# Offshore wind supply chain for fast-track scenario in Vietnam

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Norwegian Embassy
*Hanoi*

Innovation Norway

Cover 1: Arkona Wind Farm, Baltic Sea
Cover 4: Hywind Tampen, Norwegian North Sea
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## FOREWORD

Offshore wind is a promising renewable energy source that can contribute to the green transition and sustainable development of Vietnam. It has the potential to provide clean, reliable, and affordable electricity to meet the growing demand of the country. It can also create economic opportunities, social benefits, and environmental protection for the country.

Developing offshore wind projects requires a complex and coordinated supply chain that involves various stakeholders, activities, and resources. The supply chain covers the entire lifecycle of offshore wind projects, from planning and design to construction and installation, operation and maintenance, decommissioning and recycling. The supply chain faces many challenges and risks, such as technical, financial, regulatory, and logistical issues. It is essential, thus, to understand the current state and prospects of the supply chain for offshore wind projects in Vietnam. In light of that, this study aims to provide an assessment of the current offshore wind supply chain and infrastructure in Vietnam. The study focuses on areas which could have large potential for localisation and future development, namely:

- Port infrastructure which can serve the supply chain for fabrication, marshalling and O&M operations; and
- Manufacturing key components, specifically foundations, turbine towers, turbine blades and nacelle assembly.

The study aims to identify the impact of the development of these supply chains with regard to the job creation potential in Vietnam. Recommendations and actions for the development of the supply chain for each focus area are also presented herein.

The assessment is based on data, research, and insights from various sources, including public information and data provided through engagement with various ports and suppliers. This study aims to provide useful information, insights, and guidance in an easy-to-digest and readable format for the development of a robust, competitive, and sustainable supply chain for offshore wind in Vietnam.

This document is for informational purposes only and should not be used for commercial purposes. We would like to express our gratitude to all support of ports and suppliers who had spent valuable time to provide us with information and data to complete this study.

This study was commissioned and supervised by Innovation Norway and the Norwegian Embassy in Hanoi.

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# Abbreviations

| | |
|---|---|
| BIDV | Bank for Investment and Development of Vietnam |
| CAPEX | Capital Expenditure |
| CD | Chart Datum |
| CNC | Computer Numerical Control |
| COD | Commercial Operation Date |
| CWC | Converter Control Cabinet |
| CTV | Crew Transfer Vessel |
| DP | Dynamic Positioning |
| DCC | Digital Control Cabinet |
| DECEX | Decommissioning Expenditure |
| DEVEX | Development Expenditure |
| DWT | Deadweight Tonnage |
| EPC | Engineering, Procurement, and Construction |
| EPCI | Engineering, Procurement, Construction and Installation |
| FBE | Fusion Bonded Epoxy |
| FID | Final Investment Decision |
| FIT | Feed-in Tariff |
| FOU | Foundation |
| FTE | Full-Time Equivalent |
| GDP | Gross Domestic Product |
| GE | General Electric |
| HLV | Heavy Lift Vessel |
| HVAC/DC | High-Voltage Alternating Current / Direct Current |
| JKT | Jacket |
| LOA | Length Overall |
| MIG/MAG | Metal Inert Gas/Metal Active Gas |
| MONRE | Ministry of Natural Resources and Environment |
| MP | Monopile |
| NDT | Non-Destructive Testing |
| O&G | Oil and Gas |
| O&M | Operation and Maintenance |
| OEM | Original Equipment Manufacturer |
| OMS | Operation, Maintenance, Service |
| ONW | Onshore Wind |
| OPEX | Operating Expenditure |
| OSS | Offshore Substation |
| OSS JKT | Offshore Substation Jacket |
| OSS Piles | Offshore Substation Piles |
| OSW | Offshore Wind |
| OWC | Offshore Wind Consultant Limited |
| OWF | Offshore Wind Farm |
| PDP8 | Power Development Plan 8 |
| PO | Purchase Order |
| PTSC | PetroVietnam Technical Services Corporation |

| | |
|---|---|
| PTSC M&C | PTSC Mechanical and Construction |
| PVC MS | Petroleum Equipment Assembly and Metal Structure Joint Stock Company |
| PV Coating | PetroVietnam Coating |
| PV Pipe | PetroVietnam Pipe |
| PV Shipyard | PetroVietnam Marine Shipyard |
| QC | Quality Control |
| SAW | Submerged Arc Welding |
| SBIC | Shipbuilding Industry Corporation |
| SOV | Service Operation Vessels |
| SPMT | Self-Propelled Modular Transporter |
| SREC | Southern Renewable and Green Energy co., ltd |
| SRI | Subsea Rock Intervention |
| T&I | Transportation and Installation |
| TIG | Tungsten Inert Gas |
| TP | Transition Piece |
| UK | United Kingdom |
| USA | United States of America |
| VICT | Vietnam International Container Terminal |
| WBG | World Bank Group |
| WTG(s) | Wind Turbine Generator(s) |

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# Executive Summary

The Vietnam offshore wind market is considered promising, with world class high wind speed and favourable seabed conditions. The existing supply chain used by the domestic oil and gas industry, in conjunction with the current onshore and nearshore wind infrastructure, has the potential to support in-country offshore wind developments. Recent orders for offshore wind components from international markets signifies a promising commencement for Vietnam to establish itself as an Asia-Pacific hub in offshore wind. In light of these encouraging developments, Innovation Norway have commissioned OWC to deliver an in-depth study of the Vietnamese offshore supply chain for two hypothetical development scenarios. The assessment was structured as follows:

- **Port Infrastructure Assessment:** aimed at providing insights into Vietnam's existing maritime infrastructure and provide direction for future port developments.
- **Local Supplier Assessment:** aimed at identifying local suppliers capable of providing offshore wind farm components. This was focused on the fabrication of foundations, towers, nacelles, and highlighted areas of improvement which could allow suppliers to meet the existing, but growing, demand for offshore wind components.
- **Job Creation:** aimed at providing an overview of the potential socio-economic impacts in terms of future job creation resulting from offshore wind developments.

### Port Infrastructure Assessment

The ports of Vietnam have been assessed to determine their capability to support the logistics and operations of offshore wind projects. The analysis identified suitable ports for the assembly, staging, and transportation of foundations and wind turbine components. The analysis was based on various factors such as the port's available space, water depth, berthing capacity, lifting equipment, accessibility, and the infrastructure's overall readiness to handle components such as nacelles, blades, towers, and foundations. Consequently, ports with potential to support offshore wind developments have been identified.

Ports in the northern regions, including those in the Hai Phong cluster, currently demonstrate low capabilities in supporting the offshore wind industry, requiring higher investments and longer development timelines. It was found that height constraints of numerous prominent Northern shipyards would significantly limit the transportation of foundations. This limitation combined with geographical proximity to electrical components and cabling manufacturing (LS Vina Cables & System JSC, GE Vietnam Limited and ABB Automation and Electrification Vietnam Company Limited) make them ideal for future development of smaller complex components such as WTGs assembly lines or OSS components. Finally, these ports can also leverage their strong shipbuilding experience to build offshore wind dedicated vessels.

Ports in the southern regions present favourable conditions for the construction of larger components, likely influenced by the established presence of the oil and gas sector. A notable location would be the Vung Tau Port cluster, where PTSC is pioneering in the offshore wind industry. Congested quayside and yard area due to oil & gas operations in Vung Tau might obstruct the marshalling activities for future developments. The Thi Vai port cluster could also act as a staging and manufacturing hub, thanks to the presence of major manufacturing facilities for wind towers and steel foundations (CS Wind and SREC). This cluster also presents the potential for future development for manufacturing of monopile foundations.

To progress the development of the domestic supply chain capabilities, the southern ports should continue fostering their foundations and towers manufacturing capabilities. Ports in Vung Tau should reach a consensus allowing for a coordinated approach, increasing the facilities' capabilities and usage efficiency. The coordination of the various activities among ports is essential and allows for the optimisation of logistical operations ensuring the projects' seamless execution.

### Local Supplier Assessment

Local suppliers have been analysed to assess their potential in supporting offshore wind projects based on their existing capabilities and readiness to support such infrastructure-heavy projects. The study identified domestic suppliers that have already supported offshore wind projects or have announced plans to enter the offshore wind supply chain. The analysis focused on supplier's track record, manufacturing capabilities, quality standards, and future expansion plans.

The suppliers' assessment indicated that Vietnam's existing capacity to manufacture foundations and towers could meet specific offshore wind requirements. However, as the domestic, and consequently regional, demand is anticipated to increase, the existing infrastructure will not be able to support the delivery of key components such as WTG blades and nacelles. This is mainly linked to the current inactivity of WTG OEMs who have yet to confirm plans to establish such manufacturing facilities in Vietnam.

The suppliers acknowledged that their investment decisions are highly linked to the development of Vietnam's offshore wind market which should be backed-up by a consistent project pipeline. Having a consistent project pipeline is fundamental to the development of the domestic offshore wind supply chain and infrastructure.

Another key factor which can contribute to the development of a domestic supply chain is the finalisation of an offshore wind specific regulatory framework. Vietnam, as of the time of writing of this report, has yet to establish such a regulatory framework, resulting in the developers' unwillingness to engage with the domestic suppliers and commit investment in the local infrastructure. The suppliers are now making preliminary steps to kick-start the development of a domestic supply chain conducting market studies, establishing connections with other local suppliers, fostering relations and partnerships, as well as promoting their offshore wind capabilities through marketing initiatives and the establishment of representative sales offices.

### Job creation

Offshore wind projects provide job opportunities across the project's entire lifecycle, spanning from the development, construction, and operation phases. The analysis indicated a promising potential to generate numerous high-quality jobs, offering opportunities for technology transfer and knowledge exchange/sharing. The domestic personnel could potentially be mobilised to various positions in the offshore wind industry, such as mechanical engineering, electrical engineering, environmental expertise, and project management. As the offshore wind sector continues to expand, the potential for direct, indirect and induced jobs will increase.

It is estimated that about 55,000 jobs including direct, indirect and induced jobs, could be generated throughout the development of 6 GW offshore wind capacity as presented under the PDP 8. Such development could create two inter-regions renewable energy industries, northern and southern, with associated service centres. A specific emphasis would be on manufacturing, servicing, research and training, and operation & maintenance activities. Key provinces that could be benefited by the development of offshore wind project would be Quang Ninh, Hai Phong for the North, and Ho Chi Minh, Vung Tau, Binh Thuan and Ninh Thuan for the South.

## Recommendations

The analysis indicates that Vietnam's offshore wind potential presents an exceptional opportunity for the development of its national supply chain and offshore wind infrastructure. Vietnam has the potential to become a manufacturing hub, supporting the wider offshore wind industry in the region. However, through our engagement with suppliers, we understand that the suppliers are hesitant in terms of expanding the current capabilities as the current project pipeline is highly uncertain and is primarily driven by the government's appetite to promote offshore wind. If this situation change, suppliers would be willing to invest, expand their capabilities and support the domestic, initially, market.

### *Offshore Wind Specific Actions*

To promote and further grow the domestic supply chain, we recommend the following:

- **Improve the OSW policy framework**: To enhance the prospects of renewable energy projects in Vietnam, the National Assembly should issue legislation or guide authorities in establishing a robust, clear and firm legal framework for offshore wind.
- **Clear development of an implementation plan:** Developers and supply chain alike thrive when there is a clear timeline and project pipeline. Timeline certainty cannot be overstated as this allows for financial and investment planning.
- **Develop investment incentives**: The government should implement a transparent pricing plan, providing investors with clarity on anticipated price adjustments – regardless of the pricing structure. Introducing a bankable Power Purchase Agreement (PPA) will attract international financing.
- **Enhance finance access**: Drive private sector investment in wind energy through innovative financing and supply chain specific incentives. Government support, including capital subsidies, tax exemptions, and preferential loans for domestic small and midsize enterprises, will create a competitive supporting industry, lowering investment costs for sustainable energy solutions.
- **Streamlining PPA templates with clear guidelines and fast-track approval processes**: PPA negotiations must be more efficient reducing the cost to investors. Relevant government authorities should reduce the timeline required for the formulation of guidelines and regulatory approvals, which in some cases could take years. Lack of clarity and delays in permitting approvals often leads to execution delays or the complete abandonment of projects.

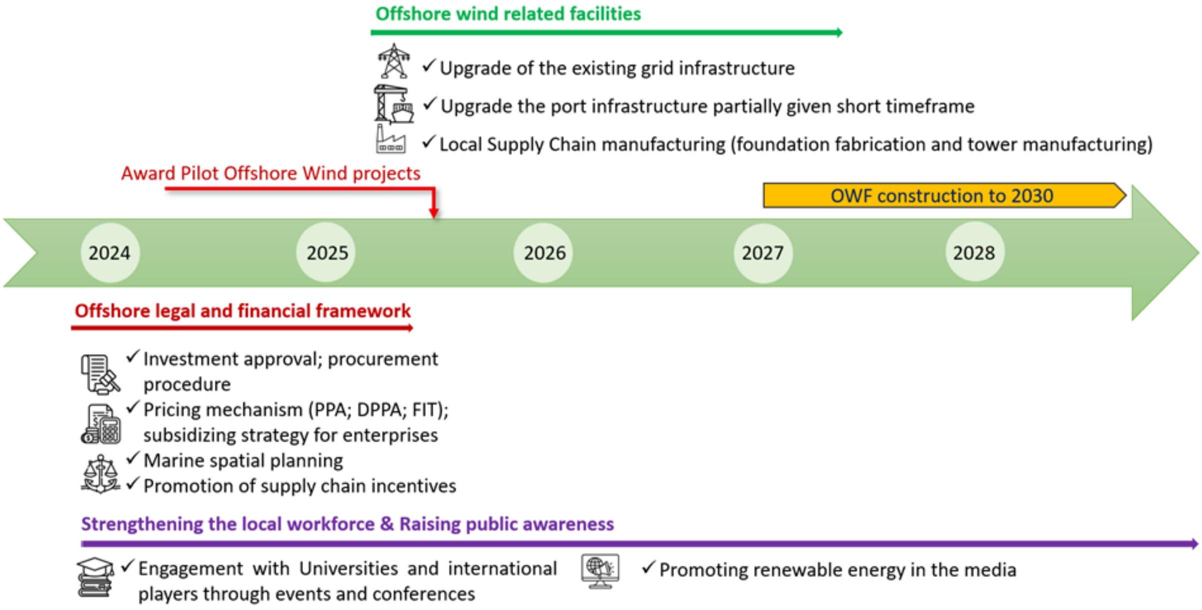
### *Wider Renewable Industry Actions*

Once such policies are in place, the domestic supply chain would be willing to invest and further expand their capabilities. Offshore wind related manufacturing facilities in Vietnam would have to be upgraded to support the emerging demand.

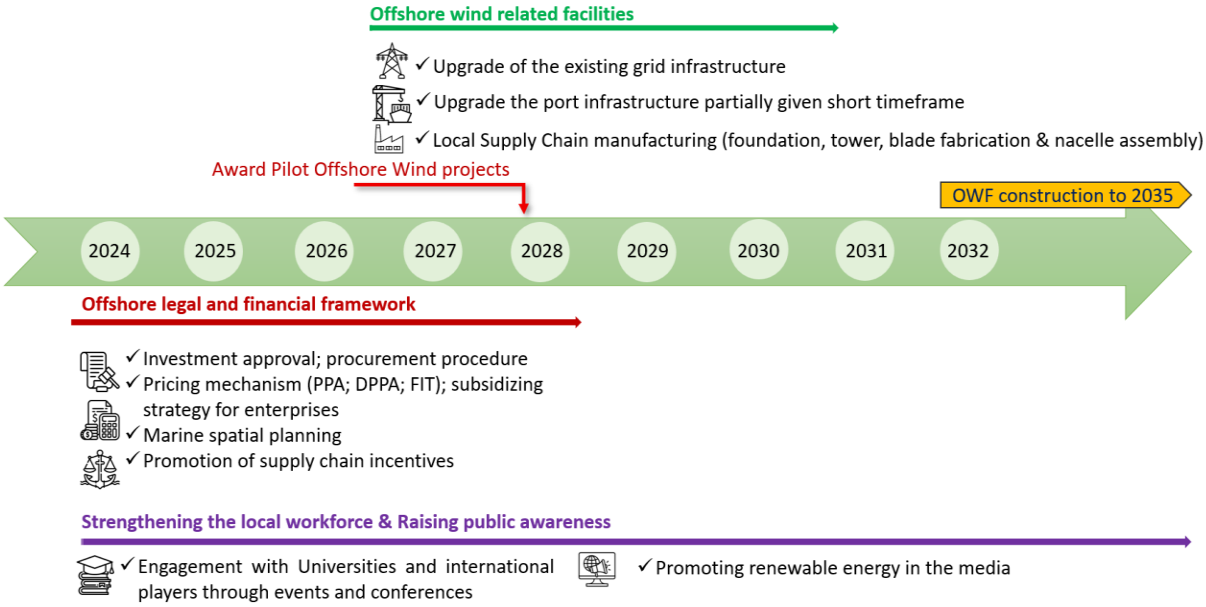
To meet the demand of the hypothetical scenarios; the 2030 and 2035 commercial operations date scenarios, the following actions should be considered:

- **Reinforcement of the grid infrastructure**: To facilitate the integration of intermittent renewable sources like offshore wind power, crucial steps should be undertaken including the upgrade of the grid infrastructure and the adoption of energy storage solutions.
- **Upgrading of the seaport infrastructure**: The government should provide incentives to propel the development of offshore wind suitable deep-sea ports.
- **University and Industry engagement:** Academic and industry engagement are critical to the long-term development of the industry and its supply chain. These are long term investments which will provide with skills and personnel to sustain the growth of wider renewable energy. The government will need to invest in dedicated university course and engagement programs with industry to develop relevant skills.

*The flowcharts with all the recommended activities to achieve the 2030 Scenario and 2035 scenario are provided in the figures below:*




**Recommendation of next steps for the 2030 Scenario**




**Recommendation of next steps for the 2035 Scenario**

*The information shared in this report is updated up to October 2023. Developers and investors are encouraged to directly engage with ports and suppliers to obtain more accurate information.*

# 1 Supply Chain Assessment

## 1.1 Project Introduction

Wind power in Vietnam holds significant potential for growth as a scalable alternative to thermal power, considering the country's favourable natural conditions. With a coastline spanning 3,000 kilometres and consistently high mean wind speeds, Vietnam has many opportunities to expand its installed wind capacity. Given the suitable water depth, distance to the shore, and good offshore wind resources, large areas of Vietnam's territorial waters are suitable for offshore wind developments.

Additionally, Vietnam boasts a pre-existing supply chain in parallel industries with synergies to offshore wind, including oil and gas and onshore wind. This suggests the country's potential to leverage its existing experience in parallel industries to supply and facilitate the development of offshore wind projects. Considering its advantageous location in the APAC region, marine traffic, and port infrastructure, Vietnam also has the potential to become a supply chain hub for offshore wind components, particularly in the following areas:

- Fabrication of jacket foundations;
- Tower manufacturing;
- Nacelle assembly;

## 1.2 Offshore Wind Components

Offshore wind turbines capture the ocean's wind energy and transform it into renewable electricity. The offshore wind turbines generate electricity and transfer to the offshore substation via inter-array subsea cables. The electricity is then transmitted from offshore substation to an onshore substation via the export subsea cables where it is transferred to the existing power grid network as presented in Figure 1-1.

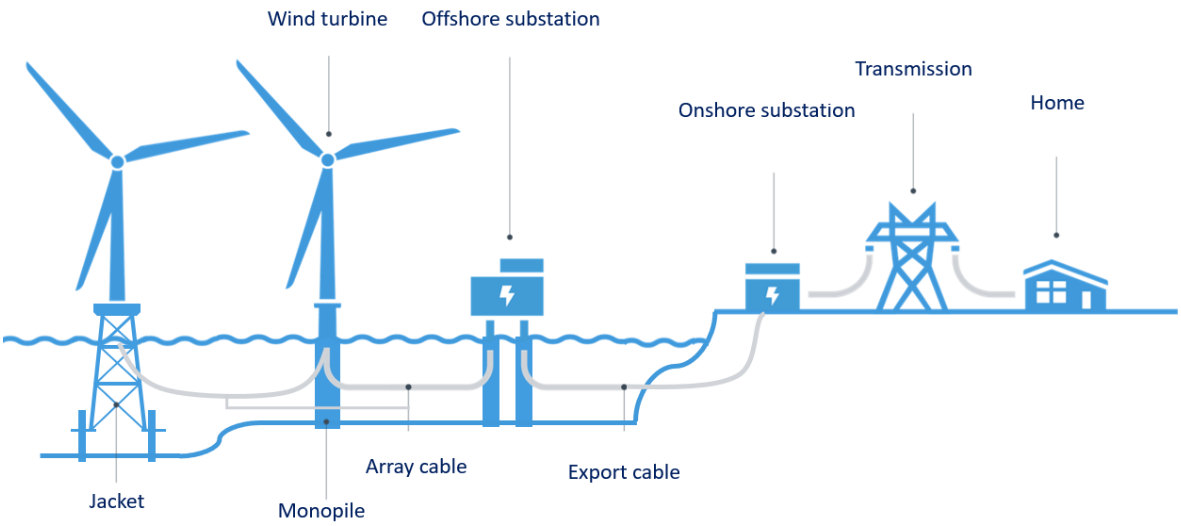



**Figure 1-1: Offshore wind farm components**

The table below presents the Offshore Wind Farm Supply Chain categories as the following:

**Table 1-1: Offshore Wind Farm Supply Chain categories**

| Tier 1 | Tier 2 |
|---|---|
| Development and project management | Environmental study |
| | Technical study |
| WTG | Nacelle |
| | Rotor |
| | Tower |
| Balance of plant | Export cables |
| | Inter-array cables |
| | Cables other |
| | Foundations |
| | Offshore substations |
| | Onshore substations and power grids |
| Installation and commissioning | Foundation installation |
| | Offshore substation installation |
| | Onshore transmission installation |
| | Cable installation |
| | Turbine installation |
| | Subsea rock intervention |
| Operation, maintenance, and service | Operation, maintenance and service |
| Decommissioning | Decommissioning |

## 1.3 Project Background

On May 15th, 2023, the market has finally welcomed the issuance of the Eighth National Development Plan (PDP 8). It was the result of a multitude of drafts, revisions, and delays that lasted almost three years. The approval of PDP 8 has further emphasised Vietnam's commitment to renewable energy and offshore wind development for the period 2021 – 2030, including a vision for 2050. This significant step is expected to drive new waves of investment and growth in the country's power market, particularly in the renewable energy sector, upcoming.

Particularly, the Government has set ambitious targets for offshore wind capacity, targeting 6 GW by 2030 under PDP 8 and under the 2050 vision, ranging from 70GW to 90.5GW, recognising its potential to greatly contribute to the country's energy security and climate change mitigation efforts. That's one of the reasons the market is currently witnessing a surge in development activities, with numerous projects progressing through early-stage development activities such as site assessments and early-stage planning.

According to PDP 8, Northern, Central Southern and Southern are highlighted as areas that possess significant offshore wind potential. The natural-socio-economic characteristics of those regions facilitate the development of a renewable energy hub in the coming period up to 2030.

In September 2021, the Norwegian Embassy and Equinor published a study on the existing and potential future supply chain in Vietnam, assessing how ports and other infrastructure could contribute to the further development of the existing supply chain [1].

In light of the recent approval of PDP 8 and to have a better understanding of the country's latest status regarding its local supply chain capabilities, building on the previously conducted study, OWC was commissioned by the Norwegian Embassy to further investigate the readiness of local ports and suppliers in terms of supporting the emerging offshore wind Industry.

## 1.4 Project Objectives

The primary objectives of this study are to set up hypothetical offshore wind projects of 1 GW each and understand the supply chain requirement and constraints these projects could have in terms of the existing supply chain infrastructure.

For the purpose of this study, two projects have been hypothesized, an 1GW project situated at the North (considering its proximity to the demand centre) and another project at the South (considering its favourable wind speed).

The scope of the study was purposely limited to 2 GW and with a generic north and south delimitation, to bring general awareness on the requirements and limitations on the local infrastructure and Supply Chains for Offshore Wind Projects.

The assessment of the whole PDP 8 planning would require more complex analysis and information and data hence was excluded from the assessment.

Figure 1-2 presents the hypothetical location of the selected projects.

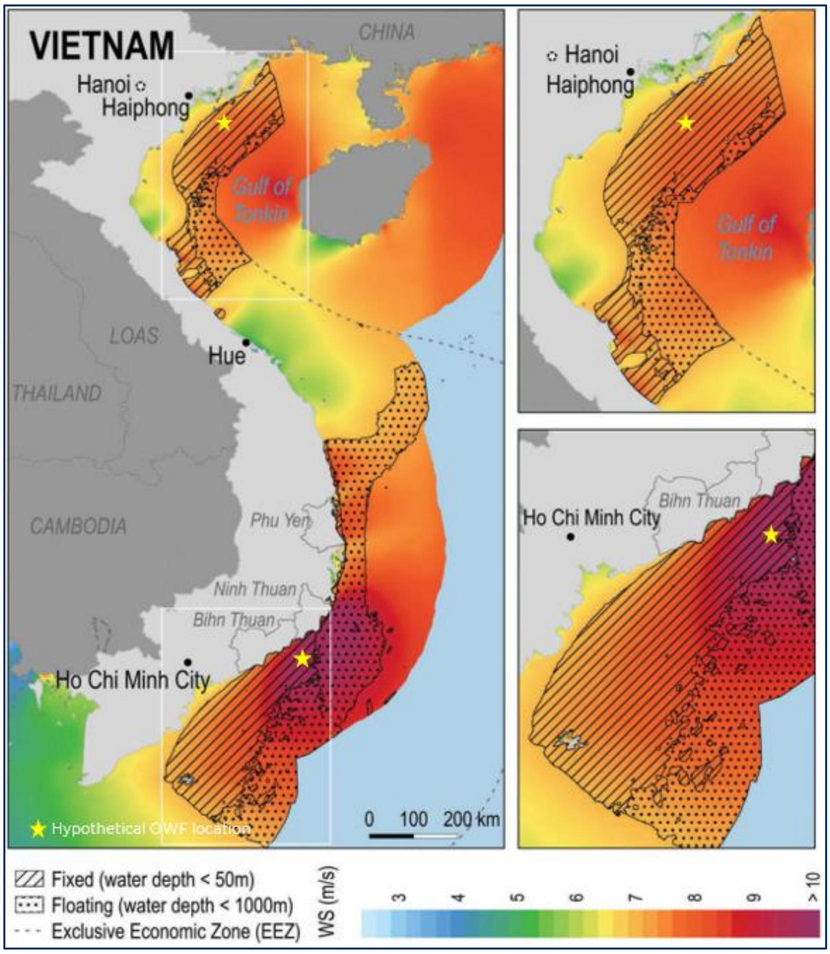



**Figure 1-2: Hypothetical locations for 2 OWF projects in the North and South (★) [2]**

## 1.5 Project specifications

The high-level technical specifications of each scenario are outlined in Table 1-2.

