ELECTRIFICATION OF EUROPEAN PORTS (UK)

Status for onshore power supply in selected UK ports

European Federation for Transport and Environment A.I.S.B.L.

Report no.: 2024-1793, Rev. 2
Date: 2024-12-04

Project name:	Electrification of European Ports (UK)	4100 - DNV AS, Norway Maritime
Report title:	Status for onshore power supply in selected UK ports	101222 - Environment Advisory
Customer:	European Federation for Transport and Environment A.I.S.B.L., 18 Square de Meeûs, 1050 Brussels, Belgium	Veritasveien 1 1363 Høvik Norway
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Date of issue:	2024-12-04	945 748 931
Project no.:	10494593	
Organization unit:	Environment Advisory	
Report no.:	2024-1793, Rev. 2	

Applicable contract(s) governing the provision of this Report:

Objective: To better understand the current level of UK port electrification and the plans for the nearest future, in order to see how ports are faring towards the expected electrification demand in 2030.

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Keywords Ports, electrification, onshore power supply

Rev. no.	Date	Reason for issue	Prepared by	Verified by	Approved by
0	2024-07-12	First issue	Eirill Bachmann Mehammer	Alvar Mjelde	Terje Sverud
1	2024-08-16	Comments from T&E	Eirill Bachmann Mehammer	Alvar Mjelde	Terje Sverud
2	2024-12-04	Updates to ferry case study	Eirill Bachmann Mehammer	Alvar Mjelde	Terje Sverud

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1 EXECUTIVE SUMMARY

This report summarises the findings from the study on electrification of European ports (UK) performed by DNV for European Federation for Transport and Environment. The findings regarding EU ports are summarised in a separate report. The study includes installed and contracted commercial-scale onshore power supply (OPS) facilities in selected major ports and assesses the infrastructural readiness to match the forthcoming requirements of EU regulations in 2030.

The findings of this report are intended to inform policy makers and other relevant stakeholders about the progress ports in the United Kingdom (UK) are making towards the 2030 shore power requirements, thereby facilitating informed decision-making for infrastructure investments and regulatory compliance.

7 major ports in the UK are selected based on activity (port visits per year), geographical distribution, and the ports' willingness to provide information. For each port, the following results are presented:

1. An overview of the current ship activity and energy requirements, based on an AIS analysis of the ship traffic in the selected ports in 2023.
2. The current status and plans for OPS in each port, based on data collection through interviews with relevant representatives for the selected ports.
3. A comparison of the installed and contracted OPS connection points, versus the estimated required number of connection points, split on high voltage and low voltage systems.

The first two points above are covered for all ship segments, with a special focus on the three ship segments relevant for the upcoming EU regulations (container, cruise, and passenger ships above 5000 gross tonnage (GT) in point 1. The assessment of OPS coverage in point 3 addresses the three regulated ship segments (container, passenger, and cruise ships). The ports' readiness to meet OPS demand from vessels that must comply with upcoming EU regulations is indicated using a "traffic light rating", where a red light indicates that less than 50% of the required connection points are either contracted or already installed, a yellow light indicates that more than 50% of the required connection points are contracted/installed, but less than 100%, and a 100% or higher coverage is denoted by a green light.

The UK ports are not subject to the same upcoming regulations for onshore power supply as EU ports. This is reflected in the findings of this study, which show that in 6 of the 7 selected UK ports there are no OPS systems installed yet and neither concrete plans for installing OPS.

Southampton is the only one of the selected UK ports that has installed onshore power supply systems. There are two high voltage connection points for cruise ships installed in the port of Southampton, but due to constraints in the National Grid, only one ship can be supplied at any given time. This is not enough to meet the estimated requirements, and there are no concrete plans to install further connection points.

Some of the selected UK ports are mapping funding opportunities (Belfast), energy demand (Thames and Dover), or the need for local grid upgrades (Dover and Milford Haven). These are important first steps in the development of shore power infrastructure. Furthermore, some ports (Dover and Milford Haven) have installed small-scale OPS systems (industrial plugs), which are outside the scope of this study.

There are many ferry routes operating in the UK, and the most suitable decarbonisation solution for a number of these is likely to be battery electrification. This will require significant electricity grid upgrades to provide high-power charging facilities. We have assessed the specific requirements of a single ferry route that could be a suitable first mover to battery-electric operation, namely the Portsmouth - Isle of Wight route currently operated by Wightlink. The required power for charging is estimated to be 9 megawatts (MW) at both sides. Each of the ports require a 14 kVA connection, according to Wightlink. The total estimated costs are approximately £16.2m, including grid connection costs at around £6.2m and charging system costs at around £10m. Note that the costs related to potential network upgrades and the onboard installations (batteries, charging plugs, and control systems) are not included in the estimate.

2 INTRODUCTION

This report summarises the findings from the study on electrification of European ports (UK) performed by DNV for the European Federation for Transport and Environment. The findings regarding EU ports are summarised in a separate report. The study includes installed and contracted onshore power supply (OPS) facilities in selected major ports and assesses the infrastructural readiness to match the requirements of the upcoming EU regulations in 2030. OPS facilities can also be used for battery charging, provided that the ships have an onboard converter and there is sufficient capacity in the electricity grid. It should be noted that charging of onboard batteries requires higher grid capacity than supplying the power needs of ships at berth.

2.1 Background

In the EU, there are upcoming regulatory requirements for the supply and use of onshore power supply. Due to Brexit, the UK ports are not subject to these upcoming regulations. However, it is likely that the same ships will be sailing between the UK and EU and therefore it is also important to harmonize OPS infrastructure in the geographical area. Furthermore, the UK ETS Authority has announced that it will expand the UK Emissions Trading Scheme (UK ETS) to include emissions from the domestic maritime sector, including emissions at berth or at anchor.[1] This will have major implications on the demand for shore power in UK ports.

The Fuel EU Maritime Regulation (FEUM) introduces a zero-emission mandate while at berth.[2] This means that seagoing passenger ships (i.e., ferries and cruise ships) and container ships above 5000 gross tonnage (GT) must use OPS or alternative zero-emission technologies[3] from 2030 onwards to meet their electrical power needs when berthed for more than two hours in a Trans-European Transport Network (TEN-T) port. From 2035, this requirement applies to all ports where shore power is available. This requirement does not apply to ships that are moored at the quayside for less than two hours or ships that have to make an unscheduled port call. There are also exceptions for ships that are unable to connect to OPS due to the unavailability of OPS connection points in a port or because electrical grid stability is at risk.

The Alternative Fuels Infrastructure Regulation (AFIR) complements this requirement by mandating core and comprehensive TEN-T ports to install enough OPS facilities to provide shore-side electricity for at least 90% of the port calls by seagoing passenger, cruise, and container ships above 5000 GT every year from 2030.[4] This requirement does not apply if the annual number of port calls, averaged over the last three years, is low (under 100 for container ships, under 40 for passenger ships, and under 25 for cruise ships).

In light of these upcoming regulatory requirements, the European Federation for Transport and Environment has approached DNV to better understand the progress European ports (EU and UK) are making towards the expected shore power requirements in 2030. The findings of this report are intended to facilitate informed decision-making for infrastructure investments and regulatory compliance.

2.2 Scope

7 major ports in the UK were selected for this study based on size (port visits per year), geographical distribution, and the ports' willingness to provide information: Belfast, Dover, Felixstowe, Harwich, Milford Haven, Southampton, and Thames (London Gateway Port).

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[1] https://www.ashurst.com/en/insights/uk-ets-to-be-expanded-to-cover-maritime-emissions-your-questions-answered/

[2] https://data.consilium.europa.eu/doc/document/PE-26-2023-INIT/en/pdf (Article 6)

[3] Defined as onboard fuel cells with zero-emission fuel, onboard electrical energy storage, or onboard power generation from wind and solar energy.

[4] https://data.consilium.europa.eu/doc/document/PE-25-2023-INIT/en/pdf (Article 9)

Chapter 3 in this report describes the methodology applied in the study. The high-level results, including the gap between supply of and demand for shore power in the selected ports, are presented in chapter 4. Detailed results and discussions for each port can be found in the Appendix, including an overview of current ship activity and energy requirements, and current status and plans for onshore power supply. The questionnaire used in the interviews with ports is also presented in the Appendix.

Results are shown for all ship segments above 400 GT, with a special focus on container, cruise, and passenger ships above 5000 GT. This is because these ships are within scope of the upcoming EU regulations regarding OPS. Hence, our assessment of OPS coverage in ports addresses these three ship segments. Small-scale OPS systems (industrial plugs, e.g., for harbour craft) are outside the scope of this study.

A case study has been performed on a single UK ferry route (Gunwharf in Portsmouth to Fishbourne on the Isle of Wight) suitable for decarbonisation through battery electrification. This is to provide an assessment of the required charging power, local electricity grid capacity and associated costs. The results are presented in Chapter 4.

The ports have been asked to provide information about the available capacity in the local power grid, but a detailed analysis of the grid infrastructure in ports is relevant for the UK ferry case study only.

3 METHODOLOGY

This chapter describes the methodology applied to evaluate ports' current installed OPS capacity and readiness to meet OPS demand from vessels that must comply with upcoming EU regulations for OPS in 2030. The overall methodology is illustrated in Figure 3-1, listing the main steps, which are further described in the following subchapters.

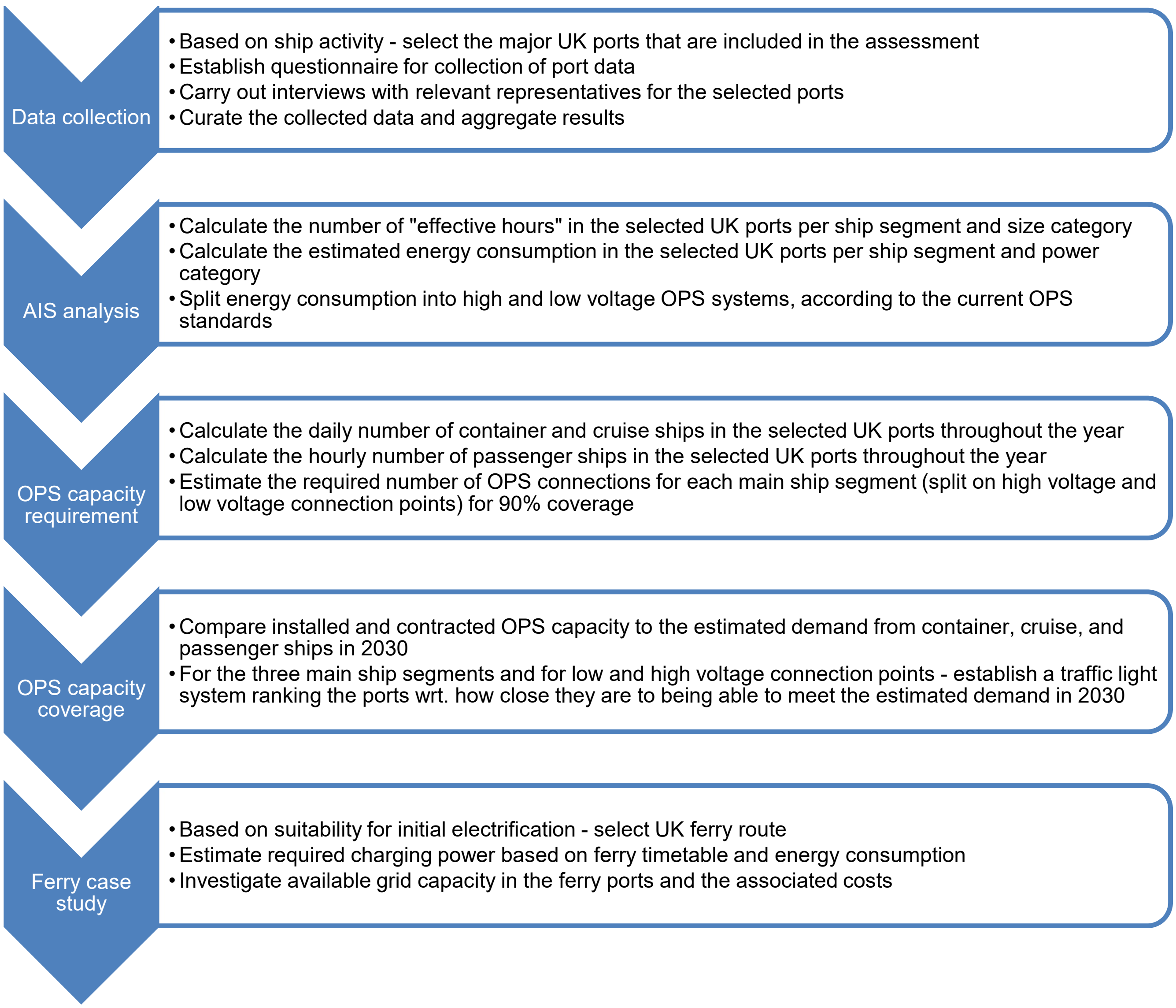


Figure 3-1 Overall methodology applied in the study.

3.1 Ship categories

In this study it has been decided to use a DNV standard ship breakdown structure derived from the IHS Markit breakdown structure.[5] The 15 different categories are listed in Table 3-1 below. There are also 7 ship size categories as shown in Table 3-2.

Table 3-1 Standard ship type breakdown structure.

Bulk carriers	Ship for carrying dry cargo in bulk
Chemical tankers	Tanker ship with segregated tanks with the ability to carry several types of liquid cargo
Container ships	Ship dedicated for carrying standardized containers stacked in dedicated holds
Crude oil tankers	Crude oil tankers
Cruise ships	Passenger ships dedicated for the cruise industry
Fishing ships	All types of ships dedicated for commercial fisheries
Gas tankers	Tankers dedicated for carrying liquified gas
General cargo ships	Ships with holds for carrying dry cargo of different types
Offshore supply ships	Ships dedicated for supplying goods to offshore installation
Oil product tankers	Tanker ship with segregated tanks with the ability to carry several types of oil cargo at the same time
Other activities	Ships outside the standard categories such as crane ships, tugs, dredgers and non-commercial service ships
Other service offshore ships	Ships serving the offshore industry such as cable laying ships and anchor handlers
Passenger ships	Ferries, Ro-Pax and general passenger ships
Refrigerated cargo ships	Ships dedicated to transporting refrigerated goods
Ro-Ro cargo ships	Ships with open space deck areas with for goods carried on vehicles

Table 3-2 Standard ship size categories.

Ship size categories	400 - 999 GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <

3.2 Port definition

DNV has modelled several thousands of ports in our AIS data system (Figure 3-2). Hence, an overview of ship activity and energy consumption for the selected ports may be generated and tabulated. The selected ports in this study are defined based on UN/LOCODEs.[6] Each UN/LOCODE corresponds to a port shape with geographical boundaries defined in the DNV analysis system. These port shapes are illustrated in the Appendix. Port visits are counted when ships are within the port shape for a given duration (depending on ship type) and with zero speed.

Modern ports may consist of a conglomerate of quays spread over a large geographical area and there is also a constant change in ownership and management introducing uncertainty with respect to what constitutes the port definition at any given time. In the analysis, the port shapes are verified and checked to our best knowledge. However, changes may have been made to the port constellation that are not reflected in the DNV analysis system, thus causing deviations between port data and our estimates.

[5] https://imonumbers.lrfairplay.com/Home/About
[6] https://unece.org/trade/cefact/unlocode-code-list-country-and-territory

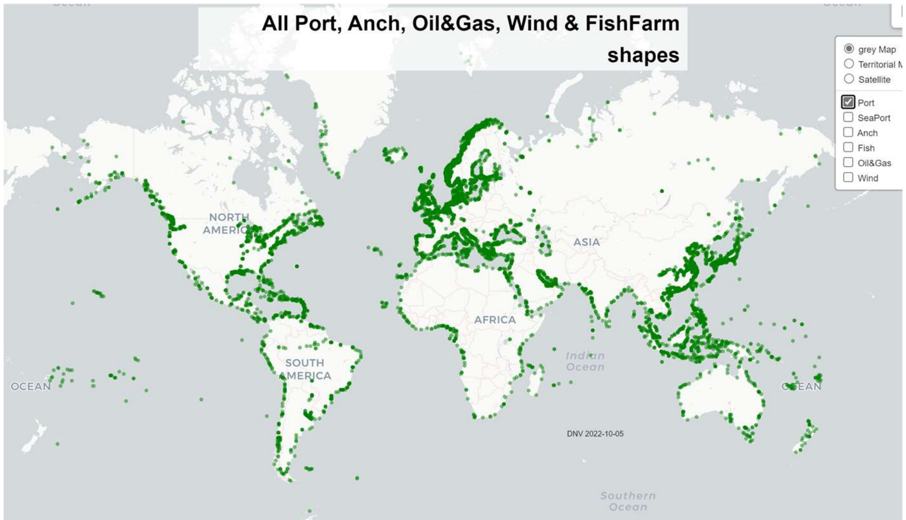


Figure 3-2 Illustration of ports modelled in DNVs AIS data system.

3.3 Current ship activity and estimated requirement for OPS connection points

DNV has utilized the MASTER (Mapping of Ship Tracks, Emissions and Reduction potentials) model which draws on Automatic Identification Systems (AIS) data for ships, to deduce the number of ships visiting each port in 2023. The MASTER model[7,8] utilizes data from the AIS system, which provide a detailed and high-resolution overview of all ship movements, where sailing speeds, operating patterns, sailed distances (nautical miles) and time spent in various areas are identifiable for each ship for those ships having the AIS system installed (carriage requirements for shipborne navigational systems and equipment, IMO). Coupling the ship positions and movements with geographical delimitation of the ports allows for counting the ships entering the ports, and thus also the need for OPS connection points for every day throughout the year. This way seasonal differences will be accounted for – particularly predominant for cruise ships.

