid connections, most of which are still in the spatial planning phase. This includes the Estonia-Latvia interconnector, crucial for Offshore wind farms west of Saaremaa and the Latvian Elwind project.

Size of wind turbines: Current wind farm projects plan for a maximum hub height of 350 meters above sea level and turbine capacities ranging from 10 to 25 MW. In the Liivi 1 and 2 areas, however, turbines are planned with capacities of up to 25 MW and hub heights up to 400 meters above sea level. As turbine sizes increase, so do the challenges for operations and maintenance (O&M).

Vessels development: The future fuel types for vessels are not yet determined.

New offshore area applications: Currently, Elwind is the only active OWF project in Latvia. New offshore areas superficies applications may appear (and old disappear) in the coming years.

Climate change: Potential impacts on operations and infrastructure remain uncertain.

Hydrogen technology: This could enhance storage, stability, and economic value for offshore wind farms, promoting their construction.

Investment climate: The investment climate may shift due to various external factors. No offshore wind farm has yet reached the investment decision stage.

5. JOINT VISION

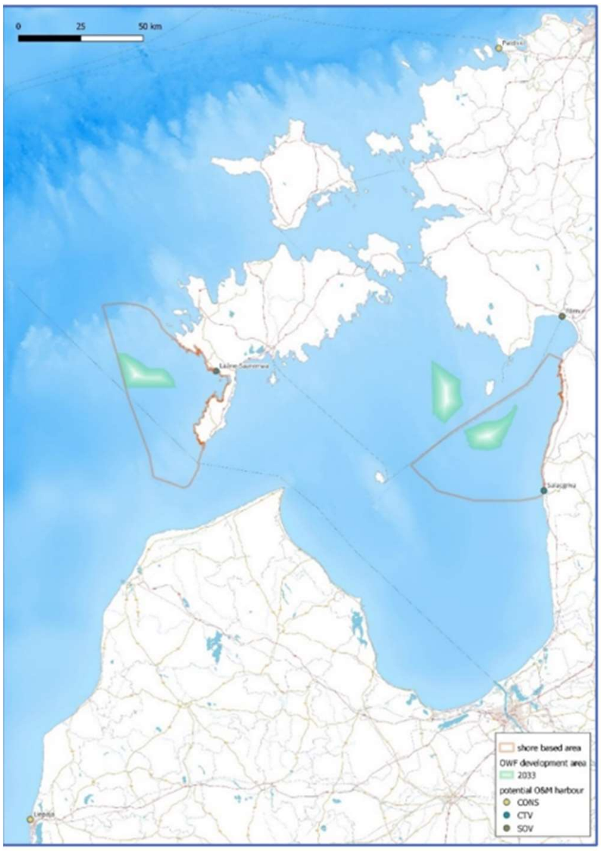
5.1. Potential developments

Current estimations for the future development scenarios (figures 16, 17 and 18) in relation of OWFs are made based on the information from Saare Wind Energy/Van Oord, Enefit Green, ELWIND Estonia and Latvia, Utilitas Wind OÜ, UAB Ignitis renewables, Deep Wind Offshore and Siemens Gamesa. It should be noted that this is merely a projection based on current knowledge, and it may not fully and same way materialized.

Scenario 2033: In the Estonian-Latvian maritime area, there are three so-called "first-wave" projects: SWE's project west of Saaremaa, and projects by Utilitas and Enefit Green in the Gulf of Riga (figure 16). Which of these will begin producing electricity in 2033 depends on the outcome of the offshore wind auction, expected to be held in 2025. According to conservative scenario, only one OWF is likely to be completed by 2033. The development of harbours will depend on the winning developer: if Utilitas wins, Pärnu harbour will have the opportunity; if Enefit Green wins, both Salacgriva and Pärnu will be prioritized; if SWE wins, a CTV harbour in Western Saaremaa will be prioritized (2033a scenario). Should Saaremaa not use this opportunity, Ventspils will be considered as an SOV port (2033b scenario).

Scenario 2033+: After 2033, the ELWIND projects in Estonia and Latvia, as well as the expansions of Utilitas and Enefit Green projects in the Gulf of Riga (figure 17), are expected to become construction-ready. In addition to the harbours described in the 2033 scenario, this will provide an additional opportunity only for Ventspils, assuming it hasn't already been utilized.