**Table 1-2: Technical assumption of two scenarios**

| Categories | Scenario 1 | Scenario 2 |
|---|---|---|
| Location | North & South | North & South |
| COD | **2030** | **2035** |
| Capacity | 1 GW | 1 GW |
| WTG type | **15 MW** | **20 MW** |
| Water depth | 40 m | 40 m |
| Distance to shore | 50 km | 50 km |
| Foundation | 50% Monopile & 50% Jacket | 50% Monopile & 50% Jacket |

## 1.6 Project timeline assumptions

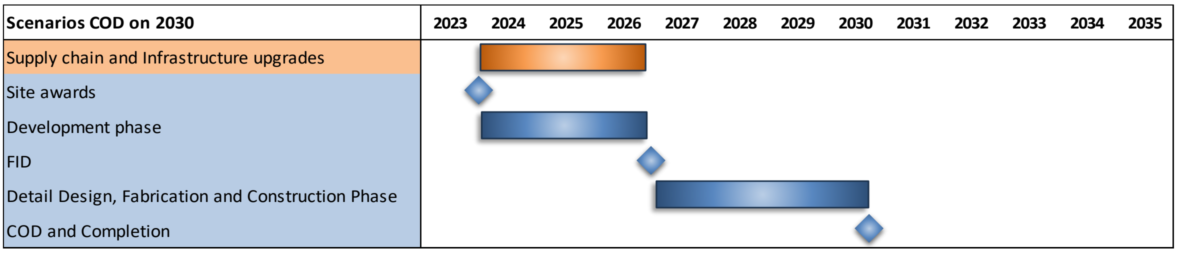
### 1.6.1 Scenario 1 Timeline

To achieve a 2030 COD (Scenario 1), we have assumed the following:

- Government takes initiative to fast-track the developments of offshore wind projects.
- The ports and suppliers would not have much time for any upgrade(s).
- The existing infrastructure will have to import equipment/materials and establish partnerships with experienced suppliers to allow for knowledge sharing.
- The offshore wind farm developers might have to outsource key components as the existing infrastructure won't be 100% ready to support 2 GW of capacity.

The timeline of Scenario 1 can be seen in Table 1-3.

**Table 1-3: Timeline of scenario for COD in 2030**



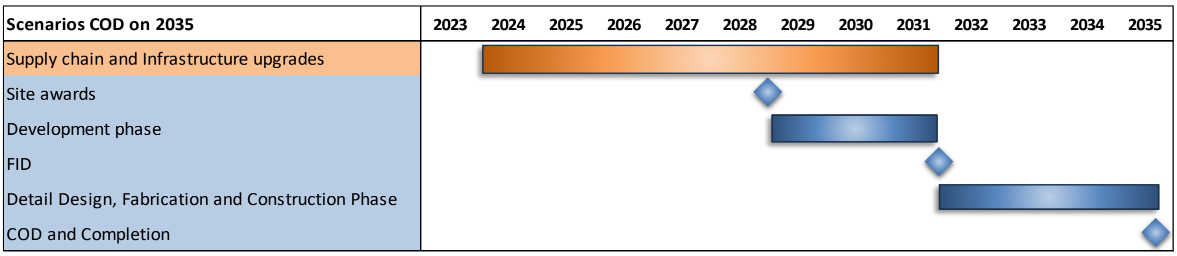

### 1.6.2 Scenario 2 Timeline

To achieve a 2035 COD (Scenario 2), we have assumed the following:

- The ports and suppliers will have sufficient time to upgrade their facilities.
- Supply chain manufacturing facilities in place to allow developers to source all key components required domestically.
- Port facilities are in place to allow for the staging, assembly, and construction of offshore wind components.
- The supply chain would be in place at the end of 2031, facilitating the construction of offshore wind projects in 2032/33.

The timeline of Scenario 2 can be seen in Table 1-4.

**Table 1-4: Timeline of scenario for COD in 2035**



# 2 Overview and focus category selection.

## 2.1 Vietnam Overview

For the purpose of this study, Vietnam can be divided into two primary regions: the northern and southern areas.

**Northern Region:**

In the years 2018-2021, renewable energy in Vietnam experienced significant growth, with most projects concentrated in the Central Highlands, Central South, and South regions. Meanwhile, the Northern region mainly developed hydroelectric and thermal power projects, many of which faced delays compared to the planned schedule. This has led to difficulties and challenges in the operation of the national power system. To mitigate the risk of power shortages, especially during hot periods in the Northern region, there is a need to accelerate the development of renewable energy sources in this area.

Additionally, with the Northern economic focal area (Ha Noi, Hai Phong, Quang Ninh, Hai Duong, etc.) being a power consumption centre, leveraging the offshore wind potential and aiming for a balanced development of source-load relationships, minimising long-distance transmission is necessary. PDP 8 encourages further development of renewable energy sources in the Northern region up to the year 2030.

Seaports in Hai Phong and Quang Ninh currently specialise in shipbuilding. This location is well-suited for researching and receiving technology transfers, domesticating mechanical engineering products, and supplying equipment for renewable energy power plants, particularly offshore wind power.

**Southern Region:**

Southern / Southern Central regions possess high potential of renewable energy especially in Ninh Thuan, Binh Thuan areas. Aside from high wind speed and ideal seabed condition for offshore wind foundation installation, Ninh Thuan also has potential to develop international ports to serve the offshore wind industry.

Additionally, Ninh Thuan and Binh Thuan areas are situated in proximity to the Southern economic focal area (Ho Chi Minh City, Binh Phuoc, Tay Ninh, Ba Ria – Vung Tau and Binh Duong) which is a power consumption centre. Utilising the existing potential of renewable sources in the Southern / Central Southern regions, avoiding long-distance transmission was therefore key in the most recent renewable energy developments.

Though seaports in the Southern Central region are mainly under development with an international orientation. Ho Chi Minh and Ba Ria – Vung Tau ports have long been specialised in shipbuilding and fabricating large scale maritime and oil & gas equipment and vessels. Their recent contracts in manufacturing offshore wind components (including jacket foundations and OSS) are proof of the existing capabilities and beginning of an offshore wind supply chain.

The southern area, thanks to its existing oil and gas manufacturing infrastructure, lends itself to a faster development timeline aligned to that of scenario 1.

## 2.2 Existing supply chain

The development of Offshore wind farms requires complex supply chains. Many components are typically manufactured across the world and will involve specialised vessels for transportation and hence capable port infrastructure and skills. Vietnam possesses strong port infrastructure, and industrial skills in various sectors (steel fabrication, renewable energy, and O&G).

The status of Vietnam's offshore wind supply chain capabilities is briefly outlined in Table 2-1:

**Table 2-1: Overall Offshore Wind Supply Chain status in Vietnam**

| Categories | General comments |
|---|---|
| <br>**Foundation supply/fabrication** | This category is the most mature in Vietnam attributed to the extensive expertise in shipbuilding and the O&G sector. Leveraging these capabilities is pivotal for the successful realisation of the Offshore Wind objectives outlined in the PDP 8. To achieve the desired scale, substantial investments are expected. |
| <br>**Nacelle assembly** | Up to now, in Vietnam there has been no major operational nacelle assembly factory. Therefore, this could be a favourable opportunity for Vietnam as seen on other markets such as Taiwan. |
| <br>**WTG Nacelle components fabrication** | This area is very specialised, and dependent on the strategy of some major WTG suppliers. None of the WTG OEMs have established such capabilities for Offshore Wind Turbine in country. GE has an operating manufacturing plant in the country, but it is used for fabrication of steam and gas turbines, as well as of smaller onshore WTG sub-components including generators, converter, pitch systems, control boxes and stator switch cabinet to name a few components. |
| <br>**WTG blades** | Up to now, there has been no factory to manufacture the blades in Vietnam. Within the specified timeline for two hypothetical projects, the likelihood leans towards the importation and transportation of blades via specialized vessels, such as cargo ships to meet the project requirement for the 2030 Scenario.<br>This could be an opportunity for Vietnam to explore this industry in the later scenario, especially considering Vietnam possesses expertise in glass and carbon fibre production, a crucial material used for the manufacturing of wind turbine blades. |

| Categories | General comments |
|---|---|
|  **Tower assembly** | Towers in Vietnam have been produced for smaller onshore WTGs. The changes in terms of machinery, processes, and storage of larger 15MW, 20MW, 24MW WTGs for Offshore Wind farms present significant challenges and will require considerable adaptation from suppliers. |
|  **Subsea cables** | Currently there are no submarine cables manufacturers in Vietnam. Worldwide there are only a few suppliers. Given the unique complexity and specialisation involved, localisation in this specific supply chain area is not a strength for Vietnam at present. |
|  **Ports and Harbours** | Vietnam boasts robust port infrastructures. In order to position itself as an assembly hub for large-scale offshore wind projects featuring substantial WTGs of 15-20 MW, upgrades are imperative in most ports regarding quayside water depth, bearing capacities, and storage areas. |
|  **WTG and foundation installation vessel** | There is no shipbuilding of WTG and foundation installation vessels in Vietnam. Such vessels are very specialised. Currently, only a few manufacturers globally have the expertise and capability to construct such vessels. Localisation in this specific supply chain area is not a strength for Vietnam at present. However, SOVs could be manufactured by VARD, Damen and PTSC shipyards. |
|  **Offshore substation** | PTSC in Vung Tau is currently building the first OSS for offshore wind from 2022. With the project gaining momentum, there are further opportunities to fabricate additional OSS for various regional projects. This underscores Vietnam's increasing traction in offshore wind development within this sector. |
|  **Onshore electrical Infrastructure** | The onshore electrical infrastructure is well known in Vietnam, and it is expected that this aspect can be undertaken by local companies already.<br><br>This has been proven through the development of nearshore windfarms. |
|  **Operation, maintenance, service** | Vietnam's mature onshore wind and offshore oil and gas industries create favourable conditions for localising Operations and Maintenance (O&M) and logistics experiences in the growing offshore wind sector. Noticeably, Vard Vung Tau – a ship building factory has delivered a SOV to Dogger Bank OSW. |

## 2.3 Focus category selection

Further to an initial assessment of the existing supply chain it was noted that some areas have higher development potential than others.

The study will therefore focus on 4 areas which are considered as those with most potential to reach advanced development in the scenarios proposed. These areas are as follows:

Port

Foundation Supply

Tower Supply


Nacelle Assembly

Other areas have still potential to be developed and should be considered when developing a project in Vietnam. The assessment only focused on the development of the supply chain to deliver the hypothetical projects presented in the scenarios. It currently disregards in part the regional and international demand for supply of these components. When considering the wider opportunities there may be critical components, for example submarine cables, which present a constrained supply chains worldwide and could offer a high potential.

# 3 Assessment Methodology

## 3.1 Ports assessment

This report will consider prospective port locations which might be capable for fabrication, assembly, marshalling, and/or O&M support for delivering offshore wind farm components typically for the identified projects in the North and the South of Vietnam. The identification of the most suitable port to serve the identified projects are based on the main parameters as in Figure 3-1:

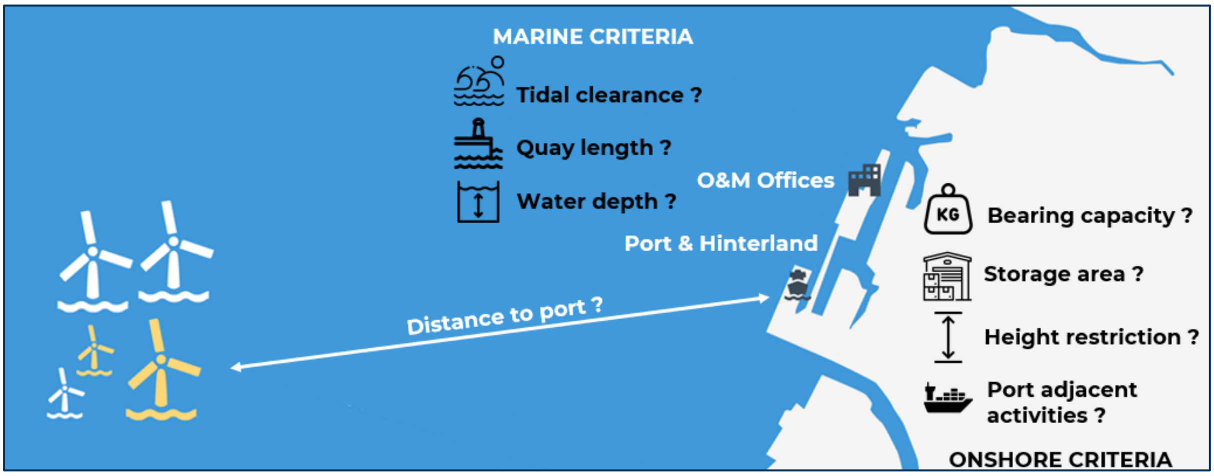



Figure 3-1: Basic parameters for port assessment [3]

The port assessments were undertaken in three stages as in Figure 3-2:

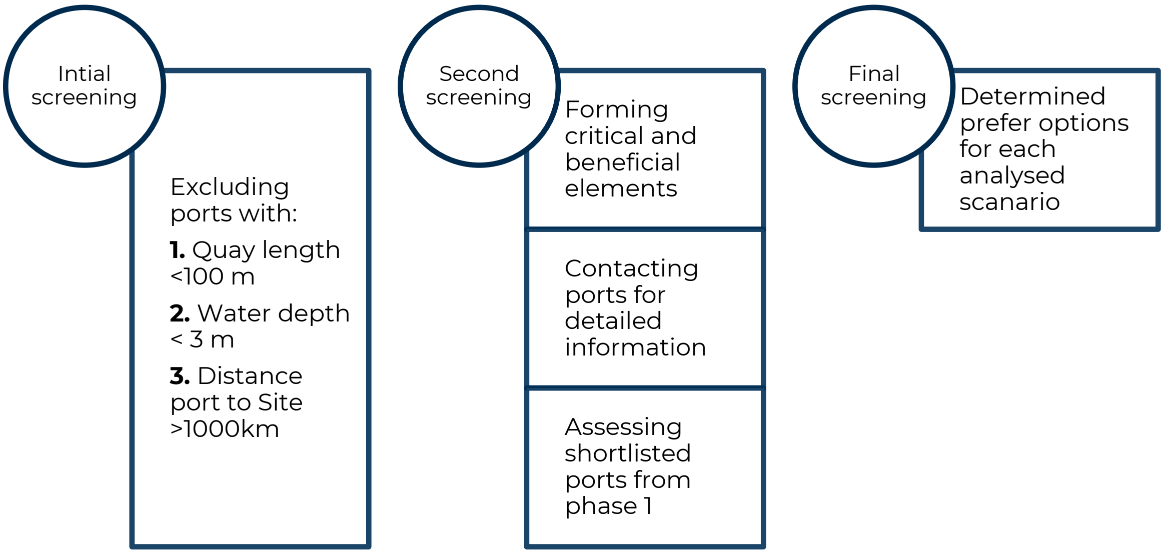



Figure 3-2: Port assessment methodology

## 3.2 Supply chain analysis

In order to evaluate the local supply chain capabilities of the Vietnamese offshore wind industry, this report assessed the ability, capacity, and alignment with industry standards of shortlisted ports and component suppliers.

The process involved a multidisciplinary approach including data collection from publicly available sources gathering insights into the readiness and capabilities of the various identified suppliers, and the distribution of questionnaires to potential shortlisted suppliers to better understand their capabilities and willingness to expand their services or infrastructure to support the country's burgeoning offshore wind industry.

Our approach for assessing Vietnam's supply chain capabilities involves four stages, as described below:

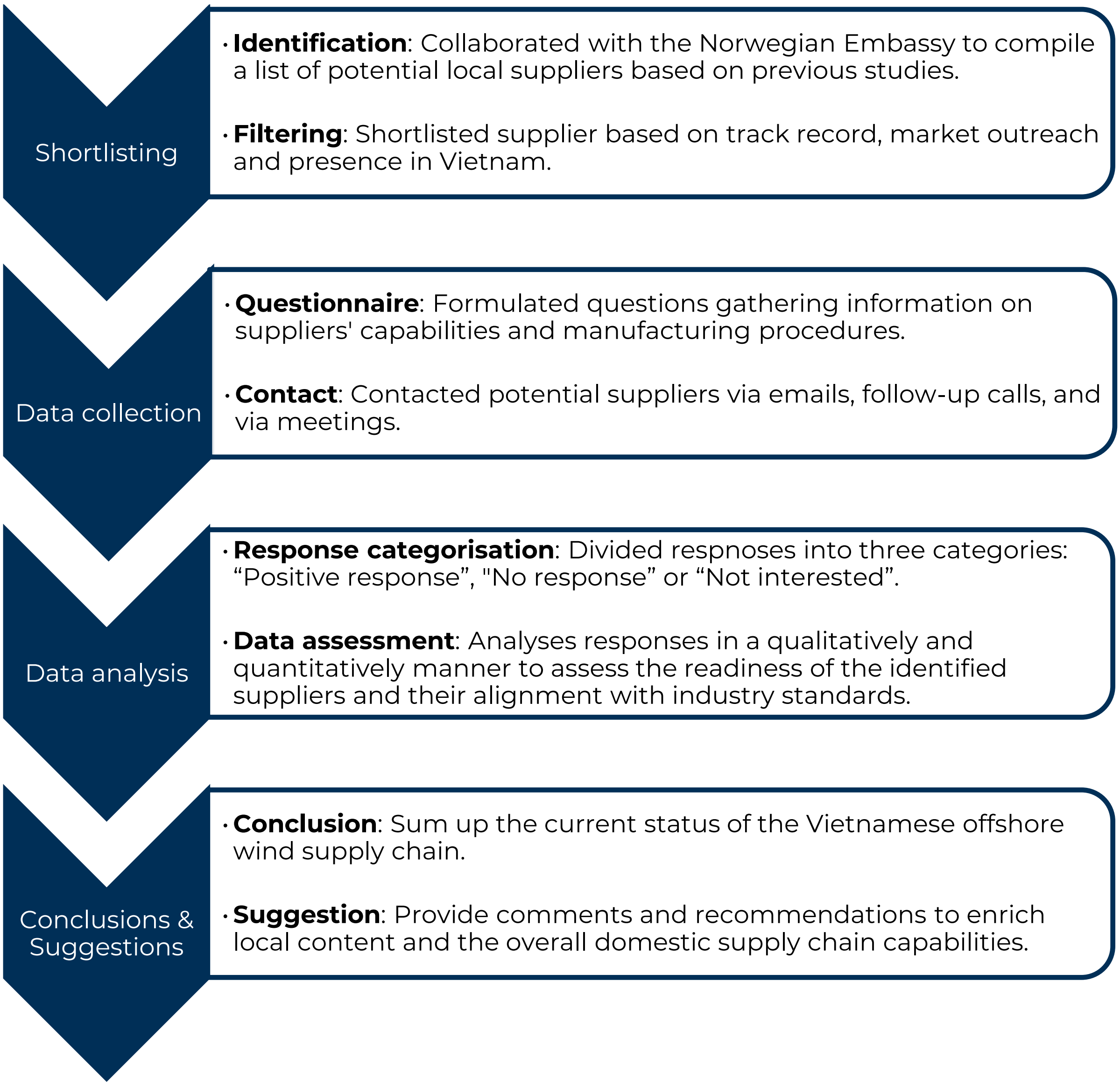



**Figure 3-3: Supply chain assessment methodology**

# 4 Port Infrastructure Assessment

## 4.1 Introduction of port infrastructure assessment

### 4.1.1 Definition of Offshore Wind Ports

Ports play an important role in the supply chain of offshore wind farms. Depending on the chosen installation strategy, a port might function as manufacturing, transhipment (stagging), assembly and/or operation hubs/bases. In every scenario, it serves as a strategic point in the supply chain, facilitating the passage of all components – structures and turbines – destined for the wind farm. Consequently, the initial step in constructing a wind farm is the careful selection of at least one primary port which could support the project mobilising its existing facilities or could support the project following minor updates.

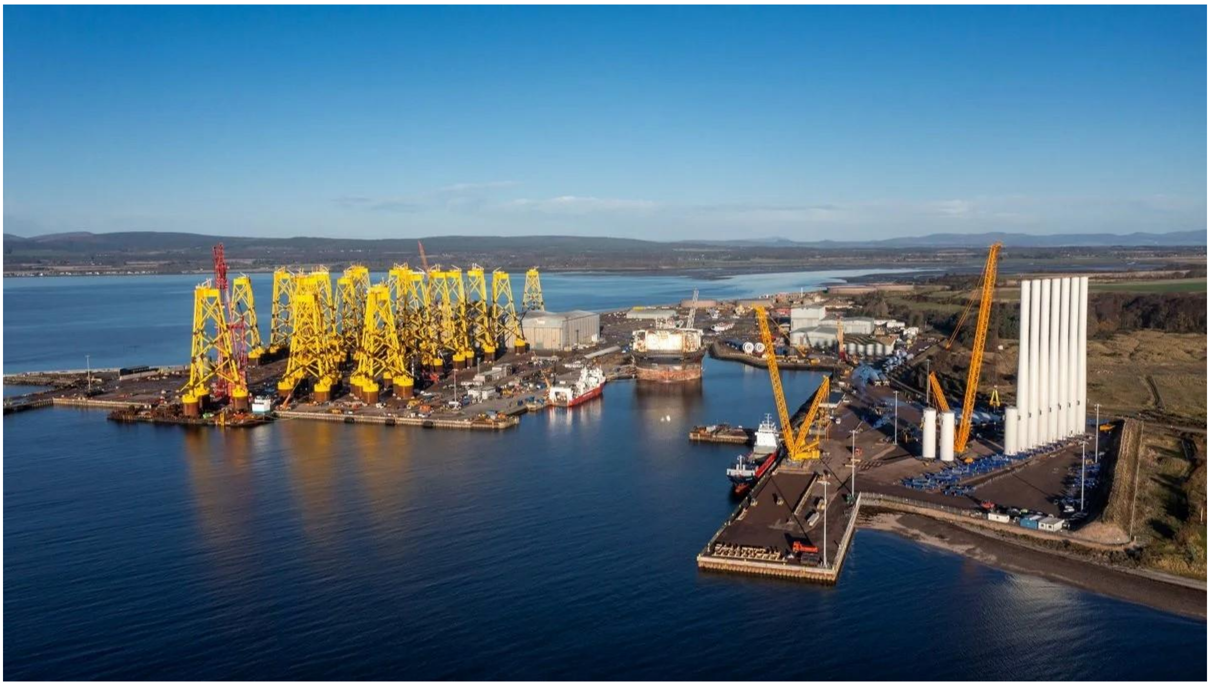


**Figure 4-1: An example of the port serving offshore wind. [4]**

Throughout the various stages of an offshore wind farm project lifecycle including component fabrication, pre-assembly, installation, commissioning, ongoing operation, and maintenance, as well as eventual decommissioning, a designated port terminal with specialised facilities would be essential. However, it is practically impossible to identify a single port which could have the available laydown area to support all project lifecycle activities at once. So far, several suppliers who manufacture key components for the offshore wind sector tend to establish a manufacturing or operations base within ports as this allow them to easier and safely transport the heavy components required for the construction of an offshore wind farm.

The development of offshore wind suitable ports is critical as such ports could facilitate the growth of the in-country offshore wind sector, as they streamline the logistical challenges associated with the pre-construction, construction, and maintenance phases. By providing a centralised hub for various activities, offshore wind ports help reduce costs, improve efficiency, create local jobs, and promote the expansion of clean and renewable energy generation from offshore wind sources.

Ports, therefore, play a critical and strategic role for all stakeholders involved in the project.

According to the Government's Decision No. 804/QD-TTg dated 8th July 2022, Vietnam currently has a list of 34 seaports. These ports are divided into four classes as detailed in Table 4-1.

**Table 4-1: Influence criteria for classification of seaports**

| Seaport Class | Potential influence level |
| --- | --- |
| Special | Seaports that serve the purposes 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 |

Based on Article 3 of Decision No. 804/QD-TTg, the criteria for evaluating and classifying ports not only involve considerations of the ports' throughput of cargos and/or the tonnage of ship received but also their potential influence level as described in the Table 4-1. Hai Phong and Ba Ria Vung Tau are two provinces which have seaports classified as special ones.