It is assumed that a ship may potentially use OPS for their time in port minus one hour. This is based on the experience that some time must be allowed for connection and disconnection to the shore power facilities every time the ship visits the port. Hence, what is referred to as “Effective hours” equals the total hours in port minus one hour per port stay. The exception is for passenger ships, which may use negligible time for connection and disconnection due to port facilities dedicated to the specific ships, often with automatic connection and disconnection mechanisms. For passenger ships, one hour is therefore not deducted to establish the number of effective hours.

The estimated energy consumption is based on regression analysis of installed auxiliary power and a relevant usage factor for each ship. To translate installed power to realistic power consumption when in port (particularly important for ship types where diesel-electric is dominating), regression analysis is performed applying energy consumption data reported on DNVs Emissions Connect[9] platform. Additionally, more than 600 applications (including documented power consumption for

[7] Mjelde (2008). *Environmental Accounting System for Ships Based on AIS Ship Movement Tracking, report no. 2008-1853.*
[8] DNV (2022). *Maritime Forecast to 2050 - Energy Transition outlook.*
[9] https://www.dnv.com/services/emissions-connect-237579/

several thousand vessels) for funding of OPS installations[10] in Norway since 2016 have been used for further calibration of the energy consumption data and to ensure correlation with the most current fleet.

The estimated requirements for OPS systems are split into high (6.6-11 kV) and low (400-690 V) voltage according to the current OPS standards. It is assumed that the power needs in the categories <100 kilowatts (kW), 100-500 kW, and 500-1000 kW can be covered by low voltage OPS systems (as described in the standard IEC 80005-3[11]), while power needs in the categories 1-5 MW, 5-10 MW, and > 10 MW are best covered by high voltage OPS systems (as described in the standard IEC 80005-1[12]). Power requirements in the range 10-15 MW are not uncommon for cruise ships in port, and it should be noted that such power requirements constitute a very demanding load for the local power grid.

Based on the daily number of ships in port throughout the year, the required number of low voltage and high voltage connection points for the three main ship segments can be estimated. Container and cruise ships above 5000 GT are assumed to stay in port for at least one full day, hence the estimated number of required connection points corresponds to the number of ship visits in each category per day. Passenger ships may typically have shorter port stays and several port visits per day, hence there is a chance that we over-estimate the requirements for connection points by aggregating on ships per day. It was therefore decided to use a finer granularity for this ship type estimating the number of required connection points on an hourly basis, but following the same methodology. When testing hourly granularity for container and cruise ships, this revealed little or no changes to the results.

To fulfil the AFIR requirements, the ports must provide onshore power supply for at least 90% of the total number of port calls of seagoing container ships above 5 000 GT, if the annual number of port calls of such ships is above 100. Similarly, the ports must provide OPS for at least 90% of the total number of port calls of seagoing passenger ships above 5 000 GT, if the annual number of port calls of such ships is above 40. Furthermore, the ports must provide OPS for at least 90% of the total number of port calls of seagoing cruise ships above 5 000 GT, if the annual number of port calls of such ships is above 25. We estimate that the ports can provide OPS for 90% of the total number of port calls for the three main ship segments if they install a sufficient number of low and high voltage connection points to cover 90% of the days (for container and cruise ships) or hours (for passenger ships) in a year.

Figure 3-3 illustrates the method for how we translate from the number of port calls to the likely number of connection points required to serve 90% of the port calls. The port visits are extracted from the voyage database for 2023 and the amount of unique IMO numbers in port during each day or hour is counted. The data is sorted and flipped, so that the number of port visits in each main ship segment per day/hour in 2023 is plotted in increasing order. Then the data is normalised to obtain the cumulative distribution of port visits for each main ship segment (blue stepped line). The orange dotted line shows the 90th percentile (the number of connection points needed for covering 90% of the days/hours in a year), in this example resulting in an estimated need for 5 high voltage connection points. The rightmost value on the bottom axis, i.e. 7 in Figure 3-3, is the required amount of connection points that would yield a 100% coverage in 2023. For ports with only one simultaneous port stay for a ship category throughout the year, 90% coverage will always require 1 connection point, no matter the number of effective hours spent in port. In such cases, plots like the one in Figure 3-3 are not shown. It should be noted that this is a conservative estimate if only a few effective hours are spent in port.

[10] https://www.enova.no/bedrift/sjotransport/maritimt-tema/landstrom/
[11] https://webstore.iec.ch/en/publication/7578
[12] https://webstore.iec.ch/en/publication/29485

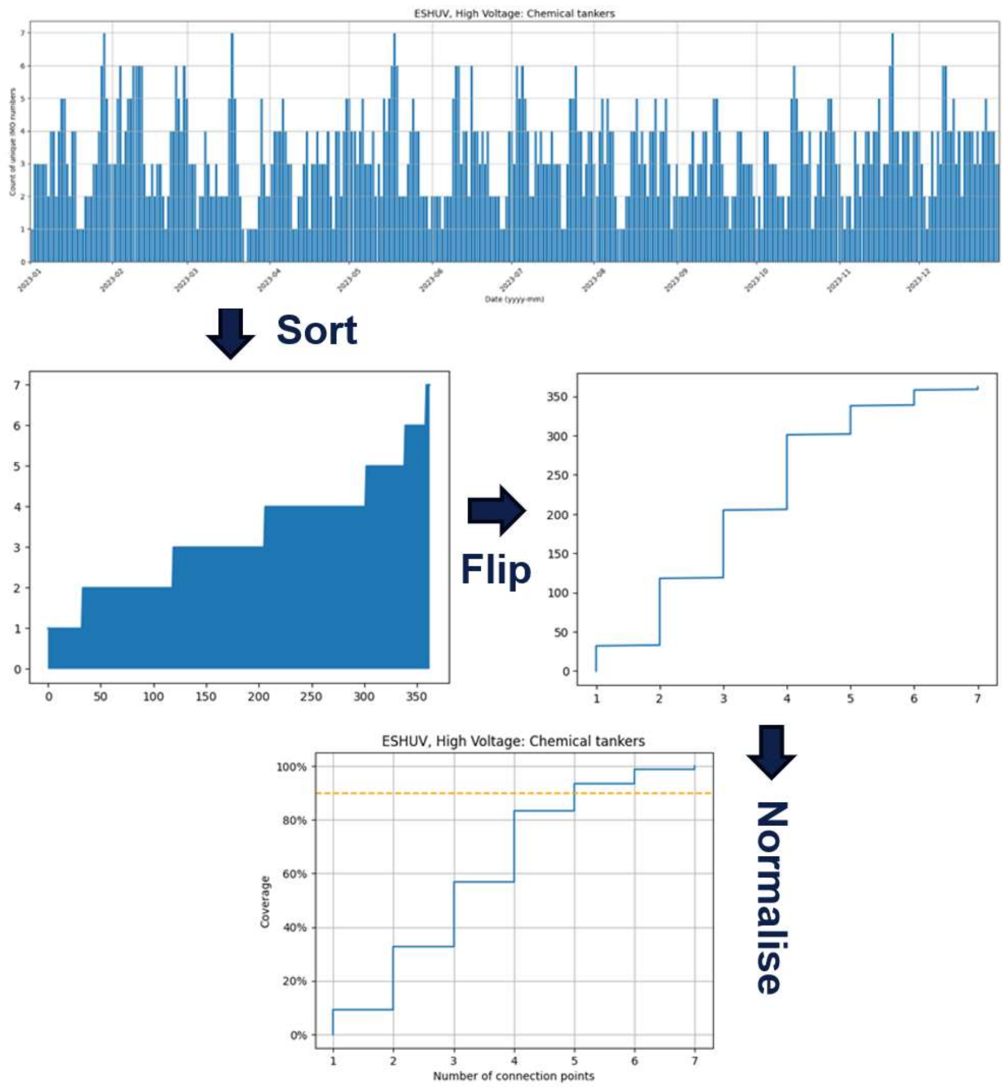


Figure 3-3 Methodology for estimating the number of required connection points for a 90% coverage.

3.4 Current status and plans for onshore power supply

Collecting data on the current OPS status and plans for OPS development in the selected ports has been a major part of the work involved with this project. As part of establishing a strategy for data collection, a questionnaire was developed in consultation with T&E (Table 6-1). This includes questions regarding the technical details of the current and planned OPS systems (power, voltage, frequency, standards, etc.), as well as the power grid in the port.

A list of contacts for all ports to be interviewed was established by DNV, and T&E contributed with their contacts. Based on previous similar undertakings, it was decided not to just send the questionnaire by email, but rather to initiate direct Teams meetings with the relevant personnel in the ports. The ports were approached via email and phone with information about the project and a request for interview. The interviews were conducted in March and April 2024.

The interviews were conducted via Teams and the questionnaire was used as an interview guide, with a degree of flexibility to accommodate variations in the availability of data and other information. This was particularly true for questions related to the local grid infrastructure and its available capacity relative to the required capacity, where there were in most cases limited knowledge about the status and the implications of an upgrade.

Only firm plans for OPS development with contracts signed (contracted OPS) are included in the quantitative analysis, but information about plans for OPS without contracts signed is also provided in this report for the ports that provided such information.

When using the results of this study, it should be considered that the information provided regarding current status and plans for onshore power supply is based on interviews with the ports. Not all ports were able to provide information regarding all the questions in the questionnaire and some of the information provided by the ports might be incorrect.

3.5 Comparison of installed/contracted and estimated requirement for OPS connection points

The estimated number of simultaneous connection points needed for container, cruise, and passenger ships above 5000 GT (Chapter 3.3) is then compared to the number of installed and contracted connection points for these ship types (Chapter 3.4). The ports' readiness to meet OPS demand from vessels that must comply with the upcoming EU requirements for OPS in 2030 is indicated with a "traffic light rating", where:

- a green light indicates that all required connection points or more are either contracted or already installed;
- a yellow light indicates that more than 50% of the required connection points are contracted or installed; and
- a red light indicates that less than 50% of the required connection points are either contracted or already installed.

It should be noted that the upcoming EU regulations apply from 2030, while the estimated requirements for connection points are based on the ship traffic in the ports in 2023. Various studies[13,14] forecast a growth in shipping in the coming years. Our assessment is that UNCTAD's Review of Maritime Transport 2023 is the most relevant for this study, since it is recent and looks at the period 2024-2028. UNCTAD forecasts maritime trade to expand at an average growth rate of 2.1% during this period. The global growth rate cannot easily be translated to growth in individual ports, but such an increase is not likely to significantly increase the requirements for OPS in terms of the number of connection points needed in the port. Some of the expected growth will likely be seen as an increase in ship size, and therefore not affect the number of port calls or effective hours. The increase in ship size applies in particular to container and cruise ships, where economy of scale is particularly important. Furthermore, most of the expected growth globally will likely be seen in areas outside of Europe. Hence, we do not have sufficient basis to estimate an increased number of required connection points in 2030 as compared to 2023.

3.6 Case study: ferry charging needs

DNV has identified the ferry traffic to/from UK ports and selected Wightlink's ferry route between Gunwharf (Portsmouth) and Fishbourne (Isle of Wight) as an additional case study. The selection was based on passenger traffic and ship size as determinants of suitability for initial electrification, as well as on the ferry operators' willingness to provide information.

[13] https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx
[14] https://unctad.org/publication/review-maritime-transport-2023

The following terminology is used for the ferry case study:

- **Network upgrades**: local / regional electricity system upgrades necessary to supply the substation nearest the port (outside the port boundary)
- **Grid connection**: connecting the port to the nearest substation (bringing the supply to the edge of Wightlink's property) (outside the port boundary)
- **Charging system**: charging units at berth and port infrastructure costs (to bring the required power supply from port boundary to berth) (inside the port boundary)

The ferry's current energy consumption was provided by the ferry operator. Based on the ferry timetable and the available time for charging, the required charging power was estimated.

In the next step, the available grid capacity in the ports at each side of the ferry route and the associated costs were investigated. The electricity distribution network operator in the area, Scottish and Southern Electricity Networks (SSEN), is responsible for delivering power to the ports. SSEN have provided current grid connection costs, but these should be considered approximate. SSEN have not provided estimates for network upgrades, but a network upgrade could be necessary over a distance of 15-20 miles. If significant network upgrades are required, they could impact the grid connection costs also. Indicative charging system costs were provided by Wightlink and should be considered high estimates due to unknowns.

4 RESULTS

4.1 Status for onshore power supply

Table 4-1 shows the compiled results of the AIS-based ship activity analysis and the results from the interviews with the selected ports regarding the installed and contracted shore power connection points for container, cruise, and passenger ships. More detailed results from both assessments can be found in the Appendix. Only firm plans with contracts signed are included in this summary table, while the Appendix also provides information about plans for OPS without contracts signed.

For each port, the currently installed and contracted connection points for container, cruise, and passenger ships above 5000 GT are added, and split on low voltage and high voltage connection points. This is then compared to the estimated number of simultaneous low voltage and high voltage connection points required for each of the main ship types, according to the observed port traffic throughout 2023.

The ports' readiness to match the requirements of the upcoming EU regulations is indicated using "traffic lights", as defined in section 3.5. If there are no contracted or installed connection points and no estimated need for any connection points, this is indicated by a hyphen (-).

Table 4-1 Summary of collected data and data analysis – including "traffic light rating".

Port Name	Ship type	Connection points (installed+contracted / required)					
		Low Voltage		High Voltage		Total	
Belfast	Container	0/3		-	-	0/3	
	Cruise	0/1		0/2		0/3	
	Passenger	0/1		0/3		0/4	
Dover	Container	-	-	-	-	-	-
	Cruise	0/1		0/2		0/3	
	Passenger	-	-	0/6		0/6	
Felixstowe	Container	0/2		0/7		0/9	
	Cruise	-	-	-	-	-	-
	Passenger	-	-	-	-	-	-
Harwich	Container	-	-	-	-	-	-
	Cruise	-	-	-	-	-	-
	Passenger	-	-	0/1		0/1	
	Container	-	-	-	-	-	-

Port Name	Ship type	Connection points (installed+contracted / required)					
		Low Voltage		High Voltage		Total	
Milford Haven	Cruise	-	-	-	-	-	-
	Passenger	-	-	0/1		0/1	
Southampton	Container	0/3		0/5		0/8	
	Cruise	0/1		2/4		2/5	
	Passenger	-	-	-	-	-	-
Thames (London Gateway Port)	Container	0/2		0/7		0/9	
	Cruise	-	-	-	-	-	-
	Passenger	-	-	-	-	-	-

4.2 Case study: ferry charging needs

There are many ferry routes operating in the UK, and the most suitable decarbonisation solution for a number of these is likely to be battery electrification. This will require significant electricity grid upgrades to provide high-power charging facilities in ports. We have assessed the specific requirements of a single ferry route that could be a suitable first mover to battery-electric operation, namely the Portsmouth - Isle of Wight route currently operated by Wightlink. Three vessels are needed to operate the route at peak frequency.

According to Wightlink,[16] the maximum energy consumption of the ferry for each crossing between Gunwharf (Portsmouth) and Fishbourne (Isle of Wight) is 3 MWh. With a battery capable of delivering 6 MWh, the ferry can comfortably complete a two-way journey on a single charge. Since the shortest available time for charging is approximately 20 minutes, the required charging power is estimated to be 9 MW on both sides, or 18 MW on one side. However, Whightink stated that charging at only one side is not feasible because ferry operations will stop in the event of a charging system breakdown and there would be no redundancy in the system.[17] Furthermore, Whightlink stated that using onshore batteries to support the local electricity grid is not feasible because there is insufficient time between port calls at peak service to recharge the onshore batteries.

Each port requires a 14 kVA connection, according to Wightlink. Both the Bulk Supply Point (BSP) at East Cowes Power Station and the BSP at Portsmouth are constrained according to Scottish & Southern Electricity Networks (SSEN), as shown in Figure 4-1 and Figure 4-2. Hence, network upgrades could be necessary over a distance of 15-20 miles to accommodate the required charging power (estimated to be 9 MW in each port). However, SSEN have not provided estimates for network upgrades. If significant network upgrades are required, they could impact the grid connection costs as well.

16 Personal communication with Charlie Field, Head of Engineering and Estates at Wightlink Ltd.

17 Please note that most electric ferries in operation have a battery hybrid propulsion system, where redundancy is provided by the use of machinery in the event of a power outage or charging system breakdown.

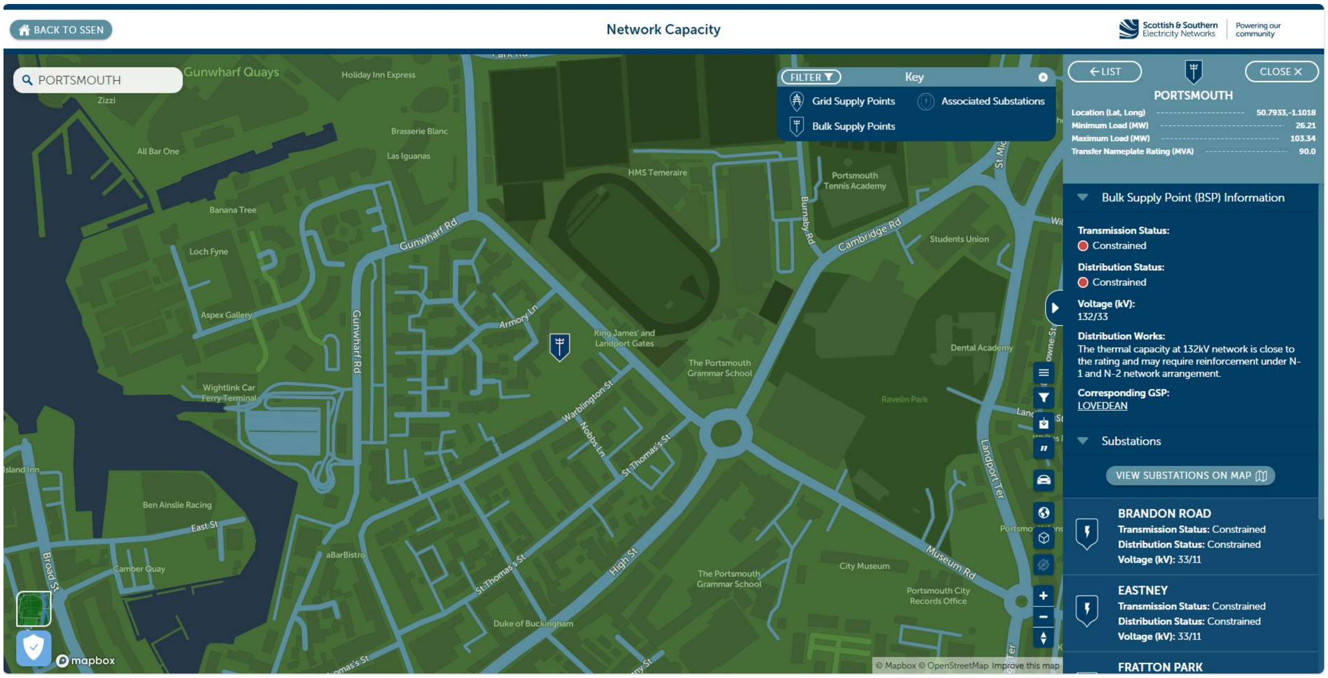


Figure 4-1 Network capacity in Gunwharf (Southampton).