Scenario 2033++: From development to electricity production, the longest time frame is expected for the Ignitis project in the Gulf of Riga, the Deep Wind Offshore project west of Saaremaa, and the Enefit Green projects near Hiiumaa (figure 18), based on the current stage of development. The Deep Wind Offshore project is not expected to bring changes regarding harbour requirements, while the Enefit Green project would provide an opportunity for the harbour of Lehtma. The realization of the Ignitis project would offer the widest range of options: depending on the selected depth, Roja, Mersrags, Skulte, Virtsu, Roomassaare, and Mõntu could all potentially compete as CTV or SOV harbours (scenario 2033++a). However, it may also be the case that a new SOV harbour is unnecessary, with these functions instead handled by the existing SOV harbour in either Pärnu or Ventspils (scenario 2033++b).



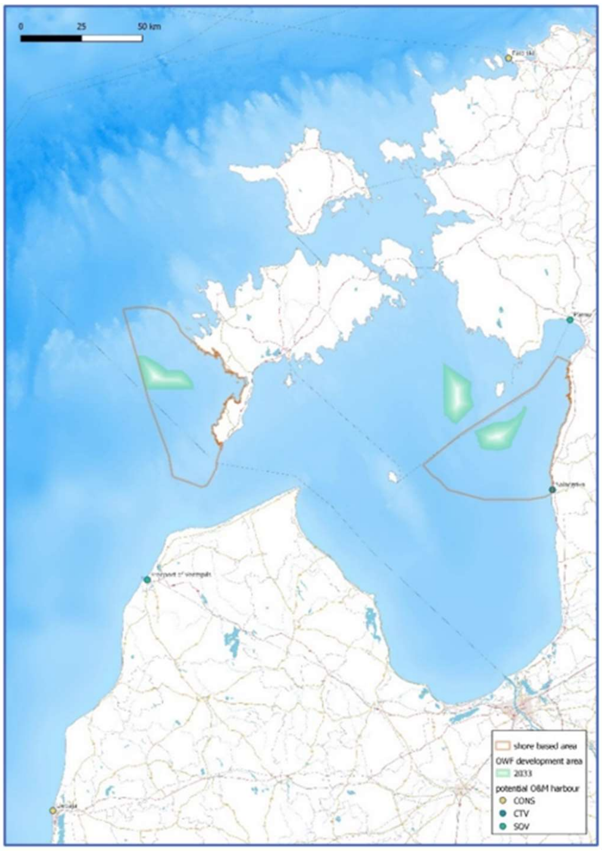


FIGURE 16. SCENARIO 2033 A AND B

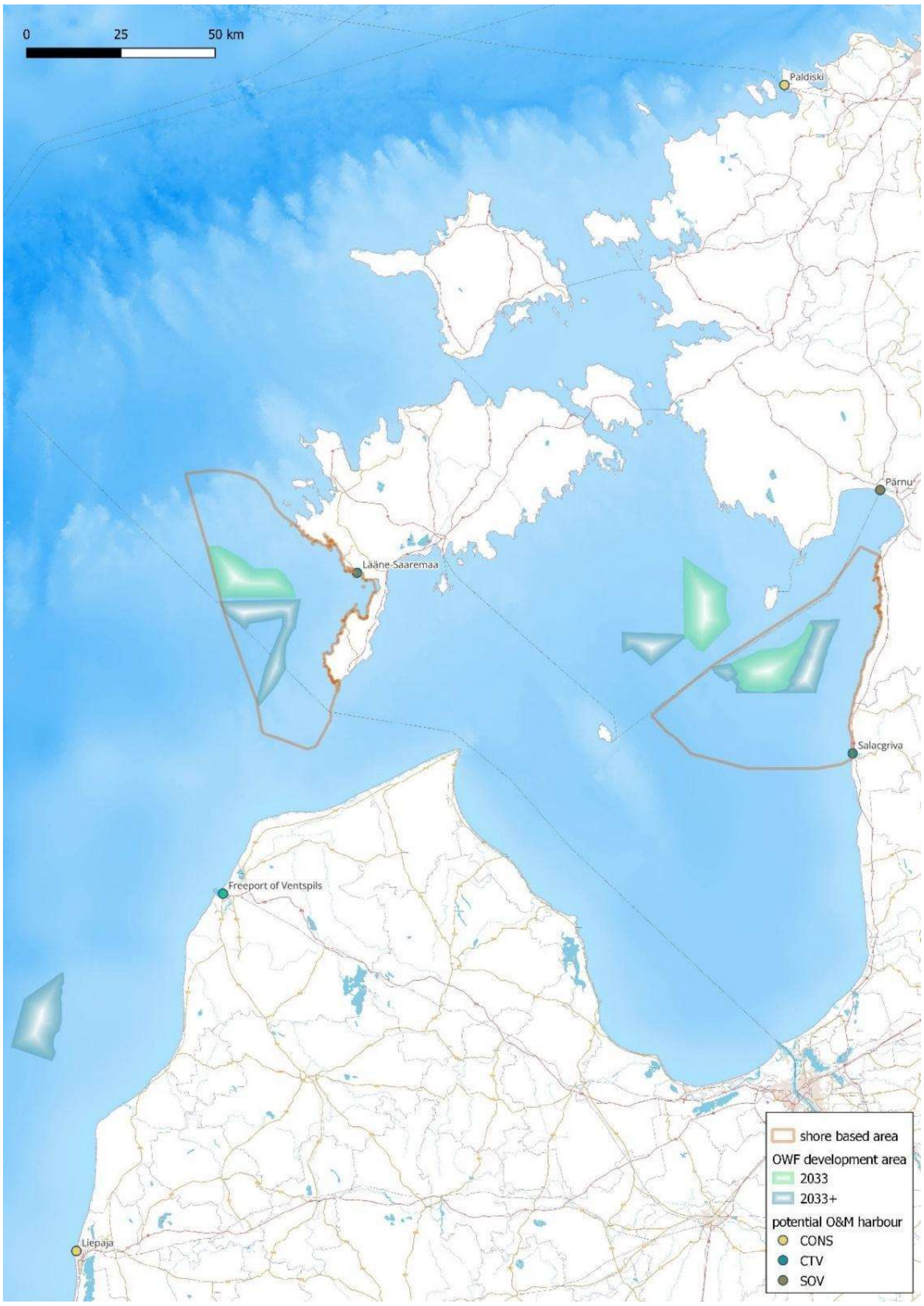


FIGURE 17. SCENARIO 2033+

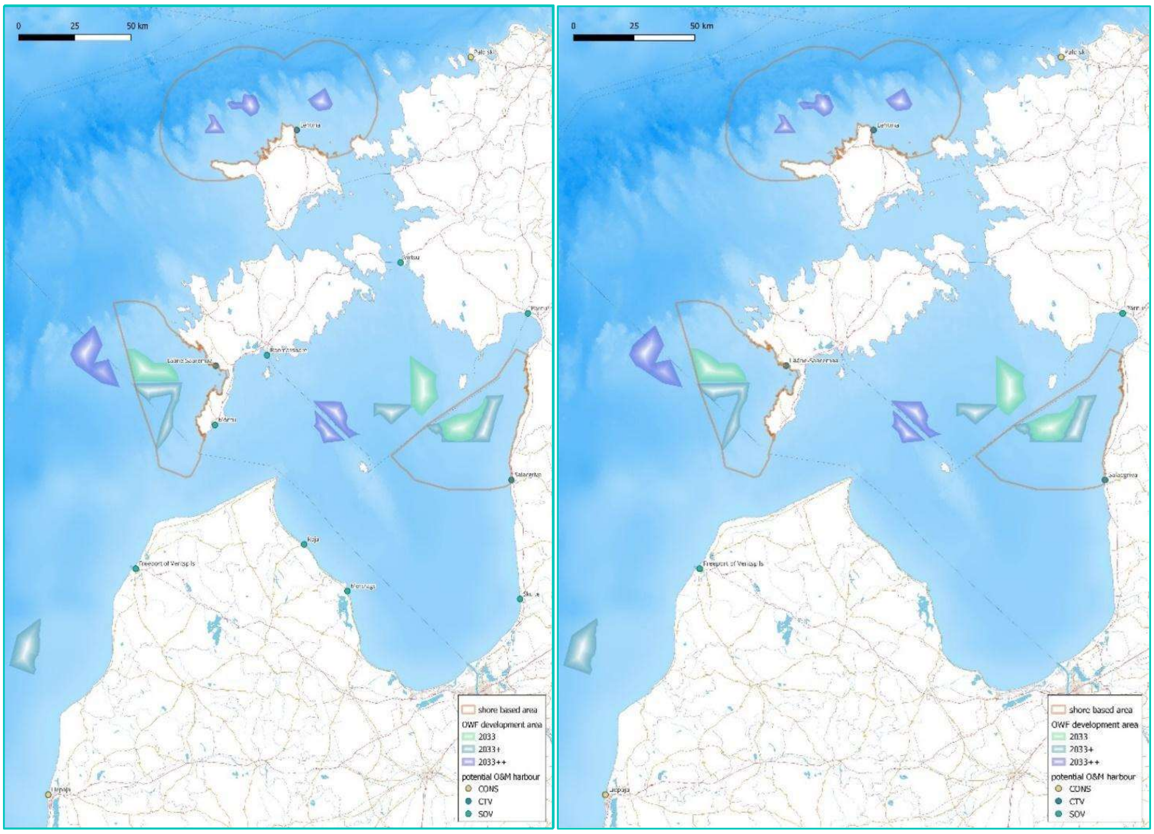


FIGURE 18. SCENARIO 2033++ A AND B

5.2. Estimated investments

Preliminary **investments** in harbours are associated with upgrading infrastructure to accommodate new functionalities, such as servicing offshore wind farms. This can involve dredging to ensure sufficient water depth, constructing or upgrading quays and berths, and installing necessary facilities like warehouses, workshops, and maintenance areas. Also, investments in modern technology for operations and management may be required. The estimated volume for harbour infrastructure investments are presented in the table 9 as follows.