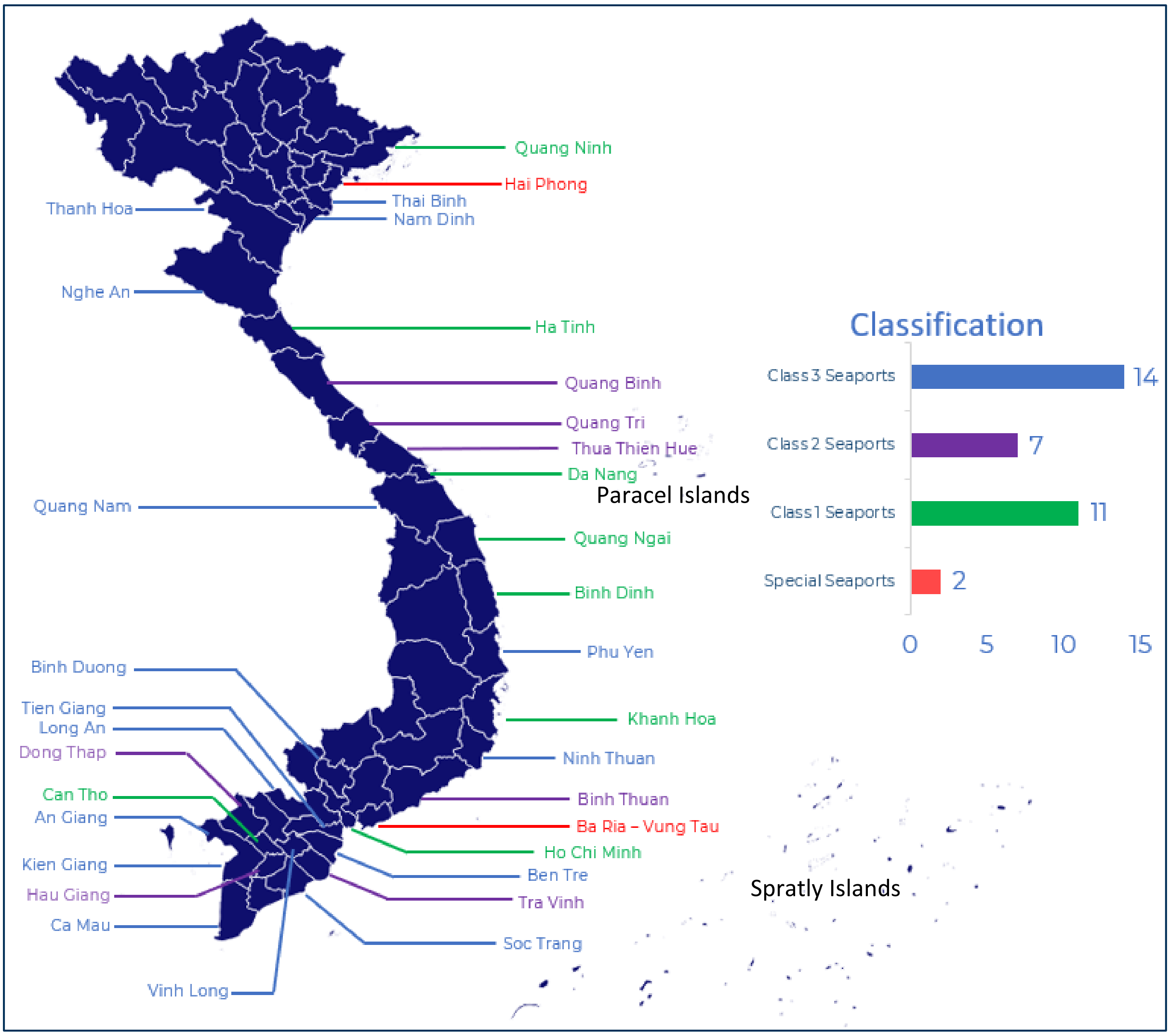



**Figure 4-2: Master scheme on seaport system in 2021-2030 with a vision towards 2050 (Decision No. 804/QD-TTg)**

## 4.1.2 Ports' features

### 1. Assembly / Marshalling

A marshalling or assembly port serves as an intermediary hub during the construction phase of an offshore wind farm. Typically situated closer to the offshore construction site than the fabrication or manufacturing ports, its purpose is to provide temporary storage and potentially serve as an assembly hub for components such as foundations and turbine towers. These components could be sourced from various manufacturing points before the installation at the offshore site.

In the context of this assessment, the processes integral to the fabrication phase encompass:

- Import and storage of WTG components.
- Assembling and storing structural components for this project, including jacket foundations (JKTs), nacelles, and towers. This process involves utilising fabricated steel sections and sub-components received from the fabrication workshop.

- Transporting Wind Turbine Generators (WTG) and fully assembling the WTGs' towers at the designated quay site before loading onto the vessels.
- Loading the components onto vessels for transportation to the offshore installation site.

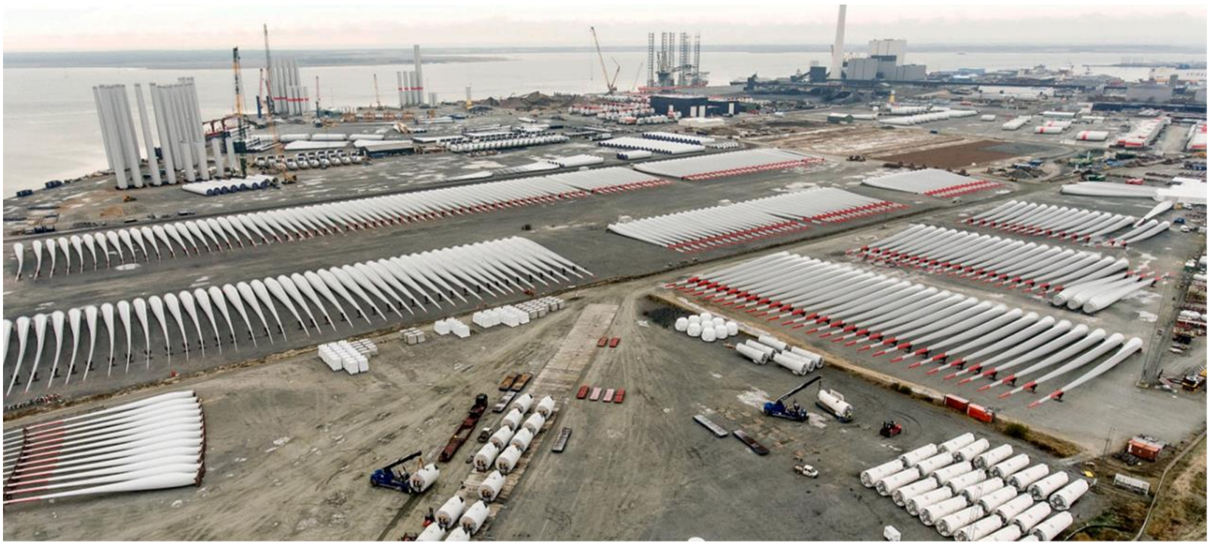


**Figure 4-3: OSW marshalling port example - The Port of Esbjerg in Denmark (2017) [5]**

## 2. Fabrication / Manufacturing

The construction of the foundations or towers is understood to be flexible, allowing multiple facilities to contribute if a dispersed construction strategy is employed. Given the diverse criteria contingent upon the fabrication capacity of individual facilities, the assessment intentionally excludes consideration of modular fabrication, focusing on the preferred approach of centralising fabrication at a single facility. Although a flexible supply chain, encompassing multiple facilities, remains a viable option, this option could increase the complexity of logistics and, sometimes, fabrication as there could be misalignment between the various under-mobilization facilities. The latter could also lead to project delays if unexperienced suppliers are mobilized which use various facilities for the fabrication of various components.

The criteria for a single facility fabrication are slightly less restrictive to that of the assembly or staging area. The bearing capacity of the fabrication area could be slightly lower than the assembly area's as single components are manufactured which then later shipped to the assembly area.

In the context of this assessment, the processes integral to the Fabrication Phase encompass:

- Raw material importation
- Fabrication of Steel Elements/Sections/Cut Plates
- Transportation to the Assembly Yard
- Assembly of Components


**Figure 4-4: Jacket foundation manufacturing at Samkang Shipyard, Korea [6]**

### 3. Operation & Maintenance (O&M)

An Operations and Maintenance (O&M) port serves as a hosting site for tasks associated with the ongoing operation and maintenance activities of an offshore wind farm throughout its designated operational lifespan. These facilities, usually established by the wind farm developer or the project operator, are tailored to align with the project's specific O&M strategy and requirements, which could involve specialised mooring equipment for O&M vessels such as crew transfer vessels (CTVs), for instance.

Typical amenities at an O&M Port can include berthing facilities for the O&M vessels with utilities and craneage, offices for operations staff, marine control centres for directing activities, terminal facilities for turbine technicians and warehouses for the storage of additional components that would be required for O&M purposes.

The primary determinant influencing the choice of an O&M Port is typically the distance to the offshore site. This selection criterion holds paramount importance for developers as the requirements for such ports are generally less stringent compared to ports dedicated to fabrication and marshalling.

**Figure 4-5: The Port of Peterhead – O&M hub for the Hywind Scotland project [7]**

## 4.2 Port colour coding methodology

To provide easy-to-digest visuals, we used a colour-coded approach for the assessment of Ports. The Ports colour-coding used aligns with the following descriptions (Table 4-2):

**Table 4-2: Colour-coding methodology for Ports**

| | | |
|---|---|---|
| GREEN | ● | Port appears potentially suitable since facilities align with key criteria and could require limited to no modifications to support offshore wind projects. |
| YELLOW | ● | Few non-prohibitive or minor constraints to key criteria exist and port is considered suitable with some minor support, enhancements, modification, or clearances. |
| AMBER | ● | Some moderate constraints to key criteria exist and the port would not be considered suitable without further enhancements, modification, and/or clearances. |
| RED | ● | The Port is not considered suitable and does not meet multiple key constraints. Ports would require significant changes, modifications, and upgrades (dredging or clearances). |

## 4.3 Port criteria

The assumptions on components' specifications, storing methods and detailed port criteria are listed in Section 8: Appendix A.

## 4.4 Port assessment results

The high-level port assessment with colour code is presented as the following, notice that Ports with no steel manufacturing/processing abilities will be marked as N/A for "Fabrication" sector.

**Table 4-3: Southern Ports suitability assessment for Scenario 1&2**

| Port | Fabrication | Marshalling | O&M |
|---|---|---|---|
| For OSW location in the South | | | |
| PTSC Supply Base / PTSC M&C | 🟢 | 🟡 | 🟡 |
| PV Shipyard | 🟡 | 🟡 | 🟡 |
| Alpha ECC | 🟡 | 🟠 | 🟡 |
| SREC | 🟢 | 🟡 | 🟡 |
| PTSC Phu My | N/A | 🟠 | 🟡 |
| Vinh Tan International | N/A | 🟠 | 🟢 |

**Table 4-4: Northern Ports suitability assessment for Scenario 1&2**

| Port | Fabrication | Marshalling | O&M |
|---|---|---|---|
| For OSW location in the North | | | |
| PTSC Dinh Vu | N/A | 🟠 | 🟢 |
| PTSC Nghi Son | 🟠 | 🟡 | 🟡 |
| Nam Dinh Vu | N/A | 🟡 | 🟢 |
| Tan Vu | N/A | 🟡 | 🟢 |

The marginal variations in port criteria between the two scenarios have not led to significant alterations in the overall port grading. While certain criteria may shift from being met to unmet between the two scenarios, these changes are insufficient for a complete revision of the port's status. The port assessment evaluation and descriptions are described in more detail in Section 10.

Aside from those analysed ports, several candidates emerged as potential repositories for temporary component storage (i.e., storing before moving to the final assembly hub). Notably, these are Thi Vai International Port, Sai Gon Vietnam International Port, Thi Vai General Port. These Ports have been used as a staging hub for WTG components for onshore and nearshore projects in the South of Vietnam. Nevertheless, it is noticed that these ports have not been thoroughly scrutinised, and their inclusion in this section is only for readers' information due to inherent constraints such as limited spatial capacity and distance from project sites.

Within the vicinity of the Thi Vai River there are also other major container ports such as Cai Mep International Terminal, Tan Cang Cai Mep Port, and Tan Cang Cai Mep Thi Vai Port. Despite their prominent position, these ports have been excluded during our data collection process as these ports have predominantly specialised in container storage. Consequently, a comprehensive assessment of their capabilities has not been undertaken. Our high-level analysis indicated that these ports could be utilised as temporary staging hubs. Figure 4-6 provides the port locations along the Thi Vai River.

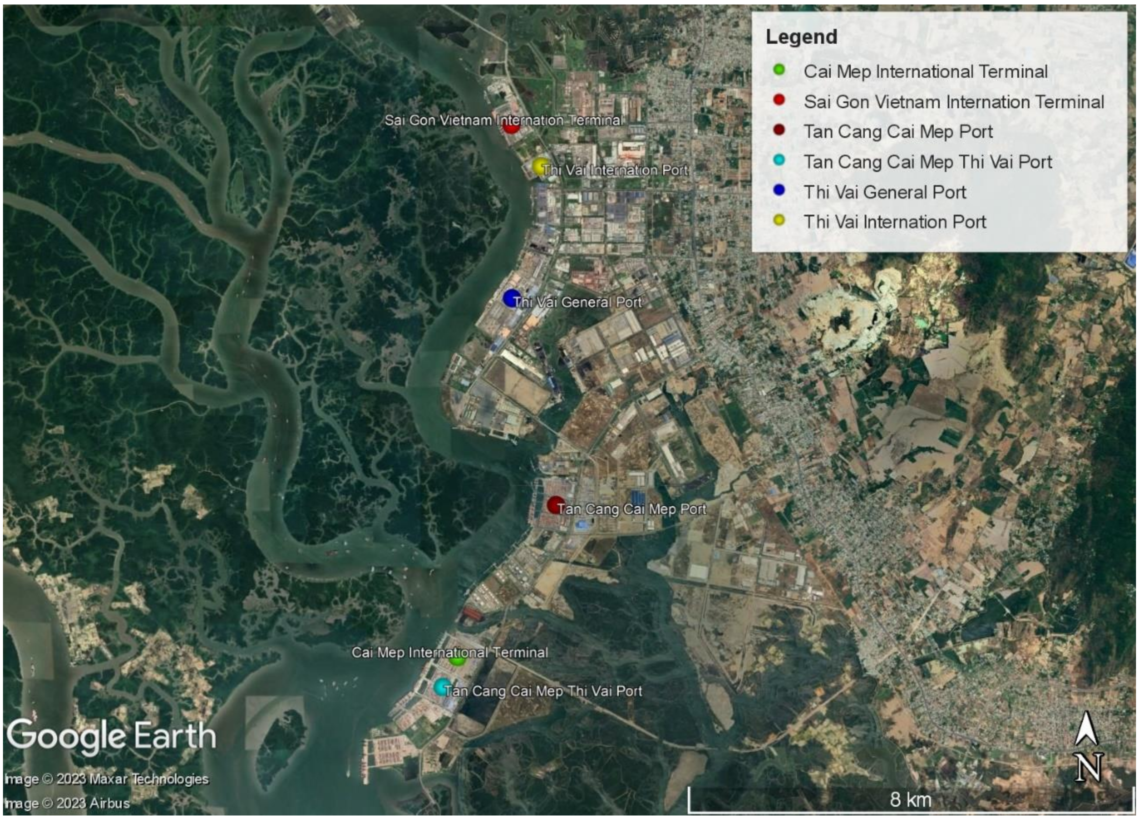



**Figure 4-6: Potential temporary hub across Thi Vai River**

## 4.5 Findings summary and recommendations for ports

### 4.5.1 Overall findings

The Northern ports, including those in the Hai Phong cluster, currently demonstrate a low interest in supporting the offshore wind industry. This is understandable considering the uncertainty of the country's offshore wind policy framework and route to market. Nevertheless, given the fact that most of the country's steel resources are in the north or imported from other northern countries, such as China, Korea, and Japan, the northern ports could become the country's logistics hub for foundations or tower if fabrication facilities are established. Such a strategic move - entering the foundation fabrication sector - could position them as the preferred ports for upcoming offshore wind projects, making Hai Phong & Quang Ninh port areas to some extent, a crucial element in Vietnam's Offshore Wind Roadmap.

In contrast, Southern ports suggest a more favourable inclination, likely influenced by the established presence of the oil and gas sector. A notable location could be the Vung Tau Port cluster, where PTSC is pioneering in the offshore wind industry. With a robust infrastructure, well-established facilities, and a wealth of experience, the ports in Vung Tau could position themselves as capable and reliable partners in the offshore renewable energy sector. Their diverse service offerings could cover the entire project lifecycle, showcasing a commitment to sustainable energy development in Vietnam.

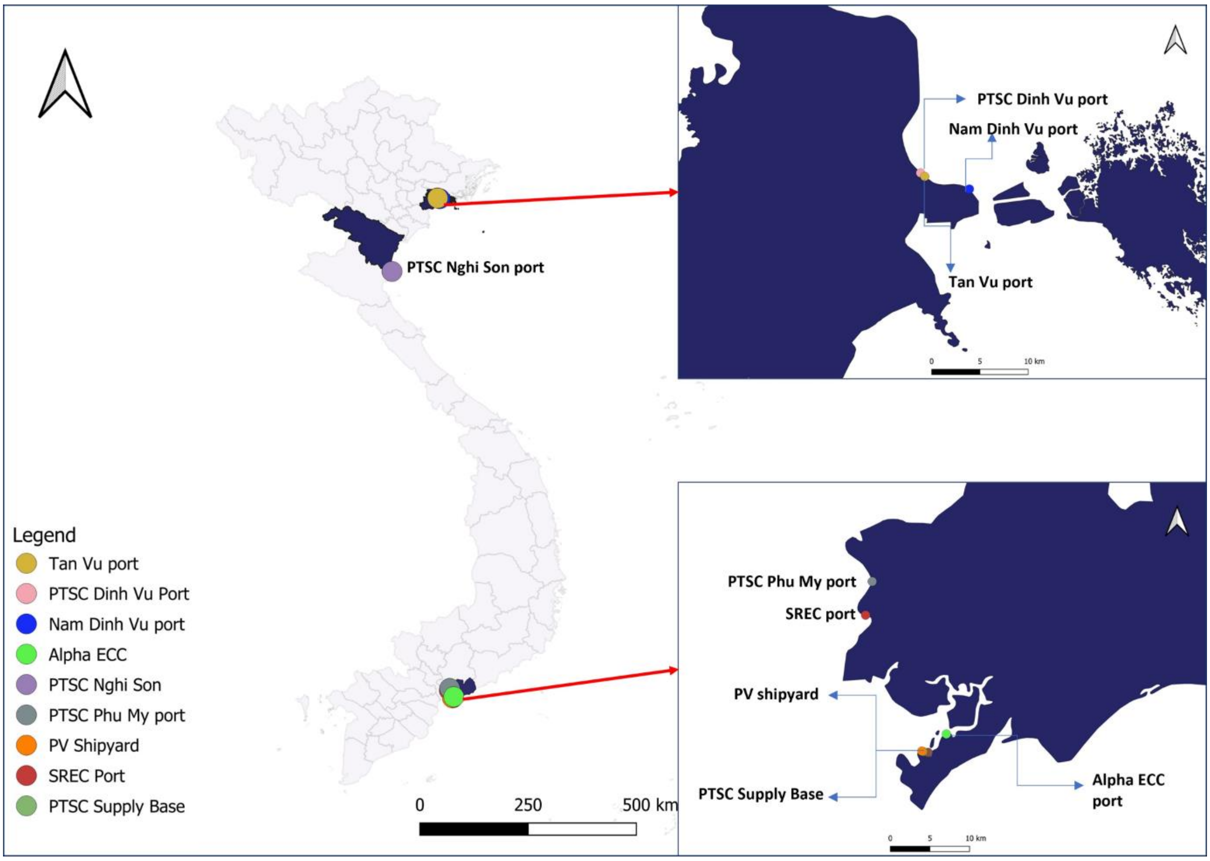



**Figure 4-7: Final port selection**

### 4.5.2 Findings for ports Scenario 2030

Our study identifies that the 2030 Scenario only allows a limited preparation window of 2 years. Therefore, no major upgrades could be expected, with only the current facilities being available to support the offshore wind project.

Based on the analysis, Vietnam has no manufacturing capabilities for WTGs and submarine cables, excluding the towers. Therefore, the project will have to import such components. More specifically, OSW projects located in the Binh Thuan Sea area, could leverage the well-established oil and gas supply chain in the Vung Tau area.

- WTG foundation (three-legged, four-legged jacket, monopile (SREC monopile facility is currently under construction and will be ready in 2024)), OSS foundation and OSS can be fabricated and marshalled in the Vung Tau Port Cluster (PTSC, PVC-MS, PV Shipyard).
    - SREC could be (sub)contracted for WTGs' foundation.
    - PV Pipe and PV Coating could be (sub)contracted for auxiliary components (metal plates, pipes, etc.), along with on-site services (NDT testing, corrosion protection, insulation protection, etc.). PV Pipe and PV Coating are situated close to the Vung Tau port cluster.
    - Tower fabrication at SREC and/or CS Wind.

For OSW projects situated at the Hai Phong Sea area, the projects could use:

- The Hai Phong Port Cluster (PTSC Dinh Vu, Nam Dinh Vu, Nam Hai Dinh Vu, Tan Vu Port) as the marshalling hub.
- Other options are limited in the South region given the immaturity of the region's offshore wind industry.

### 4.5.3 Findings for ports Scenario 2035

Moving to the later scenario with five more years of preparation, it is expected that simple secondary steel products, blades, nacelle assembly, can be sourced domestically should a continuous long-term pipeline be established. Though WTGs sub-components (rotors, shafts, generators, etc.) would still be expected to be imported given their manufacturing complexity. In general, a higher level of domestication is anticipated for this scenario.

For OSW projects located in Binh Thuan Sea and Hai Phong Sea areas, the foundations and towers manufacturing locations could still be the same with the 2030 Scenario. It is noted that, even with the later Scenario, foundation manufacturing in the North would be challenging. This is due to height constraints for many major ports / shipyards in Hai Phong as seen in Figure 10-2, Figure 10-3. Transforming the remaining northern ports, which were originally designated for container operations, into both marshalling and fabrication ports simultaneously would require significant investments that can hardly be met considering this timeframe.

### 4.5.4 Recommendation for Ports

**Northern Ports:**

Given the constrained timeline of only three years for preparation according to Scenario 1, that targets a 2030 COD, and the current slow advancement of the Vietnamese government definition of legal framework for offshore wind opportunities, it appears challenging for ports and shipyards in Hai Phong to be upgrades to serve the industry within the Scenario's deadline. Consequently, a strategic shift towards Scenario 2 seems prudent. Some potential areas of focus for this Scenario could include the following:

- Expand the country's shipbuilding industry, focusing on the construction of jack-up rig vessels, offshore installation vessels, SOVs, etc. In general, offshore wind logistics-related vessels are encouraged.
- Reinforce or upgrade the ports for marshalling activities, especially for ports that have no height constraints, via improving the bearing capacity and purchasing new crawler cranes with higher lifting capacity.
- Focusing on expanding the port laydown area to facilitate staging and increasing storage capacity for various key offshore wind farm components.

**Southern Ports:**

Considering the established oil & gas industry in the region, the ports in the southern regions have more capabilities and strengths compared to those in the northern region. Despite that, these ports still have some limitations.

For instance, the proximity of the port facilities and ongoing activities could pose constraints during operations as multiple vessels use the quaysides simultaneously.

In addition, the steel fabrication facility is adjacent to potential offshore wind component staging which would increase HSEQ risks. Lastly, the available laydown area for staging and assembly is limited as most of the existing area is used by other industries.

Therefore, we recommend that port authorities in the Vung Tau cluster should reach a consensus following the UK's example – free port status, allowing for a coordinated approach increasing the facilities usage efficiency. In other words, the coordination of the various activities among ports is essential and allows for the optimisation of logistical operations ensuring the projects' seamless execution. Some further improvements will be required; thus, we recommend the following:

- Dredging campaigns will be necessary to increase the port's water depth allowing for jack-up vessels to enter the port. Although fixed-bottom projects are considered, we recommend that the water depth should allow for the execution of both fixed and floating projects.
- Coordinating assembly activities with others port clusters (ports spanning along Thi Vai River or ports in South Central areas)
- Augment steel manufacturing capability is underscored. Alternatively, it is recommended that subcontracting arrangements with established domestic or international foundation suppliers, such as CS Wind or SREC, should be explored.

- Expand the ports’ area to accommodate for the staging of foundation and WTG components.

Furthermore, the government should establish policies and solutions to encourage the coherent and efficient development of the port infrastructure. The UK could be an example of such initiatives as the government has promoted infrastructure programs which provide funding for ports to improve their facilities for offshore wind. Through these programs, the UK government has identified more than 10 free ports, tax free heavens for manufacturing activities, with a few securing funds to expand their infrastructure allowing for fabrication facilities, such as foundation, tower and cabling, to be established.

# 5 Local Suppliers Assessment

## 5.1 Introduction of local suppliers' assessment

The offshore wind industry in Vietnam is gaining attention in the country's shift toward cleaner energy sources. This part focuses on evaluating local suppliers' response in the offshore wind sector, particularly their ability, capacity, and alignment with industry standards.

## 5.2 Supplier colour coding methodology

For suppliers, a Red-Amber-Green (RAG) method is applied to help easily identify gaps and opportunities amongst categories and suppliers.

**Table 5-1: Scoring methodology for Suppliers**

| Criteria | Score | Description |
|---|---|---|
| Track Record | 1 | No Experience |
| | 2 | Experience supplying parallel sectors such as onshore wind farm or marines |
| | 3 | Experience supplying oil & gas industry |
| | 4 | Experience supplying offshore wind farms industry |
| Manufacturing Capabilities | 1 | 1 Facility |
| | 2 | 2-4 Facility |
| | 3 | 5-10 Facility |
| | 4 | 11+ Facility |
| Company Size | 1 | 100 Employees |
| | 2 | 101-500 Employees |
| | 3 | 501-5000 Employees |
| | 4 | 5001+ Employees |
| Manufacturing location in Vietnam | 1 | No locations in Vietnam |
| | 2 | One location in Vietnam |
| | 3 | 2-5 locations in Vietnam |
| | 4 | 6 or more locations in Vietnam |

**Table 5-2: Colour-coding methodology for Suppliers**

| Colour code | Overall Score | | Description |
|---|---|---|---|
| GREEN | ● | Over 12 | Highly important Supplier |
| YELLOW | ● | Between 9 and 11 | Important Supplier |
| RED | ● | Less than 9 | Middle Supplier |

Also radar plots showing the capabilities of the identified suppliers in each of the sectors (Foundation, Tower, Nacelle, Rotor & Blade) are provided. The radar plot is based on five pillars (criteria), each scored from 1 to 3, as detailed bellow:

**Table 5-3: Radar Plot criteria for assessment of each sector**

| Criteria | Score | Description |
|---|---|---|
| Development plan for offshore wind | 1 | No intention for improvement |
| | 2 | Intention for general improvement |
| | 3 | Clear commitment for improvement in offshore wind |
| Track record | 1 | No Experience |
| | 2 | Experience supplying parallel industries |
| | 3 | Experience supplying offshore wind farms industry |
| Manufacturing capacity | 1 | No manufacturing facility in Vietnam |
| | 2 | Able to partially manufacture in Vietnam |
| | 3 | Able to completely manufacture components in Vietnam |
| Logistics readiness | 1 | Materials must be imported |
| | 2 | Materials could be partially sourced domestically |
| | 3 | Materials could be domestically sourced |
| Quality Compliance | 1 | No QC protocols in place |
| | 2 | Following only local QC protocols |
| | 3 | Following both local & international QC protocols |

## 5.3 Results of local suppliers' assessment

### 5.3.1 General findings for suppliers

From the methodology in Section 5.2, the supplier assessment is tabulated in Table 5-3. The geographical distribution of major suppliers in foundation and tower manufacturing, primarily located in the South of Vietnam, along with the concentration of onshore and nearshore wind farm projects from the Central Highlands to the Southern Coastal area, underscores a potential logistical challenge for offshore wind projects situated in the North.