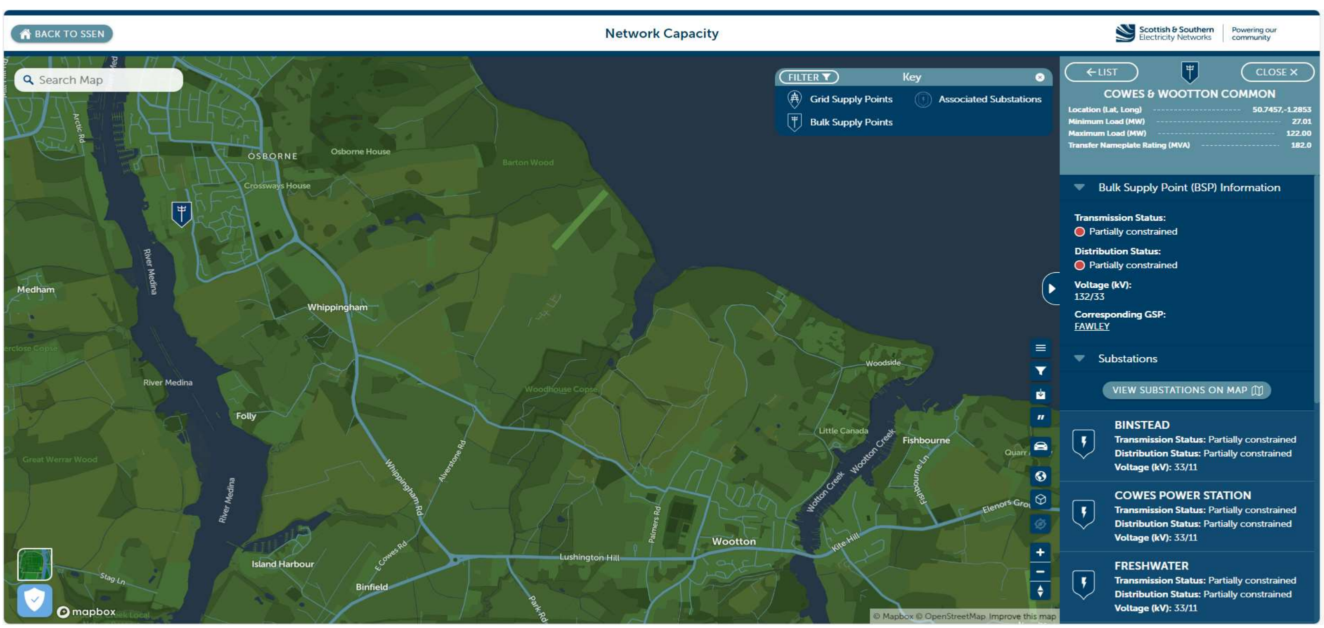


Figure 4-2 Network capacity in Fishbourne (Isle of Wight).

The total estimated costs are presented in Table 4-2. The grid connection costs are current and have been provided by SSEN. However, these should be considered approximate. The charging system costs have been provided by Whightlink and include construction costs within the ports, for installing the cabling and associated infrastructure. These are high estimates due to unknowns. Gunwharf is located in an area of listed buildings, preservation of which could increase costs. Fishbourne would require a cabling "run" of over 500 metres.

Table 4-2 Estimated costs for ferry charging needs of 9MW at each port.

	Network upgrades		**Grid connection**		**Charging system**		**Total**
Port	Gunwharf	Fishbourne	Gunwharf	Fishbourne	Gunwharf	Fishbourne	
Cost (£m)	Not estimated	Not estimated	2.1	4.1	5.0	5.0	16.2

5 CONCLUSION

UK ports are not subject to the same upcoming regulations for onshore power supply as EU ports. This is reflected in the findings of this study, which show that in 6 of the 7 selected UK ports there are no OPS systems installed yet and no concrete plans to install OPS either. In some ports, it will not be possible to install the required OPS systems by 2030, since it takes many years to get a grid connection with sufficient capacity.

Southampton is the only one of the selected UK ports that has contracted or installed onshore power supply systems for ships. There are two high voltage connection points for cruise ships installed in the port of Southampton, but due to constraints in the National Grid, only one ship can be supplied at a time. This is not enough to meet the estimated requirements, and there are no concrete plans to install further connection points.

Some of the selected UK ports are mapping funding opportunities (Belfast), energy demand (Thames and Dover), or the need for grid upgrades (Dover and Milford Haven). These are important first steps in the development of shore power infrastructure. Furthermore, some ports (Dover and Milford Haven) have installed small-scale OPS systems (industrial plugs), which are outside the scope of this study.

Several ferry routes in the UK are suitable for electrification. For the ferry route between Gunwharf (Portsmouth) and Fishbourne (Isle of Wight), the required power for ferry charging is estimated to be 9 MW on each side. Each port requires a 14 kVA connection, according to Wightlink. The total estimated costs are approximately £16.2m, including grid connection costs at around £6.2m and charging system costs at around £10m. Please note that the costs related to potential network upgrades and the onboard installations (batteries, charging plugs, and control systems) are excluded.

6 APPENDIX

In this chapter, we present the port shapes and detailed results and discussions for each of the selected ports.

The full picture of current ship activity in ports is illustrated by the number of effective hours in port per ship segment and size category. All ships above 400 GT are included, and the ship segments and size categories relevant for the upcoming regulations are highlighted in green.

The estimated energy consumption in the ports (in MWh) is presented per ship segment and power category. Energy consumption in the higher power categories (> 1 MW) is best covered by high voltage OPS systems, while energy consumption in the lower power categories (< 1 MW) can be covered by low voltage OPS systems. All ships above 400 GT are included, and the ship segments relevant for the upcoming regulations are highlighted in bold.

More details regarding current ship activity and energy requirements are presented for the ship segments relevant for the upcoming regulations (container ships, cruise ships, and passenger ships above 5000 GT). This includes plots showing the number of container and cruise ships in the ports per day in 2023, and the number of passenger ships in the ports per hour in 2023. The ship traffic is split on the ships requiring high voltage connection points and ships with power needs which can be covered by low voltage connection points. The number of ship visits in each category per day/hour in 2023 is also plotted in increasing order, with a yellow dotted line showing the estimated number of required low voltage and high voltage connection points for 90% coverage. Plots are not shown for categories with no traffic in the ports in 2023.

Furthermore, the information collected through the interviews with the ports regarding installed and planned onshore power supply systems is listed and discussed. Installed OPS systems and firm plans with contracts signed are included in tables, while plans for OPS without contracts signed are described in the text for the ports who provided such information. Each row in the tables represents one berth, except for the cases when different types of OPS systems are found on the same berth (then they are split on several rows). Table 6-1 shows the questionnaire used in the interviews with the ports, with explanations of each data field. For each port, only the data fields where the port could provide information is included.

Table 6-1 Questionnaire used in interviews with ports.

Port general questions	**Maximum power from grid**	How much power can the local electricity grid deliver to the port area (MW)
	Current surplus capacity in grid	How much power is still available in the local electricity grid after delivering shore power to the port (MW)
	Energy delivered through OPS	How much energy was delivered through onshore power supply in 2023 (MWh)
Quay general questions	**Berth name**	Berth/quay where OPS system is installed or planned
	Longitude	Geographic coordinate of berth/quay
	Latitude	Geographic coordinate of berth/quay
System specific questions	**Maximum system power capacity**	How much power can be delivered from the OPS system (kW). It is assumed that the power factor is 1, hence the active power (measured in kW or MW) is equal to the apparent power (measured in kVA or MVA).

	Maximum number of simultaneous ships	How many ships can be connected at the same time
	System voltage	Which voltage level can be delivered from the system (400-690 V / 6.6-11 kV / other)
	System frequency	Which frequency can be delivered from the system (50 Hz / 60 Hz / both). Since the electricity grid frequency in Europe is 50 Hz, a 50/60 Hz transformer is required for delivering 60 Hz.
	Types of ships	Which types of ships are using the system (see definitions in Table 3-1)
	Standard	Standard of OPS system (IEC 80005-1 / IEC 80005-3 / other). IEC 80005-1 is the high voltage OPS standard while IEC 80005-3 is the low voltage OPS standard.
	Availability	Availability of OPS system (private / public). Note that some OPS systems are private and not publicly available.
	Operational from	Year from which the system has been or will be operational
Comments		Any other information provided

6.1 Port of Belfast

Figure 6-1 Port shape for Belfast (GBBEL).

6.1.1 Current ship activity and energy requirements

Table 6-2 shows the effective hours in port per ship segment and size category for the port of Belfast in 2023. There are close to 8 000 effective hours in port for container ships larger than 5000 GT. For cruise ships larger than 5000 GT there are around 1 700 effective hours in port, and for passenger ships larger than 5000 GT there are more than 12 000 effective hours in port.

Table 6-2 Effective hours in port per ship segment and size category.

Belfast	400 - 999 GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <	Total
Bulk carriers		1 065	172	3 778	3 607	121		8 743
Chemical tankers		1 253	317	3 218	310			5 098
Container ships			5 440	2 329				7 769
Crude oil tankers					35	406		441
Cruise ships	740	372	135	125	486	660	264	2 782
Fishing ships	6 769							6 769
Gas tankers		799	173					972

General cargo ships	510	27 978	5 066	1 400	103			35 057
Offshore supply ships								0
Oil product tankers		1 586	185		53			1 824
Other activities	357	9 171	259	72	293			10 152
Other service offshore ships		180		464				644
Passenger ships		1 432	204	1 672	10 638			13 946
Refrigerated cargo ships				6889				6 889
Ro-Ro cargo ships								0
Total	8 376	43 836	11 951	19 947	15 525	1 187	264	101 086

Table 6-3 shows the estimated energy consumption per ship segment and power category for the port of Belfast in 2023.. For container ships, the estimated consumption is split between the power categories 100-500 kW and 500-1000 kW. For cruise ships, most of the energy consumption is in the power category 5-10 MW. For passenger ships, most of the energy consumption is in the power category 1-5 MW. Passenger ships account for more than half of the total estimated energy consumption in port.

Table 6-3 Estimated energy consumption in port (MWh) per ship segment and power category.

Belfast	**<100 kW**	**100-500 kW**	**500-1000 kW**	**1-5 MW**	**5-10 MW**	**>10 MW**	**Total**
Bulk carriers	0	2 690	64	0	0	0	2 753
Chemical tankers	0	0	252	3 893	0	0	4 146
Container ships	0	2 704	1 651	0	0	0	4 355
Crude oil tankers	0	0	34	508	0	0	541
Cruise ships	50	152	126	2 239	4 764	2 643	9 974
Fishing vessels	433	0	0	0	0	0	433
Gas tankers	0	304	0	173	0	0	477
General cargo ships	2 780	1 678	64	0	0	0	4 522
Offshore supply ships	0	0	0	0	0	0	0
Oil product tankers	0	382	149	0	0	0	531
Other activities	15	2 384	195	434	0	0	3 029
Other service offshore vessels	0	40	290	0	0	0	331
Passenger ships	0	511	166	40 954	0	0	41 631
Refrigerated cargo ships	0	0	5 601	0	0	0	5 601
Ro-Ro cargo ships	0	0	0	0	0	0	0
Total	3 278	10 846	8 593	48 201	4 764	2 643	78 324

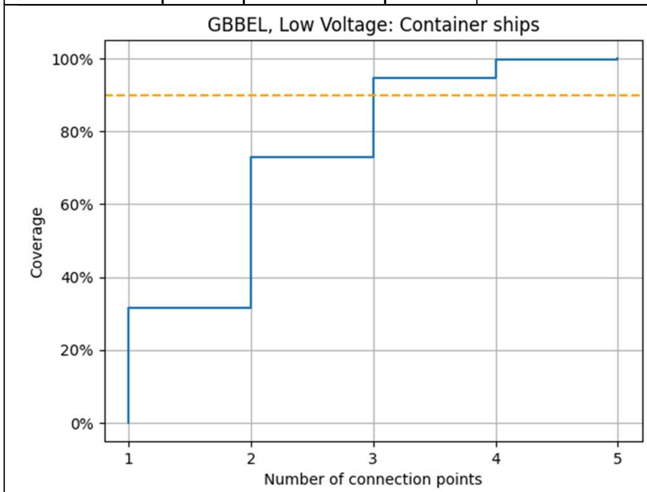
Table 6-4 presents simultaneous port calls for quantification of the need for low and high voltage connection points for container, cruise, and passenger ships above 5000 GT. There were some days in 2023 with 4 or 5 **container ships** requiring low voltage connection points in the port, but 3 such connection points would be sufficient for 90% coverage. There were no container ships requiring high voltage connection points in the port in 2023.

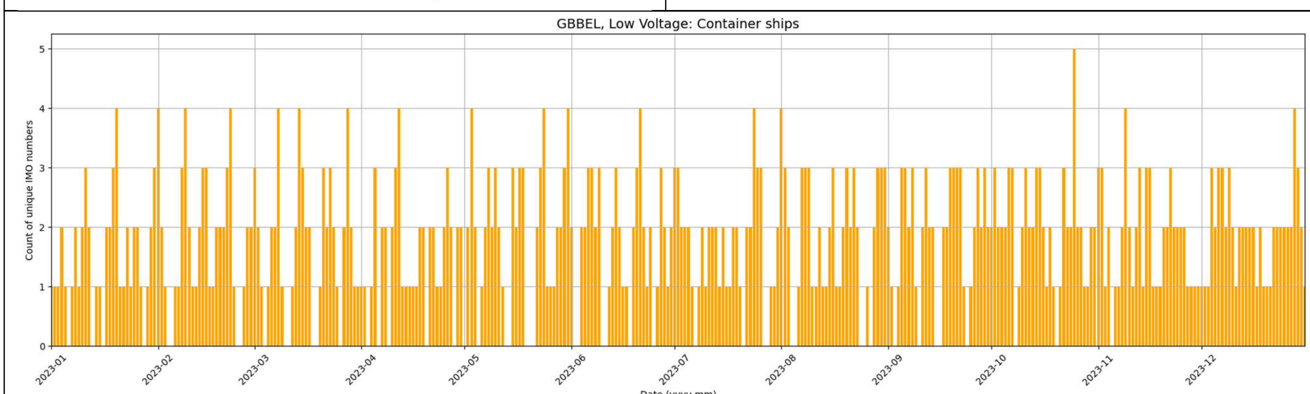
For **cruise ships**, there were some days with a need for 2 low voltage connection points and some days with a need for 3 high voltage connection points. However, 1 low voltage and 2 high voltage connection points would be sufficient for 90% coverage.

For **passenger ships**, there is an estimated need for one low voltage connection point, although there were only a few hours in 2023 with such traffic in the port. There were some hours in 2023 with 4 or 5 passenger ships requiring high voltage connection points in the port, but 3 such connection points would be sufficient for 90% coverage. In total, there is an estimated need for 3 connection points for container ships, 3 connection points for cruise ships, and 4 connection points for passenger ships.

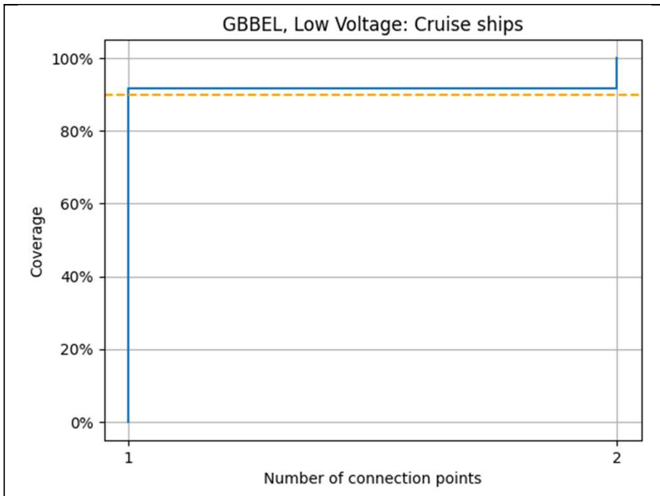
Table 6-4 Number of container and cruise ships at any day and passenger ships at any hour in 2023, and the estimated number of required connection points – split on low and high voltage.