The future development of harbors related to OWFs in the Estonian-Latvian maritime area depends on auction outcomes and project timelines. By 2033, one OWF is expected to be operational, with harbour development tied to the winning developer. Potential harbours include Pärnu or Salacgriva in the Gulf of Riga, and alternatively a harbor in Western Saaremaa, with Ventspils as an alternative for SOV (Service Operation Vessel) operations.

Pärnu harbour has a preliminary agreement with Utilitas Wind OÜ to establish a service base for SOVs. Pärnu is a functional harbour currently focused on bulk cargo transport. Additional investment for servicing SOVs would primarily involve constructing a maintenance base.

Salacgriva's advantages include its proximity to Enefit Green's Gulf of Riga OWF site, sufficient depth, available land for CTV services, an operational harbour, and relatively small additional investment needs. Salacgriva's main disadvantage is the significant distance to the nearest airport in Riga.

In Western Saaremaa, the most suitable small harbour is known to be **Lõmala** harbour. Lõmala's distance to Saare Wind Energy and Elwind OWFs makes it ideal for CTV servicing. The harbours hinterland has good infrastructure, and Kuressaare town and airport are nearby. The main drawback is the harbour's shallow depth, necessitating additional investments for dredging and quay construction.

If Saaremaa does not capitalize on the opportunity to establish a CTV harbour, **Freeport of Ventspils** could take on the role of servicing the Western Saaremaa OWFs with SOVs. Ventspils' opportunities will grow even further after 2033 if the Latvian Elwind project and Deep Wind Offshore projects are is realized. For the Latvian Elwind OWF, **Pavilosta** could also be an option as the CTV harbour, but additional investments are needed.