The inherent logistics burden arises from the need to transport key components such as foundations and towers from the South to the North for offshore wind projects in Hai Phong City. This challenge could result in increased transportation costs, longer lead times, and potential complexities in coordinating the supply chain.

**Table 5-4: Supplier size categorisation**

| Suppliers | Categories | Track record | Manufacturing capability | Company Size in Vietnam | Manufacturing Location in Vietnam | Total |
|---|---|---|---|---|---|---|
| **SREC** | Tower/ Foundation | 4 | 3 | 3 | 2 | 12 |
| **CS Wind** | Tower | 4 | 4 | 3 | 2 | 13 |
| **PV Coating** | Auxiliaries (Painting, corrosion protection) | 3 | 1 | 3 | 2 | 9 |
| **PV Pipe** | Foundation | 4 | 2 | 3 | 2 | 11 |
| **PV Shipyard** | Foundation | 4 | 2 | 3 | 2 | 11 |
| **Alpha ECC** | Foundation | 3 | 2 | 3 | 2 | 10 |

| Suppliers | Categories | Track record | Manufacturing capability | Company Size in Vietnam | Manufacturing Location in Vietnam | Total |
|---|---|---|---|---|---|---|
| **PTSC** | Foundation | 4 | 4 | 4 | 3 | 15 |
| **Sadakim JSC** | Auxiliaries (Nacelle component) | 3 | 1 | 3 | 2 | 9 |

As of now, in Vietnam there has been no major operational nacelle assembly factories. Consequently, nacelle suppliers are not mentioned in Table 5-3, but a short description of this industry is provided in Section 5.3.2.

### 5.3.2 General status of the four sectors

The status of suppliers across the four sectors: blade, nacelle, tower, and foundation can be summarised as follows based on the criteria outlined in Section 5.2.

**Foundation**:

The current status indicates that foundation suppliers in Vietnam are gathering recognition, notably through contracting engagements as foundation suppliers for wind farms in Taiwan. This trend underscores the maturation of foundation manufacturing in Vietnam, positioning it as a sector with the capability not only to meet domestic requirements but support the international market at a competitive level.

**Tower**:

The manufacturing of onshore towers in Vietnam has been undertaken by industry players such as CS Wind and SREC. Additionally, there is a discernible strategic shift in focus by SREC toward offshore wind tower production. With adequate investment, the existing infrastructure could be shifted to offshore wind tower manufacturing which could be entirely localised.

Figure 5-1 provides the current situation of local suppliers for tower and foundation manufacturing.

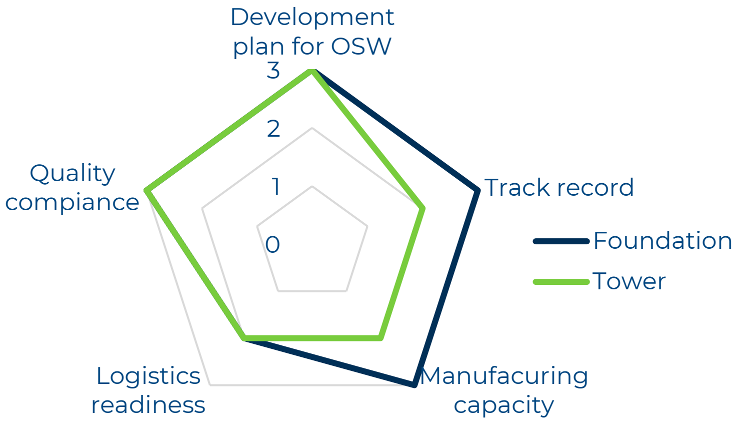



**Figure 5-1: Assessment of the foundation and tower local suppliers**

**Blade**:

Considering the existing ambiguity and uncertainties in the legal framework pertaining to the offshore wind industry, it appears sensible that major blade suppliers refrain from establishing in-country manufacturing facilities. This uncertainty has not facilitated any announcements in terms of new blade facilities. Consequently, within the specified timeline of the two hypothetical projects, the likelihood leans towards the importation of blades to meet the projects' requirements.

It is noteworthy to highlight that Vietnam possesses expertise in carbon fibre production, a crucial material used for the manufacturing of wind turbine blades. Triac Composite stands out as a representative raw material supplier in this domain, contributing to the local capabilities in the production of components essential to wind energy technologies.

**Nacelle**:

Vietnam has an extensive onshore and nearshore industry with several GWs already installed. As such major international WTG OEMs, such as GE, Vestas, Goldwind and Siemens Gamesa, have supplied the wind turbines for onshore and nearshore projects in the country. In terms of supply chain, it is understood that the major WTG OEMs listed above are familiar with the logistics and installation of projects in Vietnam. This includes knowledge of local tertiary suppliers and ports of operations.

The analysis indicates that none of the WTG OEMs have established such capabilities in the country. GE, in comparison to others, has an operating manufacturing plant in the country, but it is used for the fabrication of steam and gas turbines, as well as manufacturing of onshore WTG sub-components including generators, converter, pitch systems, control boxes and stator switch cabinet to name a few components.

In general, whilst there are certainly interests in developing a local supply chain for the delivery of offshore wind projects, all the WTG OEMs have not confirmed plans to establish such manufacturing facilities in Vietnam. Suppliers acknowledged that their decisions are subject to changes depending on the Vietnamese market developments and commitments from all the stakeholders promoting a consistent pipeline of offshore wind projects in the coming years. Goldwind also considers the market share to estimate the break-even point.

Figure 5-2 provides current situation of local suppliers in Blade and Rotor & Nacelle.

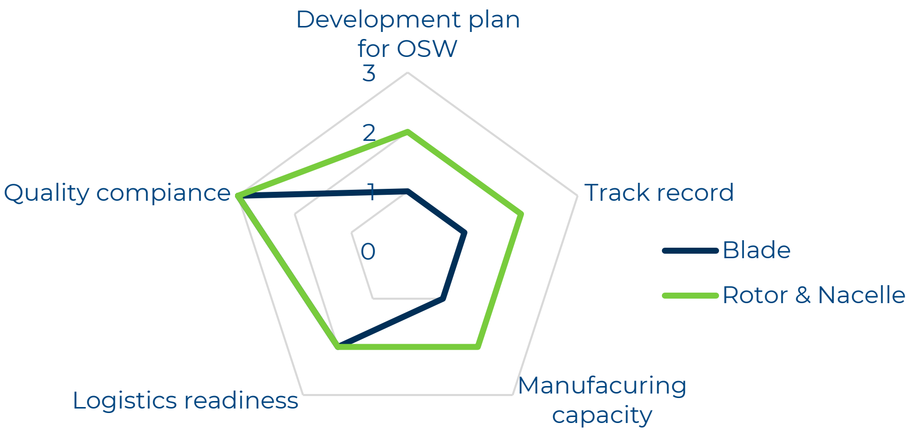



**Figure 5-2: Assessment of the blade and nacelle local suppliers**

### 5.3.3 Recommendations for Suppliers

Although Vietnam has no operational offshore wind farm excluding nearshore projects, the investment landscape is perceived as high risk due to uncertainties in the legal framework. The recent declaration of Power Development Plan VIII signals positive strides for offshore wind.

The underdevelopment of Vietnam's offshore wind supply chain is to some extent observable, particularly in the wind turbine generator space, as there are limited to no capable established suppliers. Given the immense potential capacity of offshore wind, a significant investment will be required for Vietnam to have a well-established supply chain. As the analysis indicated there are currently several suppliers capable of providing and manufacturing foundations and WTG towers. These two supply chain packages have been identified as Vietnam's strengths.

Further development is required to expand the manufacturing capabilities of the domestic infrastructure. The current legislative uncertainties necessitate a cautious approach for all industry players, domestic and interested international ones. The absence of a well-defined regulatory framework prompts a strategic stance that encourages preliminary actions rather than massive investments. Essential steps such as thorough market studies, establishing connections with local raw material suppliers, engaging with governmental bodies, public relations efforts, marketing initiatives, and the establishment of representative offices are deemed more prudent at this juncture. Another potential step for interested suppliers looking to expand in the offshore wind space is the development of partnerships or relationships with other regional or international suppliers. Such relationships could allow for knowledge exchange facilitating domestic suppliers with their expansion plans into the offshore wind industry.

Numerous suppliers in emerging markets, such as Vietnam, have established relationship with international experienced offshore wind suppliers to fast-track their plans. For instance, coming from an adjacent market – Taiwan, is that of Welcon and HighTek-Century who jointly established a tower manufacturing facility to serve the Taiwanese market. Another example, that again comes from Taiwan – APAC's (excluding China) most developed market, is the domestic supply of nacelles with Siemens Gamesa setting up a manufacturing facility. Vestas partnered with Tien Li to produce Taiwan-build blades. It should be noted that all of these partnerships were announced shortly after the Taiwanese government approved its offshore wind specific framework which increased developers' appetite to invest in the market.

To conclude, the existing strengths of Vietnam's supply chain infrastructure include foundation and tower manufacturing, but other components will have to be outsourced for projects targeting a 2030 COD, with the potential to have everything domestically sourced for projects targeting a 2035 COD. In both cases, the governments should establish a clear and supportive policy framework, encouraging investments in the offshore wind supply chain, and ensuring long-term stability and clarity for investors.

# 6 Job analysis

## 6.1 Job Development Case Studies

This section analysed published statistics of wind farms from different countries to determine the trends in job creation across the key phases of OSW development: construction, O&M, and decommissioning. While there will be a focus on direct jobs, indirect and induced jobs are also captured by the figures used in this analysis.

We have developed a job analysis methodology to estimate the number of direct, indirect and induced jobs created by an offshore wind project. This methodology is based on publicly available data we will share in the following sections. The studied countries are: United Kingdom and United States.

There are three primary types of FTE (1 FTE is defined as 1 full-time equivalent job for 1 year) that needs to be considered:

- **Direct FTE** – Direct FTE in offshore wind includes the full-time equivalent employees directly engaged in the core activities of developing, constructing, and operating offshore wind farms. This category encompasses roles such as engineers, project managers, technicians, and other personnel directly involved in the planning, installation, and maintenance of offshore wind infrastructure.
- **Indirect FTE** – Indirect FTE in the offshore wind sector represents full-time equivalent employees in supporting roles that contribute to the industry without directly participating in the primary activities. This could include individuals working in administrative positions, supply chain management, logistics, and other support functions crucial to the overall functioning of offshore wind projects.
- **Induced FTE** – Induced FTE in offshore wind accounts for the full-time equivalent employment generated as a result of broader economic activities stimulated by the offshore wind industry. This may include jobs created in local communities due to increased economic activity related to the presence of offshore wind projects. This could include the increased consumption spending on housing, healthcare, goods, and services, etc.

## 6.2 FTEs generated per wind farm

A UK offshore wind farm, Dogger Bank wind farm, is currently under construction. This is an offshore wind farm is being developed in three phases – Dogger Bank A, B and C – located between 130km and 190km from the Northeast coast of England at their nearest points. These details were extracted from a socio-economic impact study of offshore wind, as reported by Forewind [8].

Table 6-1 outlines the projected total labour inputs, measured in Full-Time Equivalent (FTE) jobs, encompassing direct, indirect, and induced roles for the two wind farms. It is noticed that this table use the Low Scenario in [8] as until 2022 UK possesses around 13 GW of offshore wind energy [9].

**Table 6-1: FTE per Wind Farm: UK**

| | UK | |
|---|---|---|
| | Dogger Bank Teesside A & B – 1.2 GW each - UK | |
| **Job Type (FTE's)** | Construction | Operation |
| Direct | 1,092 | 216 |
| Indirect | 588 | 180 |

*Source: Adapted from Forewind*

The data from the Table 6-2 was taken from a report prepared by ICF Resources, L.L.C. [10], using data and inputs provided by Empire Offshore Wind LLC, along with other information from publicly available sources, which was produced at the request of Equinor for the purpose of conducting an analysis that estimates direct, indirect, and induced jobs and economic outputs on the local (NY) level that will result from the development of the Empire Wind Farm 1 and the Empire Wind Farm 2. The expected commercial operation date of the 816 MW Empire Wind 1 is 2027, while the 1,260 MW Empire Wind 2 is a year later, according to the New York State Energy Research and Development Authority.

**Table 6-2: FTE per Fixed-bottom Wind Farm: USA (New York)**

| | USA | | | |
|---|---|---|---|---|
| | Empire Wind 1 - 816 MW – NY State | | Empire Wind 2 - 1260 MW – NY State | |
| **Job Type (FTE's)** | Construction | Operation | Construction | Operation |
| Direct | 1,261 | 1,791 | 2,154 | 2,723 |
| Indirect | 421 | 1,244 | 764 | 1,887 |
| Induced | 645 | 1,029 | 1,127 | 1,563 |

*Source: Adapted from ICF Resources, L.L.C*

To compare those publicly available data, OWC used its own methodology to estimate the number of job creation for a 1 GW offshore wind project which is similar in capacity to the hypothesized projects. Our figures assume 2 years for the development phase, 3 years for construction phase, 25 years for operation and 2 years for decommissioning phase. Figure 6-1 provides the variation of FTE jobs throughout the project lifespan.

**Table 6-3: FTE per Wind Farm: OWC assumption**

| | Hypothetical project | | | |
|---|---|---|---|---|
| | Hypothetical project - 1000 MW | | | |
| **Job Type (FTE's)** | Development | Construction | Operation | Decommission |
| Direct | 166 | 2,085 | 195 | 291 |
| Indirect | 157 | 1,822 | 212 | 272 |
| Induced | 208 | 2,121 | 257 | 327 |

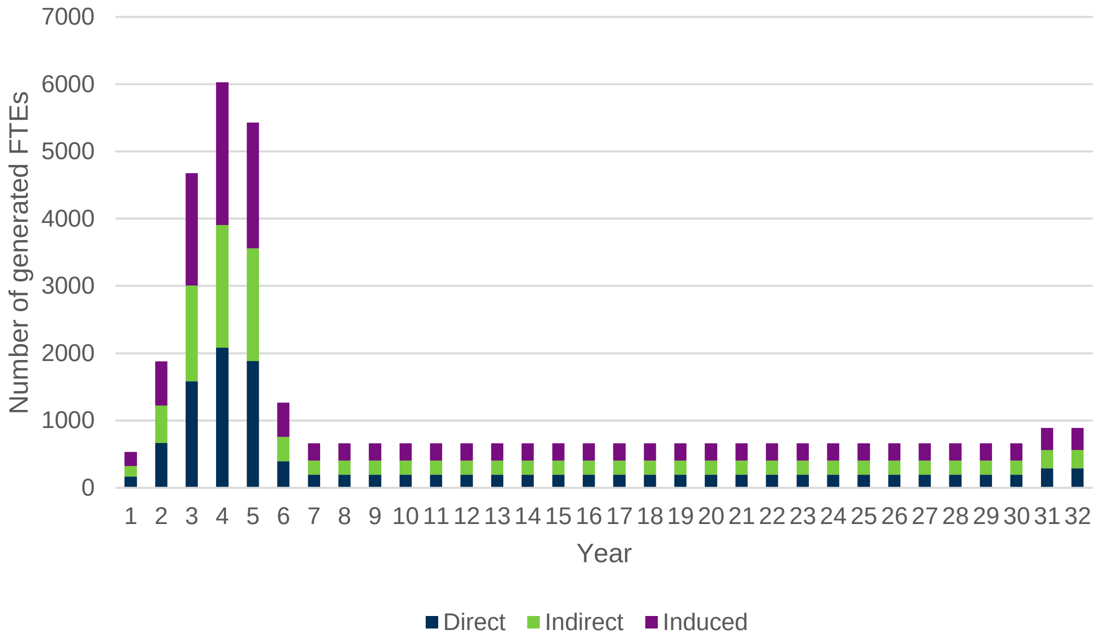



**Figure 6-1: Variations of FTE throughout the project lifespan according to OWC assumption**

The number of jobs created for such a project can be seen in the right side of the Figure 6-2. These figures are based on high-level estimations assuming that all components and services will be domestically sourced. A more detailed assessment would be required to identify the number of jobs that could be created based on the current available offshore wind infrastructure.

It is important to note that since these data were taken from different sources and case studies, they do not share the same offshore wind development scenarios. In addition, at this point in the analysis the projects have not been standardised for their varying sizes as they range from 816 MW to 1260 MW.

The purpose of this section was to observe which jobs: direct, indirect and induced, dominated each of the OSW development phases: development, construction, operations and decommissioning and which phase introduces the most FTE jobs in general.

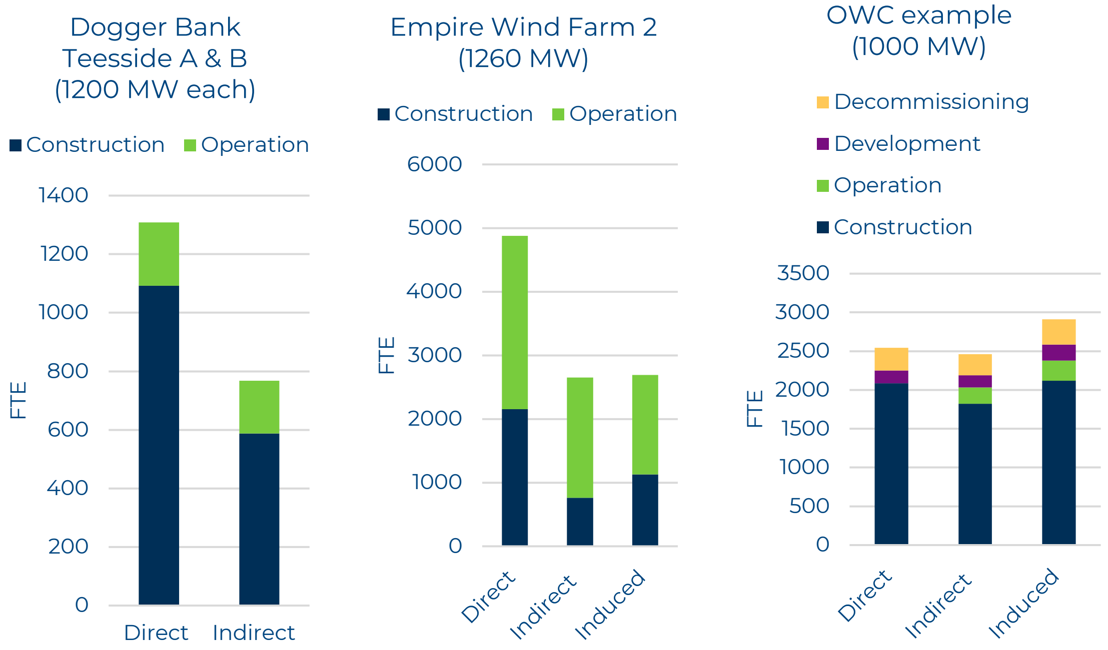



**Figure 6-2: FTE Generation per Wind Farm starting from left to right; Dogger Bank Teesside A&B (left), Empire Wind Farm 2 (middle), and OWC's 1 GW estimate (right)**

As it can be expected, the analysis indicates that the highest number of jobs is during the construction phase, which typically lasts up to three (3) years, followed by the operation phase that last at least 25 years and then decommission phase which lasts two (2) years. The development phase generates the least number of jobs as can be seen from the figure above.

## 6.3 FTEs generated per MW

The table below shows that in the UK and USA, direct jobs were produced the most but not by a large margin. Overall, for Empire Wind 1 and 2 wind farms the FTEs generated per MW across all three job types were at similar levels. For both the country level and local level indirect jobs were produced the least; induced jobs were created second-most in the USA but were produced most at OWC example.

**Table 6-4: FTEs Generated per MW**

| | UK | USA | | OWC example |
|---|---|---|---|---|
| | Dogger Bank Teesside A & B – 1.2 GW | Empire Wind 1 – 816 MW | Empire Wind 2 – 1260 MW | 1,000 MW |
| **Job Type (FTE/MW)** | Country – Level | Local – Level | Local – Level | Country – Level |
| Direct | 1.4 | 3.74 | 3.87 | 2.74 |
| Indirect | 0.33 | 2.04 | 2.1 | 2.46 |
| Induced | N/A | 2.05 | 2.13 | 2.91 |

## 6.4 Results of job analysis

To some extent, a high-level assumption on the amount of FTE generated for a 1 GW project (Scenario 1 and Scenario 2) can be seen as in Figure 6-3 and Figure 6-4 to assess the economic impact of a wind farm project on job creation.

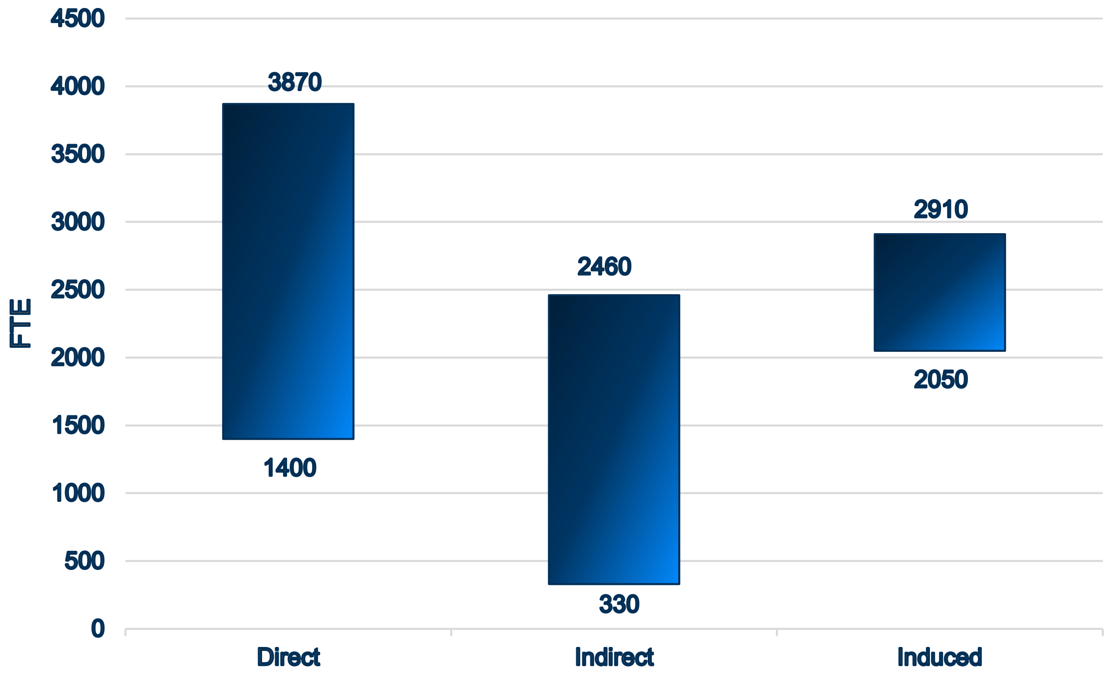



Figure 6-3: Range of FTEs created at country/local level for a 1 GW project

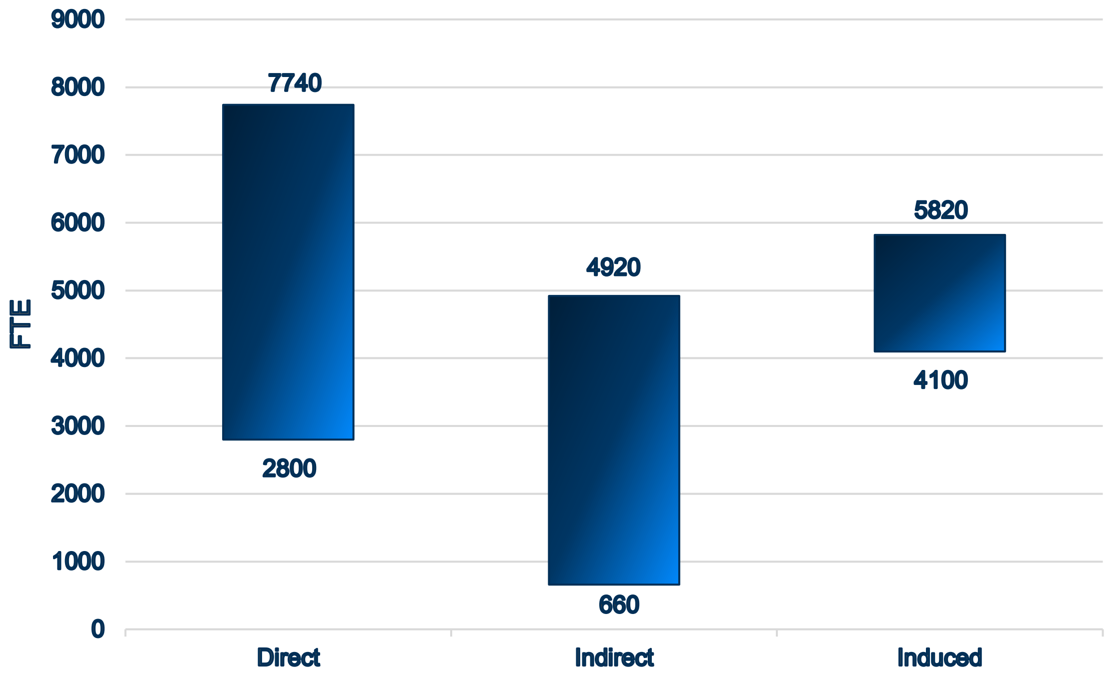



Figure 6-4: Range of FTEs created at country/local level for 2 GW (Scenario 1 and 2)

Figure 6-5 indicates high-level assumption on the amount of FTE generated throughout the whole PDP 8 with 6 GW offshore wind.