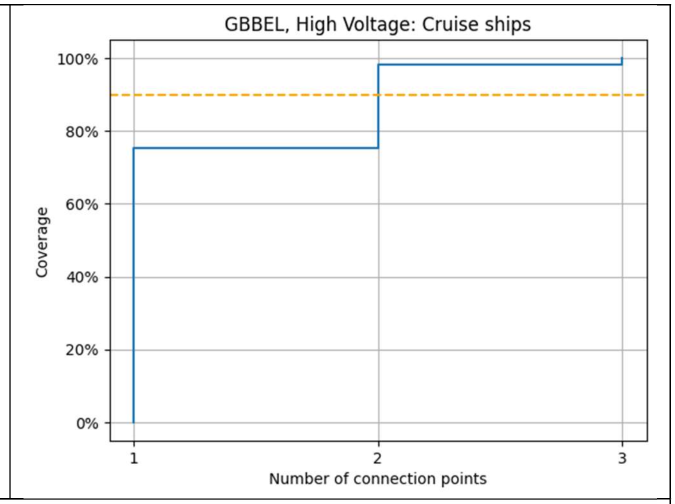
Belfast	**Low Voltage**	**High Voltage**
Container ships – req. connection points	3	0

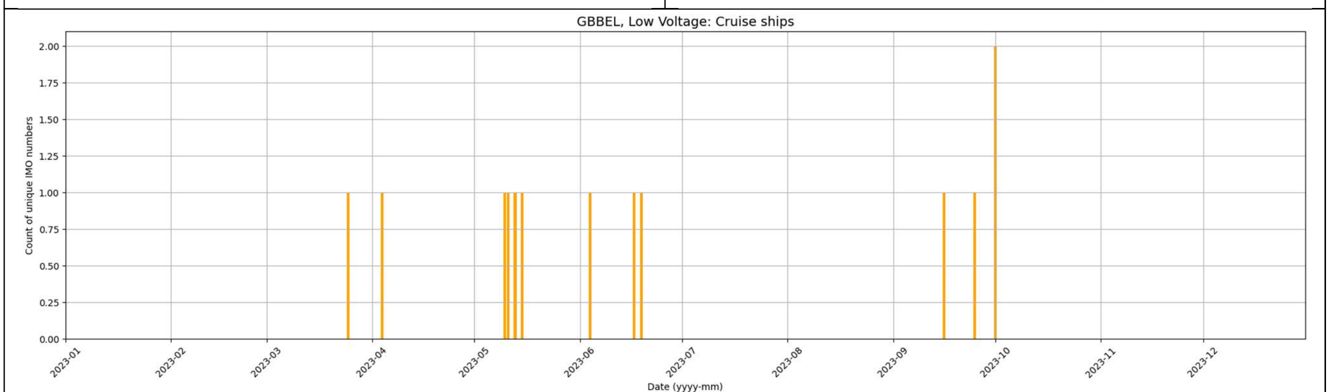


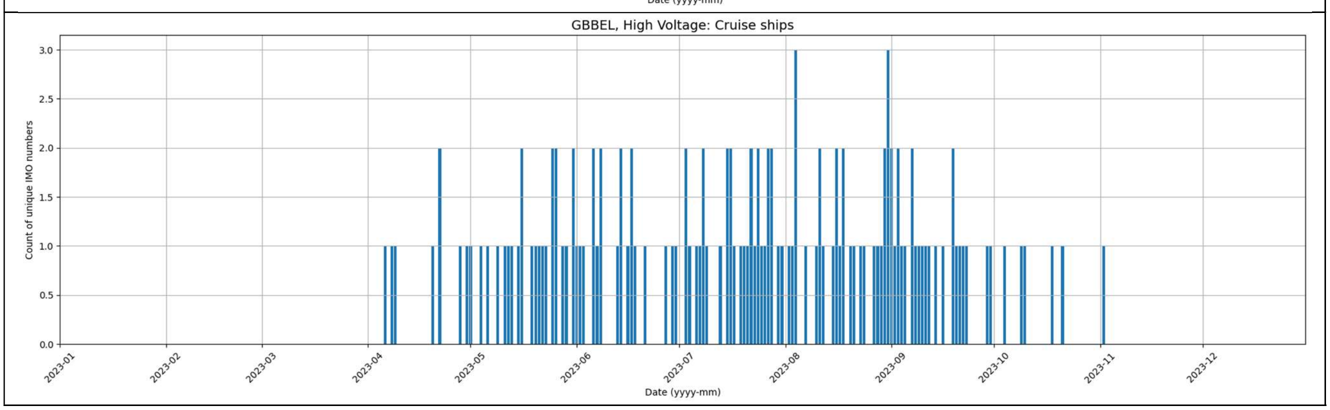


Belfast	**Low Voltage**	**High Voltage**
Cruise ships – req. connection points	1	2

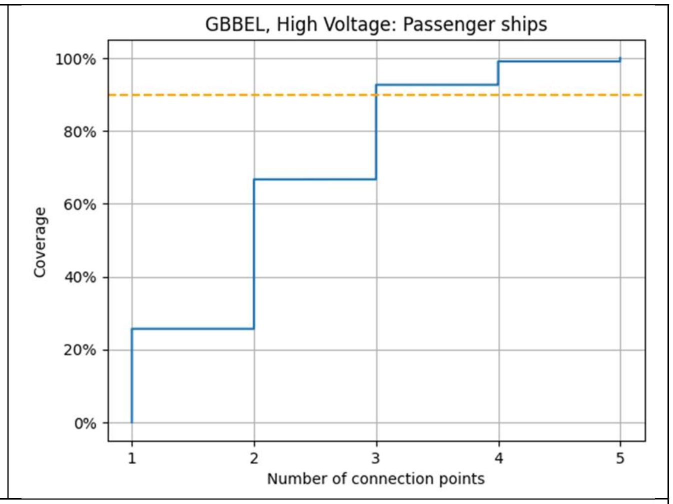


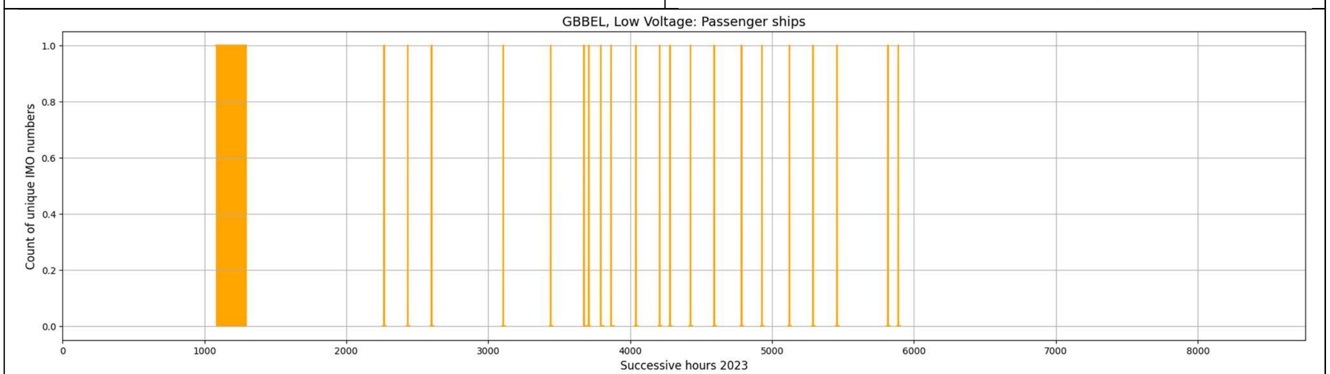


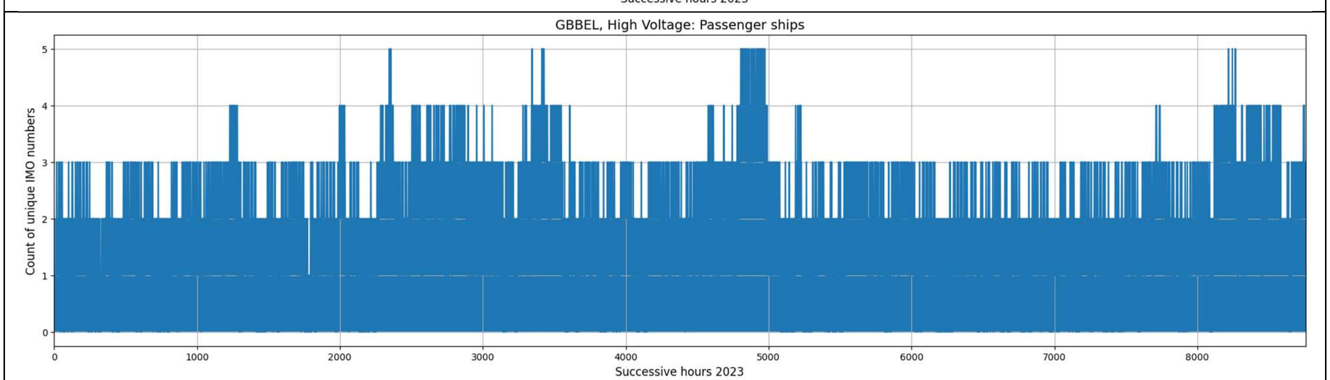




Belfast	**Low Voltage**	**High Voltage**
Passenger ships – req. connection points	1	3







6.1.2 Current status and plans for onshore power supply

In the port of Belfast, there are no OPS systems installed yet. There are no concrete plans to install OPS either, but the port is looking into opportunities for funding.

6.2 Port of Dover

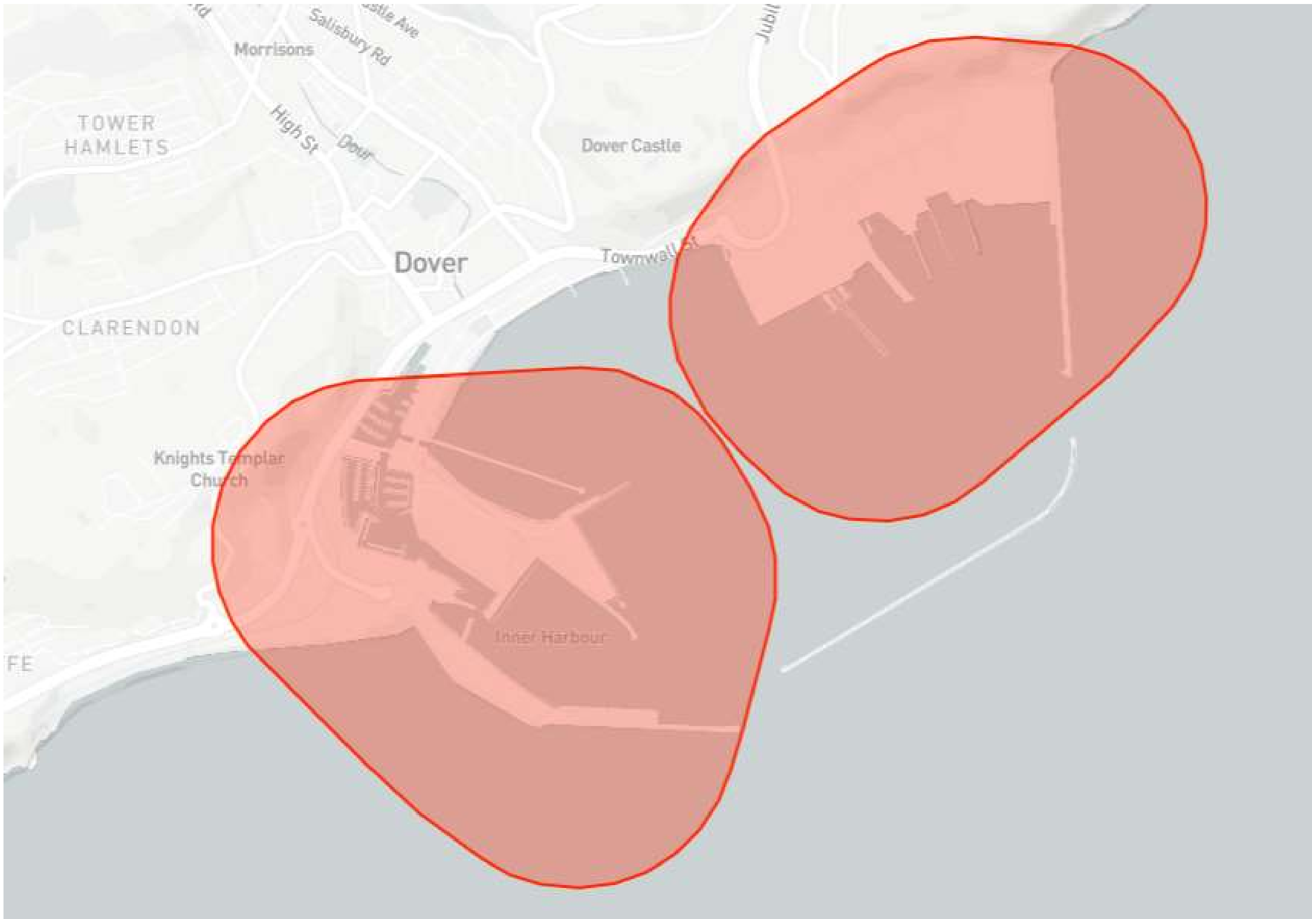


Figure 6-2 Port shape for Dover (GBDVR).

6.2.1 Current ship activity and energy requirements

Table 6-5 shows the effective hours in port per ship segment and size category for the port of Dover in 2023. There are no effective hours recorded in port for container ships larger than 5000 GT. For cruise ships larger than 5000 GT there are around 850 effective hours in port, and for passenger ships larger than 5000 GT there are close to 15 000 effective hours in port.

Table 6-5 Effective hours in port per ship segment and size category.

Dover	400 - 999 GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <	Total
Bulk carriers		11	143	78				232
Chemical tankers		404	5					409
Container ships								0
Crude oil tankers								0
Cruise ships			24	93	246	486	13	862
Fishing ships	15		5					20
Gas tankers								0

General cargo ships	19	2 222	205	48				2 494
Offshore supply ships								0
Oil product tankers								0
Other activities	117	263	17					397
Other service offshore ships			68					68
Passenger ships				1147	13577			14 724
Refrigerated cargo ships			417	504				921
Ro-Ro cargo ships								0
Total	151	2 900	884	1 870	13 823	486	13	20 127

Table 6-6 shows the estimated energy consumption per ship segment and power category for the port of Dover in 2023. For cruise ships, the majority of energy consumption is in the power category 5-10 MW. For passenger ships, all the estimated energy consumption is in the power category 1-5 MW. Passenger ships account for nearly 90% of the total estimated energy consumption in port.

Table 6-6 Estimated energy consumption in port (MWh) per ship segment and power category.

Dover	**<100 kW**	**100-500 kW**	**500-1000 kW**	**1-5 MW**	**5-10 MW**	**>10 MW**	**Total**
Bulk carriers	0	53	0	0	0	0	53
Chemical tankers	0	0	4	0	0	0	4
Container ships	0	0	0	0	0	0	0
Crude oil tankers	0	0	0	0	0	0	0
Cruise ships	0	0	22	1 192	3 508	130	4 852
Fishing vessels	1	2	0	0	0	0	3
Gas tankers	0	0	0	0	0	0	0
General cargo ships	220	65	0	0	0	0	285
Offshore supply ships	0	0	0	0	0	0	0
Oil product tankers	0	0	0	0	0	0	0
Other activities	5	68	9	0	0	0	82
Other service offshore vessels	0	26	0	0	0	0	26
Passenger ships	0	0	0	50 581	0	0	50 581
Refrigerated cargo ships	0	199	410	0	0	0	609
Ro-Ro cargo ships	0	0	0	0	0	0	0
Total	226	413	445	51 772	3 508	130	56 494

Table 6-7 presents simultaneous port calls for quantification of the need for low and high voltage connection points for container, cruise, and passenger ships above 5000 GT. For **container ships**, there was no traffic in the port in 2023, hence there is no estimated need for any connection points.

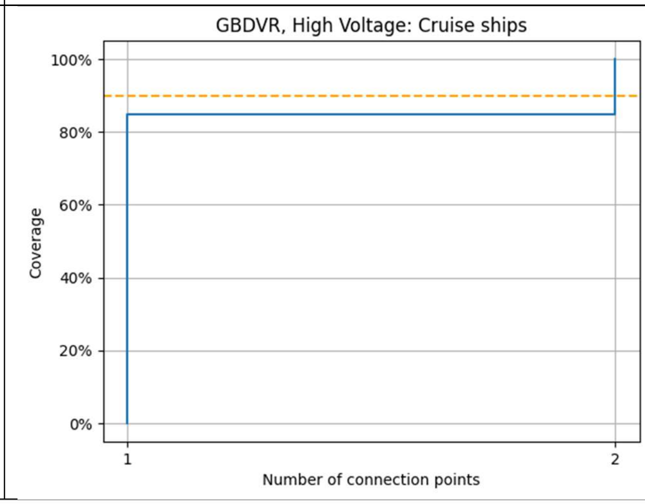
For 90% coverage, there is an estimated need for one low voltage connection point for **cruise ships**, although there were only a few days in 2023 with such traffic in the port. Unless a significant increase in the cruise traffic to the port is expected towards 2030, the port should not invest in such a connection point. 2 high voltage connection points for cruise ships are needed for 90% coverage.

