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Renewable Energy
Authority

Ports for Offshore Wind in Viet Nam

Mapping Port Infrastructure for the Offshore Wind Industry and Job Creation in Viet Nam

Prepared by COWI

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MAPPING PORT INFRASTRUCTURE FOR THE OFFSHORE WIND INDUSTRY AND JOB CREATION IN VIET NAM

FINAL REPORT

COWI A/S PROJECT NUMBER A272687

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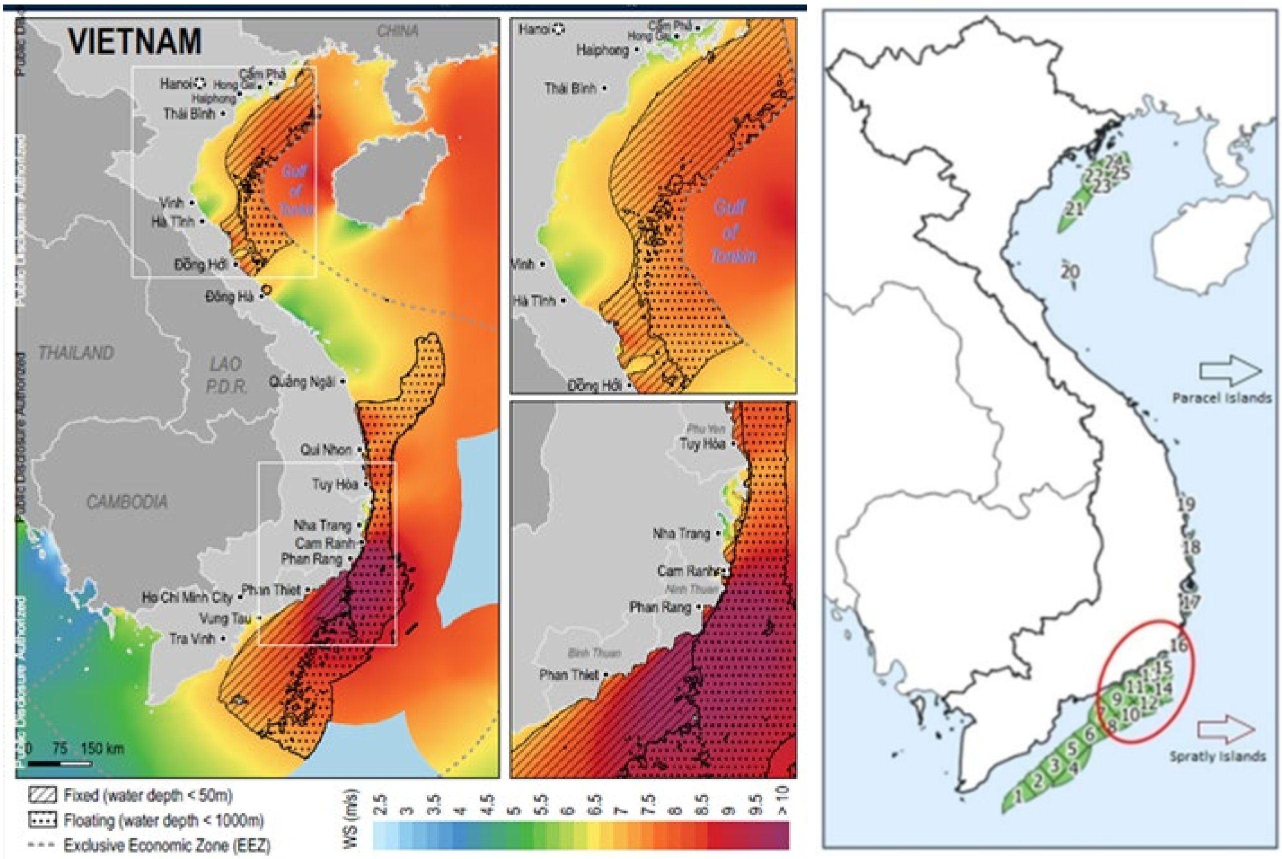
1 FOREWORD

In 2013, Viet Nam and Denmark entered into a long-term cooperation agreement for the purpose of strengthening Viet Nam's transition to a low-carbon economy. The Danish Energy Agency (DEA) cooperates with the Ministry of Industry and Trade in Viet Nam through the joint Energy Partnership Program between Viet Nam and Denmark (DEPP). The program is currently in its third phase (DEPP III, 2021-2025) and covers long-term scenario modelling of the energy sector, developing a regulatory framework for offshore wind development, the integration of renewable energy in the power grid and energy efficiency in the industrial sector. The Danish Energy Agency, Electricity and Renewable Energy Authority and the Danish Embassy in Hanoi are overall responsible for the implementation of activities under this program.

Viet Nam has some of the best offshore wind resources in Southeast Asia, with a long coastline and vast areas with average wind speeds above 7 m/s at 100 m above sea level. The World Bank has found a technical potential of up to 500 GW, while Ministry of Industry and Trade (MOIT) defines the technical potential even higher, at 600 GW. Considering only areas between 5 km and 100 km from shore, a study commissioned by DEPP in 2021 found a technical potential in the order of 160 GW, of which ~100 GW are bottom-fixed.

The best wind speeds are found in the waters off the South-Central coast, in particular near Binh Thuan province, where ~30 GW of very attractive offshore wind farm sites with wind speeds above 9 m/s are located in water depths allowing fixed-bottom foundations. The neighboring Ninh Thuan province may see even higher wind speeds but has deeper waters necessitating maturing floating technologies – a total of 30 GW of potential offshore wind has been identified here. Another 25 GW have been identified further South, outside the Mekong Delta, with wind speeds above 7 m/s and water depths that allow bottom-fixed foundations.

Despite average wind speeds only reaching 7-7.5 m/s, a total of 13 GW bottom fixed potential was identified in the North, as well as 5 GW mostly floating offshore wind off the coast of Ha Tinh province.



LHS: Map of wind speeds and identified development areas by The World Bank Group. Source: ESMAP. 2021. Going Global: Expanding Offshore Wind to Emerging Markets (Vol. 50): Technical Potential for Offshore Wind in Viet Nam—Map (English). Washington, DC: World Bank Group. RHS: Lowest cost area for first bottom-fixed GWs of offshore wind deployment in Viet Nam based on country-wide LCOE ranking incl. grid costs. Credits for original background image: C2Wind.

The Power Development Plan 8 (PDP8, May 2023) and its implementation plan (March 2024) have announced a targeted 6 GW offshore wind by 2030, distributed as follows: 2.5 GW in the North, 0.5 GW in the Central region, 2 GW in the South-Central region, and 1 GW in the South. The relatively large capacity in the North of Viet Nam, despite its lower wind speeds, reflects the North's shortage of power and limited renewable energy capacity combined with a strong existing transmission grid that could transport offshore wind generation to industrial centers.

Between 2030 and 2050, the Power Development Plan 8 envisions a steep growth in offshore wind connected to the grid, reaching 70-90 GW in 2050. In addition to the targeted capacity in Power Development Plan 8, Viet Nam is also planning to export offshore wind power to countries in the region and potentially building dedicated offshore wind power projects for hydrogen production. The targeted capacity for this is defined in the Power Development Plan 8 as 15 GW by 2035 and 240 GW by 2050. Currently only one export project has been defined, a 1.4-2 GW project in the South region with a HVDC connection to Singapore with a target date pre-2030.

However, despite the recently approved targets for 2030, there is no roadmap for developing a legal framework for offshore wind development, and no marine spatial plan indicating potential areas for offshore wind development. The assignment of a State-owned Enterprise (PVN, EVN) to lead and develop offshore wind pilot projects in the short term is the current priority of Viet Nam's government; however, the timing, scale, location and conditions for such a pilot project are yet to be defined.

Considering that ports are essential enabling infrastructure supporting the delivery and operation of offshore wind projects, this study has been conducted with the aim of mapping the current status of ports in Viet Nam with respect to their 'readiness' to serve as offshore wind construction ports, as well as O&M ports. Building new greenfield ports or major upgrades to existing ports are large infrastructure projects on their own, with significant costs and timelines. This study set out to identify short-term suitability of existing port infrastructure for supporting the first offshore wind projects in Viet Nam, with construction windows over the period 2028-2033 and deploying current state-of-the-art 15 MW turbines with bottom-fixed foundations.

This study is also relevant for the longer-term picture on offshore wind. The Viet Nam Energy Outlook Report, Pathways to Net-Zero (EOR-NZ) finds that even in the Baseline scenario without any decarbonization targets, the electricity demand in 2050 is most cost-efficiently met with 71 GW of offshore wind, as part of the power mix[1]. When adding the net-zero target in 2050, as Prime Minister Pham Minh Chinh committed Viet Nam to at COP26, the installed capacity for offshore wind reaches 112 GW in 2050. The Power Development Plan 8 targets a similar order of magnitude with 70-90 GW in 2050.

Rather than the typical approach of identifying the most suitable ports for a specific project site, this study can give MOIT, MOT as well as the designated SOEs important information to consider in the selection of the first sites for offshore wind development. This study clearly shows that there is a regional disparity in the existing port infrastructure that needs to be considered in the short term for site selection of the first pilot projects.

Viet Nam is not starting from scratch. Already today, a strong offshore wind supply chain is emerging alongside the oil and gas sector in the Vung Tau area in the South. Foundations, substations, and towers are already made in Viet Nam and supplying offshore wind projects in Asia and Europe. A combination of fabrication yards, barges, and pre-assembly and construction ports could reduce the amount of investment needed for dedicated offshore wind ports for the first pilot projects to be located ideally within 200 km, but no further away than about 400 km.

Ports in the 400 km range from offshore wind developments in the Gulf of Tonkin are currently focused on the container shipping market and have no existing plans to incorporate storage requirements and other upgrades before 2030 to enable them to also serve the offshore wind market. A dedicated effort would be needed to increase port readiness in the North of Viet Nam.

However, to reach the 2050 capacity of 70-90 GW, within 10 years from now Viet Nam must be ready to support installation rates of 3-5 GW/year up until 2050. Such installation rates require dedicated offshore wind ports, located close to the main offshore wind development areas. The scenarios modelled in EOR-NZ indicate that the capacity would be distributed roughly equally between Northern and Southern areas. The current imbalance in port readiness for offshore wind will have to be levelled in the future, in parallel with increasing the general capacity significantly.

[1] EREA & DEA: Viet Nam Energy Outlook Report, Pathways to Net-Zero (2024). https://depp3.vn/Document/DownloadFile/76

2 EXECUTIVE SUMMARY

In Viet Nam's Power Development Plan 8, the government has defined a target of 6 GW of installed offshore wind capacity by 2030 (fixed-bottom foundation), with the option of having additional capacity for electricity export and/or green hydrogen production. Towards 2050 the capacity is expected to increase by at least tenfold.

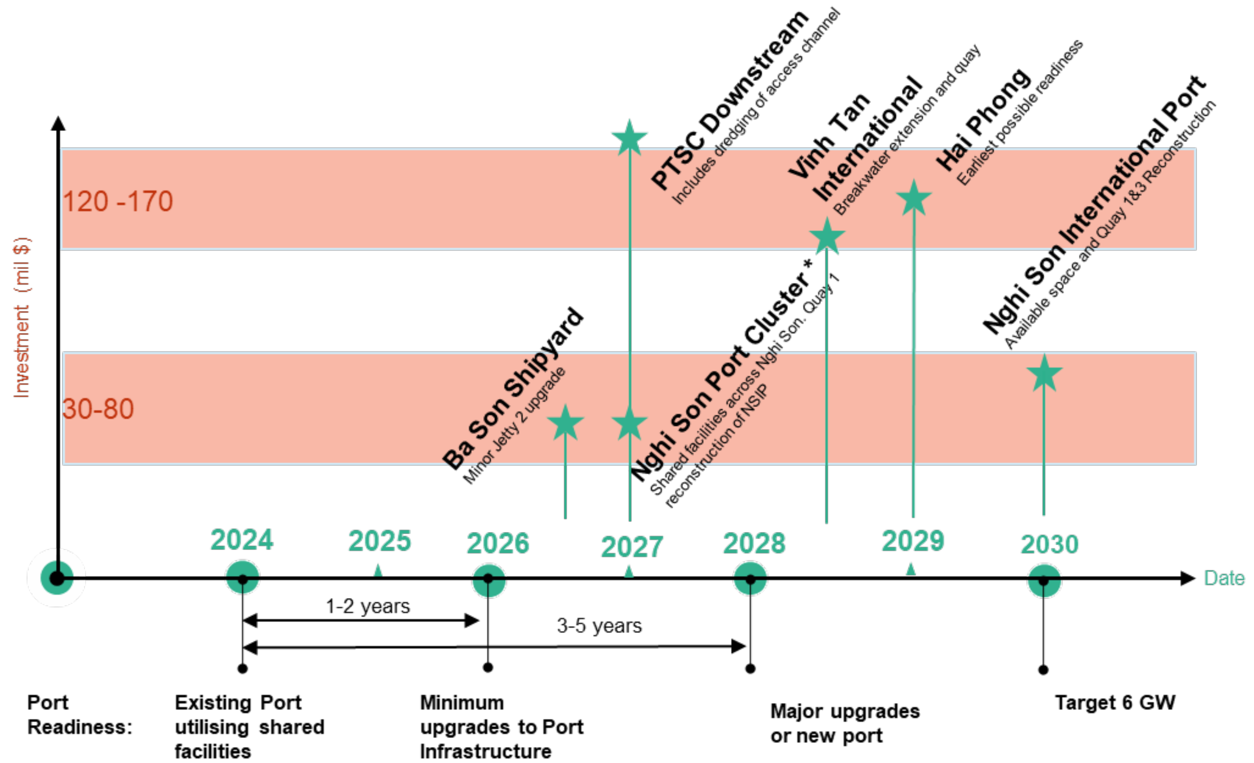
In order to realise this goal, ports in Viet Nam must be prepared to facilitate the construction and maintenance of industrial scale offshore wind within the timeframe specified and in an economically viable way. This study identifies various potential ports within 3 regions of the Viet Nam coast (North, South Central, and South) detailing the readiness of the ports, required upgrades, potential costs and local employment as well as ownership models.

2.1 Analysis of Construction Ports

The assessment of the ports has been conducted in a phased approach, using key minimum requirements to filter potential construction ports, including physical access (navigation), as well as current and planned usage of quayside and storage areas. This has been supplemented with interviews of the finally selected ports to understand their plans and incentives to develop an offshore wind business in the future.

In general, it is important to state that no port in their current state can accommodate offshore wind construction activities in Viet Nam. The shortlisted ports presented below are those considered most suitable for upgrading in their respective region.

The Southern and South-Central ports are leading the charge for offshore wind, with Ba Son Shipyard and PTSC Downstream potentially able to accommodate offshore wind by the start of 2027, and Vinh Tan International by Q2 of 2028. PTSC Downstream have started developing a greenfield site which will be dedicated to offshore wind and could potentially be ready by the start of 2027. Together with Ba Son Shipyard tailored towards the fabrication and load out of foundations only, these ports have significant potential to kickstart the development of a dedicated offshore wind supply chain in Ba Ria - Vung Tau province.



* An indicative amount has been provided for the Nghi Son Port cluster which focuses on the interim infrastructure upgrades required at Nghi Son International Port. It is unknown at this stage what upgrade requirements would be needed at Thanh Hoa Port and Long Son Port as part of this solution.

The Northern Ports are lagging, with no clear plans made to accommodate offshore wind as they currently focus on the container shipping market. Hai Phong International could potentially provide a longer-term solution for the North; however, this will require significant investment and political support. A short-term option could be to mobilise the cluster of ports in Nghi Son to service offshore wind construction activities before 2030. This is not ideal as it introduces several more interfaces for the developer to manage and an increased risk that minimum requirements may not be met.

In order to deliver 6 GW by 2030 with construction of 1 GW expected to take 3-4 years utilizing one port, it requires the readiness of 4-6 ports ideally located within each of the three regions by 2028 to 2030.

Based on the experience from this study, where clarifications during the site visits changed the benchmarking properties significantly for some ports, we recommend that the top 11 ports identified in Step 3 of the site screening exercise are reviewed carefully once there is further clarity on the location of offshore wind projects.

2.2 Coarse Screening of O&M Ports

In general, this report is focused on the construction ports for offshore wind, as these require significantly more investment that the Operations and Maintenance (O&M) Ports. Furthermore, given the necessity of these to be closer to the offshore wind farms, the location of which are as yet undefined, it is more difficult to make an assessment of the potential of ports for O&M.

14 ports along the Viet Nam's coast have been identified which (based on typical distances for O&M activities) would cover almost the entire fixed bottom offshore wind area, except the southernmost areas.

The selected 14 O&M ports include the following:

Port	Region	Ownership Structure	Port Use	Available Land (ha)	Vessel Suitability (SOV or CTV)
Nghi Son International Port	North	Single group	Multi-use (Land free)	> 1.5	SOV or CTV
Hon Gai Port	North	Many operators	Multi-use (Land free)	> 1.5	SOV or CTV
Cua Lo Port	North	Single group	General cargo (Land free)	> 1.5	CTV, possible SOV (1)
Vissai Port	North	Single group	Dry bulk (Land free)	> 1.5	SOV or CTV
Can Son Duong Port	North	Single group	Multi-use (Land free)	> 1.5	SOV or CTV
Cam Ranh International Port	South-Central	Single group	Multi-use (Land free)	> 1.5	CTV, possible SOV (1)
Ca Na Port	South-Central	Single group	Multi-use (Under construction)	> 1.5	SOV or CTV
Chan May Port	South-Central	Single group	Multi use (Land free)	> 1.5	SOV or CTV
Vinh Tan International Port	South-Central	Single group	Project Cargo (Land free)	> 1.5	SOV or CTV
Ba Son Shipyard	South	Ministry of Defence	Shipyard / project cargo (Interested in OW)	> 1.5	SOV or CTV
Vietsovpetro	South	Single group	Project cargo / oil and gas (interested in OW)	~ 1.5	CTV, possible SOV (1)
PTSC Downstream	South	Many operators	Oil and gas / project cargo / OW	> 1.5	CTV, possible SOV (1)
Long An Port	South	Single group	Container Terminal / Multi-purpose	> 1.5	SOV or CTV
Saigon Port JSC - Hiep Phuoc Terminal	South	Single group	Multi-purpose (available space)	> 1.5	SOV or CTV

(1) Depends on the type of SOV calling upon the port – may be some navigation limitations. Also see section 8.

2.3 Job Creation and Local Content

The potential for employment during the port upgrades is closely dependent on the port specific requirements. The job effect is measured in Full Time Equivalent (FTE) where one FTE is the equivalent of one person working full time for a year. The estimated employment effects for five potential port upgrades in the North, South-Central and South of Viet Nam range from 7,800 to 27,800 FTEs directly employed in the works and 3,100 to 12,900 FTEs indirectly employed of which 95-100% is the expected local employment effect, required over the length of port construction ranging from 2 to 4 years.

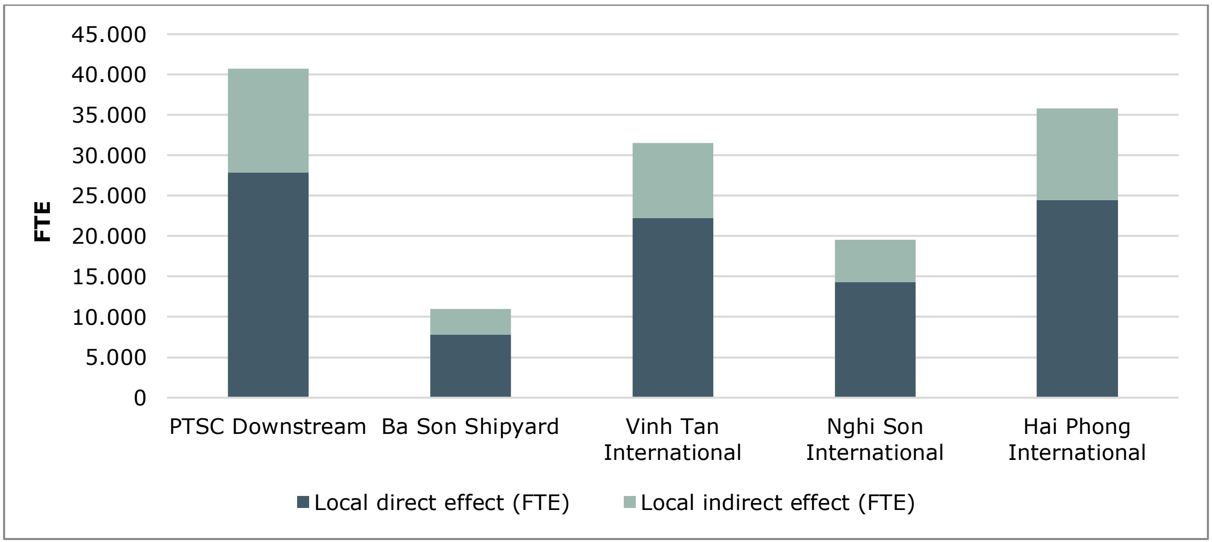


Figure 2-1 Total employment effect from expected port upgrade investments during the construction period (FTE).

The estimated local employment effect during the construction phase of a 1 GW offshore windfarm is estimated to be 83,500 FTE/year during the construction of the offshore windfarm, and 16,600 FTE/year for the operation and maintenance of the offshore windfarm. Thus, the largest employment effect is seen when the ports have been upgraded and the construction of an offshore windfarm begins. The size of the effect depends on the size of the actual offshore windfarm, and the capabilities of Viet Nam's supply chain at the time of construction. The combined effect of the increase in required labour force during construction and operation is significant and essentially lasts over a period of 30 to 35 years.

These FTEs represent the entire supply chain of the port upgrades and are made up of a majority of "technology, construction and transportation" roles (70%), 22% of this is accounted for by "unskilled" labour. The remainder is made up of "skilled" labour of different types where higher education is a pre-requisite. The competencies for the construction of an offshore wind farm are also mainly focused in the "technology, construction and transportation" roles, the unskilled category and technical training of the short cycle higher education type.

In all cases the majority of the cost of port upgrades is on the construction sector, where construction here refers to the physical works at the port.

2.4 Ownership Models

Overall, it is anticipated that a port owner who already owns and operates facilities in Viet Nam would provide the best route to securing the ownership and financial stability to proceed with the required upgrades and operation of the facilities during the offshore windfarm construction phases.

It is clear from the stakeholder engagements and site visits that the Northern ports are already busy and focused on the container shipping industry. In order to engage them and create positive interest, there would need to be clear long-term investment decisions from the government in Viet Nam to support the development of offshore wind. Ideally, this could be facilitated through the incorporation of offshore wind within the National Seaport Master Plan.

Ports in the South are in some cases already engaged in the offshore wind industry, either fabricating or planning to fabricate offshore foundations or substations. As a result, they are already incentivised and already engaged in port upgrades. However, in order to facilitate industrial scale offshore wind, as per Viet Nam's Power Development Plan 8, further investment will be required to support this.

Generally, a phased approach would be favoured where mixed use of existing areas is gradually transitioned towards offshore wind.

3 ABBREVIATIONS

For selected abbreviations* the full description is kept in the text, but abbreviations are used in Tables and Figures due to their limitations in text.

[CAPEX]	Capital expenditure
[CD]	Chart Datum
[CJ]	Coal Jetty
[CTV]	Crew transfer Vessel
[DEA]	Danish Energy Agency*
[DEPP III]	Danish Energy Partnership Programme
[DKK]	Danish Kroner
[DL]	Datum Level
[EIA]	Environmental Impact Assessment
[EPCI]	Engineering, Procurement, Construction, Installation
[EREA]	Electricity and Renewable Energy Authority
[FTE]	Full Time Equivalent
[GBS]	Gravity Based Structure
[ha]	Hectare
[HAT]	Highest astronomical tide
[HLV]	Heavy Lift Vessel
[LAT]	Lowest astronomical tide
[LOA]	Length overall
[LNG]	Liquid Natural Gas
[MHWS]	Mean High Water Springs
[MLLW]	Mean Lower Low Water
[MLWS]	Mean Low Water Springs
[MOIT]	Ministry of Industry and Trade

[OEM]	Original Equipment Manufacturer
[O&M]	Operation and Maintenance
[OJ]	Oil Jetty
[OPEX]	Operational expenditure
[OWF]	Offshore wind farm(s)*
[OWT]	Offshore Wind Terminal*
[OWZ]	Offshore Wind Zone*
[PDP8]	Power Development Plan 8*
[RORO]	Roll On – Roll Off
[RTG]	Rubber tired gantry
[SOLAS]	International Convention for the Safety of Life at Sea
[SOV]	Service operation vessel(s)
[SPM]	National Seaport Master Plan – National Viet Nam 10-year plan*
[SPMT]	Self-propelled modular transporter
[STS]	Shore-to-Ship container cranes
[TDSI]	Transport Development and Strategy Institute
[TOC]	Terminal Operating Company
[UDL]	Uniform distributed load
[VAPO]	Viet Nam Association of Port - Waterway - Offshore Engineering
[VASI]	Viet Nam Administration of Sea and Islands
[VPA]	Viet Nam Seaports Association
[WTG]	Wind Turbine Generator
[WTIV]	Wind turbine installation vessel

4 INTRODUCTION

4.1 Background

The Danish Energy Agency (DEA) in partnership with the Electricity and Renewable Energy Authority in Viet Nam, under the Ministry of Industry and Trade (MOIT), are working as part of the Danish Energy Partnership Programme (DEPP III) to assist with capacity building on leading and managing offshore wind development and roll-out. Electricity and Renewable Energy Authority is responsible for the Implementation Plan of Power Development Plan 8 (PDP8). This study will provide input on the role of ports servicing construction and O&M activities for offshore wind to meet Power Development Plan 8 offshore wind targets.

In Power Development Plan 8, Viet Nam has defined a target of 6 GW of installed offshore wind capacity by 2030 (assumed to be fixed-bottom foundation), with the option of having additional capacity for electricity export and/or green hydrogen production. Towards 2050 the capacity is expected to increase by at least tenfold.

Ports are essential enabling infrastructure which supports the delivery and operation of offshore wind projects. The facilities, structure, proximity, and linkage of ports are key aspects that influence the business case and design concept for major offshore infrastructure projects. Furthermore, ports' characteristics for manufacturing and fabrication, staging and Operation and Maintenance (O&M) activities are key factors when establishing feasible logistics for large-scale offshore infrastructure projects, as these have an impact on both cost and timelines for offshore wind projects. Moreover, port development positively impacts local economic development and job creation.

Therefore, ports are an important and integral element of the implementation plan of Viet Nam's Power Development Plan 8, and hence the need for various ports within Viet Nam to be carefully benchmarked to review the best investment opportunities available. These often relate to technical aspects of the port, location of the port with respect to both the Offshore Wind Farms and support industry, ownership structure of the port and willingness to include offshore wind as a viable business case, and if the port is located in any special economic zones which make investments financially more attractive.

As such, this study seeks to assess the existing gap associated with port infrastructure within Viet Nam and assist Vietnamese authorities in developing a detailed mapping of port infrastructure to support the future pipeline of offshore wind projects.

4.2 Objective

The objective of this study is to support Electricity and Renewable Energy Authority and MOIT with the Implementation Plan for Viet Nam's Power Development Plan 8 by mapping current port infrastructure in Viet Nam and identifying the required port upgrades and potential expansions to support the realisation of the offshore wind targets as set out in Viet Nam's Power Development Plan 8. This study will therefore contribute to enhancing capacity at Electricity and Renewable Energy Authority and MOIT, as well as other relevant authorities, in planning for the needed port infrastructure to support the implementation of offshore wind projects. The main objectives of this study include the following:

1) Map and benchmark existing and planned port infrastructure in Viet Nam and estimate the required upgrades of port facilities necessary to accommodate the planned offshore wind development for Viet Nam for Construction and O&M ports.

2) Estimate labour market impact (i.e. job creation) for different skills, as a result of the port development phase, as well as the construction/O&M activities for offshore wind projects.

3) Assess and report on the ownership models and incentive structures as well as the planning framework for facilitating investments in port upgrades in Viet Nam.

This study will focus on the short-term suitability for the first offshore wind projects in Viet Nam, with an expected offshore wind build-out of 6 GW towards 2030, assuming the 5-year period from 2028 to 2033 as an active part for wind park construction and using state-of-the-art offshore wind technology and as such caters to turbine deployment with a minimum of 15 MW capacity. These assumptions extend the Power Development Plan 8 goal from 2030 for several years, but are more realistic given the time it will take to get ports ready as outlined in this study.

4.3 Scope of Work

The scope of work for this study has been split into several tasks and subtasks, which are shown below.

- **Task 1:** Map existing port infrastructure and development plans for offshore wind in Viet Nam.
  - From online data sources, previous studies and a separate desktop analysis, an initial data base of ports along Viet Nam's coastline was established and categorised in line with identified regions from Viet Nam's Power Development Plan 8 i.e. North, Central and South Central, and South.
  - These ports were then cross-referenced with local consultants and stakeholders to ensure all relevant ports which could potentially service offshore wind activities were included in the list. This list also included potential greenfield sites.
  - From the data base an initial screening was performed to assign ports to either construction or Operation and Maintenance activities. The screening focused on general navigation and draft requirements.
- **Task 2:** Benchmark existing and planned port infrastructure against pre-defined baseline criteria for both Construction and O&M ports.
  - Key selection criteria were established for both construction and O&M ports, and was based on industry accepted practice. This criterion was then used to refine the initial port data base from Task 1 to a preferred list of ports for both construction and O&M activities. The benchmarking process consisted of the following key steps:
  - Traffic light screening based on established coarse key selection criteria;
  - Review of the screening results and further refinement of the selection by benchmarking similar ports in the same regions (North, South-Central, South) – benchmarking of O&M ports stopped here due to unknown offshore wind farm locations.
  - Create port profiles of the refined list which incorporates additional information regarding port Master Plans and future development, ownership structure, location, and additional port selection criteria related to quay infrastructure and navigation. This was then used to create the final preferred list for construction ports.
  - The results of the benchmarking process were presented to key stakeholders to ensure alignment and acceptance prior to moving to Task 3.

- **Task 3:** Make a detailed ports assessment of the preferred ports within the Northern, South-Central, and Southern regions along Viet Nam's coastline.
  - A gap analysis was performed on the preferred ports to establish and quantify the upgrade requirements to meet industry standards. This was then confirmed during site visits to each of the ports where high-level upgrade concepts were shown and workshopped.
  - From this, a recommended offshore wind construction port concept was developed for each of the selected ports together with a high-level cost estimate and indicative construction duration.
- **Task 4:** Estimate the economic and social impact on the local labour market due to offshore wind investments.
- **Task 5:** Assess ownership models of identified relevant ports and incentive structures for facilitating investments.
  - Identify possibilities and potential recommendations for "port development models"
  - Assess the most relevant methods to create incentives for ports, as well as the most appropriate models for financing upgrade requirements for offshore wind ports.
  - Highlight advantages and disadvantages for the various ownership models and incentive structures.

4.4 Previous and Ongoing Studies

This study built on knowledge developed from previous offshore wind port studies and further refine these outcomes to best align with the requirements of Viet Nam. These previous studies include:

- Joint Study on Wind Farm Port Construction for Fostering Wind Industries and Creating Jobs – Korea (2020)
- Study on Improvement Needs for Potential Turkish Ports Suitable for Support to OSW Development – Turkey (2021)
- India Offshore Wind Ports Study – India (2022).

In addition, the following studies were supplied and the findings thereof incorporated into this study:

- Offshore Wind Development Program. Offshore Wind Road Map for Viet Nam. World Bank Group 2021 June
- Rijksdienst Voor Ondernemend (RVO) Nederland – Requirements Harbour and Infrastructure OWE, MTBS (2021)

4.5 Proposed Offshore Wind Farm Zones

Although the preferred Offshore Wind Zones for development have not been confirmed in Viet Nam's Power Development Plan 8, the World Banks ESMAP study in 2021 (World Bank Group, 2021) suggest that the preferred locations for fixed bottom foundations are situated along Northern and Southern regions. Figure 4-1 shows the relevant Offshore Wind Zones for development based on the 2021 ESMAP study where zones for both fixed and floating foundations are shown. Note that this study will focus on port selection criteria for fixed bottom foundations only.

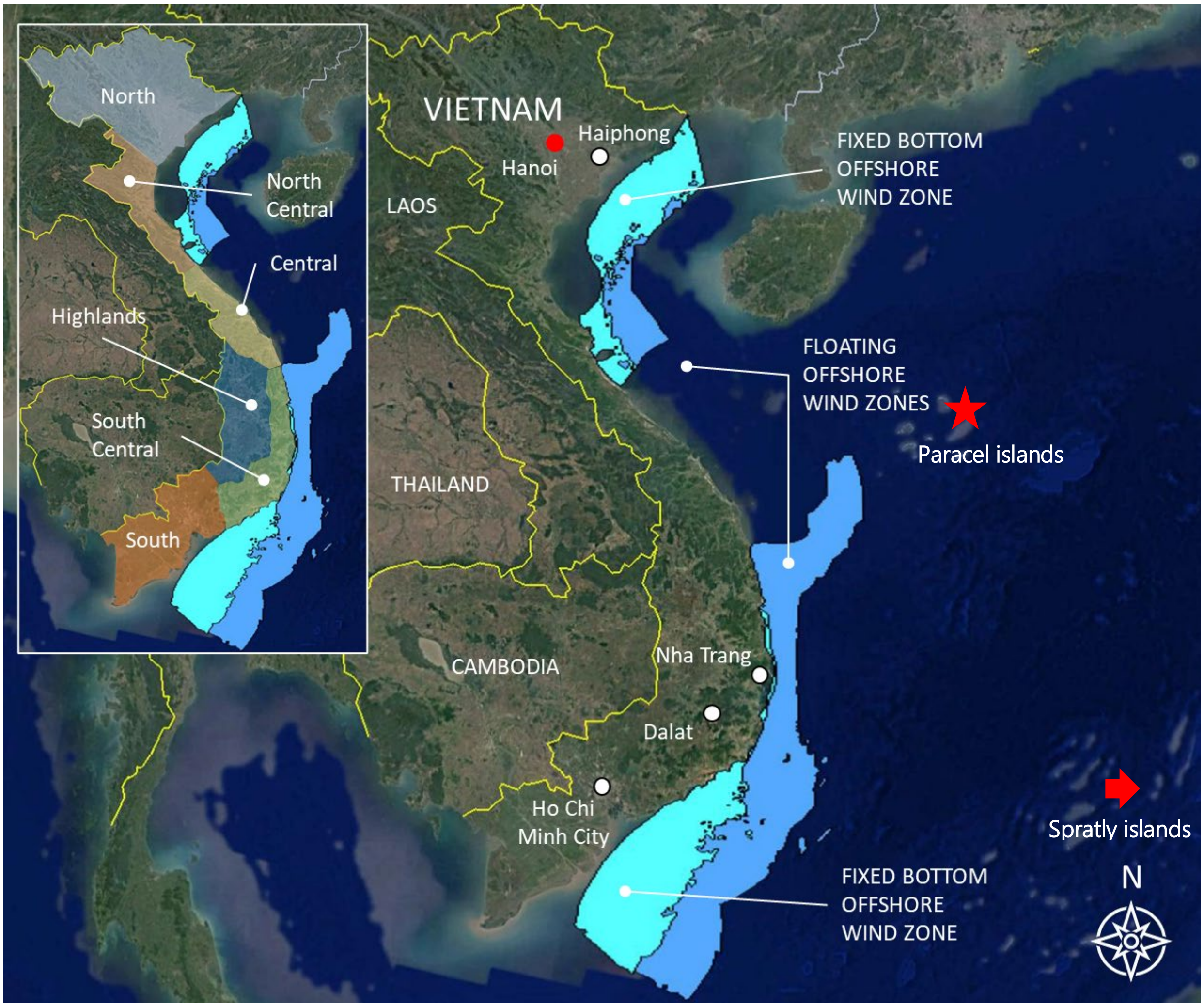


Figure 4-1: Identified offshore wind zones (World Bank Group, 2021)

Viet Nam's Power Development Plan 8 has outlined offshore wind development targets for the next 5 years i.e. until 2030. Table 4-1 shows these targets together with their allocated regions (refer to Figure 4-1). For the purposes of this study, these regions have been consolidated to three; namely: Northern, South-Central and South regions. Notably, the North and South have a much larger allocation of offshore wind potential than the Central region and we assume ports in these regions to be prioritised accordingly.

The information shown in Figure 4-1 and Table 4-1 was used as a basis for the screening and selection of construction and O&M ports.

Table 4-1: Installed capacity of offshore wind power sources by region

No.	Region Name (PDP8)	Consolidated Regions for this Study	Capacity Increase to 2030 (MW)
1	North	North	2,500
2	Central	South-Central	500
3	South Central		2,000
4	Highlands	Not applicable	0
5	South	South	1,000
		TOTAL	**6,000**

4.6 Current Viet Nam Setting Impacting the Port Study

The current port infrastructure in Viet Nam supports the container industry, oil and gas industry and various other single and multiuse industries, with no current focus on offshore wind. Therefore, it is important to identify ports that can be upgraded within the time frame set out in the Power Development Plan 8 within the multipurpose usage of ports in order to enable timely port upgrades at the lowest cost.

Based on the current setting in Viet Nam and the necessity to build port infrastructure in a short time frame, it is crucial to identify fast-track transitionary methods to enable the first stage of offshore wind build-out. Examples like the port of Cuxhaven in Germany show a workable way forward, where the existing port infrastructure in multiuse activities allows utilization of existing port's facilities with short preparation time. This approach could be applied to the build-out of the first 1-5 GW in selected areas, if possible. It is anticipated that the willingness to invest in offshore wind and upgrade the port infrastructure feeds on the success of the first phase.

4.7 A Typical Offshore Wind Farm

Offshore wind energy, or colloquially "offshore wind", is a form of electricity generated by wind turbines that have been installed in the sea. These could be based on fixed foundation and floating installations. Turbines are typically grouped into arrays which form an offshore wind farm.

An offshore wind farm typically consists of several components schematically shown in Figure 4-2.

Turbines are typically connected to each other by inter-array cables in strings of six to ten turbines. Historically, inter-array cable voltage has been 33 kV, but more recent offshore wind projects have been adopting a 66 kV inter-array system.

The inter-array cables lead into the offshore substation (or offshore transformer platform) where the electrical power is "stepped up" to its export voltage. The export cable connects the offshore substation to the onshore substation. At the onshore substation, the power is transformed and conditioned such that it can be integrated into the existing electrical grid.

Offshore wind farms can have any number of wind turbines, depending on the size of location. Commercial-scale projects are typically start at 200 MW. The world's current largest offshore wind farm, Hornsea 1, commissioned in 2020, has 174 turbines of 7 MW for a total of 1.2 GW installed capacity. Offshore wind turbines have steadily increased in size over the previous 20 years. In current projects turbines are between 6 MW and 9.5 MW while projects in the pipeline are planned with turbines of up to 15 MW. The next generation of a 15+ MW turbine has been announced by major turbine manufacturers. This study will be based on fixed foundation offshore wind farms with a 15 MW turbine.

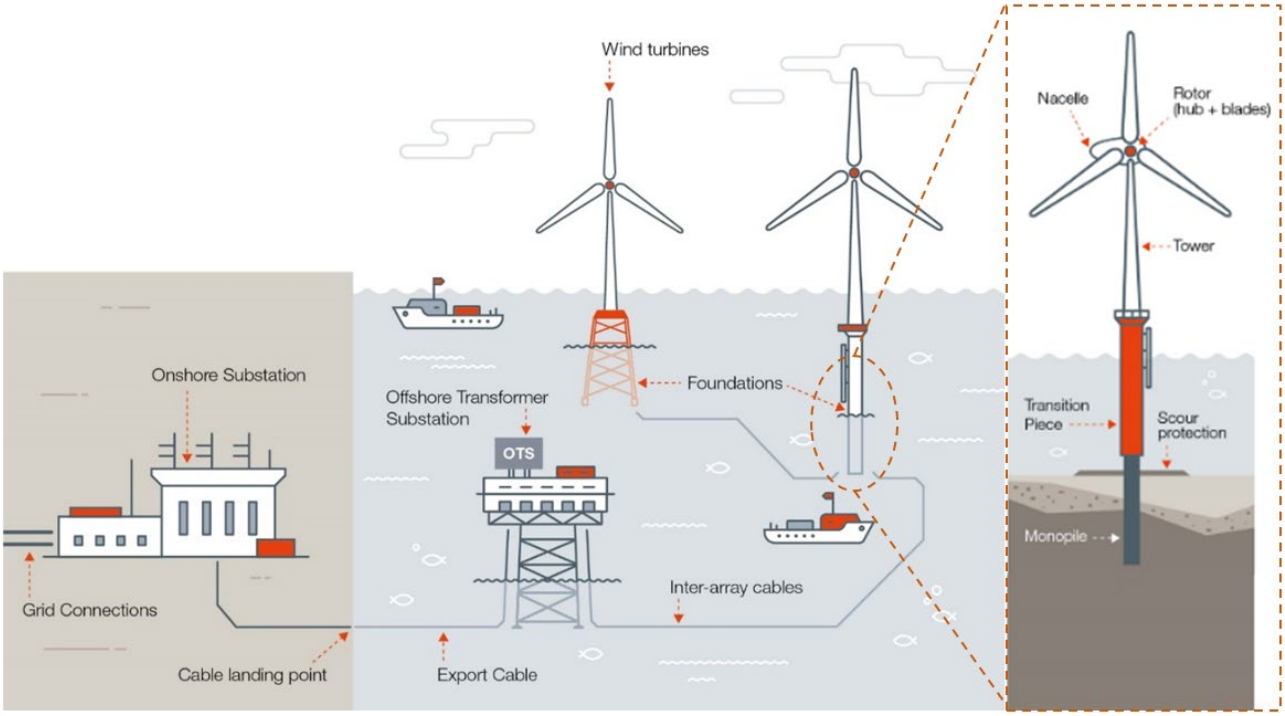


Figure 4-2: Elements of a typical offshore wind farm with fixed-bottom foundations

Components of a typical offshore wind turbine, mounted on a monopile foundation, are shown on right hand side of Figure 4-2.

The turbine shown in Figure 4-2 is installed on a monopile foundation. Monopile foundations are the most common type of foundation which is coupled with a transition piece, connecting the turbine to the monopile; however, they are not suited for all soil conditions. Foundation types are typically governed by water depth and geotechnical conditions. Jacket foundations are more expensive to manufacture, but can be used in deeper water than monopiles, or in geotechnical conditions unsuitable for monopiles (e.g. too hard for driving or too soft to provide sufficient lateral support).

Gravity based foundations can be made of lower cost materials and are often used in shallower waters where they are not driven into the seabed but simply rest on top. Tripod foundations look similar to monopile foundations above the water line but can be used in softer soils because of the extra stability provided by the three legs. Figure 4-3 shows these other common foundation types for offshore wind.

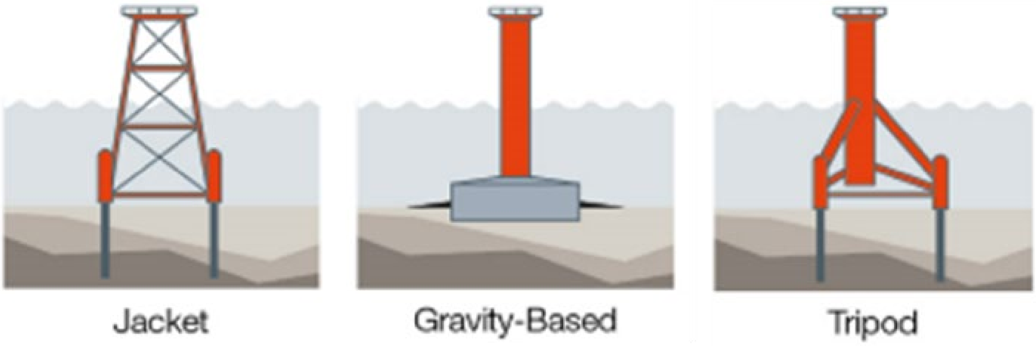


Figure 4-3: Other typical offshore wind foundation types

What is relevant to this study is both the assumption on the foundation type to be used, as well as the consideration of implications for port facilities (refer to Table 5-3 for further details). This is determined by considering the typical vessel types that would be involved in the transport, installation and commissioning of the windfarm based on this information. Of particular relevance is the consideration of the design envelope – i.e. the expected size of the monopiles which would be likely the limiting factor (considering lay down weight) and the expected size of the vessel for transporting and lifting these. Overall, it is assumed that the construction port will be visited by transportation barges bringing items (monopiles, Transition Pieces (TP), towers, nacelles, etc.) to the construction port and then also installation vessels (jack-up or 3D positioned heavy lift vessels) taking the items to the site. Therefore, the jack-up or heavy lift vessel is considered as the limiting factor, due to their draft requirements, high charter costs and demand – refer to section 5.3.1 and 5.3.4 for further information. The port will also have to cater for cable and secondary structures, but generally these require smaller vessels and the components themselves are substantially lighter.

Furthermore, it is assumed that the site modelled in this scenario would be 1 GW and use 15 MW turbines. This would roughly equate to 67 WTGs and associated components that will all likely have to be stored on the quayside. With good planning, the amount (or percentage) of components that should be stored on the quayside may be reduced if there are storage constraints. This can however significantly impact the time schedule, which may lead to longer built times and can result in very expensive liquidated damages or delays (refer to section 5.3.1 for further detail). Therefore, the quayside itself needs to be sufficiently strong to bear the load of the heaviest components and large enough to allow the storage of a significant proportion of the proposed windfarm.

The fabrication and construction of an offshore wind farm of the 1 GW size is generally expected to take around 3-4 years, including marshalling and storage of the components and taking full account of the risk of weather delays. It is noted that, for example, the South-Central is anticipated to have 2.5 GW of wind power installed, indicating that should a single port be selected, this would require around 10 years of dedicated use for offshore wind installation and construction activities. It is important to note that the dedicated activities are referred to a terminal within the port i.e. other business will still operate in parallel provided there is adequate space available.

The size of WTGs today (15 MW for this study) means that the majority of components (Blades, Hubs, Nacelles, Towers, Transition Pieces, Monopiles etc) are too large to transport by land except in very certain circumstances (this is typically due to the fact that the components are so large and heavy that road access must ensure no bridges or overhead cables, as well as the fact that the transportations vehicles would typically be crawler type vehicles requiring special road conditions, to name the major obstacles to road transportation). Generally, it is accepted that all components will be either fabricated within easy reach of a port facility and delivered to the construction port by sea transportation only. For delivery from the fabrication yard to the construction port, this will typically be in the form of a transportation barge. The result of this is that whilst it is important that the port is not physically isolated (i.e. a suitable workforce is available within a reasonable area) it is not essential to have land access for very large components.

The operations and maintenance (O&M) activities are also a critical aspect of offshore wind power, where the park will require regular inspections, maintenance and control. This has less onerous requirements on the space and navigational limitations, as the vessels and components involved are generally smaller. However, one of the key limitations is that the O&M port should preferably be close to the windfarm, so that the daily sail time to and from the wind farm is limited (this distance to offshore wind farms is typically < 200 km for SOVs and < 100 km for CTVs). This is not such a key requirement for the construction site, as large key components will be transported to and from the marshalling/construction port in batches where the installation of a batch of components may take up to several weeks offshore.

4.8 A Typical Port Used for Offshore Wind

Ports play a critical role in realising offshore wind potential, as they represent the natural gateway from land to sea and provide a centralised base from which operations can be undertaken. To help understand port related terms, a typical section is shown in Figure 4-4, with definitions presented in Table 4-2.

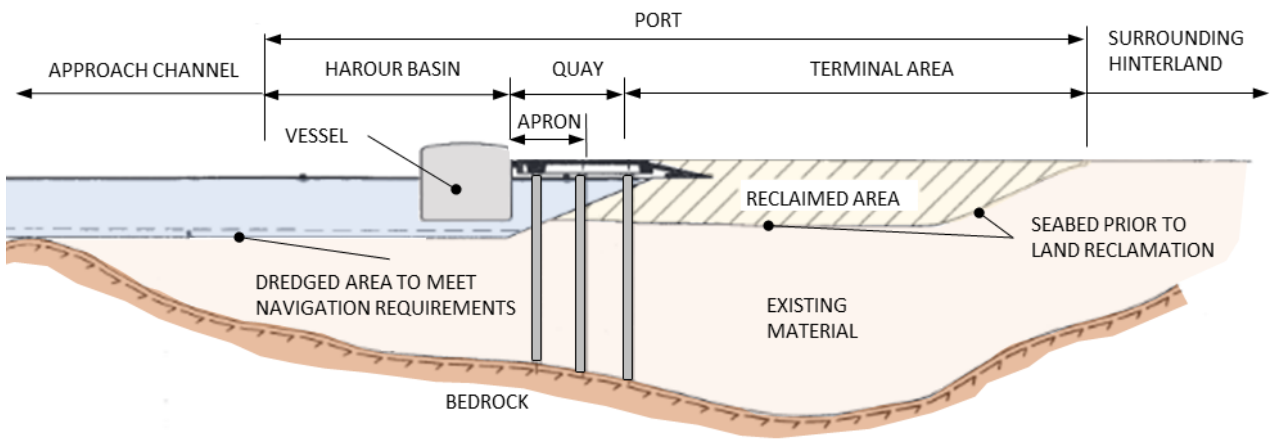


Figure 4-4: Typical Port Section

The section shown in Figure 4-4 is a representative of a typical port which can service multiple functions, which include containers, dry bulk, project cargo (to a specified weight class), liquid bulk and break-bulk cargo. Offshore wind does however have requirements which will necessitate certain upgrades. These are primarily concerned with the following:

- Navigation constraints and adequate depth at the berth / quay.
- Strength requirements at the quay and storage yard (within the terminal area) to ensure safe storage and lifting operations of heavy offshore wind components.
- Storage area size and the possible expansion if there is available land nearby.

These requirements will be discussed further in the subsequent sections as the potential construction ports within Viet Nam are identified.

Table 4-2: Typical Port definitions

Term	Definition
Approach Channel	Demarcated route from the natural deep water offshore to the port.
Apron	The area between the berth line and the storage area for loading and unloading of cargo.
Berth	A place where the ship can moor. In the case of a quay or jetty structure it will include the section of the structure where labour, equipment and cargo move to and from the ship.
Dredging	Dredging refers to loosening and lifting earth and sand from the bottom of water bodies. Dredging is often carried out to widen the stream of a river, deepen a harbour or navigational channel, or collect earth and sand for landfill; it is also carried out to remove contaminated bottom deposit or sludge to improve water quality.
Harbour (Port)	Encompasses the entire developed area from the harbour basin to the terminal area.
Harbour Basin	Protected water area to provide safe and suitable accommodation for ships for transfer of cargo, refuelling, repairs, etc.
Hinterland	The area behind the port which is economically tied to the region.
Quay	A berth structure parallel to the shoreline.
Terminal Area	Adjacent to the quay, and primarily used for temporary storage of in-bound and outbound cargo (the storage area). Workshops, fabrication yards and offices may also be located in the terminal area.
Turning Basin	An area of water or enlargement of a channel used for turning around of ships.

5 PORT-SCREENING BENCHMARK

5.1 Introduction

The screening of port facilities was performed using a benchmark – a list of key port properties with defined thresholds. The screening is developed using the following approach:

Analysis of operations: A list of properties is generated by analysing operations carried out during marshalling and installation of offshore wind farm. Draft threshold values are proposed based on typical vessels and onshore equipment requirements.

Previous offshore wind projects: Review of previously prepared studies and including a non-comprehensive catalogue of European ports currently serving the offshore wind industry. Draft threshold values are checked and compared against these example ports.

Market Insight: From several past studies, including the most recent India Offshore Wind Ports Study (DEA, COWI, 2022b), COWI have attained key market insights from industry experts from across the offshore wind industry on Port activities related to OW, including manufacturing, loading/unloading, supply chain, navigation, etc. Key discussion points included their requirements but also their views on the future trends in offshore wind (particularly relating to 15+ MW turbines and the consequences for port infrastructure).

Due to the high-level nature of this study, this benchmark is intended to be used as a guide for development and expansion of existing ports and terminals to serve offshore wind and not as a rigid set of rules. It is prepared for specific objectives of this study and can be reconstructed and developed further depending on phase and focus of a specific project.

Focus of the benchmark and the rest of the report is on bottom-fixed foundation installation. This type of offshore wind farm installation has a long track record of more than 30 years and has gone through many iterations and refinements leading to a level of standards expected within the industry. In contrast, floating offshore wind is still in early stages of development without a track record of large commercial projects and is not part of the scope of this report.

5.2 Role of Ports in Offshore Wind Phases

The offshore wind farm supply chain is inseparable from port infrastructure and operations due to the very fact that access to the wind farm location must be facilitated by seafaring vessels. Moreover, as the offshore wind industry matures, the role of ports is continuously evolving. This role is shaped by markets which dynamically price the availability of facilities, vessels, components, weather windows and distances between different sites of interest. The implication here is that the offshore wind installation market is a supply and demand market, where the limited number of installation vessels and facilities means that the price (and therefore viability) of offshore wind development is highly dependent on the planning of vessels and facilities with respects both to other wind farm developments but also weather and migratory time windows. Where a clash occurs (for example with another development) this can lead to escalation of daily pricings for vessels or delays, as the vessels are in demand elsewhere. By ensuring a marshalling harbour that is matched to the vessel requirements reduces the likelihood of a clash or bottleneck during this critical phase of transport and installation.

Typical activities and functions that ports facilitate are shown in Table 5-1 and are grouped by phases in life cycle of offshore wind farms. The focus of this study is on Phase 3, **Installation / Construction and Commissioning** and Phase 4, **Operation and Maintenance**. It is considered that port-related operations for these activities are not only necessary and a critical enabler in the construction of offshore wind farms, but also must be in relative proximity to the site. Apart from that, requirements for the port infrastructure for the facilities that are servicing transhipment of turbine components are not more stringent than for the ports used in installation.

Table 5-1: Offshore wind farm life cycle and phase of ports

Phase	Offshore Wind Farm Phase	Role of Port
1	Planning (includes design, development and consenting)	Survey vessels, test areas, installation of wind and wave measurement equipment.
2	Manufacturing and procurement	Loading, unloading and storage of main components (turbines, foundations, cables, etc.) to/from production facilities.
3	**Installation / construction**	Pre-assembly and staging of turbine tower and storage/marshalling of nacelle, blades, foundations...
4	**Operation and maintenance**	Berthing of O&M vessels, hosting of spare parts storage and crew charter.
5	Decommissioning and disposal	Break-up and recycling.

The role of ports in **manufacturing and procurement**, Phase 2, is related to the subject of ports, but is primarily a service to support the manufacturing side of the supply chain and therefore not a focus of this study; however, this topic is briefly discussed here.

Turbine component manufacturing facilities can either be located inland and use nearby ports for transhipment, or alternatively they can be located within the port itself. As WTG increase in generation capacity and physical size, the components are becoming increasingly more cumbersome for road transport and the ability to load them directly onto cargo (or installation) vessels can allow for a reduction in both time and cost.

Production phase differs from fabrication site to fabrication site and in the case of monopiles, research of existing fabrication plants indicates that a range of anywhere from 70 to 350 monopiles per year can be attained depending on the targeted market and investment. Due to the nature and complexity of construction of jacket-type foundations it is assumed that production will be less for the same level of investment in manufacturing capacity. It is also noted due to their size and weight, WTG foundation fabrication facilities (monopiles, transition pieces, jackets) are almost always located adjacent to waterways and ports to facilitate the use of waterborne transport due to the size and weight of completed elements. The same steel fabricators often also produce substation foundations and topsides – a good local example is PTSC (Vung Tau) who have been involved in multiple offshore wind projects related to the fabrication of both foundations and substations.

Export cables, which connect the offshore substation to the onshore substation, and array cables, which connect individual WTGs to the offshore substation, are usually directly transported in cable installation vessels from the manufacturing site to the offshore wind farm for installation. Although relatively shorter distances for the shipment of export and array cables from manufacturing site to the offshore wind farm can provide a minor reduction in the overall development costs of an offshore wind farm, it is expected that the significant investment required for developing new specialized cable manufacturing facilities directly in the region will greatly outweigh any potential savings on shipping costs.

5.3 Port Usage in Installation of Bottom-Fixed Turbines

5.3.1 Logistics

Pre-assembled turbine components (blades, nacelles, tower) are transported to a construction port[2] which is a key link in a bottom-fixed turbine offshore wind farm installation. A typical offshore wind farm terminal can be divided into four zones, each with a distinct function. A brief description is provided below, together with a graphical representation shown in Figure 5-1.