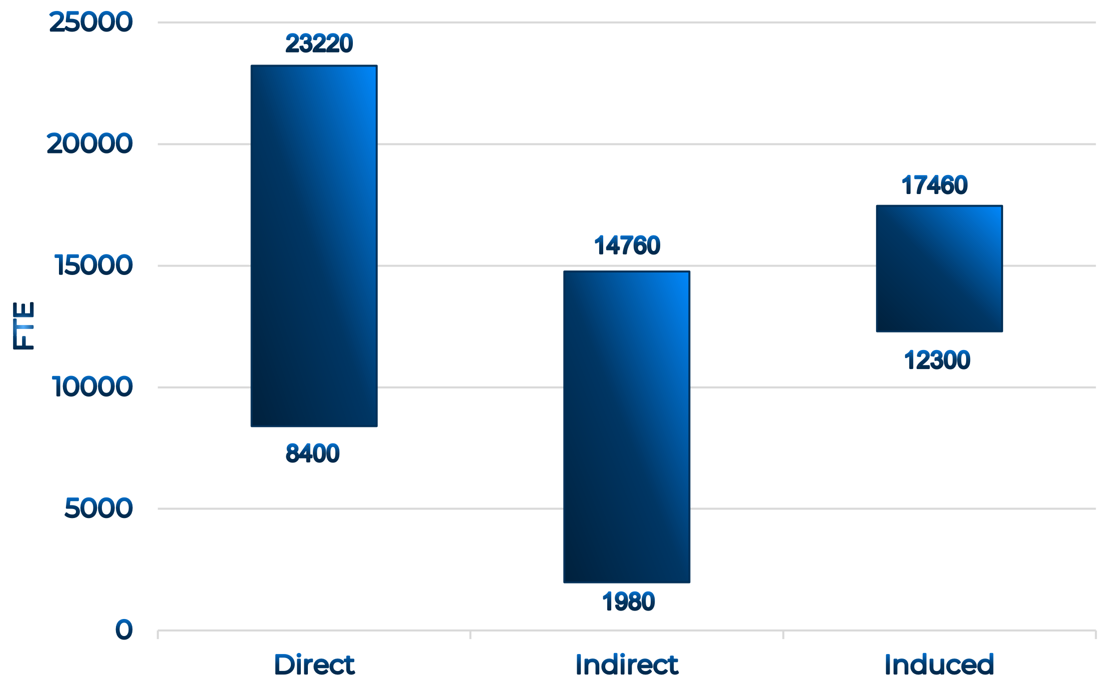



**Figure 6-5: Range of FTEs created at country/local level for 6 GW as in PDP 8**

To sum up, FTE's range for a typical 1 GW project, for Scenario 1 or 2 and for the whole PDP8 for are tabulated below:

**Table 6-5: FTE's range for a typical 1 GW project, for Scenario 1 or 2 and PDP8**

| FTE Type | 1 GW | 2 * 1 GW for Scenario 1 or 2 | 6 GW (as in PDP 8) |
|---|---|---|---|
| Direct | 1,400 – 3,870 | 2,800 – 7,740 | 8,400 – 23,220 |
| Indirect | 330 – 2,460 | 660 – 4,920 | 1,980 – 14,760 |
| Induced | 2,050 – 2,910 | 4,100 – 5,820 | 12,300 – 17,460 |
| Total | 3,780 – 9,240 | 7,560 – 16,480 | 22,680 – 55,440 |

Following the analysis outcomes, the construction phase usually generates the most FTEs jobs as this phase includes fabrication - a labour-intensive process. For Northern Vietnam, there is a huge potential to stimulate local direct FTE jobs during fabrication, leveraging the metallurgy industry which is a key sector at the region. Geographical proximity to electrical components and cabling manufacturing (LS Vina Cables & System JSC, General Electric Vietnam Limited. and ABB Automation and Electrification Vietnam Company Limited) make the Northern area ideal for future development of small complex components such as WTGs assembly lines or OSS components.

For the Southern Vietnam, the manufacturing sector experienced significant growth during 2018 and most of 2019 due to the O&G industry and onshore/nearshore wind industry which shows potential for generating local and direct FTE jobs. Another strength of the Vietnamese supply chain could be during operations leveraging the country's existing strength on logistics. Although the required FTE jobs during operations are lower than those required during construction, it should be mentioned that these FTEs have a longer lifespan of 25-years instead of 3-years.

## 6.5 Recommendations for job analysis

It is recommended for governments to institute and fortify policies conducive to bolstering the existing conditions, thereby augmenting the positive impact of the manufacturing and operation phases on local employment. Such governmental initiatives increase investors' appetite to establish manufacturing facilities and training facilities improving the country's supply chain capabilities. Subsequently, such initiatives would allow offshore wind developers to source components domestically and use local technicians for the O&M.

Given PDP 8's renewable energy development plan and the socio-economic benefits offshore wind could have for each region, we recommend establishing two inter-regions renewable energy clusters, the Northern and Southern clusters. Each cluster would act as a renewable energy centre supporting any offshore wind project in proximity.

Given the port and supply analysis, the northern cluster (around Hai Phong) could serve as a hub of jobs that could support the manufacturing activities of nacelles and blades, given the current fabrication facilities. Similarly, the existing cable manufacturing facilities could offer job opportunities for this regional cluster. Another potential job creation opportunity could come from the assembly of key parts required for the delivery of offshore substation as ABB and Siemens have fabrication facilities in the region. Building offshore wind dedicated vessels also emerges as a strategic option given the traditional shipbuilding industry in Hai Phong and Quang Ninh ports.

On the contrary, the Southern cluster (around Vung Tau) could offer opportunity for jobs within the foundation and wind turbine tower fabrication. Another potential area which could generate jobs is shipbuilding as offshore wind dedicated vessels will be required to install offshore wind project. It should be noted that, the potential of this cluster to generate offshore wind jobs lies in the long-term development of offshore wind in Vietnam. The southern region has good wind resource potential and shallow areas which could provide numerous opportunities for fixed-bottom projects. Therefore, it is highly recommended the industry cluster to focus on expanding the existing capabilities potentially increasing the number of generated offshore wind FTEs jobs.

To maximise the number of generated FTEs jobs from offshore wind, the following actions are suggested for each cluster:

- Perform a detailed supply chain assessment to understand the region's strengths and weakness considering the existing and future potential the region could have in terms of offshore wind developments.

- Establish relationships with universities and other research and development (R&D) institutions which could result in the training of new offshore wind workers. Such relationships would have long-term benefits for the domestic supply chain.
- Engage with the government to facilitate the formulation of a supply chain development plan which will be assisted by governmental incentives allowing for the upgrading of the existing port infrastructure and expanding of the domestic supply chain capabilities.
- Form relationships and/or partnerships with key offshore wind stakeholder that have proposed projects in the region or aiming to develop projects. Such relationships are critical for the development of a sustainable offshore wind supply chain.

# 7 Conclusion and Recommendations

## 7.1 Final conclusion

**Key takeaways**

- No supply chain specific incentives are in place so far, which creates hurdle to the development of a domestic offshore wind supply chain. The government is advised to take actions, starting with the allocation of investments to improve the domestic port infrastructure, which could act as marshalling or staging port for projects not only in Vietnam but also to other countries in the vicinity.
- Vietnam's current supply chain strengths lay within the manufacturing of fixed-bottom offshore wind foundations. A few identified suppliers have already been awarded contracts to supply such structures to other regional markets.
- Vietnamese suppliers have established relationships with other international players aiming to exchange experience and knowledge, which will facilitate the development of the domestic supply chain. Semco Maritime and PTSC have forged such a partnership for the delivery of two offshore substations for the Hai Long project in Taiwan.
- Vietnam's capabilities to provide wind turbine units (nacelle and blade) are limited as there is no manufacturing facility present in the market. A significant investment will be required to establish such facilities, which could require up to 3 years to be fully operational.
- Vietnam's port infrastructure is suitable and capable of supporting the nearshore projects. However, the infrastructure will require investments to upgrade the port's facilities. Targeted investment is advised, allowing for the creation of two clusters, one in the North and one other in the South.

When it comes to manufacturing offshore wind components, Vietnam already has extensive experiences in producing towers and foundations as well as shipping these structures to other regional markets such as Taiwan and Korea. Meanwhile, wind turbine OEMs have developed supply chains to produce high-class and affordable nacelles and blades for the Asia Pacific region. Such facilities are ready to support the Vietnamese offshore wind industry. Therefore, should a considerable market develop, Vietnam would be well poised to capture the potential capacity expansions due to its cost position.

The analysis indicated that Vietnam's domestic oil and gas sector has facilitated the development of the existing supply chain infrastructure which is crucial as a number of services and activities could be transferred to the offshore wind industry. Transferring engineering capabilities from the oil and gas sector has been observed in emerging offshore wind markets as such activity facilitates the development of the domestic supply chain requiring low investments. Examples of transferable services and activities can be seen in Table 7-1.

**Table 7-1: Transferability from oil and gas to offshore wind industry [11]**

| Sector | Transferability |
|---|---|
| Project management, technical surveys | • Site surveys: Similar to an extent for both oil and gas and offshore wind projects.<br>• Consenting and permitting: Similar permitting procedures are followed to secure seabed permits, but surveys might be slightly different.<br>• Project management: Oil and gas project managers could manage the various activities for the development of OSW projects. |
| Substation structures | • Major one-off designs that are similar in scale to oil and gas projects. |
| Turbine foundation | • Utilise the same skillset required to produce modular components. |
| Installation support services | • Vessels required for the installation of oil and gas platform can be used to install OSW projects as has been observed in other markets |
| Maintenance and inspection services | • Subsea inspections: Underwater inspections are similar in both industries. Divers and remote operated vehicles could be used for such activities. |

Overall, the O&G industry has helped the development of a well-established Vietnamese supply chain infrastructure in terms of foundation and tower manufacturing as well as the marshalling port. This is the main reason why these packages outperform the other packages (Figure 7-2).

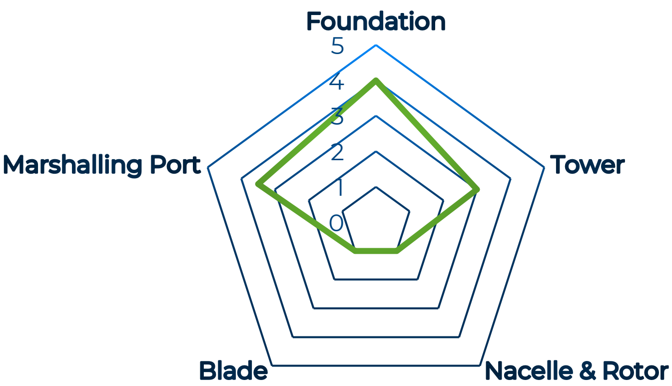



**Figure 7-1: Readiness of the Vietnamese supply chain**

(Note: 1 = low supply chain capabilities, and 5 = high supply chain capabilities (i.e., ready to use))

The supply chain package which will require significant investments is the WTG package as there are no manufacturing facilities capable of supplying nacelles and blades for offshore wind projects in Vietnam. General Electric (GE) is the only WTG OEM which has a small facility situated in the Northern region, supplying units to the domestic onshore wind market. Following our analysis and announced plans, it is yet unclear if WTG OEMs will expand their WTG manufacturing facilities or establish new ones to support the emerging offshore wind sector. Therefore, it should be anticipated that most of the WTG components for early projects will be outsourced as the development of such facilities could take up to 3 years, assuming an investment decision is reached as soon as possible.

The Vietnam's efforts to develop its domestic offshore wind supply chain infrastructure can be easily recognised as regional offshore wind stakeholders have awarded contracts for the manufacturing of foundations, for instance. However, further investments will be required to improve the domestic capabilities, thus, the Vietnamese government should continue and increase its supply chain incentives, including regulatory frameworks which support local content. Such incentives facilitate the establishment of a well-rounded infrastructure, which will support the offshore wind sector in the long-term, as such support also increases the appetite to invest of both offshore wind stakeholders and suppliers. As can be seen from other emerging markets, targeted supply chain incentives have affected local investments which were vital and have contributed significantly to the establishment of domestic supply chains in other regional markets, such as Taiwan and Japan.

## 7.2 Final recommendations

The successful implementation of the PDP 8 and the domestic expansion of the offshore wind market, requires comprehensive and detailed guidelines. The government's role is vital for the promotion of offshore wind, as has been observed from other emerging markets. Such involvement should include the introduction of supply chain specific policies, incentivizing local businesses to invest either in manufacturing facilities or port infrastructures. However, such incentives should be targeted allowing for Vietnamese in a timely manner. First incentives should target the expansion of the existing domestic capabilities, which could fast-track the development of specific offshore wind supply chain aspects. For Vietnam, such incentives should target the manufacturing capabilities of fixed-bottom foundations and offshore substations. Subsequent subsidies and incentives are advised to target other areas of the domestic supply chain which would have long-term benefit for Vietnam. Such subsidies could target the port infrastructure and various O&M activities, leveraging the existing O&G knowledge and manpower. Last resort should be to target the manufacturing of Vietnamese towers, wind turbine units and cables. Such infrastructure will require significant investment from the suppliers. To improve the suppliers' appetite, the government will have to establish a wealthy offshore wind project pipeline attracting developers and creating multiple opportunities for the domestic supply chain industry to top in and leverage as many opportunities as possible.

To unlock the full potential of wind energy in Vietnam, it is imperative to promptly conduct actions as followed:

- **Establish an offshore wind regulatory framework:**

The government should establish a robust legal framework, creating a wealthy offshore wind project pipeline. Such framework will provide a long-term vision for offshore wind in Vietnam and should include incentives for local content. The framework should include specific steps that will allow for the development of a domestic offshore wind market. Such steps should be the identification of offshore wind suitable areas, conduction of early environmental studies, and implementation of a transparent pricing plan. Following these steps would attract developers and increase their appetite to invest to the domestic market.

- **Set up non-binding local content requirements:**

  Emerging markets usually suggest non-binding local content requirements aiming to fast-track the engagement between domestic suppliers and international players. Such a comprehensive legal structure would offer clarity and certainty for investors, fostering the growth of renewable power in Vietnam. Such approach has benefit significantly the Taiwanese and Japanese offshore wind supply chains. Other international markets have followed a similar approach, but they have imposed penalties if the developers deviate from their proposed supply chain visions.

- **Engage with Universities and promote Research and Development activities:**

  The government should engage with the country's Universities identifying those interested in offshore wind. Through such engagement, the government should set up modules educating and cultivating new personnel capable of supporting the emerging offshore wind market. Such training and knowledge sharing is said to be more efficient through the conduction of R&D programs which are funded by the government. Establishing exchange/international university programs related to offshore wind or promoting connections between universities/research institutes and companies in OSW areas via internship programs, field trips, scholarships, etc. would be the first step to nurture a skilful workforce in the future.

- **Encourage cross-regional and international dialogue**:

  The government should engage with other countries with offshore wind track record and promote events where domestic and international suppliers could meet to discuss partnership opportunities. Given the fact that language could be considered as a barrier to enter the Vietnamese market, it is highly advised to mobilise people from the various domestic Embassies and target Government-Embassy events. Organising such events and conferences which are geared toward both domestic and international enterprises could foster partnerships and potentially promote domestic investment opportunities.

- **Promoting renewable energy in the media**:

  Raising public awareness about the future benefits of offshore wind energy, particularly its role in reducing carbon emissions, is essential to garner widespread support and understanding for the inevitable development of offshore wind industry.

To meet the 2030 Scenario deadline, the legal and financial framework of offshore wind should be completed as early as in 2025/26. For the 2035 Scenario, such developments could be achieved at a later year but should be in place by 2030 the latest. Once the transparent policy framework is in place foreign investors, both developers and suppliers, would be certain regarding the Vietnamese market which would increase their investment appetite.

However, establishing an offshore wind specific framework is not sufficient. The Vietnamese government will have to engage with the domestic Transmission System Operator (TSO) and other supply chain actors – such as ports – to understand existing barriers. Understanding the barriers in terms of existing grid or port infrastructure is key as they could affect the efficient and timely delivery of offshore wind projects. For the 2030 Scenario, the existing grid infrastructure will have to be upgraded and the port infrastructure should be partially improved. Therefore, we recommend the following:

- **Strengthen the grid infrastructure**:

  To facilitate the integration of intermittent renewable sources like offshore wind power, crucial steps include upgrading the grid should be considered. The current limitation in state capital and the power transmission corporation's extensive responsibilities hinder timely investments in renewable energy grid enhancements. To address this, the government should consider:

  (i) increasing preferential capital for grid infrastructure upgrades,

  (ii) extending payback periods,

  (iii) adjusting transmission charges, and

  (iv) amending the Electricity Law to allow private individuals to design and develop the transmission grid infrastructure between the renewable energy project and the designated national transmission points.

- **Upgrade the port infrastructure**:

  The government should provide incentives to propel the development of deep-sea ports in the southern and northern regions. These ports will serve as critical hubs for logistical support, facilitating the transportation and assembly of components required for offshore wind projects.

Overall, to properly develop a domestic supply chain, the government should work in tandem with offshore wind stakeholders as such engagement can fast-track the development of a wealthy offshore wind project pipeline which can contribute toward the development of a well-rounded supply chain infrastructure.

The flowcharts with all the recommended activities to achieve the 2030 Scenario and 2035 scenario are provided in

Figure 7-2 and Figure 7-3, respectively.

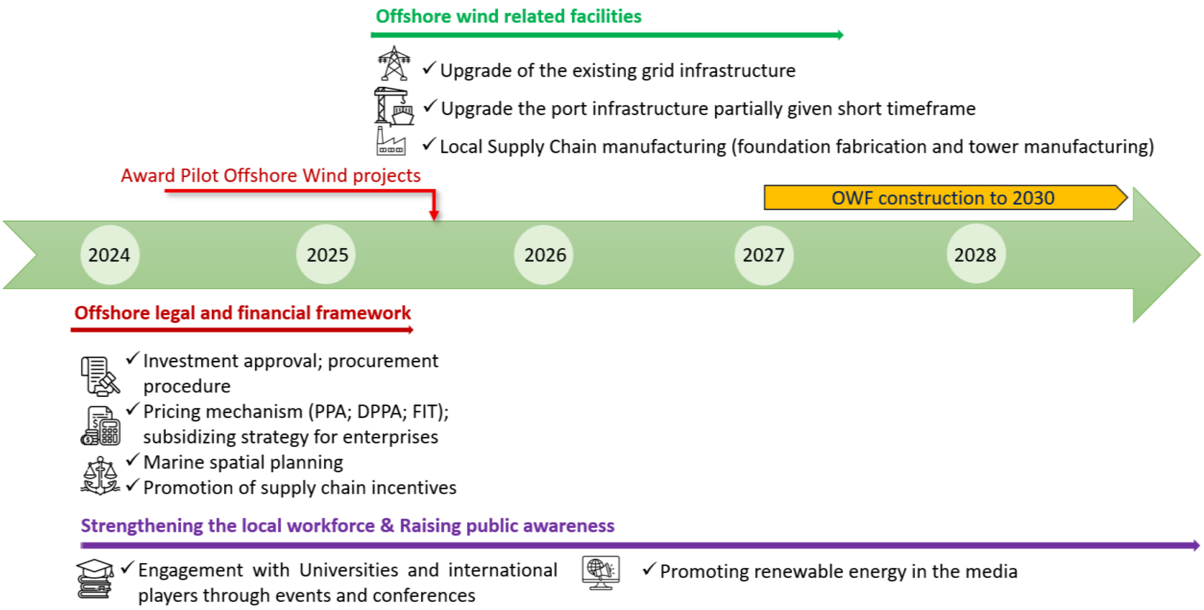



**Figure 7-2: Recommendation of next steps for the 2030 Scenario.**

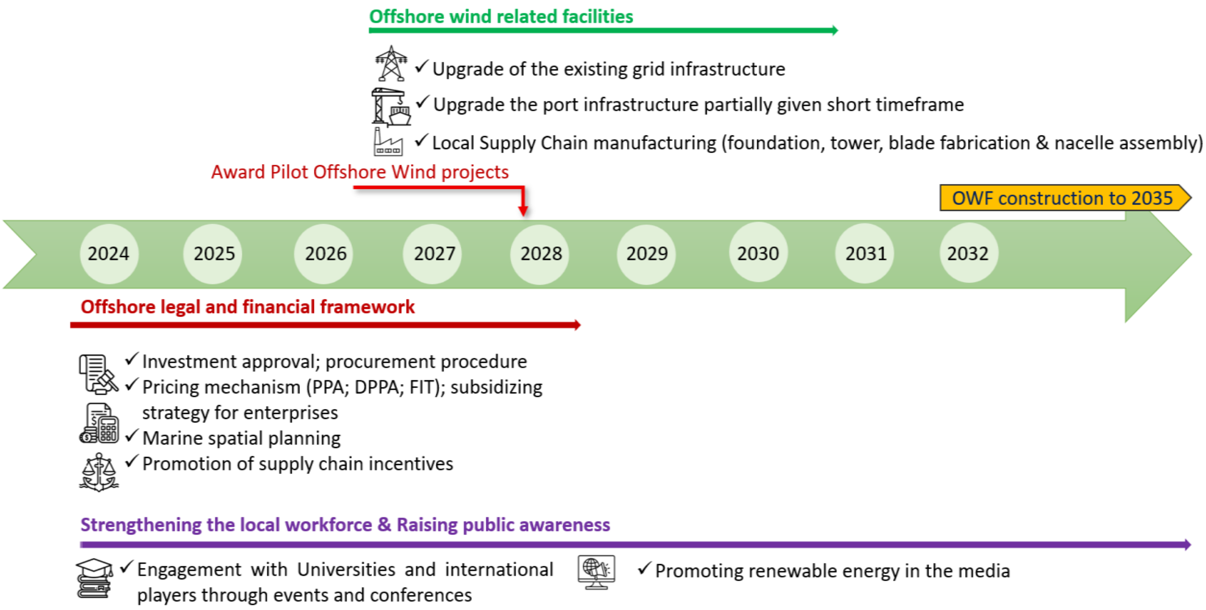



**Figure 7-3: Recommendation of next steps for the 2035 Scenario.**

# 8 Appendix A: Port criteria baselines

## 8.1 Port criteria

The Port criteria are assumed in the tables below:

**Table 8-1: Fabrication port criteria**

| Category | Minimum Requirement for Scenario 1 & 2 | |
|---|---|---|
| **Marine Criteria** | | |
| Quay length | 115 m | |
| Available water depth alongside quay | 6.5 m | |
| Available water depth along inner channel | 6.9 m | |
| Turning Circle | 170 m | |
| Channel Width | 79 m | |
| Vertical Clearance above water | 70 m | |
| **Onshore criteria** | | |
| Quay area | 0.3 ha | |
| Quay bearing capacity | 7 t/m$^2$ | |
| Steel fabrication workshop | **Scenario 1**: 43,000 t/year | **Scenario 2**: 40,000 t/year |
| Hinterland access | Yes | |

**Table 8-2: Assembly port criteria**

| Category | Minimum Requirement for Scenario 1 | Minimum Requirement for Scenario 2 |
|---|---|---|
| **Marine Criteria** | | |
| Quay length | 480 m | 480 m |
| Available water depth alongside quay | 6.7 m | 6.9 m |
| Available water depth along inner channel | 7 m | 7.2 m |
| Turning Circle | 430 m | 430 m |
| Channel Width | 225 m | 225 m |
| Vertical Clearance above water | 70 m | 70 m |
| **Onshore Criteria** | | |
| Quay area | 3.5 ha | 3.5 ha |
| Yard area | 27 ha | 24 ha |
| Quay bearing capacity | 14 t /$m^2$ | 15 t /$m^2$ |
| Road bearing capacity (during transport) | 14 t /$m^2$ | 15 t /$m^2$ |
| Yard bearing capacity | 15 t/$m^2$ | 18 t/$m^2$ |
| Yard and Quay Areas are directly adjacent to each other | Yes | Yes |

**Table 8-3: O&M port criteria**

| Category | Minimum Requirement for Scenario 1 | Minimum Requirement for Scenario 2 |
|---|---|---|
| **Marine Criteria** | | |
| Channel width | 85 m | |
| Quay length | 100 m | |
| Available water depth alongside quay and channel | 5 m | |
| Distance to Site | < 150 km | |
| Operation restriction | No | |
| **Onshore Criteria** | | |
| Laydown area | 8000 $m^2$ | |
| Workshop | Yes | |
| Internal Storage | Yes | |
| Hinterland access | Yes | |

The port's equipment and facilities (SPMT, shore cranes, port tugs, onshore accommodation etc.) should be an additional beneficial criterion and not a mandatory requirement when examining each port. For the purpose of this study, the port's capability in handling jackets and monopiles will also be examined. Appearances of third-party vessels at adjacent berth will also be considered as this relates to manoeuvres abilities of offshore vessels. This also applies for the assessment of fabrication and marshalling ports.

## 8.2 Preliminary sizing of WTG components

To help readers further understand the port requirements in terms of the needed area, bearing capacity, quay length, water depth, etc., a preliminary sizing process of the foundation (monopiles and jackets) and WTG components has been conducted. This is based on internal experience and extrapolation rules considering the available site conditions, the WTG nameplate capacity and the OSSs' preliminary characteristics. At this stage, no load assessment or structural calculations have been performed.

**Considerations for monopile pre-sizing:**

- Provided primary steel weights assumptions based on industrial practices.
- Monopile mud penetration is taken as 3x the monopile's diameter.
- No consideration of transition type is assumed at this stage (grouted, bolted).