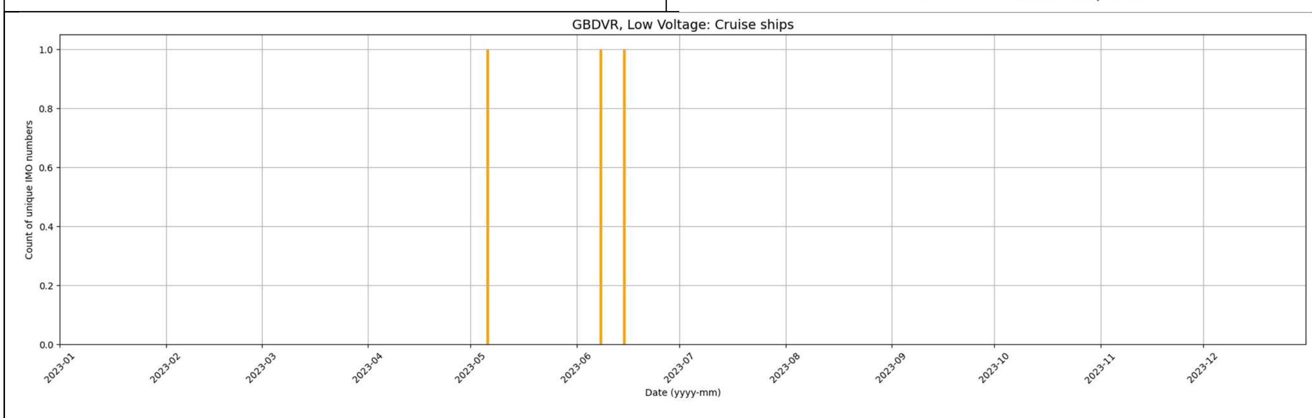
There were no **passenger ships** requiring low voltage connection points in the port in 2023. There were some days in 2023 with more than 8 passenger ships requiring high voltage connection points in the port, but 6 such connection points would be sufficient for 90%. In total, there is an estimated need for 3 connection points for cruise ships and 6 connection points for passenger ships.

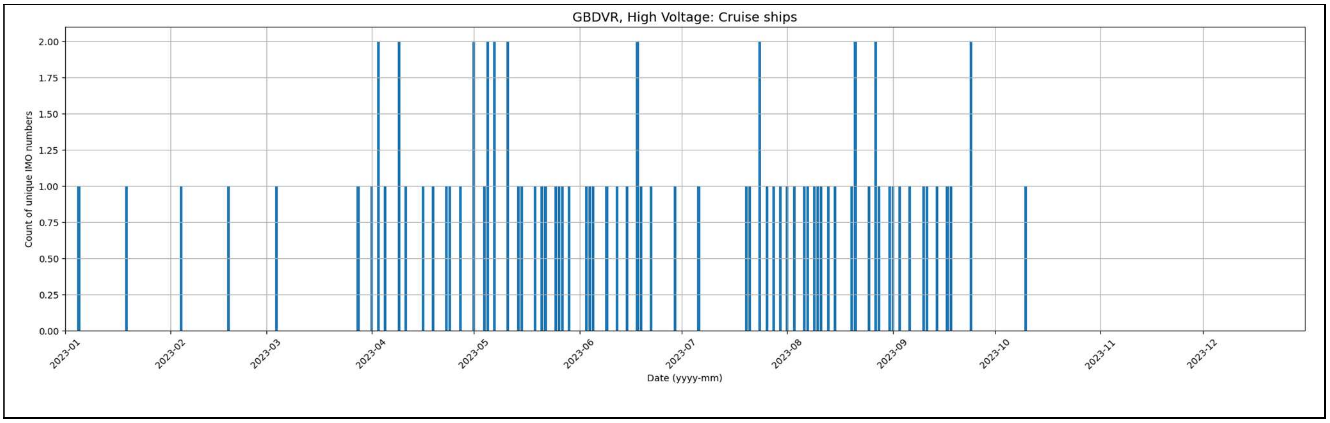
Table 6-7 Number of container and cruise ships at any day and passenger ships at any hour in 2023, and the estimated number of required connection points – split on low and high voltage.

Dover	**Low Voltage**	**High Voltage**
Container ships – req. connection points	0	0
No data		

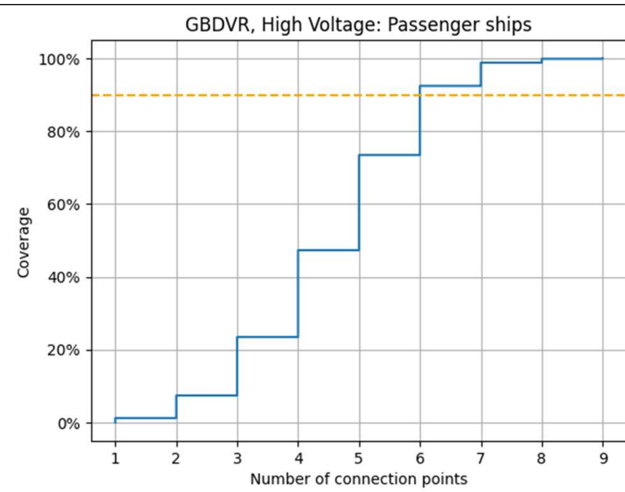
Dover	**Low Voltage**	**High Voltage**
Cruise ships – required connection points	1	2

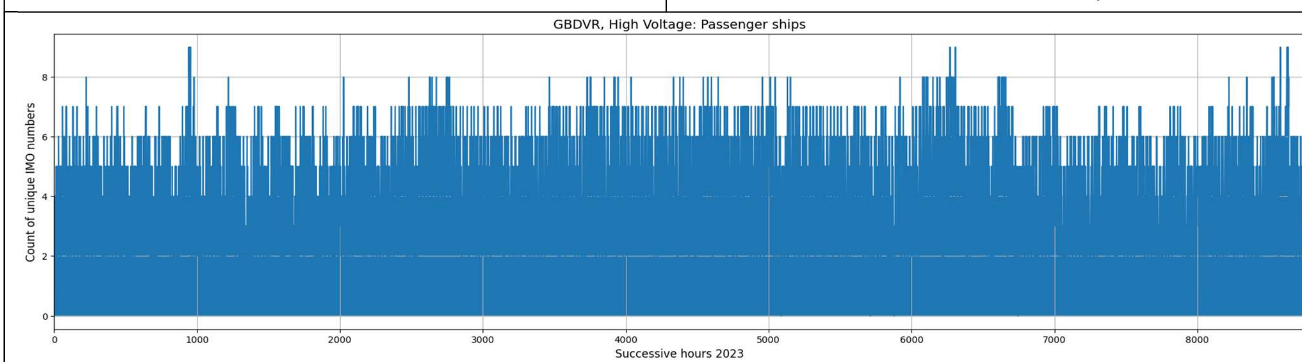






Dover	Low Voltage	High Voltage
Passenger ships – req. connection points	0	6





6.2.2 Current status and plans for onshore power supply

In the port of Dover, there are no OPS systems installed yet, other than for the port's own ships (dredger, 2 tugs, 2 pilot, and a survey ship). Although the port has a longer-term net-zero plan involving shore power, there are no concrete plans to install OPS yet. According to the port, there is limited power readily available from the UK grid, and the current timeline for them to access the required power for OPS is around 2030/2031. The port is currently undertaking some work to see if they could have a minor upgrade of the local electricity grid and use a battery energy storage system to support at least one cruise ship sooner. However, the amount of energy required by both ferries and cruise ships is significant.

6.3 Port of Felixstowe

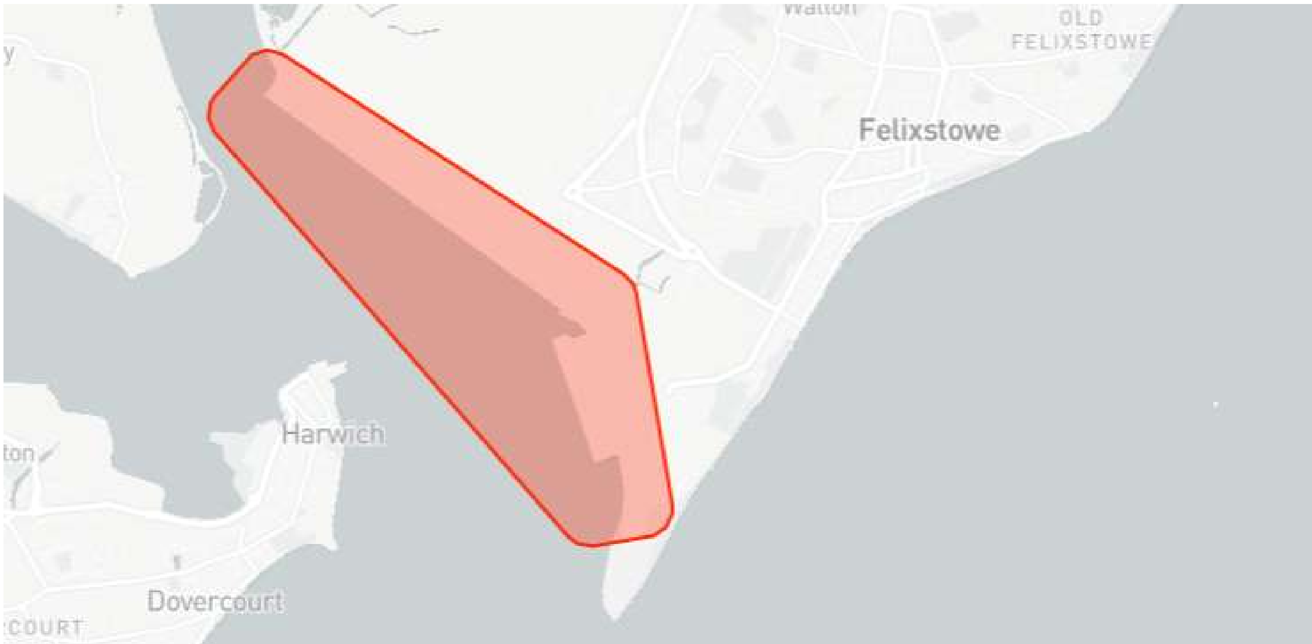


Figure 6-3 Port shape for Felixstowe (GBFXT).

6.3.1 Current ship activity and energy requirements

Table 6-8 shows the effective hours in port per ship segment and size category for the port of Felixstowe. For container ships larger than 5000 GT, there are recorded around 29 000 effective hours in port. There are no effective hours recorded in port for cruise ships and passenger ships larger than 5000 GT.

Table 6-8 Effective hours in port per ship segment and size category.

Felixstowe	400 - 999 GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <	Total
Bulk carriers		112						112
Chemical tankers		932						932
Container ships		7	1 700	637	3940	5540	17327	29 151
Crude oil tankers								0
Cruise ships								0
Fishing ships								0
Gas tankers								0
General cargo ships		102	57	61				220
Offshore supply ships			66					66
Oil product tankers								0
Other activities	12293	2 445	2	51				14 791

Other service offshore ships								0
Passenger ships								0
Refrigerated cargo ships								0
Ro-Ro cargo ships				749	4616			5 365
Total	12 293	3 598	1 825	1 498	8 556	5 540	17 327	50 637

Table 6-9 shows the effective hours per ship segment and power category for the port of Felixstowe in 2023. For container ships, most of the energy consumption is in the power category 1-5 MW. Container ships account for more than 90% of the total estimated energy consumption in port.

Table 6-9 Estimated energy consumption in port (MWh) per ship segment and power category.

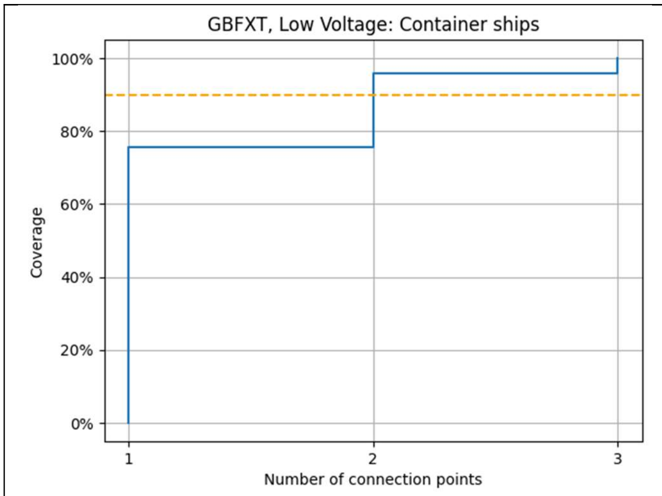
Felixstowe	**<100 kW**	**100-500 kW**	**500-1000 kW**	**1-5 MW**	**5-10 MW**	**>10 MW**	**Total**
Bulk carriers	0	13	0	0	0	0	13
Chemical tankers	0	3	0	0	0	0	3
Container ships	0	846	452	77 518	0	0	78 816
Crude oil tankers	0	0	0	0	0	0	0
Cruise ships	0	0	0	0	0	0	0
Fishing vessels	0	0	0	0	0	0	0
Gas tankers	0	0	0	0	0	0	0
General cargo ships	10	36	0	0	0	0	47
Offshore supply ships	0	0	34	0	0	0	34
Oil product tankers	0	0	0	0	0	0	0
Other activities	516	636	45	0	0	0	1 197
Other service offshore vessels	0	0	0	0	0	0	0
Passenger ships	0	0	0	0	0	0	0
Refrigerated cargo ships	0	0	0	0	0	0	0
Ro-Ro cargo ships	0	0	4 131	0	0	0	4 131
Total	526	1 535	4 661	77 518	0	0	84 240

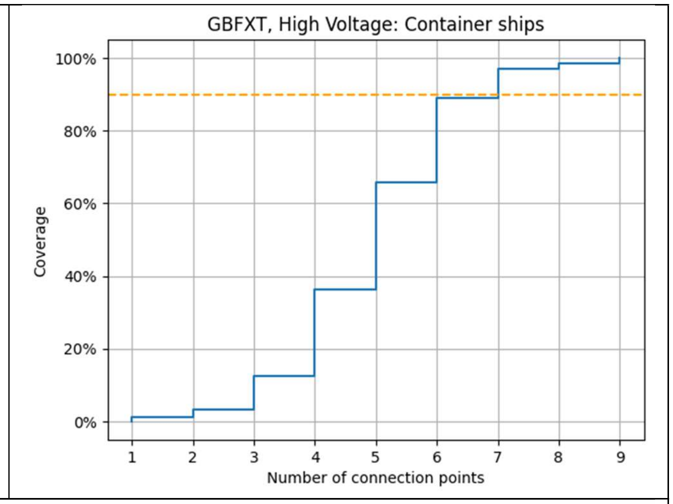
Table 6-10 presents simultaneous port calls for quantification of the need for low and high voltage connection points for container, cruise, and passenger ships above 5000 GT. There were some days in 2023 with more than 3 **container ships** requiring low voltage connection points in the port, but 2 such connection points would be sufficient for 90% coverage. Similarly, there were some days in 2023 with more than 8 container ships requiring high voltage connection points in the port, but 7 such connection points would be sufficient for 90% coverage.

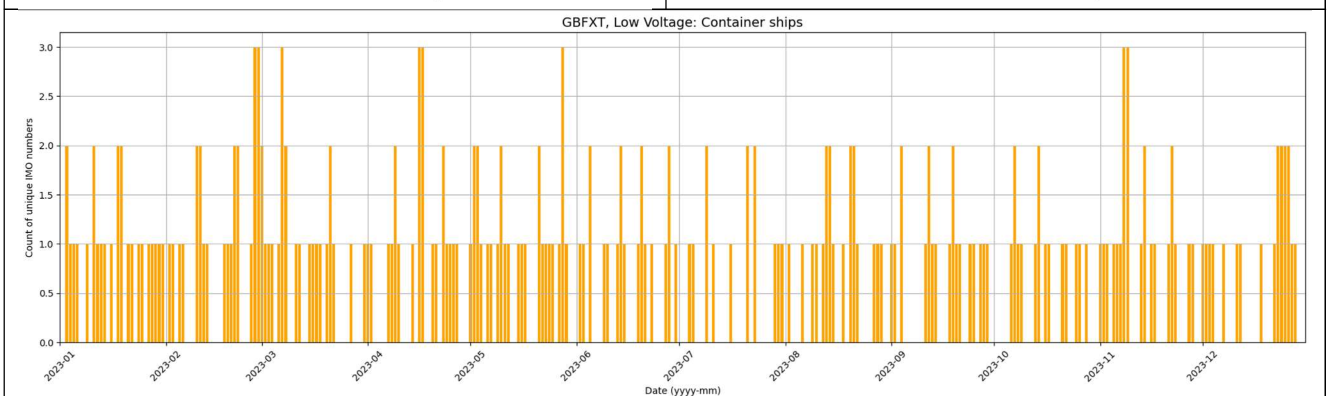
For **cruise and passenger ships**, there was no traffic in the port in 2023, hence there is no estimated need for any connection points.

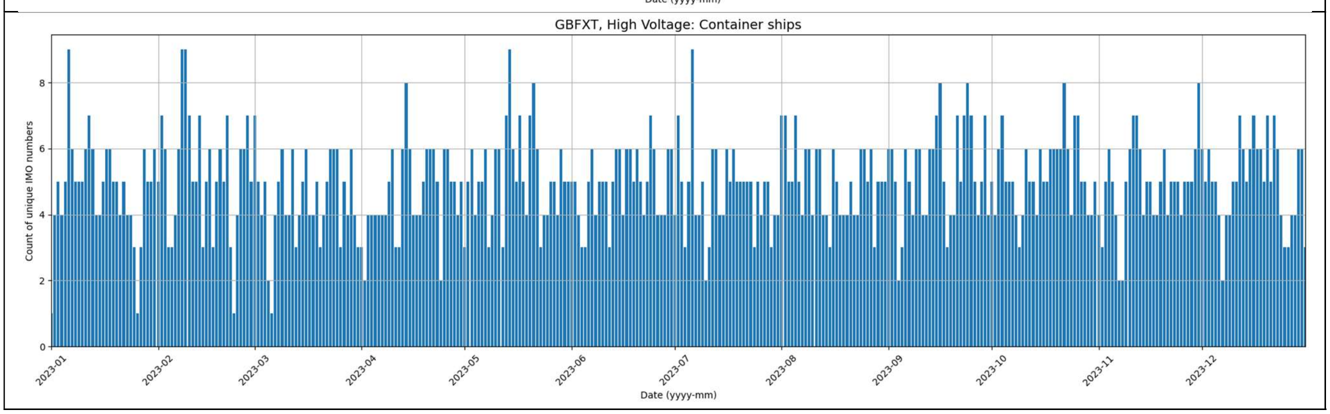
Table 6-10 Number of container and cruise ships at any day and passenger ships at any hour in 2023, and the estimated number of required connection points – split on low and high voltage.