Already today, **Freeport of Ventspils** is positioning itself as a key hub for OWF operations and renewable energy. The Freeport of Ventspils Authority is in discussions with developers and conducting studies to optimize OWF service infrastructure. The port's potential roles include turbine assembly, production of oversized components, wind farm management, and green fuel (hydrogen, ammonia) production and storage. The port has developed a study and terminal model for OWF servicing.[30]

Other harbours along the Gulf of Riga, that are technically suitable for CTV or SOV servicing, include **Roja, Mersrags, Skulte, Salacrgiva, Mõntu, Roomassaare, and Virtsu.** Their potential as CTV or SOV harbours will become clearer once the feasibility, placement and O&M strategy of the Ignitis OWF near Ruhnu are determined.

The harbours of Hiiumaa – **Lehtma, Kõrgessaare, and Kärdla** – also have comparable potential to function as O&M ports in the long-term future.

[30] SIA "Konsorts", 2024. Development of the common strategy of small ports for the development of offshore wind farms in the Baltic Sea and the Gulf of Riga. Analysis of the current situation and expected changes - version for October 21. 1. draft,

TABLE 9. ESTIMATED INVESTMENTS OF HARBOURS (MLN EUROS)

Harbour	Dredging for CTV	Dredging for SOV	Port construction for CTV	Port construction for SOV	Facilities
Roja	0	4,7	0	3,9	0
Pavilosta	0	na	2	na	0
Mersrags	0	1,5	0	4,9	0
Skulte	0	0,5	0	4	1
Pavilosta	0	na	0	na	0
Salacgriva	0	0,5	0	4	2
Ventspils	No datas				
Roomassaare	0	2 (max depth 6,5 m)	10	0	2
Mõntu	No datas				
Virtsu	0	0	8	12	2
Lõmala	0,8-1	na	4	na	3
Kärdla	0	na	5	na	2
Lehtma	0,7	na	4	na	2
Kõrgessaare	0,8-1	na	4	na	2
Pärnu	na	0	na	0	0