**Considerations for jacket pre-sizing:**

- Provided primary steel weights assumptions based on industrial practice.
- A typical pile length of 50m is assumed, without any geotechnical considerations for weight estimation purpose only.
- Only 3-leg jackets are considered; the findings are expected to be comparable to 4-leg jackets also.

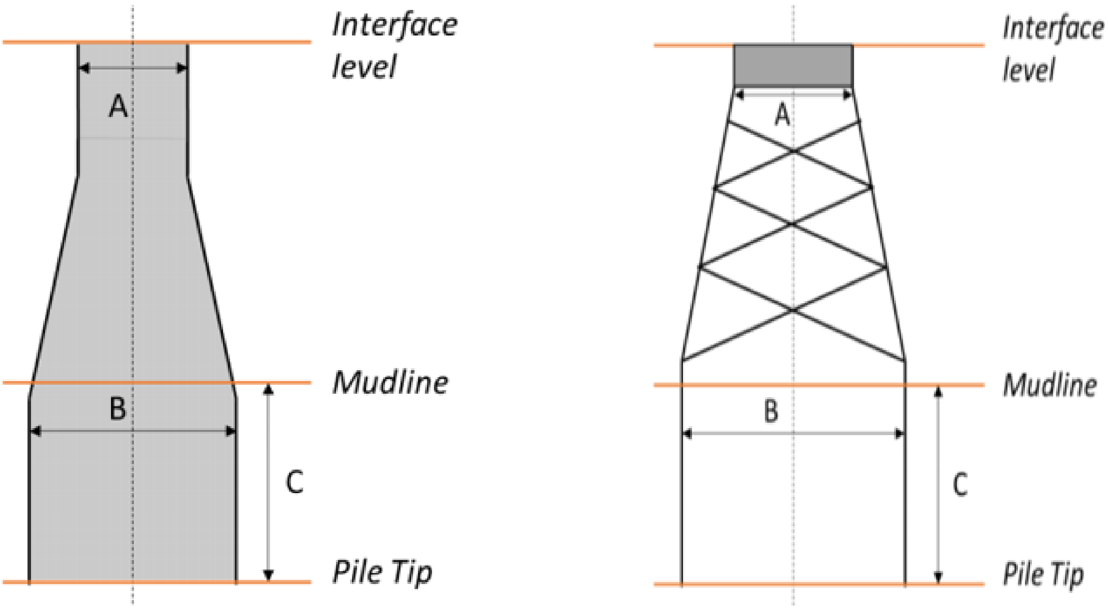



**Figure 8-1: Dimension illustration of Monopile FOU (left) and Jacket FOU (right)**

**Table 8-4: Pre-sizing summary for Jacket in 40m water length**

| Jacket Dimension | Unit | 15 MW WTG | 20 MW WTG | Label Figure 8-1 (right) |
|---|---|---|---|---|
| Jacket height (incl. stab-in, without TP) | [m] | 62 | 64 | |
| Top width | [m] | 19 | 22 | A |
| Bot width | [m] | 29 | 31 | B |
| Transition piece (TP) primary steel weight | [t] | 420 | 620 | |
| Jacket (JKT) Primary steel weight | [t] | 1310 | 1560 | |
| Jacket + TP primary steel weight | [t] | 1730 | 2180 | |
| Piles length | [m] | 50 | 50 | C |
| One pile primary steel weight | [t] | 150 | 180 | |
| Total pile primary steel weight | [t] | 450 | 550 | |

**Table 8-5: Pre-sizing summary for Monopile in 40m water length**

| Monopile Dimension | Unit | 15 MW WTG | 20 MW WTG | Label Figure 8-1 (left) |
|---|---|---|---|---|
| Transition piece (TP) diameter | [m] | 8 | 9 | A |
| Transition piece primary steel weight | [t] | 210 | 240 | |
| Monopile – mudline diameter | [m] | 11 | 12 | B |
| Monopile length (without TP) | [m] | 80 | 83 | |
| Monopile embedded length | [m] | 33 | 36 | C |
| Monopile primary steel (without TP) | [t] | 2000 | 2200 | |

**Considerations for other WTG Components and OSS**

The dimensions and weights of WTG components have been assumed from experience and currently available WTG models.

**Table 8-6: Pre-sizing summary for 15MW and 20MW OSW components**

| OSW components dimension | | Unit | 15 MW WTG | 20 MW WTG |
|---|---|---|---|---|
| Tower | Configuration | [-] | Ø8m * 125m long | Ø8m * 140m long |
| | Weight | [t] | 1000 | 1300 |
| Nacelle | Configuration | [-] | 22m * 11m | 25m * 13m |
| | Weight | [t] | 750 | 1000 |
| Blade | Configuration | [-] | Ø6m * 125m long | Ø6m * 140m long |
| | Weight | [t] | 60 | 100 |
| Hub | Configuration | [-] | 7m * 8m | 8m * 9m |
| | Weight | [t] | 100 | 130 |
| OSS Jacket (4-legged) | Configuration | [-] | Column space 37m | |
| | Weight | [t] | 2400 | |
| HVDC OSS Topside | Configuration | [-] | 45m(width) * 60m(length) * 20m(height) | |
| | Weight | [t] | 5750 | |

## 8.3 Offshore wind installations vessels

In order to transport WTG components (turbines, foundations, cables, OSSs), specialised vessels with unique technical features are required [12]. Given that these WTGs components have to be picked up at ports, the size of the installation vessels will form critical criteria when determining the ports' capabilities. Figure 8-2 indicate some key vessels that might be involved in OWF construction.

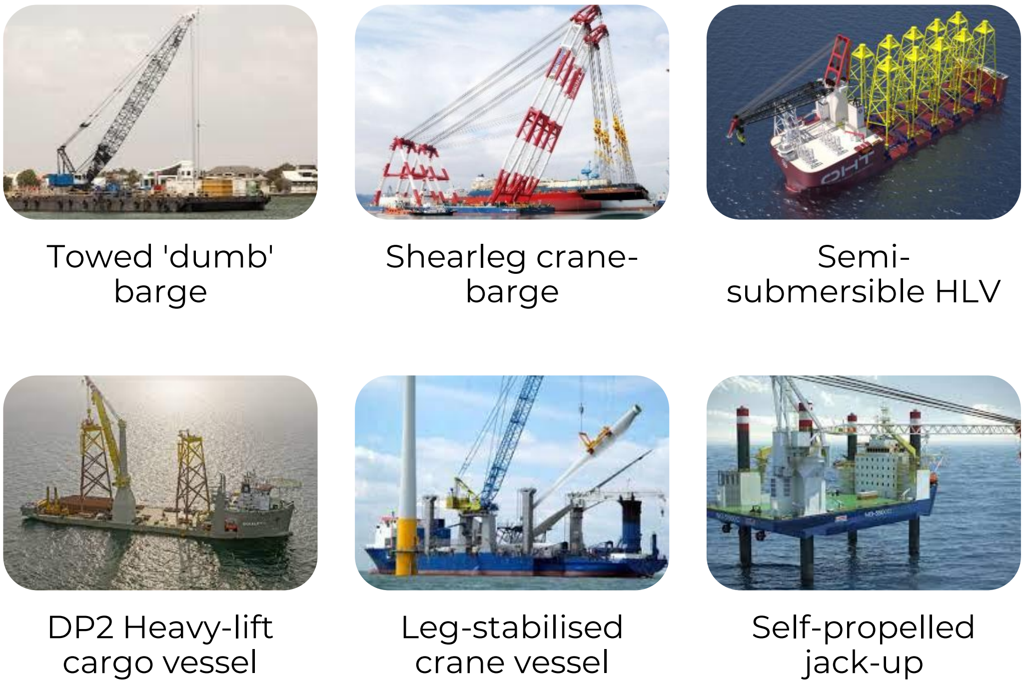



**Figure 8-2: Installation vessels**

Reference vessels were selected on the basis of transporting and installing up to 4 JKTs of 15MW WTG units or 3 JKTs of 20 MW WTG units per trip. For monopiles, the basis is that the vessel will be able to transport and install up to 6 monopiles of either 15 MW or 20 MW WTGs. The monopiles are assumed to be stored in stacks of two or three for the purposes of this study. Assuming longitudinal and transverse clearances of 10m and 5m respectively, the required carrying capacity shall be more than 12,000 DWT and crane capacity being just over 3,200t. The chosen vessels are:

- Boskalis 1 for the transportation and installation of jacket foundations, and
- DEME's Orion for monopiles.

The design parameters of the identified reference vessels can be observed in Figure 8-3 with more information included in Table 8-7. These figures will be pivotal for marine criteria of ports.

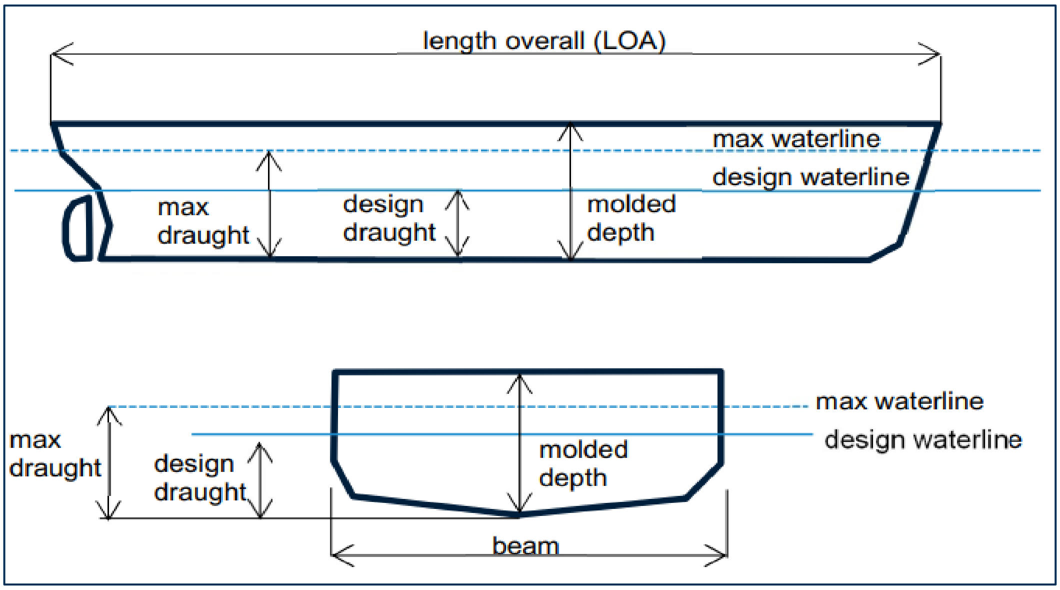



**Figure 8-3: Particulars of a Vessel**

Table 8-7: References vessels for analysis

| | | | | |
|---|---|---|---|---|
| **Type:** | General Cargo Ship | **Scope** | | |
| **Name:** | TURK YILDIZI 1 | | | |
|  | | Used during fabrication stage to import material. | | |
| | | **Particulars:** | LOA: | 83.12 (m) |
| | | | Beam: | 16 (m) |
| | | | Depth: | 10.12 (m) |
| | | | Max Draught: | 8.6 (m) |
| | | | DWT: | 5000 (DWT) |
| **Type:** | Floating Ship-shaped Vessel | **Scope** | | |
| **Name:** | DEME Orion | | | |
|  | | Used during assembly stage to install monopile. | | |
| | | **Particulars:** | LOA: | 216.5 (m) |
| | | | Beam: | 49 (m) |
| | | | Depth: | 16.8 (m) |
| | | | Max Draught: | 11 (m) |
| | | | DWT: | 30000 (DWT) |
| | | | Deck area: | 8000 ($m^2$) |
| **Type:** | Heavy Lift Vessel | **Scope** | | |
| **Name:** | Boskalis 1 | | | |
|  | | Used during assembly stage to transport jacket. | | |
| | | **Particulars:** | LOA: | 216 (m) |
| | | | Beam: | 43 (m) |
| | | | Depth: | 13 (m) |
| | | | Max Draught: | 9 (m) |
| | | | DWT: | 15000 (DWT) |
| | | | Deck area: | 6300 ($m^2$) |
| **Type:** | Service Operation Vessel (SOV) | **Scope** | | |
| **Name:** | TWIN X-STERN | | | |
|  | | Used during O&M phases for repairing and maintenance services. | | |
| | | **Particulars:** | LOA: | 89.6 (m) |
| | | | Beam: | 19.2 (m) |
| | | | Max Draught: | 5.9 (m) |
| | | | DWT: | 2300 (DWT) |
| | | | Deck area: | 500 ($m^2$) |

## 8.4 Assumptions for Ports onshore criteria

**Foundation storage**:

- Monopiles are considered to be stored horizontally, in one piece, on cradles with TP are separately stored. The storage area per monopile and TP would also consider the sum of the clearance required for sandbanks / cradles and walkways / driveway.

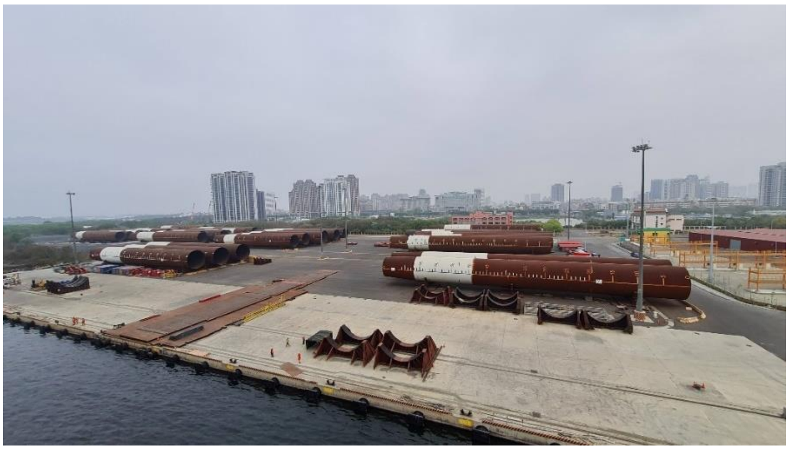


**Figure 8-4: Monopile storing at Ports on cradles for OSW in Yunlin, Taiwan [13]**

- Jacket structures are stored vertically upright, in one piece, with TP attached. The storage area of each jacket is equivalent to the jacket's footprint area. Small in-between corridors are purposely left for clearance.

**Figure 8-5: Jacket storing at Ports on load-bearing pads for OSW in Kitakyushu, Japan [14]**

**WTG component storage**:

- Nacelle-hubs are each stored on grillages ready to be loaded to the installation vessel.
- WTG towers are considered to arrive at the port in three sections, each stored horizontally on cradles. The installation vessel will then assemble the towers which are subsequently stored upright on grillages.
- Blades are stored lying horizontally with three blades on each stack.

Storing nacelle on grillages

Storing towers in parts

Storing blades in stacks of three

**Figure 8-6: WTG components storing method.**

**Storage area and Footprint area:**

- Storage areas indicate the top-view size needed to store components. This parameter is crucial for estimating the needed quayside and yard area.
- Footprint areas indicate the ground contact area while storing components. This parameter is crucial for estimating bearing capacity needed of the quayside and the yard. It is noticed that this parameter can be increased to reduce the ground pressure. Given the purpose of this study, footprint areas will be equal for two scenarios to illustrate the increasing bearing capacity and laydown area required between the 15MW WTG and 20MW WTG units.
- It is assumed that at one time, 100% of WTG components and 50% of foundation components will be stored at a port.
- The values of the various required port areas can be found in Table 8-8.

**Table 8-8: Specification for onshore criteria calculations**

| Storing Component | Storage area per unit ($m^2$) | | Footprint area per unit ($m^2$) | Quantity (unit) | |
|---|---|---|---|---|---|
| | 15 MW WTG | 20 MW WTG | | 15 MW WTG | 20 MW WTG |
| Monopile | 1020 | 1150 | 140 | 33 | 25 |
| Jacket | 420 | 560 | 145 | 33 | 25 |
| Blade | 1100 | 1200 | 32 | 198 | 150 |
| Hub | 100 | 120 | 37 | 66 | 50 |
| Nacelle | 330 | 430 | 56 | 66 | 50 |
| Tower | 1340 | 1500 | 32 | 66 | 50 |
| WTG Piles | 300 | 390 | 32 | 99 | 75 |

| Storing Component | Storage area per unit ($m^2$) | | Footprint area per unit ($m^2$) | Quantity (unit) | |
|---|---|---|---|---|---|
| | 15 MW WTG | 20 MW WTG | | 15 MW WTG | 20 MW WTG |
| **TP** | 190 | 200 | 36 | 66 | 50 |
| **OSS JKT** | 1500 | | | 1 | |
| **OSS** | 2350 | | | 1 | |
| **OSS Piles** | 300 | | | 4 | |

**In-port Transportation:**

- To facilitate the in-port transportation of offshore wind (OSW) components or foundations, a specialised 6-axle self-propelled modular transporter (SPMT) is being used.
- The assumed specifications for this vehicle include a weight of 28 tons and a footprint area of 20 square meters. It is designated as the primary mode of transport for the OSW elements, and the required quantities of SPMTs for each component are outlined in Table 8-9.
- Taking into account the fact that the Jackets will need to be loaded out/in most probably by way of SPMTs, there are two separate methods which utilises either two SPMTs connected via link bridge (Figure 8-8) or a single SPMT placed directly under the upper grillage of the legs (Figure 8-9). In this case, 3 SPMTs would be put under each leg of the jacket to mitigate the ground bearing pressure.

**Table 8-9: Specification for onshore transportation criteria calculations**

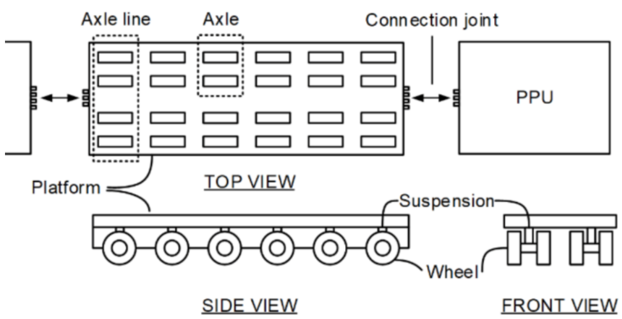
<table>
<tr><th>Transporting Component</th><th>Number of SPMTs used</th><th>SPMT specifications</th></tr>
<tr><td>Transition piece</td><td>1</td><td rowspan="7">

Figure 8-7: Simplified model of a 6-axle-line SPMT unit [15]</td></tr>
<tr><td>Monopile</td><td>8</td></tr>
<tr><td>Jacket</td><td>9</td></tr>
<tr><td>Blade</td><td>1</td></tr>
<tr><td>Tower</td><td>2</td></tr>
<tr><td>Nacelle</td><td>4</td></tr>
<tr><td>OSS Jacket</td><td>8</td></tr>
</table>

**Figure 8-8: Loadout with 2 x SPMTs under each leg**

**Figure 8-9: Discharge with 1 x SPMT under each leg**

# 9 Appendix B: Initial findings

## 9.1 Initial findings from the dialogue with potential ports

We reached out to a total of **19 ports** across the country with 10 in the North and 9 in the South. The responses and findings are as follows:

- **Positive response (6 Ports)**: 6 of the contacted ports displayed keen interest in the offshore wind industry. Furthermore, these ports have expressed their commitment to developing the necessary infrastructure to support offshore wind projects, indicating a proactive approach to align with the industry's demands and requirements.

  List of ports with interest and development plan in offshore wind:

  1. PTSC Supply Base port in Vung Tau
  2. PTSC Nghi Son port in Thanh Hoa
  3. PTSC Dinh Vu port in Hai Phong
  4. AlphaECC port in Vung Tau
  5. Petrovietnam Shipyard in Vung Tau
  6. SREC Ba Son Shipyard in Vung Tau

  It is noticed that PTSC has all their ports (6 in total) interested in developing for offshore wind. Nonetheless, given the scenarios in this study only 3 ports are contacted and thoroughly analysed.

- **No response (10 Ports):** A significant portion, precisely 10 out of the 20 ports, chose to remain silent in response to our inquiries. Their silence can be interpreted in two ways: either they are not inclined towards participating in the offshore wind sector or they may have plans related to offshore wind that they are not yet ready to disclose. This implies a need for further investigation or follow-up at a later stage.

- **Not interested (3 Ports)**: Three ports explicitly conveyed their lack of interest in the offshore wind sector. These ports have indicated that offshore wind is not within their strategic purview. This direct response helps in clarifying the stance of these ports concerning offshore wind-related developments.

  1. Hyundai Vinashin Shipyard
  2. Vung Ang Port
  3. International Container Port Tan Cang – Hai Phong

## 9.2 Initial findings from the dialogue with potential suppliers

We reached out to a total of **18 suppliers** across the country. The responses and findings are as follows:

**Suppliers:**

- **Positive response (9 Suppliers)**:

  Nine of the contacted suppliers exhibited a strong interest in the offshore wind sector. Moreover, these suppliers have shared their development plans, indicating their commitment to providing components for offshore wind projects. This proactive engagement underscores their readiness to align with the industry's growth and requirements, making them potential valuable partners.

- **No response (8 Suppliers)**:

  A significant portion, specifically eight out of the 20 suppliers, chose not to respond to our inquiries. Their lack of communication can be interpreted in two ways: either they do not have an intention to participate in the offshore wind sector or they may have plans related to offshore wind but do not wish to disclose yet. This implies a need for further investigation or follow-up at a later stage.

- **Not Interested (1 Supplier):**

  Lilama 5 explicitly stated their lack of interest in the offshore wind sector. This supplier has made it clear that offshore wind does not align with their strategic focus. This direct response helps in clarifying their position concerning offshore wind component production.

### 9.2.1 Foundations

We identified 6 suppliers within the region that we consider possessing the necessary ability and capacity to produce foundations tailored to the unique demands of the offshore wind farms.

Out of the 6 suppliers identified, **5 suppliers** have responded with notable interest and have already put forward plans to further develop their capabilities in this domain.

Those **5 foundations suppliers** are:

1. AlphaECC
2. PTSC M&C
3. PV Pipe
4. PetroVietnam Marine Shipyard
5. SREC

### 9.2.2 WTG

#### *9.2.2.1 Towers*

In our evaluation of potential suppliers for towers, we received positive responses from **2 suppliers**, namely:

1. SREC
2. CS Wind

Both suppliers have expressed their interest and willingness to engage in the offshore wind sector, indicating their commitment to supporting the manufacturing of wind turbine towers for domestic projects.

#### *9.2.2.2 Blades*

Currently there is no established supplier for offshore wind blades within the country. We only identified **1 potential supplier** for raw material (composites, carbon fibre) within the country being Triac Composites.

The supplier did not indicate any intention or plans to provide blades for offshore wind.

#### *9.2.2.3 Nacelle Assembly*

We contacted **4 major nacelle suppliers** GE, Vestas, Gold wind, Siemens. At this stage, none of the WTG OEMs have developed, to date, plants, or supply chains to support the sector offshore.

GE, differently to others, does have a current operating manufacturing plant in Vietnam, though it is only used for, alongside steam and gas turbines, manufacturing of specific onshore WTG sub-components.

In general, whilst there are certain interests to develop a local supply chain for delivery of offshore wind projects, all the WTG OEMs did not confirm plans to establish manufacturing facilities in Vietnam.

#### *9.2.2.4 Auxiliaries*

Auxiliaries' services suppliers are suppliers that do not participate in creating the products firsthand but rather participate in machining, improving it. We contacted 8 potential suppliers. At this stage, our responses have been limited. So far, only **3 suppliers** have responded with interest and expressed their willingness to be part of the offshore wind sector in Vietnam.

1. PV Coating (major in coating, corrosion protection)
2. Sadakim JSC (major in providing nacelle components such as gearbox, ring, gear joint)
3. ABB Group (though ABB Group indicates some interests during the back-and-forth discussions, they stated that ABB mainly involves in assembly the electrical parts inside the tower rather than manufacturing, therefore ABB facilities will not be provided in later parts)

The remaining suppliers have chosen not to respond, leaving an unanswered question regarding their intentions or plans related to supplying auxiliaries nacelle or WTG components.

# 10 Appendix C: Port Assessment and Descriptions

## 10.1 Port Assessment

It is noticed that most ports marked as "Red" based on the colour-coding method detailed in Section 4.2 have already been excluded from the initial screening stage. For example, ports such as the VICT (Vietnam International Container Terminal), Ben Nghe Port, Tan Thuan Port, and Cat Lai Port will not meet the vertical clearance limitations imposed by Phu My Bridge (<55m) and potentially Binh Khanh Bridge or Phuoc Khanh Bridge as these two are under construction. Similarly, several major ports and shipyards in the North were also omitted due to height restrictions from Bai Chay Bridge (Figure 10-2) or Hai Phong - Mong Cai Highway (Nguyen Trai Bridge) (<50m) (Figure 10-3). While some of these ports may still be suitable for fabrication despite height constraints, the study adopts a conservative approach and excludes them from the analysis.