Felixstowe	**Low Voltage**	**High Voltage**
Container ships – req. connection points	2	7









Felixstowe	Low Voltage	High Voltage
Cruise ships – required connection points	0	0
No data		

Felixstowe	Low Voltage	High Voltage
Passenger ships – req. connection points	0	0
No data		

6.3.2 Current status and plans for onshore power supply

In the port of Felixstowe, there are no OPS systems installed yet, and no concrete plans to install OPS either.

6.4 Port of Harwich

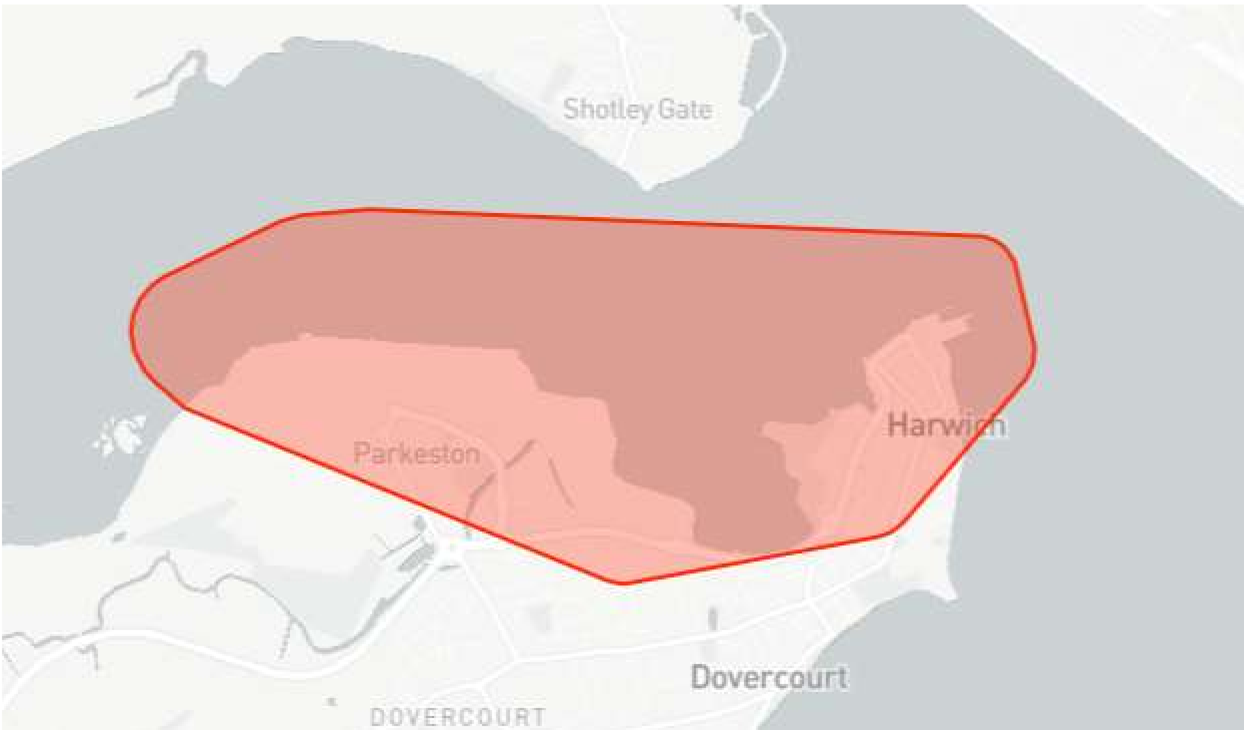


Figure 6-4 Port shape for Harwich (GBHRW).

6.4.1 Current ship activity and energy requirements

Table 6-11 shows the effective hours in port per ship segment and size category for the port of Harwich in 2023. There are no effective hours recorded in port for container ships larger than 5000 GT. For cruise ships larger than 5000 GT there are only 5 effective hours in port, and for passenger ships larger than 5000 GT there are around 3000 effective hours in port.

Table 6-11 Effective hours in port per ship segment and size category.

Harwich	400 - 1000 GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <	Total
Bulk carriers								0
Chemical tankers		1 348	189	222				1 759
Container ships								0
Crude oil tankers								0
Cruise ships				5				5
Fishing ships	16							16
Gas tankers								0
General cargo ships		490	203	27				720

Offshore supply ships	6	18	90					114
Oil product tankers	3	195						198
Other activities	1419	4 108	39	609				6 175
Other service offshore ships	9	21	203					233
Passenger ships				136		2846		2 982
Refrigerated cargo ships								0
Ro-Ro cargo ships				4 214	3			4 217
Total	1 453	6 180	724	5 213	3	2 846	0	16 419

Table 6-12 shows the effective hours per ship segment and power category for the port of Harwich in 2023. For passenger ships, most of the energy consumption is in the power category 5-10 MW. Passenger ships account for nearly 80% of the total estimated energy consumption in port.

Table 6-12 Estimated energy consumption in port (MWh) per ship segment and power category.

Harwich	**<100 kW**	**100-500 kW**	**500-1000 kW**	**1-5 MW**	**5-10 MW**	**>10 MW**	**Total**
Bulk carriers	0	0	0	0	0	0	0
Chemical tankers	0	0	150	241	0	0	391
Container ships	0	0	0	0	0	0	0
Crude oil tankers	0	0	0	0	0	0	0
Cruise ships	0	0	0	10	0	0	10
Fishing vessels	1	0	0	0	0	0	1
Gas tankers	0	0	0	0	0	0	0
General cargo ships	49	56	0	0	0	0	104
Offshore supply ships	0	4	47	0	0	0	51
Oil product tankers	0	47	0	0	0	0	47
Other activities	60	1 068	540	0	0	0	1 668
Other service offshore vessels	1	81	0	0	0	0	82
Passenger ships	0	0	0	233	17 927	0	18 160
Refrigerated cargo ships	0	0	0	0	0	0	0
Ro-Ro cargo ships	0	0	2 623	0	0	0	2 623
Total	110	1 256	3 361	483	17 927	0	23 137

Table 6-13 presents simultaneous port calls for quantification of the need for low and high voltage connection points for container, cruise, and passenger ships above 5000 GT. For **container ships**, there was no traffic in the port in 2023, hence there is no estimated need for any connection points.

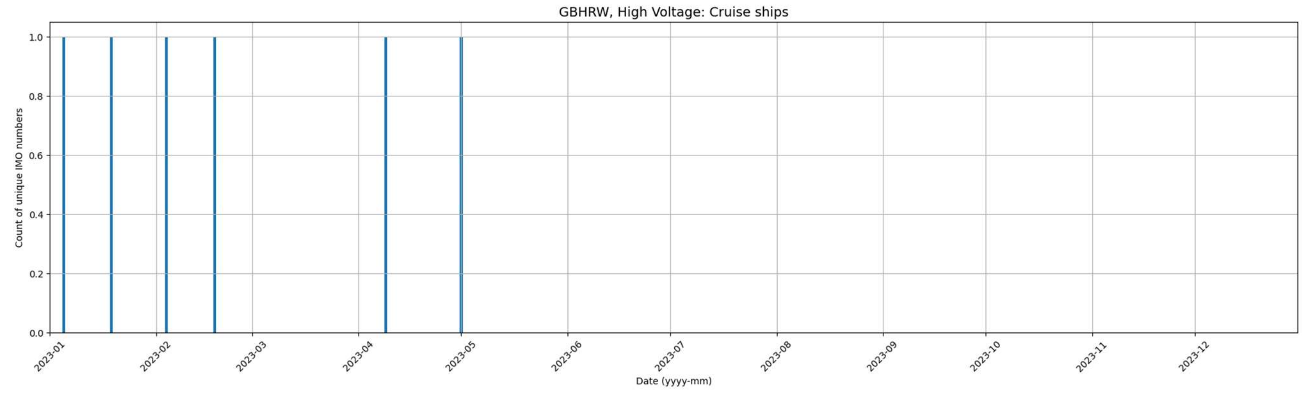
Since there were less than 25 port calls from **cruise ships** in 2023, it is assumed that there is no need for connection points for this segment in the port of Harwich.

There were some hours in 2023 with 2 **passenger ships** requiring high voltage connection points in the port, but 1 such connection point would be sufficient for 90% coverage. There were no passenger ships requiring low voltage connection points in the port in 2023.

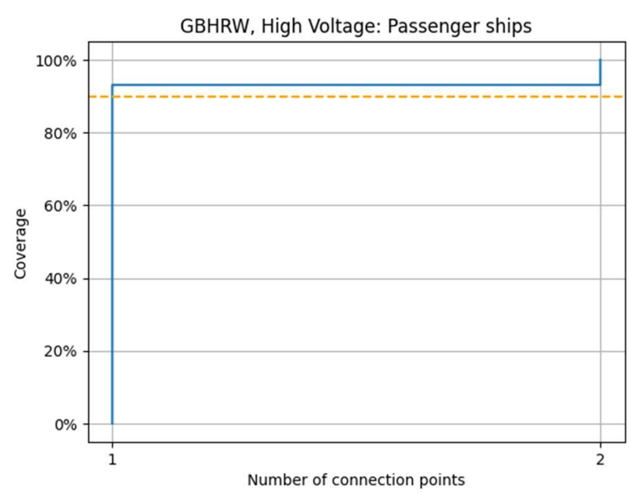
Table 6-13 Number of container and cruise ships at any day and passenger ships at any hour in 2023, and the estimated number of required connection points – split on low and high voltage.

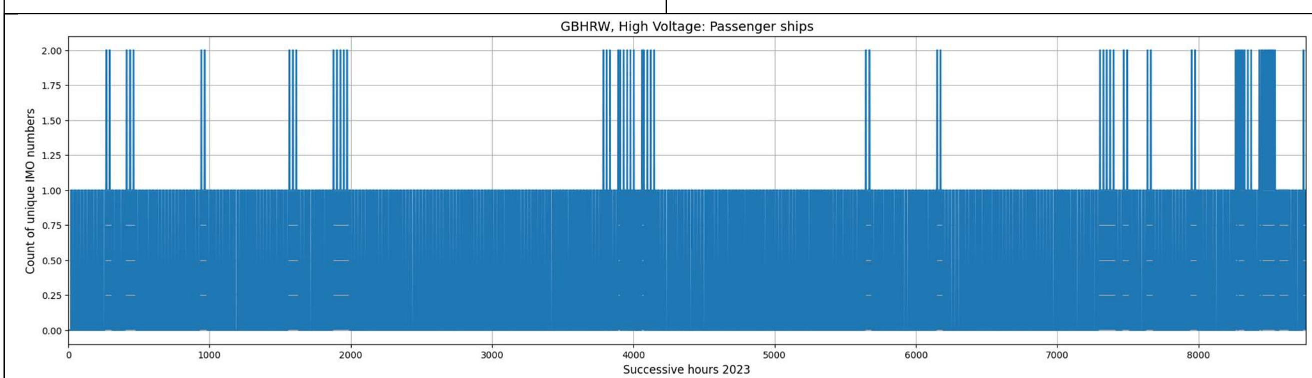
Harwich	Low Voltage	High Voltage
Container ships – req. connection points	0	0
No data		

Harwich	Low Voltage	High Voltage
Cruise ships – required connection points	0	0



Harwich	Low Voltage	High Voltage
Passenger ships – req. connection points	0	1





6.4.2 Current status and plans for onshore power supply

In the port of Harwich, there are no OPS systems installed yet, and no concrete plans to install OPS either.

6.5 Port of Milford Haven

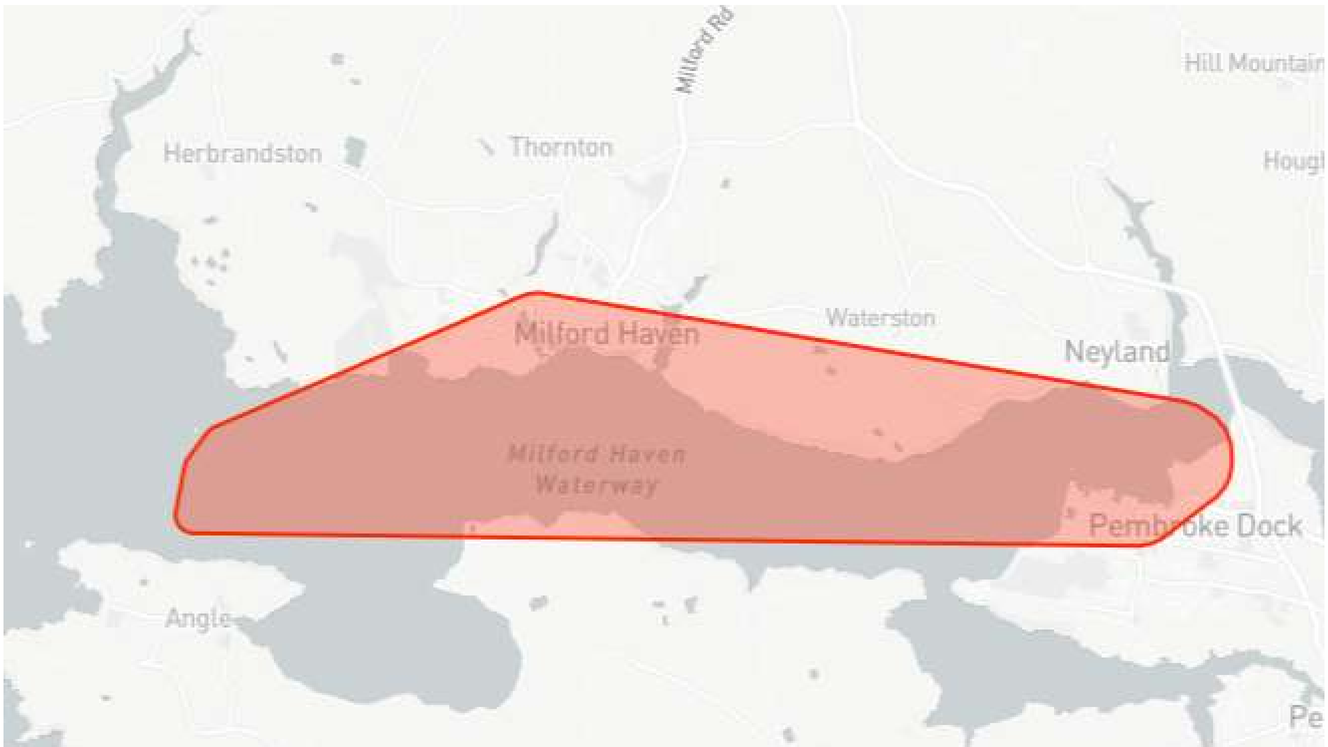


Figure 6-5 Port shape for Milford Haven (GBMLF).

6.5.1 Current ship activity and energy requirements

Table 6-14 shows the effective hours in port per ship segment and size category for the port of Milford Haven in 2023. There are no effective hours in port for container ships larger than 5000 GT. For cruise ships larger than 5000 GT, there are 7 effective hours in port, and for passenger ships larger than 5000 GT there are around 2000 effective hours in port.

Table 6-14 Effective hours in port per ship segment and size category.

Milford Haven	400 - 999GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <	Total
Bulk carriers								0
Chemical tankers		5 404	918	14 878	9681			30 881
Container ships								0
Crude oil tankers				168	257	8984		9 409
Cruise ships					7			7
Fishing ships								0
Gas tankers		1418	617	23	1562	453	4892	8 965

General cargo ships		626	23	138				787
Offshore supply ships								0
Oil product tankers		7 856			1910	148		9 914
Other activities	61378	621						61 999
Other service offshore ships		36		172			23	231
Passenger ships	21				1 997			2 018
Refrigerated cargo ships								0
Ro-Ro cargo ships								0
Total	61 399	15 961	1 558	15 379	15 414	9 585	4 915	124 211

Table 6-15 shows the effective hours per ship segment and power category for the port of Milford Haven in 2023. For cruise ships and passenger ships, most of the effective hours are in the power category 1-5 MW. However, the two major contributors to the total estimated energy consumption are chemical tankers and gas tankers, accounting for 70% of the energy consumption in port.

Table 6-15 Estimated energy consumption in port (MWh) per ship segment and power category.

Milford Haven	**<100 kW**	**100-500 kW**	**500-1000 kW**	**1-5 MW**	**5-10 MW**	**>10 MW**	**Total**
Bulk carriers	0	0	0	0	0	0	0
Chemical tankers	0	0	731	28 689	0	0	29 420
Container ships	0	0	0	0	0	0	0
Crude oil tankers	0	0	369	11 230	0	0	11 599
Cruise ships	0	0	0	29	0	0	29
Fishing vessels	0	0	0	0	0	0	0
Gas tankers	0	540	0	5 087	26 089	0	31 716
General cargo ships	62	59	0	0	0	0	121
Offshore supply ships	0	0	0	0	0	0	0
Oil product tankers	0	1 893	1 851	185	0	0	3 929
Other activities	2 578	161	0	0	0	0	2 739
Other service offshore vessels	0	8	108	24	0	0	139
Passenger ships	1	0	0	7 151	0	0	7 153
Refrigerated cargo ships	0	0	0	0	0	0	0
Ro-Ro cargo ships	0	0	0	0	0	0	0
Total	2 641	2 662	3 058	52 394	26 089	0	86 845

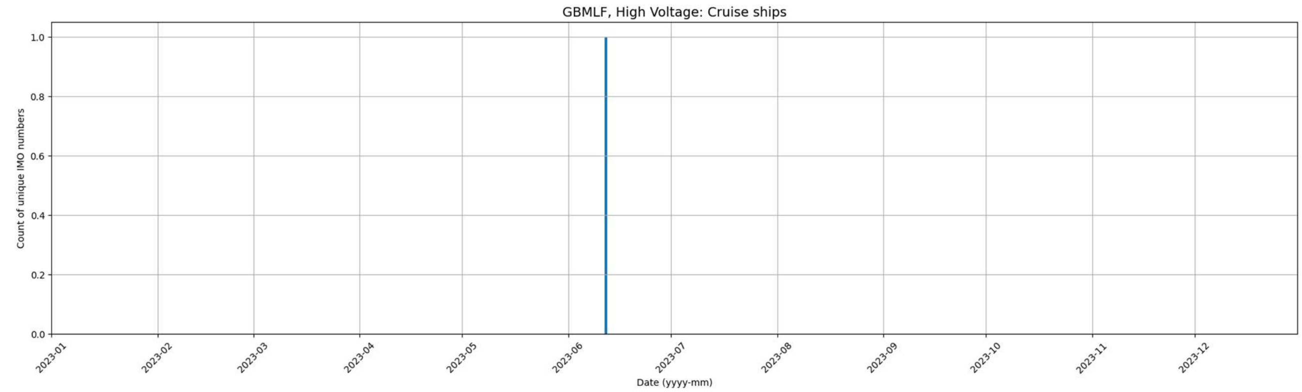
Table 6-16 presents simultaneous port calls for quantification of the need for low and high voltage connection points for container, cruise, and passenger ships above 5000 GT. There were no **container ships** requiring low or high voltage connection points in the port in 2023.