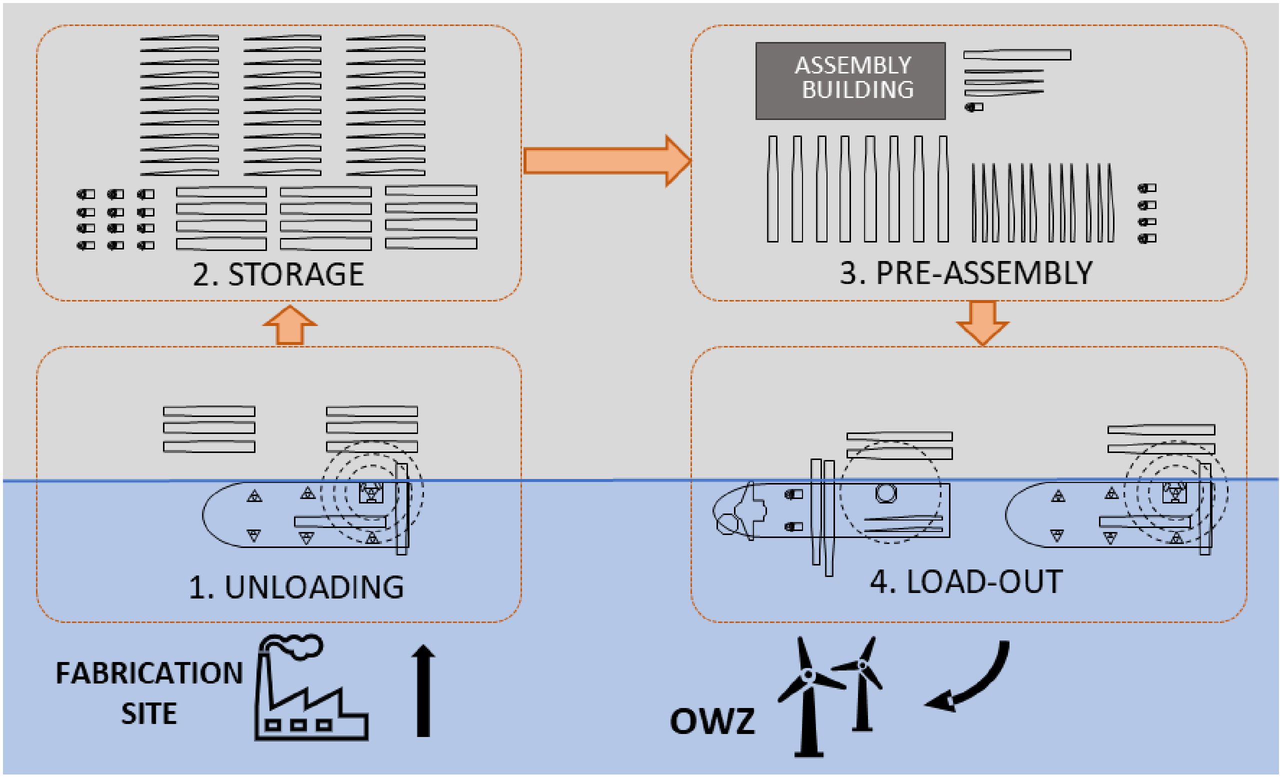


Figure 5-1: Diagrammatical layout for a construction port

To facilitate the unloading and loadout process, a continuous transition between the quay and storage yard is required. This ensures uninterrupted transportation of offshore wind components by limiting potential logistical bottlenecks i.e. single lane access bridges. Furthermore, this will assist in having a more even load distribution between the quay and storage area. Where the quay is separated from the storage area, the open space between the quay and storage area should be reclaimed.

Unloading and Loading Area

[2] Terms "construction ports" can also be referred to as "marshalling", "staging ports" or "installation" ports.

- Receipt of main and secondary turbine components (fixtures, electric components, etc.), inspection, securing and storage (in buildings if weather sensitive); and

- Frames from the pre-assembly area are loaded.

Storage Area

- Where WTG components are prepared and stored, and empty transport frames are stored;

- Set in a certain layout to serve the preferred distribution of WTG components based on a specific selection approach which maximises throughput and ensures safety throughout operations;

- The storage area can also be setup to accommodate washing activities, sub-assembly of secondary components (under cover in buildings/warehouses), and any warehouses and office buildings.

Pre-assembly Area

- Where towers are prepared before loadout onto the Wind Turbine Installation Vessel (WTIV). Towers can be fully pre-assembled or partially assembled (final assembly on the WTIV) if the apron does not meet the load bearing requirements;

- Foundation, nacelle, blade and cable preparation for loadout;

- Quality control walk-down and hand-over of necessary documentation;

- Pre-commissioning, where systems are verified for functional operability to achieve readiness for the commissioning works – and shorten the duration of the installation process in the offshore environment).

Loadout Area

- Loadout (loading components onto the installation vessel).

Figure 5-2 shows an example of Esbjerg Port. The functions of zone 3 and 4 (pre-assembly and loadout) are often merged where berth space is limited; however, scheduling of supply vessels in zone 1 (unloading) must be carefully coordinated such that it does not interfere with critical loadout operations in zone 4. Although the process flow remains the same, the layout of the respective zones changes on a project-to-project basis.

Figure 5-2: Typical layout for a construction port (Esbjerg Port)

Installation of turbines is carried out by specialized jack-up vessels called wind turbine installation vessels (WTIV) – refer to the vessel portfolio in Section 5.3.4. Due to the significant demand and cost of these highly specialized vessels, both in terms of capital investment and operational expense, charter of these vessels is more costly than ordinary cargo vessels and their availability can be limited which is why the staging process is an intensive one. Port facilities are often located and planned as to minimize charter time of WTIVs.

The choice of WTIV for a particular wind farm is generally dependent on the foundation type and size, together with the water depth and access requirements for the selected construction port. However, as a rough guide, for a 15 MW WTG, it would be anticipated to have a cost for the WTIV of between 500,000 EUR to 1,000,000 EUR per day, where mobilisation and de-mobilisation would be significantly more than this. This would not include secondary installation vessels (CTV, guard vessels etc.). It is also noted that the day rate for such vessels can vary dramatically depending on the demand for those vessels. As offshore wind farms increase in size, and new areas are brought online in Northern Europe this will likely drive up the price of the already limited number of WTIVs.

It should be noted specifically in this investigation, many ports are located on rivers with traffic control (one-way systems or similar), for which it is considered that further unnecessary delays to the construction process through the traffic controls would be difficult to justify within the context of very tight scheduling limitations and high daily costs of the rental of WTIVs.

A typical process of sourcing and installation of components in offshore wind farm is shown in Figure 5-3.

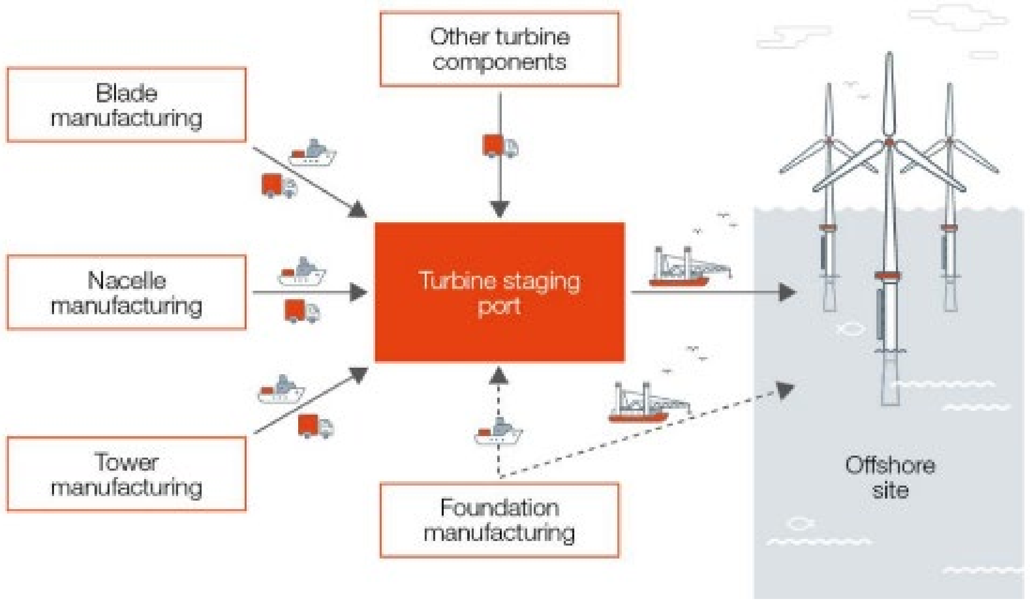


Figure 5-3: Typical process of sourcing and installing components in an offshore wind farm.

It is assumed that the installation rate of the WTIV is 3-4 days per turbine (nacelle, blades and towers), which includes load-out, transport and reasonable downtime due to weather (R.Y.N, 2018). Therefore, assuming a wind farm size of 1 GW (15 MW turbines), this would take approximately 8-9 months provided only a single WTIV was working on the project. Therefore, with a monthly throughput of approximately 8-10 turbines per month, the storage area should allow for a laydown area of at least twice that volume to ensure sufficient buffer in case of transportation and productions delays.

Transition pieces and foundations can be completely finalized and fitted out in the fabrication facility needing only to be unloaded from vessels at the staging port, if not taken directly to the offshore wind farm for installation. Otherwise, secondary steel works and fabrication can be completed in the staging port.

5.3.2 Components, Storage and Handling

A starting point to estimate space and load requirements for the apron and yard should be the properties of the components that are handled in an installation/staging port. Component size and weight can vary with producer as well as the assembly and storage process. Offshore wind components and their typical storage and handling procedures are described in more detail below.

Foundations: Monopile foundation loadout activities typically use Self-Propelled Modular Transporters (SPMT). These however can be challenging in macrotidal environments where the required barge height cannot be kept within a safe limit. In some cases, a combination of using SPMT and large ring cranes can be a solution to reduce downtime. SPMTs also require more clearance at the quay and can significantly reduce storage areas.

Embankments and steel or concrete racks are typically used for storage of monopiles in the yard to allow the standoff for the SPMT to enter below the monopile which assists lifting operations. Loadout can be completed by either SPMT or crane; however, loads imposed by cranes are often much higher than those imposed by SPMT due to the smaller bearing area, and in some cases pose a limit for foundation size to be handled at the port.

Transition Pieces: Transition pieces are generally stored vertically within a 10m x 10m area to allow access all-around. Jacket structures are typically stored standing. Transportation of these transition pieces is generally done by SPMT.

Towers: Tower sections typically arrive prewired. However, tower internal platforms must be pre-assembled in a sheltered facility at the port to protect sensitive power electronics and other electrical equipment. Completed internal platforms must be stored and sheltered, either in the assembly facility or other location, until they are lifted into place inside the towers and secured. Properly covered and secured tower sections can be stored securely outdoors for later loadout.

Turbines: Turbine components are kept in an open-storage yard away from the quay. Each component has a storage & transport frame to facilitate manipulation and lifting. Components and frames are stored on supports which are selected based on load bearing and settlement limitations.

Blades: Blades can be stored in multiple levels using stacking frames.

The substation topside is generally transported directly from the fabrication port to site. In some cases, foundation components are stored on barges at the installation port, not using any of the staging area.

As a guideline, the main properties of general WTG and foundations for various turbines are provided in Table 5-2 and Table 5-3. Note that these are indicative, and the size and weight of the various components will vary depending on project specific conditions (water depth, soil conditions) and on the manufacturer.

Table 5-2: Main properties of WTG components for various MW capacity

Component	**Property**	**Unit**	**10-12 MW**	**15 MW (2)**	**20 MW (1)**
Tower	Length	[m]	110	130-140	Up to 160
	Diameter	[m]	8	8-10	Up to 12
	Weight	[t]	600	700-1000	1000-1500
Nacelle	Weight	[t]	650	650-900	900-950
	L x W x H	[m]	22 / 10 / 12	28 / 12 /12 to 30 / 14 / 14	Up to 30 / 17 / 17
Blade	Length	[m]	100	110-120	135-145
	Weight	[t]	50-60	65-70	>70

(1) Figures provided for 20 MW WTG units are projections; **(2)** Applicable turbine size for this study

Table 5-3: Main properties of bottom-fixed foundations for various MW capacity

Type	Property	Unit	10-12 MW	15 MW (2)	20 MW(1)
Monopile	Length	[m]	50-80	Up to 120	120
	Diameter	[m]	5-7	Up to 12	Up to 15
	Weight	[t]	800-1200	Up to 2500	Up to 3500
Transition Piece	Length	[m]	30	30-40	30-40
	Diameter	[m]	6-7	7-9	9-12
	Weight	[t]	400-500	500-1000	1000
Jacket	Weight	[t]	550	550-1000	1000
	L x W x H	[m]	20/20/50	20/20/50	20/20/50
Substation	Weight	[t]	1000-5000	1000-5000	1000-5000
	L x W x H	[m]	34/27/24	34/27/24	34/27/24
Gravity Base Solutions	Weight	[t]	5000	5000-6000	>6000
	Diameter (Base)	[m]	30	30-35	>35

(1) Figures provided for 20 MW WTG units are projections; **(2)** Applicable turbine size for this study

There are no requirements for fixed cranes for installation ports. This is primarily because loadout is usually carried out by a high-capacity crane mounted on the WTIV which is not sensitive to tide variations. In some cases where there is not enough load bearing capacity at the quay side, the tower can be pre-assembled as:

- Two tower sections with only section 1 and 2 pre-assembled and the last sections loaded out separately; or
- No pre-assembly and all sections loaded out separately.

Storage area can be estimated by multiplying the area taken by one turbine by the number of turbines required to be stored at the port. Additional space for warehouse and offices must also be considered. An example is provided in Table 5-4; however, it must be noted that there are several factors that influence the area. Component sizes differ from one manufacture to another, and density of storage can have an influence as well. Blades can be stacked up which greatly affects the resulting area. Furthermore, depending on the location and the installation strategy used, the number of staged components at the port can cover part or the entire project.

Table 5-4: Example of required storage area estimation

Component	Property	Unit	10MW WTG	15MW WTG
Towers	Area	[m^2]	1060	1400
Nacelle	Area	[m^2]	230	335
Blades	Area	[m^2]	775 (1 to 3 rack)	930 (1 to 3 rack)
WTG	Area	[m^2]	3620 / 2070*	4525 / 2665*
OWF Size		[MW]	1000	
No. WTG		[-]	100	67
No. WTG at port		[-]	50-100	35 - 67
Area required		[ha]	20 - 50	

*Stacked blades

The example above presents the area required for storing all WTG components at port. This is not required in all projects. It is usually the pace of the installation which determines the required WTG components buffer. If WTG components are expected to be imported outside of East Asia, it is recommended that a large number of components are stored at the installation port, prior to commencement of installation, in order to reduce the risk of delays.

5.3.3 Ground Preparation and Loading

During storage, ground settlement is generally limited to 5 cm and allowable inclinations up to approximately 3% may be permissible. This however depends on different factors such as channelling of the rainwater runoff and maximum slope for operation of SPMT vehicles. Settlement should be anticipated due to the high bearing loads of the various components and their management should be built into either the storage area design and construction, or operational tolerances and active maintenance measures. Either of which can have different cost schedules and trade-offs. This is particularly relevant in cases that require soil reclamation, improvement, or replacement.

Table 5-5 provides an overview of the typical surface (ground) loading of the various components and activities that are usually found in offshore wind terminals.

Table 5-5: Activities, equipment and estimated loads at offshore wind installation port

Activity	Equipment	Estimated load (based on 10 – 15 MW WTG)	Methods to reduce load
Load in WTG components	SPMT/Ramp Crawler cranes Mobile cranes (Blades)	10 t/m² when unloaded/transported by SPMT (load under vehicle axles) 30 t/m² when unload using heavy crane (load under crane tracks)	Layer of crushed stone or gravel Crane mats or crane foundation
Loadout of WTG components	WTIV Crane/ HLV crane	No load to the apron	
Load in / Loadout of MP	SPMT Crawler crane	10-12 t/m² (load under vehicle axles) 25-60 t/m² (load under crane tracks)	Layer of crushed stone or gravel Crane mats or crane foundation
	Vessel crane/ HLV crane	No load to the apron	
Transport & Load in / Loadout of TP	Crawler crane	20-30 t/m² (load under crane tracks)	Layer of crushed stone or gravel Crane mats or crane foundation
	SPMT	10 t/m² (load under vehicle axles)	
	Vessel crane	No load to the apron	
WTG Components transport	SPMT	10t/m² (load under vehicle axles)	Layer of crushed stone or gravel
Assembly of towers	Crawler crane	Crane+T1 section up to 30 t/m² (load under crane tracks)	Crane mats Foundations
Nacelle storage	Concrete blocks Crane mats	Varies depending on layout, global spreading, lifting equipment…	Crane mats Embankments
Tower sections storage			
Blades storage	Supports / frames		
Monopile storage	Concrete/steel pads or gravel		
TP storage	frames/saddles Concrete blocks		

Figure 5-4 and Figure 5-5 provide additional reference on the scale of these various offshore wind components, together with examples of storage, handling and loadout operations.

Figure 5-4: Blade, nacelle, tower storage operations

Figure 5-5: Typical loadout and storage operations for foundations

5.3.4 Vessel Portfolio

This section provides an overview of typical vessels that call at staging / construction ports. A given vessel's size and manoeuvrability will dictate the port navigational requirements. Examples of the vessels discussed herein, and their dimensions are provided in Table 5-6.

Turbine components are transported by multi-cargo transporters and open deck carriers. Some multi-cargo transporters have also been converted to serve exclusively the transport of blades or nacelles. They can be equipped with a lifting bow to allow RORO (roll-on/ roll-off) loading process.

RORO ships are cargo ships designed to carry wheeled cargo, such as cars, motorcycles, trucks, semi-trailer trucks, buses, trailers, and railroad cars, that are driven on and off the ship on their own wheels or using a platform vehicle, such as a self-propelled modular transporter. This is in contrast to lift-on/lift-off (LOLO) vessels, which use a crane to load and unload cargo. RORO vessels have either built-in or shore-based ramps or ferry slips that allow the cargo to be efficiently rolled on and off the vessel when in port.

Wind turbine components (tower, nacelle, and blades) are generally installed using WTIVs, that are specifically designed for offshore wind installations and have the capability to jack the vessel off the seabed and lift the entire vessel out of the water. Jack-up vessels are required due to the large hub-heights of turbines and provide the stability and control required during heavy lift activities at hub height with tight tolerances. Additionally, jack-up WTIVs can be used for installation of foundations as well.

To load components, the WTIV is required to jack-up adjacent to the loadout quay. This minimizes movement and potential damage to components during lifting and sea-fastening and is one of the governing factors that need to be accounted for in qualifying a port for staging. In the past, this was solved by prescribing a minimal standoff from the quay and estimating penetration of the spuds into the seabed. However, increase in component sizes has resulted in limiting the crane reach and the preference is now to ensure that vessels can jack-up without standoff. This can be ensured by various methods of seabed strengthening, which can be achieved through different strengthening methods, such as but not limited to:

- stone bedding to distribute the load from spud cans
- rigid inclusions
- soil improvement
- lateral confinement

An alternative would be to verify that the leg penetration does not compromise quay stability and that a safe distance to the quay is maintained. However, this should be carefully considered and avoided for quays that are intensively used for installation.

With offshore wind projects being developed all around the globe, different constraints (such as vertical clearances and soil conditions) have led to the development of alternative loadout processes and installation methods. [3]

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[3] Heerema Marine Contractors developed a method of assembling and installing XXL wind turbines on a floating dynamically positioned vessel (tested by using the crane vessel Sleipnir). The method was used for the offshore wind farm Arcadis Ost1 in the Baltic Sea. The company deployed the vessel Thialf for the project, which was able to sail through the Storebaelt Bridge.

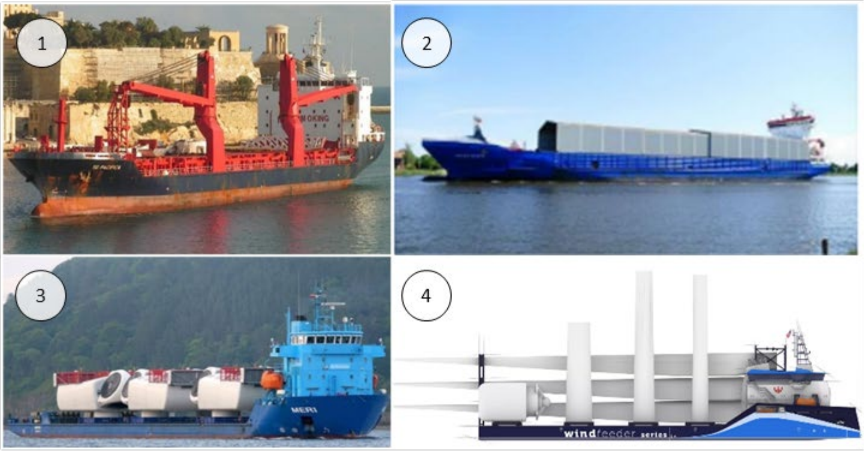
In addition to the typical vessel properties shown in Table 5-6, Figure 5-6 to Figure 5-8 show examples thereof.

Table 5-6: Typical vessels that call at offshore wind construction ports

Vessel Type	Name	LOA [m]	B [m]	Draft [m] (1)	Comment
WTG Components transport					
Multi-cargo vessel	M/V Pacifica	138.5	21.0	8.0	Geared to 300t
Offshore component transporter	Rotra Vente	141.0	20.0	6.5	Ro-ro bow and flush deck
Open deck carrier	M/S Meri	105.5	18.8	4.7	1660m^2 deck area
Feeder vessel concept	Designed by Ampelmann	103.5	23.8	5.5	20 crew+12 passenger; 2.5m Hs
Foundation components transport & installation					
Heavy lift vessel	Seaway Yudin	183.3	36	5.5-8.9	2500t main crane; 2560m^2
Crane vessel	Svanen	102.8	74.6	4.5	5705t capacity
Semi-sub	GPO Grace	225	48	10.6	183x48m free deck
Semi-sub	MV. Sun Shine	168.5	40	7.08	134 x 44 m deck space
Jack up vessel	Aeolus	139.4	44.5	10.1	3775m^2 deck area
Wind Turbine Installation Vessels					
WTIV (jack up)	Wind Orca (2) (recently upgraded)	160.9	49.0	6.0	1200t@31m crane
WTIV (jack up)	Voltaire (2)	169.3	60.0	7.5	3000t crane Deadweight for jacking 14000t
New generation of installation vessels for large scale OWF					
FDP Vessel	Thialf (2)	201.6	88.4	11.9	14200t capacity
Semi-sub crane Vessel	Sleipnir (2)	220	102	12	20000t capacity
WTIV	Orion (2)	216.5	49.0	11.0	5000t@35m crane Also XXL MP and Jacket installation
WTIV (jack up)	Atlas-A (2)	155.4	57.4	6.5	@14000t deadweight

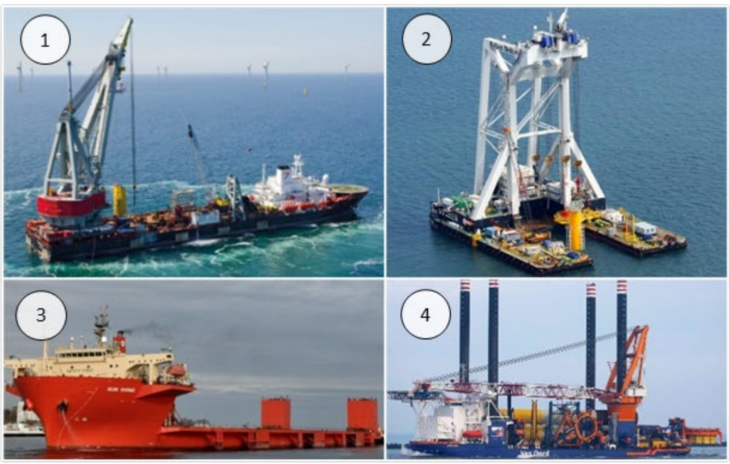
Note 1: Vessel draft represented in fully loaded condition.

Note 2: WTIV capable of transporting/installing 15 MW offshore wind components.



1. Multi-cargo vessel
2. Offshore component transfer
3. Open deck carrier
4. Feeder vessel

Figure 5-6: WTG components transport



1. Heavy lift vessel
2. Crane vessel
3. Semi sub vessel
4. Jack up vessel

Figure 5-7: Foundation components transport and installation

1. FDP vessel
2. Semi sub crane vessel
3. Jack up vessel
4. Jack up vessel

Figure 5-8: Wind Turbine Installation Vessels (WTIVs)

Other vessels which are involved in the construction activities include:

- Transport barges
- Cabin installation vessels
- Platform supply vessels
- Tugboats
- Safety vessel / Standby Emergency Response Rescue Vessel (ERRV)
- Multi-purpose project vessel

These vessels are typically smaller, and therefore their dimensions are not the driving factors for port requirements.

5.4 Port Usage in O&M of Bottom-Fixed Turbines

Requirements of ports used for operation and maintenance (O&M) of offshore wind farms are far less demanding than the requirements on ports used for installation. The vessels commonly used for O&M are Crew Transfer Vessels (CTV) and Service Operation Vessels (SOV).

5.4.1 Logistics

offshore wind farms in operation require regular inspection and maintenance to minimize downtime and maximize generation of electricity. These activities typically include:

- Management of the asset: remote monitoring, environmental monitoring, administration etc.
- Preventive maintenance: routine inspections, change of lubrication oils and regular replacement of wear parts.
- Corrective maintenance: repair or replacement of failed or damaged components.

In addition, the O&M strategy differs from one operator to the next with the aim to find an optimal intersection of access to the asset and onshore support. A typical definition of the two terms is provided below.

- Access to the asset: transit time and time in which a turbine can be reached by O&M personnel.
- Onshore support: availability of parts and services taking part in maintenance or repair.

O&M base ports can be at an entirely different location from the installation ports, as their main requirement is to be within close proximity to the offshore wind farm. Furthermore, the infrastructure requirements are less demanding compared to construction ports.

O&M strategy can roughly be split in two groups:

- Shore-based: where personnel and spare parts are in the port and shuttled to the offshore wind farm.
- Offshore based: where personnel and parts are located on a fixed or floating accommodation base.

An O&M port should ideally have 0.75 to 1.5 ha of available area, adjacent to the berth, to allow for onshore facilities such as offices, storage, accommodation, and workshops. For wind farms served by CTVs, the O&M port is typically located 50-100 km from the wind farm.

With an SOV service concept, the O&M port is typically located 100-200 km from the wind farm. SOV O&M ports are becoming increasingly popular with developers. As the vessels return to port less frequently, the berth can be shared with vessels from other terminal operators, maximising the port usage. Furthermore, the SOV can undertake certain tasks on the vessel which may have originally been serviced within the storage yard. This ultimately ensures less yard area is required for SOV O&M activities.

Figure 5-9 shows a typical O&M port for both CTV and SOV vessels.

Figure 5-9: Typical CTV and SOV O&M ports

5.4.2 Vessel Portfolio

CTVs are small vessels with an overall length of 15-30 m and a shallow draft. They are used to reach wind farms which are relatively close to shore and are used for day trips, with the crew returning to shore at the end of the day. To accommodate CTVs, ports need about 4 m depth at the channel entrance and berth, a harbour entrance width of approx. 12 m and a vertical clearance of only 10 m, as CTVs do not transport large components. When using CTVs, only spare parts and equipment are stored at the port, consequently, a high load capacity is no longer required.

SOVs are larger vessels with crew lodging and warehousing areas on deck. They can stay at sea for longer periods of time (up to two weeks), making them useful for wind farms that are further from shore or very large. Compared to CTVs, SOVs require deeper (approx. 7 m) and longer berths, as well as a higher vertical clearance (Above approx. 40 m).

Table 5-7 summarises typical vessels which call at offshore wind O&M ports, with Figure 5-10 providing examples.

Table 5-7: Typical vessels which call at offshore wind O&M ports

Vessel Type	Name	LOA [m]	B [m]	Draft [m]	Comment
CTV	Damen FCS 2610	26.3	10.3	2.4	100 m2 deck area, 12 personnel
CTV	Ribcraft CRC Voyager	15.0	3.6	0.7	1500 kg payload, 12 personnel
CTV	MHO-Balder	35.89	11	1.59	8x single cabins crew 6. 175m2 deck area
CTV	MHO Flash	27.1	10.4	3.2	3-6 crew. 40m2 deck area
SOV	Ulstein SX 175	88	18	6.4	350 m2 deck area, 60-90 personnel
SOV	ESVAGT SOV	93	19.6	6.5	124 personnel

Note: Vessel draft represented in fully loaded condition.

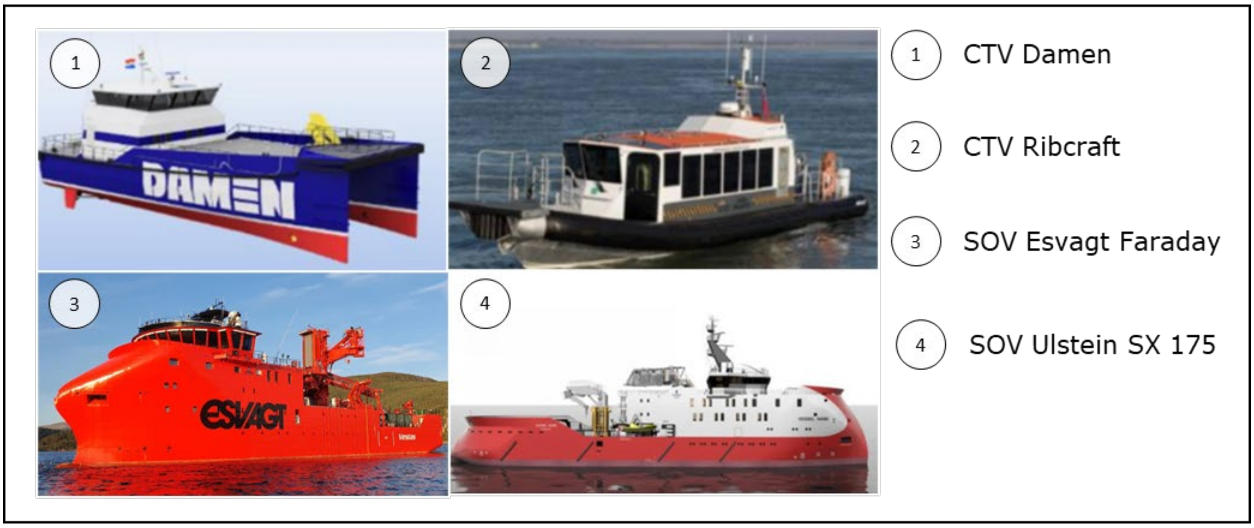


Figure 5-10: Typical CTV and SOV vessels

6 SCREENING OF CONSTRUCTION PORTS

6.1 Introduction

This section presents the process followed for the selection of potentially suitable construction ports for further assessment, as described in Section 7. During the screening of the construction ports, both qualitative and quantitative metrics were used to assess and benchmark ports within the North, South-Central and South regions of Viet Nam.

The process followed for the port selection is summarized in Figure 6-1.

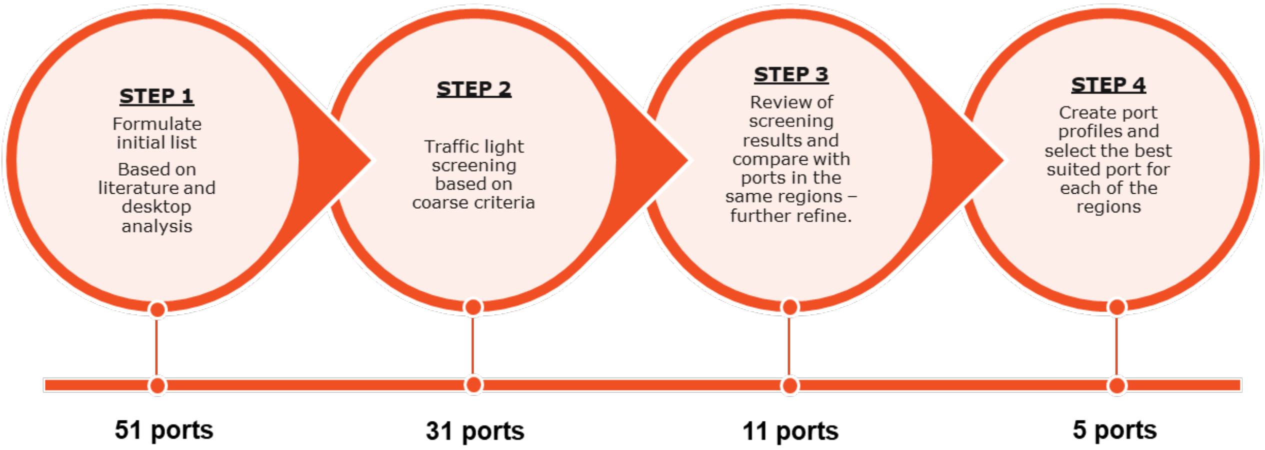


Figure 6-1: Port screening selection process

Step 1: Prepare an initial list of ports based on available literature and location properties. Note that the list includes any potential green field sites which were recommended in previous studies, or by relevant stakeholders.

Step 2: Undertake a traffic light assessment on the ports identified in Step 1 using coarse criteria which focus on navigation and access criteria, available yard area and current use and occupancy of the terminal.

Step 3: Further refine the screening undertaken in Step 2, to identify the top (11) ports which best meet all recommended parameters within the 3 strategic regions i.e. North, South-Central, and South. The selected ports represent the best opportunities to accommodate offshore wind at this stage, using current available information.

Step 4: Establish port profiles which will be used to benchmark ports against one another and inform the selection of the most suitable ports for OWS construction in the North, South-Central and South regions. The outcome of this step is the selection of the 5 best suitable ports that are then taking to the next phase of the study where they are further analysed and a high-level upgrade plan proposed to make it suitable to serve as an offshore wind construction port. Note this step included a Workshop with key stakeholders Danish Energy Agency, Electricity and Renewable Energy Authority, Royal Danish Embassy in Hanoi, Viet Nam Petroleum Institute, Viet Nam Association of Ports, Viet Nam Association of Seaports, Viet Nam Administration of Sea and Islands, Transport Development Strategy Institute, and Vinamarine during which the selection process and criteria, as well as the port list, were presented and discussed through bilateral dialogue. Viet Nam Petroleum Institute was subcontracted for this study as local partner and participated in all workshops and provided technical input to all phases of the report.

Based on the initial screening, it is understood that ports in their current condition, will not have the minimum requirements to meet key offshore wind construction port criteria at this stage, and thus certain upgrades will be required to achieve these. Therefore, the objective of the entire screening process is to select the most suitable candidate ports which can be easily upgraded / developed to meet the requirements as shown in Table 6-1: Bottom fixed construction port criteria.

Table 6-1: Bottom fixed construction port criteria

<table>
<tr><th></th><th>Property</th><th>Unit</th><th>Minimum Req.</th><th>Recommended Req.</th></tr>
<tr><td rowspan="7">Location & harbour</td><td>Distance to OWF</td><td>[km]</td><td><400</td><td><200</td></tr>
<tr><td>Harbour entrance width</td><td>[m]</td><td>160</td><td>0.8-1 LOA
(LOA = length overall)</td></tr>
<tr><td>Channel depth</td><td>[m LAT]</td><td>9</td><td>> 12.5</td></tr>
<tr><td>Access channel width (1)</td><td>[m]</td><td>200</td><td>> 200</td></tr>
<tr><td>Presence of lock/gate</td><td>[y/n]</td><td colspan="2">Not Acceptable</td></tr>
<tr><td>Vertical clearance</td><td>[m]</td><td colspan="2">Unrestricted</td></tr>
<tr><td>Turning circle</td><td>[m]</td><td>240</td><td>300</td></tr>
<tr><td rowspan="5">Berth & yard</td><td>Berth length</td><td>[m]</td><td>200</td><td>400-500</td></tr>
<tr><td>Depth at berth</td><td>[m LAT]</td><td>8</td><td>> 12</td></tr>
<tr><td>UDL load capacity</td><td>[kN/m²]</td><td>75</td><td>100-150</td></tr>
<tr><td>Seabed</td><td>[y/n]</td><td colspan="2">Strengthened</td></tr>
<tr><td>Yard area</td><td>[ha]</td><td>20-25</td><td>30-40</td></tr>
</table>

(1) To be assessed on a case-by-case basis depending on access channel properties

Appendix A (page 2) provides an overview of the selection process for the Construction Ports and a list of the ports selected in Step 1 (pages 4-9). Development road maps were then established for each of the preferred ports – refer to Section 7.

6.2 Step 1 - Port List Database

The first task of the study consisted of mapping the existing port infrastructure and development plans for offshore wind in Viet Nam by establishing a database of existing and planned port facilities along the Viet Nam coastline. The database is the basis of the study from which potential ports and greenfield areas with potential to serve as installation/construction and/or O&M ports are identified.

The initial port list was based on:

- Existing studies and literature (refer to Section 4.4 for a complete list)
- Desktop analysis via Google Earth and engine search

- National Seaport Master plan

- Recommendations from Danish Energy Agency, Electricity and Renewable Energy Authority, Royal Danish Embassy in Hanoi, Viet Nam Association of Ports, Viet Nam Association of Seaports, Viet Nam Administration of Sea and Islands and Vinamarine.

The National Seaport Master plan (SPM) was approved by the Deputy Prime Minister in 2021 and provides a roadmap for the development of the seaport system within Viet Nam. The plans immediate time horizon extends to 2030, which is well aligned with Power Development Plan 8, with a long-term goal of 2050. The Sea Port Master Plan aims to expand marine infrastructure to meet growing freight demand and to act as a catalyst for economic growth within the various regions.

As such, the National Seaport Master Plan provided a good basis for identifying suitable candidate ports; however, as the offshore wind industry is still in its infancy, there was no mention of potential port developments or upgrades to help accommodate the offshore wind industry. For now, ports selected for multipurpose, or general cargo, can also be utilised for offshore wind.

Nevertheless, key observations from the Sea Port Master Plan are shown below:

- The approved National Seaport Master Plan defines the area, main functions, and maximum ship size of all seaports (34) and terminals (~ 300) in Viet Nam.

- The National Seaport Master Plan is under review for amendment due to some changes related to demand forecasts and the upgrade of Ho Chi Minh seaport to a special category.

- Allocated dredging upgrades and resulting yearly operationally budget as part of the Sea Port Master Plan generally requires multipurpose demand

In addition to the observations made, various classes are assigned to ports based on their throughput, size of vessels received, and potential influence level to surrounding jurisdictions (Article 3 of Decision No. 804/QD-TTg). The four seaport classes are defined in Table 6-2 and will be referenced to throughout the report.

Table 6-2: Influence criteria for the classification of seaports within Viet Nam (Innovation Norway, 2023)

Seaport Class	Potential Influence Level
Special	Seaports that serve the purpose of the nationwide or inter-regional socio-economic development and function as international transit or international gateway ports.
Class 1	Seaports that serve the purposes of the nationwide or inter-regional socio-economic development.
Class 2	Seaports that serve the purposes of regional socio-economic development.
Class 3	Seaports that serve the purposes of local socio-economic development.

All types of offshore wind ports are not yet defined in the National Seaport Master Plan and there is an on-going amendment to update this.

Note that the distance of an offshore wind farm is generally an important driver when considering appropriate ports to service offshore wind activities. As we don't have site specific data at this stage, ports located close to the identified bottom-fixed areas were prioritised. This aligned well with the three identified regions – North, South-Central and South.

The initial list criteria were high-level and focused on existing sheltered locations, and available spaces to either refurbish, reconstruct, or construct new terminals. In general, channels above 80 m width and 6 m depth were preferred when developing the initial port list. Channels with a lower width were only considered if the facility presented very good conditions with respect to available area (existing or with potential to be developed). A total of 51 ports were included into the database list together with 30 shipyards which were identified for further investigation. The location of these ports is shown in Figure 6-2.

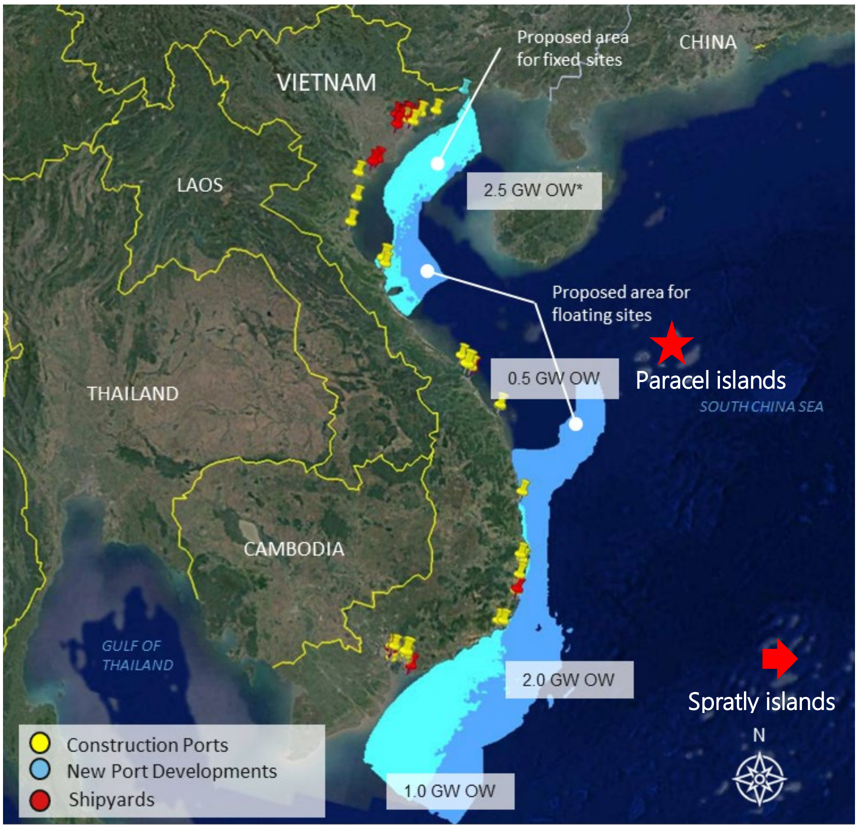


Figure 6-2: Database of selected ports and their location with respect to Offshore Wind Zones

A full list of the 51 identified ports is shown in Appendix A (page 4-9), where they have been split into the 3 strategic regions. Furthermore, details are provided on the location, port ownership, and port type.

6.3 Step 2 – Traffic light screening

This step involved a coarse screening of the ports by using a traffic light system. The coarse screening criteria intended to identify parameters which would clearly disqualify the port, mainly in terms of vessel access and available space. Soft criteria such as terminal use, potential for expansion and expected upgrades were also considered during the screening. The criteria used for installation/construction ports is shown in Table 6-3.

Table 6-3: Traffic light code used in coarse screening Step 2 for installation/construction ports

Light code	Air draft [m]	Channel width [m]	Channel depth [m LAT]	Use of terminal/ occupancy	Available space
Red	Restrictions to air draft (OH cables, bridges…)	<80	<7m	Highly occupied, container business, PA contacted and not interested in OW	No potential for expansion, or existing terminal yard below minimum requirements < 20 ha
Amber	Unrestricted	≥80	≥7m	Highly occupied, container business, PA contacted and interested in OW	Potential for expansion, sufficient yard area for coexisting activities ~ 20 ha
Green	Unrestricted	≥80	≥7m	Low occupancy	Potential for expansion, or sufficient yard area available > 20 ha

A total number of 31 ports were selected for offshore wind installation/construction activities. Although a few of the selected ports showed high occupancy, a low likelihood to switch current business operations to offshore wind, and little space available for future development, they were included at this stage with final decision pending the outcome of contact with the relevant Port Authorities (PA). If confirmed that the port was not interested in offshore wind, or if the port was not able to accommodate offshore wind in the near future due to operational and financial constraints, these would then be revisited in Step 3 and deselected. The selection process is linked to Table 5-2, and commentary is shown in Appendix A.

6.4 Step 3 – Review of Coarse Screening by Region

The 31 selected ports are grouped by region and investigated to understand which ports present better conditions in terms of location, upstream channels, current condition/use and available space, future development plans and timelines. The ports which present better opportunities at this stage based on current available information are selected.

Port Master Plans were obtained for most of the selected ports which allowed for a better overview of future developments and review of possible opportunities for where offshore wind terminals could be established. In addition, dialogue was had with various port owners on their current business operations and whether offshore wind could be a suitable business case for them in the future.

A minimum of 3 ports per region were selected. The considered and selected ports are shown in Table 6-4, Table 6-5, and Table 6-6 respectively. 11 ports made the final selection based on this study, and inputs received from internal and external workshops with key stakeholders.

6.4.1 North Region Ports

A total of 9 ports located in the Northern region were shortlisted for Step 3. All the ports except Van Ninh Port cover the entire offshore wind area and are within a 400 km distance. Figure 6-3 shows the location of the ports with respect to the Offshore Wind Zones.

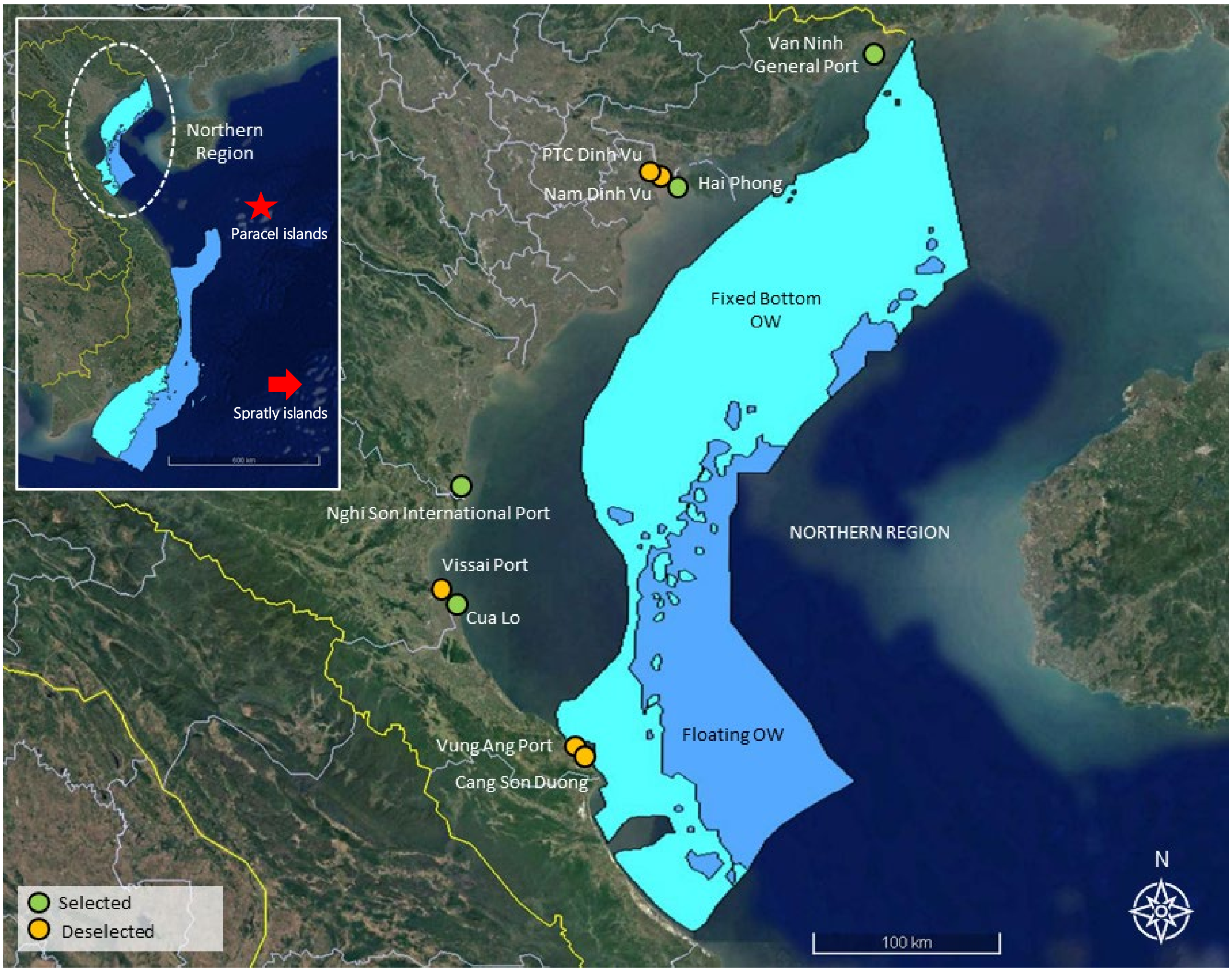


Figure 6-3: Top 9 identified northern ports for Step 3 screening.

Of the 9 ports within the Northern region, the following 4 ports were selected to be taken forward to Step 4 of the port screening process and are listed in the top part of Table 6-4.

- Hai Phong International Port (JV between Saigon New Port, MOL, Wanhai and Itochu)
  - Strong growth plans which could accommodate offshore wind. Sheltered location, good navigation.
- Nghi Son International Port (Owned by VAS Group)
  - Project cargo port with experience of handling onshore wind components. Development plans to the North could be used for OW. Located in an industrial area.
- Van Ninh Port (JV between Duong Dong Group and Vinaconex)
  - New proposed development where offshore wind could participate.
- Cua Lo Port (Owned by Vietsun Corp. Included based on stakeholder feedback)

- Low occupancy multi-purpose port with offshore wind growth ambitions. A new terminal within the port is planned which can be used for offshore wind.

Table 6-4 provides a summary of the findings during the Step 3 screening based on current port operations, available area, and future development plans.

Table 6-4: Selected installation/construction ports for the North region

Port name	Ownership	Current use	Future Developments
Hai Phong International Port	JV: (Saigon New Port, MOL, Wanhai and Itochu)*	At least one of the berths and great part of container terminal would be used, disrupting activities.	Possibility to develop a dedicated offshore wind terminal within future development plan. Terminals 9 and 10 could be used.
Nghi Son International Port	VAS Group**	Entire Northern terminal would have to be used, displacing existing operations. Channel may pose restrictions.	Potential to develop a dedicated terminal or expand current yard and berths. Channel seems to be widened as part of Master Plan.
Cua Lo Port	Vietsun Corp	Almost entire port terminal would have to be used, displacing existing operations. However, the occupancy seems low-medium based on aerial images. Channel depth and width are below minimal requirements.	Expansion plans show additional yard area and berths at the eastern side of the port. Channel width may pose restrictions. Dredging is required but depths are unknown. Positive feedback received from stakeholders for offshore wind business case.
Van Ninh Port	JV: Duong Dong Group and Vinaconex	Not yet developed.	Possibility to develop a dedicated offshore wind Terminal but presents risk with development timeline and accessibility.
Can Son Duong Port	Formosa Steel	Potential to use some of the available area but would need to use existing berths, disrupting current activities. Needs to be confirmed with PA.	Expansion plans show new terminals which could be used; however, timeline seems to be mainly focused on 2030 and after – this is beyond our study requirements.
Vissai Port	Vissai Group	Good location and space. Channel width may pose restrictions. Activities would need to be disrupted and relocated. PA to confirm interest.	Future expansion presents enough yard area and berth length, but channel width may pose restrictions (planned for only 100m).
Vung Ang Port	JSC: VLP	Does not qualify with current available infrastructure; however, future development may create opportunities.	Unclear when future development is planned and what will be developed.
Nam Dinh Vu Port	Gemadept Corporation	Quay is detached from land to reach appropriate depth, would require major intervention and majority use of the terminal yard area.	Development could allow using some land for offshore wind terminal but would require adjusting existing berths or a new berth tailored to offshore wind activities. There are also overhead cables downstream which would need to be relocated. Channel width may pose some restrictions.
PTSC Dinh Vu	PTSC	PA contacted and they are interested in offshore wind activities. Unknown timeline and ambition (O&M / Installation). Highly efficient container terminal; however, old terminals can potentially be converted to OW. The port is further upstream of Nam Dinh Vu Port therefore navigation constraints are similar.	

***** Owner of the current terminals. The identified future terminals 9 and 10 (National Seaport Master Plan) do not have any owners. This presents an opportunity to bring in the right owners to develop an offshore wind construction port.

****** Owners of the Nghi Son International Port. However, there is an opportunity to use the cluster of ports within the Nghi Son Economic Zone to assist with offshore wind. Refer to Section 7.6.

6.4.2 South-Central region ports

A total of 9 ports were shortlisted for the South-Central region. The ports at the central region (Chan May, Lien Chieu, Dung Quat Shipyard, PTSC Quang Ngai and Quy Nhon) cover the southern part of the North Offshore Wind Zones and a small stretch of the Central South Offshore Wind Zone. Although these ports are well suited for the floating Offshore Wind Zones, they are not ideally located in terms of distance to the bottom fixed Offshore Wind Zones.

Figure 6-4 shows the location of the respective ports in the South-Central region.

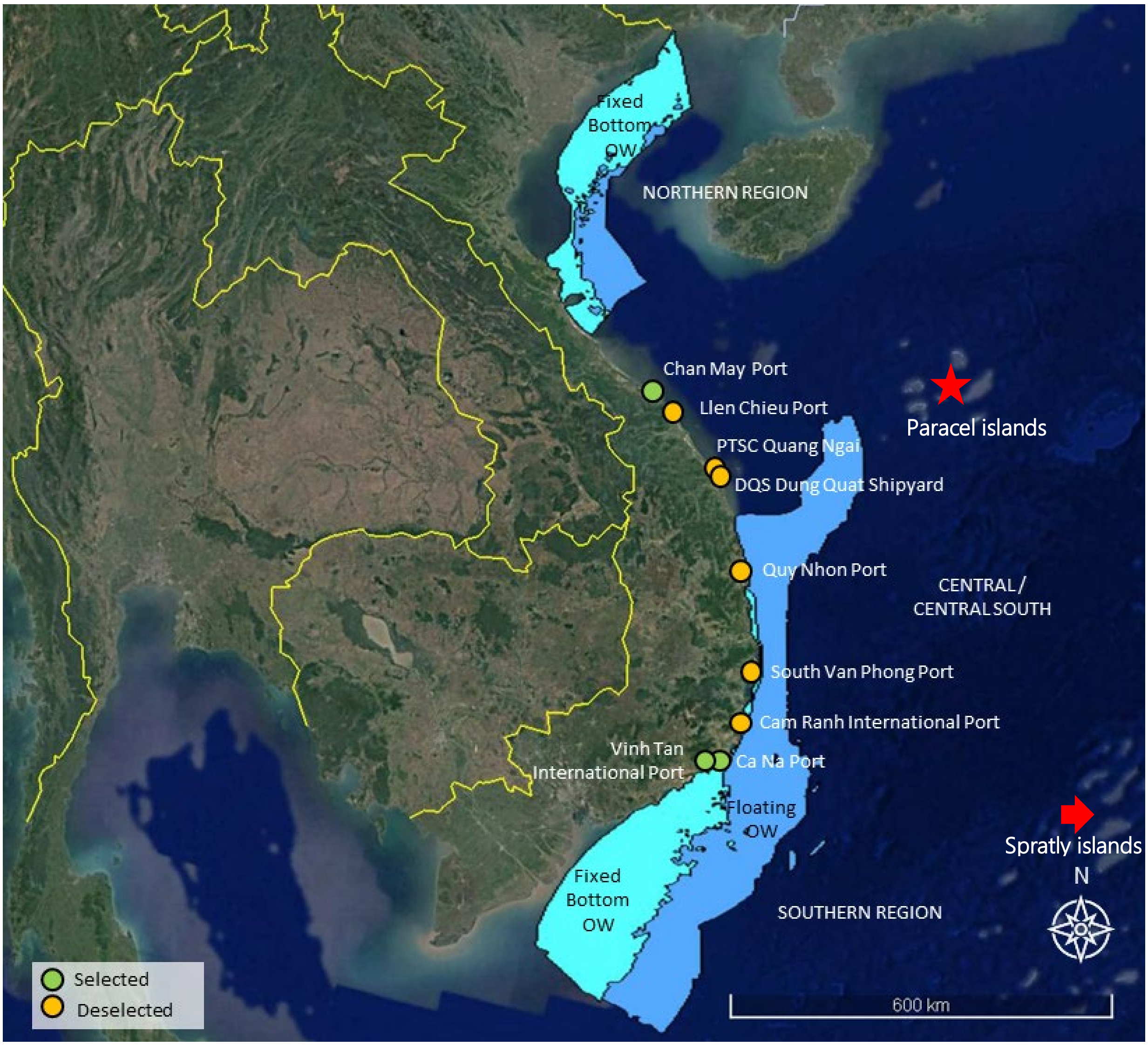


Figure 6-4: Top 9 identified ports located in the South-Central region for Step 3 screening.

Of the 9 ports within the South-Central region, the following 3 ports were selected to be taken forward to Step 4 of the port screening process and are listed in the top part of Table 6-5.