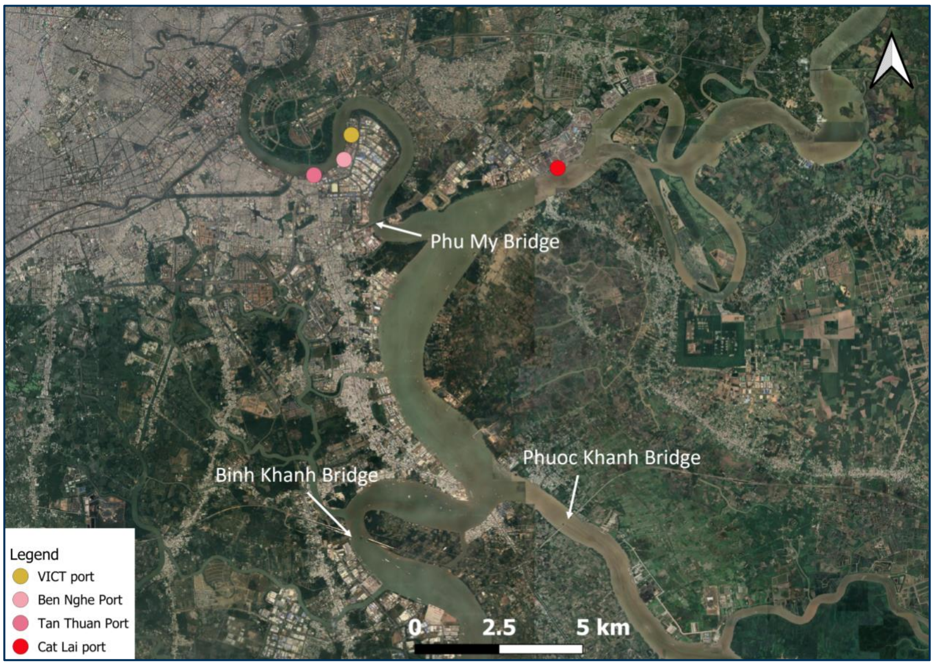



**Figure 10-1: Vertical clearance constraint of Ports due to Bridges in Ho Chi Minh City**


**Figure 10-2: Height constraint of Ports due to Bai Chay Bridge in Hai Phong City**


**Figure 10-3: Height constraint of Ports due to Nguyen Trai Bridge in Hai Phong City**

Based on the colour-coding method and criteria stated in Section 3.2, the shortlisted ports for the Scenario 1 and 2 are assessed in Table 10-1, respectively. For ports specialising in storing cargos or containers without any steel processing ability, their capabilities in fabrication will not be assessed as the available facilities and equipment will require significant investment, and thus we have marked the fabrication capability as “N/A”.

It is noticed that ports in Vung Tau City are situated more than 200km from the sites, that could be quite a severe drawback if these ports are used for O&M. There are some ports in the vicinity, for instance Vinh Tan Port or Ca Na Port, which could be used for O&M purposes.

Though the Vinh Tan Port primarily serves the Vinh Tan Thermal Power Plant and has a minor laydown area which is used to store cargos. The Ca Na Port is currently under construction. As this report provides a high-level port assessment, we have only assessed key ports. A more detailed assessment will be required once an offshore wind site has been identified.

**Table 10-1: Ports suitability assessment for Scenario 1 & 2**

| Port | Fabrication | Marshalling | O&M | Note |
|---|---|---|---|---|
| **For OSW in the South** | | | | |
| PTSC Supply Base / PTSC M&C | 🟢 | 🟡 | 🟡 | 1. Congested yard area, crowded quayside.<br>2. Suitable channel depth.<br>3. Slight upgrade needed for manufacturing abilities.<br>4. Distant to Site. |
| PV Shipyard | 🟡 | 🟡 | 🟡 | 1. Limited area and road bearing capacity.<br>2. Limited channel depth.<br>3. Upgrade needed for manufacturing abilities.<br>4. Distant to Site. |
| Alpha ECC | 🟡 | 🟠 | 🟡 | 1. Limited area and road bearing capacity.<br>2. Limited channel depth.<br>3. Huge upgrade needed for manufacturing abilities.<br>4. Distant to Site. |
| SREC | 🟢 | 🟡 | 🟡 | 1. Yard and quay are adjacent (small distance).<br>2. Suitable channel depth.<br>3. Upgrade needed for manufacturing abilities.<br>4. Distant to Site. |
| PTSC Phu My | N/A | 🟠 | 🟡 | 1. Limited area, quay length, bearing capacity.<br>2. Suitable channel depth.<br>3. No manufacturing abilities.<br>4. Distant to Site. |
| Vinh Tan International | N/A | 🟠 | 🟢 | 1. Potential area limitation from thermal plant activities<br>2. Upgrades needed for road bearing capacity.<br>3. No manufacturing abilities.<br>4. Closed to Site. |

| Port | Fabrication | Marshalling | O&M | Note |
|---|---|---|---|---|
| **For OSW in the North** | | | | |
| PTSC Dinh Vu | N/A | 🟠 | 🟢 | 1. Upgrades needed for road bearing capacity, limited area.<br>2. Suitable channel depth.<br>3. No manufacturing abilities.<br>4. Closed to Site. |
| PTSC Nghi Son | 🟠 | 🟡 | 🟡 | 1. Upgrades needed for road bearing capacity.<br>2. Suitable channel depth.<br>3. Huge upgrade needed for manufacturing abilities.<br>4. Distant to Site. |
| Nam Dinh Vu | N/A | 🟡 | 🟢 | 1. Upgrades needed for road bearing capacity.<br>2. Suitable Channel depth.<br>3. No manufacturing abilities.<br>4. Closed to Site |
| Tan Vu | N/A | 🟡 | 🟢 | 1. Upgrades needed for road bearing capacity.<br>2. Suitable Channel depth<br>3. No manufacturing abilities.<br>4. Closed to Site |

The marginal variations in port criteria between the two scenarios have not led to significant alterations in the overall port grading. While certain criteria may shift from being met to unmet between the two scenarios, these changes are insufficient for a complete revision of the port's status.

It is noted that to a lesser or greater extent, some beneficial requirements (i.e., requirements that are not mandatory) remain unfulfilled by most of the ports in Vietnam. The predominant challenge would be the onshore crawler crane capacity requirement which would be about more than 2,000t. Numerous Vietnamese ports lack of onshore accommodation facilities. Only several ports can provide tugs, such as the ports of PV Shipyard, SREC, which could be used during construction. Though these issues are not imminent, addressing them is imperative for the long-term support of offshore wind initiatives in the region.

## 10.2 Port descriptions

This section will provide comprehensive descriptions of all "Positive response" Ports, denoted by (*). Conversely, Ports with a "No Response" (denoted by **) or deemed "Not Interested" will be omitted from this discussion. Nevertheless, recognising the pivotal role of Hai Phong Seaports in Vietnamese marine traffic and their potential as an Offshore Wind Seaport Cluster, a concise introduction based on available online sources will be presented for some ports in that area.

It is important to note that the information provided for Ports categorised as "**" may contain inaccuracies as the information is Internet based only, and it only aims to provide readers with a preliminary overview of the facilities and capabilities of those Ports. Information relating to offshore wind development plans or track record for those may also be insufficient due to a lack of data. The addressed information include:

Port technical specifications:

- Maximum quay length
- Minimum water depth (considering water depth in channel and the longest quay)
- Port area distribution
- Ports facilities
- Offshore related experience / track records
- Port layout
- Development plan for offshore wind
- Key remarks

# PV Shipyard*

**Introduction:**

Vung Tau City, Ba Ria - Vung tau, Vietnam

Petrovietnam Marine Shipyard was founded in 2007 by PTSC, BIDV, LILAMA and SBIC.

**Port technical specifications:**

Maximum quay length:

# 156 m

Minimum water depth (CD):

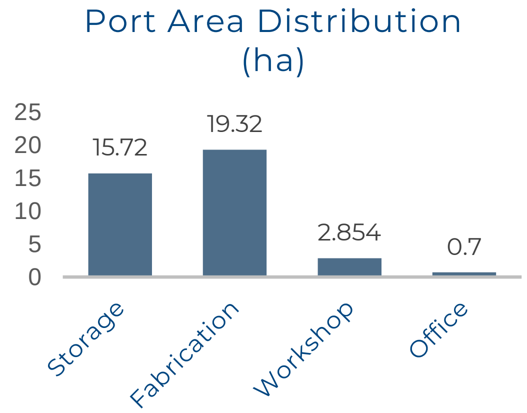
# -7 m

Maximum bearing capacity:

# 8 t/m²

Total port area*:

# 40 ha




* The Port Distribution area add up will slightly mismatch with the total area. It is understood that the remaining areas are for parking, road, etc.


**Port facilities:**

Port cranes, crawler cranes with load up to **1250t**

CNC cutting, drilling, milling, blasting and bending machine

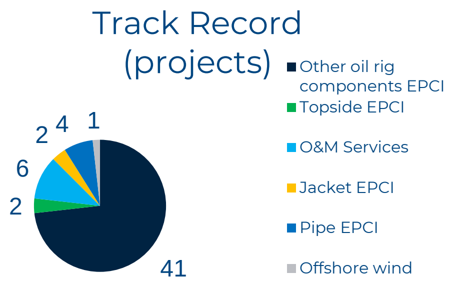
**Offshore related experience:**

PV Shipyard has successfully completed over **55** projects, providing services to the O&G industry, including:

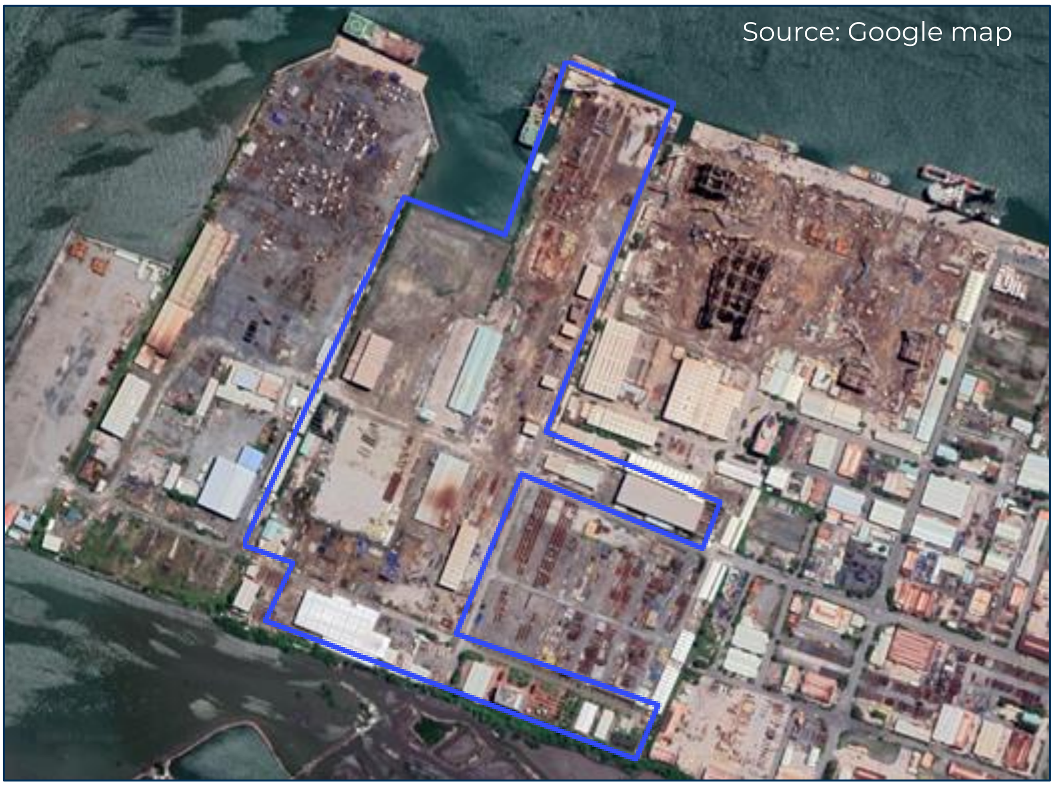
EPCI, T&I, O&M of jackets, piles, pipe, topside and offshore facilities.

Port, logistics, and vessels transportation

Sub-structure fabrication and yard rental service for Hai Long 2 and Hai Long 3 Offshore Wind Power (ongoing).



## Port layout:




**PV Shipyard layout**

## Development plan for offshore wind:

Generally, there are no progressed plans for additional development at the current stage.

## Key remarks:

- PV Shipyard offers engineering, procurement, construction and installation (EPCI) for O&G related activities and it is transitioning to include other offshore facilities within the offshore wind energy sector, of topside and jackets. PV Shipyard is capable in being an O&M Port for offshore projects in the South of Vietnam.
- It is noticed that PV Shipyard may have other projects occupying their yards in the future considering the hypothetical timeline. Therefore, it is advisable to engage with them early to ensure access to the necessary facilities.

# Alpha ECC*

## Introduction:

Dong Xuyen Industrial Zone, Vung Tau City

Alpha ECC was incorporated in 2003.


## Port technical specifications:

Maximum quay length:

**310 m**

Minimum water depth (CD):

**-6 m**

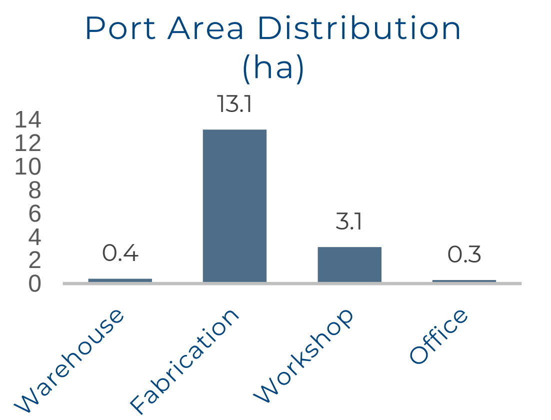
Maximum bearing capacity:

**20 t/m$^2$**

Total port area*:

**17 ha**

* The Port Distribution area add up will slightly mismatch with the total area. It is understood that the remaining areas are for parking, road, etc.




## Port facilities:

Rolling, Press bending, heating pipe, bending machines

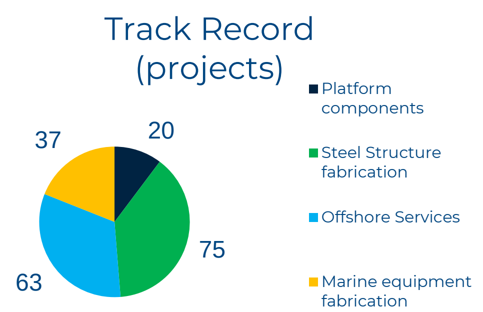
CNC cutting, welding machines

## Offshore related experience:

Alpha ECC has successfully completed over **200** projects, providing services to the O&G industry, including:

EPCI, T&I of offshore facilities, skid, module pressure vessel.

Port, logistics, and vessels transportation.



**Port layout:**


**Alpha ECC Port Layout**

**Development plan for offshore wind:**

Generally, there are no progressed plans for additional development at the current stage.

**Key remarks:**

- Alpha ECC majors in detailed design and manufacturing complete equipment including welding, tubing, and electrical works instead of manufacturing the whole topside, foundation, etc.
- The small area, shallow water depth may severely limit this port's capability in Marshalling and to some extent limit the O&M activities.

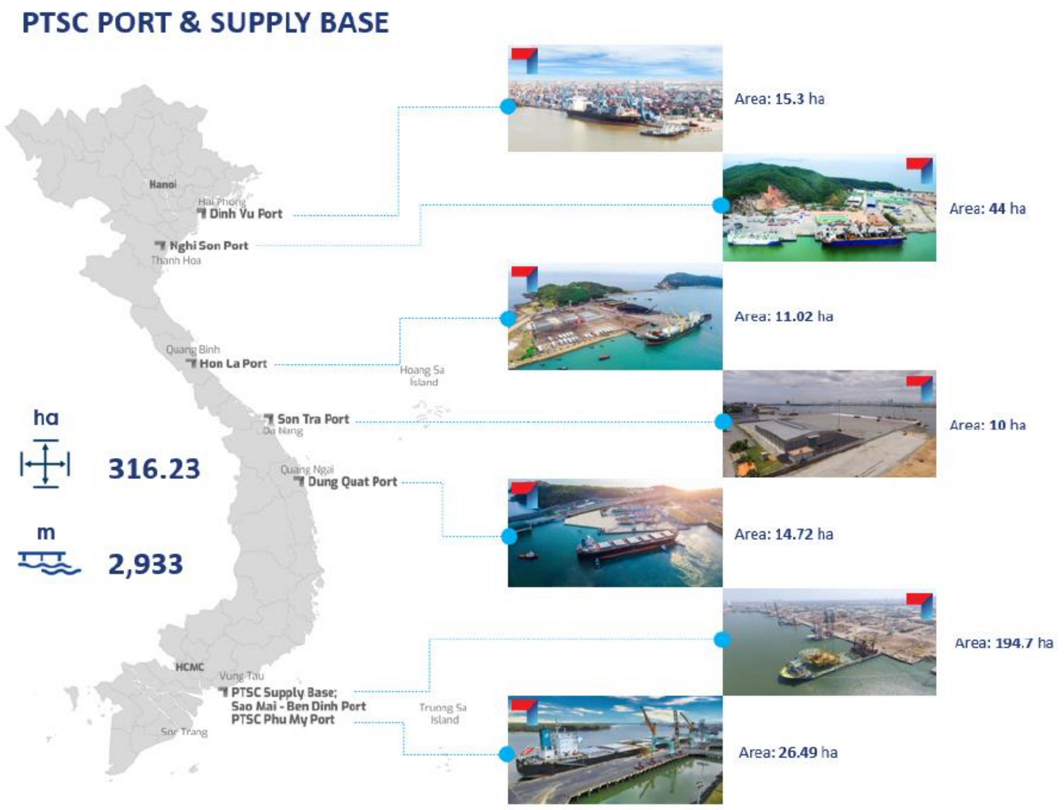
## PTSC*

**Introduction:**

PTSC, a member of Vietnam Oil & Gas Group (PetroVietnam - PVN), traces its origins back to Geophysical Group 36F, established in 1966. Over 47 years of development, PTSC has achieved significant milestones, propelling itself to the forefront as a premier contractor in delivering technical services to the oil & gas (O&G) industry and various other sectors within Vietnam and the broader region. Based on the company information, PTSC operates across eight (08) core business domains: (1. EPCI for Offshore Facilities; 2. EPC for Onshore Facilities; 3. FSO/ FPSO/ FSRU/ FLNG; 4. T&I, O&M for Onshore & Offshore Facilities; 5. Port & Supply Base Services; 6. Geo Survey & ROV; 7. Marine Vessels; 8. Renewable Energy).

PTSC is managing and operating a nationwide network of ports and supply bases, from the North to the South of Vietnam, with a total area of over 320 hectares. PTSC has 7 bases crossing Vietnam from North to South. It is noticed that, since the OSW hypothetical locations are in the North and the South of Vietnam, the Ports situate in the middle region (Hon La Port, Son Tra Port, Dung Quat Port) are only briefly mentioned due to their distance to Site. Other Ports (Dinh Vu Port, Nghi Son Port, PTSC Downstream Port) will be further elaborated.

It is noticed that, given the location of hypothetical projects, only Dinh Vu, Nghi Son, PTSC Supply Base, Phu My Port, and Sao Mai Ben Dinh Port are described in detail, other ports are just briefly mentioned for reader information.




**Locations of PTSC Ports & Supply Bases [16]**

# PTSC Dinh Vu Port

**Introduction:**

Operator: PTSC Dinh Vu - a subsidiary under PTSC Dinh Vu Industrial Zone, Hai An District, Hai Phong City

**Port technical specifications:**

Maximum quay length:

# 330 m

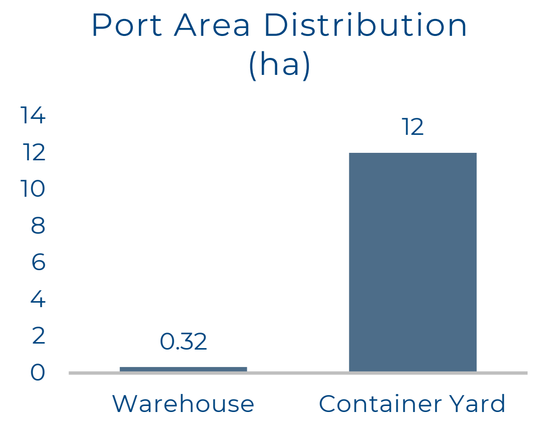
Minimum water depth (CD):

# -7 m

Total port area*:

# 15 ha

* The Port Distribution area add up will slightly mismatch with the total area. It is understood that the remaining areas are for parking, road, offices etc.


**Port facilities:**

Crane, Reach Stacker (up to **45 ton**), Forklift, Tractor - Trailer

**Industrial related experience:**

In general, PTSC Dinh Vu mainly serves in transportation services for container and petroleum.

- Port, logistics, and vessels transportation
- Multi inland & sea transportation services for container and petroleum
- Import & Export services
- CFS Warehouse, Bonded warehouse
- Goods transit services
- Tug Boat services
- Other maritime services...

# PTSC Nghi Son Port


## Introduction:

Operator: PTSC Thanh Hoa – a subsidiary under PTSC Nghi Son Ward, Tinh Gia District, Thanh Hoa Province

## Port technical specifications:

Maximum quay length:

**225 m**

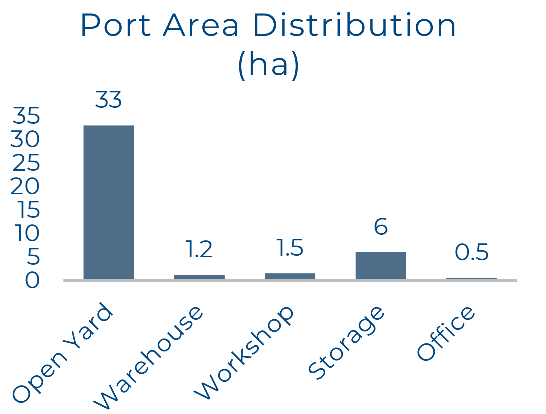
Minimum water depth (CD):

**-11 m**

Total port area*:

**43.9 ha**

* The Port Distribution area add up will slightly mismatch with the total area. It is understood that the remaining areas are for parking, road etc.




## Port facilities:

Various types of machinery & equipment:

- Cranes: Crawler (800T), Gantry (30T), Overhead (20T), Tyre Mobile (80T), Forklift...
- CNC machines for: Laser/CNC Oxy-Gas Plasma Cutting, Plate CNC /CNC 3 Axis/CNC H-Beam Drilling, Semi-Auto Miter Cutting Band Saw, Plate Punching
- Automatic machines for: Welding, Rolling, Bending, Beam Straightening, Hydraulic Guillotine Shearing, Beam Combiner...
- Others for Mechanical & Construction services.

## Offshore related experience:

In general, PTSC Nghi Son mainly serves in:

Port, logistics, and vessels transportation for container and machinery equipment.

Offshore Wind Power Industry (Components Fabrication / Logistics, O&M...)

Besides offshore, PTSC Nghi Son also serves in:

EPCI and O&M for Oil Refinery, Chemical Plants

# PTSC Downstream Port (include PTSC Supply Base and Sao Mai – Ben Dinh Port)


**Introduction:**

No 65A, 30/4 Str., Thang Nhat ward, Vung Tau City, Ba Ria-Vung Tau Province

**Port technical specifications:**

Total quay length:

# 1070 m

Minimum water depth (CD):

# -9.5 m

Total port area*:

# 194.7 ha

**Key remarks:**

The PTSC Downstream Port is the largest supply base and fabrication yards Complex for the offshore energy industries in Vietnam.

The PTSC Downstream Port is presently undergoing comprehensive enhancements, rearrangement, and expansion of reclamation areas to augment the fabrication yard capacity.

This initiative is strategically aligned to cater to pivotal offshore projects within the O&G and Renewable Energy sectors, both domestically in Vietnam and on an international scale.

**PTSC Downstream Port (Vung Tau), Plan to 2030 (Source: PTSC)**

# PTSC Supply Base

## Introduction:

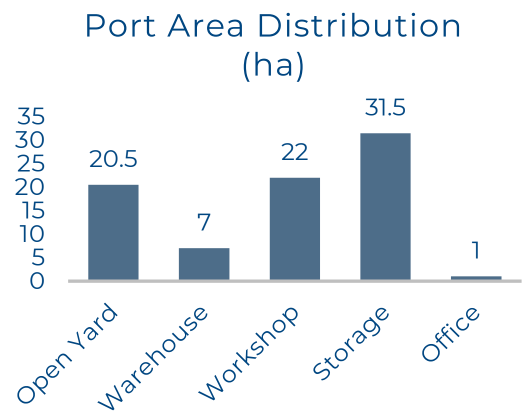
No 65A, 30/4 Str., Thang Nhat ward, Vung Tau City, Ba Ria-Vung Tau Province

## Port technical specifications:

Total port area*:

# 82 ha

* The Port Distribution area add up will slightly mismatch with the total area. It is understood that the remaining areas are for parking, road etc.




## Port Layout:



## Port facilities:

**Cranes**: various (crawler crane 1200MT-550MT –250MT, tower crane, rough terrain crane, cargo crane, overhead crane, ring crane, etc.).

**Handling Equipment**: forklifts, trucks, trailers, SPMT... measuring machine, hydraulic machines.

**Construction Facilities:** Structural manufacturing, Auto beam manufacturing; Piping workshops; Mechanical workshops; Painting workshop; Auto blasting workshop; X-Ray workshop.

## Offshore related experience:

In general, PTSC Supply Base mainly serves in:

Port & Supply Base logistics services; O&M Hubs; T&I, Hookup & Commissioning

Mechanical & Construction services (EPC/EPCI/ EPCIC) for onshore & offshore projects: Processing Platform; Living Quater Platform; Topsides Modules; Subsea Structures; Industrial Plan; PAU/PAR Modules; etc.

Renewable Energy: Technical Services Provider/Manufacturer for: Substation Platform (OSS); Foundation &Substructures; Floating components

# Sao Mai – Ben Dinh Port

## Introduction:

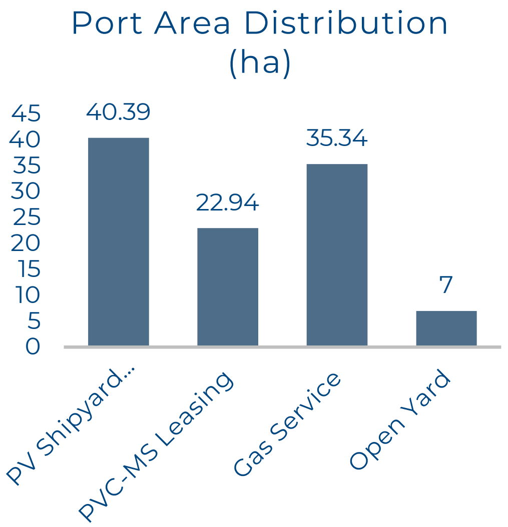
65A3 Street 30/4, Ward Thang Nhat, Vung Tau City, Vietnam

## Port technical specifications:

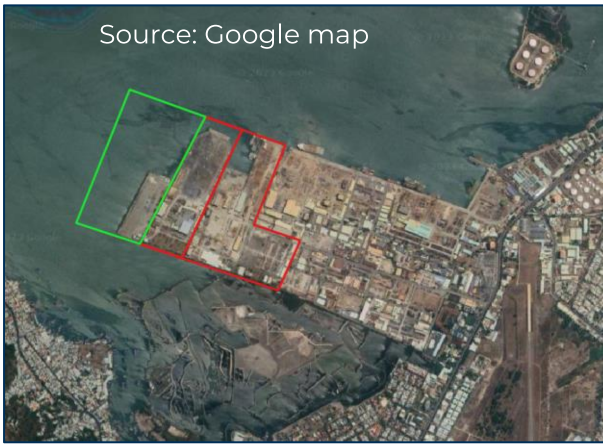
Total port area*:

# 112.5 ha

* The Port Distribution area add up will slightly mismatch with the total area. It is understood that the remaining areas are for parking, road etc.