Since there were less than 25 port calls from **cruise ships** in 2023, it is assumed that there is no need for connection points for this segment in the port of Milford Haven. For **passenger ships,** there is an estimated need for one high voltage connection point.

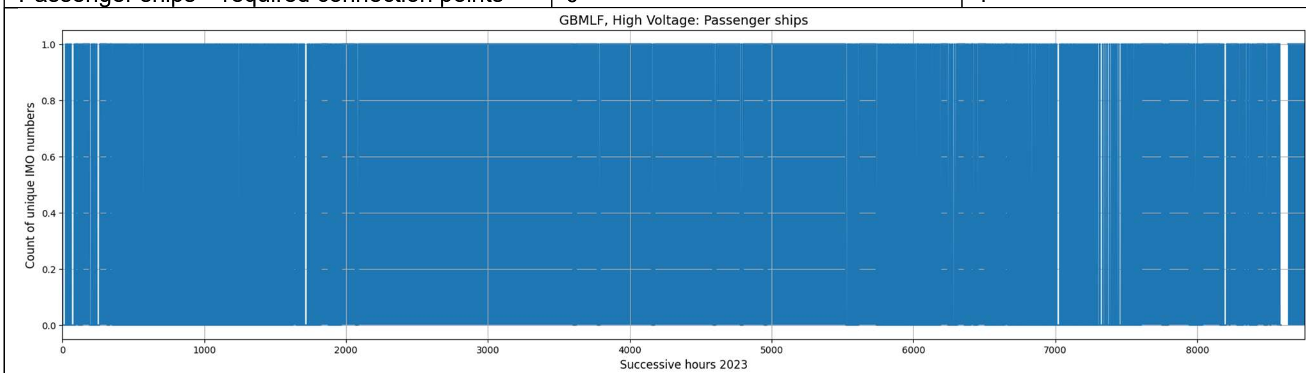
Table 6-16 Number of container and cruise ships at any day and passenger ships at any hour in 2023, and the estimated number of required connection points – split on low and high voltage.

Milford Haven	Low Voltage	High Voltage
Container ships – required connection points	0	0
No data		

Milford Haven	Low Voltage	High Voltage
Cruise ships – required connection points	0	0



Milford Haven	Low Voltage	High Voltage
Passenger ships – required connection points	0	1



6.5.2 Current status and plans for onshore power supply

In the port of Milford Haven, there are no OPS systems installed yet, other than industrial plugs. Although the port has ambitious net-zero plans which would result in the decarbonization of port operations, there are no concrete plans to install OPS yet. In Pembrooke dock, there is an 11 kV substation, which can be upgraded to suit the port's needs. The National Grid connection to the substation is not dedicated to the port, which could be a limitation. National Grid has suggested that the port put in a connection agreement for a 1 MW grid reservation. Additionally, the port has identified the cost of 50/60 Hz transformers, which are required for delivering an OPS system frequency of 60 Hz, and found the cost too high to realise a return.

6.6 Port of Southampton

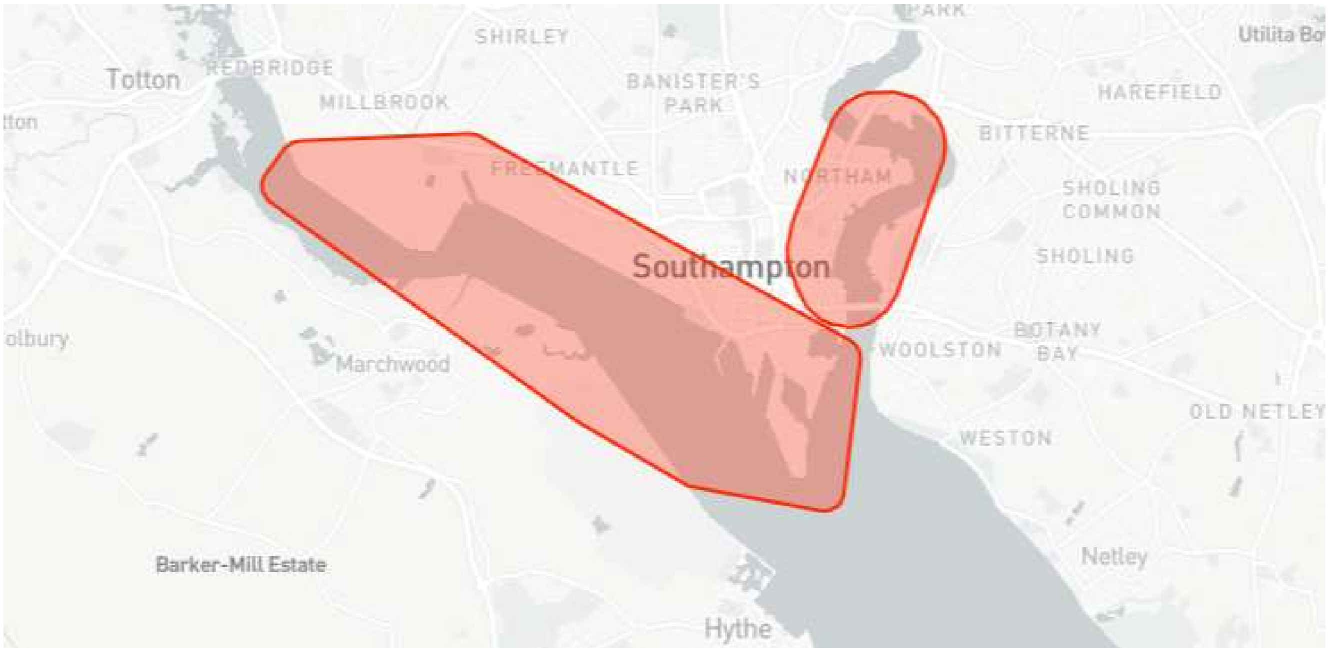


Figure 6-6 Port shape for Southampton (GBSOU).

6.6.1 Current ship activity and energy requirements

Table 6-17 shows the effective hours in port per ship segment and size category for the port of Southampton. There are more than 17 000 effective hours in port for container ships larger than 5000 GT. For cruise ships larger than 5000 GT, there are around 6000 effective hours in port, and for passenger ships larger than 5000 GT, there are around 500 effective hours in port.

Table 6-17 Effective hours in port per ship segment and size category.

Southampton	400 - 999 GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <	Total
Bulk carriers		82	110	542	892			1 626
Chemical tankers		84	30					114
Container ships		280	1 439	504	3847	2551	9287	17 908
Crude oil tankers								0
Cruise ships			9		379	1607	3907	5 902
Fishing ships								0
Gas tankers		4	310					314
General cargo ships	44	5 808	2 506	1 712	675			10 745
Offshore supply ships		19	8					27
Oil product tankers		16 951						16 951
Other activities	10965	7 986	2607	93				21 651
Other service offshore ships								0
Passenger ships	176	6 939	311	194				7 620

Refrigerated cargo ships								0
Ro-Ro cargo ships		6829	6	5 702	1774	12051		26 362
Total	11 185	44 982	7 336	8 747	7 567	16 209	13 194	109 220

Table 6-18 shows the estimated energy consumption per ship segment and power category for the port of Southampton in 2023. For container ships, most of the estimated energy consumption is in the power category 1-5 MW. For cruise ships, most of the estimated energy consumption is in the highest power category (> 10 MW). For passenger ships, however, most of the estimated energy consumption is in the 100-500 kW power category. Container and cruise ships account for more than 70% of the total energy consumption in port. Ro-Ro cargo ships also have a substantial energy consumption.

Table 6-18 Estimated energy consumption in port (MWh) per ship segment and power category.

Southampton	**<100 kW**	**100-500 kW**	**500-1000 kW**	**1-5 MW**	**5-10 MW**	**>10 MW**	**Total**
Bulk carriers	0	541	0	0	0	0	541
Chemical tankers	0	121	24	0	0	0	145
Container ships	0	766	357	42 832	0	0	43 955
Crude oil tankers	0	0	0	0	0	0	0
Cruise ships	0	0	8	1 555	11 599	39 109	52 272
Fishing vessels	0	0	0	0	0	0	0
Gas tankers	0	2	0	310	0	0	312
General cargo ships	576	1 226	421	0	0	0	2 223
Offshore supply ships	0	4	4	0	0	0	8
Oil product tankers	0	4 085	0	0	0	0	4 085
Other activities	461	2 076	1 425	0	0	0	3 962
Other service offshore vessels	0	0	0	0	0	0	0
Passenger ships	11	2 477	253	332	0	0	3 073
Refrigerated cargo ships	0	0	0	0	0	0	0
Ro-Ro cargo ships	0	965	4 955	12 075	0	0	17 995
Total	1 047	12 263	7 448	57 104	11 599	39 109	128 570

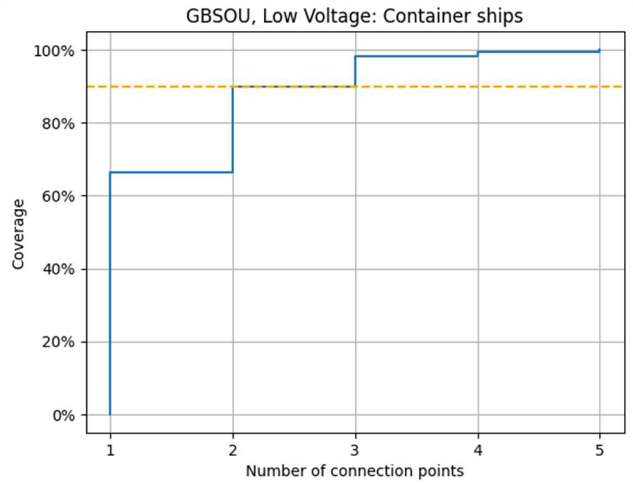
Table 6-19 presents simultaneous port calls for quantification of the need for low and high voltage connection points for container, cruise, and passenger ships above 5000 GT. There were some days in 2023 with 4 or 5 **container ships** requiring low voltage connection points in the port, but 3 such connection points would be sufficient for 90% coverage. Similarly, there were some days in 2023 with more than 10 container ships requiring high voltage connection points in the port, but 8 such connection points would be sufficient for 90% coverage.

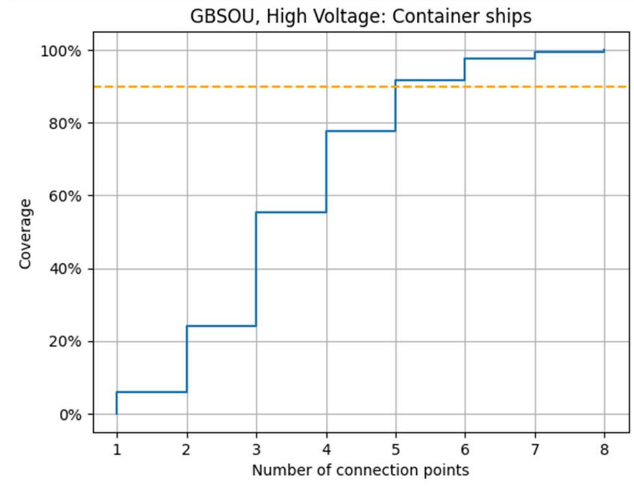
For 90% coverage, there is an estimated need for one low voltage connection point for **cruise ships**, although there were only a few days with such traffic in the port in 2023. Unless a significant increase in the cruise traffic to the port is expected towards 2030, the port should not invest in such a connection point. There were some days with a need for 5 high voltage connection points for cruise ships, but 4 high voltage connection points would be sufficient for 90% coverage.

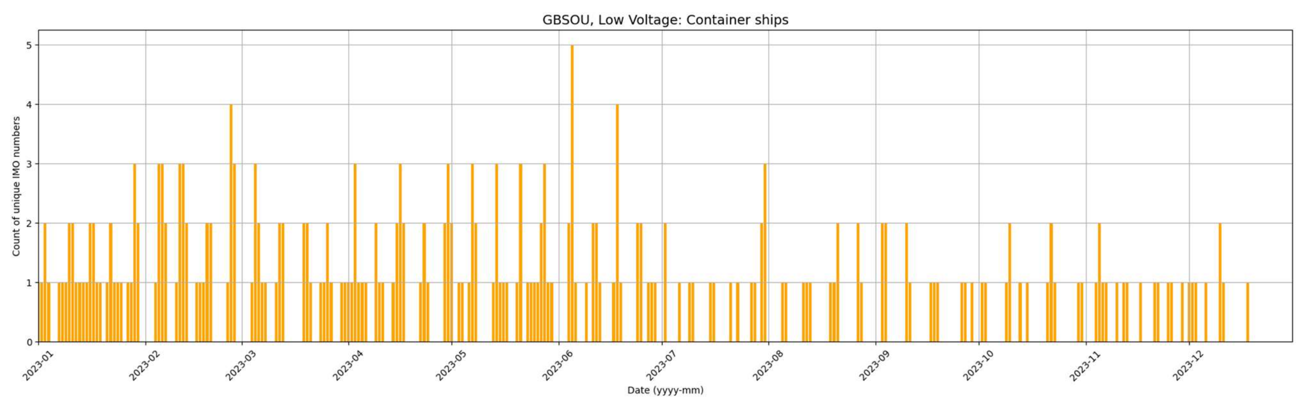
Since there were less than 40 port calls from **passenger ships** in 2023, it is assumed that there is no need for connection points for this segment in the port of Southampton. In total, there is an estimated need for 11 connection points for container ships and 5 connection points for cruise ships.

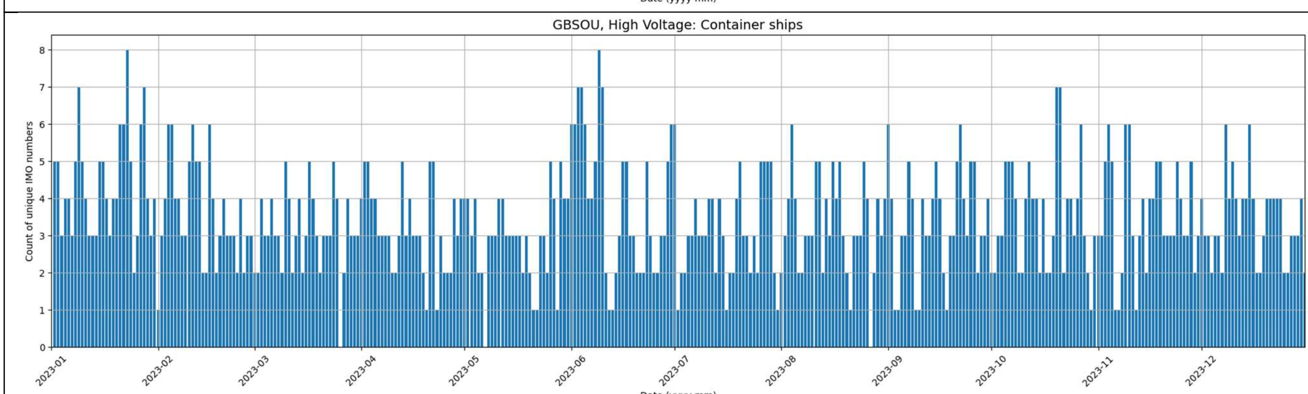
Table 6-19 Number of container and cruise ships at any day and passenger ships at any hour in 2023, and the estimated number of required connection points – split on low and high voltage.