- Chan May Port (Owned by JSC: SBIC)
  - The current business case for the port is not performing well and there is a low berth occupancy. Therefore, there is an opportunity for offshore wind to replace existing operations. Expansion plans to the South represent a good opportunity to bring in an offshore wind construction port, otherwise the existing facility can potentially be upgraded.
- Vinh Tan International Port (Owned by the Pacific Group)

- Experience with onshore wind components and owners are interested in transitioning to OW. The port has a continuous transition from the quay to storage area which is well suited for OW.

- Ca Na Port (New development under construction – Trung Nam Group)

  Earmarked as a key national port. New development under construction which could service offshore wind if this does not displace other operations.

Table 6-5 provides a summary of the findings during the Step 3 screening based on current port operations, available area, and future development plans.

Table 6-5: Selected installation/construction ports for the South-Central region

Port name	Ownership	Current use	Future developments
Chan May Port	JSC: SBIC	Current operations have been unsuccessful and the port owner is open to transition to offshore wind. Majority of the available yard area would be required for offshore wind activities.	Expansion presents good opportunity to set a dedicated offshore wind terminal. May require breakwater extension. Due to location, possible to service some northern offshore wind farm sites.
Vinh Tan International Port	Pacific Group	Currently used as a general cargo port with experience in handling onshore wind components. Land available behind the existing terminal buildings has been identified for possible development.	Expansion plans present a good opportunity for an offshore wind terminal. Breakwater may be required which may pose a risk in timeline.
Ca Na Port	Trung Nam Group	Currently in development with phase 1A and 1B planned for June 2024 completion.	Presents a good opportunity for an offshore wind terminal provided this does not displace other planned operations. Breakwater required may pose a risk in timeline.
DQS Dung Quat Shipyard	PVN	There is a dry dock between both potential areas. Depending on master plan (use of that area).	There is a dry dock between both potential areas. Would require demolition of dry dock (unclear in Master Plan if this area is refurbished)
Cam Ranh international port	VIMC	Based on the current area, channel widths and wharf, this port would require major investment to meet offshore wind requirements.	Adjacent areas developed which could be used but quay layout does not seem adequate for installation operations. Not sufficient quay length as it is shown in the masterplan.
Quy Nhon	VIMC or Saigon New Port	The whole port should be used as yard area. There are existing buildings.	Channel appears widened as 175m; adjacent areas developed (642m quay + yard). This is planned for 2030 which may be too late for the required timeline.
South Van Phong Port	JSC: SVP	Berth is currently not suitable and would need major upgrades.	Future development presents good yard area, berth layout would need to be modified from current plans (land reclamation) and potential requirement for a new breakwater.
PTSC Quang Ngai	PTSC	Does not present sufficient yard area or room for expansion.	Expansion plans consider new terminals; however, it is unclear if sufficient yard area could be developed in time. Furthermore, the berth layout would need modifications to meet offshore wind requirements.
Lien Chieu Port	JSC: Unknown	Not yet developed.	Deprioritize as the breakwater would need to be developed before the terminal is in use. Risk of the breakwater not being developed in time.

6.4.3 South Region Ports

There are several ports located in the Southern region of Viet Nam which have characteristics which are well suited for an offshore wind terminal. However, most of the ports are located in river channels which may pose some restrictions to navigation or result in navigation delays due to the high number of terminals within the same channel and vessel traffic may be an issue. The closer the port is located to the river mouth the more beneficial is it for logistics, provided there is suitable shelter for port operations. Figure 6-5 provides an overview of the ports considered in the Southern Region.

Figure 6-5: Top 14 identified Southern region ports for Step 3 screening

Of the 13 ports within the Southern region, the following 3 ports were selected to be taken forward to Step 4 of the port screening process and are listed in the top part of Table 6-6.

- Ba Son Shipyard (publicly owned)
  - Existing shipyard with extensive fabrication and handling experience of onshore wind components. The owners are interested in transitioning to OW.
- Cai Mep Downstream Development (New development – in planning stage)
  - New development which can accommodate offshore wind in the South region.
- Long An Port (Owned by the Dong Tam Group)
  - Dedicated multi-purpose terminal which can be upgraded to meet offshore wind requirements. This will not disrupt container business of the port.

- PTSC Downstream (Owned by PTSC) Included based on stakeholder feedback.
  - Favoured over Vietsovpetro due to extensive oil and gas experience and port owner's ambition to enter the offshore wind market. The port has extensive fabrication and project cargo experience which is valuable.

Table 6-6 provides a summary of the findings during the Step 3 screening based on current port operations, available area, and future development plans.

Table 6-6: Selected installation/construction ports for the South region

Port name	Ownership	Current use	Future developments
Ba Son Shipyard	Ministry of Defence	Sufficient storage yard area; however, would need upgrades to the quay or new quay in the adjacent area. Port is experienced with handling project cargo from onshore wind activities.	Port owners are keen to establish an offshore wind business. Master plan indicates new areas developed along the adjacent land. Potential delays due to one-way channel vessel traffic.
Cai Mep downstream dev.	Unknown	Not yet developed.	Possibility to develop a dedicated offshore wind terminal but presents risk with development timeline and environmental permits.
PTSC Downstream	PTSC	Would require use of a significant portion of the existing terminal disrupting activities. Channel width is 100m which does not meet minimum requirements. National Seaport Master Plan shows this upgraded to 150 m.	Expansion plans present an opportunity. Channel width may pose some restrictions. Risk with development timeline. Port owners have experience with offshore wind and are keen to include offshore wind as a business case.
Long An Port	Dong Tam Group	Container terminal with general cargo purpose areas. Would need upgrades to the quay. Potential delays due to navigation channel and the dredging thereof.	Master plan shows a dedicated multi-purpose terminal which could potentially be converted to an offshore wind construction port. Land would need to be reclaimed for the quay.
Cang Posco	Posco Group	Would need to upgrade the quay or provide a new quay in the adjacent area. The current entire area would need to be used for offshore wind. This is however dedicated to the steel business.	Port owners not interested in OW.
Vietsovpetro Port	VSP	Would require the use of the entire terminal for offshore wind, disrupting activities. Channel width is 100m which does not meet minimum requirements.	Expansion plans present an opportunity. Channel width may pose restrictions. Risk with required timeline.
Tan Cang–Cai Mep Terminal TCIT	Saigon New Port	Currently a container terminal, therefore, need to confirm offshore wind business case with PA. Existing and planned quay infrastructure does not meet offshore wind requirements and would need to be adjusted and upgraded.	
Thi Vai General Port SP PSA	JSC: VIMC, Singapore PSA, Saigon Port JSC	Offshore wind terminal would disrupt existing operations. Potential to repurpose the southern berths and yard area however we would need buy-in from the port owners. Increased waiting time due to upstream location of the port – risk for delays in schedule.	
SITV (Phu My)	CK Hutchison Holdings Limited	Offshore wind terminal would disrupt existing operations. Potential to repurpose the southern berths and yard area however we would need buy-in from the port owners. Increased waiting time due to upstream location of the port – risk for delays in schedule.	
SPCT container terminal	JV: DPW and VIMC	Air draft (under power cables) 55 m. Night-time navigation limitation 18:00 – 6:00.	Unknown if future plans consider overhead cables relocation.

Port name	Ownership	Current use	Future developments
Saigon Port JSC - Hiep Phuoc Terminal	Saigon Port	Offshore wind terminal would need to disrupt current activities and upgrade quay to meet requirements.	Adjacent areas developed, but quay infrastructure would need to be adjusted to meet offshore wind requirements. Channel seems to remain as 120m which may pose restrictions. May have navigation restrictions as described for the SPCT Container Terminal.
Gemalink Cai Mep Terminal	JV: Gemadept and CMA CGM	Newly constructed container terminal. Would require repurposing and the reclamation of land at the quay to meet offshore wind requirements. Substantial upgrades for a facility which is new.	Potential for expansion but would require dedicating that entire area to offshore wind. Unknown timeline due to the recent construction of Gemalink Cai Mep Terminal.
SP-SSA INTERNATIONAL TERMINAL (SSIT)	JV: Saigon Port and SSA Marine VIMC /Vinalines)	Container terminal which would require major repurposing along the quay. Offshore wind would disrupt current operations. Potential delays due to the one-way channel and multiple terminals in the area.	Potential for expansion but would require dedicating that entire area to offshore wind. Unknown timeline.

6.4.4 Summary of Step 3 Results

From the Step 3 screening process, 4 ports were identified in the Northern and Southern regions, and 3 in the South-Central regions respectively. These ports are best aligned to the offshore wind requirements in terms of location, navigation, quay and yard infrastructure, future development plans and the willingness of port owners to accommodate offshore wind as a possible business case. Circumstances may change for these ports in the future; however, these are representative of the most suited candidates based on current information (March, 2024). Table 6-7 summarises the selected ports, which will form part of the final Step 4 screening process.

Table 6-7: Preferred ports from the Step 3 screening

No.	Port name	Region	Ownership	Current Business
1	Hai Phong International	North	JV: Saigon New Port, MOL, Wanhai, Itochu	Container terminal
2	Nghi Son International	North	VAS Group	Multi-purpose
3	Cua Lo Port *	North	Vietsun Corp	Multi-purpose
4	Van Ninh Port	North	JV: Duong Dong Group and Vinaconex	Multi-purpose
5	Ca Na Port	South-Central	Trung Nam Group	Multi-purpose
6	Vinh Tan Port *	South-Central	Pacific Group	Project Cargo
7	Chan May Port *	South-Central	JSC	Cruise terminal, multi-purpose
8	Ba Son Shipyard *	South	Ministry of Defence	Project Cargo, multi-purpose
9	Cai Mep Downstream Development	South	Unknown	Multi-purpose
10	PTSC Downstream *	South	PTSC	Project Cargo, multi-purpose
11	Long An Port	South	Dong Tam Group	Container terminal and multi-purpose

* Port interested in accommodating offshore wind farms

6.4.5 Stakeholder Workshops

On the 27th March 2024 initial screening results were presented to key stakeholders (Danish Energy Agency, Electricity and Renewable Energy Authority, Royal Danish Embassy in Hanoi, Viet Nam Petroleum Institute, Viet Nam Association of Ports, Viet Nam Association of Seaports, Viet Nam Administration of Sea and Islands, Transport Development Strategy Institute, and Vinamarine) to ensure selection criteria, port properties and key observations were all aligned before selecting the preferred ports to be taken into the detailed roadmap assessment. Viet Nam Petroleum Institute was subcontracted for this study as local partner and participated in all workshops and provided technical input to all phases of the report.

The stakeholders in general verified the selection of ports and provided further information on new developments and ports to be considered. They expressed the opinion that busy container ports will likely not be interested in offshore wind port usage and therefore believe it is important to ensure that interest in offshore wind business is given a high rating in final port selection.

A subsequent workshop with key stakeholders was held on the 7th of May 2024 to present an update of the selection progress and present the final port selection and assessments including observations from the site visit. Although the final selection could not be changed, inputs from the stakeholders have been incorporated in the assessment of the suitability of the ports.

6.5 Step 4 – Development of Port Profiles for Benchmarking

Short port profiles were established for each of the identified ports from Step 3 to be used for benchmarking purposes – refer to Table 6-1: Bottom fixed construction port criteria for reference on the minimum requirements. The objective is to identify at least 1 suitable port for each of the three strategic regions i.e. North, South-Central, and South. It is important to note that the selected 11 ports from Step 3 are all viable options for offshore wind construction ports, either now or in the future due to proposed development plans within their Port Master Plan. Step 4 is a means to select the most appropriate ports which can best service offshore wind development towards 2030, but at the same time offer flexibility in the type of port selected to ensure solutions developed are transferable if circumstances of the selected ports change. It is expected that given the dynamic environment in the early phase of establishing offshore wind farms and relevant port structure, the overall development scene will change both at port level and regional level requiring a revisit of prioritization of suitable ports.

Therefore, as part of the benchmarking process, the five ports selected are also representative of the following types of developments for offshore wind construction ports.

- **Type 1:** A suitably identified greenfield site to be developed as an offshore wind construction port. The site is located within the port boundary and has been identified within the Ports Master Plan for development. Typical construction time is 3-5 years and will require significant investment.

- **Type 2:** A suitable terminal within an existing port which meets minimum navigation and spatial requirements; however, the current berth layout is not suitable (access bridges are used to separate the storage yard from the quay) and requires land reclamation in addition to berth upgrades. Furthermore, the storage yard may be constrained by other port operations requiring various zones (refer to Section 5.3.1) to be positioned away from one another i.e. not a continuous yard extending from the berth. Typical construction time is 2-3 years and will require more investment than Type 3.

- **Type 3:** A suitable terminal within an existing port which has the appropriate berth layout and yard space directly behind the berth but will need upgrades to meet minimum load requirements for an offshore wind construction port. Typical construction time is 1-2 years.

The subsequent sections provide additional information on each of the 11 ports which will be used for benchmarking purposes. At the end of the Step 4 screening process, 5 preferred ports will be selected for the detailed road map.

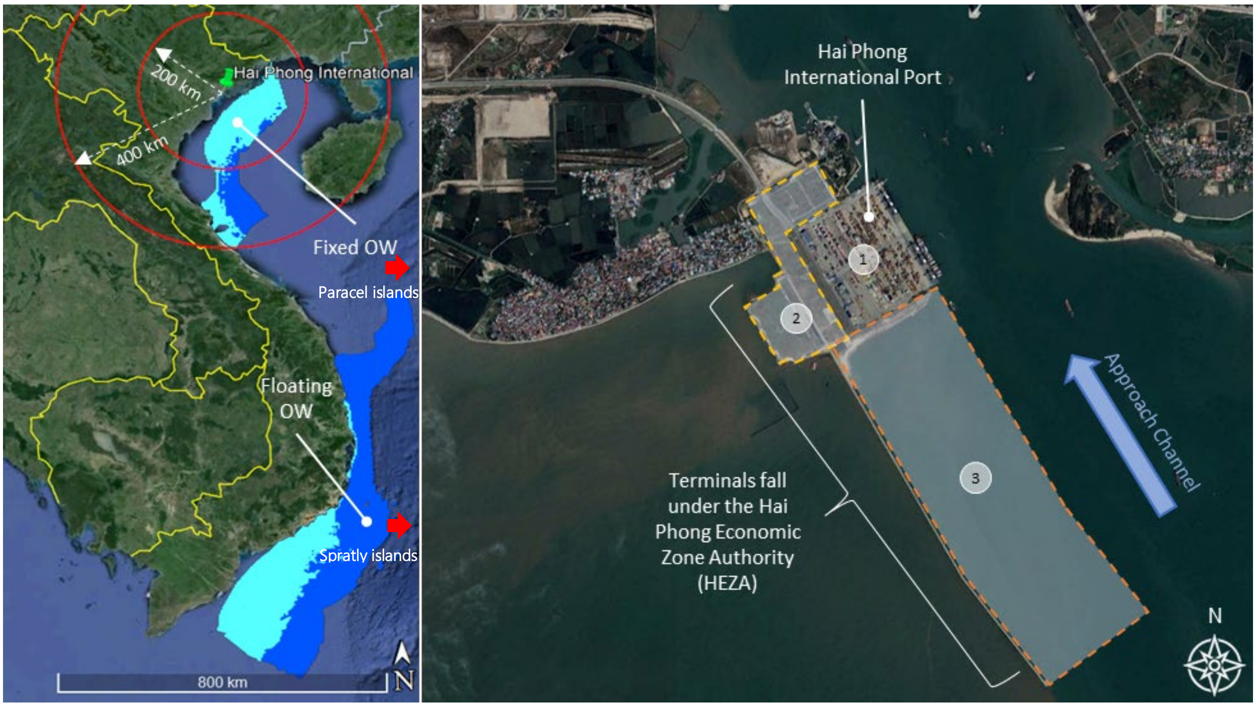
6.5.1 North Region Ports

The results of the developed port profiles and benchmarking exercise is shown below

- Hai Phong International Port: Table 6-8, Table 6-9
- Nghi Son Port: Table 6-10, Table 6-11
- Cua Lo Port: Table 6-12, Table 6-13
- Van Ninh General Port: Table 6-14, Table 6-15

Table 6-8: Hai Phong International Port Profile 1 (Special Class, container terminals)

Hai Phong International Port – NORTH REGION JV: Saigon New Port, MOL, Wanhai and Itochu (Terminals 1 to 6). **Interested in Terminals 9 and 10 (No owner, yet to be developed)**	**Coordinates:** 698333.85 m E, 2301006.29 m N



Descriptions:

- Located on the Northern coastline of Viet Nam.
- Traditionally a container terminal and has significant development plans to extend into region 3 (as per figure).
- Offshore wind can form part of development plans if the port owners are interested – especially for new greenfield sites. Marked as a strategic development port in the National Seaport Master Plan.

Key Observations (Refer to Figure):

1. Existing terminal is far too congested and any disruptions to the core business will not be accepted.

2. Area behind the existing terminal could possibly be used; however, there will be no dedicated berth for the offshore wind construction port which is a concern. Furthermore, there is a large access route which splits the identified zone. This will pose logistical issues.

3. Area for port expansion – refer to Port Master Plan (Terminals 9 and 10). Ideally located and is an opportunity for a greenfield offshore wind construction port. Currently there are no owners for terminals 9 and 10.

Positive Attributes

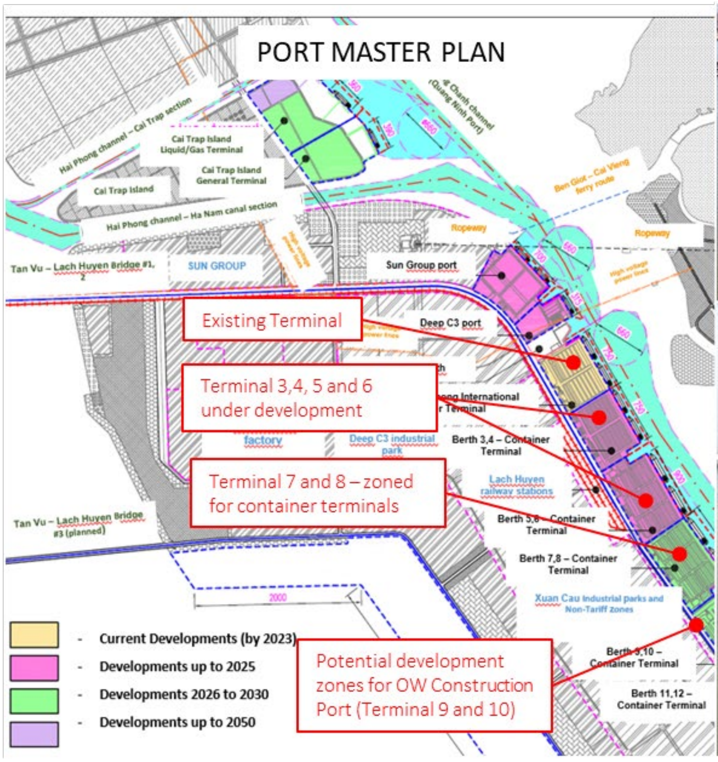
- Port owners and HEZA have ambitious growth plans which can be used to incorporate offshore wind.
- Offshore wind construction ports can be easily transitioned to a container terminal (core business of the port) at a later stage due to similar loading and yard requirements.
- Navigation requirements are generally acceptable and the terminals are in close proximity to the preferred Offshore Wind Zones.
- Strategic area within the National Seaport Master Plan.
- Permits and authorisations should not be an issue.

Development Risks

- The existing container terminals, and terminals under development, are not suitable for an offshore wind construction port. This is not within the JV partners business interests.
- Development zones 7 and 8 have already been earmarked for additional container terminals – this is a risk that this trend will continue to terminal 9 and 10 as this is the preferred business case within the region.
- Requires suitable funding for development (greenfield site).

Table 6-9: Hai Phong International Port Profile 2 (Special Class, container terminals)

Hai Phong International Port and Hai Phong Economic Zone Authority – NORTH REGION
Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

	Property	Unit	Existing	2025+	2030+
Location & harbour	Distance to OWF	[km]	Covers all planned area at North within 400km		
	Harbour entrance width	[m]	N/A	N/A	N/A
	Channel depth	[m]	13	13	13
	Access channel width	[m]	160-250	160-250	160-250
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	660	800	800
Berth & yard	Berth length	[m]	375	1650	1650
	Depth at berth	[m]	16.0	16.0	16.0
	UDL load capacity	[kN/m2]	-	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	41	>20	>40

Closing Statements:

Terminals 9 and 10 are strong candidates for a greenfield offshore wind construction port (Type 1), provided these can be zoned for offshore wind activities (general port), and an appropriate owner selected. The location is ideally situated close to the Northern Offshore Wind Zones and has good navigation properties. The terminal can then at a later stage be converted back to a container terminal once support for offshore wind is no longer needed.

Table 6-10: Nghi Son Port Profile 1 (Class 1 seaport, Bulk and general cargo)

Nghi Son International Port – NORTH REGION Private VAS Group	**Coordinates** 585138.61 m E, 2136073.88 m N

Descriptions:

- Located on the Northern coastline of Viet Nam.
- A bulk cargo/multi-purpose port with a heavy-duty quay capable of withstanding 20t/m².
- Located in a strong industrial area which can provide necessary skills and personnel for the offshore wind construction port.
- Forms part of a strategic economic zone which will provide easier access to funding.

Key Observations (Refer to Figure):

1. Existing terminal offers good opportunity for offshore wind; however, the existing operations would need to be relocated.

2. Area at the northern end of the port has been identified for development according to the Port Master Plan. The proposed use case is unknown; however, stakeholders have indicated that development plans are ramping up and it may be a good business case for offshore wind.

3. The Eastern side of the port (No. 3) is used for bulk cargo – not suitable for an offshore wind construction port.

4. Possible use of Thanh Hoa port in collaboration with Nghi Son International.

Positive Attributes

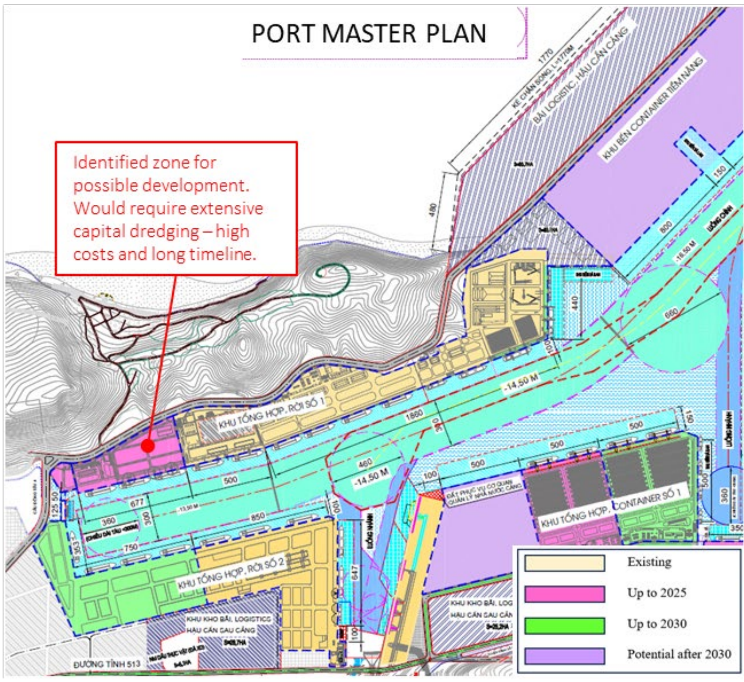
- Port owners have ambitious growth plans which can be used to incorporate offshore wind.
- Opportunity to develop the identified area along the North Eastern side if there is a business case.
- The port is located in a strong industrial zone where there are possible collaboration opportunities with existing ports i.e. Thanh Hoa (Point 4 in the figure).
- The existing northern key has a high load carrying capacity which is advantageous towards offshore wind.

Development Risks

- Using the existing northern terminal for offshore wind will displace current operations. These however could be relocated to the North Eastern site.
- The identified area for development along North Eastern side would require extensive capital dredging and excavation.
- Current access channel width does not meet minimum requirements.

Table 6-11: Nghi Son International Port Profile 2 (Class 1 seaport, Bulk and general cargo)

Nghi Son International Port – NORTH REGION
Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

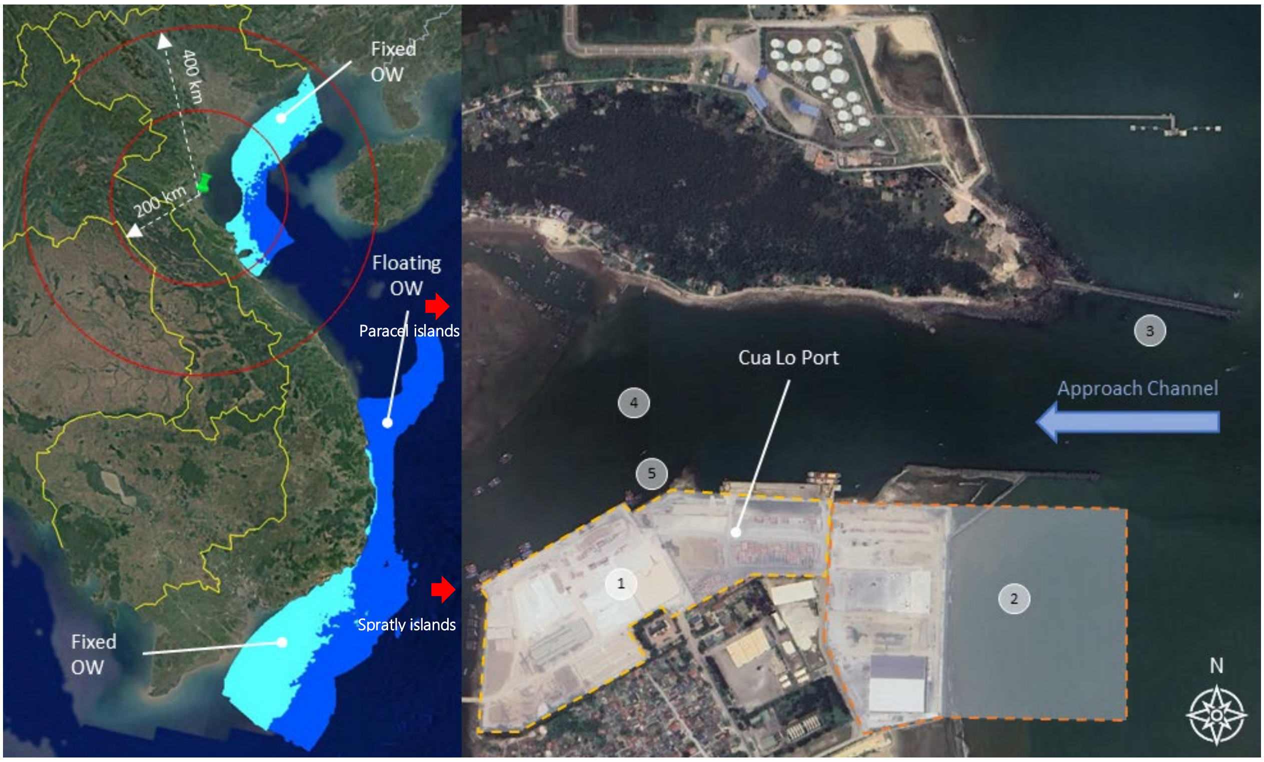
	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]	Covers all planned area at North within 400km		
	Harbour entrance width	[m]	N/A	N/A	N/A
	Channel depth	[m]	10.3	-	-
	Access channel width	[m]	120	300	300
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	335	>300	>300
Berth & yard	Berth length	[m]	1547	>2000	>2000
	Depth at berth	[m]	9.5-13	-	-
	UDL load capacity	[kN/m2]	200 (TBC)	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	14-33	-	-

Closing Statements:

Nghi Son International Port is optimally located to service both of the northern Offshore Wind Zones and offers a sheltered port with high uptime. There was concern around the small access channel width, however it is understood that this will be dredged to 200 m by the end of 2024. Offshore wind would however need the entire yard area of the existing North Eastern terminal disrupting current operations which the port owners are not willing to relocate prior to 2030. Consideration will also need to be given to possible LNG and container developments as set out in the National Seaport Master Plan. If however, the Northern terminal (existing) can be used for offshore wind, this is a viable and attractive prospect. There may also be a case of using the cluster of ports within the Nghi Son area to service offshore wind.

Table 6-12: Cua Lo Port Profile 1 (Class 1 seaport, Bulk and general cargo)

Cua Lo Port – NORTH REGION Private: Vietsun Corp	**Coordinates** 575123.00 m E, 2082000.00 m N



Descriptions:

- Port located in the Nghe An province, at the River Song Cam.
- Involved with ship repair, container and bulk cargo with four cargo handling berths.

Key Observations (Refer to Figure):

1. Existing terminal has a low-medium occupancy with a total storage area of 15-20 ha. This entire area would be required for offshore wind.

2. Land marked for development which could be integrated with the existing Eastern terminal to create an offshore wind construction port.

3. North breakwater sheltering entrance and western berths may need to be extended to ensure adequate operational conditions.

4. River Song Cam sediment accumulation at shallow areas is observed which raises concerns about maintenance dredging requirements.

5. Current berth depths are 7-7.5 m CD which does not meet minimum requirements – requires dredging.

Positive Attributes

- The port seems to have a low occupancy and plans for expansion.
- Currently there is sufficient yard area within the port.
- Ideally located and offshore wind can be used as the port's main revenue stream.

Development Risks

- Shallow waters imply dredging requirements for access channel and quay.
- Discharge from river may pose high maintenance dredging due to draft requirements.
- New berths may be too exposed if the north breakwater is not extended, there is a risk of downtime and delays if the breakwater is required.
- Access channel is narrow and exposed

Table 6-13: Cua Lo Port Profile 2 (Class 1 seaport, Bulk and general cargo)

Cua Lo Port – NORTH REGION

Port Master Plan and Benchmark

Benchmark (Updated according to Port Master Plan):

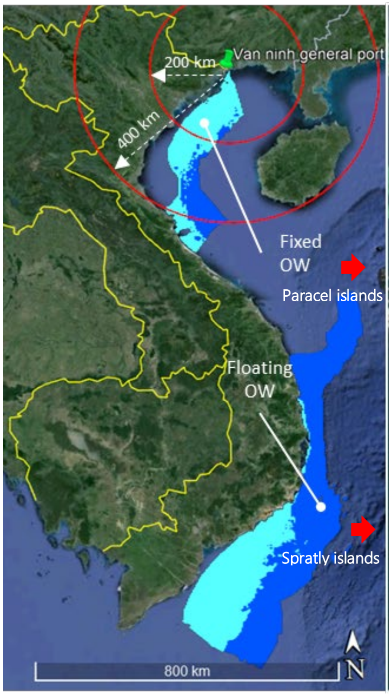
	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]			
	Harbour entrance width	[m]	>300	>300	>300
	Channel depth	[m]	7.2	-	-
	Access channel width	[m]	100-120	100-120	100-120
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	180-220	300	300
Berth & yard	Berth length	[m]	200+300	>500	>500
	Depth at berth	[m]	7.5	-	-
	UDL load capacity	[kN/m2]	-	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	20	>30	>30

Closing Statements:

Cua Lo is a port well located with respect to the planned Offshore Wind Zones which currently presents sufficient yard area to serve as construction port, provided the majority of the port is used for this purpose. Water depths are shallow and major dredging is required to accommodate WTIV. If development plans go ahead there is a possibility to dedicate one of the new terminals to offshore wind and reduce the required yard area from the existing port. There is a risk of the new terminal being too exposed to waves if the north breakwater is not extended. The narrow access channel may pose some risks as it is quite exposed.

Table 6-14: Van Ninh General Port Profile 1 (in development)

Van Ninh General Port – NORTH REGION JV: Duong Dong Group and Vinaconex	**Coordinates** 803492.00 m E, 2370824.00 m N



Descriptions:

- New proposed multi-purpose port on the Northern end of Viet Nam's coastline.
- Proposed development is still in the planning phase.

Key Observations (Refer to Figure):

1. The proposed development is along an environmentally sensitive area and will require extensive studies to ensure all environmental and social aspects are met. This will include public engagement processes, which can be lengthy.

2. The proposed development is in a remote location and is not well connected. Significant investment will be required to ensure access to main access routes.

3. The quay infrastructure in the proposed development is not suited for offshore wind construction ports. There must be a continuous transition from the quay to the storage yard. The access bridges shown will limit manoeuvrability and will not have adequate strength to resist imposed loading.

Positive Attributes	Development Risks
› New development in the planning phase which could be altered to assist with offshore wind activities in the future.	› Connectivity and length planning process. The proposed development will more than likely not be available for Power Development Plan 8 goals of 6 GW by 2030. › Proposed quay infrastructure does not currently meet offshore wind requirements.

Table 6-15: Van Ninh General Port Profile 2 (in development)

Van Ninh General Port – NORTH REGION
Master Plan and Benchmark

Benchmark (Updated according to Port Master Plan):

No information available at this stage for benchmarking purposes.

Closing Statements:

Van Ninh is a newly proposed general port at the Northern tip of Viet Nam. The development is still in the planning phase and will need to get through all environmental requirements before any construction activity can commence. offshore wind does not form part of the proposed use case and the current layout of the quay infrastructure is not suited. There is potential to influence the development to include an offshore wind terminal; however, the expected completion date will more than likely extend beyond 2030. As such, Van Ninh will likely not be participating in Power Development Plan 8s goal of 6 GW of offshore wind by 2030. There however may be opportunity beyond this time frame.

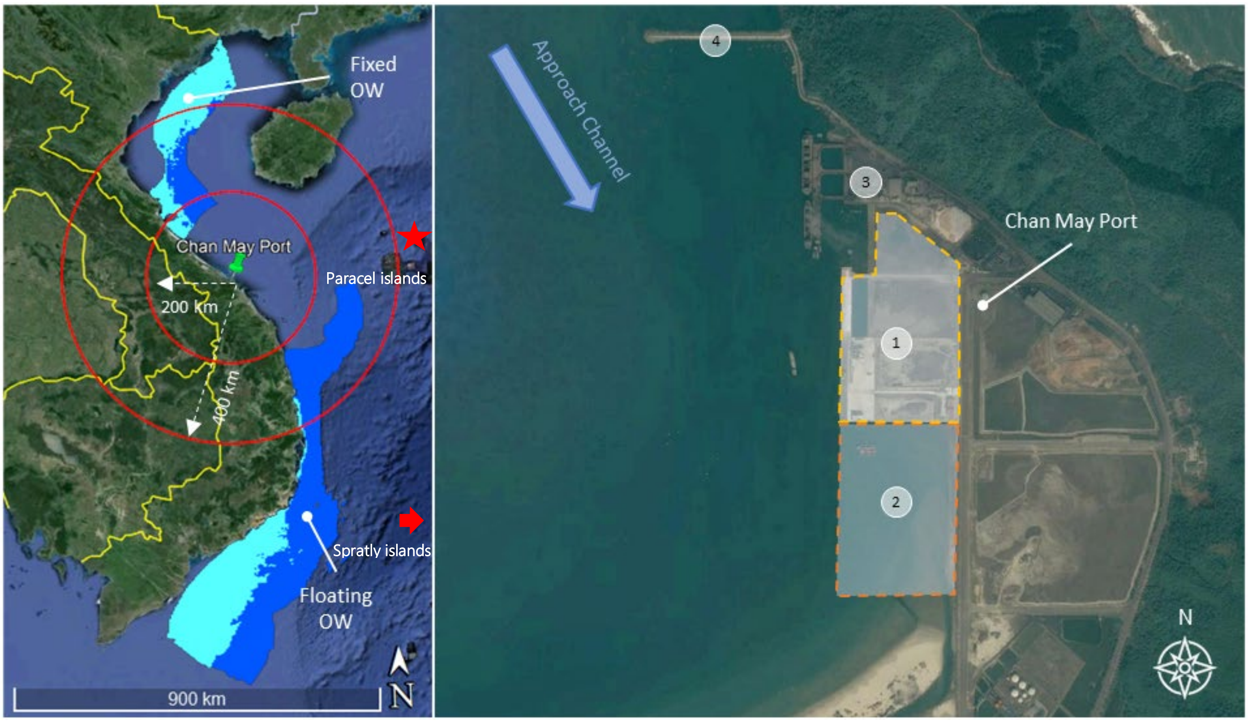
6.5.2 South-Central Region Ports

The results of the developed port profiles and benchmarking exercise is shown in the following tables for the three selected ports.

- Chan May Port: Table 6-16, Table 6-17
- Vinh Tan International Port: Table 6-18, Table 6-19
- Ca Na Port: Table 6-20, Table 6-21

Table 6-16: Chan May Port Profile 1 (Class 1 seaport, Bulk and general cargo)

Chan May Port – SOUTH-CENTRAL REGION JSC: SBIC	**Coordinates** 181405.33m E, 1807812.05 m N



Descriptions:

- Located on the Central Vietnamese coastline.
- A bulk cargo port and cruise terminal for the tourist industry.

Key Observations (Refer to Figure):

1. Majority of the existing terminal will need to be converted to offshore wind in order to meet yard requirements.

2. Area identified for port expansion – refer to Master Plan. In addition to the quay infrastructure, significant capital dredging would be required to achieve suitable depths.

3. The current terminal is not in high demand and offshore wind provides an opportunity for Chan May Port to pivot to offshore wind.

4. If the greenfield site is to be used for offshore wind, then the breakwater would more than likely require extension, further increasing capital expenditure and associated construction timelines.

Positive Attributes

Current port business has not performed well, and the Port Owners see offshore wind as a business opportunity.

- Navigation requirements are generally acceptable; however, the channel width would need to be widened.
- Permits and authorisations should not be an issue – development within an existing port.
- Located optimally for the central region were 0.5 GW of offshore wind development has been envisioned in the 2021 WB study.

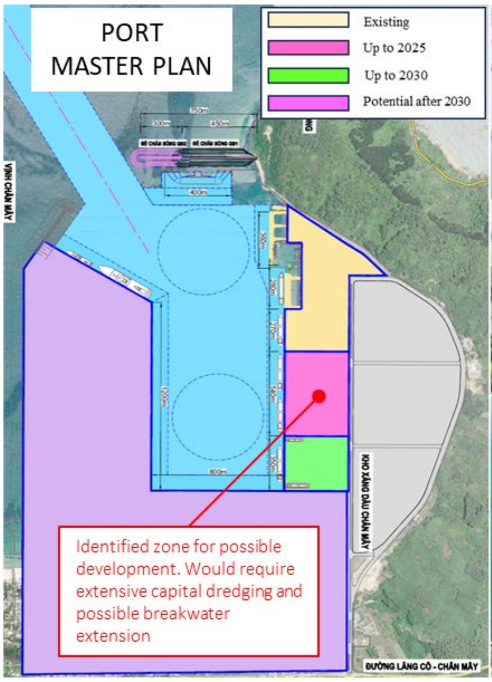
Development Risks

- The port in its current state is not suitable for an offshore wind construction port and significant upgrades will be required.
- The port is not ideally located for the fixed offshore wind development zones.
- The port is not located in a large industrial zone which limits any skills transfer, assistance received from outside the port area.
- The greenfield site identified in (2) will require significant funding.

Table 6-17: Chan May Port Profile 2 (Class 1 seaport, Bulk and general cargo)

Chan May Port – SOUTH-CENTRAL REGION

Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

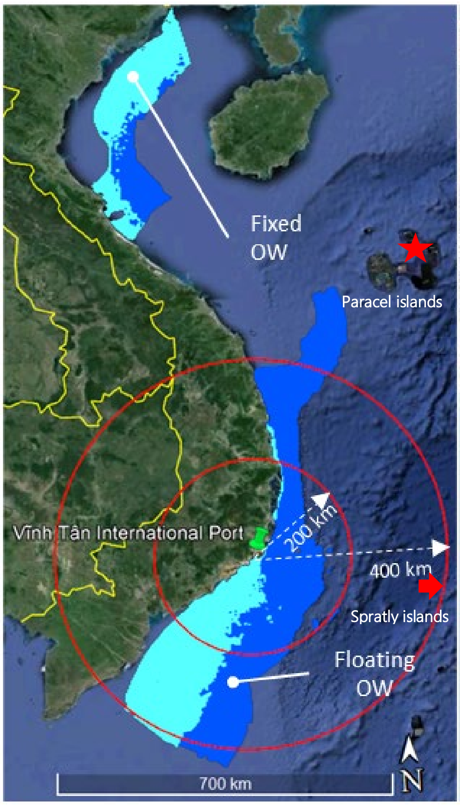
	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]	Covers southern part of North, and Northern part of South Offshore Wind Zones		
	Harbour entrance width	[m]	N/A	N/A	N/A
	Channel depth	[m]	12.3	12.3	12.3
	Access channel width	[m]	120	150	150
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	470	470	470
Berth & yard	Berth length	[m]	860	540	540
	Depth at berth	[m]	14	14	14
	UDL load capacity	[kN/m2]	-	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	>20	>30	>30

Closing Statement:

Chan May Port services both general bulk cargo and cruise liners for the tourist industry. The port is currently under utilised and there is an opportunity for the Port owners to pivot towards offshore wind provided they receive adeqaute support and funding. offshore wind can be serviced within the exsiting port; however, almost the entire yard area will need to be upgraded to accommodate the load and spatial requirements. The identified greenfiled site to the South is another option, and has been allocated for development in the National Seaport Master Plan. This would require significant captial due to the additional dredging and lengthening of the breakwater. Furthermore, the location of the port limits its effectiveness when servicing offshore wind farm further north. The suitability of the port is therefore dependent on the location of planned offshore wind in 2030.

Table 6-18: Vinh Tan International Port Profile 1

Vinh Tan International Port – SOUTH-CENTRAL REGION Private: Pacific Group	**Coordinates** 261262.03 m E, 1251874.88 m N



Descriptions:

- Located on the South-Central coastline of Viet Nam.
- The port has experience in handling project cargo i.e. smaller onshore wind components.
- The port is separate to the adjacent Vinh Tan International Power Station.

Key Observations (Refer to Figure):

1. Available yard space which can be used to accommodate offshore wind requirements. This site is well suited provided the needed quay, yard and navigation upgrades are undertaken.

2. The Vinh Tan International Power Station has its own dedicated port facilities which are not to be used for offshore wind purposes.

3. There are plans to develop this region which includes a secondary breakwater and a dedicated storage yard and heavy-duty quay for offshore wind. This is extremely promising, as the port is closely located to preferred Offshore Wind Farms sites in the South.

Positive Attributes

- The Port owners are very keen to expand their business offering to offshore wind.
- The port has significant experience in handling smaller onshore wind components – this can be transferable to offshore wind.
- Located in close proximity to the proposed southern fixed Offshore Wind Zones.
- Plans to develop a dedicated offshore wind storage area and quay

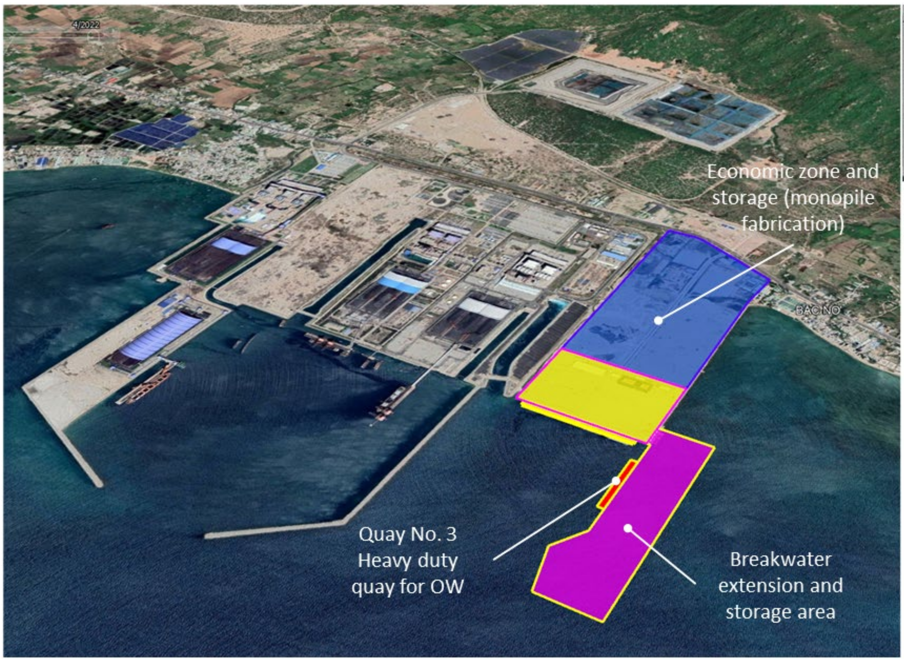
Development Risks

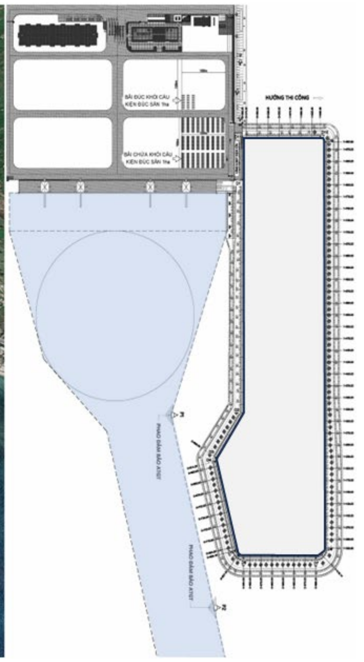
- Funding requirements and development timelines for the dedicated offshore wind storage area and quay.

Table 6-19: Vinh Tan International Port Profile 2

Vinh Tan International Port – SOUTH-CENTRAL REGION

Port Master Plan and Benchmark





Benchmark (Updated according to Port Master Plan):

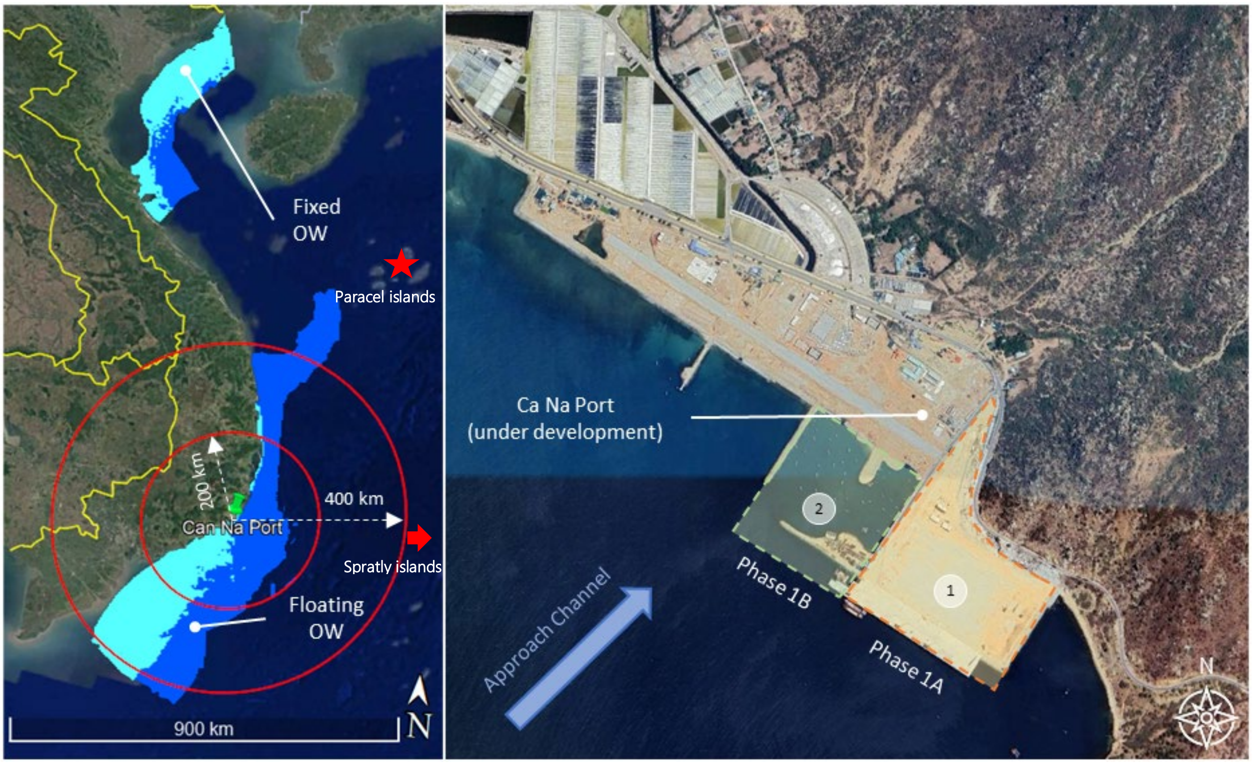
	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]	Good location with respect to Offshore Wind Zones central and south		
	Harbour entrance width	[m]	N/A	N/A	N/A
	Channel depth	[m]	10	10	10
	Access channel width	[m]	150	150	190
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	360	360	360
Berth & yard	Berth length	[m]	450	>600	>600
	Depth at berth	[m]	11.4	11.4	11.4
	UDL load capacity	[kN/m2]	-	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	10	>20	>20

Closing Statement:

Vinh Tan International Port has strong experience in handling project cargo such as onshore wind components, and the port owners are interested to expand their business offering to offshore wind – refer to the Master Plan shown above. Provided funding can be obtained for the development, Vinh Tan International is a strong candidate port for an Offshore wind construction port in the South-Central region.

Table 6-20: Ca Na Port Profile 1 (in development)

Ca Na Port – SOUTH-CENTRAL REGION Private: Trung Nam Group	**Coordinates** 272252.00 m E, 1251720.00 m N



Descriptions:

- Located on the Central-South coastline of Viet Nam.
- The port is currently under development and has been classified as a National general port.
- Phase 1A is complete and Phase will be completed by June 2024.

Key Observations (Refer to Figure):

1. The Phase 1A berth and storage area has been identified as a container terminal and would have been designed as such.
2. Phase 1B berth and storage area seems to be aligned for general cargo; however, there is limited space available for storage.

Positive Attributes

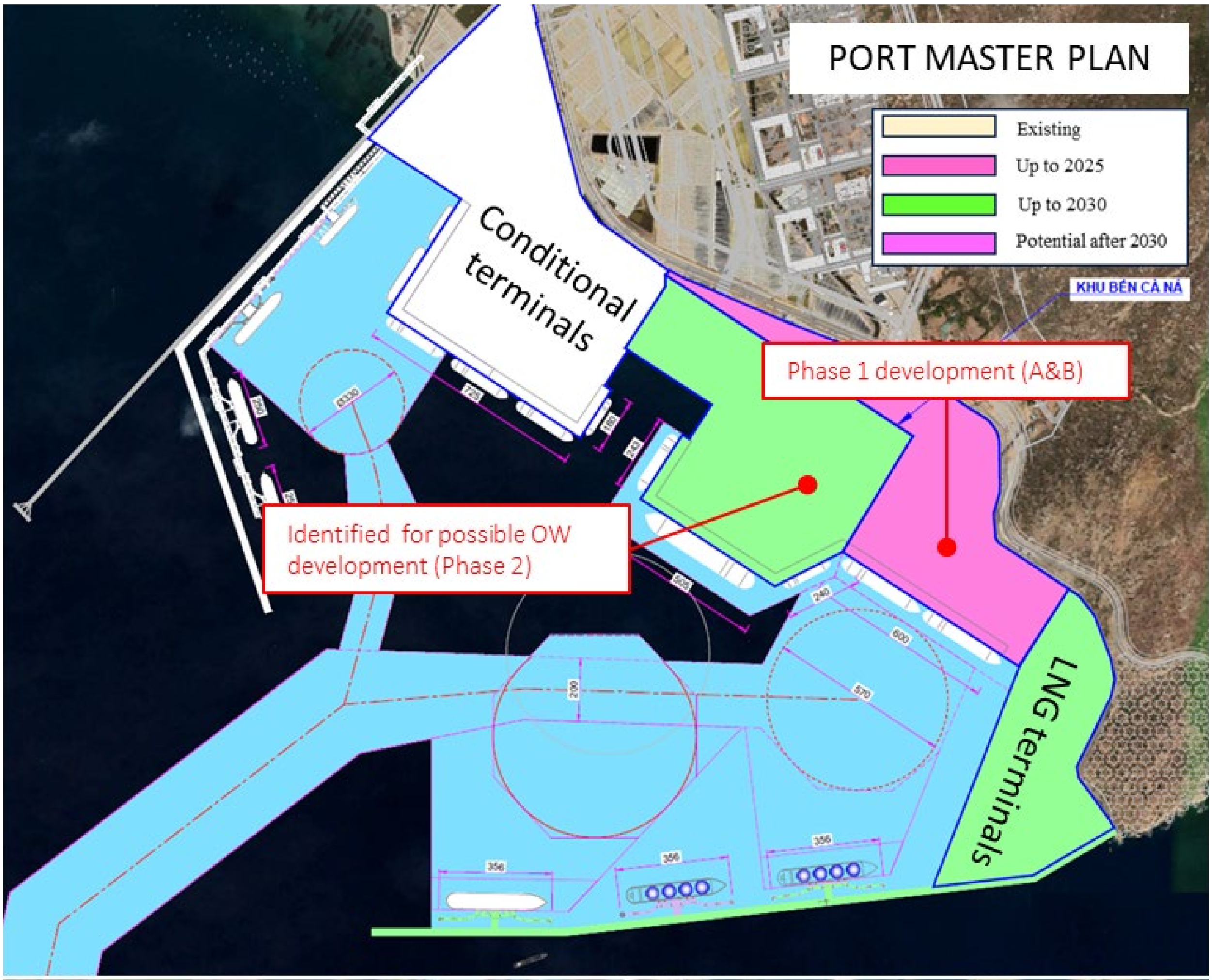
- The new port has received significant backing from the government and will more than likely be developed in line with the timelines as set out in the Master Plan.
- Phase 2 of the development will be able to receive vessels up to 300,000 DWT (refer to Port Master Plan).
- Located in close proximity to the proposed southern fixed Offshore Wind Zones.
- Phase 2 development can possibly be altered to accommodate offshore wind.

Development Risks

- The Ca Na development may require a breakwater to ensure suitable uptime depending on the wave conditions. This has been highlighted in the Master Plan for development by 2030.
- The current design (especially for Phase 1A and 1B) may not be suited for the high load carrying requirements for offshore wind. It will be too late for the developer to account for this during phase 1. Required upgrade works so early in the asset’s life is not feasible.

Table 6-21: Ca Na Port Profile 2 (in development)

Ca Na Port – SOUTH-CENTRAL REGION
Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]	Good location with respect to Offshore Wind Zones central and south		
	Harbour entrance width	[m]	-	>300	>300
	Channel depth	[m]	-	16	16
	Access channel width	[m]	-	200	200
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	-	570	570
Berth & yard	Berth length	[m]	-	600	>1000
	Depth at berth	[m]	-	9.8	-
	UDL load capacity	[kN/m2]	-	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	-	>20	>20

Closing Statement:

Ca Na Port has been classified as a National general port and is seen as a strategic asset for development to promote growth within the region. To date the port has completed phase 1A and is due to complete phase 1B by the end of June 2024. Phase 1 comprises of both a container and general cargo terminal. Therefore, in its current state, the quay and yard infrastructure of Phase 1 would need to be upgraded in order to accommodate offshore wind. This is not feasible at such an early stage of an asset's life. Thus, offshore wind can only be accommodate during the Phase 2 development. It is unclear at this stage if this is something that has been considered in the Port Master Plan; however, Phase 2 does seem to have a large open storage area avaiable. Therefore, to ensure Ca Na Port plays a role in the offshore wind future of Viet Nam, it is of paramount importance to investigate the infrastructure requirements and potential business case for offshore wind prior to the Phase 2 development. At this stage, the development requirements will be too onerous to consider the Ca Na Port for Power Development Plan 8 offshore wind development goals through to 2030 – this port is possibly one for the future.