Potential **financing sources** for harbour developments are Public-Private Partnerships (PPPs), which can leverage private investment for public infrastructure projects; European Union grants and funding initiatives aimed at supporting green energy and infrastructure projects; national government funding and budget allocations for port development; private investments from companies involved in offshore wind energy and maritime services or loans from financial institutions and development banks, such as the European Investment Bank (EIB), which has been involved in financing port expansions related to offshore wind. The perspectives and potential for different sources of financing are presented in chapter 5.3.

The Danish study[31] estimates that a 1 GW offshore wind farm could generate around 0.5 million EUR annually for the harbour through docking fees and rent for facilities used by local O&M operations. **Harbours income** stems from fees charged for docking and berthing vessels, particularly Crew Transfer Vessels (CTVs) and Service Operation Vessels (SOVs); rental income from facilities used by offshore wind operators for maintenance and operations; supporting services, such as logistics, warehousing, and other value-added activities. Additionally, the increased economic activity in the surrounding region due to enhanced port operations will lead to higher tourism and local business revenues, generating wider local benefits.

Operational expenses for ports include maintenance costs for port infrastructure, including quays, berths, and storage facilities; staffing costs for personnel involved in port operations, security, and maintenance; utilities and service costs, such as water, electricity, and waste management; insurance and liability costs associated with operating the harbour; costs related to environmental compliance and sustainability initiatives.

Comparison with existing harbour facilities with requirements to render offshore maintenance related services are presented in Chapter 5, with rough estimations of the preliminary investment volumes and specific potential finance allocation sources.

[31] QBIS, 2020. Socio-economic impact study of offshore wind. Danish Shipping, Wind Denmark and Danish Energy with support from The Danish Maritime Foundation.

5.3. Cooperation and collaboration possibilities

5.3.1. COOPERATION

General comparative advantages and challenges of Estonian and Latvian harbours in ownership, functionality, infrastructure, aquaculture potential, and investment costs for operations and maintenance (O&M) can be described as thus:

Ownership and Management

Estonian harbours are primarily privately owned or managed by local municipalities, with only a few state-operated options. This diversity enables management approaches that can better cater to local needs and tourism. In contrast, most Latvian small port authorities are institutions established by regional councils, focusing on service provision and revenue generation, which may facilitate more uniform development strategies across harbours.

Focus and Functionality

Estonian harbours tend to prioritize maritime tourism, local community services, and coastal fishing, making them potentially more appealing to recreational users and tourism promotion. Conversely, Latvian harbours focus on economic functions, particularly cargo transport and commercial fishing, which includes a strong presence in trawling. This focus gives Latvia a competitive edge in handling larger volumes of cargo and commercial activities.

Infrastructure and Capacity for O&M Functions

Estonian harbours face infrastructure challenges, particularly for servicing larger operations like offshore wind farms, due to depth limitations. However, certain areas, such as the western coast of Saaremaa and the northern coast of Hiiumaa, are identified as suitable for Crew Transfer Vessel (CTV) harbours. Harbours like Virtsu and Pärnu show potential advantages for servicing Service Operation Vessels (SOVs). In contrast, Latvian harbours such as Ventspils and Liepaja are better equipped with the necessary infrastructure for cargo and fishing operations, making them more suitable for servicing SOVs. Additionally, Latvian harbours like Salacgriva, Skulte, Mersrags and Roja also express readiness to serve SOVs. Salacgriva also has good location for rendering CTV services for offshore windfarms.

Potential for Aquaculture

In Estonia, emerging opportunities for aquaculture exist in areas like the northern part of Hiiumaa and northwest Saaremaa, with harbours such as Veere, Saaremaa, Varese, Kalana, Lehtma, and Kõrgessaare potentially advantageous for servicing aquafarms. In Latvia, while the development of aquaculture is limited by natural conditions, designated areas in the Gulf of Riga are expected to provide future advantages, particularly for harbours like Roja and Mersrags.

Investment Costs for O&M

The development of CTV-serviced offshore wind farms is projected to create local jobs, with estimates indicating that a 1 GW offshore wind farm could generate around 45 direct jobs, supporting the case for investments in public-private partnership formats. Latvian harbours may require less investment to adapt their existing infrastructure for O&M services compared to the larger-scale requirements in Estonia.