Southampton	Low Voltage	High Voltage
Container ships – req. connection points	3	5

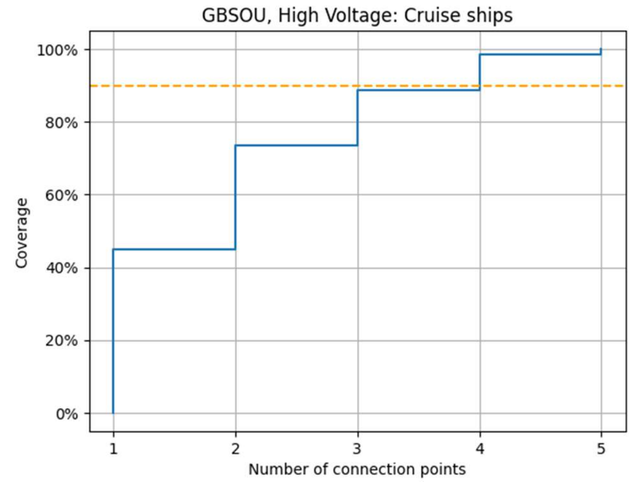


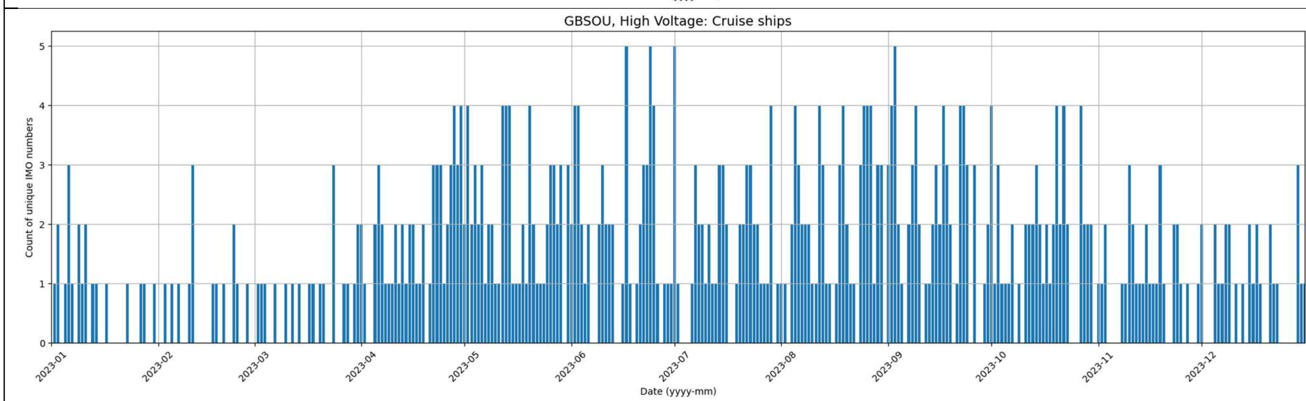




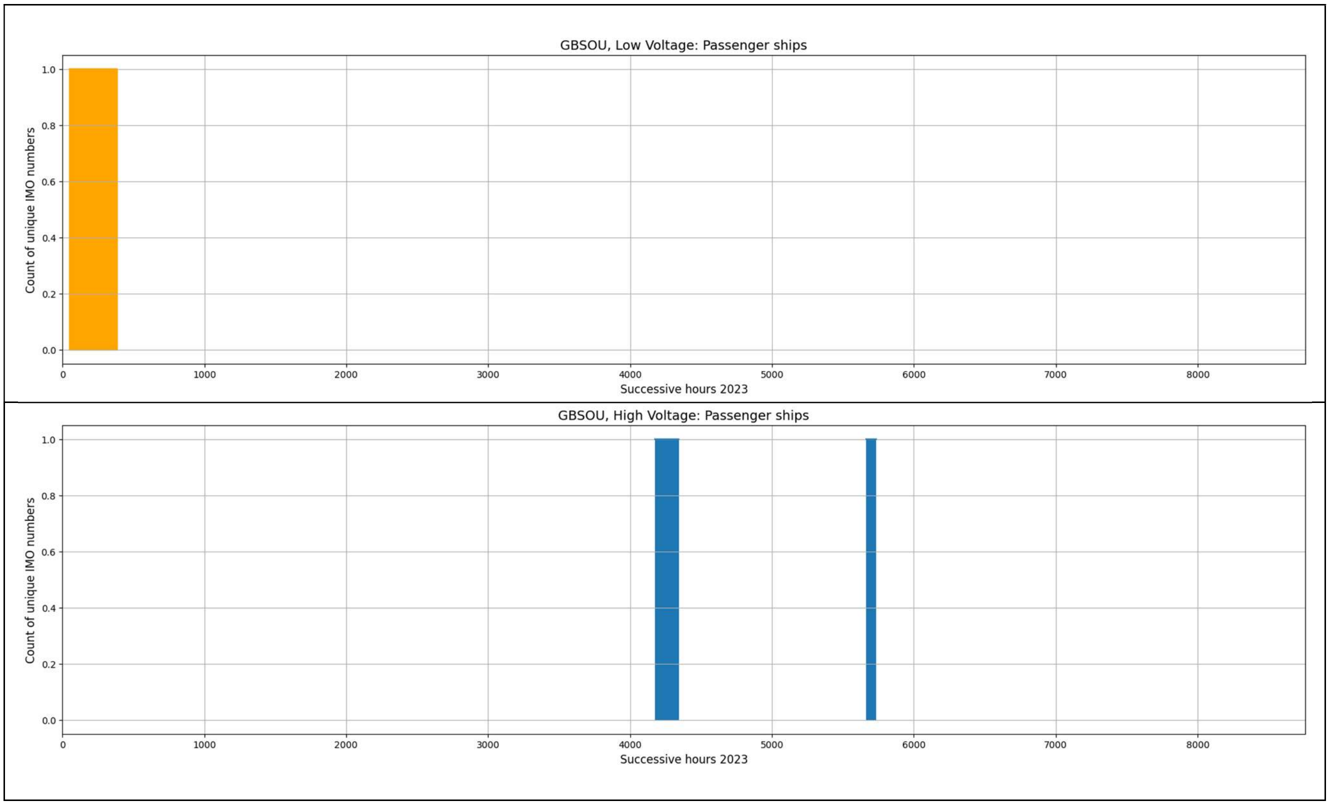


Southampton	Low Voltage	High Voltage
Cruise ships – required connection points	1	4





Southampton	Low Voltage	High Voltage
Passenger ships – req. connection points	0	0



6.6.2 Current status and plans for onshore power supply

In the port of Southampton, there are two high voltage connection points for cruise ships in operation (see Table 6-20). The connection points are installed at two terminals with 16 000 kW each, but due to constraints in the National Grid, only one ship can be supplied at a time. There are no concrete plans to install further connection points.

Table 6-20 Installed OPS in the port of Southampton.

Max. no. of simultaneous ships	Types of ships	Max. system power capacity [kW]	System voltage [kV]	System frequency [Hz]	Standard
1	Cruise	16 000	6.6-11	50 and 60	IEC 80005-1
1	Cruise	16 000	6.6-11	50 and 60	IEC 80005-1

6.7 Port of Thames

Port of Thames (London Gateway Port) is currently managed by London Port Authority, along with other ports along the Thames, but the results presented here relate to the port with UN/LOCODE GBLGP (Figure 6-7).

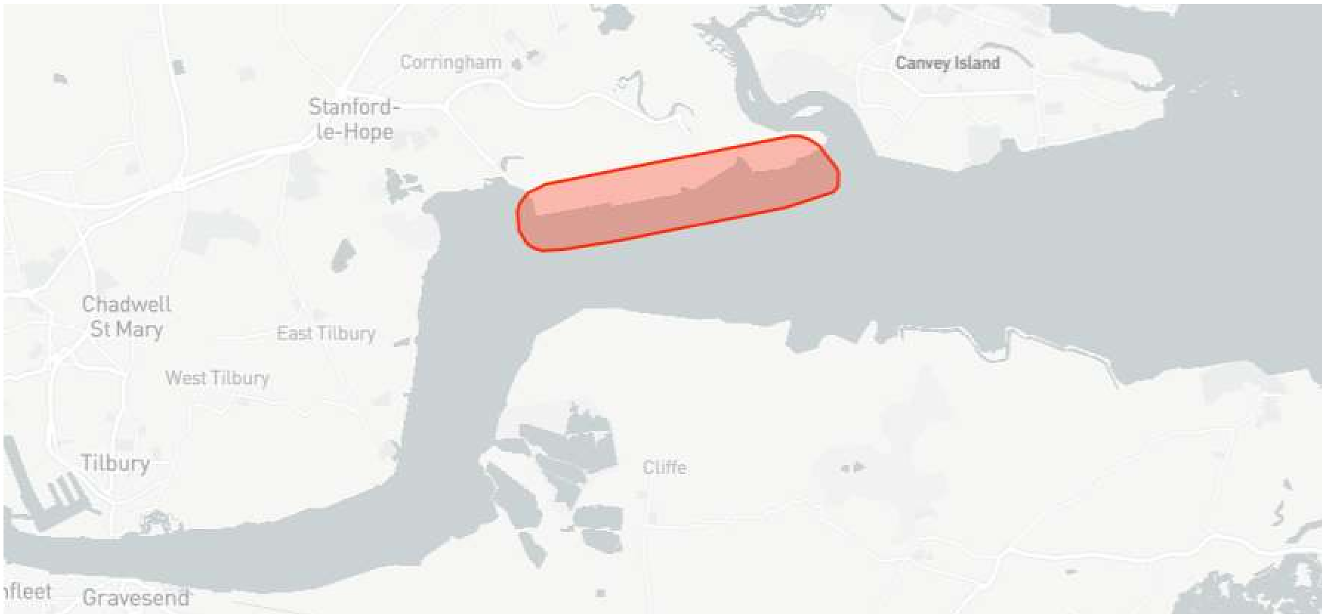


Figure 6-7 Port shape for Port of Thames (GBLGP).

6.7.1 Current ship activity and energy requirements

Table 6-21 shows the effective hours in port per ship segment and size category for the port of Thames in 2023. There are more than 19 000 effective hours in port for container ships larger than 5000 GT. For cruise ships and passenger ships larger than 5000 GT there are no effective hours in port.

Table 6-21 Effective hours in port per ship segment and size category.

Thames	400 - 999 GT	1000 - 4999 GT	5000 - 9999 GT	10000 - 24999 GT	25000 - 49999 GT	50000 - 99999 GT	100000 GT <	Total
Bulk carriers		1 210	431		65	128		1 834
Chemical tankers		2 744	1284	5 007	3468			12 503
Container ships			409	823	2949	9908	5414	19 503
Crude oil tankers					250	1351		1 601
Cruise ships								0
Fishing ships								0
Gas tankers		489						489
General cargo ships	3	233	32	100				368
Offshore supply ships								0
Oil product tankers		87	97	321	674	104		1 283
Other activities	20663							20 663
Other service offshore ships								0
Passenger ships								0
Refrigerated cargo ships								0
Ro-Ro cargo ships				20	8999	155		9 174
Total	20 666	4 763	2 253	6 271	16 405	11 646	5 414	67 418

Table 6-22 shows the effective hours per ship segment and power category for the port of Thames in 2023. For container ships, most of the estimated energy consumption is in the power category 1-5 MW. Container ships account for roughly two thirds of the total estimated energy consumption in port. Other segments with substantial energy consumption in the port are chemical tankers and Ro-Ro cargo ships.

Table 6-22 Estimated energy consumption in port (MWh) per ship segment and power category.

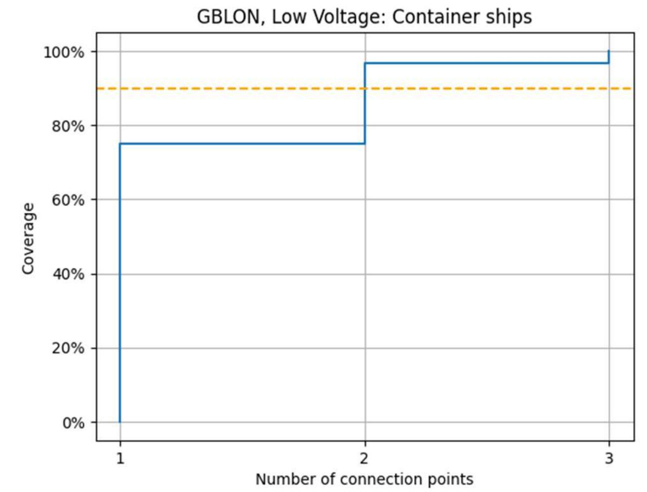
Thames	<100 kW	100-500 kW	500-1000 kW	1-5 MW	5-10 MW	>10 MW	Total
Bulk carriers	0	255	67	0	0	0	322
Chemical tankers	0	0	1 022	9 927	0	0	10 949
Container ships	0	203	584	45 277	0	0	46 064
Crude oil tankers	0	0	242	1 689	0	0	1 931
Cruise ships	0	0	0	0	0	0	0
Fishing vessels	0	0	0	0	0	0	0
Gas tankers	0	186	0	0	0	0	186
General cargo ships	23	46	0	0	0	0	69
Offshore supply ships	0	0	0	0	0	0	0
Oil product tankers	0	21	934	130	0	0	1 084
Other activities	868	0	0	0	0	0	868
Other service offshore vessels	0	0	0	0	0	0	0
Passenger ships	0	0	0	0	0	0	0
Refrigerated cargo ships	0	0	0	0	0	0	0
Ro-Ro cargo ships	0	0	7 158	155	0	0	7 313
Total	891	712	10 006	57 179	0	0	68 788

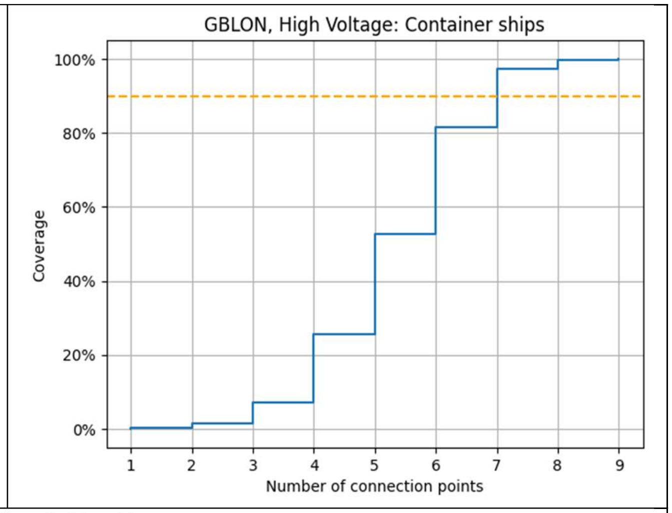
Table 6-23 presents simultaneous port calls for quantification of the need for low and high voltage connection points for container, cruise, and passenger ships above 5000 GT. There were some days in 2023 with 3 **container ships** requiring low voltage connection points in the port, but 2 such connection points would be sufficient for 90% coverage. Similarly, there were some days in 2023 with more than 8 container ships requiring high voltage connection points in the port, but 7 such connection points would be sufficient for 90% coverage.

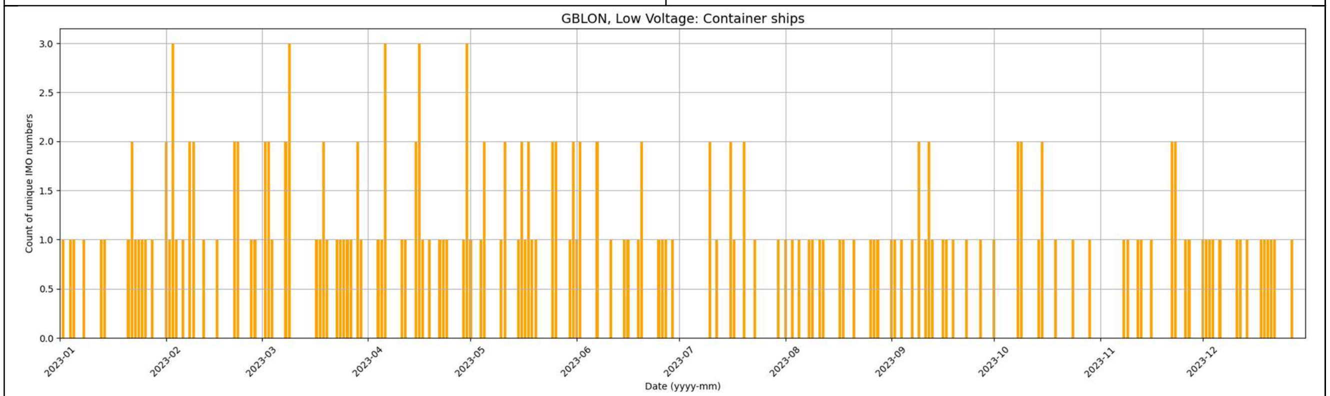
For **cruise and passenger ships**, there was no traffic in the port in 2023, hence there is no estimated need for any connection points.

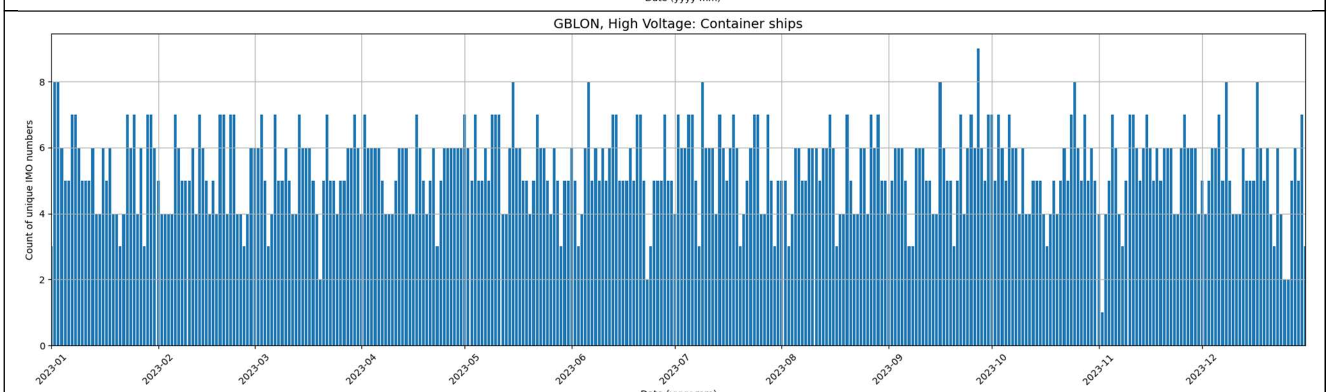
Table 6-23 Number of container and cruise ships at any day and passenger ships at any hour in 2023, and the estimated number of required connection points – split on low and high voltage.

Thames	Low Voltage	High Voltage
Container ships – req. connection points	2	7









Thames	Low Voltage	High Voltage
Cruise ships – required connection points	0	0
No data		

Thames	Low Voltage	High Voltage
Passenger ships – req. connection points	0	0
No data		

6.7.2 Current status and plans for onshore power supply

In the port of Thames, there are no OPS systems installed yet. There are no concrete plans to install OPS either, but the port is currently participating in a project in which the energy demand is being mapped.

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