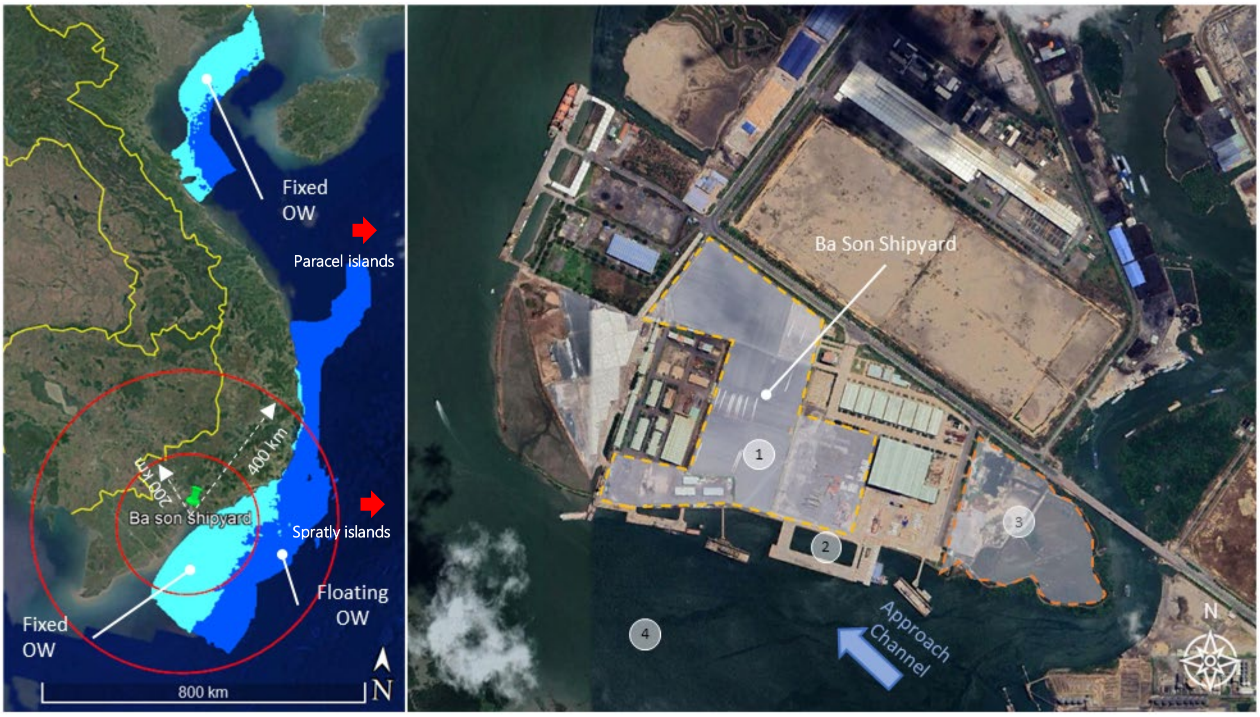
6.5.3 South Region Ports

The results of the developed port profiles and benchmarking exercise is shown in the following tables for the three selected ports.

- Ba Son Shipyard: Table 6-22, Table 6-23
- Long An Port: Table 6-24, Table 6-25
- PTSC Downstream: Table 6-26, Table 6-27
- Cai Mep Downstream Development: Table 6-28, Table 6-29

Table 6-22: Ba Son Shipyard Port Profile 1 (Class 1 seaport, falls under HCMC, General cargo)

Ba Son Shipyard –SOUTH REGION Public: Military	**Coordinates** 721246.27 m E, 1167010.38 m N



Descriptions:

- Located on Viet Nam's Southern coastline along the Thi Vai River.
- The port is publicly owned and has significant experience in the onshore wind power industry which includes fabrication of towers and foundations and installation and O&M activities.
- The port is located upstream of the Thi Vai River and hence sheltered from any adverse wave climate.

Key Observations (Refer to Figure):

1. Existing yard space is spatially constrained; however, the most optimal storage solution for offshore wind components can be detailed during the upgrade design process (>20 ha available).

2. The quay layout does not suit offshore wind and may need to be redesigned which will include reclaiming land behind the quay.

3. Dedicated land which can be further developed according to the Port Master Plan.

4. The approach channel is upstream along the Thi Vai River. There are many other ports within the river which may cause vessel congestion and delays.

Positive Attributes

- The port is in a sheltered location which will have good uptime.
- The port has experience in accommodating onshore wind components and has expressed interest in transferring this skill to offshore wind.
- The port is located in an industrial zone.
- Close proximity to the Southern fixed Offshore Wind Zones.

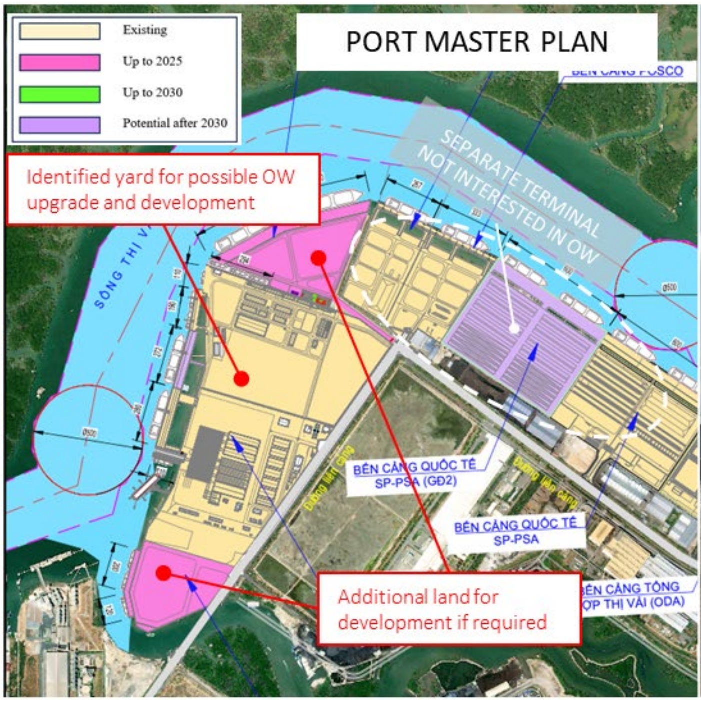
Development Risks

- A dedicated new quay suited for offshore wind will need to be constructed.
- Access to the and from the port is along the Thi Vai River which may lead to significant vessel congestion and delays.
- Spatial constraints within the identified yard area; however, this can be overcome during the detail design.
- Public owner may result in project procurement delays due to increased regulation.

Table 6-23: Ba Son Shipyard Port Profile 2 (Class 1 seaport, falls under HCMC, General cargo)

Ba Son Shipyard –SOUTH REGION

Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

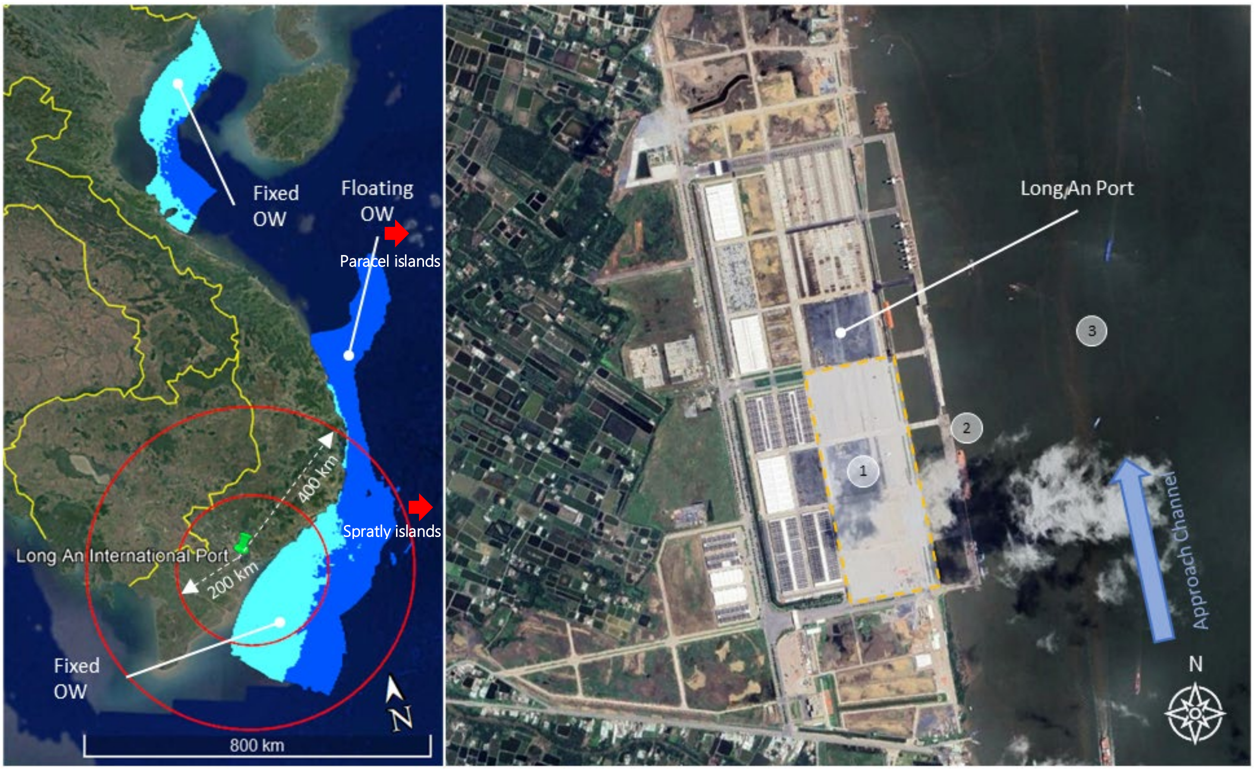
	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]	Good location with respect to Offshore Wind Zone south		
	Harbour entrance width	[m]	N/A	N/A	N/A
	Channel depth	[m]	12	12	12
	Access channel width	[m]	300	300	300
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	>300	>300	>300
Berth & yard	Berth length	[m]	280	792	792
	Depth at berth	[m]	10.5	10.5	10.5
	UDL load capacity	[kN/m2]	-	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	>20	>30	>30

Closing Statement:

Ba Son Port offers an interesting prospect for an offshore wind construction port due to the port's strong history with accommodating onshore wind projects and its desire to transfer these skills to offshore wind and hence create a new business case. Although the storage yard is contrained, this is not a deal breaker as there is suitable available area which can be designed to accommodate offshore wind components. Furthermore, the benchmarking criteria is well aligned with offshore wind minimum requirements. This is a strong candidate for a type 2 solution within the Southern region.

Table 6-24: Long An Port Profile 1 (Class 1 seaport, container terminal)

Long An Port –SOUTH REGION Private: Dong Tam Group	**Coordinates** 690170.45 m E, 1165349.28 m N



Descriptions:

- Located on Viet Nam's Southern coastline along the Soai River.
- The port is privately owned with its main business centred around container traffic. The port does have a multi-purpose terminal which has offloaded onshore wind components in the past.
- The port is located upstream of the Soai River and hence sheltered from any adverse wave climate.

Key Observations (Refer to Figure):

1. Existing yard space within the multi-purpose terminal. There is an opportunity to upgrade the yard to meet offshore wind requirements.

2. The quay layout does not suit offshore wind and will need to be redesigned, which will include reclaiming land behind the quay. Access bridges present both logistical and loading constraints.

3. The water depth of the access channel is a concern. There is however an ongoing dredge campaign of the Soai River to ensure 70,000 DWT vessels can access the river.

Positive Attributes

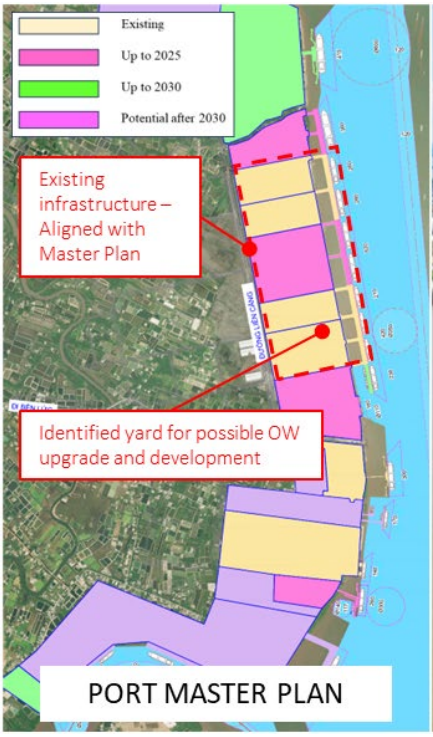
- The port is in a sheltered location which will have good uptime.
- Active port with strong growth prospects – offshore wind could possibly be a strategic business case.
- Large yard area directly behind the multi-purpose quay.
- Close proximity to the Southern fixed Offshore Wind Zones.
- The port does have some experience with handling lighter onshore wind components.

Development Risks

- Navigation constraints are a concern and additional dredging will be required for both the quay and access channel.
- The channel width may also need to be widened as this does not meet minimum requirements as shown in the Master Plan.
- The quays would need to be upgraded to ensure a continuous transition to the yard i.e. no access bridges.

Table 6-25: Long An Port Profile 2 (Class 1 seaport, container terminal)

Long An Port –SOUTH REGION
Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

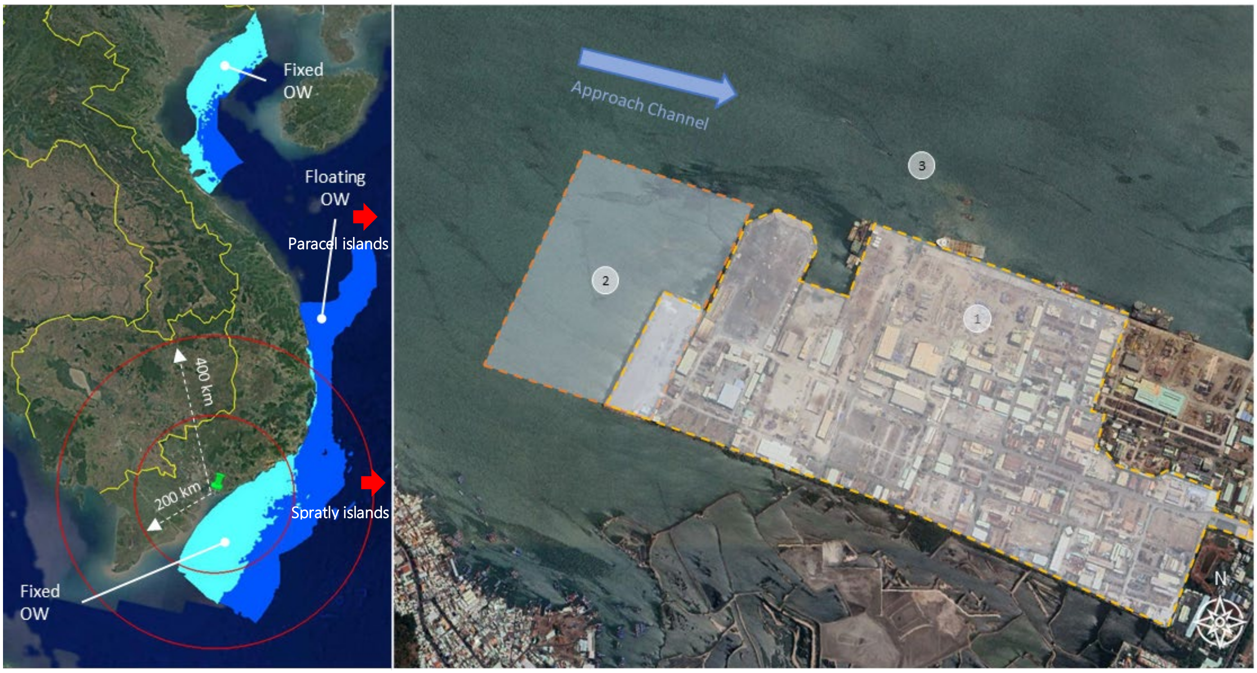
	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]	Good location with respect to Offshore Wind Zone south		
	Harbour entrance width	[m]	N/A	N/A	N/A
	Channel depth	[m]	9	9	9
	Access channel width	[m]	160	160	160
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	>300	>300	>300
Berth & yard	Berth length	[m]	2030	2030	2030
	Depth at berth	[m]	7-9.5	7-9.5	7-9.5
	UDL load capacity	[kN/m2]	-	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	>20	>30	>30

Closing Statement:

Long An Port has the potential to become an offshore wind construction port provided the port owners are keen to include this as a business case in the future. The Multi-purpose terminal has adequate space (> 20 ha) and is located directly behind the quay, providing a free flowing operation. There are however concerns with regards to the access channel and depth requirements. There is currently a dredge campaign ongoing; however, the exact future depth is unknown. This is critical for the WTIVs, who typically have deeper drafts than most conventional transport barges.

Table 6-26: PTSC Downstream Port Profile 1 (Special Class seaport, general cargo)

PTSC Downstream –SOUTH REGION Private: PTSC	**Coordinates** 727865.81m E, 1149451.07m N



Descriptions:

- Located on Viet Nam's Southern coastline and is south of the Thi Vai river (less congested).
- Extensive experience with Oil & Gas industry and fabrication of offshore wind foundations.
- Fabrication capabilities.

Key Observations (Refer to Figure):

1. Potential to use 180 ha in the area shown above however this will disrupt existing operations. Due to existing oil and gas operations, the yard area may have adequate bearing capacity, or only require minor upgrades.
2. Additional greenfield site which could be used if there is no room to accommodate offshore wind in the existing yard.
3. Water depth and channel width are a concern as current values are below minimal requirements.

Positive Attributes

- Active port with strong growth prospects – offshore wind could possibly be a strategic business case.
- Presents sufficient yard area and has plans for expansion to the West.
- Close proximity to the Southern fixed Offshore Wind Zone.
- The port does have experience with fabricating foundations for offshore wind.
- Located downstream of the Thi Vai river which should assist with any vessel congestion in the area.

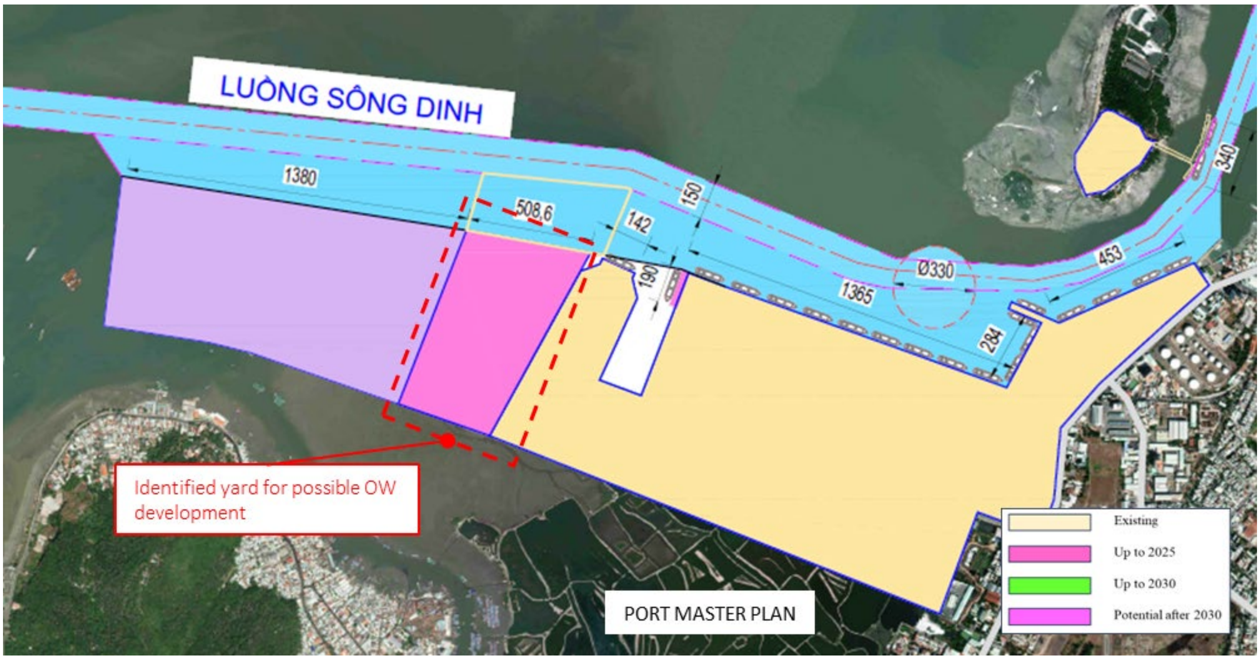
Development Risks

- Navigation constraints are a concern in terms of the width and depth of the navigation channel. Additional dredging will be required.

Table 6-27: PTSC Downstream Port Profile 2 (Special Class seaport, general cargo)

PTSC Downstream –SOUTH REGION

Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

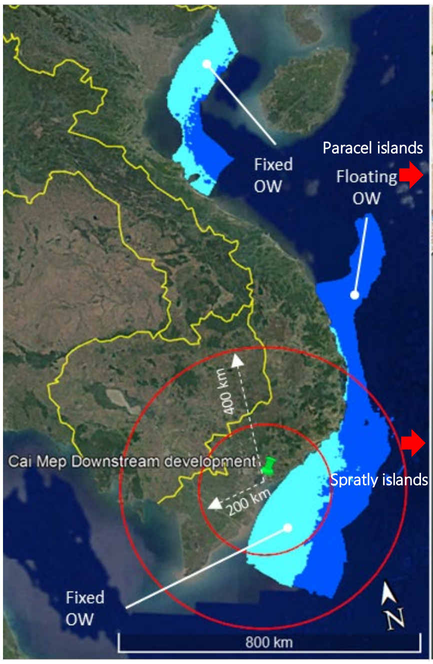
	Property	Unit	Current	2025+	2030+
Location & harbour	Distance to OWF	[km]	Good location with respect to Offshore Wind Zone south		
	Harbour entrance width	[m]	N/A	N/A	N/A
	Channel depth	[m]	7	-	-
	Access channel width	[m]	100	150	150
	Presence of lock/gate	[y/n]	N	N	N
	Vertical clearance	[m]	Unrestricted	Unrestricted	Unrestricted
	Turning circle	[m]	200	>300	>300
Berth & yard	Berth length	[m]	754	Additional 510	Additional 1380
	Depth at berth	[m]	9	-	-
	UDL load capacity	[kN/m2]	60	-	-
	Seabed	[y/n]	-	-	-
	Yard area	[ha]	> 50	> 50	> 50

Closing Statement:

PTSC Downstream is a good candidate in terms of yard area, experience within Oil & Gas and the offshore wind industry (fabrication and storage). Furthermore, the owners are keen to make offshore wind a core component of their business offering in the future and has plans to develop the area to the West (as shown in the figure above) into a dedicated offshore wind Construction terminal. Although the current access channel width and depth is not suitable, the National Seaport Master Plan shows a widened channel (150 m) which will benefit smaller WTIVs.

Table 6-28: Cai Mep Downstream Development Profile 1 (in development)

Cai Mep Downstream Development – SOUTH REGION Ownership unknown – New Development	**Coordinates** 720136.47 m E, 1160029.87 m N



Descriptions:

- Located on Viet Nam's Southern coastline at the mouth of the Thi Vai River (South of Ba Son Shipyard).
- A new proposed development which primarily services the container industry. This however could change as the development is still in the planning phase.

Key Observations (Refer to Figure):

1. The development is dominated by container terminals and is seen as the primary business case.
2. There is allocated available land at the Northern end of the port which could be motivated to be developed as an offshore wind Construction Terminal within the Cai Mep Port.
3. The development is located at the mouth of the Thi Vai River and is thus more exposed to the oncoming wave climate. It is unclear at this stage whether breakwaters would need to be included in the development. This is however a development risk.

Positive Attributes

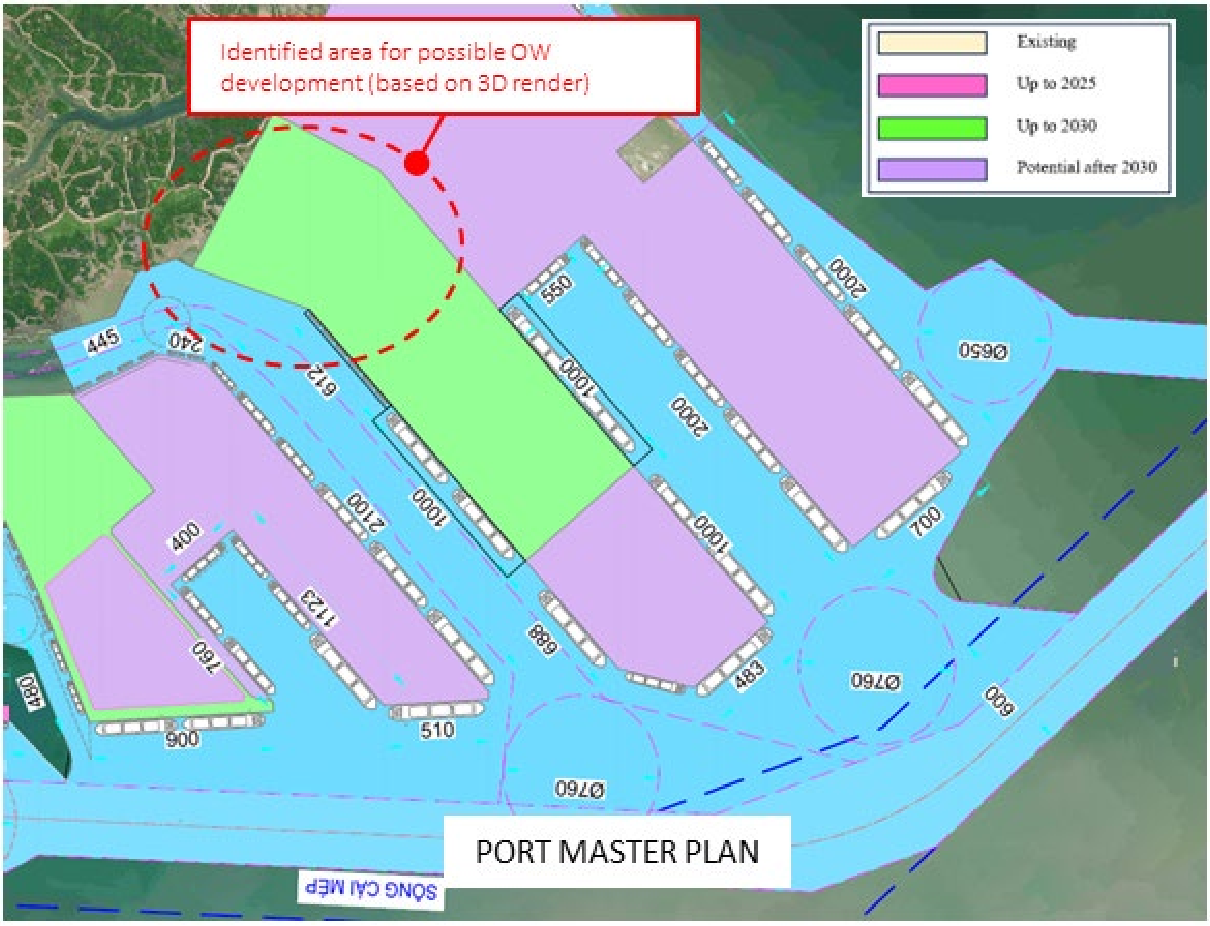
- Large new development where offshore wind could play a significant role during the early phase.
- The proposed site is very close to the Southern fixed Offshore Wind Zone.
- As the development is located at the mouth of the Thi Vai River, vessel congestion should be less of an issue for the Cai Mep development.

Development Risks

- Timelines on the Master Plan suggest that phase 1 of the development only to be completed by 2030. This does not align with Power Development Plan 8 requirements.
- The port is more exposed to the oncoming wave climate and an uptime assessment will be required to confirm no breakwaters are needed.
- Greenfield site outside of existing port boundaries will require suitable permits and consents to progress – these could impose further project delays.

Table 6-29: Cai Mep Downstream Development Profile 2 (in development)

Cai Mep Downstream Development – SOUTH REGION
Port Master Plan and Benchmark



Benchmark (Updated according to Port Master Plan):

No information available at this stage for benchmarking purposes.

Closing Statements:

The Cai Mep Downstream Development is currently still in development; however, there is an opportunity to include an offshore wind construction terminal in the early phases of development (shaded green area in the Master Plan). Although this is only scheduled to be operrational by 2030, provided all environmental permits and consents are obtained, the offshore wind terminal may assist with additional fixed bottom offshore wind sites from 2030 and beyond, and provide the port with a steady revenue stream while the remaing container terminals are developed. Furthermore, the offshore wind terminal can at a later stage be converted back to a container terminal when the demand reduces. There is still uncertainty with uptime due to the relatively exposed site. This should be confirmed early on in the development to limit risk.

6.5.4 Summary of Results

From the observations made in Section 6.5.1 to 6.5.3, five ports were selected for the three identified regions (North, South-Central, and South) which not only showed great promise in terms of meeting typical offshore wind construction port requirements, but also aligned well with softer selection criteria associated with Port Owners development ambitions, Master Plans, surrounding hinterland, and complexity of the port's ownership structure.

Furthermore, the selection process also identified different types of upgrade requirements for the offshore wind construction ports. This will provide the necessary flexibility if additional ports are added to the preferred list in the future as these would have similar development requirements as the ones outlined in the roadmap herein.

Similar to Section 6.3, a coarse screening with traffic light system was used to benchmark the top 11 ports with one another. The focus for this assessment was more on the softer (qualitative) criteria, as each of the ports meet minimum technical offshore wind requirements for possible construction ports.

Table 6-31 shows the coarse scoring criteria used for benchmarking purposes.

Table 6-30 summarises the results of the various port profiles.

Table 6-30: Summary of port profile benchmarking

Port	Region	Ownership Structure	Business Case	Navigation	Master Plan Alignment	Timeline	Development Type (1)
Hai Phong Inter. (2)	North	Unknown	Uncertain	Good navigation	Different use case	Potentially beyond 2030	1
Nghi Son International	North	Single group or Cluster of ports within Nghi Son (3)	Uncertain	Minor constraints	Different use case	Aligned with PDP8 if storage available	3
Vinh Tan Inter.	South-Central	Single group	Interested in OW	Minor constraints	Project cargo / offshore wind alignment	Significant development (breakwater and storage area)	3
Ba Son	South	Ministry of Defence	Interested in OW	Vessel Congestion	Project cargo / offshore wind alignment	Aligned with PDP8	2/3
PTSC Downstream	South	Many operators	Interested in OW	Channel constraints	Project cargo / offshore wind alignment	Aligned with PDP8; however major upgrades suggested.	1
Cua Lo	North	Single group	Interested in OW	Major constraints	Different use case	May require breakwater	1 / 3
Van Ninh	North	Single group	Haven't considered OW	Good navigation	Development not suited for OW	Beyond 2030	1
Chan May	South-Central	Single group	Interested in OW	Minor constraints	Different use case	May require breakwater extension	3
Ca Na	South-Central	Single group	Undecided	Good navigation	Different use case	Beyond 2030	1
Long An	South	Single group	Undecided	Channel constraints	Different use case	Aligned with PDP8	2
Cai Mep	South	Unknown	Undecided	Uptime uncertainty / vessel congestion	Different use case	Beyond 2030	1

(1) Refer to Section 6.5, the development type was not used as a critical scoring metric, but rather to showcase the variety of solutions presented.

(2) Refers to Terminals 9 and 10 – currently no port owner.

(3) Cluster of ports within Nghi Son may be required if there is no storage space available at Nghi Son International Port

Table 6-31: Coarse screening traffic light criteria - step 4

Light code	Ownership	Business Case	Navigation	Master Plan Alignment	Timeline
	Complex JV's with multiple partners and business interests.	Port owners are not interested in offshore wind.	Large uncertainty associated with vessel navigation. (includes updates from Master Plan)	No available land for possible offshore wind development.	Development timelines extend beyond 2030.
	JV with no more than two partners, or many terminal operators	Port owners are neutral / undecided.	Small risks associated with vessel navigation. (includes updates from Master Plan)	Available land for development, however different use case.	To be completed by 2030. (includes provision for a breakwater)
	Single owner or group.	Port owners have expressed a keen interest in offshore wind.	All required navigation metrics achieved. (includes Master Plan)	Green field site identified for development / existing facilities to be upgraded.	Aligned with PDP8 requirements i.e. port ready before 2028.

The following ports have been selected to take forward into the detailed port assessment and road map development. The preferred ports include the following:

- Northern Region 1: Nghi Son International Port
  - Although there may be initial navigation (channel width) and storage yard constraints, Nghi Son International port provides a unique opportunity to upgrade the existing multi-purpose terminal (which already has a heavy-duty storage area) to meet offshore wind requirements. The port is located in a strong industrial area and forms part of a strategic economic zone which should provide funding opportunities. Nghi Son International is one of the very few sheltered deep-water ports in the North. If Nghi Son International Port's storage yard is too constrained, there is an opportunity to use the cluster of ports in the surrounding Nghi Son Economic Zone.
- Northern Region 2: Hai Phong International Port (Terminals 9 and 10)
  - Hai Phong is ideally located to service the Northern offshore wind farms and meets all critical navigation requirements. The port has also been targeted as a strategic port for development within the National Seaport Master Plan which should provide added financial and political support. If terminals 9 & 10 can be dedicated to offshore wind, this presents a strong greenfield site for development. Furthermore, this will provide the port owners with the flexibility of later converting terminals 9 & 10 into a container terminal (aligned with core business) when demand for construction ports in the North subsides. However, based on the site visit undertaken from the 8th to 12th of April (Refer to Section 6), it was understood that rezoning the National Seaport Master Plan to accommodate offshore wind will be challenging for Hai Phong due to the lucrative container business established in that area – this will require significant government support.
- South-Central: Vinh Tan International Port
  - Vinh Tan International Port has experience in handling onshore wind components and the port owners are interested in using this experience to transition to offshore wind. There is a large storage area available for upgrade, and this is directly behind the quay allowing for optimal handling operations for offshore wind components. The port is also located within a region which

has been targeted by government for development. The upgrade works could help stimulate growth in the region together with the development of the adjacent Ca Na Port.

- South Region 1: Ba Son Shipyard
  - Ba Son Shipyard has experience in handling onshore wind components and the port owners are interested to accommodate offshore wind. Furthermore, the port has experience in fabrication and pre-assembly activities – all of which are important enablers for offshore wind construction ports. Although the yard is constrained in terms of the quay infrastructure and positioning of the yard area, the port has the fundamental requirements to be upgraded into an offshore wind construction port. If it is found that if regulation requirements are too onerous for Ba Son Shipyard due to public ownership, then PTSC Downstream is the next best candidate for the South.
- South Region 2: PTSC Downstream
  - Similar to Ba Son Shipyard, PTSC Downstream has experience in handling both onshore and offshore wind components, and the port owners see offshore wind being a core business for them in the future. Existing quay infrastructure is well suited for unloading and loading of offshore wind components, provided adequate yard storage can be obtained. In addition, PTSC Downstream have fabrication and pre-assembly capability. Close attention will need to be observed for the navigation requirements and how this can be implemented into the Ports Master Plan – an opportunity if the greenfield site to the West is used.

7 ANALYSIS OF CONSTRUCTION PORTS

7.1 Introduction

From the results obtained in Section 6, five ports have been identified as best candidates to service offshore wind projects along Viet Nam's coastline. This section will expand on these findings and provide a more detailed account of the various development opportunities available to the ports, as well as identify any potential development risks for further investigation, based on additional documentation received from the various Port Owners and information acquired during the site visit undertaken from the 9th – 12th of April 2024.

For each candidate port, available berths were checked for capability to serve offshore wind construction. Where relevant, conceptual plans have been prepared with an assessment of costs and schedule to complete suggested improvements to align with minimum offshore wind construction port requirements, as well as Power Development Plan 8 development timelines.

The cost information provided herein is based on industry standard practice for cost estimating and falls between Concept Screening level (Class 5) and Study/Feasibility level (Class 4) as defined by AACE International. This gives an accuracy range of ±50%.

7.2 Site Visit

A site visit was undertaken from the 9th – 12th of April, where four out of the five candidate ports were viewed. In addition, meetings were held with key stakeholders. The objective was to confirm the validity of the port profiles developed in Section 5, gain additional information on the existing port infrastructure, and obtain a better understanding of the ports current business model and whether offshore wind could be accommodated within the port's future development plans. Table 7-1 summarises the various meetings held during the site visit.

Table 7-1: Site Visit Itinerary

No.	Meeting With	Region	Date
1	PTSC Downstream	South	Tuesday, 9th of April 2024
2	Ba Son Shipyard	South	Tuesday, 9th of April 2024
3	Vinh Tan International Port	South-Central	Wednesday, 10th of April 2024
4	Copenhagen Infrastructure Partners	North	Thursday, 11th of April 2024
5	Lach Huyen International Gateway Port	North	Thursday, 11th of April 2024
6	Vinamarine (Port Authority)	North	Friday, 12th of April 2024

Nghi Son International Port did not form part of the site visit; however, a virtual call was arranged with the port on the 10th of May 2024, where various clarifications and questions were answered.

The site visit provided valuable information on current operations and provided the opportunity for the port owners to present their future development ambitions. This information, together with existing data collected during the initial port screening process (Section 5) was then used to further assess and develop potential road maps for offshore wind construction ports in Viet Nam.

It should be noted that clarifications during the site visit changed the benchmarking properties significantly for some of the ports – this included navigation, quay, available storage area properties, as well as market appetite for offshore wind. These changes were brought into the analysis of the 5 candidates for offshore wind construction ports; however, knowing this earlier may have changed the selection outlined in Section 5. It is therefore recommended that the top 31 ports identified in Step 2 of site screening exercise be reviewed once there is further clarity on offshore wind development in Viet Nam – this review was out of scope for this study.

7.3 PTSC Downstream

7.3.1 Port Overview

PTSC Downstream is located in the bay of Vinh Ganh Rai in Vung Tau along Viet Nam's Southern coastline. The port is naturally sheltered from any oncoming waves and is the first port along the access channel which leads into the Dinh River. PTSC Downstream traditionally services the oil and gas industry and is the largest logistics and fabrication hub within the area with a total yard area of 180 ha – which includes the following key terminal operators, all housed under PTSC Downstream.

- PTSC Supply Base – 82 ha
- PV Shipyard – 40 ha
- PVC-MS – 23 ha
- PVSB – 35 ha (future development area)

Figure 7-1 shows the location of PTSC Downstream and where the various terminals are situated within the port.

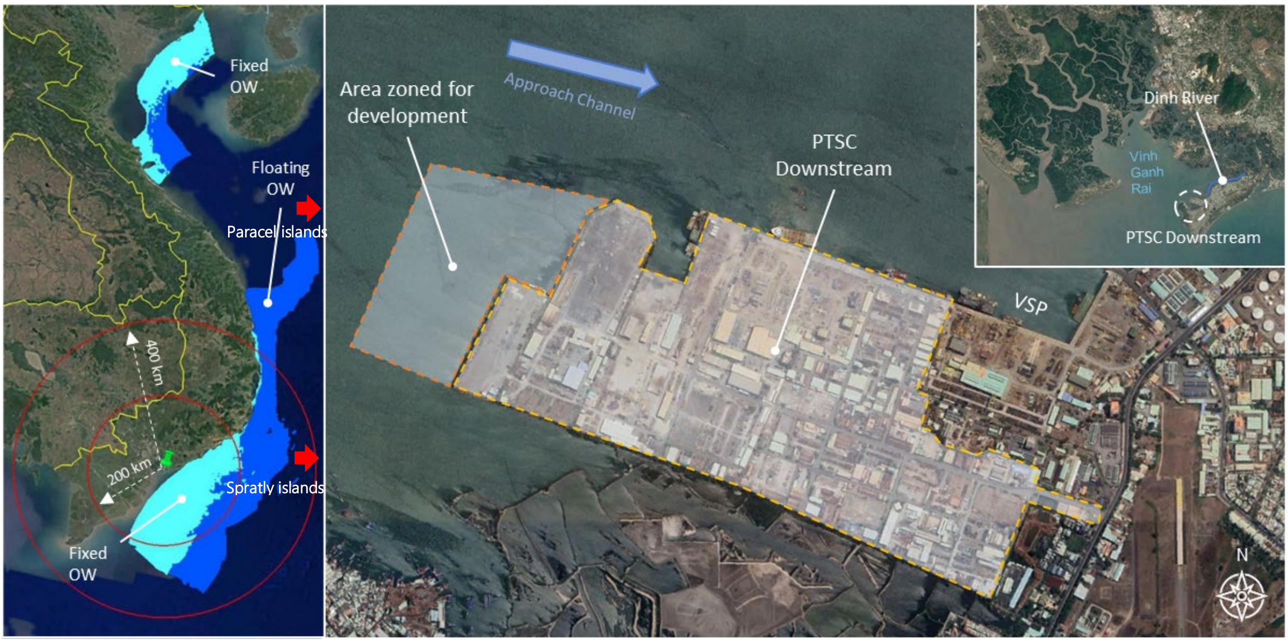


Figure 7-1: Location of PTSC Downstream

Although PTSC traditionally services the oil and case industry, there have been several recent offshore wind projects and initiatives which the port has actively contributed to. The most notable projects include the following and are shown in Figure 7-2:

- Great Changhua 2B&4 – Taiwan (fabrication and loadout of 33 jacket foundations)
- Hai Long 2&3 – Taiwan (fabrication and loadout of offshore wind substations)

Figure 7-2: PTSC Downstream offshore wind Projects

As such, PTSC Downstream view offshore wind as a key future business area and are continually upgrading their facilities to accommodate the various offshore wind foundation fabrication and storage requirements. Further details of their development plans are provided in Sections 7.3.3.

7.3.2 Existing Port Facilities

<u>PTSC Supply Base</u>

The PTSC supply base (82 ha) is where majority of the existing oil and gas, and current offshore wind projects are executed from. The area is representative of a long jetty, with a storage yard capable of resisting high bearing loads. In addition, PTSC have recently invested in new covered warehouses where environmental sensitive pre-assembly activities are undertaken, which include the application of protective paint systems on steel components. Figure 7-3 shows the extent of the PTSC Supply Base.

Figure 7-3: PTSC Supply Base - Vung Tau

Key properties for the jetty and storage yard include the following:

- Jetty:
  - Length and width: 750 x 30 m
  - Available Depth: 9.0 m CD
  - Bearing Capacity: 50 t/m² (capable to load out 20,000 t structure)
  - Skidways available: 10 000, 20 000 and 25 000 t
- Yard Facilities
  - Storage yard: 31.5 ha
  - Fabrication yard: 20 ha
  - Covered warehouse: 7 ha
  - Workshop complex: 2.5 ha
  - Anti-corrosion workshop: 2.2 ha
  - Storage yard bearing capacity: 20-30 t/m²

PV Shipyard and PVS-MC

Figure 7-4 shows the extent of PV Shipyard and PVS-MC.

Figure 7-4: PV Shipyard and PVC-MS

PV Shipyard and PVS-MC is a provider of new construction and repair services for the oil and gas and renewable energy industries. The area borders the PTSC Supply Base and falls under the PTSC Downstream service offering. Activities and storage space requirements are often shared between PV Shipyard, PVS-MC and PTSC Supply Base to maximise logistics within the port.

PVSB

The PVSB site has been selected for future development with the core objective to service the offshore wind industry. Refer to section 7.3.3 for further details. The available yard area for development totals 35 ha.

7.3.3 Port Master Plan

PTSC Downstream has become a market leader in the oil and gas industry for servicing and fabricating various offshore assets. They have a strong pipeline of projects and are looking to further enhance their offering by incorporating various pre-assembly functions – most recent inclusion are the anti-corrosion warehouses where protective paint systems are applied. Although this will continue to be a core revenue stream for PTSC, they have ambitions of developing their offshore wind capability to further diversify their offering and future-proof the business.

As such PTSC Downstream have included a greenfield site for development within their Port Master Plan. Figure 7-5 shows the identified zone (PVSB) and the extent of the development.

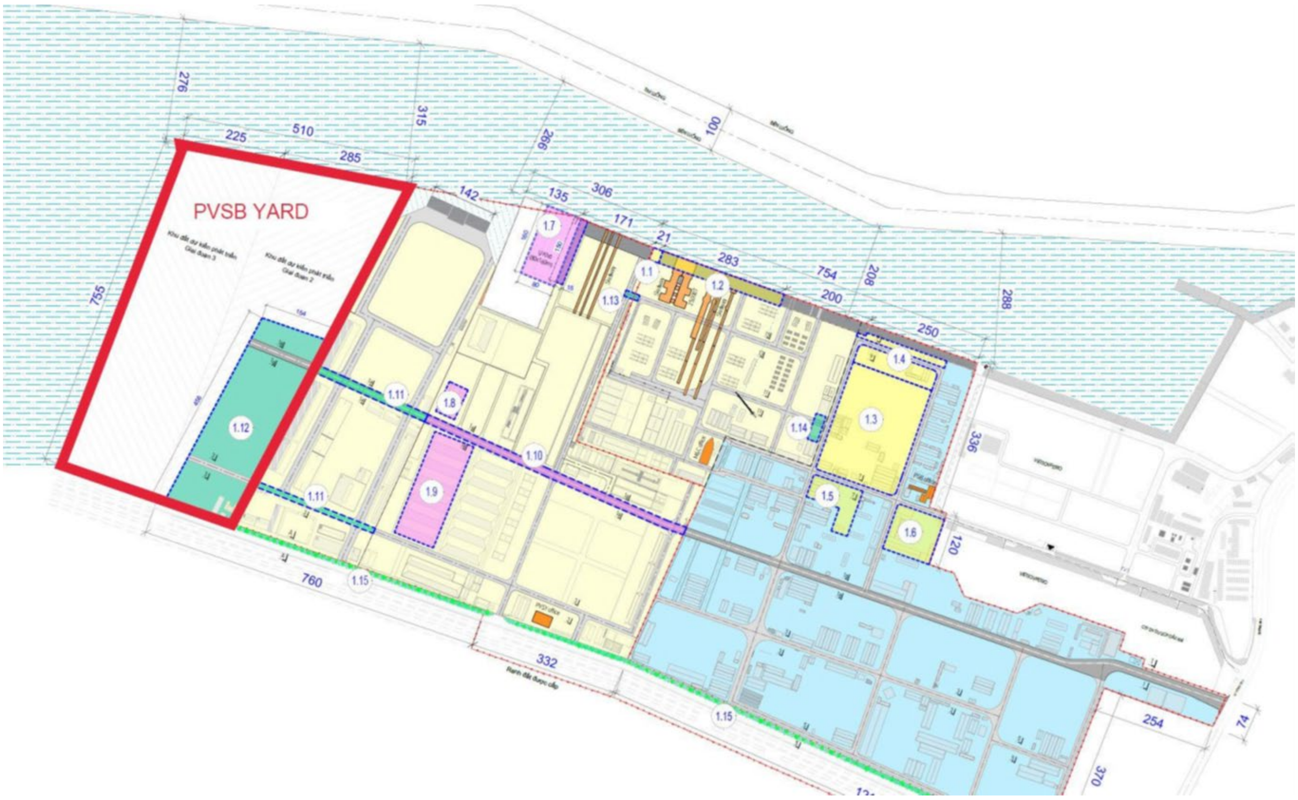


Figure 7-5: PTSC Downstream Port Master Plan

The PVSB yard will be primarily used to service the offshore wind industry by creating a dedicated storage zone and two additional heavy-duty load-quays (total length of 510 m). This will ensure adequate infrastructure to meet offshore wind construction port requirements, as well as allow for the continued operation of the oil and gas business within the existing PTSC Supply Base area.

PTSC have secured funding for the development of this greenfield site and are progressing with the land reclamation which should be completed by the end of 2024, with the PVSB terminal potentially coming online by the end of 2025. This will be a major boost for Power Development Plan 8's plan of installing 3 GW of offshore wind energy in the South and South-Central regions.

In addition to constructing the new PSVB terminal, the National Sea Port Masterplan have indicated a widening of the access channel from 100 m to 150 m.

7.3.4 Port Gap Analysis

Table 7-2 summarises key functional requirements which have been used to assess the applicability of PTSC Downstream's existing port infrastructure with typical offshore wind construction port requirements.

Table 7-2: Gap Analysis - PTSC Downstream

Property	Unit	Existing	Benchmark	Comment
Distance to OWF	km	< 200	200	Ideally located for southern OWFs
Channel Depth	LAT	7	> 9	Below benchmark, will need mitigation measures.
Access channel width	m	100	200	Below benchmark, will need mitigation measures.
Turning circle	m	200	240	Below benchmark, will need mitigation measures.
Berth length	m	754	200	
Depth at berth	m LAT	9	8	
Bearing capacity (quay)	t/m²	6	7.5-15	50 t/m² at designated locations along the quay.
Bearing capacity (yard)	t/m²	20-30	20	
Seabed strengthening	-	No	Required	Will require seabed strengthening for jack-up legs.
Yard area	Ha	> 100	20-25	Adequate yard storage space between Supply Base, PV Shipyard and PVS-MC.

Navigation:

The results from Table 7-2 show that although PTSC's existing infrastructure is well suited for offshore wind, there are concerns around navigation, specifically the access channel width and depth. The benchmark is set for 200 m, and is primarily dependent on several factors, the more notable include:

- Type of WTIV calling upon the terminal; and
- Above water level obstructions which could result in collision risks with the offshore wind turbine blades during transportation.

Therefore, as PTSC Downstream has no above water obstructions on the opposite side of the channel, the benchmarked channel width could be reduced from the stated 200 m. This would however need to be approved by the WTIV owner and port authority. Figure 7-6 shows the extent of the access channel.

Figure 7-6: Existing access channel (Navionics, 2024)

In addition to the above water obstructions, the access channel width must maintain an adequate width along the dredged seabed which comprises of two distinct zones, measured as a multiple of the beam (B) of the design vessel i.e. WTIV.

- Ship manoeuvring lane (factor of 1.6 to 2.0 times B); and
- Bank clearance lane (factor of 1.0 to 2.0 times B)

Figure 7-7 shows the extent of the channel width for a single lane access channel, together with the appropriate width in accordance with (Thoresen, 2014) provided the Beam of the vessel is 50.0 m (typical of a WTIV).

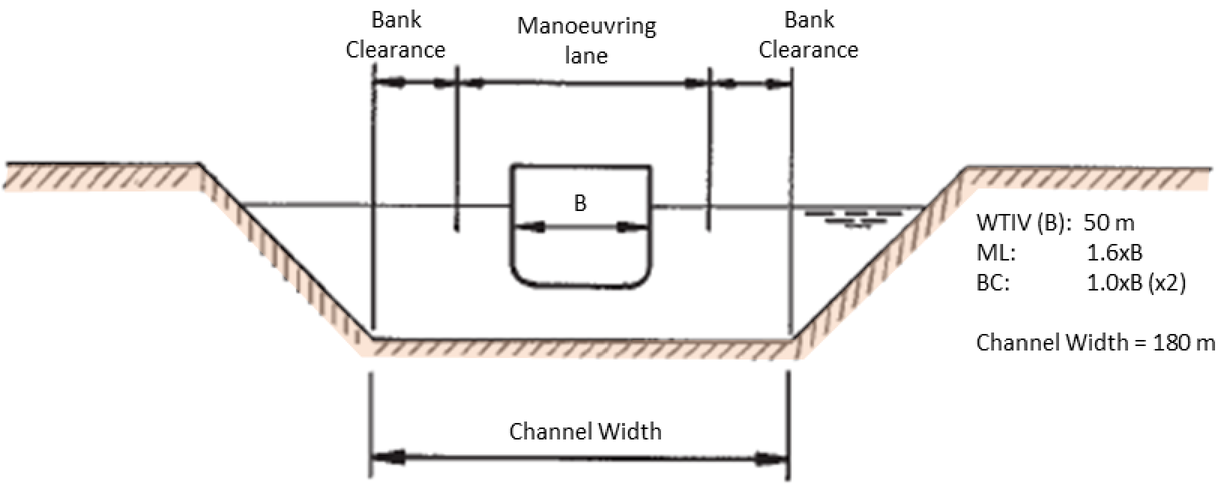


Figure 7-7: Access channel width requirements (Thoresen, 2014).

Therefore, based on (Thoresen, 2014), it is recommended to have an access channel width of approximately 180 m, which is 30 m wider than the proposed dredge width in the National Seaport Master Plan. This, however, could be challenged, i.e. maintain the proposed 150 m channel width as per the National Seaport Master Plan, if suitable navigation studies support this.

Another navigation concern is the depth of the access channel. This will be a significant limiting factor for the type of WTIV which will call upon the construction port – especially if unrestricted access is to be offered to developers, i.e. not relying on the tides when approaching/leaving the port. Based on the existing channel depth, only a handful of WTIVs will be able to call upon PTSC Downstream. This will not only limit possible future WTG sizes which can be accommodated at the port, but also impose a risk of not securing the vessel for installation works due to limited market supply.

Figure 7-8 shows the typical WTIV which will need to be used at PTSC Downstream with the existing channel depths.

<u>Wind Turbine Installation Vessel</u>

- Name: Orca
- Owner: Cadeler
- Length: 161.3 m
- Breadth: 49.0 m
- Draft (max): 6.0 m
- Deck load: 15 t/m²

Figure 7-8: Typical Wind Turbine Installation (WTIV) - PTSC Downstream

<u>Quay Infrastructure:</u>

PTSC Downstream has significant quay and storage yard capacity for traditional oil and gas operations, which include dedicated high-load skid ways that can accommodate weights of up to 25,000 t and a quay bearing capacity of up to 6 t/m². The bearing capacity of the quay falls short of the 7.5 t/m² minimum benchmark requirement typical for 15 MW turbines. These requirements are largely driven by the sizes of the monopile foundations. An alternative would be to use the strengthened sections of the quay where the skid ways are located to unload/loadout the monopile foundations; however, this will limit operability, slow loadout times and impact existing operations of the oil and gas business.

Therefore, PTSC Downstream would need to either upgrade the existing quay or develop an entirely new quay which will serve the offshore wind industry. Although the latter option will require significant more investment, the port has already secured financing and have started development of the identified PSVB terminal.

7.3.5 Offshore Wind Concept and Upgrade Requirements

From discussions with PTSC Downstream, it is clear that offshore wind will form a key component of the port's future operations and expansion plans. The port is already servicing offshore wind projects and they have ambitions to become the offshore wind hub in the South of Viet Nam. As such, PTSC have developed a Port Master Plan which includes a dedicated offshore wind terminal (PSVB Terminal) for storing and fabricating offshore wind components. The required land reclamation has already commenced and is planned to be completed by the end of 2024.

Figure 7-9 shows a concept of how this 35 ha terminal may look when developed.

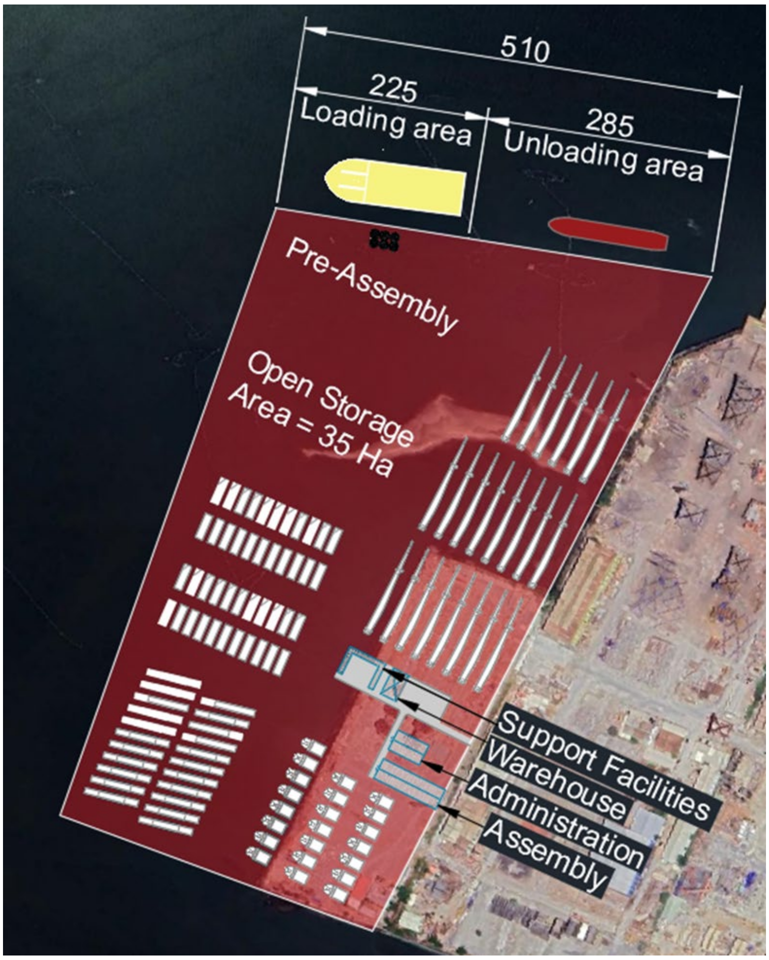


Figure 7-9: PTSC Downstream offshore wind construction port Concept (blades stacked 3-high)

The terminal has adequate space to ensure an appropriate amount of offshore wind components can be stored prior to construction of the offshore wind farm. This will assist with limiting WTIV wait times by creating enough float within the programme for unloading and loading activities. In addition, there are two dedicated berths which can be used to unload and loadout offshore wind components simultaneously. Figure 7-9 represents the offshore wind components required for a 1 GW offshore wind farm. Note that the foundations will be typically installed in a separate campaign and thus are not shown. PTSC Downstream can however be used for staging of foundations, if required.