5.3.2. COLLABORATION

Generally, Estonia may have a competitive advantage in tourism and local community engagement, as well as in facilitating CTV service models. Meanwhile, Latvia excels in commercial shipping and fishing due to its superior infrastructure and management practices, along with better facilitation of SOV service models.

However, the investments and developments in both countries offshore areas and harbours should be jointly coordinated in order to avoid wrong investment decisions and facilitate the synergies in harbours network. The collaboration areas might cover the following:

1. **Integrated Infrastructure Development**: The focus is on creating a network of harbours that can support various maritime activities. This includes investment in infrastructure for servicing offshore wind farms, particularly Crew Transfer Vessels (CTVs) and Service Operation Vessels (SOVs). There's an emphasis on seeking investments for new fuels, gathering detailed information for investment decisions, establishing a rescue and emergency harbour network, and ensuring proper use intensity of harbours to increase local benefits.
2. **Sustainable Economic Growth**: Enhancing harbour operational capabilities to support maritime transport, fishing, and tourism. The goal is to create multifunctional ports that can adapt to future maritime activities, thereby ensuring resilience and profitability. It also addresses community engagement concerning marinas and coastal developments, proposing ways to alleviate concerns from fishermen and local communities regarding industrialization and tourism.
3. **Environmental Considerations**: Development plans must comply with Environmental Impact Assessments (EIA) and align with marine spatial plans in both countries to minimize disruption to existing maritime

activities. Developing new projects based on common environmental requirements and implementing strategies for pollution prevention, climate resilience, and early warning systems for pollution.

4. **Regional Connectivity**: The establishment of formal and informal cooperation mechanisms between Estonian and Latvian authorities to share information on market changes, offshore incentives, and knowledge. This may include joint study trips and widening cooperation to engage main harbour users.
5. **Upskilling**: There is an emerging need for a skilled workforce to maintain and operate offshore facilities. The cooperation may include developing and aligning training courses in both countries, promoting student exchanges, and organizing joint teacher training for subjects where there is no available study program, or native speaking lecturers.
6. **Promotion of Maritime Tourism**: Enhancing maritime tourism through the development of guest harbours and improved visitor facilities, alongside the promotion of joint tourism routes and co-marketing initiatives.
7. **Innovation and Technological Advancement**: The adoption of new technologies in harbour operations, including investments in digital solutions for monitoring and managing activities, energy storage technologies, novel naval architecture and the integration of green technologies.
8. **Monitoring, Evaluation, and Implementation**: A joint task force comprising representatives from both countries is suggested to oversee the implementation and monitoring of the relevant changes in marine territories and investment climate. This includes conducting annual updates on developments, and holding formal annual meetings to review and adjust the strategy based on evolving conditions.

As both Estonia and Latvia aim to enhance their maritime capabilities, the findings suggest that collaboration between the two countries is essential to optimize harbour functionalities and investment strategies. The potential for socio-economic growth, driven by offshore wind farms and aquaculture, presents new opportunities for job creation and local economic benefits. However, not all harbours will be equally positioned to capitalize on these developments due to geographical and infrastructural limitations.

To maximize the benefits from the emerging marine sectors, it is crucial for stakeholders and relevant local municipalities to coordinate investments, emphasize sustainable development, and engage local communities in the decision-making processes. Future initiatives should focus on integrated infrastructure development, environmental compliance, and the promotion of maritime tourism, all while fostering innovation and upskilling the workforce to meet the demands of an emerging offshore industry and thus changing the structure of blue economy.

ANNEX 1 THE LIST OF SURVEYED PORTS/HARBOURS

1. Abruka
2. Atla
3. Engure
4. Heltermaa
5. Jurmala
6. Kalana
7. Kaunispe
8. Kihnu
9. Kuivastu
10. Kuivici
11. Kuressaare
12. Kõiguste
13. Kõrgessaare
14. Kärdla
15. Lehtma
16. Liepaja
17. Lõmala
18. Lõunaranna
19. Mersrags
20. Munalaiu
21. Mõntu
22. Orissaare
23. Orjaku
24. Paldiski
25. Papissaare
26. Pavilosta
27. Pärnu
28. Roja
29. Roograhu
30. Roomassaare
31. Ruhnu
32. Saaremaa
33. Salacgriva
34. Skulte
35. Soela
36. Suuresadam
37. Sõru
38. Taaliku
39. Triigi
40. Varese
41. Veere
42. Ventspils
43. Vikati
44. Virtsu

ANNEX 2 THE MAP OF SURVEYED HARBOURS