The offshore wind terminal as shown in Figure 7-9 will have the following key properties:

- Berth water depth: -9 m LAT
- Total storage area: 35 ha
- Quay length and width: 510 x 30 m
- Quay bearing capacity: 9 t/m²
- Yard bearing capacity: 50 t/m²

To further future proof the site for offshore wind, it is important that the concerns raised over the access channel in Section 7.3.4 are addressed. The required upgrades include the following:

- Increase the width of the navigation channel in two distinct phases:
  - Increase to 150 m as per the National Seaport Master Plan (Phase 1).
  - Further increase the channel width to the recommended minimum value of 200 m as described in Table 6-1. This should however be supported by navigation studies.
- Increase the depth of the navigation channel to the minimum benchmark requirement of 9 m LAT.
- Greenfield terminal for offshore wind which include the following:
  - Land reclamation of 29 ha and associated soil improvement.
  - Scour protection.
  - Quay construction (includes a suspended deck, revetment and seabed strengthening for jack-up legs). In addition, the deck will be constructed with foundations for pre-assembly tower packs – the black square shown along the quay. This area requires higher loads than stated in the benchmark criteria and are difficult to retrofit at a later stage.
  - Associated quay furniture, buildings, and electrical requirements (lighting, substation, etc.).

7.3.6 Indicative Construction Cost and Timeline

Based on the proposed new offshore wind terminal and upgrade requirements of the access channel, an indicative construction cost and development timeline have been prepared.

The cost estimate has been developed using COWI's internal project data base and should be used merely as a guide for further investigation and development. Table 7-3 shows the cost estimate for PTSC Downstream.

Table 7-3: Indicative cost estimate - PTSC Downstream

No.	Construction	Cost (m USD)
1	Dredging (access channel and berth pocket) (1)	46.0
2	Scour protection, revetment and land reclamation (2)	42.3
3	Soil improvement	21.8
4	Quay construction	30.2
5	Quay furniture	1.2
6	Lighting and electrical works	4.8
7	Buildings, parking and fencing	3.5
8	Mob and demob (8%)	12.0
	TOTAL	**161.8**

(1) Access channel = 150 m wide; berth pocket = -9m LAT

(2) Includes provision for seabed strengthening along the length of the quay

From the construction items highlighted in Table 7-3 a high-level timeline has been developed for major works which form the critical path – refer to Figure 7-10.

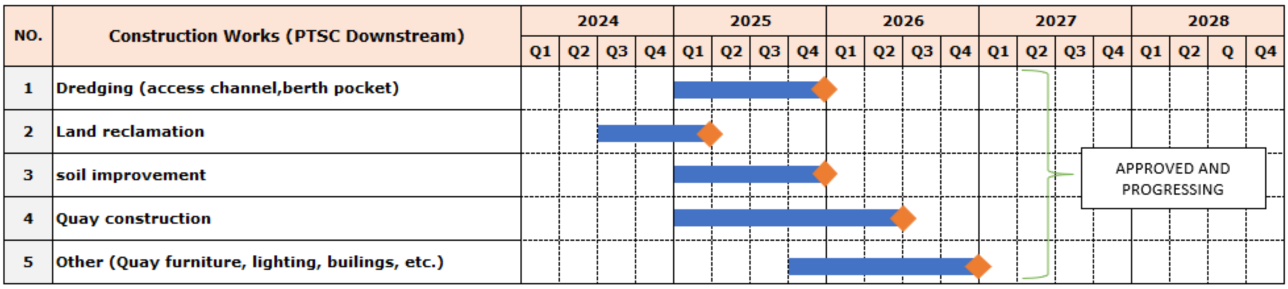


Figure 7-10: Indicative construction timeline

7.3.7 SWOT Analysis and Conclusion

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis has been prepared in Table 7-4 which highlights key observations made for PTSC Downstream and their potential role as a future offshore wind construction port.

Table 7-4: SWOT Analysis - PTSC Downstream

STRENGTHS	OPPORTUNITIES
› Port owners see offshore wind as a core future business case for the port. › Extensive experience in fabricating and handling project cargo – more recently OW. › Large existing port area capable of supporting the offshore wind industry.	› Large Greenfield site available for the development of a dedicated offshore wind terminal. › Offshore wind hub for the southern region of Viet Nam. › Established player in the global offshore wind market.
WEAKNESSES	**THREATS**
› Current navigation properties (channel width and depth) do not meet minimum offshore wind requirements. › Large capital outlay required to develop the offshore wind terminal with limited domestic demand. PTSC will need to rely on external markets and possible oil and gas contracts to fund the development.	› Limited availability of WTIVs capable of accessing the port based on the current access channel properties. › Dredging of the access channel will require national authorisation from Vinamarine and public funding.

PTSC Downstream has significant experience in fabricating and handling large project cargo from their existing oil and gas business and are slowly transitioning to the offshore wind space – this is evident with their current offshore wind projects. To facilitate this transition, PTSC Downstream have identified a large greenfield site adjacent to their port for the development of an offshore wind terminal. This has been included in their Master Plan, with land reclamation works already under way and scheduled to be completed by the end of 2024. Once the terminal is completed, PTSC Downstream will be a significant player within the offshore wind industry not only locally, but on the global market as well. There are however significant navigation constraints, which will not only limit possible future WTG sizes which can be accommodated at the port, but also impose a risk of not securing the vessel for installation works. This is due to limited market supply of the smaller-size vessels that can call at PTSC port and install 15MW turbines. Therefore, further upgrades beyond what is included in the National Seaport Master Plan will be required to future proof the terminal for the ever-increasing WTG sizes and hence the WTIV required to install these offshore.
Key Takeaway:

› Dedicated port in the South for staging offshore wind components (blades, nacelles and towers).

› The port may also be used to stage foundations; however, it is anticipated that using Ba Son Shipyard further upstream will be more economical – refer to Section 7.4.

› Expected port readiness for Power Development Plan 8: start of 2027.

7.4 Ba Son Shipyard

7.4.1 Port Overview

Ba Son Shipyard is located upstream of the bay of Vinh Ganh Rai in the Thi Vai River. The port is naturally sheltered from any oncoming waves and is one of many ports located within the area. Ba Son Shipyard is a general project cargo and ship manufacturing port with ambitions of playing a more active role within the offshore wind market. Current core capabilities include the following:

- Shipbuilding, repair, and conversion.
- Module fabrication of heavy steel structures for the oil and gas industry, as well as foundations for the offshore wind industry (suction bucket).
- General steel manufacturing.

Figure 7-11 shows the location of Ba Son Shipyard and the extent of the port's facilities.

Figure 7-11: Location of Ba Son Shipyard

Recent heavy fabrication and loadout projects have involved not only oil and gas structures, but various components related to offshore wind projects. Interestingly, Ba Son Shipyard has worked with PTSC Downstream to assist with some of their workload, creating a local supply chain within the southern region of Viet Nam. Recent projects of interest include the following and are shown in Figure 7-12.

- SHWE – Myanmar (Skirt pile fabrication, loadout, and transportation, 2022, Customer: PTSC MC)
- Gallaf 3 – Qatar (Subsea template, fabrication and loadout, 2022-2023, Customer: PTSC MC)
- Changhua offshore wind farm – Taiwan (Suction bucket, TP can and jacket segment, 2023-2024, Customer: PTSC Corporation)

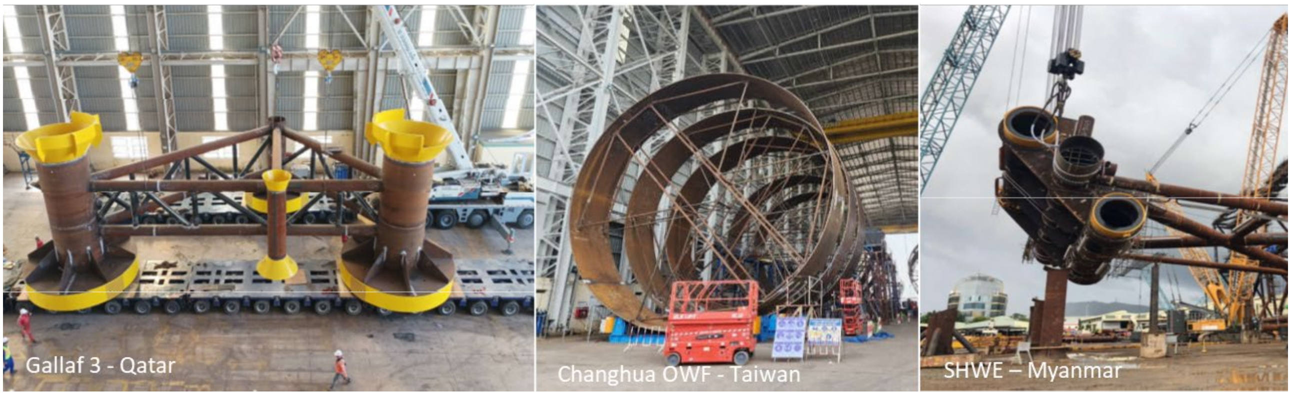


Figure 7-12: Ba Son Shipyard heavy cargo and offshore wind projects

7.4.2 Existing Port Facilities

Ba Son Shipyard has two distinct core businesses within the port. These include the shipbuilding business to the East and steel fabrication to the West (piles, jacket, suction buckets, etc.). The existing storage yard which is in the centre of the port is approximately 30 ha and primarily services loadout of heavy project cargo. In terms of marine infrastructure, Jetty 2 is used as the primary unloading/loadout jetty for the port and is accessed through a heavy-duty access bridge which is 40 m wide. Although the current orientation of Jetty 2 is not ideal for unloading of offshore wind components, Ba Son Shipyard have managed to make this work for the previous projects noted in Section 7.4.1.

Figure 7-13 shows the extent of the various facilities within Ba Son Shipyard.

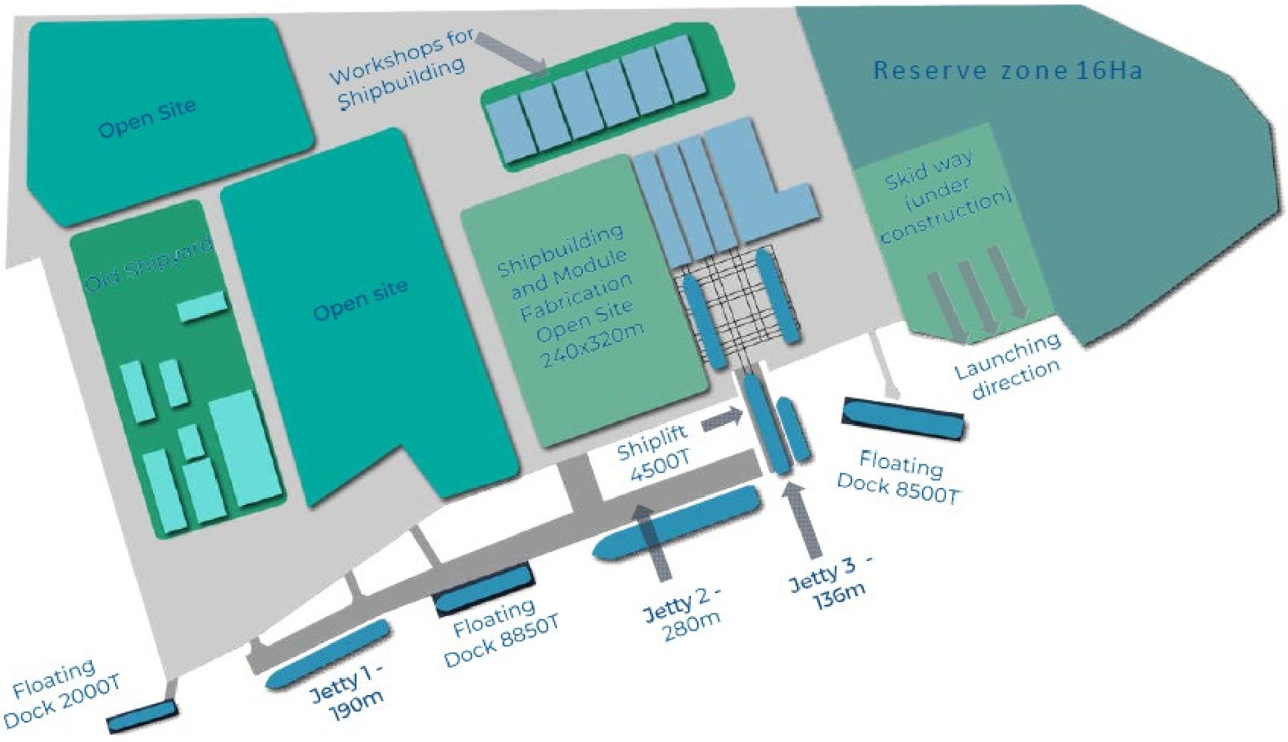


Figure 7-13: Existing port facilities of Ba Son Shipyard (Source: Ba Son Shipyard, 2024)

Key properties for the jetty and storage yard include the following:

- Jetty 2:
  - Length and width: 280 x 40 m
  - Available Depth: 10.5 m CD
  - Bearing Capacity: 15 t/m² (40x40 m area), thereafter 4 t/m²
  - Available skid ways: 4x 30t/m² along the access bridge
- Yard Facilities
  - Storage yard: 30.0 ha
  - Fabrication yards: 25.0 ha
  - Additional storage: 16.0 ha
  - Workshop complex: 2.5 ha
  - Anti-corrosion workshop: 2.2 ha
  - Storage yard bearing capacity: 30 t/m²

7.4.3 Port Master Plan

Ba Son Shipyard have significant plans to develop their fabrication capability to align with monopile foundation requirements of 15 MW+ WTGs. This will further solidify their already strong business relationship with PTSC Downstream in assisting them with various offshore wind projects in the South-East Asia markets, and possibly even Europe. Rather than an outright construction port where various components are stored and pre-assembled, Ba Son Shipyard would like to evolve into the fabrication port of choice for monopile foundations for offshore wind farms.

As such, Ba Son Shipyard have already undertaken concept and preliminary engineering on the new fabrication yard and hope to bring this online within the next couple of years with a monopile fabrication capability of 16 m diameter x 210 mm plate thickness. Figure 7-14 shows a high-level graphic of the planned storage yard for Ba Son Shipyard. The items marked in red are planned for future development. Notably there is an additional U-shaped berth which has been included for the loading and load-out of heavy project cargo which ties into the temporary proposed solution presented in Section 7.4.4 and 7.4.5.

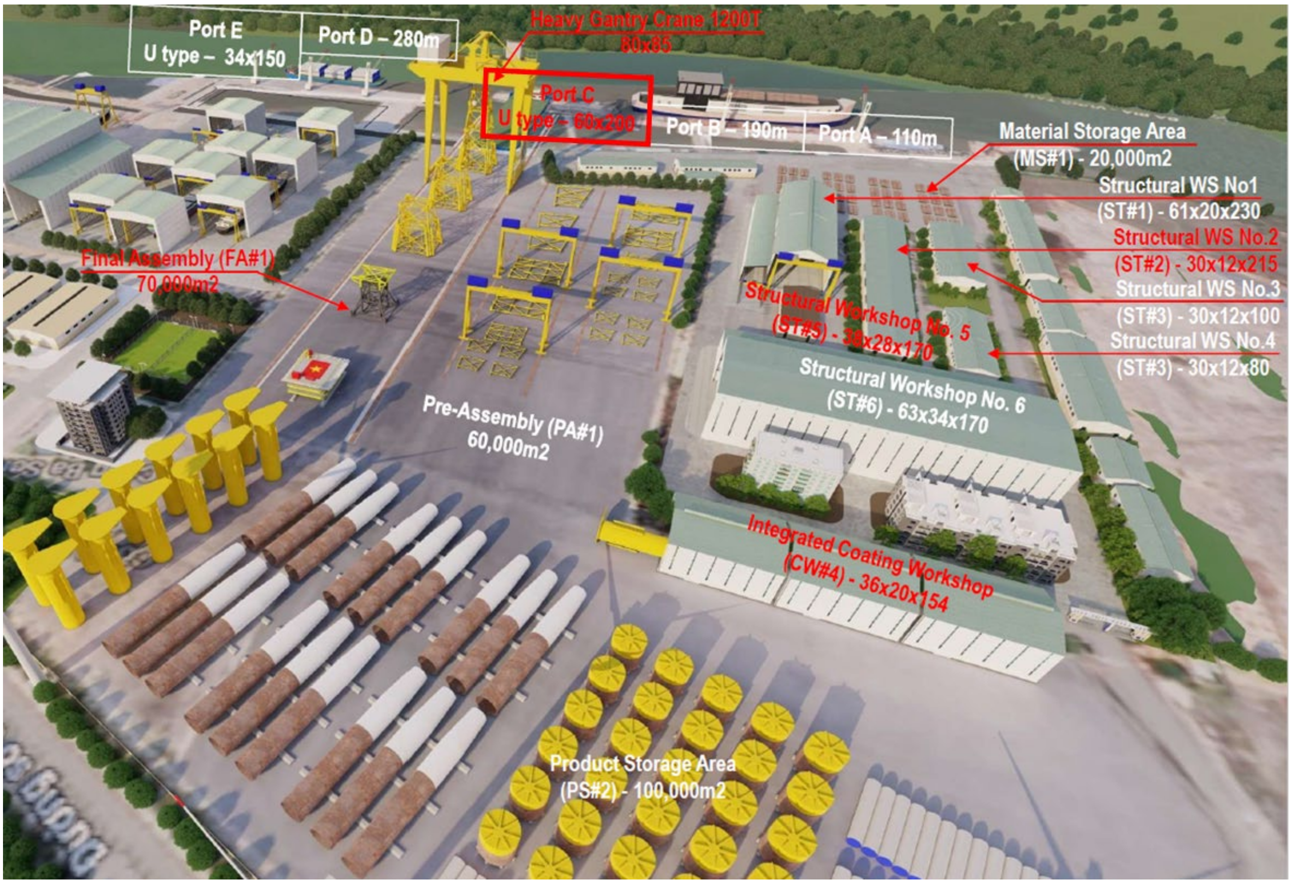


Figure 7-14: Graphic showing the proposed Port Master Plan - Ba Son Shipyard (Source: Ba Son Shipyard, 2024)

In addition to the new fabrication facilities, Ba Son Shipyard have already started to develop additional storage space to the East of the port, where this will primarily be used for offshore wind and large oil and gas project cargo. Funding has been received for this work and is ongoing.

The shipbuilding business will continue to be a core component of Ba Son Shipyard's growth plans with the goal of using and upgrading their floating dock and skid ways to assist with floating offshore wind once this market reaches maturity.

7.4.4 Port Gap Analysis

Table 7-5 summarises key functional requirements which have been used to assess the applicability of Ba Son Shipyard's existing port infrastructure with typical offshore wind construction port requirements.

Table 7-5: Gap Analysis – Ba Son Shipyard

Property	Unit	Existing	Benchmark	Comment
Distance to OWF	km	< 200	200	Ideally located for southern OWFs
Channel Depth	m LAT	12	> 9	-
Access channel width	m	300	200	100 m vessel beam limit on the berth
Turning circle	m	500	240	-
Berth length	m	280	200	-
Depth at berth	m LAT	10.5	8	-
Bearing capacity (quay)	t/m²	4	7.5-15	15 t/m² in a 40x40 m block on the Western end of the quay.
Bearing capacity (yard)	t/m²	30	20	meets requirements
Seabed strengthening	-	No	Required	Will require seabed strengthening for jack-up legs.
Yard area	Ha	30	20-25	Adequate yard storage space.

Navigation:

The navigation conditions and properties for Ba Son Shipyard are well aligned with the requirements for offshore wind and should not impose any limitations on the type and size of WTIV which can call upon the port. It was however noted that due to the limited berth length of 280 m (Jetty 2), it may be required to double stack the berth to assist with loadout activities, typically foundations. This is manageable provided the total Beam (B) of the two vessels does not exceed 100 m. This is to ensure loadout activities do not encroach on the access channel which is used by many other ports within the area. If this cannot be avoided, the whole channel will need to be closed for Ba Son Shipyard. Figure 7-15 shows this loadout arrangement and the buffer zone that must be maintained to the access channel. This is however seen as an unlikely and extreme case for loadout operations.

Another consideration, due to the single lane access channel along the Thi Vai River, are possible wait times. Ba Son Shipyard is situated along a popular river with many other operational ports. Therefore, access to and from Ba Son Shipyard will need to be carefully monitored by the port authority. Although not substantial, wait times at anchorage, or at the berth can be anywhere between 45 to 90 minutes. This will need to be factored in when understanding the greater logistics around offshore wind farm construction times and associated weather windows.

Figure 7-15: Access channel buffer zone

Quay Infrastructure and Storage Yard:

Ba Son Shipyard's primary quay infrastructure used for loading and loadout activities is Jetty 2, which is 280 m in length and 40 m wide. The jetty can withstand a general bearing load of 4 t/m², with a strengthened 15t/m² 40x40 m section on the western end where the access bridge connects to the jetty. The current configuration of the berth is not typical for offshore wind construction ports. These would normally have a continuous transition to the landside, which provides additional space for the required lifting equipment, as well as for large offshore wind components. In its current form, the WTIV may struggle to lift foundations, towers and blades of the sizes required for 15 MW+ WTGs using only the skid ways along the access bridge and the strengthened corner of the jetty. Although these concerns were raised during the site visit, Ba Son Shipyard were confident this can be achieved with the existing layout. The planned approach will be to berth the vessel parallel to the access bridge, therefore, creating a larger area where the foundations can be loaded from. Essentially, SPMTs will transport the foundations from the yard to the designated high-load skid ways along the access bridge where they will then be kept for loadout. Although plausible for foundations, we do not believe this arrangement will work for other offshore wind components due to space constraints along the jetty i.e. towers, blades, nacelles. Generally, the vessel will arrive with 3-6 preassembled and commissioned towers on packs with blades and nacelles waiting on the quay – this is to ensure a fast turnaround of the WTIV. This is not practically achievable with Ba Son Shipyards Jetty layout.

Based on this, Ba Son Shipyard is more suited as a fabrication and construction port for foundations only.

Figure 7-16 illustrates how the terminal will be rearranged to facilitate the loadout of foundations, more specifically monopile foundations.

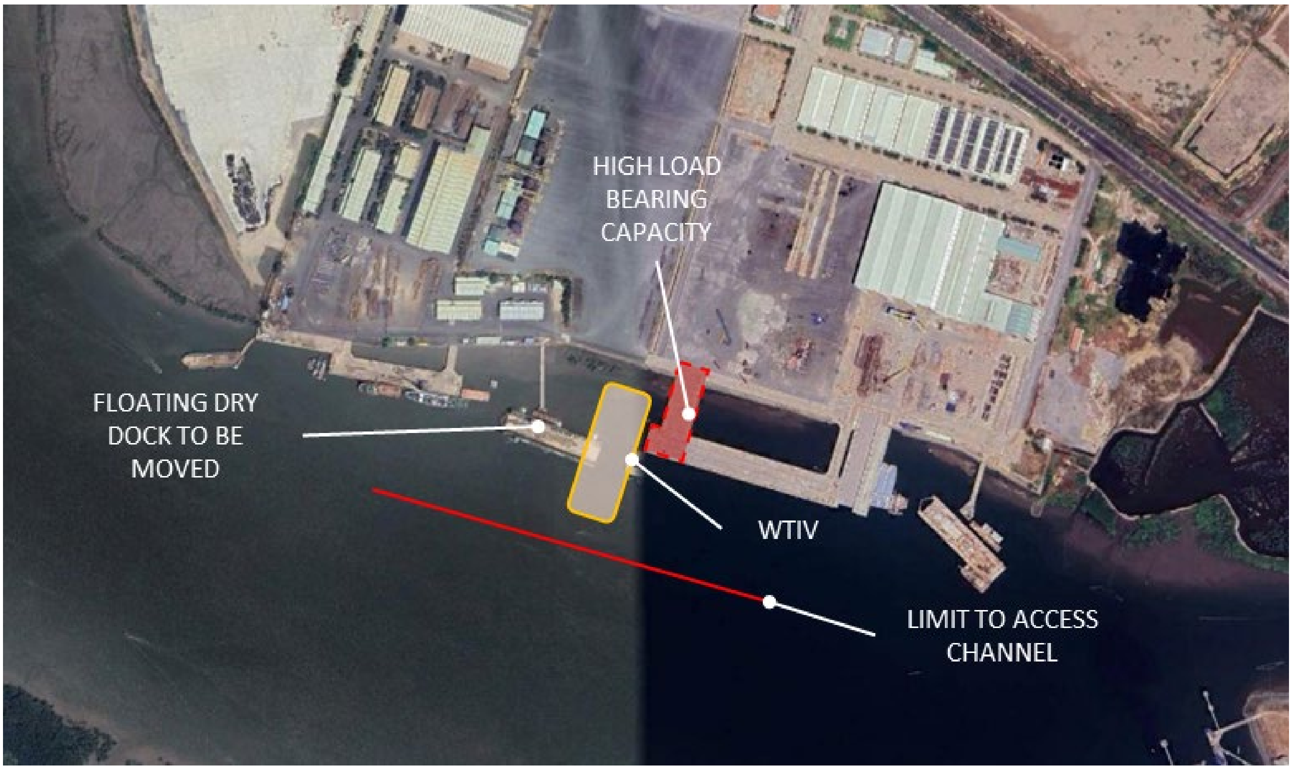


Figure 7-16: Loadout operation for Ba Son Shipyard – monopile foundations

7.4.5 Offshore Wind Concept and Upgrade Requirements

From discussions with Ba Son Shipyard, it is clear that offshore wind will form a key component of the port's future operations and expansion plans. The port is already servicing offshore wind projects in collaboration with PTSC Downstream and have ambitions to become a fabrication port for monopile foundations and provide additional storage space for various offshore wind components if required and if loadout is feasible.

To ensure the successful unloading and loadout of monopile foundations, the current berth configuration would however need to change, with the following adjustments/upgrades suggested:

1) Land reclamation behind Jetty 2, in addition to upgrading the existing section of jetty 2 which only has a load bearing capacity of 4 t/m² (± 200 m). This will be an expensive and timely operation not suitable for Power Development Plan 8 timelines.

2) Re-orientate the berth for Jetty 2 for offshore wind projects. This will require dredging works, the re-positioning of the floating dry dock, and possibly berthing dolphins to ensure a safe offset from the access bridge and jetty. This aligns with the proposed Port Master Plan for Ba Son (Port C – Figure 7-14); however, this represents more of a temporary solution to ramp up offshore wind capability prior to the dedicated rectangular U-berth as proposed (berth that runs perpendicular to the access channel). This will require additional funding which Ba Son does not currently have.

Figure 7-17 shows a concept of how this 46 ha terminal may look when upgraded as per point 2) above.

Figure 7-17: Ba Son Shipyard offshore wind construction port Concept

If the orientation of the Jetty 2 berth is adjusted for WTIVs as described above and shown in Figure 7-17, the offshore wind terminal will have the following properties.

- Berth water depth: -10.5 m LAT (to be dredged)
- Total storage area: 30 ha of primary storage + 16 ha of additional storage
- Quay length and width: 115 x 40 m (below minimum length requirements for offshore wind components)
- Quay bearing capacity: 15 t/m²
- Yard bearing capacity: 20 t/m²

It is important to note that this change does however reduce the berth length below our benchmark values and thus we recommend that Ba Son Shipyard focus on the production and loadout of monopile foundations only. Additional navigation and loadout assessments should be undertaken prior to confirming this solution.

Therefore, the required infrastructure upgrades include the following:

- Additional 16 ha storage yard to the East of Ba Son shipyard:
- Jetty 2
  - Seabed strengthening for WTIVs jack-up legs.
  - Installation of Berthing dolphins and quay furniture upgrades for the jetty 2 berth orientation adjustment.
  - Dredging for the jetty 2 berth reorientation for WTIVs and appropriate scour protection.

7.4.6 Indicative Cost Estimate and Construction Timeline

Based on the upgrade requirements of Jetty 2 and the additional storage area, an indicative construction cost and development timeline have been prepared.

The cost estimate has been developed using COWI's internal project data base and should be used as merely a guide for further investigation and development. Table 7-6 shows the cost estimate for Ba Son Shipyard.

Table 7-6: Indicative cost estimate – Ba Son Shipyard

No.	Construction	Cost (m USD)
1	Dredging (for Jetty 2 reorientation)	1.0
2	Scour protection, revetment and land reclamation (1)	12.5
3	Soil improvement	12.7
4	Quay construction	-
5	Quay furniture (includes 2 berthing dolphins)	5.7
6	Lighting and electrical works	2.6
7	Buildings, parking and fencing	3.6
8	Mob and demob (8%)	3.1
	TOTAL	**41.2**

(1) Includes provision for seabed strengthening

From the construction items highlighted in Table 7-6 a high-level timeline has been developed for major works which form the critical path – refer to Figure 7-18.

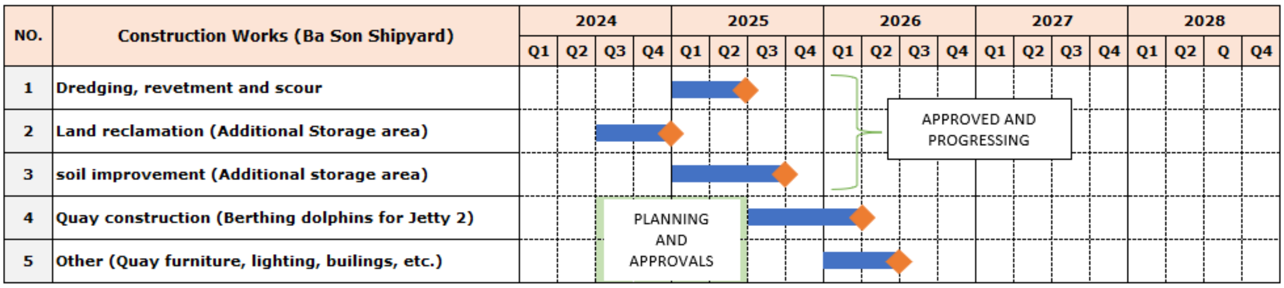


Figure 7-18: Indicative construction timeline

Additional time has been allocated from the start of Q3 2024 to the end of Q2 of 2025 to secure appropriate funding, government authorisations, development plans and associated design work for the minor upgrade works of Jetty 2.

7.4.7 SWOT Analysis and Conclusion

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis has been prepared in Table 7-7 which highlights key observations made for Ba Son Shipyard and their potential role as a future offshore wind fabrication port.

Table 7-7: SWOT Analysis – Ba Son Shipyard

STRENGTHS	OPPORTUNITIES
› Port owners see offshore wind as a core future business case for the port. › Extensive experience in fabricating and handling project cargo – more recently foundations for OW. › Deep access channel allowing unrestricted access to the port.	› Large land available to the East to be used as an additional storage area. › Further collaboration with PTSC Downstream to create a dedicated offshore wind supply chain in the South. › Supplier of monopile foundations to both the local and global offshore wind market.
WEAKNESSES	**THREATS**
› Berth orientation with access bridge. This is not typical for offshore wind construction and fabrication ports. › Only a portion of Jetty 2 meets the required offshore wind bearing capacity. › Vessel congestion within the navigation channel may increase transit time to and from the offshore wind farm.	› Owned by the Ministry of Defence which may prevent direct foreign investment due to strict regulations. › The reorientation of jetty 2 for WTIVs may not be feasible in the short term, and thus the proposed U-berth in Figure 7-14 (Master Plan – longer term, Port C) would need to be constructed, or the entire jetty 2 demolished and upgraded.

Ba Son Shipyard has experience in fabricating and handling large project cargo which includes various foundation components for offshore wind. As such, they want to position their business to become a supplier of monopile foundations – a gap in Viet Nam's existing offshore wind supply chain. To realise this ambition, Ba Son Shipyard will develop a new fabrication facility capable of fabricating monopiles up to 16 m in diameter and 210 mm thick. It is unclear when this facility will be complete; however, to further their commitment Ba Son Shipyard have also started to develop an additional 16 ha storage yard at the Eastern end of the port which will service the offshore wind market. In addition, Ba son will look to re-orientate jetty 2 specifically for WTIVs. These upgrades are relatively minor and should be completed well before the required timelines to meet Power Development Plan 8 targets.

Key Takeaway:

- Dedicated port in the South for fabricating, storing and loadout of monopile foundations.
- The following minor port upgrades are required:
  - Additional storage space to the Eastern end of the Port.
  - Reorientation of Jetty 2 with dedicated berthing dolphins to be able to successfully moor WTIVs and loadout monopiles where required. This is a temporary solution before the dedicated U-berth is constructed as per Ba Son Shipyard's Master Plan.
- Expected port readiness for Power Development Plan 8: Q2 of 2026 as a fabrication and construction port for foundations only.
- Ba Son Shipyard to work in collaboration with PTSC Downstream and form a supply hub within the southern region of Viet Nam, i.e. foundation fabrication, and storage of offshore wind components (blades, nacelles and towers).

7.5 Vinh Tan International

7.5.1 Port Overview

Vinh Tan International Port is located in the South-Central region along Viet Nam's coast and has direct access to deep water. Although the port is located next to an existing power station with separate port facilities, Vinh Tan is under different ownership and supports general and project cargo. Current core capabilities include the following:

- Loading and unloading of general and bulk cargo.
- Unloading of containerised cargo; and
- Unloading, storage and loadout of various project cargo, which includes onshore wind components.

Figure 7-19 shows the location of Vinh Tan International and the extent of the port's facilities which could possibly be upgraded to meet offshore wind requirements.

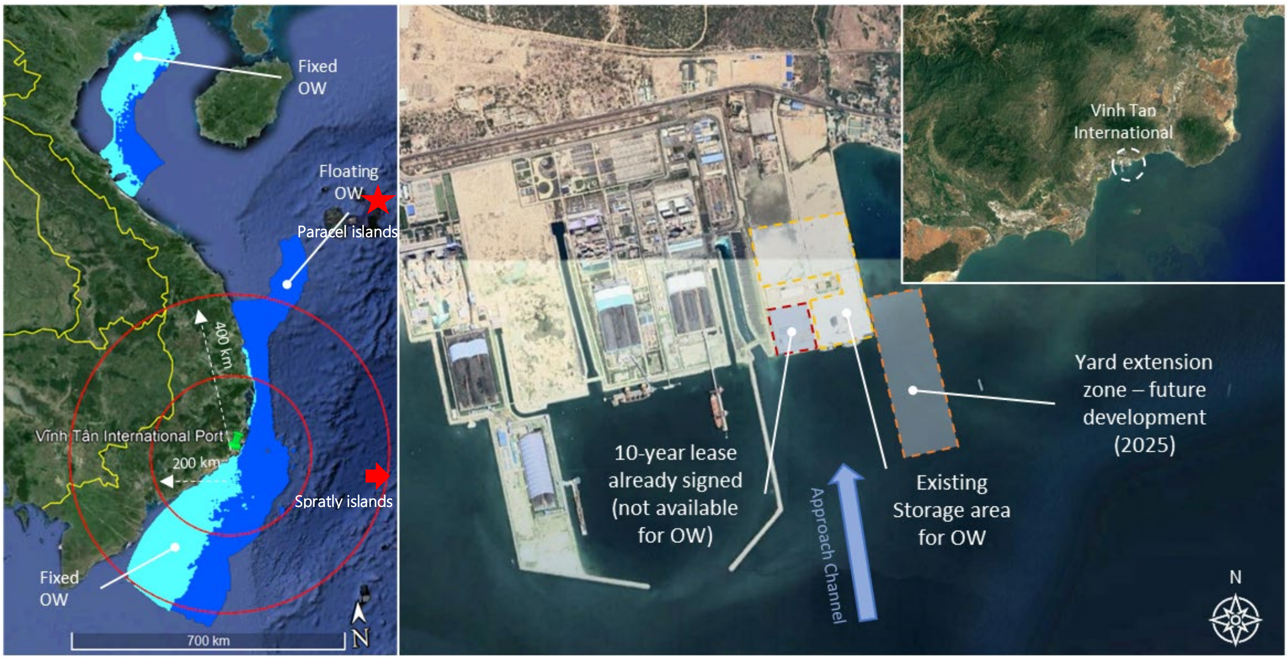


Figure 7-19: Location of Vinh Tan International.

Strategically, Vinh Tan is ideally located in the South-Central region, as it is the closet port to the most suitable fixed bottom Offshore Wind Zones along the entire coastline. This is due to the wind potential in the area and relatively shallow seabed. Therefore, if Vinh Tan can upgrade its facilities to transition from onshore wind project cargo to offshore wind, the port will play an important role in Viet Nam reaching its Power Development Plan 8 goals.

7.5.2 Existing Port Facilities

Vinh Tan International port has 2 primary quays with a total length of 573 m and are capable of servicing 50,000 DWT vessels. There is an additional smaller auxiliary quay available to the East of the port; however, this can only service vessels up to 3,000 DWT and will be decommissioned as part of Vinh Tan's Master Plan – refer to Section 7.5.3. Of the current total 16 ha storage yard, only 10 ha is available due to a recent 10-year lease agreement signed for the area in the South Western corner. There is available land behind the terminal buildings; however, this would need to be upgraded.

Figure 7-20 shows the extent of the existing facilities within Vinh Tan International Port.

Figure 7-20: Existing port facilities - Vinh Tan International

Key properties for the jetty and storage yard include the following:

- Quay 1 and 2:
  - Length and width: 450 x 30 m
  - Available Depth: 11.4 m CD
  - Bearing Capacity: 3 t/m²
  - Available skid ways: not applicable
- Yard Facilities
  - Storage yard: 16.0 ha (only 10 ha available)
  - Warehouse and workshop: 3.7 ha
  - Available land: 54.8 ha (behind terminal building)
  - Storage yard bearing capacity: 4 t/m²

7.5.3 Port Master Plan

Vinh Tan's core business model has been to accommodate various types of general cargo on an ad-hoc basis for the region, as well as support requirements for the adjacent power station which recently led to the newly signed 10-year lease agreement for 6 ha of storage area. However, as Vinh Tan have understood their strategic position along the coastline in terms of offshore wind, the port has pivoted its focus more towards servicing offshore wind.

As such, a Port Master Plan is currently being developed in which the following additions have been planned for the port:

- A breakwater extending into the bay which will provide additional shelter and uptime for vessels during the stormy season (this has already been approved by the national port authority).
- Extension area behind the breakwater which will act as additional storage space.
- Dedicated heavy duty quay for loading and unloading of offshore wind components.
- Economic zone behind the terminal for possible monopile fabrication and additional storage.

Figure 7-21 provides a high-level overview of the proposed areas for development. Note that these plans are still in development and will need approval from the National Port Authority before any works can be completed.

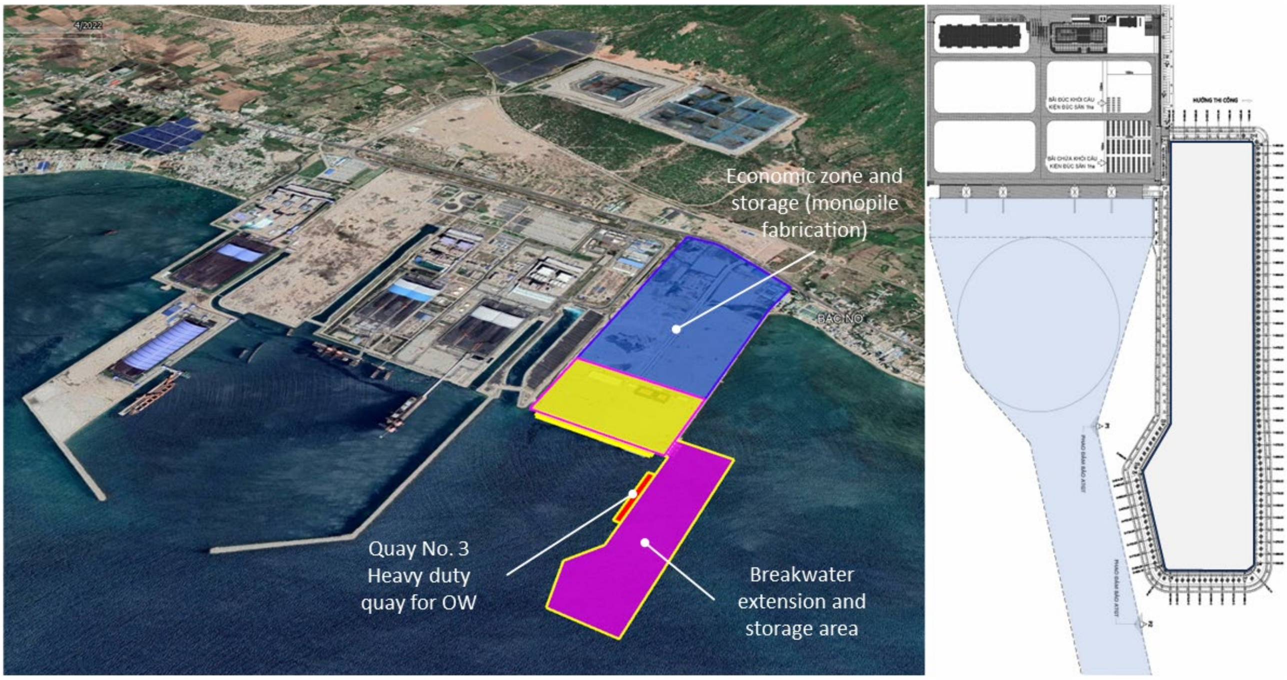


Figure 7-21: Vinh Tan International Master Plan (Vinh Tan International, 2024)

It is understood from discussions with Vinh Tan, that initial funding has been received for development of the breakwater extension, and the port plans to have this part of the works completed by 2027. The dedicated quay (quay 3) will however still need investors to be realised and thus there is uncertainty over when the full offshore wind terminal (breakwater extension and quay 3) will be operational.

Nevertheless, this is a great opportunity for Vinh Tan to be a "first mover" in the offshore wind space which will assist developers and government with both pilot and large-scale offshore wind development projects. Ports are massive enablers for offshore wind and thus Vinh Tan's development plans should enhance the local offshore wind supply chain.

7.5.4 Port Gap Analysis

Table 7-8 summarises key functional requirements which have been used to assess the applicability of Vinh Tan International's existing port infrastructure with typical offshore wind construction port requirements.

Table 7-8: Gap Analysis – Vinh Tan International

Property	Unit	Existing	Benchmark	Comment
Distance to OWF	km	< 200	200	Ideally located for southern OWFs
Channel Depth	m LAT	10	> 9	-
Access channel width	m	150	200	Below benchmark, will need mitigation measures (navigation study)
Turning circle	m	360	240	-
Berth length	m	225	200	Quay No. 2
Depth at berth	m LAT	11.4	8	-
Bearing capacity (quay)	t/m²	3	7.5-15	Will require major upgrades
Bearing capacity (yard)	t/m²	4	20	Will require upgrades
Seabed strengthening	-	No	Required	Will require seabed strengthening for jack-up legs
Yard area	Ha	10	20-25	Will require additional space (extension area behind breakwater planned)

Navigation:

The navigation conditions and properties for Vinh Tan are generally well aligned with the requirements of offshore wind barring the navigation channel width. As discussed in Section 7.3.4, guidelines suggest that this value should be in the order of 180 m provided there is no above water obstructions which will risk collision of offshore wind components i.e. WTG blades with other marine infrastructure.

This is not the case for Vinh Tan and thus the existing 150 m channel width may be justified provided necessary navigation studies support this. In addition, the access channel is fairly short (+- 1000 m) which could further justify maintaining the 150 m channel width based on the navigation study results. Note that the channel depth is not limiting in this regard and is suitable for a variety of WTIVs.

Quay Infrastructure and Storage Yard:

Vinh Tan's quay 1 and 2 comprises of a suspended deck supported on vertical steel tubular piles and has a bearing capacity of 3 t/m². This unfortunately does not meet offshore wind requirements and major upgrade works (demolition and reconstruct) would be required to bring this to the minimum benchmark of 7.5 t/m². This will however limit operations for the port during the quay reconstruction.

The existing storage yard is another aspect of Vinh Tan that will require upgrades in terms of load carrying capacity. Furthermore, there is limited available space and additional land will be required – this aligns well with the planned extension area behind the breakwater (Figure 7-21). Typically, a storage area of between 20 and 25 ha is required to undertake unloading, storage, preassembly, and loadout activities.

7.5.5 Offshore Wind Concept and Upgrade Requirements

Vinh Tan International port has a strategic advantage over its competitors due to its close proximity to the preferred Offshore Wind Zones in the South. As such, the port has pivoted its business case to not only become a construction port for offshore wind projects, but also potentially a fabricator of monopile foundations in the longer term.

Therefore, to realise these ambitions as soon as practically possible key infrastructure upgrades will need to be made. Figure 7-22 shows a concept of how Vinh Tan International may look if these upgrades are realised.

Figure 7-22: Vinh Tan International offshore wind construction port concept

The concept shown in Figure 7-22 aligns with Vinh Tan's Master Plan and addresses the concerns raised in Section 7.5.4, notably the available storage space, and dedicated quay which will have adequate bearing capacity to service the heavy offshore wind components.

The proposed upgrades will enable Vinh Tan to service the local offshore wind market, especially the sites in the South and South-Central regions. Moreover, if additional storage space is required at a later stage, a small portion of land allocated to the Vinh Tan industrial zone can be converted.

The offshore wind terminal as shown in Figure 7-22 will have the following key properties:

- Berth water depth: -11.4 m LAT (no dredging required)
- Total storage area: 25 to 30 ha
- Quay length and width: 300 x 30 m*
- Quay bearing capacity: 10 t/m²
- Yard bearing capacity: 20 t/m²

* With only a single berth available for unloading and loadout of offshore wind components, the storage yard will need to be optimised to ensure there are no delays with loadout and installation activities. For a single berth, it is generally suggested to ensure all offshore wind components are stored at the port prior to the start of construction. This is challenging for a 1 GW offshore wind farm, as this will approximately require 67 WTGs (15 MW). Therefore, the logistics around Vinh Tan International must be investigated further, which may result in additional storage space needed at the back of the terminal (the identified Vinh Tan International Economic Zone – Figure 7-21).

The required upgrades include the following:

- Greenfield terminal for offshore wind:
  - Land reclamation of 20 ha and associated soil improvement
  - Coastal protection along the outside of the reclaimed land
  - Scour protection
  - Quay construction (includes a suspended deck, revetment and seabed strengthening for jack-up legs). In addition, the deck will be constructed with foundations for pre-assembly tower packs – the black square shown along the quay. This area requires higher loads than stated in the benchmark criteria and are difficult to retrofit at a later stage.
  - Associated quay furniture, buildings, and electrical requirements (lighting, substation, etc.).
- Upgrade existing storage yard to achieve a bearing capacity of 20 t/m².
  - Installation of vertical drains (where required).
  - Appropriate layer works and vibro compaction
  - Application of surcharge
  - Crushed rock distribution layer

7.5.6 Indicative Cost Estimate and Construction Timeline

Based on the upgrade requirements for Vinh Tan International port, an indicative construction cost and development timeline have been prepared.

The cost estimate has been developed using COWI's internal project data base and should be used as merely a guide for further investigation and development. Table 7-9 shows the cost estimate for Vinh Tan International.

Table 7-9: Indicative cost estimate – Vinh Tan International

No.	Construction	Cost (m USD)
1	Dredging	-
2	Scour protection, breakwater, land reclamation (1)	71.8
3	Soil improvement	15.9
4	Quay construction	17.8
5	Quay furniture	0.7
6	Lighting and electrical works	4.3
7	Buildings, parking and fencing	3.6
8	Mob and demob (8%)	9.1
	TOTAL	**123.2**

(1) Includes provision for seabed strengthening

From the construction items highlighted in Table 7-9 a high-level timeline has been developed for major works which form the critical path – refer to Figure 7-23.

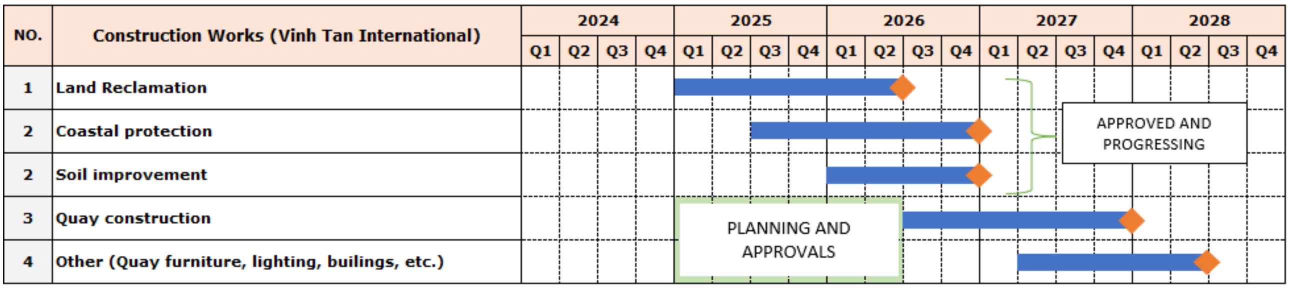


Figure 7-23: Indicative construction timeline

Additional time has been allocated from the start of Q1 2025 to the end of Q2 of 2026 to secure appropriate funding, government authorisations, development plans and associated design work for the quay 3 Construction.

7.5.7 SWOT Analysis and Conclusions

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis has been prepared in Table 7-10 which highlights key observations made for Vinh Tan International and their potential role as a future offshore wind construction port.

Table 7-10: SWOT Analysis – Vinh Tan International

STRENGTHS	OPPORTUNITIES
› Port owners see offshore wind as a core future business case for the port. › Experience in handling project cargo, which included onshore wind components. › Good navigation characteristics. › Strategically located close to the best Offshore Wind Zones in Viet Nam.	› Large land available behind the terminal buildings which can be developed for offshore wind storage and possible fabrication activities (monopiles). › Port Master Plan (in development) looks to construct a dedicated offshore wind terminal within the port.
WEAKNESSES	**THREATS**
› Only offering a single berth which may slow loud-out times for WTIVs during offshore wind construction. The storage yard must be optimised to limit any delays during construction.	› The port is unable to secure funding for the development of Quay 3 which substantially delays the port development to 2030 and beyond. › Navigation studies show that the access channel width should be widen beyond the existing 150 m.

Vinh Tan International is a deep-water port which is ideally located close to the most promising fixed bottom Offshore Wind Zones in Viet Nam. The port has a good understanding of heavy project cargo and has experience in unloading and loading of onshore wind components which can be transferred to the offshore wind industry. The port has ambitions of not only becoming an offshore wind construction port for Viet Nam, but also a fabrication hub for monopile foundations (longer term). Vinh Tan are developing a Port Master Plan which will include a dedicated offshore wind terminal which extends off the proposed breakwater. The breakwater and extension area have already received government approval and funding, and construction is scheduled for the start of 2025. Quay 3 will however require additional approval and funding and thus construction has been scheduled for Q2 of 2026.

Key Takeaway:

- Dedicated port in the South-Central region for staging offshore wind components (blades, nacelles and towers) provided the following major upgrades are undertaken.
  - Breakwater extension which includes a 20 ha storage area.
  - Upgrade of the existing storage area behind quay 2.
  - Construction of a dedicated quay (quay 3) for offshore wind.
- The port may also be used to stage foundations; however, this will be completed in a separate installation campaign.
- Expected port readiness for Power Development Plan 8: Q2 of 2028

7.6 Nghi Son International and Surrounds

7.6.1 Port Overview

Nghi Son International Port (NSIP) is located along the Northern coastline of Viet Nam and forms part of the deep-water port cluster in the Nghi Son area where a variety of services are provided. In addition, the port falls under one of the Strategic economic zones of Viet Nam, making this an attractive area for investment. The port's sheltered location, together with deep accessible waters make this an attractive candidate port for offshore wind developments in the North. Current core capabilities of Nghi Son Port include the following:

- Container and bulk cargo handling and storage.
- Packaging, re-packaging and cargo handling.
- Project cargo unloading, storage and loadout activities.

Figure 7-24 shows the location of Nghi Son International Port within the wider cluster.

Figure 7-24: Location of Nghi Son International Port

In addition to the identified Nghi Son International Port, Long Son and PTSC Thanh Hoa have been identified as possible collaborative ports within the cluster which could assist Nghi Son International Port with certain storage, loading and unloading activities for various offshore wind components.

7.6.2 Existing Port Facilities

Nghi Son International Port has five separate quays which are used for various operations as noted in Section 7.6.1. The 6th quay is currently out of service and is located in the Northern corner of the port. All quays have relatively deep berth pockets and have a continuous transition back to the landside where various cargoes are stored. The total available storage area is approximately 33 ha, of which 4 ha is used for containers and 1.5 ha for warehousing.

Figure 7-25 shows the existing port facilities within Nghi Son International Port as well as the location of the quays, warehouses and open storage areas for general project cargo. Note that the storage area is flexible within the port and is dependent on the various lease agreements signed for the terminal operators.

Figure 7-25: Existing port facilities

Key properties for the quay and storage yard are shown below (Quay 5 not in service). Note that the bearing capacity of the various quays has been stated at 4 t/m².

- Quay 1 and 2
  - Length and width: 250 x 27 m
  - Available Depth: 12.0 m CD
- Quay 2A
  - Length and width: 147 x 21 m
  - Available Depth: 9.5 m CD
- Quay 3
  - Length and width: 300 x 27 m
  - Available Depth: 13.2 m CD

- Quay 4
  - Length and width: 300 x 27 m
  - Available Depth: 13.2 m CD
- Yard facilities:
  - Total Storage yard: 33 ha (only 10 ha available)
  - Warehouse and workshop: 1.5 ha
  - Container yard: 4.4 ha
  - Available land: 27.1 ha
  - Storage yard bearing capacity: 20 t/m²

7.6.3 Port Master Plan

Nghi Son International Port do have development plans for the port; however, these are scheduled to be completed by 2030 and will result in substantial capital expenditure. This can be viewed on the National Seaport Master Plan where the is a new dig-out development set for the Northern part of Nghi Son International Port. Furthermore, there are substantial growth plans for the Nghi Son cluster. Figure 7-26 shows the indicative growth plans for the area and where the new greenfield site for Nghi Son International Port is proposed.

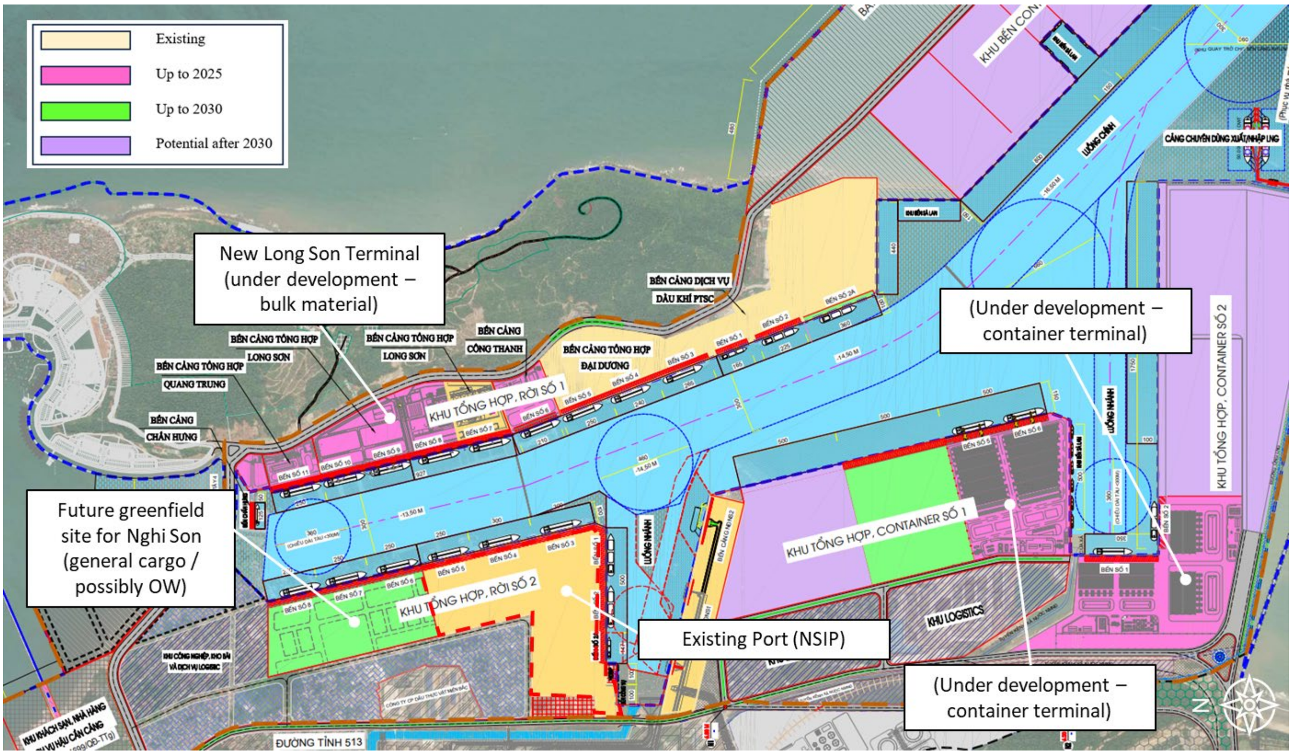


Figure 7-26: Nghi Son International (NSIP) Port Master Plan (Source: National Seaport Master Plan, Viet Nam)

From Figure 7-26 it is clear that the Nghi Son area have strong growth plans for the next 10 years which will cater for a number of different industries. The issue is however that the developments which are currently in planning phase i.e. up to 2025 (pink) will primarily be used for container and general bulk terminals. Offshore wind is currently not part of the National Seaport Master Plan for Nghi Son and thus existing infrastructure in NSIP and possible surrounds will be best placed to service offshore wind to meet the immediate goals of Power Development Plan 8 in the North. There is however a possibility to develop the Future greenfield site of NSIP into a dedicated offshore wind port; however, this will only be realized beyond 2030.

As described in Section 7.6.2 Nghi Son International Port has deep water quays, a storage yard which can handle offshore wind component bearing capacities. Thus, Nghi Son International Port is a viable option for an offshore wind construction port provided other port activities can be relocated to free up storage space in the yard.

7.6.4 Port Gap Analysis

Table 7-11 summarises key functional requirements which have been used to assess the applicability of NSIP's existing port infrastructure with typical offshore wind construction port requirements.

Table 7-11: Gap Analysis – Nghi Son International Port

Property	Unit	Existing	Benchmark	Comment
Distance to OWF	km	< 200	200	Ideally located for northern OWFs
Channel Depth	m LAT	10.8	> 9	-
Access channel width	m	120	200	To be widened to 200 m by the end of 2024
Turning circle	m	300	240	-
Berth length	m	300	200	Quay No. 1 and 3
Depth at berth	m LAT	12 and 13.2	8	Quay No. 1 and 3
Bearing capacity (quay)	t/m²	4	7.5-15	Will require major upgrades
Bearing capacity (yard)	t/m²	20	20	Aligns with benchmark requirements
Seabed strengthening	-	No	Required	Will require seabed strengthening for jack-up legs.
Yard area	Ha	29	20-25	Will need to relocated existing operations.

<u>Navigation:</u>

The navigation characteristics of Nghi Son International Port are well suited to accommodate offshore wind, especially since the access channel width will be widened to meet the 200 m general requirement by the end of 2024. The berth depths are also well above benchmark requirements and will be able to accommodate a range of WTIVs and provide unrestricted access to and from the terminal.

<u>Quay Infrastructure and Storage Yard:</u>

Nghi Son International Port's quay 1 and 3 comprises of a suspended deck supported on steel tubular piles and has a bearing capacity of 4 t/m². This unfortunately does not meet offshore wind requirements and major upgrade works would be required to bring this to the minimum benchmark of 7.5 t/m². Due to the restricted yard size, it is proposed that both quay 1 and 3 be upgraded to ensure loading and loadout activities can be undertaken simultaneously. This will ensure that the storage yard does not need to have all components in the yard prior to construction activities commencing – ultimately resulting in a more flexible offshore wind farm construction programme which could potentially reduce the overall construction timeline.

The storage yard has a total available area of approximately 29 ha. This assumes that the current activities are relocated elsewhere to make space for offshore wind when required. Nghi Son International Port have however commented that due to existing lease agreements, only 3 ha (possibly up to 10 ha) of storage is currently available and that the remainder will only become available after 2030. Therefore, Nghi Son International Port will need to be supported by other ports within the cluster in order to store an adequate amount of offshore wind components to make the Nghi Son area feasible in servicing offshore wind in the North. Furthermore, if the storage yard is not available, it then does not make sense to carry out the upgrades on quay 1 and 3.

7.6.5 Offshore Wind Concept and Upgrade Requirements

Nghi Son International Port is one of the few deep-water ports in the North which is capable of serving the offshore wind industry. The access channel is to be widened to 200 m by 2024, and the existing berths have adequate depth to ensure unrestricted access to a range of WTIVs. Using the existing storage area in its entirety, together with upgrading quays 1 and 3, Figure 7-27 shows how Nghi Son International Port can be used as a construction port for offshore wind, i.e. unloading, storing, pre-assembling and loadout of offshore wind components.

Figure 7-27: Nghi Son International Port offshore wind construction port concept

The unloading area (quay 1) and loadout area (quay 3) will need to be upgraded to withstand the required bearing capacities for +15 MW WTGs. This will involve demolishing and reconstructing the existing quays. Note that this is the only substantial upgrade needed for Nghi Son International Port as navigation and storage requirements are already met.

The offshore wind terminal as shown in Figure 7-27 will have the following key properties:

- Berth water depth: -12.0 and -13.2 m LAT (no dredging required)
- Total storage area: 26 ha
- Quay length and width: 550 x 27 m (quay 1 and 3)
- Quay bearing capacity: 10 t/m²
- Yard bearing capacity: 20 t/m²

The required upgrades include the following:

- Upgrade quay 1 and 3 to achieve a bearing capacity of 10 t/m².
  - Demolish the existing quays in sections to limit disruptions to operations.
  - Remove existing revetment and scour, store for later use.
  - Install steel tubular piles, concrete suspended deck and existing revetment. In addition, the deck will be constructed with foundations for pre-assembly tower packs – the black square shown along the quay. This area requires higher loads than stated in the benchmark criteria and are difficult to retrofit at a later stage.
  - Strengthen the seabed for jack-up legs.
  - Place existing scour protection.
  - Install quay furniture.

The above solution however only holds if the entire storage area of Nghi Son International Port can be used for offshore wind when required. As mentioned in Section 7.6.4, this can only be arranged after 2030. Therefore, if Nghi Son International Port and the broader Nghi Son area were to contribute to Power Development Plan 8 in the North, there would need to be a coordinated effort with the general ports of Nghi Son International Port, i.e. Long Son and Than Hoa. An example of how this split of storage responsibility could look is shown below.

- Nghi Son International Port: 7 ha of storage area
- Long Son: 5 ha of storage area
- Thanh Hoa: 15 ha of storage area

Nghi Son International Port would still require either quay 1 or 3 to be upgraded in order to unload and loadout foundations and transition pieces (heavy components). Note that this is generally a separate installation campaign and thus space will be freed for other offshore wind components once the WTG installation commences. Long Son and Thanh Hoa would store the remainder of offshore wind components. This would however require the WTIV to stop at multiple ports to loadout various components, increasing the total installation time. A work around solution would be to ensure all components which comprise of the WTG, excluding foundations, (tower, blades and nacelle) are stored in each of the ports defined above – the quantity of which dependent on the total available storage area within each port. Therefore, the WTIV would be able to call upon a single port at any given time to loadout the nacelle, blades and towers minimising disruptions.

The above solution will however depend on whether the marine infrastructure of Long Son Port and Thanh Hoa Port meet minimum load requirements. The navigation characteristics at these ports seem feasible; however, the load carrying capacity of the storage yards and quay infrastructure is unknown at this stage. Furthermore, buy-in from all three ports would be required.

Figure 7-28 shows the proposed breakdown of shared storage responsibilities for Nghi Son International Port, Long Son Port and Thanh Hoa Port.

Figure 7-28: Nghi Son Port (NSIP) cluster proposed storage responsibilities

7.6.6 Indicative Cost Estimate and Construction Timeline

Based on the upgrade requirements for Nghi Son International Port, an indicative construction cost and development timeline have been prepared. Note that two separate timelines have been provided which represent the Nghi Son port cluster solution, as well as the solution where the entire Nghi Son International Port is used for offshore wind i.e. post 2030.

The cost estimate has been developed using COWI's internal project data base and should be used as merely a guide for further investigation and development. Table 7-12 shows the cost estimate if the entire upgrade works for Nghi Son International Port is implemented.

Table 7-12: Indicative cost estimate – Nghi Son International Port (entire upgrade works)

No.	Construction	Cost (m USD)
1	Dredging	13.0
2	Scour protection, revetment (1)	8.8
3	Soil improvement	-
4	Quay construction (includes demolition, quay 1 and 3)	36.7
5	Quay furniture (for quay 1 and 3)	1.1
6	Lighting and electrical works	4.3
7	Buildings, parking and fencing	3.6
8	Mob and demob (8%)	4.5
	TOTAL	**72.0**

(1) Includes provision for seabed strengthening

From the construction items highlighted in Table 7-12 a high-level timeline has been developed for major works which form the critical path – refer to Figure 7-29.

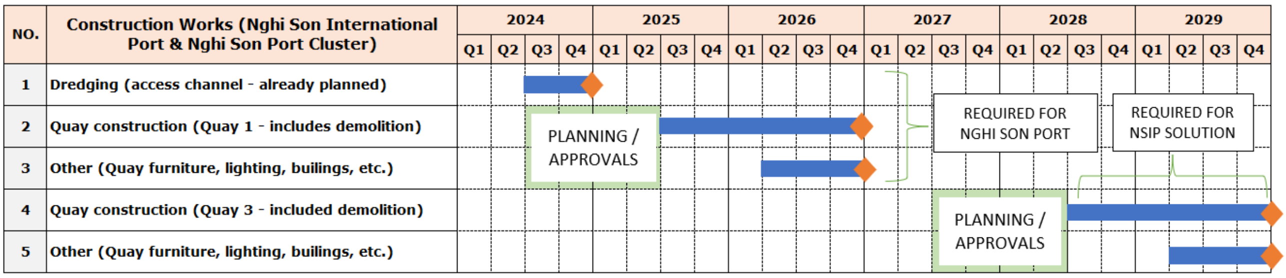


Figure 7-29: Indicative construction timeline

Additional time has been allocated from the start of Q3 of 2024 to the end of Q2 of 2025 to secure appropriate funding, government authorisations, development plans and associated design work for the quay 1 reconstruction work. Provisions for this additional time has also been made for the quay 3 reconstruction work.

7.6.7 SWOT Analysis and Conclusions

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis has been prepared in Table 7-13 which highlights key observations made for Nghi Son International Port as well as the greater Nghi Son port cluster and their potential role as a future offshore wind construction port.

Table 7-13: SWOT Analysis – Nghi Son International Port (NSIP)

STRENGTHS	**OPPORTUNITIES**
› Storage yard has adequate bearing capacity with capable heavy lifting equipment. › Experience in handling project cargo, which included onshore wind components. › Several quays which can be used to support various offshore wind operations and requirements.	› Collaboration with other ports within the Nghi Son area which can develop stronger business ties. › Government commitment to create a longer-term offshore wind hub within the Northern region beyond Power Development Plan 8 2030 requirements. › Offshore wind pilot projects in the North to test the Nghi Son port cluster concept and further identify areas for development. › Develop a dedicated offshore wind port within the allocated future expansion zone of NSIP. This has been zoned as a general cargo port as per the Nghi Son Economic Zone and thus can be developed for offshore wind.
WEAKNESSES	**THREATS**
› Constrained storage yard with active lease agreements. Availability scarce until 2030. › Quay 1 and 3 will need major upgrades to align with offshore wind load requirements.	› Collaboration with neighbouring ports (Long Son and Thanh Hoa) are unsuccessful resulting in no available yard space within the Nghi Son area for offshore wind. › Long Son and Thanh Hoa ports do not have the required marine infrastructure to meet offshore wind requirements i.e. load carrying capacities. › Nghi Son International Port is not interested in offshore wind and will pursue other business opportunities beyond 2030. › Nghi Son region is targeted for other Viet Nam industries.

Although Nghi Son International Port meet many of the offshore wind requirements of a construction port, there is a fundamental issue with storage availability in the near-term, which could impact Power Development Plan 8 commitments in the northern region. Therefore, even if quays 1 and 3 were upgraded and came online by the end of 2026, the port would still need to wait until 2030 to be able to fully service the construction requirements for offshore wind farms in the North.

Therefore, to ensure port readiness in the shorter term, a collaborative model is proposed with Long Son and Thanh Hao ports. Note that these ports have been identified based on stakeholder engagements; however, there are a number of other ports in the Nghi Son area who could also form part of this solution provided there is support from the national government and Port Authority. A positive way of testing this collaborative model and business case in Nghi Son would be to roll-out an offshore wind pilot project in the North over the next few years. This will provide opportunity to test the supply chain and identify how the various ports could support one another for offshore wind.

Key Takeaway:

- Nghi Son International Port has limited storage space to accommodate offshore wind prior to 2030 (3 to 10 ha). Beyond 2030, Nghi Son could become a dedicated port in the North for staging offshore wind components (blades, nacelles and towers) provided the following major upgrades are undertaken.
    - Reconstruction of quay 1 and 3 for 10 t/m² bearing capacity.
- Prior to 2030 the Nghi Son port cluster will need to be engaged to split storage and loadout responsibilities. This includes the following;
    - NSIP: 7 ha of storage area.
    - Long Son: 5 ha of storage area.
    - Thanh Hoa: 15 ha of storage area.
- The above split is dependent on the following:
    - Reconstruction of either quay 1 or 3 of Nghi Son (the two quays are only required beyond 2030 if Nghi Son is to become the dedicated offshore wind construction port in the North).
    - Thanh Hoa and Long Son meet minimum offshore wind construction port requirements.
    - Support received from Government and national port authority to activate the Nghi Son cluster of ports for offshore wind.
- Expected port readiness for Power Development Plan 8: Start of 2027 (Nghi Son Port Cluster - single quay available in Nghi Son International Port, together with the use of Tanh Hoa and Long Son).

Additional Remark:

As there is still uncertainty in the Viet Nam offshore wind market, there is a possibility that the Power Development Plan 8 target dates are extended into 2030. Furthermore, it is likely that the southern offshore wind farms take priority due to their favourable site conditions. This provides an opportunity to rather hold off on upgrade works on the existing Nghi Son International Port, and rather develop the future greenfield site to the North as an Offshore Wind construction port – refer to Figure 7-26. This will ensure adequate storage space across the entire Nghi Son International Port which will remove any requirement to use a cluster of ports within Nghi Son. Furthermore, new dedicated heavy-duty quays can be constructed without disrupting existing operations by reconstructing quays 1 and 3.

7.7 Hai Phong International (Greenfield Site)

7.7.1 Port Overview

Hai Phong International is representative of the port development area within Hai Phong, located on Cat Hai Island, before the Bach Dang River. This area is located at the start of the primary access channel to several ports in the North and is not limited by the following navigation constraints which many of these Northern ports deal with; these include:

- Vertical clearance limits (overhead power lines and bridges);
- Vessel congestion; and
- Narrow canal connecting to the Bach Dang River.

In addition, the access channel to the development area is located in deep waters.

It is understood that the future potential terminal identified for offshore wind is located in a region dominated by container terminals. This business model is highly lucrative in the North and is well understood by many developers who have a business interest in the Hai Phong area. Figure 7-30 shows the location of the proposed site for Hai Phong International.

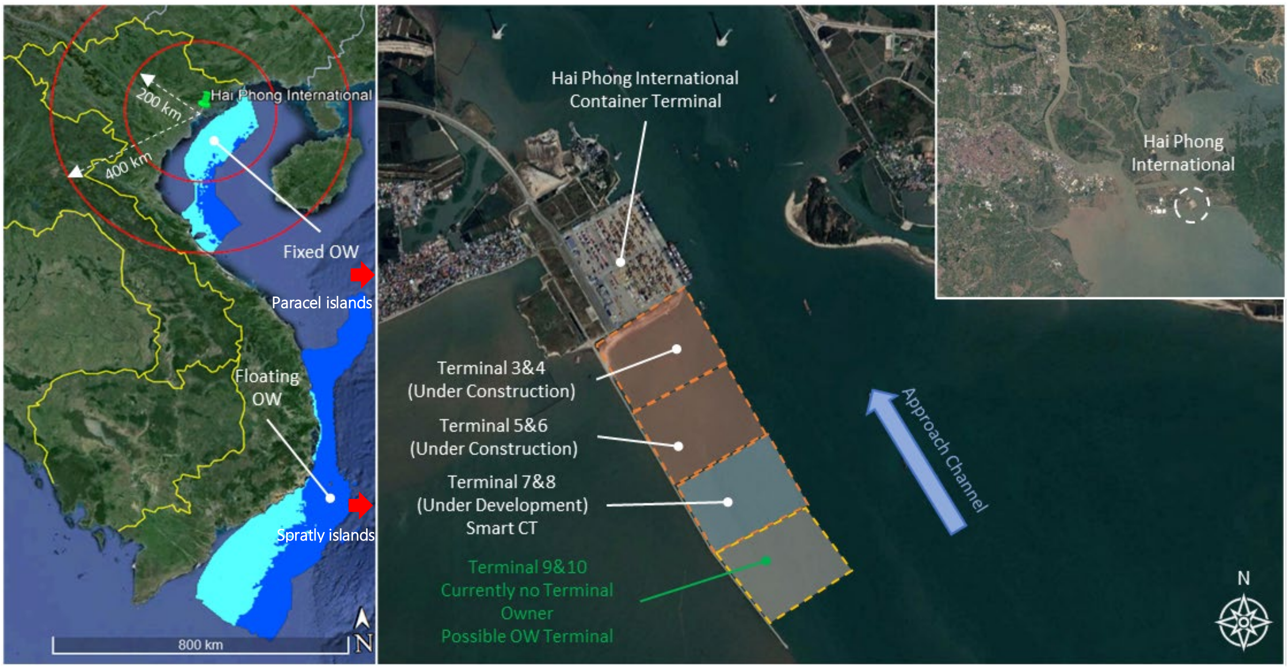


Figure 7-30: Location of Hai Phong International

As shown in Figure 7-30, Terminals 3&4 and 5&6 (container terminals) are currently under construction and are planned for completion by Q1 and Q2 of 2025 respectively. Terminals 7&8 are currently under development and have been designed as Smart container terminals. Terminal 9&10 however do not have an owner and the business case for the terminals have not yet been established. In terms of the National Sea Port Master Plan, Terminals 9&10 are to be developed between 2026 and 2030. This provides an opportunity for the government to develop an offshore wind construction port in a favourable location to service offshore wind farms in the North. Although the development timeline will not align with requirements of Power Development Plan 8, this may be seen as a more longer-term solution to help drive Viet Nam's ambitious offshore wind targets.

7.7.2 Existing Port Facilities

The proposed Hai Phong International Terminal is a greenfield site with no existing marine infrastructure except for the breakwater to the West and deep-water access channel. Figure 7-31 shows the current layout for Hai Phong International Port.

Figure 7-31: Existing layout for Hai Phong International Port

7.7.3 Port Master Plan

The National Seaport Master Plan for the Hai Phong Port is shown in Figure 7-32. As mentioned in Section 7.7.1, there is a strong focus on container cargo in the region, with all terminals initially marked as container terminals. However, the National Seaport Master Plan can be updated to reflect changes in market sentiment, i.e. if an owner of a specific terminal would want to change the initially zoned terminal to align with another business case – in terms of offshore wind this would be marketed as a general cargo port.

Therefore, as terminals 9 and 10 currently do not have an owner, there is a chance that this could be rezoned to a general cargo port if there is support from government and foreign and local investors. If, however, there is already appetite in the market to develop terminals 9 and 10 into container terminals, then the offshore wind construction port could be shifted to terminals 11 and 12. This will however be a long-term solution for Viet Nam and their offshore wind ambitions.

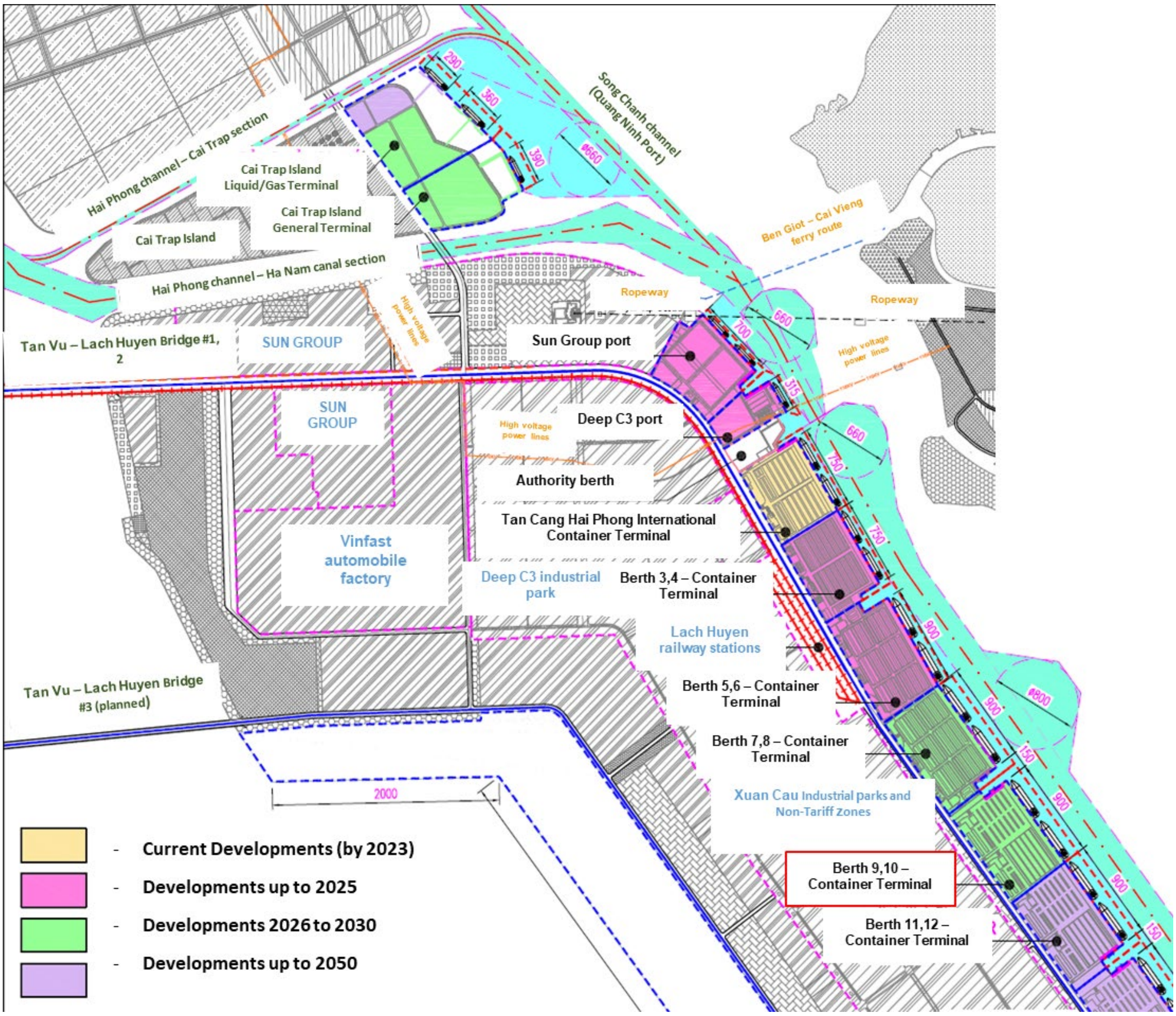


Figure 7-32: National Seaport Master Plan - Hai Phong International Port

7.7.4 Port Gap Analysis

Table 7-14 summarises key functional requirements which have been used to assess the applicability of Hai Phong International with typical offshore wind construction port requirements. As this is a greenfield site with a more longer time horizon, navigation characteristics and location were primary drivers.

Table 7-14: Gap Analysis – Hai Phong International

Property	Unit	Existing	Benchmark	Comment
Distance to OWF	km	< 200	200	Ideally located for northern OWFs
Channel Depth	m LAT	13.3	> 9	-
Access channel width	m	160	200	May impose restrictions of certain WTIVs.
Turning circle	m	660	240	-
Berth length	m	450	200	Greenfield site
Depth at berth	m LAT	12.0	8	Greenfield site (16m future depth)
Bearing capacity (quay)	t/m²	10	7.5-15	Greenfield site
Bearing capacity (yard)	t/m²	20	20	Greenfield site
Seabed strengthening	-	yes	Required	Greenfield site
Yard area	Ha	35	20-25	Greenfield site

Navigation:

The navigation characteristics of Hai Phong International are well suited to accommodate offshore wind. Key observations include the following:

- Access channel depth is far beyond the 9 m LAT benchmark requirement and will ensure large WTIVs with deep drafts can access the site unrestricted (without using tidal assistance).
- The site is located at the start of the access channel which will help relieve some of the vessel congestion typically seen with ports in Hai Phong (up to 4 to 6 hours for some of the ports further upstream).
- Close to identified fixed bottom Offshore Wind Zones in the North.
- Large turning circles which will further assist navigation of WTIVs in and out of the terminal.
- No vertical clearance obstructions such as bridges and overhead powerlines, which is common in the North.

Although the access channel width is below benchmark requirements, the large unobstructed above water space should not be a limitation to WTIVs. This will however need to be confirmed with additional navigation assessments. Therefore, Hai Phong International is a well-suited site and will require minimal capital expenditure to ensure unrestricted access to WTIVs.

Quay Infrastructure and Storage Yard:

As this is a greenfield site, there are no existing quay infrastructure. The proposed concept will however be developed to align with both offshore wind and container terminal requirements.

7.7.5 Offshore Wind Concept and Upgrade Requirements

Terminals 9 or 10 of Hai Phong International will be developed with the primary goal of servicing offshore wind for a 5- to 10-year time horizon, and then later transferred to a container terminal once the demand for offshore wind construction activities declines. Note that only a single terminal (9 or 10) will be developed, further freeing up space for the conventional container terminals in Hai Phong International.

Figure 7-33 shows an initial high-level concept of the Hai Phong International offshore wind construction port.

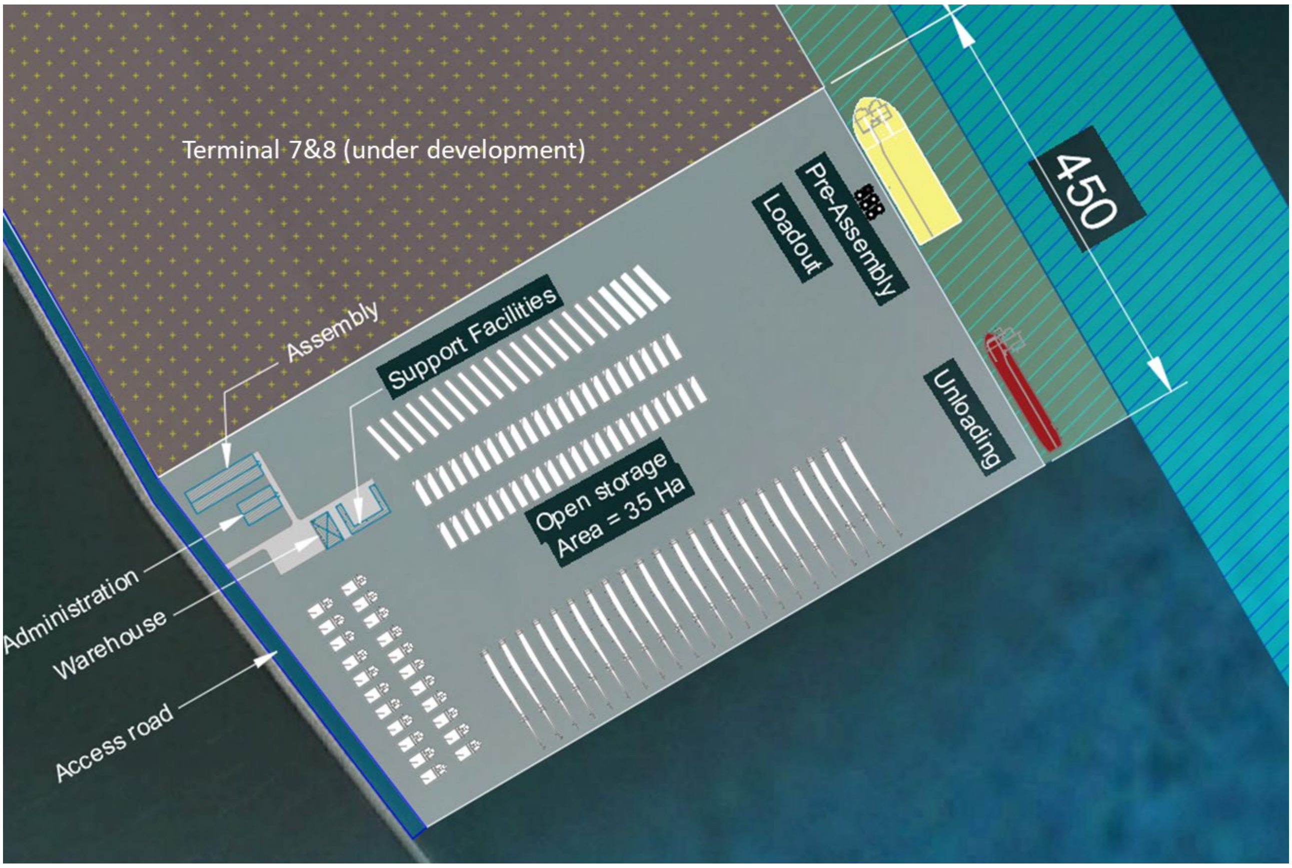


Figure 7-33: Hai Phong International Port offshore wind construction port concept (Terminal 9)

As discussed above, the terminal will be future proofed by ensuring the infrastructure can be easily converted to a container terminal at a later stage. This will involve the following requirements:

- Design the quay infrastructure for a berth pocket depth of 16 m CD. Container vessels have deeper draft requirements than WTIVs, and thus the berth pocket will need to be dredged to deeper depths at a later stage if this is not undertaken and maintained from the start; and

- Dedicated crane rail beams built into the quay infrastructure to accommodate large STS cranes for container operations.

The storage yard will have adequate bearing capacity and will only need to be resurfaced with concrete pavers to ensure a durable and level surface for container operations and stacking.

Therefore, the offshore wind terminal as shown in Figure 7-33 will have the following key properties:

- Berth water depth: -12.0 m LAT (design for -16 m CD – container terminal requirement)

- Total storage area: 35 ha

- Quay length and width: 2x 225 m (450 m total)

- Quay bearing capacity: 10 t/m²
- Yard bearing capacity: 20 t/m²
- Greenfield terminal for offshore wind which include the following:
  - Land reclamation of 35 ha and associated soil improvement
  - Scour protection
  - Quay construction (includes a suspended deck, revetment and seabed strengthening for jack-up legs. In addition, the deck will be constructed with foundations for pre-assembly tower packs and dedicated crane rail beams for later conversion to a container terminal).
  - Associated quay furniture, buildings, and electrical requirements (lighting, substation, etc.).

The solution proposed will require buy-in from local authorities and port owners to drive the renewable narrative within Viet Nam, but more specifically within the Northern region. Other than Nghi Son, there are no other ports which have favourable characteristics in the North and have a dedicated National Sea Port Master Plan mapping out infrastructure developments which could be used for OW. The solution is for the longer term i.e. beyond Power Development Plan 8 development goals; however, this can form a core component in ensuring Viet Nam can reach their future offshore wind targets.

7.7.6 Indicative Cost Estimate and Construction Timeline

Based on the development requirements for Hai Phong International (Terminal 9), an indicative construction cost and development timeline have been prepared.

The cost estimate has been developed using COWI's internal project data base and should be used as merely a guide for further investigation and development. Table 7-15 shows the cost estimate for Hai Phong International.

Table 7-15: Indicative cost estimate – Hai Phong International (Terminal 9)

No.	Construction	Cost (m USD)
1	Dredging	7.7
2	Scour protection, revetment, land reclamation (1)	60.0
3	Soil improvement	26.8
4	Quay construction	26.7
5	Quay furniture	1.1
6	Lighting and electrical works	5.9
7	Buildings, parking and fencing	3.6
8	Mob and demob (8%)	10.5
	TOTAL	**142.3**

(1) Includes provision for seabed strengthening

From the construction items highlighted in Table 7-15 a high-level timeline has been developed for major works which form the critical path – refer to Figure 7-34.

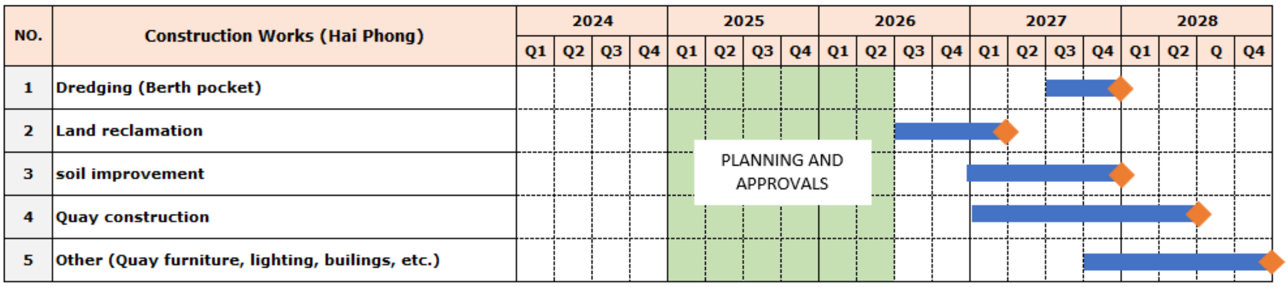


Figure 7-34: Indicative construction timeline

Additional time has been allocated from the start of 2025 to Q2 of 2026 to secure appropriate funding, government authorisations, development plans and associated design work.

7.7.7 SWOT Analysis and Conclusions

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis has been prepared in Table 7-16 which highlights key observations made for Hai Phong International and their potential role as a future offshore wind construction port.

Table 7-16: SWOT Analysis – Hai Phong International (Terminal 9)

STRENGTHS	OPPORTUNITIES
› Greenfield site with the flexibility to be developed to serve both offshore wind in the near term and containers in the longer term. › Well positioned in the North and has direct access to deep water. › Meets all key navigation criteria and can provide unrestricted access for WITVs.	› Terminal 9 and 10 currently do not have an owner, and there is an opportunity to rezone either of the terminals for general cargo (offshore wind). › Can be used as a catalyst within the North to promote the green energy transition and kick-start offshore wind projects in Viet Nam. › Convert the offshore wind terminal into a container terminal once demand for offshore wind services subsides. › Assist with the development on an energy hub within the Northern region.
WEAKNESSES	**THREATS**
› Will require significant investment away from the core business model in the Hai Phong region (container business). › Huge demand for container business in the area and this has been planned for the Hai Phong region in the National Seaport Master Plan.	› Developers are not interested in offshore wind in the North and would rather like to stay with the traditional container business. › Unable to rezone the terminal in the National Seaport Master Plan for general cargo purposes (offshore wind).

Hai Phong International Port has the best navigation characteristics in the North, with very few alternatives other than Nghi Son International Port. It is however noted that the proposed development is within a region which is dominated by the container industry and will require significant investment and local support to realise this opportunity. Although Terminals 9 and 10 have been targeted for the greenfield site, this could be shifted to further terminals (11 and 12), if there is no immediate business case which is attractive for developers.

As such, Hai Phong International Port is not likely to be port ready in time for Port Development Plan 8 timelines; however, this should be given serious consideration as a key enabler for longer term offshore wind development goals of Viet Nam. The area (Terminal 9 and beyond) has the potential to be developed into a future offshore wind construction port (unloading, storage, preassembly, and loadout) for offshore wind components in the Northern region. Furthermore, this can be later transitioned back into a container terminal when required.

Key Takeaway:

- Terminals 9, 10 (and beyond), offer an attractive greenfield site for an offshore wind construction port in the North.
- Development of the terminal may assist with kick-starting Viet Nam's offshore wind industry and the development of an energy hub in the North.
- Longer term development plan which will not likely form part of Port Development Plan 8. Support will need to be provided in the form of the following:
  - National government support and financing to attract developers to market.
  - Rezoning of the specific terminal for general cargo purposed i.e. offshore wind.
- Expected port readiness for offshore wind construction: 2028 and beyond (long term solution).

7.8 Port Readiness Summary

From the observations made in Section 7.3 to 7.7, Figure 7-35 summarises the port readiness level of the five candidate ports selected for Viet Nam. The readiness level is presented as a function of upgrade requirements, and associated cost and construction timelines.

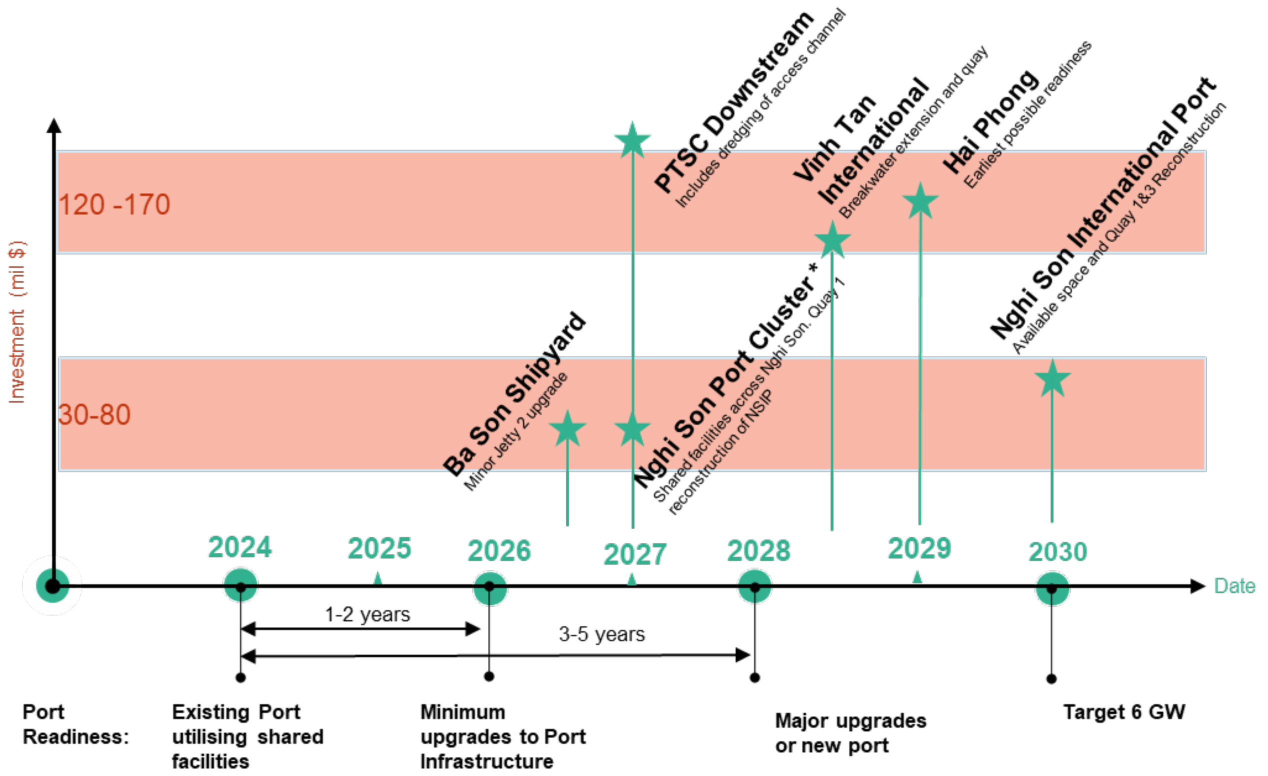


Figure 7-35: Port Readiness for Viet Nam

* An indicative amount has been provided for the Nghi Son Port cluster which focuses on the interim infrastructure upgrades required at Nghi Son International Port. It is unknown at this stage what upgrade requirements would be needed at Thanh Hoa and Long Son as part of this solution.

From Figure 7-35, a few key observations can be made:

1. The 5 candidate ports, in their current state, cannot accommodate offshore wind construction activities and will need a variety of port upgrades.

2. The Southern ports are leading the charge for offshore wind, with Ba Son Shipyard and PTSC Downstream potentially able to accommodate offshore wind by the start of 2027, and Vinh Tan International by Q2 of 2028.

3. Ba Son Shipyard requires the least amount of upfront investment; however, this is tailored towards the fabrication and load out of foundations only, which is complementary to the PTSC Downstream site.

4. PTSC Downstream have started developing a greenfield site which will be dedicated to offshore wind and could potentially be ready by the start of 2027. Therefore, PTSC Downstream and Ba Son Shipyard have the potential to develop a dedicated offshore wind supply chain in the south.

5. The Northern Ports are lagging, with no clear plans made to accommodate offshore wind. As such, a cluster of ports within Nghi Son would be required to service offshore wind construction activities in time to meet Power Development Plan 8. This is not ideal as it introduces several more interfaces for the developer to manage. This is also based on the premise of the reconstruction of quay 1 (or 3) of

Nghi Son International Port, and Long Son and Thanh Hoa ports meeting minimum offshore wind requirements.

6. Hai Phong International could potentially provide a longer-term solution for the North; however, this will require significant investment and political support.

8 COARSE SCREENING OF O&M PORTS

8.1 Introduction

This section presents the process followed to arrive at the selected ports for O&M activities. During the screening, both qualitative and quantitative metrics were used to assess and benchmark ports within the North, South-Central and South regions of Viet Nam.

As the location of the offshore wind sites are unknown at this stage, the navigation selection criteria were based on the more conservative SOV vessel requirements. Requirements for CTV ports are not demanding, and many ports can be used as long as they are situated close enough to the offshore wind farm.

The process followed for the port selection is summarized in Figure 8-1.

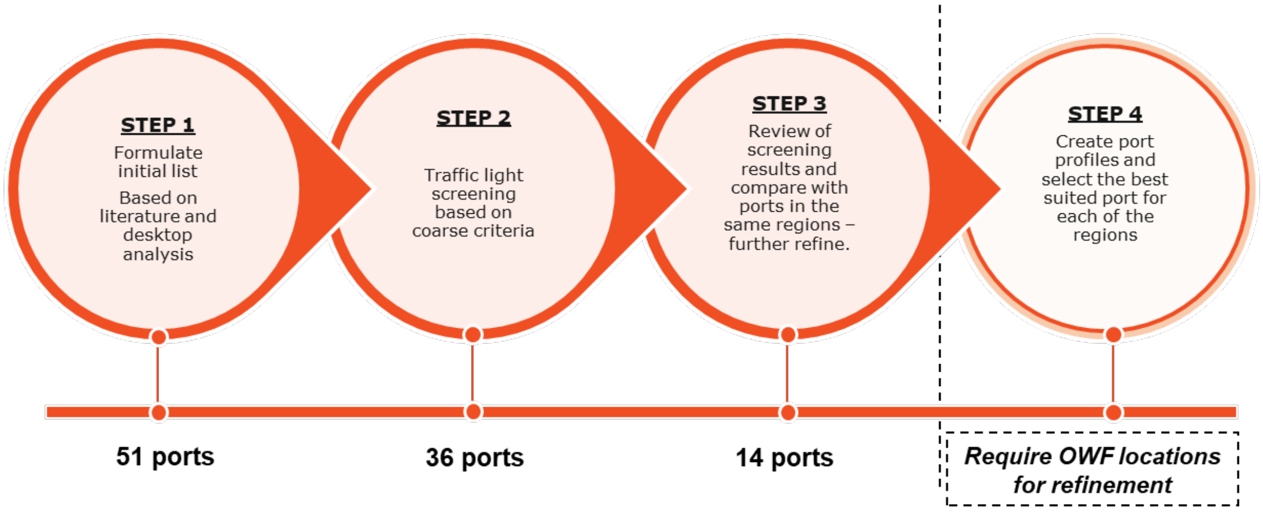


Figure 8-1: Selection process for O&M ports

Step 1: Prepare an initial list of ports based on available literature and location properties. Note that the list includes any potential green field sites which were recommended in previous studies, or by relevant stakeholders. Note that this is the same initial list which was used for the offshore wind Construction Ports.

Step 2: Undertake a traffic light assessment on the ports identified in step 1 using coarse criteria which focusses on navigation and access criteria, available yard area and current use and occupancy of the terminal. The requirements are less stringent then offshore wind construction ports and thus more ports were selected during the Step 2 phase.

Step 3: Further refine the screening undertaken in Step 2, to identify top potential O&M ports which best meet all recommended parameters within the 3 strategic regions i.e. North, South-Central, and South. The selected ports represent the best opportunities to accommodate offshore wind at this stage, using current available information.

Note, it was decided to not progress with further shortlisting of Step 4 as described in Figure 8-1 due to the unknown locations of the offshore wind farms. This is a key selection criterion and often drives the decision-making process due to how sensitive the final OPEX cost estimate is to this metric.

Therefore, instead of selecting a preferred O&M port for a specific region, multiple O&M ports were identified based on meeting the key criteria as shown in Table 8-1. Furthermore, the identified list of ports provides a reasonable spread along the coastline to ensure that a single identified O&M port will always be within 200 km of the offshore wind farms.

Table 8-1: Bottom-fixed O&M port criteria for SOV vessels (CTV Minimum requirement included for reference)

			CTV (2)	SOV	
	Property	**Unit**	**Minimum Req.**	**Minimum Req.**	**Recommended Req.**
Location & harbour	Distance to OWF	[km]	<100	<200	<100
	Harbour entrance width	[m]	>15	20-25	0.8-1 LOA (LOA = length overall)
	Channel depth	[m LAT]	>4	6-7	> 9
	Access channel width (1)	[m]	-	55	>55
	Presence of lock/gate	[y/n]	tolerable	Not Acceptable	
	Vertical clearance	[m]	> 10	>40	>75 or unrestricted
	Turning circle	[m]	40	100-150	>200
Berth & yard	Berth length	[m]	-	90-100	1.25-1.5LOA
	Depth at berth	[m LAT]	>4	6-7	>7
	Building area	[m²]	-	300	300
	Workshop	[m²]	-	700	700
	Yard area	[ha]	0.75	0.75-1.5	1.5
Other	Hinterland	[y/n]	y	Y	y
	Local qualified workforce	[y/n]	y	y	y
	Permits / licenses cost	[-]	-	-	-
	Possibility to lease existing infrastructure or equipment	[y/n]	y	y	y

(1) To be assessed on a case-by-case basis depending on access channel properties
(2) For information. If O&M ports use both SOVs and CTVs, CTV minimum requirements for distance to offshore wind farm must be adhered to.

Appendix A (page 3) provides an overview of the selection process for the O&M ports.

8.2 Step 1 - Port List Database

This step is described in Section 6.2 where the initial port list was established. The list is common for O&M and for construction ports.

A full list of the 51 identified ports is shown in Appendix A (pages 4-9), where they have been split into the 3 strategic regions. Furthermore, details are provided on the location, port ownership, and port type.

8.3 Step 2 – Traffic light screening

This step involved a coarse screening of the ports by using a traffic light system. The coarse screening criteria intended to identify parameters which would clearly disqualify the port, mainly in terms of vessel access and available space. Soft criteria such as terminal use, potential for expansion and expected upgrades were also considered during the screening. The criteria used for O&M ports is shown in Table 8-2.

Table 8-2: Traffic light code used in coarse screening Step 2 for O&M ports

Light code	Air draft [m]	Channel width [m]	Channel depth [m LAT]	Use of terminal/ occupancy	Available space
Red	Restrictions to air draft (Overhead cables, bridges…) Air draft <40m	<55	<7m	Highly occupied, container business, PA contacted and not interested in OW	No potential for expansion, or existing terminal yard below minimum requirements < 1.5ha
Yellow	Air draft restrictions >40m	≥55m	≥7m	Highly occupied, container business, PA contacted and interested in OW	Potential for expansion, sufficient yard area for coexisting activities ~ 1.5 ha
Green	Unrestricted	≥55m	≥7m	Low occupancy	Potential for expansion, or sufficient yard area available > 1.5 ha

A total number of 36 ports were selected for offshore wind O&M activities. Although a few of the selected ports showed high occupancy, a low likelihood to switch current business operations to OW, and little space available for future development, they were included at this stage of the screening exercise. The selection process linked to Table 8-2, and commentary is shown in Appendix A.

8.4 Step 3 – Review of Coarse Screening by Region

The 36 selected ports are grouped by region and investigated to see which ports meet minimum O&M requirements as shown in Table 8-1 based on its current available infrastructure and expected future development plans. High functioning container terminals will see little value in developing, or setting aside yard space, for O&M activities due to a more lucrative container business model. Unless there is a plan to convert some of these terminals to offshore wind construction terminals, they have been penalised in the selection process.

From the Step 3 screening exercise, a preferred list of O&M ports is provided for each of the regions along Viet Nam's coastline. This list can be used as a basis for selecting a preferred O&M port for a specific offshore wind farm once its location is known.

An updated Traffic light assessment was used in Step 3 which focused more on the minimum requirements aligned to Table 8-1. The assessment criteria are presented in Table 8-3 and is used throughout the Step 3 selection process. In addition, commentary is provided on the suitability of the ports for offshore wind O&M activities based on its current use and future development plans.

Table 8-3: Traffic light code used in the Step 3 screening process for O&M ports

Light code	Channel depth [m]	Channel width [m]	Vertical clearance (m)	Turning Circle	Berth Depth	Available yard area	Port use / availability
🔴	< 7	< 55	< 40	< 100	< 7	No available yard area	Highly occupied, not interested in OW
🟡	> 7, ≤ 9	≤ 55	> 40	> 100, ≤ 200	> 7, ≤ 8	Yes, ~ 1.5 ha	Highly occupied, but interested in OW
🟢	> 9	> 55	unrestricted	> 200	> 8	Yes, > 1.5 ha	Low occupancy

8.4.1 North Region Ports

A total of 10 ports located in the Northern region were shortlisted for Step 3. Figure 8-2 shows the location of the ports with respect to the Offshore Wind Zones.

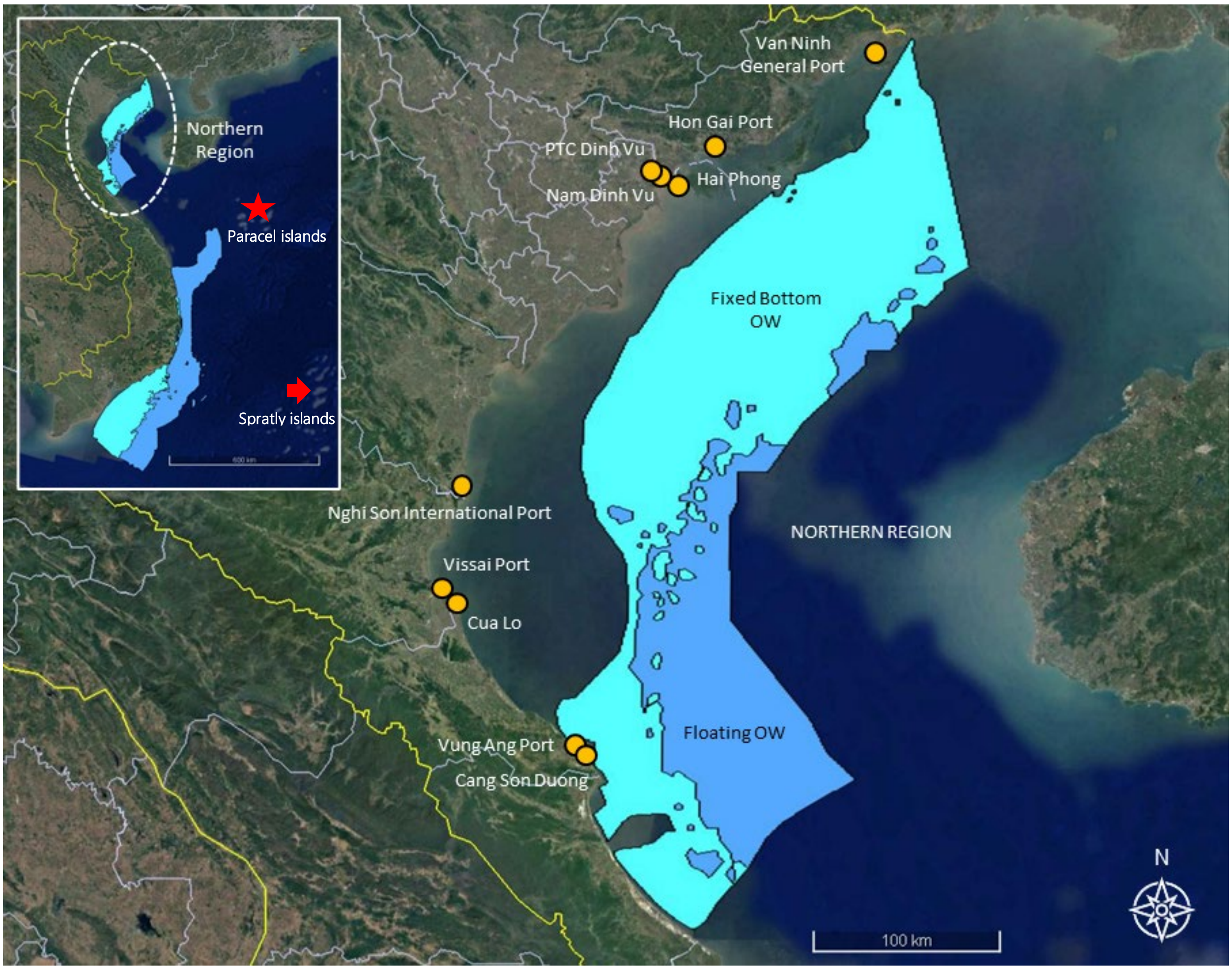


Figure 8-2: Identified Northern O&M ports

Table 8-4 provides a summary of the findings during the Step 3 screening based on current port operations, available area, and future development plans.

Table 8-4: Selected northern ports for O&M screening

Port name	Ownership	Current use	Future Developments
Nghi Son International Port	VAS Group	The port presents good conditions for O&M base, part of the existing terminal 1.5ha would be required.	Potential to develop a dedicated terminal or expand current yard and berths. Channel seems to be widened as part of Port Master Plan.
Hon Gai	CICT: JV SSA Marine and VIMC Quang Ninh port: Private	Vertical clearance of about 50-55m needs to be further investigated. There seems to be enough space for an O&M terminal	Vertical clearance about 50-55m needs to be further investigated. There seems to be enough space for an O&M terminal
Cua Lo Port	Vietsun Corp	The occupancy seems low-medium based on aerial images. Channel depth and width are below minimal requirements. Channel depth may require minimal dredging depending on SOV draft.	Expansion plans show additional yard area and berths at the eastern side of the port. Positive feedback received from stakeholders for offshore wind business case.
Vissai Port	Vissai Group	Good location and space. Activities would need to be disrupted and relocated. PA to confirm interest.	Future expansion presents enough yard area and berth length
Can Son Duong Port	Formosa Steel	Potential to use some of the available area and existing berths, as there seems to be low occupancy. Needs to be confirmed with PA.	Expansion plans show new terminals which could be used; however, timeline seems to be mainly focused on 2030 and after – this is beyond our study requirements
Hai Phong International Port	JV: Saigon New Port, MOL, Wanhai and Itochu	At least one of the berths and part of the container terminal would be used disrupting activities. Northern berth presents tugboats and could be upgraded (dredged). 1.5ha with direct access to quay would be needed.	Possibility to develop a dedicated offshore wind Terminal within future development plan. Terminals 9 and 10 could be used.
Van Ninh Port	JV: Duong Dong Group and Vinaconex	Not yet developed.	Possibility to develop a dedicated offshore wind Terminal but presents risk with development timeline and accessibility.
Vung Ang Port	JSC: VLP	Current activities would be disrupted as one berth would be required. There is enough yard area.	Unclear when future development is planned and what will be developed but could accommodate O&M base.
Nam Dinh Vu Port	Gemadept Corporation	There are OH cables downstream where clearance needs to be assessed. Current activities would be disrupted as one berth would be required together with 1.5ha space (high functioning container terminal).	Development could allow using some land for offshore wind terminal. There are OH cables downstream where clearance needs to be assessed.
PTSC Dinh Vu	PTSC	PA contacted and they are interested in offshore wind activities. Unknown timeline and ambition (O&M / Installation). Highly efficient container terminal; however, old terminals can potentially be converted to offshore wind. The port is further upstream of Nam Dinh Vu Port; therefore, navigation constraints are similar.	

Using the commentary in Table 8-4 a further screening process was undertaken looking into specifics related to O&M port criteria. The results of this screening exercise are provided in Table 8-5.

Table 8-5: Additional step 3 screening of Northern O&M Ports

Port	Channel Depth (m)	Channel Width (m)	Vertical Clearance (m)	Turning Circle (m)	Berth depth (m)	Available Yard Area (ha)	Port Use
Nghi Son International Port	10.3	120	N/A	335	9.5-13	> 1.5	Multi-use (land free)
Hon Gai	10	130	55 (bridge)	350	11.7	> 1.5	Multi-use (Land free)
Cua Lo Port	6.8-7.2	100	N/A	220	7.5	> 1.5	General cargo (Land free)
Vissai Port	11.5	100	N/A	280	11.5	> 1.5	Dry bulk (Land free)
Can Son Duong Port	18.5	400	N/A	900	18.5	> 1.5	Multi-use (Land free)
PTSC Dinh Vu	7	80	OH Cables (unknown)	260	6-8	~ 1.5	Container Terminal (congested)
Hai Phong International Port	13	160	N/A	660	16	> 1.5	Container Terminal (congested)
Van Ninh Port	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Multi-use (unknown)
Vung Ang Port	Unknown	Unknown	Unknown	Unknown	9.6-12.5	Unknown	Multi-use
Nam Dinh Vu Port	7	80	OH Cables (unknown)	300	8.5	> 1.5	Container Terminal (congested)

Based on current data available, the following ports have been selected as preferred O&M ports for the North.

- Nghi Son International Port
- Hon Gai Port (provided vertical clearance is not an issue)
- Cua Lo Port
- Vissai Port
- Can Son Duong Port

Hai Phong International port could service O&M activities but only if terminals 9 & 10 are developed into an offshore wind construction Port as described in Section 7. As this is a prerequisite, Hai Phong International has been excluded from the preferred list of O&M ports in the North. Figure 8-3 shows the selected O&M ports and the extent of their 200 km operating radius.

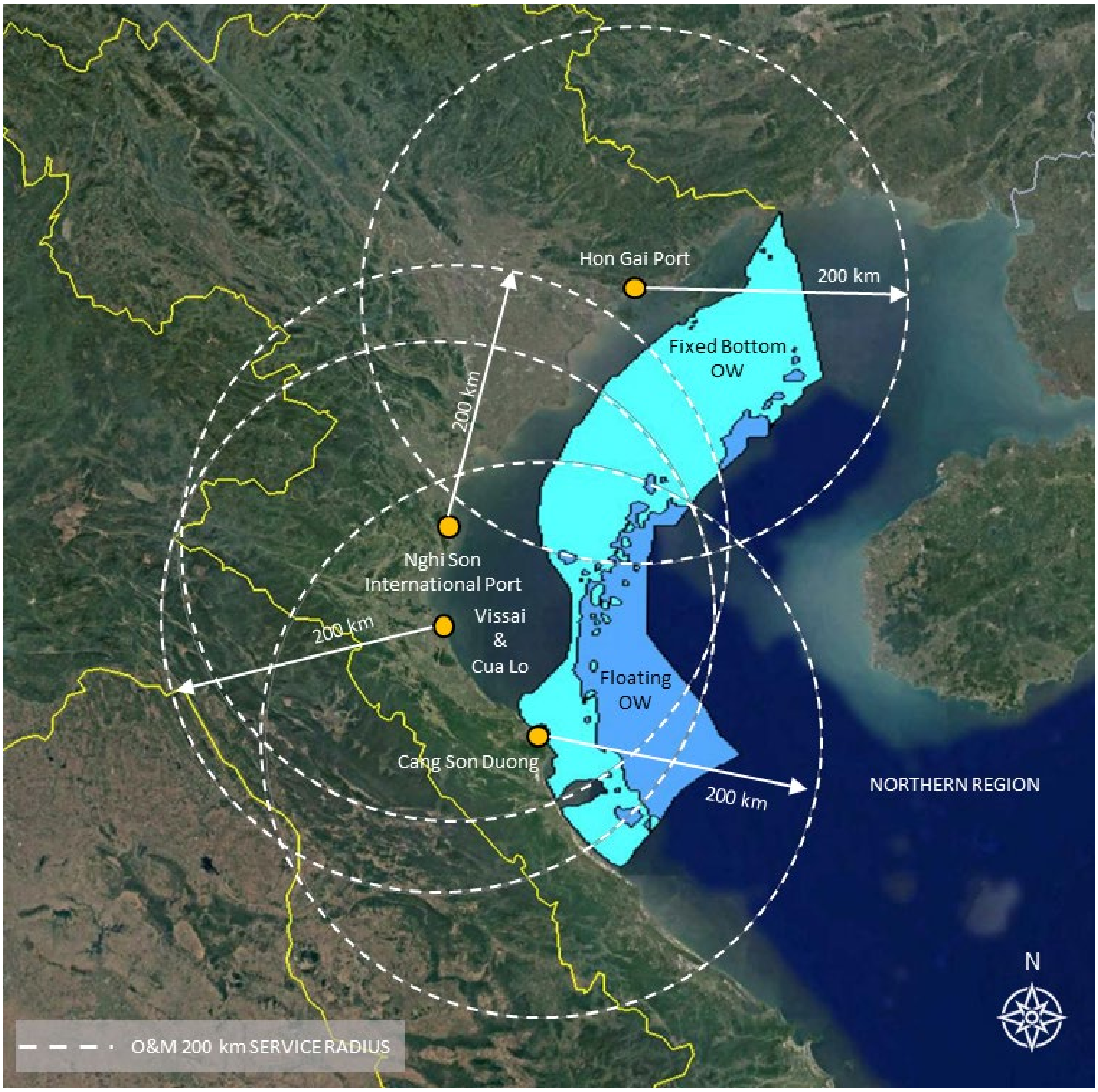


Figure 8-3: Possible O&M ports in the Northern region (Vissai & Cua Lo represented as one marker due to proximity)

8.4.2 South-Central region ports

A total of 11 ports were shortlisted for the Central and South-Central region. Although these ports are well suited for the floating Offshore Wind Zones, they are not ideally located in terms of distance to the bottom fixed Offshore Wind Zones.

Figure 8-4 shows the location of the respective ports in the South-Central regions.

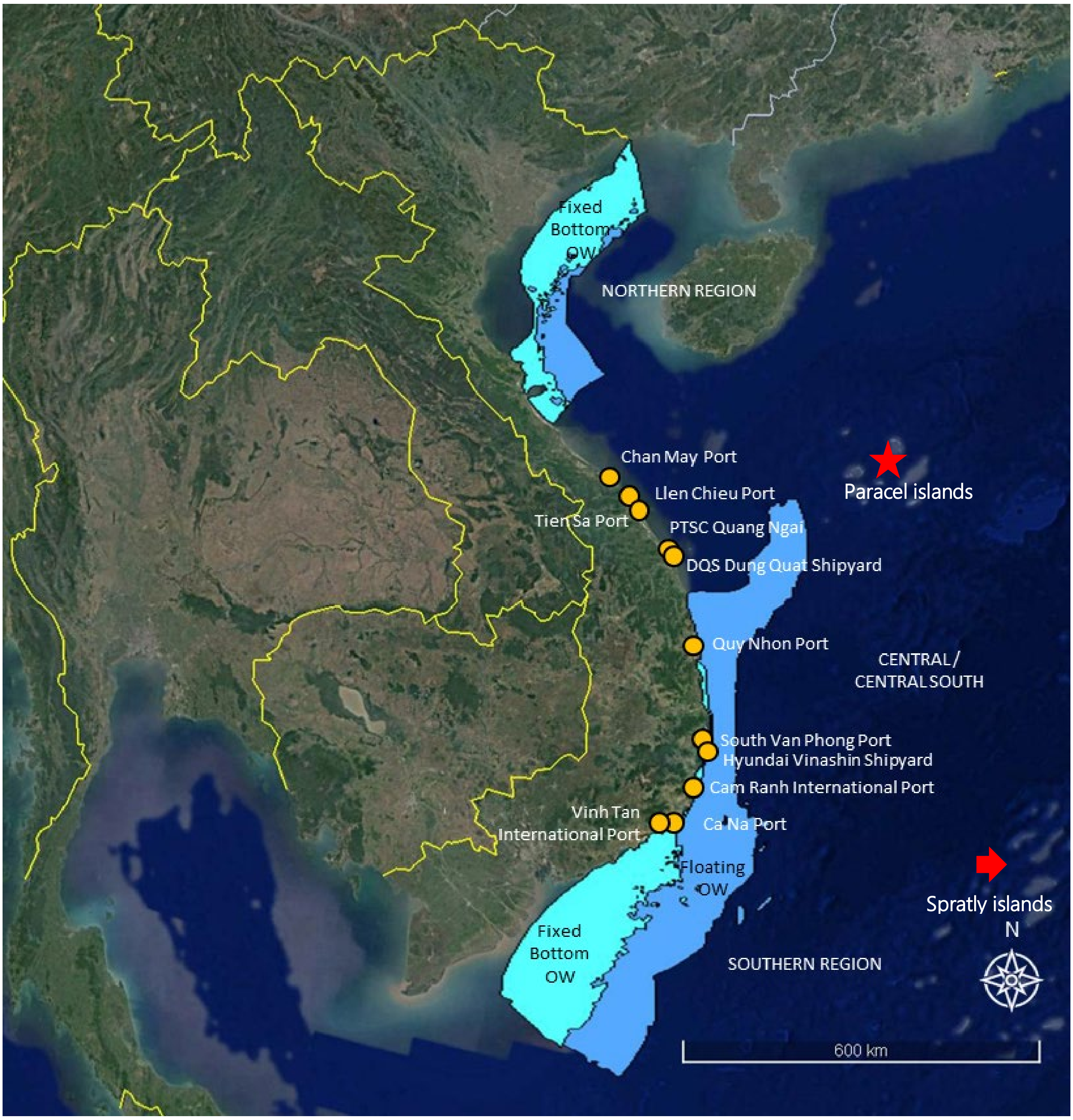


Figure 8-4: Identified South-Central O&M ports.

Table 8-6 provides a summary of the findings during the Step 3 screening based on current port operations, available area, and future development plans.

Table 8-6: Selected installation/construction ports for the Central and South-Central region

Port name	Ownership	Current use	Future developments
Cam Ranh International port	VIMC	Could serve O&M activities provided direct access from quay to O&M base. Would require using one berth.	Adjacent areas developed which could be used.
Ca Na Port	Trung Nam Group	Currently in development with phase 1A and 1B planned for June 2024 completion.	Presents a good opportunity for an offshore wind terminal provided this does not displace other planned operations. Breakwater required may pose a risk in timeline.
Chan May Port	JSC: SBIC	Current operations have been unsuccessful, and the port owner is open to transition to OW.	Expansion presents good opportunity to set a dedicated offshore wind terminal. May require breakwater extension. Due to location, possible to service some northern offshore wind farm sites.
Vinh Tan International Port	Pacific Group	The terminal seems to work well with Onshore Wind cargo. O&M base would disrupt some activities, but yard area and berth length seem sufficient.	Expansion plans present a good opportunity for an offshore wind Terminal. Breakwater may be required which may pose a risk in timeline.
DQS Dung Quat Shipyard	PVN	The shipyard presents good conditions for O&M base, expected to have qualified workforce.	There seems to be enough yard area for O&M base.
Hyundai Vinashin Shipyard	JV: Hyundai and SBIC	Good potential for using existing facilities. One berth would be required disrupting activities.	Expansion plans in the region do not affect the Shipyard where the O&M facilities would be located.
Tien Sa Port	VIMC	Seems congested, navigation conditions are good but there does not seem to be room for O&M base unless some land behind quay will be reclaimed or container storage space reduced.	Expansion plans unknown.
Quy Nhon	VIMC or Saigon New Port	New quay recently constructed which could be used for O&M. There seems to be sufficient yard area with access to quay. May require some dredging at quay depending on location.	Channel appears widened as 175m; adjacent areas developed (642m quay + yard). This is planned for 2030 which may be too late for the required timeline.
South Van Phong Port	JSC: SVP	Berth configuration is currently not suitable for offshore wind activities. It only has a pier with 2 berths. Check future development for suitable alternatives.	Future development presents good yard area, berth layout would need to be modified from current plans (land reclamation) and potential requirement for a breakwater.
PTSC Quang Ngai	PTSC	May need some dredging at the eastern side. We need 1.5ha for O&M which would need direct access to quay so one of the terminals would have to stop operating as it is now. Not much room for expansion,	Expansion plans consider new terminals; however, it is unclear if sufficient yard area could be developed in time.
Lien Chieu Port	JSC: Unknown	Not yet developed	Deprioritize as the breakwater would need to be developed before the terminal is in use. Risk of the breakwater not being developed in time.

Using the commentary in Table 8-6 a further screening process was undertaken looking into specifics related to O&M port criteria. The results of this screening exercise are provided in Table 8-7.

Table 8-7: Step 3 screening of Central, South-Central O&M ports

Port	Channel Depth (m)	Channel Width (m)	Vertical Clearance (m)	Turning Circle (m)	Berth depth (m)	Available Yard Area (ha)	Port Use
Cam Ranh International Port	9.5	125	N/A	330	6-13.3	> 1.5	Multi-use (Land free)
Ca Na Port	Unknown	Unknown	N/A	Unknown	16	> 1.5	Multi-use (Under construction)
Chan May Port	12	150	N/A	235	12	> 1.5	Multi-use (land free)
Vinh Tan International Port	9	140	N/A	360	10	> 1.5	Project Cargo (Land free)
DQS Dung Quat Shipyard	12	150	N/A	360	10.9	> 1.5	Shipyard (Land free)
Hyundai Vinashin Shipyard	17	200	N/A	300	10.9	> 1.5	Shipyard (congested)
Tien Sa Port	11.7	160	N/A	200	10-12	~ 1.5	Container / General cargo (congested – unknown expansion plans)
Quy Nhon	11	110	N/A	350	9-12.5	> 1.5	Multi-use (Land free)
South Van Phong Port	15	Unknown	N/A	Unknown	15	> 1.5	Multi-use (Berth not suitable for O&M)
PTSC Quang Ngai	Unknown	Unknown	Unknown	Unknown	Unknown	not available	Multi-use (congested)
Lien Chien Port	14	160	N/A	Up to 800	14	> 1.5	Under Construction (breakwater requirement)

Based on current data available, the following ports have been selected as preferred O&M ports for the Central and South-Central regions.

- Cam Ranh International
- Ca Na Port
- Vinh Tan International Port
- Chan May (servicing the northern offshore wind farm region)

Note that the two shipyards (DQS Dung Quat and Hyundai Vinashin) would be good candidates for a floating offshore wind O&M base, as they are more likely to present a qualified workforce, fabrication facilities and deep-water depths or sheltered areas for wet storage of the floaters, if they need to be towed to the facility. Thus, these have not been selected for this round of O&M ports, which focuses specifically on O&M ports for bottom-fixed offshore wind farms. If, however, it is shown that the proposed offshore wind farm will be located close to both DQS Dung Quat and Hyundai Vinashin Shipyard, then these can be alternatives to the list above.

Although Quy Nhon also seems like a good candidate, the location of the port relative to the fixed Offshore Wind Zones is not ideal and would ultimately result in its exclusion for consideration.

Figure 8-5 shows the selected O&M ports and the extent of their 200 km operating radius.

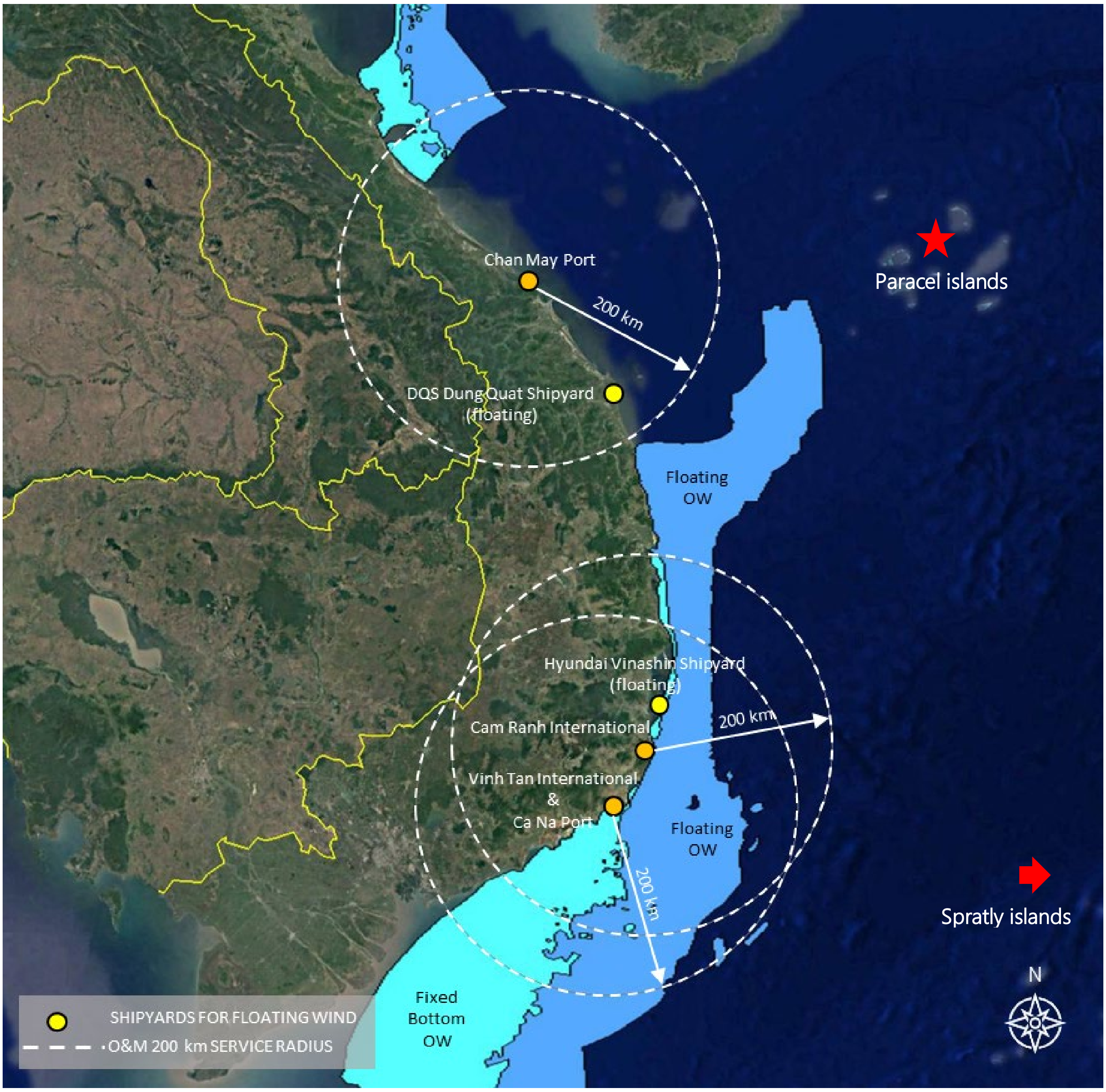


Figure 8-5: Possible O&M ports in the central region (Vinh Tan & Ca Na represented as one marker due to proximity)

8.4.3 South region ports

There are 15 ports located in the Southern region of Viet Nam which have characteristics well suited for an offshore wind terminal. However, most of the ports are located in river channels which may pose some restrictions to navigation or result in navigation delays, due to the high number of terminals within the same channel. Here vessel traffic may be an issue; hence the closer the port is located to the river mouth the more beneficial, provided there is suitable shelter for port operations.

Figure 8-6 provides an overview of the ports considered in the Southern Region.

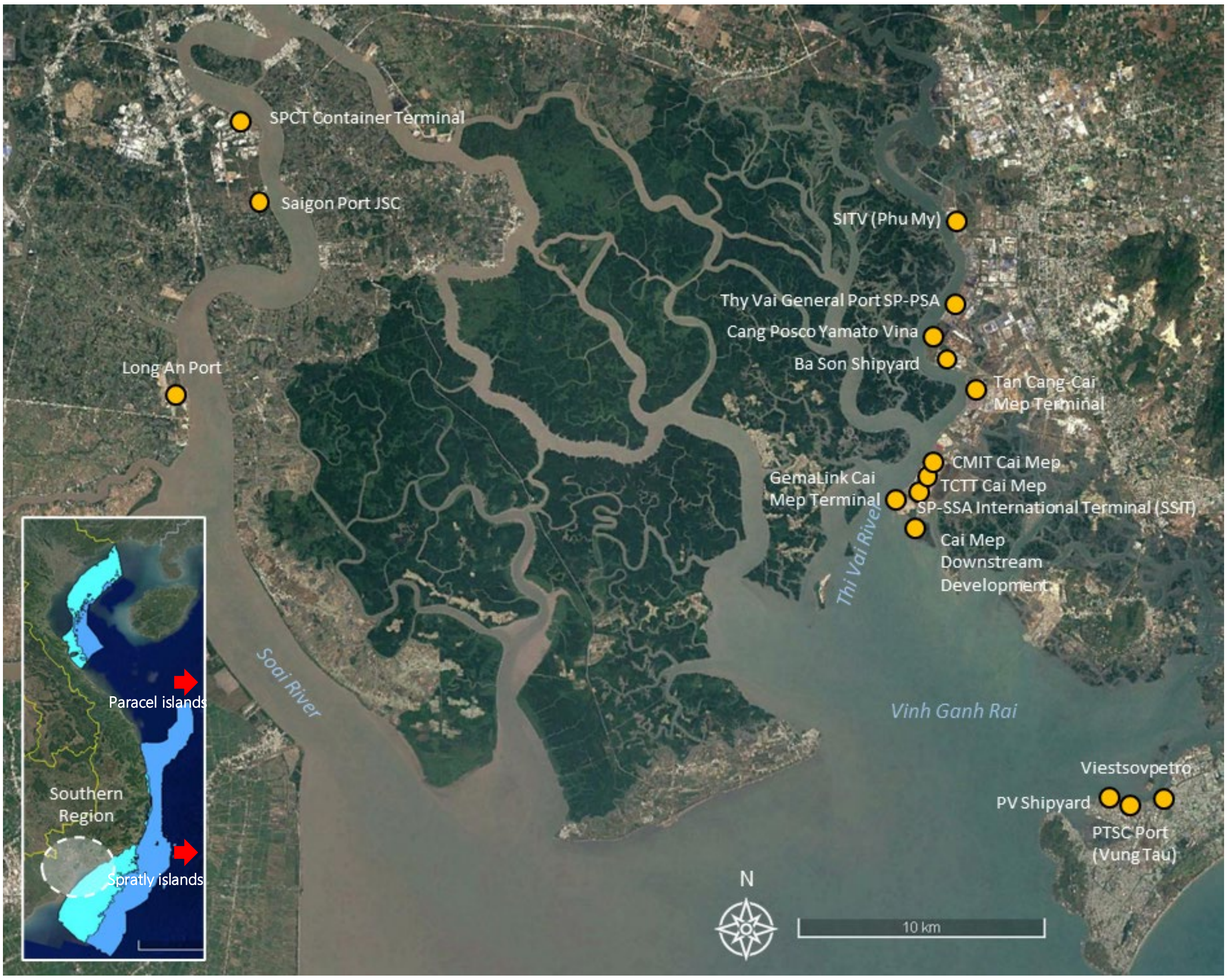


Figure 8-6: Identified Southern O&M ports

Table 8-8 provides a summary of the findings during the Step 3 screening based on current port operations, available area, and future development plans.

Table 8-8: Selected installation/construction ports for the South region

Port name	Ownership	Current use	Future developments
Ba Son Shipyard	Ministry of Defence	Sufficient storage yard area; however, may need upgrades to the quay or new quay in the adjacent area. Port is experienced with handling project cargo from onshore wind activities.	Port owners are keen to establish an offshore wind business. Master plan indicates new areas to be developed along the adjacent land. Potential delays due to one-way channel vessel traffic.
Vietsovpetro	VSP	May require dredging depending on vessel draft. Experience in handling project cargo which is a positive.	Expansion plans in the area present an opportunity. Offshore wind has been a target market for the future for the port.
PTSC Downstream	PTSC	May require dredging depending on vessel draft. Experience in handling offshore wind components.	Expansion plans present an opportunity. Port owners are keen to include offshore wind as a business case.
Long An Port	Dong Tam Group	Container terminal with general cargo purpose areas with sufficient yard space. Potential delays due to navigation channel.	Master plan shows a dedicated multi-purpose terminal which could potentially be used.
Saigon Port JSC - Hiep Phuoc Terminal	Saigon Port	OW terminal would need to disrupt current activities. May have navigation restrictions as described for the SPCT Container Terminal.	Adjacent areas developed. May have navigation restrictions as described for the SPCT Container Terminal.
Cai Mep downstream dev.	Unknown	Not yet developed.	Possibility to develop a dedicated offshore wind Terminal but presents risk with development timeline and environmental permits.
Cang Posco	Posco Group	Would need to upgrade the quay or provide a new quay in the adjacent area. This is however dedicated to the steel business.	Port owners not interested in offshore wind.
Tan Cang–Cai Mep Terminal TCIT	Saigon New Port	Currently a container terminal, therefore, need to confirm offshore wind business case with PA.	
Thi Vai General Port SP PSA	JSC: VIMC, Singapore PSA, Saigon Port JSC	Offshore wind terminal would disrupt existing operations. Potential to repurpose the northern berths for O&M activities but would need buy-in from the port owners. Increased waiting time due to upstream location of the port – risk for delays in schedule.	
SITV (Phu My)	CK Hutchison Holdings Limited	Offshore wind terminal would disrupt existing operations. Potential to repurpose the southern berths and yard area, however would need buy-in from the port owners. Increased waiting time due to upstream location of the port causing risk for delays in schedule.	
SPCT container terminal	JV: DPW and VIMC	Air draft (under power cables) 55 m. Night-time navigation limitation 18:00 – 6:00.	Unknown if future plans consider OH cables relocation.
Gemalink Cai Mep Terminal	JV: Gemadept and CMA CGM	Newly constructed container terminal. Would require repurposing.	Potential for expansion. Unknown timeline due to the recent construction of Gemalink Cai Mep Terminal.
SP-SSA INTERNATIONAL TERMINAL (SSIT)	JV: Saigon Port and SSA Marine VIMC /Vinalines)	Container terminal which would require major repurposing along the quay. Offshore wind would disrupt current operations. Potential delays due to the one-way channel and number of terminals in the area.	Potential for expansion but would require dedicating that entire area to OW. Unknown timeline.
TCTT Cai Mep	Saigon New Port	Container terminal which would require major repurposing along the quay. Offshore wind would disrupt current operations. Potential delays due to the one-way channel and number of terminals in the area.	No potential for expansion.
CMIT Cai Mep International terminal	Saigon New Port	No interest in offshore wind, based on communication with port	No plans dedicated to offshore wind, based on communication with port

Using the commentary in Table 8-8 a further screening process was undertaken looking into specifics related to O&M port criteria. The results of this screening exercise are provided in Table 8-9

Table 8-9: Step 3 screening of Southern O&M ports

Port	Channel Depth (m)	Channel Width (m)	Vertical Clearance (m)	Turning Circle (m)	Berth depth (m)	Available Yard Area (ha)	Port Use
Ba Son Shipyard	12	220	N/A	> 300	8-12	> 1.5	Shipyard / project cargo (Interested in OW)
Vietsovpetro	7 (1)	100	N/A	150	5.1-8.5	~ 1.5	Project cargo / oil and gas (interested in OW)
PTSC Downstream	7 (1)	100	N/A	200	9.0	> 1.5	Oil and gas / project cargo / OW
Long An Port	9	160	N/A	> 300	7-9.5	> 1.5	Container Terminal / Multi-purpose
Saigon Port JSC - Hiep Phuoc Terminal	8.5	120-160	N/A	> 300	9	> 1.5	Multi-purpose (available space)
Cai Mep downstream dev.	14	250	N/A	> 300	12-18	> 1.5	Still in planning phase (not ready for PDP8)
Cang Posco	12	250	N/A	> 300	7-11	Not available	Not interested in OW
Tan Cang–Cai Mep Terminal TCIT	12	250	N/A	> 300	12	Not available	Container Terminal (congested)
Thi Vai General Port SP PSA (2)	12	250	N/A	> 300	12	~ 1.5	Container Terminal / Multi-purpose
SITV (Phu My) (2)	12	250	N/A	> 300	12	~ 1.5	Container Terminal / Multi-purpose
SPCT container terminal	8.5	120-160	55 m	> 300	9	> 1.5	Container Terminal (congested / limited berth space)
Gemalink Cai Mep Terminal	14	250	N/A	> 300	16.5	Not available	Container Terminal (congested)
SP-SSA INTERNATIONAL TERMINAL (SSIT)	14	250	N/A	> 300	16.5	Not available	Container Terminal (congested)
TCTT Cai Mep	14	250	N/A	> 300	16.5	Not available	Container Terminal (congested)
CMIT Cai Mep International terminal	14	250	N/A	> 300	16.5	Not available	Container Terminal (congested)

(1) Ports may require dredging of the channel depending on vessel availability and type. There are future plans to dredge both the berth pocket and navigation channel; however, specific details are unknown.

(2) Located far upstream of the Thi Vai river which will result in significant delays due to one-way vessel navigation.

Based on current data available, the following ports have been selected as preferred O&M ports for the Southern region. Based on current interaction with the port owners in this cluster, PTSC Downstream have expressed the most interest in offshore wind and have previous experience in handling offshore wind components.

- Ba Son Shipyard
- Vietsovpetro
- PTSC Downstream
- Long An Port
- Saigon Port JSC

Thi Vai General Port and SITV meet key requirements for O&M ports; however, their remote location upstream of the busy Thi Vai River may impose significant delays in O&M activities due to vessel congestion. It is for this reason that they have not been included in the preferred list above.

Figure 8-7 shows the selected O&M ports and the extent of their 200 km operating radius.

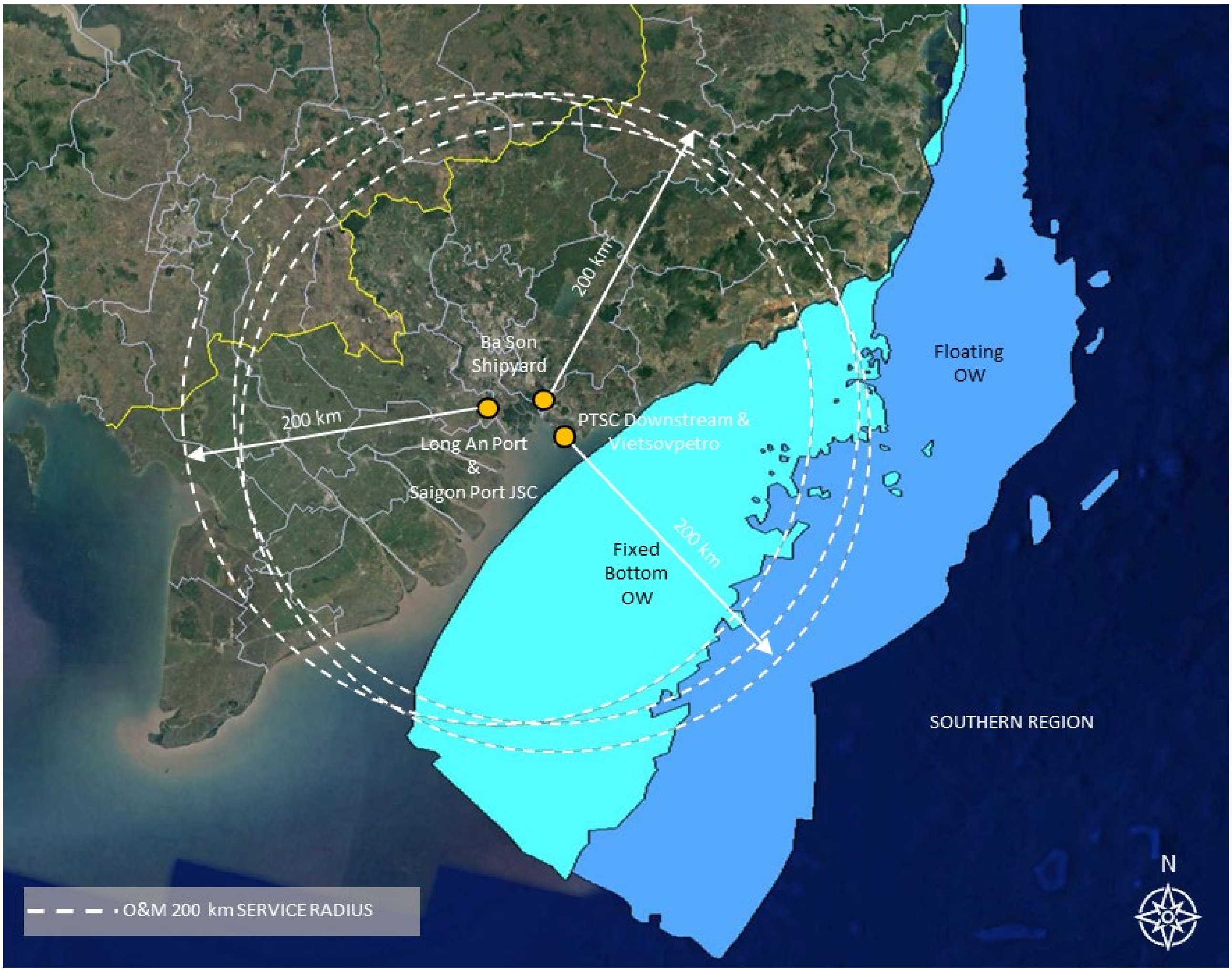


Figure 8-7: Possible O&M ports in the Southern region (Long An & Saigon represented as one marker due to proximity)

8.4.4 Summary of Step 3 results

From the Step 3 screening exercise, 14 ports along Viet Nam's coastline have been identified as possible offshore wind O&M bases. The screening criteria primarily focused on navigation properties, quay infrastructure, storage yard availability and general proximity to the identified fixed-bottom Offshore Wind Zones in the North and South regions. Although the Northern region is well represented along the coastline, and covers the entire Offshore Wind Zone, the O&M ports within the Southern region are all centred around Ho Chi Minh City. This creates an unserviceable area at the southernmost part of the identified Offshore Wind Zones, based on minimum SOV requirements. This gap could perhaps be filled with the new proposed development of the Soc Trang Deep Sea Port further South along the Viet Nam coastline

Figure 8-8 summarises the locations of the selected 14 O&M ports for Viet Nam.

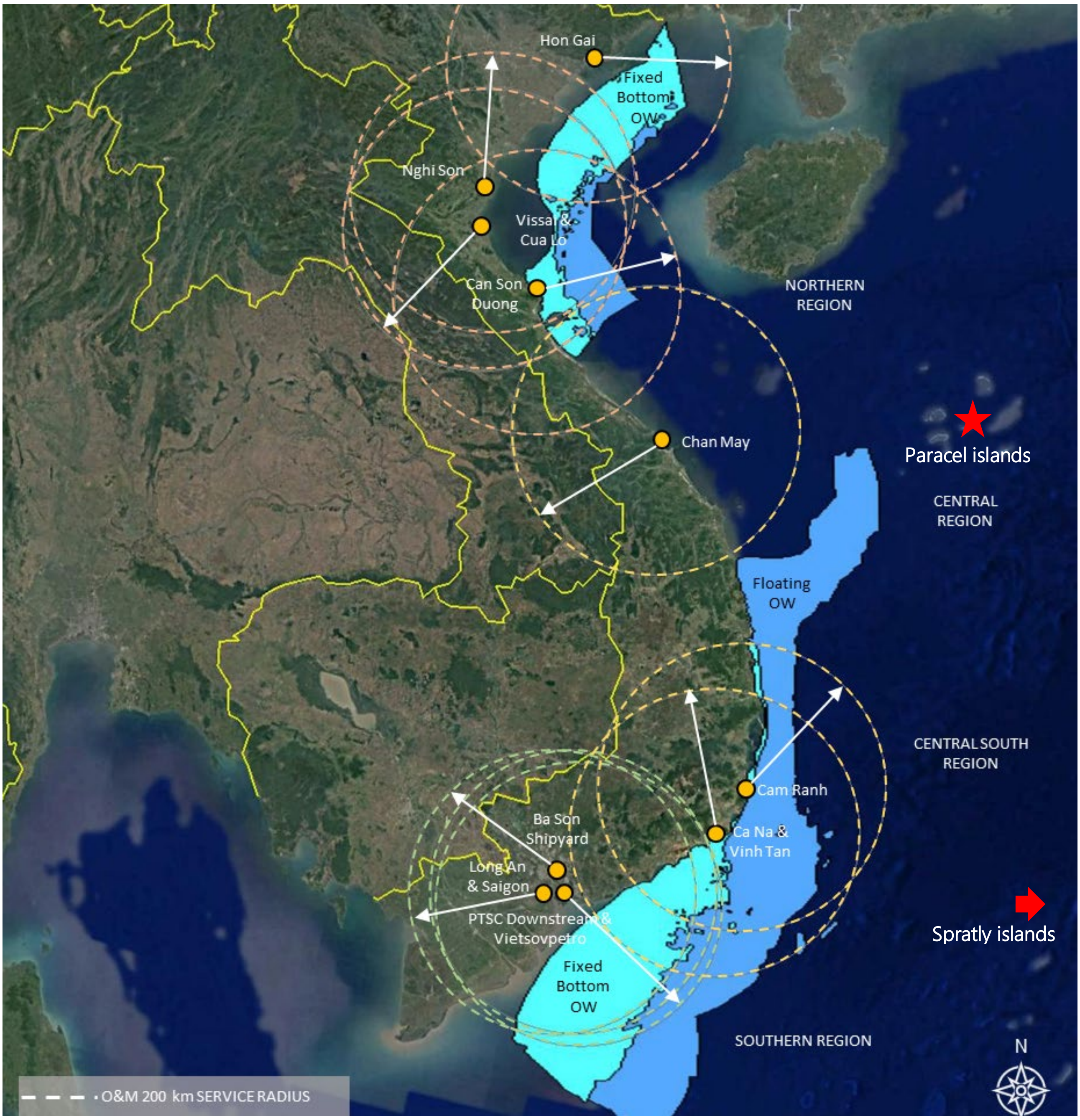


Figure 8-8: Summary of selected O&M ports

As distance to specific offshore wind farms is a key driver in selecting preferred O&M base ports for development, it is not recommended to progress further with shortlisting O&M ports as the exact locations of the offshore wind farms for Power Development Plan 8 are currently unknown. Going forward, these 14 ports should provide a good basis for further refinement. Note, the selection was based on accommodating SOVs. The use of CTV's may have increased the number of candidate O&M ports; however, their service radius would reduce to 100 km. This would more than likely lead to a reduction in serviceable Offshore Wind Zones in the South, as majority of the ports are located in proximity to one another.

The selected 14 O&M ports include the following:

- Northern Region
  - Nghi Son International Port
  - Hon Gai Port (provided vertical clearance is not an issue)
  - Cua Lo Port
  - Vissai Port
  - Can Son Duong Port
- Central, Central South Region
  - Cam Ranh International
  - Ca Na Port
  - Vinh Tan International Port
  - Chan May (servicing the northern offshore wind farm region)
- Southern Region (all centred around Ho Chi Minh City):
  - Ba Son Shipyard
  - PTSC Downstream
  - Long An Port
  - Saigon Port JSC
  - Vietsovpetro

8.5 Shipyards in Viet Nam

In addition to the construction ports and O&M ports identified in the previous sections for offshore wind in Viet Nam, there are many other shipyards, which can also play an active role in the development of offshore wind. Shipyards are primarily used for the fabrication and load out of foundations due to their qualified workforce, fabrication facilities and deep-water depths or sheltered areas for wet storage – an example of this to a certain extent is Ba Son Shipyard. In addition, shipyards can be used to fabricate the required vessels for O&M activities (CTVs and SOVs), and perhaps even WTIVs if there is adequate capability and available infrastructure.

Shipyards facilities are also closely aligned to requirements for floating offshore wind. They possess either dry or floating docks where large foundations can be fabricated and then floated out to sea when complete.

Viet Nam has several shipyards close to deep water which can possibly be used to assist both fixed and floating offshore wind developments. Table 8-10 provides a summary of identified shipyards along the Viet Nam coastline.

Table 8-10: Identified shipyards in Viet Nam

No.	Name	Location	Region
1	Ha Long shipyard	Quang Ninh province	North
2	Pha Rung shipyard	Hai Phong province	North
3	Bach Dang shipyard	Hai Phong province	North
4	Song Cam shipyard	Hai Phong province	North
5	Thinh Long shipyard	Nam Dinh Province	North
6	Dong Bac shipyard	Quang Ninh province	North
7	Hong Ha shipyard	Hai Phong province	North
8	Dai Tay Duong shipyard	Hai Phong Province	North
9	Dai Duong shipyard	Hai Phong province	North
10	Lisemco shipyard	Hai Phong province	North
11	X46 shipyard	Hai Phong province	North
12	Nam Trieu shipyard	Ho Chi Minh City	North
13	Ben Kien shipyard	Hai Phong province	North
14	Damen Song Cam	Hai Phong province	North
15	Cam Ranh shipyard	Khanh Hoa province	South-Central
16	Hyundai – Vinashin shipyard	Khanh Hoa province	South-Central
17	Song Thu shipyard	Da Nang province	South-Central
18	Dung Quat shipyard	Quang Ngai province	South-Central
19	SSIC shipyard- Ho	Ho Chi Minh City	South
20	Saigon shipmarin shipyard	Ho Chi Minh City	South
21	Vard shipyard (STX)	Ba Ria - Vung Tau province	South
22	SEAS shipyard	Ho Chi Minh City	South
23	Strategic Marine	Ba Ria - Vung Tau province	South
24	Triyard shipyards	Ba Ria - Vung Tau province	South
25	Vuot Song shipyard	Ho Chi Minh City	South
26	An Phu shipyard	Ho Chi Minh City	South
27	PTSC shipyard	Ba Ria - Vung Tau province	South
28	Vung Tau shipyard	Ba Ria - Vung Tau province	South
29	PV shipyard	Ba Ria - Vung Tau province	South
30	Ba Son shipyard	Ba Ria - Vung Tau province	South

9 JOB CREATION AND LOCAL CONTENT

9.1 Introduction

Construction projects such as a port upgrade or offshore wind farm construction require large investments and often employ a considerable number of people. The construction phase requires workers to produce and transport equipment and raw materials to the ports and offshore wind farms. This is the direct employment effect. The investments will also result in employment effects related to the extraction of raw materials, production of construction tools, provision of administrative, health and other support to the work force who are directly engaged in the construction. This is the indirect employment effect. The following sections will highlight the estimated employment effects for the potential port upgrade projects, as well as the employment effects created from an example case of a 1 GW offshore wind farm and the annual operation and maintenance of the offshore wind farm. The expected offshore wind farm development size for a port is about 1 GW to start with. For Viet Nam the resulting local employment effect is of importance and this is calculated based on experience from similar projects.

9.2 Methodology and Assumptions

Employment is measured in terms of full time equivalents (FTE), which measure the workload equivalent to that of an individual working full time for one year.

The calculation of the employment effects in input-output models relies on Leontief multipliers, total production output, and annual employment data by economic activity (ADB Data Library, 2022) (General Statistics Office, 2021) (General Statistics Office, 2021). These models were applied to analyse the direct and indirect impacts of investments. The dataflow of the calculation process is illustrated in Figure 9-1.

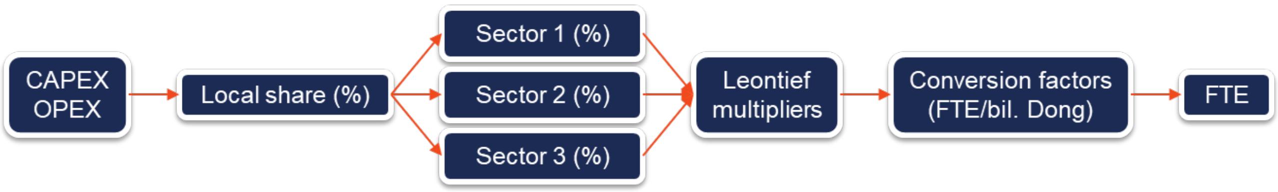


Figure 9-1 Data flow in the employment effect calculation.

Note: Sector shares are found in Table 9-1 and local shares in Table 9-2

The direct effect represents the increase in economic activity resulting directly from the investment itself. It includes tasks such as development, supervision, installation, and construction work. In contrast, the indirect employment effect emerges from the subsequent increase in labour demand due to the procurement of goods and services, which affects the suppliers in the supply chain.

In the specific case of Viet Nam's economy, the Leontief multipliers provided by the ADB divide the economy into 35 sectors. To assess the impact of port construction or upgrade, a connection to the relevant sectors is necessary (ADB Data Library, 2022). As port projects involve various tasks, each project category is linked to 3 sectors based on international experiences. The relative weights assigned to these sectors for each project are presented in Table 9-1.

Table 9-1 Assumptions on main sectors for each port upgrade project and example case

Construction project	Sector 1	Sector 1 share	Sector 2	Sector 2 share	Sector 3	Sector 3 share
PTSC Downstream	Construction	50%	Inland transport	20%	Manufacturing	30%
Ba Son Shipyard	Construction	70%	Inland transport	10%	Manufacturing	20%
Vinh Tan International	Construction	60%	Inland transport	20%	Manufacturing	20%
Hai Phong International Port	Construction	50%	Inland transport	20%	Manufacturing	30%
Nghi Son Port	Construction	80%	Inland transport	10%	Manufacturing	10%
Example case of 1 GW OWF - CAPEX	Construction	60%	Water transport	10%	Manufacturing	30%
Example case of 1 GW OWF - OPEX	Construction	70%	Water transport	25%	Manufacturing	5%

Source: COWI experience

The impact on GDP is converted to FTE years by using sector-specific employment figures from the General Statistics Office (General Statistics Office, 2021) and sector-specific production values from the General Statistics Office (General Statistics Office, 2021).

Viet Nam has not yet built any large-scale offshore wind projects, and the experience in offshore wind construction is therefore limited. Based on COWI experience from similar projects the local share for the first GW of offshore wind construction is in the low end. However, as Viet Nam has experience in manufacturing cables and the processing of steel (including some monopile, jacket and OSS fabrication facilities), and work is underway on enlarging these foundation production capabilities, the local share can increase. The increase is dependent on whether the production facilities are completed in time for the first offshore wind farm construction, whether the optimal conditions for the offshore wind farm site match what Viet Nam can manufacture, and the choices of the developer in the design and procurement process. The local share is expected to increase as Viet Nam accumulates experience in offshore wind construction, see Table 9-2. The local share of employment for operation and maintenance of an offshore windfarm is expected at a level of 90% and will not change over time.

Table 9-2 Expected development in local share for offshore wind development

Total installed capacity	CAPEX	OPEX	Components added to local supply chain
1 GW	30%	90%	Development, foundations, cables and secondary steel
5 GW	35%	90%	Tower components, XL foundations
30 GW	40%	90%	Installation and blades

Source: COWI experience from projects in India, adjusted with Viet Nam specific knowledge.

Based on the estimated investment for each port project (Table 9-3), the employment effects are calculated by sector. The model calculates both the direct and indirect effects, which can be summed to the total effect.

Table 9-3 Investment estimates (mUSD)

Name	Investment (mUSD)
PTSC Downstream	162
Ba Son Shipyard	41
Vinh Tan International	123
Nghi Son International Port	72
Hai Phong International Port	142
Example case of 1 GW OWF* - CAPEX	3,150
Example case of 1 GW OWF* – OPEX (annual investment)	70

*Source: sections 7.3.6, 7.4.6, 7.5.6, 7.6.6 and 7.7.6, *) example case based on COWI knowledge from other offshore wind projects in Viet Nam* (EREA & DEA, 2021).

9.3 Employment Estimates

Based on our analysis of the investment estimates made for the port upgrades, it has been calculated that these port upgrades have the potential to generate between 7,800-27,800 FTEs in direct employment and 3,100-12,900 FTEs in indirect employment as shown in Figure 9-2. The generated FTEs are the total amount created over the time span of the relevant port upgrades, which range from 2-4 years.

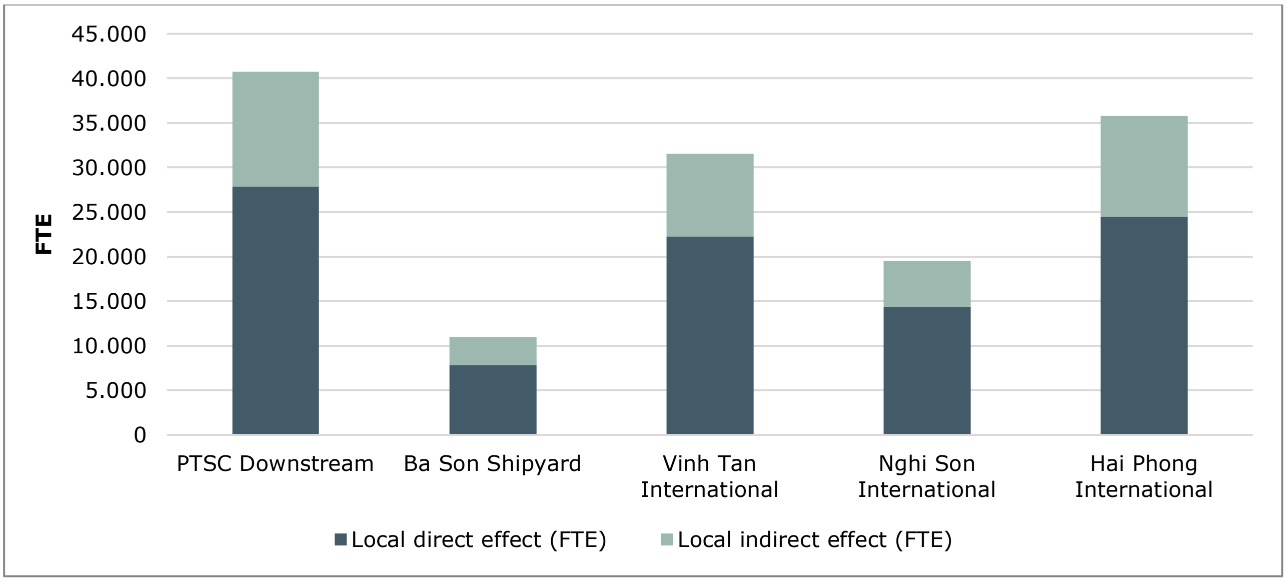


Figure 9-2 Total local employment effect from expected port upgrade investments during the construction period (FTE)

Source: COWI calculations based on employment model

As Viet Nam has vast experience in port construction and upgrade, the local share of the employment effect is expected to be 95-100% depending on the need to import steel and other raw materials. The employment effects are therefore estimated assuming a local share of 100%. The expected local total (direct and indirect) annual employment effect for each of the ports based on the timelines highlighted in sections 7.3.6, 7.4.6, 7.5.6, 7.6.6 and 7.7.6 are summarized in Table 9-4.

The annual local total employment effect calculated in Table 9-4 ranges between 4,900-16,300 FTE/year during port construction upgrade estimated to last between 2-4 years. The annual local total employment effects during the construction of the offshore wind farm is estimated at 83,500 FTE/year during the construction of the offshore wind farm, and 16,600 FTE/year during the 30-35 year span of operation.

Table 9-4 Annual local total employment effect (FTE/year) assuming 100% local employment in port construction, 10% in offshore wind farm construction and 90% in the offshore wind farm O&M phase

Port	Timeline	Construction time (years)	Expected local total effect (FTE/year)
PTSC Downstream	mid 2024 - end 2026	2.5	16,300
Ba Son Shipyard	mid 2024 - mid 2026	2.0	5,500
Vinh Tan International	Start 2025 - mid 2028	3.5	10,500
Nghi Son International	mid 2024 - mid 2027, mid 2028 – end 2029	4.0	4,900
Hai Phong International	mid 2026 - end 2028	2.5	14,300
Offshore wind farm	Timeline	Construction time (years)	Expected local total effect (FTE/year)
Example case 1 GW OWF CAPEX	When a port is ready	3	83,500
Example case 1 GW OWF OPEX	Once construction is complete	(1)	16,600

Source: COWI calculations based on timeline assumptions in sections 7.3.6, 7.4.6, 7.5.6, 7.6.6 and 7.7.6.

The construction of a 1 GW offshore wind farm is projected to contribute to the generation of approximately 250,400 FTEs, of which 171,900 FTEs are in direct and 78,500 FTEs are indirect jobs during the construction phase. With a construction period of three years, this amounts to 57,300 FTE/year direct and 26,200 FTE/year of indirect employment, see Table 9-4 and Figure 9-3. The jobs created from O&M amounts to 11,900 direct FTE/year and 4,700 indirect FTE/year, resulting in a total employment effect of 16,600 FTE/year which will continue to support local employment on an ongoing basis.

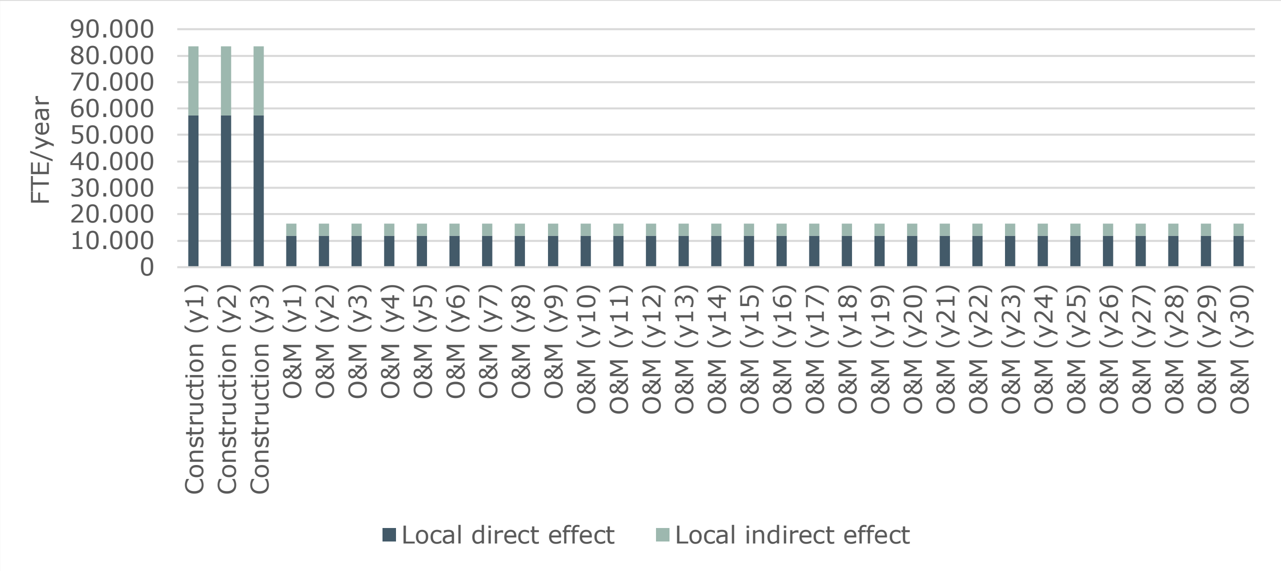


Figure 9-3 Annual local total employment effect from example case: 1 GW offshore wind farm during the construction of the offshore wind farm and the subsequent total annual effect from O&M (FTE/year).

Source: COWI calculations based on employment model

Overall, the job creation potential associated with the port upgrades is substantial, not only during the initial construction phase but also in the long term through the operation and maintenance activities. Additionally, the following construction of an offshore wind farm will have an even larger effect, and the O&M will continue to provide a steady flow of employment lasting 30 years or longer. This thriving employment ecosystem makes the port upgrades a promising investment, benefiting both the local economy and the broader community. The model does not consider whether there are sufficient workers to fill the jobs or whether the employment of the workers postpones other construction projects.

The employment effects are higher than the per MW estimates in e.g. European projects. When evaluating job creation in the offshore wind industry (e.g. FTE/MW), it is crucial to consider the contrasting contexts of e.g. Europe and Viet Nam. An investment in an offshore wind farm may have the potential to create more jobs in Viet Nam than in Europe. In the European context, productivity is influenced by well-established infrastructure, advanced technologies, and a high degree of automation. European countries benefit from economies of scale in the offshore wind industry, enabling efficient production processes and higher productivity levels. This, in turn, affects the number of jobs created.

9.4 Employment Split

Through interviews and analysis of Danish projects, valuable insights have been obtained into the employment split by educational level for projects on port construction and offshore wind farm construction. This is summarized in Table 9-5. The following section will outline the educational level breakdown assumed for the direct employment effects in the construction projects.

Technology, construction, and transport: This category includes workers with practical skills in various construction-related professions. Examples of job roles in this category are welders, electricians, chauffeurs, masons, carpenters, and joiners, building painters, and mechanics. These workers are skilled in their respective trades and play a vital role in the construction industry.

Unskilled: These workers typically perform tasks that do not require specialized skills. They may be involved in general labour, earthwork, concrete casting, basic maintenance, or other similar roles. Unskilled workers provide support and assistance in various areas of the construction and offshore wind farm industries. These workers have no formal education but might have gone through security courses which enables them to operate heavy machinery or conduct other specialized tasks.

Technical science, long-cycle higher education: This category includes workers with a higher education background in civil engineering, including management. These individuals have in-depth knowledge and expertise in technical sciences and are responsible for the planning, design, and management of construction projects.

Technical science, medium-cycle higher education: This category encompasses workers with medium-cycle higher education, such as building technicians and certified engineers. They have acquired highly specialized technical skills and knowledge through their education and play a significant role in the technical aspects of construction and infrastructure projects.

Technical training, short-cycle higher education: Workers in this category have received specialized technical training but have completed a shorter cycle of higher education. Examples include building technicians, construction technicians, plumbing, heating and sanitation experts, and those with technical qualifications from a technical college.

Higher education without further specification: This category includes workers who have reached higher education degrees and possess knowledge in various areas that can be applied to the construction or offshore wind farm industry as specialists or managers.

Office, commerce, and business services: Workers in this category engage in administrative and support functions within the construction and offshore wind industries. They typically perform tasks related to clerical work, business operations, and commercial activities.

Other: the competencies in this category provide a wide range of support functions in humanities, social science, food, agriculture, healthcare, maritime services, natural science, police, and defence. These competencies provide with administration, legal questions, business development, design and similar.

Table 9-5 Employment split of the direct effect by educational level (%)

Educational Level	Port Construction (%)	Offshore Wind Construction (%)
Technology, construction, and transport	70%	29%
Unskilled	22%	36%
Technical science, long-cycle higher education	3%	3%
Technical science, medium-cycle higher education	0-1%	3%
Technical training, short-cycle higher education	2%	16%
Higher education without further specification	2%	0%
Office, commerce, and business services	0-1%	6%
Other*	0%	7%

Note: the employment split is based on experience from projects for the Danish Road Directorate and the Educational Secretariat for Industry (Educational Secretariat for Industry, 2023).
** Skills under the "Other" category are not specified in the port construction material but are included under the other educational levels.*

The indirect employment effects cannot be split up by educational background, as was done with the direct effects above. However, with each of the construction/upgrade projects linked to the three primary sectors highlighted in Table 9-5 it is possible to identify which sectors will contribute the most to the indirect employment effect. This effect includes procurement of equipment and resources, as well as support from most other sectors in the economy.

The construction sector obtains a large part of its support from the sectors of basic metals and fabricated metal, financial intermediation, real estate activities and coke, refined petroleum, and nuclear fuel. The sector also finds support from the electricity, gas and water supply sector, the sector of wholesale trade and commission trade and the renting of machinery and equipment and other business activities sector. Finally, the construction sector obtains goods and services from itself.

The main sector contributing to the inland transport sector is the coke, refined petroleum, and nuclear fuel sector, which provides fuel and fuel related support. The transport support sector also provides a great deal of support in terms of auxiliary transport activities and activities of travel agencies. Finally sectors such as the basic metals and fabricated metal sector, the machinery sector, the wholesale trade and commission trade sector, the water transport sector, the financial intermediation sector, as well as the renting of machinery and equipment and other business activities sector also provide support to a smaller extent.

Similar to the inland transport sector, the water transport sector obtains its main support in terms of goods and services from the coke, refined petroleum, and nuclear fuel sector and the transport support sector. To a small extent, the water transport sector obtains goods and services from the financial intermediation sector and the sector of renting of machinery and equipment.

The manufacturing sector obtains its main support from the electricity, gas and water supply sector and the mining and quarrying sector. Sectors such as the coke, refined petroleum, and nuclear fuel sector, the basic metals and fabricated metals sector, the whole sale and commission trade sector and the construction sector provide goods and services for the manufacturing sector as well.

In summary the main sectors manufacturing, construction and inland and water transport provide the direct employment effects. In turn these sectors produce goods and services from other sectors which results in an indirect employment effect. This indirect employment occurs when the sectors obtain fuel and electricity for running the operations, raw materials for manufacturing and construction and machinery to support in all four of the main sectors. The financial and real estate sectors are important sectors, as the project requires financing and real estate support throughout the supply chain.

The split of the direct employment by educational level is estimated by port below in Table 9-6 and for an offshore wind project of 1 GW in Table 9-7.

Table 9-6 Employment split of the local direct effect by educational level by port upgrade project during the construction period (FTE)

Port	PTSC Downstream (FTE)	Ba Son Shipyard (FTE)	Vinh Tan International (FTE)	Nghi Son International (FTE)	Hai Phong International (FTE)
Unskilled	19,500	5,500	15,600	10,000	17,100
Technology, construction, and transport	6,100	1,700	4,900	3,100	5,400
Technical science, medium-cycle higher education	800	200	700	400	700
Technical science, long-cycle higher education	500	200	400	300	500
Technical training, short-cycle higher education	500	100	400	300	500
Office, commerce, and business services	200	100	100	100	200
Higher education without further specification	200	100	100	100	200
Total (FTE)	**27,800**	**7,900**	**22,200**	**14,300**	**24,600**

Source: COWI calculations based on employment model

Table 9-7 Employment split of the local direct effect by educational level by offshore wind project phase during the construction period of the offshore wind farm and one year of O&M (FTE)

Offshore Wind Farm	Example case 1 GW OWF CAPEX (FTE/year)	Example case 1 GW OWF OPEX (FTE/year)
Unskilled	16,700	3,500
Technology, construction, and transport	20,400	4,200
Technical science, medium-cycle higher education	1,900	400
Technical science, long-cycle higher education	8,900	1,800
Office, commerce, and business services	1,800	400
Higher education without further specification	3,500	700
Other	4,100	800
Total	**57,300**	**11,800**

Source: COWI calculations based on employment model. Note: the above distribution of skills assumes an even distribution of the skills over the construction period.

9.5 Summary

Construction projects such as port upgrades and offshore wind farm constructions are significant investments that have a substantial impact on employment. These projects create both direct and indirect employment opportunities. Direct employment involves tasks such as development, installation, and construction, while indirect employment arises from increased labour demand in the supply chain due to the procurement of goods and services. The estimated employment effects for 5 potential port upgrades in the North, South-Central and South of Viet Nam, as well as an example case for 1 GW offshore wind farm, is based on input-output models with Leontief multipliers, measuring the impacts in full-time equivalents (FTE).

For the port upgrades in Viet Nam the total employment effects range between approximately 7,800-27,800 FTEs in direct employment and 3,100-12,900 FTEs in indirect employment over the construction period, of which 95%-100% is the expected local effect, with the larger port upgrades generating higher employment effects.

For the example case of an offshore wind farm of 1 GW, the local share is very much dependant on the choice of site for the first offshore wind farm, and whether this matches the manufacturing capabilities available in Viet Nam, as well as the specific developer strategy. The construction phase of a 1 GW offshore wind farm is estimated to generate total local employment effects of approximately 83,500 FTE/year. The annual O&M effect is estimated to generate a total local employment effect of approximately 16,600 FTE/year. Thus, the largest employment effect is seen when the ports have been upgraded and the construction of an offshore wind farm begins. The size of the effect depends on the size of the actual offshore wind farm. The combined effect of the increase in required labour force during construction and operation is significant and essentially last over a period of 30 to 35 years.

The direct employment effect is further analysed by educational level, highlighting the range of roles from unskilled labour to highly specialized technical positions. The main employment effect for both port upgrade construction and offshore wind farm construction is to be found in technology, construction, and transport, as well as in unskilled labour. The latter will be sourced locally and therefore has a strong positive impact for the people and the economic benefit of the region. It is recommended to invest in sourcing and training the work force in a timely fashion.

Additionally, the indirect employment effect is generated in the interaction between the main sectors involved in port upgrade and offshore wind farm construction and other sectors such as fuel, electricity, raw materials, machinery, construction, financial services, and real estate services. This emphasizes the interconnectedness of economic activities within these projects and their broader impact on the economy.

10 OWNERSHIP MODELS AND INCENTIVE STRUCTURE FOR OFFSHORE WIND PORTS

10.1 Introduction

10.1.1 Background

Viet Nam has defined a target of 6 GW of installed offshore wind capacity in Viet Nam by 2030 and towards 2050 the capacity is expected to increase at least tenfold.

This development places great demands on the infrastructure in e.g. the ports of Viet Nam and other land-based infrastructure that can support the development of offshore wind energy. The development of both offshore wind farms and the ports requires planning, the involvement of authorities, securing financing, etc. These are processes that will often take several years to complete. There is therefore a need to involve the relevant stakeholders in a timely manner and make investment decisions that ensure the development of the infrastructure.

Viet Nam has a growing port sector, where the focus is mainly on goods transport, primarily container traffic. Viet Nam thus has extensive experience in developing the port infrastructure. It is therefore important to ensure that offshore wind is included in the development of port capacity in Viet Nam in the coming years, especially in the areas of Viet Nam that have a relevant location in relation to the offshore wind farms.

As analysed in this report, this means that the ports must either prioritize using their current port capacity for the offshore wind market, or that the ports must develop new capacity, i.e. investments in quay facilities, equipment and areas that can be used in connection with storage, pre-assembly and unloading of offshore wind components. It is important for the development of a large capacity for offshore wind energy, that models can be found for the development and operation of offshore wind ports, that can motivate the owners of the ports to enter the offshore wind market. The models need to support the expected capacity and need to be realistic and include a practical way to finance the new capacity.

This section presents models for developing offshore wind ports and outlines advantages and disadvantages for different models. In addition, the section also contains a description of the regulation of the port sector, including the planning processes that have been established for the development of the ports.

10.1.2 Objective

The overall objective of this study is to support Electricity and Renewable Energy Authority and MOIT with the implementation Plan for the Power Development Plan 8 by identifying models for port development, i.e. port facilities that are necessary to developing and operating offshore wind farms.

More specifically in this section, the objectives are as following:

- To identify approaches to incentivize port owners to move into the offshore wind market.
- To identify possibilities and limitations in Viet Nam’s regulations regarding port development.

- To identify different business models for offshore wind ports, including describing the advantages and disadvantages of each.

The task includes both ports used for construction of wind turbines and O&M ports (ports used for O&M activities).

10.1.3 Scope of Work

This task has been based on case studies from international examples of offshore wind ports, desk studies of Viet Nam's regulations for ports and planning procedures for port development, interviews with port owners and other relevant stakeholders during a series of workshops with selected Viet Nam ports in April 2024.

10.2 Case studies of offshore wind ports

10.2.1 Introduction

The case studies in this section contain studies of different models for the development and operation of ports, which are used in either the construction phase or the operation phase of an offshore wind farm. The case studies are based on desk studies of the individual projects. In some cases, the study is based on direct dialogue with the individual ports in connection with COWI's previous analyses.

The case studies are all European examples of ports which have developed both the capacity to handle offshore wind turbines, and which have achieved a position on the market for offshore wind. In Northern Europe in particular, the offshore wind industry is well developed.

10.2.2 Installation and Construction Case studies of an Offshore Wind Farm.

Port of Cuxhaven, Germany

Figure 10-1: Port of Cuxhaven, Germany

Ownership and Economical Structure

Port of Cuxhaven is part of the port company 'Niedersachsen Ports' in Northwest Germany. Niedersachsen Ports is owned by the State of Niedersachsen and the company operates 6 ports altogether.

The port in Cuxhaven is a cargo port and offshore wind is one of several business areas. The port is divided into several terminals and handles 2.5 million tons of goods (2022). The goods vary from vehicles (cars for export) to solid goods (sand, building materials etc.) and cargo trailers. Moreover, several ferry connections are operated from the port.

Port of Cuxhaven – Development in Wind Industry

Until the 1980's, Port of Cuxhaven was primarily a fishing port and ferry port for local traffic. In recent decades, the port has experienced growth in RORO traffic, bulk cargo and in recent years especially project cargo, primarily wind turbines for offshore wind farms.

Cuxhaven is located ideally for offshore wind farms in the southern part of the North Sea. In 2015, Siemens Gamesa started the construction of a construction plant for offshore wind turbines. The plant is located approx. 300 meters behind the quay. The plant manufactures nacelles for 14MW offshore wind turbines. Since 2020, Titan Wind Energy has been operating a plant for wind turbine towers in Cuxhaven.

Since Siemens Gamesa has a fabrication facility in Cuxhaven, there is a relatively constant activity of shipping wind turbines for offshore sea farms in the North Sea. The 'Hollandse Kust Zuid' offshore wind farm in The Netherlands for the offshore wind developer Vattenfall is an example of this. The project was developed in 2022 and comprises 140 wind turbines, each with an effect of 11MW. In 2024, 60 14MW wind turbines will be shipped from Cuxhaven to the offshore wind farm 'Moray West' near Scotland.

Development Plans

Port of Cuxhaven expects to see substantial growth in cargo volumes, i.e. a doubling in volumes by 2040. Vehicles, trailers, wind turbines, and building materials have the strongest growth potential[4]. This means that Niedersachsen Ports expect to develop more port areas in the future, including berths and hinterland for offshore wind activities.

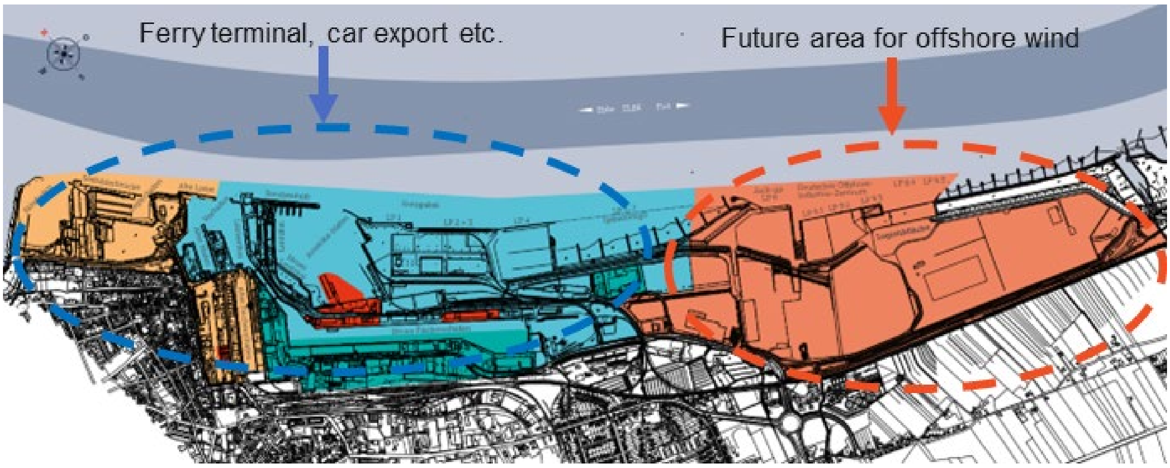


Figure 10-2: Future area for offshore wind. Source: Port of Cuxhaven, Outlook Paper.

[4] Outlook Paper, Port of Cuxhaven, 2020.

Financial Sources and Investments

The development of port capacity in Niedersachsen takes place in close cooperation between the port company and the state. Port expansion projects are often on the Niedersachsen State investment plan for several years before a final investment decision is made. The financing is a split between the State of Niedersachsen and the port company, but the exact distribution may vary from project to project, depending on the nature of the project. The port will generate income from renting out land and from port fees.

In March 2024 it was published that Port of Cuxhaven will begin construction of a major port expansion. The project includes 1,250 meters of new quays and associated hinterland, and the facility will have specifications to handle the market's largest offshore wind turbines. The project's total costs are 300 million EUR. The State of Niedersachsen will contribute 100 million EUR for financing and the port and private partners will contribute the remaining 200 million EUR. The total sum of 300 million EUR also includes investments in storage and manufacturing facilities, used by the wind turbine manufacturing industry. The private share of the investments covers these facilities.

Key Learnings from Port of Cuxhaven

Port of Cuxhaven presents an example of a port which has established itself on the offshore wind market during approx. a ten-year period. The Port is part of the state-owned port company 'Niedersachsen Ports'.

The port is still an active port within other market areas, such as ferries, bulk cargo, car export etc. and these business areas continue to be developed. Through several phases, the port has developed from a construction port to a hybrid fabrication/construction port incl. two wind turbine manufactures.

All port infrastructure is owned by the port company and investments are made by the port, with some state co-funding.

Port of Hull, Great Britain

Figure 10-3: Port of Hull, England

Ownership and Economical Structure

Port of Hull is located on the Humber River, close to the North Sea. Since 2020, the Port of Hull has been owned by Great Britain's largest port operator, Associated British Ports (ABP). ABP is a holding company which owns a total of 23 ports in the UK. ABP is owned by five pension investment funds. Port of Hull handles approx. 10 million tonnes of goods a year. The port handles timber and other dry bulk products, containers etc. and it has several ferry routes.

Port of Hull – Development in Wind Industry

Port of Hull has experienced a decline in traditional goods (steel, coal, etc.) since the 1980's, due to a decline in traditional industrial production (steel industry etc.) in the UK. Port of Hull has become one of the largest business development areas in Great Britain, due to a long-term recovery plan for Hull. The recovery plan facilitates the transition to new industries, including offshore wind. Port of Hull has become a significant offshore wind centre because of its proximity to the largest offshore wind farms in the North Sea. Since 2010, Siemens Gamesa has been operating a wind turbine factory in the port. Production has been expanded several times and in 2021 Siemens Gamesa began a major expansion of the production of wind turbine blades in Hull. The facility is located directly next to one of the quays in the port.

Figure 10-4: Siemens Gamesa facility. Port of Hull, England. Source: Green Port Hull.

Since Siemens Gamesa has a production facility in Hull, the port has been involved in several offshore wind projects, e.g. the 1.32GW Hornsea Two-project in the North Sea for the Danish offshore wind developer Ørsted. The project was developed in 2022 and comprises 165 wind turbines, each with an effect of 8.4MW. Blades for the offshore wind farm 'Moray West' near Scotland has also been supplied from Siemens Gamesa's factory in Hull.

Development Plans

Since Port of Hull is owned by a private company, the development of the port's offshore wind activities is closely linked to the development of this market. There are no official public development plans for offshore wind activities in Port of Hull, but Associated British Ports has announced 'ABP Sustainability Strategy for 2023[5], which foresees significant investments in capacity within offshore wind in the coming decades.

Financial Sources and Investments

[5] ABP Sustainability Strategy for 2023, February 2023.

In recent years, Associated British Ports has been successful in attracting large private investment to Hull and the rest of the Humber area. As mentioned, Siemens Gamesa has invested in production facilities in more cases. The investment in 2021 was followed up by public support from "Offshore wind manufacturing investment support scheme", which is a public support program. The program was launched by the government's Department for Business, Energy & Industrial Strategy in 2021. Port of Hull has also received public economic support from local and regional sources; however, these are smaller amounts for development projects.

The conversion of the Port of Hull from traditional industry to offshore wind includes, to a lesser extent, actual port constructions. The investments have primarily concerned production facilities, which are to some extent supported by public funds, targeting the offshore wind industry.

Key Learnings from Port of Hull

Port of Hull presents an example of a port which has established itself on the offshore wind market since 2010. The port is owned by the private company British Ports.

Beside offshore wind, Port of Hull is active within containers, dry bulk and liquid bulk, RORO and ferries, etc. and these activities are still very important for the port.

Siemens Gamesa has a large factory in the port, which is manufacturing turbine blades. The factory is located immediately behind the quay. This means that port is now an offshore wind fabrication port, with focus on offshore wind farms in the North Sea and the rest Northern Europe.

The port infrastructure is owned by the port company and investments are made by the port, with some state contribution from special schemes.

Port of Rønne, Denmark

Figure 10-5: Port of Rønne, Denmark

Port of Rønne is a small port on the relatively small Danish Island 'Bornholm' in the Baltic Sea. Port of Rønne is a limited company, however the majority of shares are owned by the local municipality. Two local trade organizations own the rest of the shares. The activities in the port are ferries, solid goods (sand, building materials etc.) cargo trailers etc. The port handles approx. 1.3 million tonnes of goods a year. Until 10 – 20 years ago, fishing was a major industry in the port, but it has almost completely disappeared in recent years.

Development in Wind Industry

Offshore wind is a relatively new business in the Port of Rønne. The Port and the island have no wind turbine industry, and the island is expected to be too small for that. This means that the port acts as a pre-assembly port - meaning that all components are transported to the island and assembled there. The ports role is primarily to be a logistics and service hub throughout the construction period of a wind farm.

Offshore wind farms are developing significantly in the Baltic Sea these years and there are plans for offshore wind farms in both Poland, Germany and the other Baltic countries. In 2021, Port of Rønne entered the first offshore wind project, as the port was chosen for the construction of the 605 MW 'Kriegers Flak' offshore wind farm in Denmark. Since then, also the 'Arcadis Ost1' (257 MW) and 'Baltic Eagle' (457 MW) in Germany have been constructed, using Port of Rønne as a pre-assembly port.

Development Plans

Although the Port of Rønne is a smaller port, the port has undergone a significant transformation over the past 10 years.

The port has expanded and optimized the areas in a number of smaller stages, firstly to be able to continuously finance the project and secondly to be able to maintain normal operations during the construction process. The final stage is expected to be completed during 2025. However, the port will remain a smaller port, but with new quays and port areas dedicated to offshore wind.

As there are several offshore wind farms on the way in the Baltic Sea area, the Port of Rønne may also have a role as an O&M port in the future. However, the possibilities for further expansion of the port are limited by the surrounding city and by environmental restrictions. Therefore, it is expected that the port will reach its maximum size within a short time. At the same time, it is expected that several ports in the Baltic Sea will be competitors as construction ports on the offshore wind market in the near future.

Figure 10-6: Port of Rønne, new port area for offshore wind. Source: Port of Rønne

Financial Sources and Investments

Danish ports finance their own development, typically with loans guaranteed by the local municipality. In Rønne, there are no private investors involved in the investments. The ports business model is that energy companies and wind turbine manufacturers lease the ports land on a project basis and pay normal port charges, while the port retains ownership of the infrastructure.

Altogether Port of Rønne has invested more than 130 million EUR in new port facilities since 2019. The investments include a new breakwater, navigation channel a with a water depth of 11 meters, approx. 1000 meters of new quay designed for heavy loads and approx. 20 hectares of hinterland.

Key Learnings from Port of Rønne

Port of Rønne presents an example of a small port, which has just recently (since 2020) established itself on the offshore wind market.

Port of Rønne is also active within ferries, dry bulk and liquid bulk, cruise ships etc.

There is no wind turbine manufacturing in the port. This port mainly operates as an offshore wind construction port, with focus on offshore wind farms in the Baltic Sea. The port has been involved in three offshore wind project up to 605 GW.

The port is a limited company owned by the local municipality. All investments are made by the port itself.

10.2.3 Case Studies of Ports, used in the O&M Phase

Port of Łeba, Poland

Port of Łeba is a small port on the Baltic Sea coast of Poland, near Gdynia and Gdansk. The port is owned by the local municipality and has mainly been functioning as a yacht port until now.

The two energy companies ORLEN Group and Northland Power have acquired a site at the port. The plan is to develop an O&M base for one or more major offshore wind farm in the Baltic Sea. At first, the site will house an O&M base for the 1.2 GW Baltic Power offshore wind farm in the Baltic Sea. The 70 wind turbines will be delivered by Vestas.

The base is expected to employ a total of around 60 people and will service the offshore wind farm for its entire life cycle i.e., at least 25 years. An area of approximately 1.1 hectares will house a warehouse for spare parts and a workshop. The port facilities will be able to accommodate vessels with a maximum length of 35 meters. The base will be permanently serviced by 3-4 specialized crew vessels (CTVs), designed to transport equipment and service personnel.

The project for port development, storage facilities etc. is financed by ORLEN Group and Northland Power.

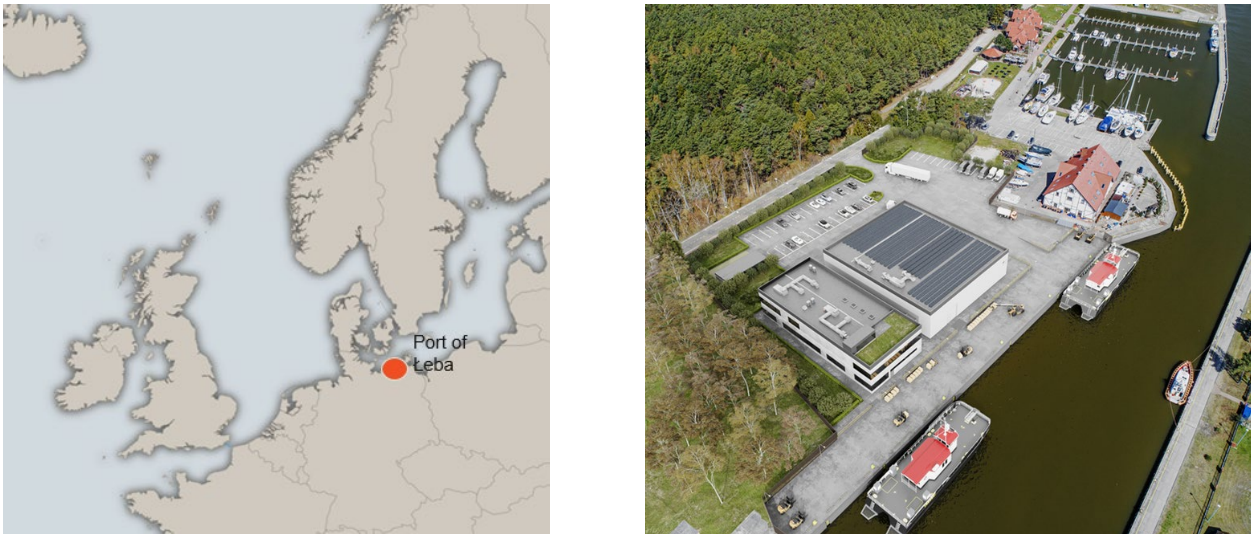


Figure 10-7: Port of Łeba, Poland. Source: Baltic Power

Port of Thorsminde, Denmark

Port of Thorsminde is a small fishing port on the North Sea coast of Denmark. The port is an independent port, owned by the local municipality.

In 2022, the German offshore wind developer RWE decided that Port of Thorsminde will be O&M port for the new Thor offshore wind farm. Thor will consist of 72 wind turbines (14 MW each) delivered by Siemens Gamesa. Construction is expected to start at the end of 2024, and it is expected that the O&M facility will be fully operational from 2026 and the offshore wind farm will be operational in 2027. RWE is financing its own facilities in the port and will lease the land for the facility from the port. The port has financed the needed deepening of the port basin and the navigation channel and receives normal port fees from the vessels that service the offshore wind farm. The port will be a base for 2-4 crew vessels (CTVs) in the operating phase. RWE is expected to create 50-60 permanent local jobs in connection with the operation. This includes technicians, engineers, as well as seamen for the service ships.

Figure 10-8: Port of Thorsminde, Denmark. Source: Port of Thorsminde

Key Learnings from Port of Łeba and Port of Thorsminde

Both Port of Łeba and Port of Thorsminde represent very small ports, which are chosen as O&M ports, due to their proximity to the relevant offshore wind farms.

The O&M activities place limited demands on the ports' capacity.

In Port of Łeba, the offshore wind developer has acquired a small site and established storage facilities and a small quay for CTVs etc. In Thorsminde, the offshore wind developer is building its facilities on land, leased from the port.

10.3 Regulations for Ports and Planning Procedures for Port Development

Ports and port development in Viet Nam are regulated by the Maritime Law (Law no. 95/2015/QH13) and the Planning Law (Law No. 21/2017/QH14), including amendments.

The Maritime law regulates all activities related to the sea, shipping, and transport at sea. The law also regulates seaports, the activities related to seaports and the seaports roles and functions. A central provision in the Maritime Law is, that the State must secure the development of marine infrastructure, by adopting a national planning for maritime infrastructure, including ports (the National Seaport Master Plan (SMP).

The Planning Law defines which authorities must carry out the planning and which requirements are set for the specific planning. The concrete planning for port infrastructure (e.g. spatial planning, planning of road connections etc.) takes place at Provincial level, but within the framework of the overall national planning. Development of new port infrastructure must take place within the framework of the plans, i.e. Master Plan for the Development of Viet Nam’s Seaport System (National Seaport Master Plan). The Planning Act therefore plays an important role in the development of port infrastructure.

10.3.1 Regulation via The Maritime Law and The Planning Law

The Maritime Law stipulates that the construction of new ports must be based on the overall National Seaport Master Plan, which is based on the country's socio-economic development, including the development of industrial production and the need for the transport of goods etc.

The National Seaport Master Plan contains plans for the development of clusters of ports, port terminals, wharves etc. Ministries and the provinces are responsible for the concrete implementation of the master plan, including that land areas are reserved for port facilities etc. The port master plan is an important instrument in the development of port capacity in Viet Nam and the construction of new ports or new terminals and port facilities must therefore be done within the framework of the master plan. It therefore requires long-term planning if an expansion of the capacity in the port sector is to be carried out, in order to meet the needs of the offshore wind industry.

Amendments to the National Seaport Master Plan were being prepared in 2024 and the plan was approved in March 2024.

The Maritime Law also determines the organizational framework for the ports, including ownership and management and implementation of investments.

10.3.2 Investments, Operations and Ownership of Seaports

Investments in seaports and navigation channels must be consistent with the National Seaport Master Plan. It is allowed for foreign organizations (e.g. foreign companies or investors) to invest in seaports, terminals etc., as long as it is done within the applicable legislation in the maritime area.

There are several examples of international companies that invest and operate ports or port terminals in Viet Nam. This applies, for example, to SPCT port in Ho Chi Minh City, where DP World (United Arab Emirates) participates in both investments and the operation of this port, SSA Marine (USA), which participates in SSIT port in the Ba Ria-Vung Tau province and APM Terminals (Denmark) which invests in operating CMIT Port in the Ba Ria-Vung Tau province.

Ports or port terminals which are owned and/or operated by international companies, are subject to the general laws governing the operation of ports and the construction or expansion of ports. This means, that before investment in a project, a written consent from the Ministry of Transport must be obtained.

Since 2023, it has been an official government objective to attract foreign capital to develop infrastructure in ports. The policy of attracting external financing is a result of the fact, that Viet Nam’s state in 2015 decided to target the state funds for maritime investments towards the more general maritime infrastructure, such as navigational channel system, lighthouses, anchorage areas, shelters etc. On the other hand, the state contributes to a lesser extent with financing for port construction.

However, the state and the private sector can continue to participate in investments in port projects. The Law on Public-Private Partnerships (PPP) in Viet Nam is a clear legal option for this.

10.4 Ownership and Business Models for Offshore Wind Ports

10.4.1 Introduction

This section presents different models for the establishment and operation of offshore wind ports. The models for port development, which are described here, are based partly on the international case studies of offshore wind ports, and partly on the legal regulation of the port sector, which is applicable in Viet Nam.

A large number of ports in Viet Nam are undergoing a major development in cargo volumes in these years and many ports have a very high-capacity utilization. This means that new business areas within offshore wind must compete with established business areas in the ports. Considerations about development models for offshore wind ports therefore also include considerations about how to develop port capacity for this purpose, while the other market areas, for example freight, are also experiencing significant growth.

10.4.2 Port Development Models

Based on the international cases, we can observe at least two general models for the development of ports for the offshore wind market.

It is possible to find variants of the two overall models presented below, based on local conditions. It is also possible for a port to change status over a period of time, from being a construction port, possibly with smaller projects, to taking on larger and larger projects and possibly transitioning to a fabrication port.

From the assessment carried out in connection with the selection of relevant and suitable offshore wind ports in Viet Nam, it can be seen that all shortlisted ports will be able to function as initially construction ports and, in most cases, the selected ports have the potential to also develop into fabrication ports, with a key role in the offshore wind industry. Crucial to this is that the ports have the opportunity to develop additional capacity, so that wind turbine manufacturers can establish production on areas near the quays in the ports.

Construction port

The construction port is a model, where an existing port rents out land, quay facilities, etc. to an offshore wind developer or a wind turbine manufacturer, during the construction of one or more offshore wind farms. This model will be particularly relevant in situations where the need for port capacity is temporary, i.e. for un-loading pre-assembled turbine components (blades, nacelles, tower) at the port, short term storage of the components, pre-assembly activities in the port and loading the components, when wind turbines are to be installed in the offshore wind farm.

If energy companies and wind turbine manufacturers plan to use the port for several offshore wind farms over a long period of years, then the port will in practice be a permanent offshore wind port. There may still be breaks between projects, where storage capacity, quays, etc. can be used for other purposes.

In this model, the port also has other purposes (business areas), for example as a container port, ordinary cargo port, ferry port etc. and offshore wind activities take place in parallel with the other port activities, often in separate terminals.

In this situation, it will be the owner of the existing port who invests in the facility and takes care of operation and maintenance. The offshore wind developer or wind turbine manufacturer then rents land, services (crane service, storage, etc.) from the owner of the port.

Fabrication port (permanent and specialized offshore wind port)

The permanent and specialized offshore wind port is a model for a dedicated offshore wind port, i.e. a port facility which is designed to function as an offshore wind port. This model will be particularly suitable if there is a production of offshore wind turbines near the port, possibly directly on the port's hinterland, and a continuous production and shipment of wind turbines from the port is therefore expected.

The port can be either owned by a port company or the facility may also be owned by a private operator, for example a wind turbine manufacturer. In that case, the facility will be part of a larger port system, as it is observed seen the case with the privately-run container terminals in Viet Nam.

A manufacturing port for offshore wind will thus in practice be part of a port that has several market areas within container traffic, ferries, etc. The offshore wind activities will therefore be assigned a terminal built for the purpose. The case studies show examples of this in both Esbjerg (Denmark), Cuxhaven (Germany), and Hull (England).

10.4.3 Characteristics of the Two Models

Below, the advantages and disadvantages of the two models are described schematically.

It is important to note that in practice, it will be possible to observe a smooth transition between the two types. There are construction ports that invest in facilities designed for offshore wind, because there is a business interest in this market.

Table 10-1: Characteristics of port models

Parameters	**Construction port** (Owned by a port company)	**Fabrication port** **(Permanent and specialized offshore wind port or terminals)** (Owned by a port company or a private operator)
International examples	Port of Rønne, Denmark Port of Grenaa, Denmark	Port of Esbjerg, Denmark Port of Hull, England Port of Cuxhaven, Germany
Ownership	The port – including the facilities targeted offshore wind - is owned by the port company (often a public owned company). The wind turbine manufacturer and/or the developer of the offshore windfarm leases land and port facilities on a short time basis.	A turbine manufacturer and/or developer can invest in production facilities and other dedicated port facilities for shipping out wind turbine components etc. However, there is a general tendency for manufacturers and energy companies to avoid investing capital in port facilities and prefer to rent the facilities. This means, that in most known cases, the port facilities (land, quay facilities etc.) are still owned by the port company.
Investment needs	The port facilities are multifunctional and not designed specifically as an offshore wind port. For that reason, the need for investment is limited. However, larger and larger wind turbines make demands on the infrastructure, including deeper and wider navigation channels, quays designed for heavy loads etc.	A port and port facilities dedicated for offshore wind activities require large investments, because all the infrastructure must be built for this purpose, including quay facilities, hinterland areas, access roads, etc.
In accordance with the Maritime Law	There are no obvious obstacles in the law in relation to developing port capacity or to convert the port for offshore wind purpose and making it available for the construction of offshore wind farms.	Developing port capacity and making it available for the construction of offshore wind farms requires that the project be covered by the National Seaport Master Plan.
Feasibility according to the National Seaport Master Plan	If the offshore wind related activities can be integrated in the existing facilities without affecting normal transport activities etc., there is no need for a special permit for offshore wind activities, according to the National Seaport Master Plan.	New port facilities must be developed according to the National Seaport Master Plan. This means that major planning work must be expected before a new port can be developed.

10.4.4 Advantages and disadvantages of each model

Based on the above-mentioned characteristics of the two models, the following advantages and disadvantages can be outlined for a construction port (Table 10-2) and a fabrication port (Table 10-3).

Table 10-2: Advantages and disadvantages of a construction port

Advantages	Disadvantages
› Less capital needed, as the model is based on using existing infrastructure. › Shorter planning period, if there is available capacity in the ports. › Port capacity can possibly be made available without changes to the National Seaport Master Plan. › Ports with available capacity and ports in declining markets can see new opportunities in the offshore wind market. › This model is overall better socio-economically and has fewer investment risks.	› Offshore wind activities must compete with other market areas, i.e. freight transport, which is growing in several ports in Viet Nam. › The consequence can be that offshore wind activities can be crowded out. › As wind turbines are getting bigger and bigger, it will often prove necessary to expand the port facilities anyway.

Table 10-3: Advantages and disadvantages of a fabrication port (permanent and specialized offshore wind port)

Advantages	Disadvantages
› The port is designed for the purpose, which means that port facilities, quays, navigation channel etc. have the right dimensions from the start. › A port that has been built for the purpose will - all other things being equal - have the optimal location in relation to the offshore wind farms. › A dedicated offshore wind port is not in risk of being crowded out by other activities/market areas.	› Construction of a dedicated offshore wind port is very capital-intensive. › The market for offshore wind is characterized by changing players and investors. This means that these players will be hesitant to make large investments in capital-intensive facilities. › The National Seaport Master Plan is crucial to development of new ports and port infrastructure. New projects must be included in it, which has an influence on the time horizon.

10.5 Summary

10.5.1 Summary of Case Studies

The case studies show the following approaches to offshore wind ports:

› The case study shows both examples of large, specialized port facilities with wind turbine fabrication on or near the port (Port of Hull and Port of Cuxhaven) and examples of ports which primarily play a role in the construction phase of an offshore wind farm (Port of Rønne).

› In the fabrication ports, offshore wind is a permanent activity and the wind turbine manufacturer owns their fabrication facilities. The construction ports are only used for pre-assembly activities for specific offshore wind farm projects on ad hoc basis. For these ports, a location relatively close to the offshore wind farms is important. Furthermore, they must have the capacity to handle the pre-assembly activities - or be willing to make the necessary investments.

- However, all the analysed ports also have other business areas, for example ferry connections, container traffic, bulk goods etc. These activities are run together with the offshore wind activities and share certain facilities.

- Offshore wind ports are mostly owned by the port companies. In the large scale specialized offshore wind ports, the wind turbine manufacturers will own the fabrication facility, storage facilities etc., whereas the port company usually own the actual port facilities.

- Investments in dedicated port facilities are either made by the port, with contributions from the state or in partnerships between the port and the wind turbine manufacturer. Here, the different traditions between the countries play a big role. It is important to note that although the ports are mostly independent companies, there is almost always a large public ownership in the port companies. The UK case is the exception to this.

- The ports regard the offshore wind market as other port activities, i.e. that offshore wind developers or manufacturers etc. lease or buy land like other companies and offshore wind vessels pay port charges etc. like other ships. Investments in port capacity for the offshore wind market will therefore also be based on commercial assessments.

- O&M ports are often established in very small ports (fishing ports, yacht ports etc.). In these cases, the distance to the offshore wind farm site is the decisive factor. The need for investment in these ports is in most cases limited.

The case studies point to a number of trends and development features, with regard to the roles of offshore wind ports, which - to a certain extent - can be used as inspiration in Viet Nam. In the Viet Nam cases, both PTSC Downstream and Ba Son Shipyard have experience with industrial production, which makes them suitable in the role of fabrication ports. Vinh Tan International, Ba Son Shipyard, Hai Phong International and Nghi Son International Port are assessed as suitable construction ports. However, this is an assessment of the current status, and the role of the ports may change in the longer term.

Table 10-4: Examples of specific ports in different roles.

The port's role in the offshore wind industry	Ports from case studies	Selected Viet Nam ports (in the first stage as offshore wind ports)
Fabrication ports (wind turbine fabrication)	Port of Cuxhaven, Germany Port of Hull, England	PTSC Downstream Ba Son Shipyard
Construction port (storage and pre-assembly)	Port of Rønne, Denmark	Vinh Tan International Hai Phong Nghi Son Port

10.5.2 Summary: Ownership, Incentives and Regulation

In the case of Viet Nam, the most likely and realistic model is one where the owner is a port company. In practice, this means an owner who already owns and operates port facilities and who can create synergy between different business areas, of which offshore wind is one. In addition, the offshore wind market is characterized by changing wind turbine suppliers, investors, etc. Currently there is no sign, that offshore wind developers or manufacturers are willing to invest in capital-intensive facilities, including ports. Therefore, investment needs to come from the port owners who need to clearly see the long-term benefits of the offshore wind industry.

Identified ports in the Northern part of the country are busy and focused on the containership business as income stream. The container transport business is experiencing strong growth, which places great demands on the ports' capacity. As the offshore wind sector is still an uncertain market and the ports lack clear indications that there is a long-term perspective within the offshore wind sector, they are hesitant to enter the offshore wind market. The key incentive to creating positive interest from the ports in relation to offshore wind is that long-term investment decisions, guidelines and regulations are made by the Government in Viet Nam that support the development of offshore wind farms.

Identified ports in southern regions have had certain activities within the offshore wind market globally. These ports benefit from their stronghold in the oil and gas industry and are now investing in port upgrades to further expand into offshore wind. However, some of the planned investments for part of the needed port upgrades have yet to be sourced. Further, meeting the 6 GW short-term target in Power Development Plan 8 requires further investments than those already planned.

The case studies, interviews and site visits show that long-term investment decisions that support the development of offshore wind farms is the most realistic approach for Viet Nam to develop offshore wind ports. This is best achieved through a phased approach, as seen for example in Cuxhaven, Germany, where existing 'dual use' areas (areas with more purposes) are used in the initial stages of the development of an offshore wind harbour. This approach requires limited investment in necessary upgrades. Regulation of the port sector in Viet Nam plays a major role in the possibility and timing for developing offshore wind ports. The main instruments are the Maritime Law and the National Seaport Master Plan. The Maritime Law stipulates that the construction of new ports must be based on the overall National Seaport Master Plan. This means, that construction of new port facilities must be adopted by the National Seaport Master Plan, before investments can be launched. This process requires strong alignment between all stakeholders in the offshore wind industry.

11 References

ADB Data Library. (2022). *Viet Nam: Input-Outout Economic Indicators*. (Asian Development Bank) Retrieved February 2024, from OECD.stat: https://data.adb.org/dataset/viet-nam-input-output-economic-indicators

DEA, COWI. (2022a). *FIMOI version 2: Cost estiamtes for the first offshore wind farms in India.* Copenhagen: Danish Energy Agency. Retrieved May 2024, from https://ens.dk/sites/ens.dk/files/Globalcooperation/Publications_reports_papers/fimoi-final2_2.pdf

DEA, COWI. (2022b). *India Offshore Wind Ports Study, A study of existing ports to serve the installation and opertions & maintenance of offshore wind projects off the coasts of Gujarat and Tamil Nadu.* Centre of Excellence for Offshore Wind and Renewable Energy.

Educational Secretariat for Industry. (2023). *Beskæftigelseseffekter af investeringer i den grønne omstilling i Industrien 2023-2035 (EMPLOYMENT EFFECTS OF INVESTMENTS IN THE GREEN TRANSITION IN THE INDUSTRY 2023-2035).* Copenhagen: Industriens Uddannelser (Educational Secretariat for Industry). Retrieved May 2024, from https://iu.dk/media/clplz2dc/besk%C3%A6ftigelseseffekter-af-investeringerne-i-den-gr%C3%B8nne-omstilling-i-industrien-2023-2035.pdf

EREA & DEA. (2021). *Vietnamese Technology Catalogue 2021.* Copenhagen: Danish Energy Agency. Retrieved from https://ens.dk/sites/ens.dk/files/Globalcooperation/viet_nam_technology_catalogue_2021_-_eng.pdf

General Statistics Office. (2021). *Gross domestic product at current prices by types of ownership and by kinds of economic activity*. (General Statistics Office of Vietnam) Retrieved February 2024, from https://www.gso.gov.vn/en/px-web/?pxid=E0304-05&theme=National%20Accounts%20and%20State%20budget

General Statistics Office. (2021). *Number of employed persons and structure employed persons in the economy by kinds of economic activity(*)*. (General Statistics Office of Vietnam) Retrieved February 2024, from Data portal for statistics: https://www.gso.gov.vn/en/px-web/?pxid=E0242&theme=Population%20and%20Employment

Innovation Norway. (2023). *Offshore Wind Supply Chain for Fast-track Scenario in Vietnam.* Hanoi: Norwegian Embassy.

R.Y.N, L.-A. (2018). *Offshore Wind Installation: Analysing the Evidence Behind Improvements in Installation Time.* Elsevier Ltd.

Thoresen, C. A. (2014). *Port Designer's Handbook.* London: Institute of Civil Engineers (ICE).

World Bank Group. (2021). *Offshore Wind Development Program: Roadmap for Vietnam.* World Bank Group.

Appendix A Project Information – Separate document

Appendix A – Selection Processes and Port Lists

29-07-2024

Selection Process for Construction Ports

Step 1

Initial port list based on:

- Existing studies
- Sea Port Master Plan (SMP)
- Desktop analysis
- Focus on channels above 80 m, depths above 6 m and space availability
- Look at existing sheltered locations (natural or with existing breakwater) and look for available spaces to either refurbish, reconstruct or construct new terminal

51

Step 2

Traffic light screening based on coarse benchmark criteria:

- Air draft restrictions (unrestricted for installation or above 40 m for O&M)
- Available yard area or potential for expansion
- Channel depth (above 6 m)
- Channel width above 80 m
- Current use of the terminal, occupancy, expected upgrades
- Construction of new sheltered basins not considered unless there are immediate plans for construction

32 (31)*

Divide results into Regions

North	9
South-Central	9
South	15 (14)*

Eliminate all locations that do not meet minimal criterion, in terms of access parameters.

NOTE: PTSC Downstream includes PV shipyard and PTSC Port

Step 3

Review of screening results and refine:

- Narrow down to locations that meet all recommended parameters or tope three per region that meet most recommended parameters

North	4
South-Central	3
South	4

* Investigate which ports present better conditions in terms of location, upstream channels, current condition/use and available space, future development plans and timelines. Select the ports which present better opportunities at this stage based on current available information.

Step 4

Port profiles for selection:

- Establish port profiles which will be benchmarked against one another to select the preferred port in the North, South-Central and South regions as an example for development / road map establishment

North	2
South-Central	1
South	2

Selection process for O&M ports

Step 1

Port list based on:

- Existing studies
- Vietnam Sea Port Master Plan (SMP)
- Desktop analysis (Google Earth, open-source data)
- Focus on channels above 80m, depths above 6m and space availability

51

Step 2

Screening exercise based on rough benchmark criteria:

- Air draft restrictions (unrestricted for installation or above 40 m for O&M)
- Available yard area or potential for expansion
- Channel depth (above 6 m)
- Channel width above 80 m
- Current use of the terminal, occupancy, expected upgrades

37 (36)*

See list of 37 O&M ports in the Appendix.
NOTE: PTSC Downstream includes PV shipyard and PTSC Port

Divide into Regions

North
10

South-Central
11

South
16 (15)*

Note that some of this locations will be more favourable than others with respect to available qualified workforce and hinterland (industry nearby) by the time the port is selected.

Step 3

Review of screening results and refine:

- Narrow down to locations that meet all recommended parameters or tope three per region that meet most recommended parameters.

North
5

South-Central
4

South
5

14 candidate ports for OW.

O&M port selection is very dependent on distance to OWF. It is deemed that the ports in the list could serve as an O&M base provided 1.5ha yard area with direct access to berth is available, and distance to OWF is less than 200km. **However, it is not recommended to progress further with the shortlisting at this stage as the OWF locations are unknown.**

Port list (51)

Ports page 1 of 5

No.	Port name	Coordinates	Region	Area	Ownership
1	PTSC Dinh Vu	683681.00 m E 2305532.28 m N	Hai Phong	North	Private: PTSC
2	Hai Phong International Container Terminal (HICT) Lach Huyen Port	698333.85 m E 2301006.29 m N	Hai Phong	North	JV: Saigon New Port, MOL, Wanhai and Itochu
3	NGHI SON INTERNATIONAL PORT | NSIP	585138.61 m 2136073.88 m N	Thanh Hoa	North	Private VAS Group
4	Hon Gai	713553.02 m E 2320199.00 m N	Ha Long, Quang Ninh	North	CICT: JV SSA Marine and VIMC Quang Ninh port: Private
5	Cua Lo Port	575123.00 m E 2082000.00 m N	Vinh	North	Public: VIMC
6	Le Mon	586229.54 m E 2188560.83 m N	Thanh Hoa	North	
7	Cam Pha	745749.61 m E 2325988.34 m N	Quang Ninh	North	
8	Cảng Sơn Dương	653080.59 m E 1996337.45 m N	Ky Anh district	North	Private: Formosa Steel
9	Cảng MPC Port	687773.00 m E 2303982.00 m N	Hai Phong	North	Private: Mipec
10	NAM DINH VU PORT	689313.00 m E 2303605.00 m N	Hai Phong	North	Gemadept Corporation

Ports page 2 of 5

No.	Port name	Coordinates	Region	Area	Ownership
11	Vissai Port	575515.00 m E 2084290.00 m N	Nghệ An	North	
12	Tien Sa Port	202522.06 m E 1784399.87 m N	Da Nang City	South-Central	Public: VIMC
13	DQS Dung Quat Shipyard	262711.30 m 1702767.25 m N	Quang Ngai	South-Central	Public: PVN
14	Chan May Port	181405.33 m 1807812.05 m N	Thừa Thiên–Huế Province	South-Central	JSC
15	Cang Tong Container Terminal	264310.00 m E 1704123.00 m N	Quang Ngai	South-Central	
16	Hyundai Vinashin Shipyard	313188.04 m E 1380885.66 m N	Van Phong Bay	South-Central	JV: Hyundai and SBIC
17	Cam Ranh international port	298403.22 m E 1315760.61 m N	Khanh Hoa Province	South-Central	Public: VIMC
18	Vinashin	307540.06 m E 1392514.37 m N	Van Phong Bay	South-Central	Vietnam Coast Guard & Khanh Hoa Salt Joint Stock Company
19	Vinh Tan Power Station Port	260033.00 m E 1251676.00 m N	Vinh Tan	South-Central	Private: Pacific Group
20	Quy Nhon	310592.36 m E 1524055.41 m N	Quy Nhon	South-Central	Public: VIMC or Saigon New Port

Ports page 3 of 5

No.	Port name	Coordinates	Region	Area	Ownership
21	Nha Trang	305925.08 m E 1349965.13 m N	Khanh Hoa	South-Central	
22	South Van Phong Port	311072.00 m E 1382421.00 m N	Khanh Hoa	South-Central	
23	Ca Na Port	272252.00 m E 1251720.00 m N	Ninh Thuan	South-Central	
24	PTSC Quang Ngai	263580.00 m E 1705498.00 m N	Quang Ngai	South-Central	
25	Vinh Tan International Port	261262.03 m E 1251874.88 m N	Vinh Tan	South-Central	
26	Vietsovpetro Port	727406.00 m E 1149160.00 m N	Vung Tau	South	Private
27	Tan Cang Cat Lai Terminal	696590.71 m E 1190548.08 m N	Ho Chi Minh	South	Private: Saigon New Port
28	PTSC Port (Vung Tau)	728440.33 m E 1149242.12 m N	Vung Tau	South	Private – Part of PTSC Downstream
29	Tan Cang–Cai Mep Terminal TCIT	721986.17 m E 1165415.66 m N	Ba Ria	South	Private: Saigon New Port
30	Thi Vai General Port SP PSA	721484.61 m E 1169227.35 m N	Phu My	South	JSC

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No.	Port name	Coordinates	Region	Area	Ownership
31	SITV (Phu My)	721627.97 m E 1172302.77 m N	Phu My	South	JSC
32	PTSC Phu My	722305.44 m E 1170606.79 m N	Phu My	South	Private: PTSC
33	VICT	689716.35 m E 1190401.28 m N	Ho Chi Minh	South	JV: SOWATCO and MITORIENT
34	Hiep Phuoc Port	690767.54 m E 1177484.21 m N	Ho Chi Minh	South	Public: Saigon New Port
35	SPCT container terminal	692712.42 m E 1176290.18 m N	Ho Chi Minh	South	JV: DPW and VIMC
36	Saigon Port JSC - Hiep Phuoc Terminal	693565.15 m E 1173639.18 m N	Ho Chi Minh	South	Private: Saigon Port
37	Gemalink Cai Mep Terminal	719115.47 m E 1161149.23 m N	Cai Mep (Ba Ria)	South	JV: Gemadept and CMA CGM
38	SP-SSA INTERNATIONAL TERMINAL (SSIT)	719849.08 m E 1162064.39 m N	Cai Mep (Ba Ria)	South	JV: Saigon Port and SSA Marine VIMC /Vinalines)
39	TCTT Cai Mep	720094.00 m E 1162450.00 m N	Cai Mep (Ba Ria)	South	Private: Saigon New Port
40	CMIT Cai Mep International terminal	720342.69 m E 1162890.09 m N	Cai Mep (Ba Ria)	South	JV: Saigon Port, APMT and VMIC
41	Ba son shipyard	721246.27 m E 1167010.38 m N	Cai Mep (Ba Ria)	South	Public

Ports page 5 of 5

No.	Port name	Coordinates	Region	Area	Ownership
42	CẢNG POSCO YAMATO VINA	720465.54 m E 1167841.64 m N	Cai Mep (Ba Ria)	South	JSC
43	PV Shipyard	727865.81 m E 1149451.07 m N	Vung Tau	South	Private: PTSC – Part of PTSC Downstream
44	Long An International Port	690170.45 m E 1165349.28 m N	Long An	South	
Other Developments					
45	VAN NINH GENERAL PORT Quang Ninh	803492.00 m E 2370824.00 m N		North	
46	Vung Ang Port	648913.00 m 2002901.00 m N	Hai Phong	North	
47	Lien Chieu Port	192492.81 m E 1786400.17 m N	West Da Nang	South-Central	
48	Son My Port	Unknown	Binh Thuan	South-Central	
49	My xuan port & Phuoc An port	720735.00 m E 1176758.00 m N 718250.00 m E 1174470.00 m N	Phu My	South	Formosa international development corporation
50	Cai Mep downstream development	720136.47 m 1160029.87 m N	Cai Mep (Ba Ria)	South	
51	Soc Trang Deep Sea Port	unknown	Soc Trang	South	

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O&M ports (36)

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1	PTSC Dinh Vu	683681.00 m E 2305532.28 m N	Hai Phong	North	Private: PTSC
2	Hai Phong International Container Terminal (HICT) Lach Huyen Port	698333.85 m E 2301006.29 m N	Hai Phong	North	JV: Saigon New Port, MOL, Wanhai and Itochu
3	NGHI SON INTERNATIONAL PORT | NSIP	585138.61 m 2136073.88 m N	Thanh Hoa	North	Private VAS Group
4	Hon Gai	713553.02 m E 2320199.00 m N	Ha Long, Quang Ninh	North	CICT: JV SSA Marine and VIMC Quang Ninh port: Private
5	Cua Lo Port	575123.00 m E 2082000.00 m N	Vinh	North	Public: VIMC
8	Cảng Sơn Dương	653080.59 m E 1996337.45 m N	Ky Anh district	North	Private: Formosa Steel
10	NAM DINH VU PORT	689313.00 m E 2303605.00 m N	Hai Phong	North	Gemadept Corporation
11	Vissai Port	575515.00 m E 2084290.00 m N	Nghệ An	North	
12	Tien Sa Port	202522.06 m E 1784399.87 m N	Da Nang City	South-Central	Public: VIMC
13	DQS Dung Quat Shipyard	262711.30 m 1702767.25 m N	Quang Ngai	South-Central	Public: PVN

*Number in port list

Ports page 2 of 4

No.*	Port name	Coordinates	Region	Area	Ownership
14	Chan May Port	181405.33 m 1807812.05 m N	Thừa Thiên–Huế Province	South-Central	JSC
16	Hyundai Vinashin Shipyard	313188.04 m E 1380885.66 m N	Van Phong Bay	South-Central	JV: Hyundai and SBIC
17	Cam Ranh international port	298403.22 m E 1315760.61 m N	Khanh Hoa Province	South-Central	Public: VIMC
20	Quy Nhon	310592.36 m E 1524055.41 m N	Quy Nhon	South-Central	Public: VIMC or Saigon New Port
22	South Van Phong Port	311072.00 m E 1382421.00 m N	Khanh Hoa	South-Central	
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26	Vietsovpetro Port	727406.00 m E 1149160.00 m N	Vung Tau	South	Private
28	PTSC Port (Vung Tau)	728440.33 m E 1149242.12 m N	Vung Tau	South	Private: PTSC – Part of PTSC Downstream

*Number in port list

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No.*	Port name	Coordinates	Region	Area	Ownership
29	Tan Cang–Cai Mep Terminal TCIT	721986.17 m E 1165415.66 m N	Ba Ria	South	Private: Saigon New Port
30	Thi Vai General Port SP PSA	721484.61 m E 1169227.35 m N	Phu My	South	JSC
31	SITV (Phu My)	721627.97 m E 1172302.77 m N	Phu My	South	JSC
35	SPCT container terminal	692712.42 m E 1176290.18 m N	Ho Chi Minh	South	JV: DPW and VIMC
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42	CẢNG POSCO YAMATO VINA	720465.54 m E 1167841.64 m N	Cai Mep (Ba Ria)	South	JSC
43	PV Shipyard	727865.81 m E 1149451.07 m N	Vung Tau	South	Private: PTSC – Part of PTSC Downstream
44	Long An International Port	690170.45 m E 1165349.28 m N	Long An	South	
Other Developments					
45	VAN NINH GENERAL PORT Quang Ninh	803492.00 m E 2370824.00 m N		North	
46	Vung Ang Port	648913.00 m 2002901.00 m N	Hai Phong	North	
47	Lien Chieu Port	192492.81 m E 1786400.17 m N	West Da Nang	South-Central	
50	Cai Mep downstream development	720136.47 m 1160029.87 m N	Cai Mep (Ba Ria)	South	

*Number in port list

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