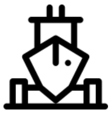

## Port layout:





## Offshore related experience:

In general, Sao Mai Ben Dinh port mainly serves in:



Shipbuilding; Ship repairing and leasing; manufacturing,

Constructing oil & gas storage, piping projects; civil and industrial construction

Renewable Energy: Foundations & Substructure Manufacturing

## PTSC Phu My Port

**Introduction:**

No.3 Street, Phu My 1 Industrial Zone, Phu My Ward Phu My Town, Ba Ria -Vung Tau Province


**Port technical specifications:**

Maximum quay length:

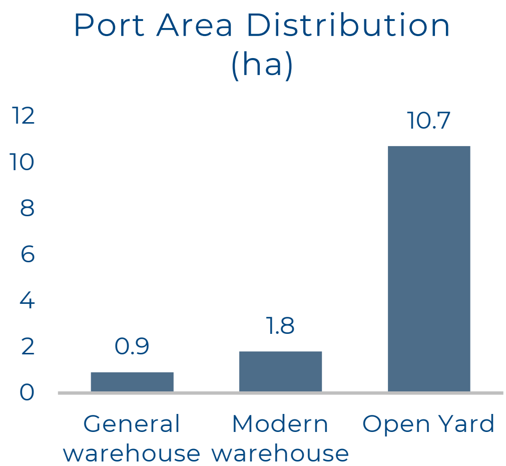
# 385 m

Minimum water depth (CD):

# -14.5 m

Total port area:

# 26.5 ha

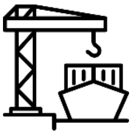



**Port facilities:**

- Multi-Purpose cranes (upto 40MT)
- Crawler crane (up to 250T)
- Mobile crane (up to 160T)
- Forklift (up to 30T)
- Truck, semi-trailer, trailer, SPT/SPMT

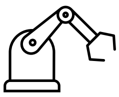
**Offshore related experience:**

In general, PTSC Phu My port mainly serves in:



Loading/unloading, trucking a wide range of general dry bulk cargoes and other logistics.

(Bonded) yard and warehouse rental.



Structures fabrication.

## PTSC general experience in offshore wind

Today, PTSC stands as the leading local EPC/EPCI Technical Services Provider with a proven track record of over 100 O&G projects in Vietnam and internationally. This wealth of experience underscores their capability to navigate and excel in complex energy projects. Leveraging its extensive offshore engineering expertise, PTSC strategically entered the offshore wind sector at the close of 2021 with dual pivotal roles as a Technical Services Provider (Manufacturing Contractor) and Investor & Developer.

As a technical services provider, PTSC commenced its first milestone in this sector by winning the manufacturing contract for 02 units of Offshore Substations (OSS) in 2022 for The Hai Long 2 and Hai Long 3 Offshore Wind Farms in Taiwan. In consortium with Semco Maritime, PTSC has cumulatively secured the manufacturing contracts for 9 OSS units, serving leading offshore wind developers in Taiwan & Europe markets by the end of 2023. Another significant achievement for PTSC was securing the Procurement and Construction contract (EPC) in May 2023 for 33 Suction Bucket Jacket (SBJ) foundations – the first to be manufactured in Asia - for the Greater Changhua Offshore Wind Farms in Taiwan. By December 2023, PTSC recorded a substantial total backlog for contract value in the offshore wind sector, exceeding 1.2 billion USD. PTSC is poised to participate in numerous projects involving the fabrication of components (open to various types) for offshore wind power in the near future. PTSC plays a crucial role as a linchpin in the supply chain for offshore renewable energy in Vietnam.

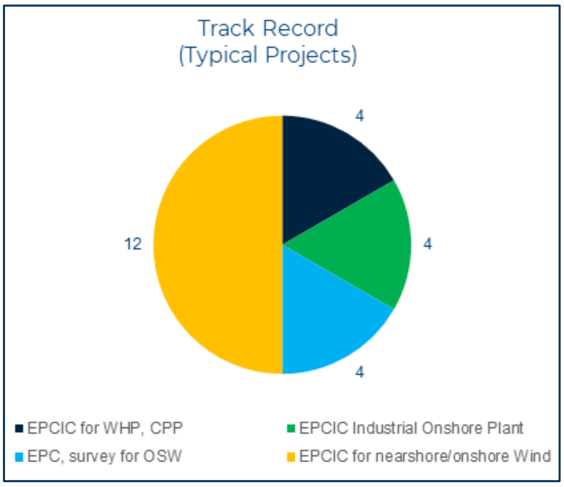
In its role as an investor and a developer, PTSC is distinguished as one of the foremost local investors and developers for offshore wind farm projects in Vietnam. Presently, in collaboration with Sembcorp Utilities Ltd Pte (SCU, Singapore), PTSC is actively engaged in the joint development of the 2.3 GW Offshore Wind Farms Project off the south coast of Vietnam. This project is part of the Government-to-Government cooperation, with the aim of exporting green electricity to Singapore. Notably, PTSC stands as the first and only domestic investor in Vietnam to have been granted the extensive marine survey license for an offshore wind project by MONRE.

PTSC claims to be capable of supporting the following key supply chain work packages. However, it is noticed that to some extent despite their O&G detailed design experience, PTSC currently might lack OWF detailed design capabilities. This deficiency is particularly evident in their lack of involvement in Integrated Load Assessment or experience in managing large capacity electrical cables. However, PTSC's strategic partnerships with leading international well-established offshore wind investors/developers and technical services providers, such as Furgo and Semco Maritime would help augment PTSC's proficiency in those fields.


**PTSC capabilities in OSW**

With a network of 7 ports expanding along the country's border. PTSC fulfils the comprehensive logistics service requirements for petroleum companies, oil and gas operators, and contractors operating in Vietnam.

Additionally, it can function as fabrication yards for modules and supports construction activities for oil and gas, industrial, and offshore renewable projects, both within and outside Vietnam.




**Track record of major projects of PTSC**

## Development plan for offshore wind:

Leveraging the knowledge acquired from the initial renewable energy ventures in Vietnam, such as the projects on Truong Sa islands (2008) and Phu Quy Island (2010) and extending participation in contemporary renewable energy service supply chains, PTSC is strategically positioning itself to align with the transition from conventional hydrocarbons to renewable energies.

In line with the Vietnamese Government's commitment to achieve net-zero CO2 emissions by 2050, PTSC is actively engaged in the renewable energy sector, with a particular focus on offshore renewable energy, functioning as a with a particular focus on offshore renewable energy, functioning as a Technical Services Provider and an Investor & Developer. [17]

PTSC major OSW projects are mentioned below:

### Offshore substation

- Role: Technical service provider
- Secured contacrt for 9 OSS
- Location: Taiwan, EU
- Duration: 2022 - 2027

### Offshore foundation

- Role: Technical service provider
- EPC for 33 suction bucket jackets
- Location: Taiwan
- Duration: 2023 - 2025


### 2300 MW OSW exporting electrcity to Singapore

- Role: Investor & Developer
- PTSC & Semco are executing the early stage of survey works
- Location: Vietnam, Singapore

**Track record of major OSW projects of PTSC**

# SREC*

## Introduction:

Rach Dua Ward, Vung Tau City, Ba Ria Vung Tau Province

SREC was formed in 2021

## Port technical specifications:

Maximum quay length:

**280 m**

Minimum water depth (CD):

**-13 m**

Maximum bearing capacity:

**30 t/m²**

Total port area:

**100 ha**

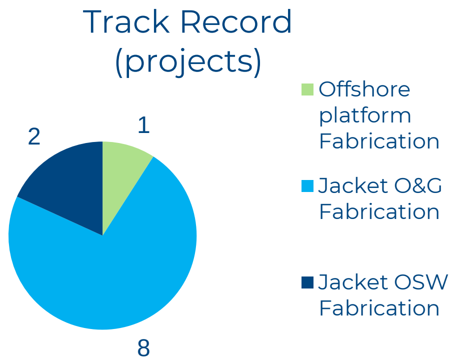
## Port facilities:

CNC, cutting, Shape Bending, Shape Rolling, Welding Machine


## Industrial related experience:

In general, SREC mainly serves in:

- Port, logistics, and vessels transportation for container and machinery equipment.
- Experience in production of jackets (3/4 legs) and monopiles, and fabricating foundations for both onshore (4-5MW) and offshore (10-15MW) installations.



**Port Layout:**


**SREC Port Layout**

**Development Plan for Offshore Wind:**

- Additional Jetty Construction to 200m
- Yard Storage Capacity Expansion by 16 hectares
- Increased Production Capacity to produce monopiles (up to Ø 15m, thickness 197 mm)
- Considering expanding to floating structure

**Key remarks:**

- The water depth is quite suitable for operation of HLVs, and offshore wind related vessels.
- PTSC announced their collaboration with SREC which is highly advantageous for the fabrication and installation strategy for future Offshore Wind Projects in Vietnam.

# Vinh Tan International Port **

## Introduction:

Vinh Tan commune, Tuy Phong district, Binh Thuan province – Vietnam

Vinh Tan International Port was formed in 2019.

## Technical Specifications

Total quays length:

# 573 m

Minimum water depth (CD):

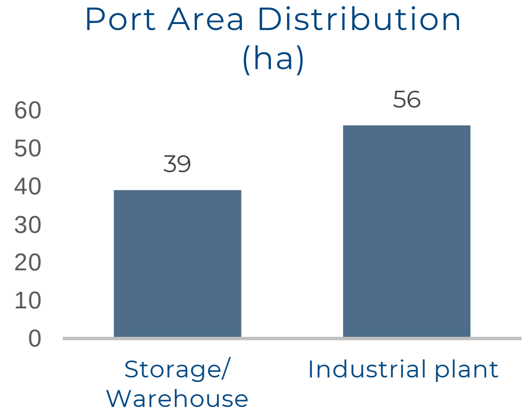
# -9.9 m

Maximum bearing capacity:

# N/A

Total port area:

# 95 ha




Vinh Tan Port

## Port facilities:

Port cranes, crawler cranes with load up to **150t**

## Industrial related experience:

In general, Vinh Tan Port mainly serves in:

Port, logistics, and vessels transportation for container and machinery equipment.

Importing materials for thermal power plant

## Key remarks:

- Vinh Tan Port used to store wind farm components before for an onshore wind project in Ninh Thuan Province. [18]
- Thermal power plant activities occupy most of the area in Vinh Tan Port, limited space for storing offshore wind components is expected.

# Nam Dinh Vu Port**

**Introduction:**

Dong Hai 2 Ward, Hai An District, Hai Phong City – Vietnam

Nam Dinh Vu Port was formed in 2018.

**Technical Specifications**

Total quays length:

# 440 m

Minimum water depth (CD):

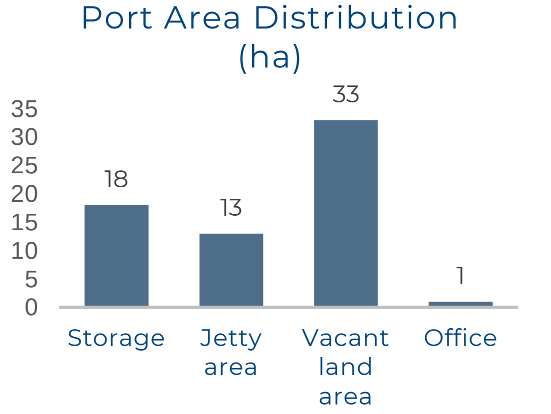
# -8.5 m

Maximum bearing capacity:

# 30 $t/m^2$

Total port area*:

# 65 ha




* The Port Distribution area add up will slightly mismatch with the total area. It is understood that the remaining areas are for parking, road etc.

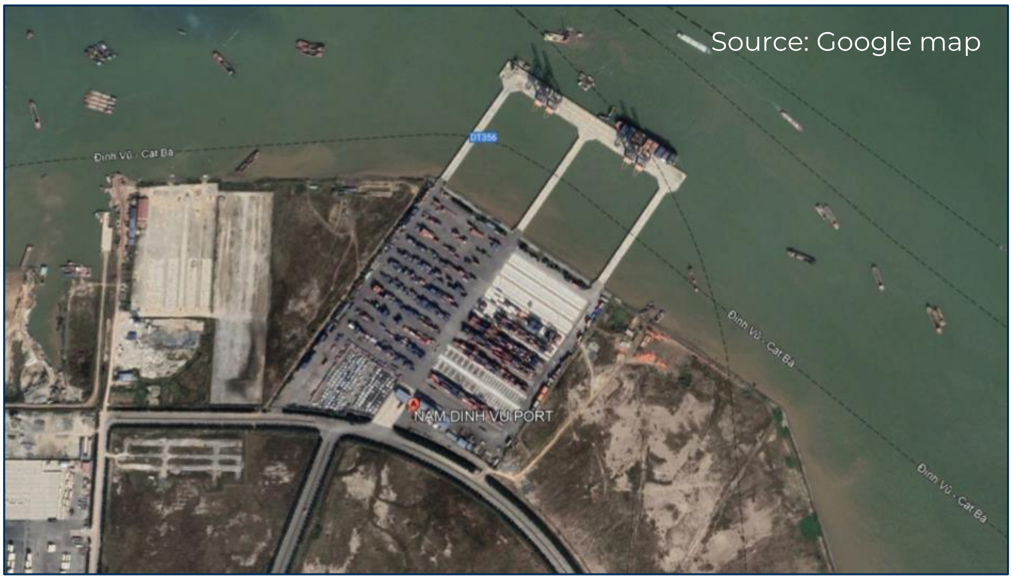
**Port facilities:**

Port cranes, crawler cranes with load up to **800t**

**Industrial related experience:**

In general, Nam Dinh Vu Port mainly serves in:

Port, logistics, and vessels transportation for container and machinery equipment.




**Nam Dinh Vu Port layout**

# Tan Vu Port **

## Introduction:

Dinh Vu - Cat Hai Economic Zone, Dong Hai 2 Ward, Hai An District, Hai Phong City, Vietnam

Tan Vu Port was formed in 2008.

## Port technical specifications:

Total quays length:

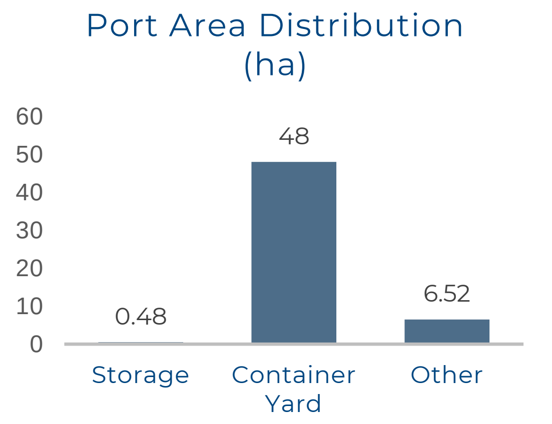
# 980,6 m

Minimum water depth (CD):

# -9.4 m

Total port area:

# 55 ha


* The Port Distribution area add up will slightly mismatch with the total area. It is understood that a lack of information, etc

## Port facilities:

Port cranes, crawler cranes with load up to **70t**

## Industrial related experience:

In general, Tan Vu Port mainly serves in:

Port, logistics, and vessels transportation for container.

## Port layout:

# 11 Appendix D: Supplier descriptions

It is noticed that most foundation and tower suppliers have their own ports/shipyards for fabrication and storage, therefore, we only mention their specific equipment in the following sections.

## PTSC

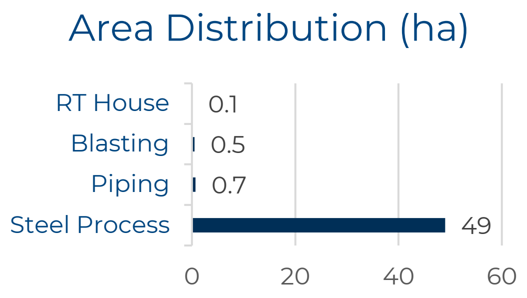
### General information

Refer to Section 10 for further information.

### Facilities

The facility spans a total area of:

# 50 ha




Although the facility doesn't have direct steel manufacturing capabilities, it is equipped with an array of steel processing machinery, including:

- Electric Welding, TIG
- MIG/MAG Welding Machines,
- Beam Profile Cutting Machines
- Pipe Profile Cutting, Beveling Machines

These capabilities could support the manufacturing of components for offshore wind turbines, with sizes reaching up to

# 14MW

### Capacities

N/A

### Materials

N/A

### Manufacturing and Quality

The manufacturing processes adhere to multiple quality standards:

# ISO 9001

and other related protocols.

### Fabrication Duration

No typical lead time is provided. It is supposed that this duration is subject to variation based on the specific project's approval process and unique requirements.

### Maintenance and Support

PTSC M&C possess the capability to offer maintenance and repair services for mechanical components post-installation.

PTSC M&C is actively looking to venture into the offshore wind industry and has strategic plans in place for expansion. The company boasts a sizable yard, and along with its adjacent sister companies, presents a valuable advantage for both jacket fabrication and facilitating the storage of the produced foundations before the commencement of the construction phase. This collaborative environment among all sister companies promises an efficient and synergistic approach toward offshore wind projects.

### Track record & Future development

Refer to Section 10 for further information.

**Manufacturing area of PTSC M&C**

# SREC

## General information

Referring to Section 10 for general description of SREC

## Capacities

Steel tonnage throughput:

**15000 – 30000 t/year.**

High potential to scale due to available area.

## Materials

Sourcing of raw materials from:

A stable and reliable source from a firm relationship with:

**Nippon Steel**

## Manufacturing and Quality

The manufacturing procedure adheres to:

**ISO 9001**

and other related protocols.

## Fabrication Duration

The typical lead time:

**1 month**

For manufacturing and delivering products varies upon the receipt of the Purchase Order (PO).

## Maintenance and Support

These services include:

- Underwater inspection,
- Painting
- NDT services

## Typical production procedure at SREC

Raw material import, and storage

↓

Cutting and beveling

↓

Bending

↓

Welding and finishing

# PV Shipyard

## General information

Referring to Section 10 for general description of PV Shipyard

## Facilities

CNC+Gas+Plasma Cutting Machine: HYPERTHERM 200 and PHC 4000

Welding Machinery:

- SAW Welding Machines: 4 sets
- TIG Maxstar 350 XL by Miller: 10 sets
- TIG Maxstar 200 DX by Miller: 20 sets
- Manual Arc Welding machine 426: 10 sets
- Manual Arc Welding machine 626: 10 sets

## Capacities

The current annual production capacity is estimated at approximately:

**24,200 t**

PV Shipyard possesses a high adaptability to scale up production swiftly and effectively. This can be achieved by increasing work shifts, expanding the workforce, investing in advanced equipment and facilities, and refining operational processes.

## Materials

The raw materials for WTG foundations primarily come from China, EU G7, and Korea.

PV Shipyard has established strong and reliable relationships with suppliers for critical and raw materials, ensuring a steady and consistent supply chain.

## Manufacturing and Quality

The manufacturing processes adhere to multiple quality standards:

**ISO 9001**

and other related protocols.

These stringent protocols ensure that project quality aligns with both client specifications and internal quality standards, thereby meeting all contractual requirements.

## Fabrication Duration

The typical lead time for manufacturing and delivering products is contingent upon the order reception.

## Maintenance and Support

PV Shipyard offers maintenance and repair services for:

- offshore rigs,
- floating facilities, modules,
- and steel structures.

PV Shipyard also handles

- HVAC and accommodation repairs, tank and vessel cleaning
- preparation, coating removal, and recoating.

## Future development & Track record

Referring to Section 10 for this information of PV Shipyard

# Alpha ECC

## General information

Referring to Section 10 for general description of Alpha ECC.

## Facilities

Alpha ECC stands as a proficient fabrication facility, despite its small scale, well-suited for component manufacturing. While its capabilities are adept for subcontracting purposes, it's important to note that the facility operates within constraints due to its limited infrastructure and resources.

The facility boasts a range of essential machinery, including steel cutting, rolling, and bending equipment, such as:

- Laser cutting machine – 2m x 8m;
- Rolling machine (100mm X 3,100);
- Press bending (25mm X 6,000);
- Head/cap forming (40mm x 6,000 / 1,500X 700);
- Weld overlay/cladding;
- Heating pipe bending machine.

Alpha ECC demonstrates a robust capability in the fabrication of jackets, topsides, and pin-piles. Their expertise spans across various sectors including oil and gas, power, and renewable energy. Notably, they have an established track record in procuring, fabricating, and installing offshore facility jackets and topsides, notably showcased through their involvement in the Spratly Reef project.

## Capacities

Annual steel fabrication of up to

**15,000 t**

## Materials

N/A

## Manufacturing and Quality

The manufacturing processes adhere to multiple quality standards:

**ISO 9001**

and other related protocols.

## Fabrication Duration

No typical lead time is provided. It is supposed that this duration is subject to variation based on the specific project's approval process and unique requirements.

## Maintenance and Support

N/A

## Track record & Future development

Referring to Section 10 for general description of Alpha ECC

**Large steel Structure manufactured by Alpha ECC**

# PV PIPE

## General information

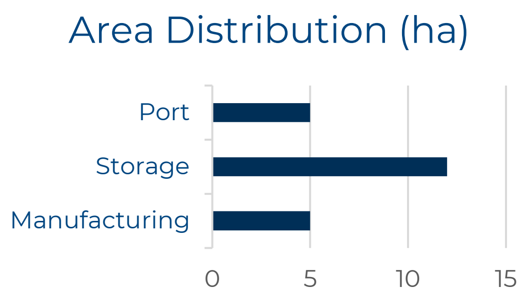
Soai Rap Petroleum Services Industrial Zone, Kieng Phuoc Commune, Tien Giang Province.

Formed in 2010, with a tenure of 13 years in the Vietnamese market

## Facilities

The facility spans a total area of

**22 ha**




The yard specializes in manufacturing jacket legs, focusing on the production of typical foundation sizes akin to jacket legs.

## Capacities

Steel tonnage processing:

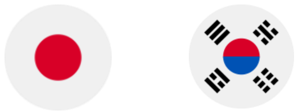
**100,000 t/year/shift**

Line pipe and Casing pipes:

**30-50 pipes/shift**

## Materials

The sourcing of raw materials for WTG (Wind Turbine Generator) foundations from:



Japan Korea

The company has established robust and reliable supplier relationships for both critical and raw materials, ensuring a steady and consistent supply chain.

## Manufacturing and Quality

The manufacturing procedure adheres to:

**ISO 9001**

and other related protocols.

## Fabrication Duration

The typical lead time for manufacturing and delivering products is contingent upon the weight. Variations in weight directly influence the duration required for production and delivery.

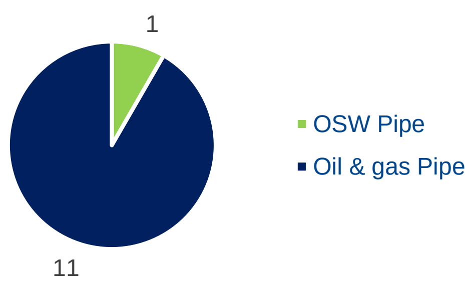
## Maintenance and Support

Post-installation maintenance and repair services are not available.

## Future development

Expansion plans for facility functions and enhancement of existing infrastructure, including storage areas, are in progress. The completion date for these upgrades has not yet been finalized. Regarding future aspirations and investment plans related to the offshore wind industry, there are ongoing initiatives and strategies in development.

## Track record



# General Electric Haiphong Company Limited

## General information

GE is situated in the Japan-Hai Phong Industrial Zone, An Duong District, Hai Phong City

Formed in 2008, with a tenure of 15 years in the Vietnamese market.

## Facilities

The facility spans a total area of

# 8.2 ha

And is equipped with the following machinery:

- Welding machinery such as Mig/Mag/brazing/spot welding,
- Laser cutting capabilities for mild steel up to 20mm and stainless steel up to 15mm,
- Steel bending machinery for materials up to 5mm.

For composite materials, GE collaborates with LM Wind Power for ONW/OFW Blades.

GE plant is used for, alongside steam and gas turbines, manufacturing of specific onshore WTG sub-components including

- Generator
- Converter, Pitch System, Control Box (Topbox, CWC, DCC)
- Stator Sync Switch.

## Materials

The raw materials primarily originate from:

China

EU

And a diverse set of regions parts of Asia.


**GE based in Hai Phong**

# PV Coating JSC

## General information

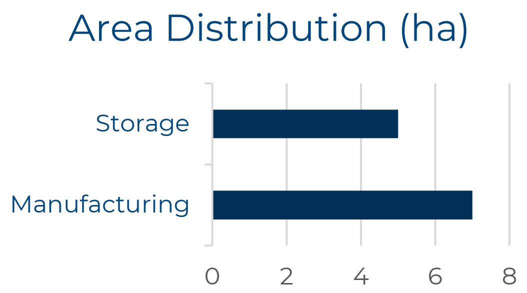
Phu My 1 Industrial Zone, Phu My Ward, Phu My Town, Ba Ria Vung Tau Province.

Formed in 2007, with a tenure of 14 years in the Vietnamese market, PV Coating has established a strong foothold.

## Facilities

The facility spans a total area of

**12 ha**




It's important to note that PV Coating exclusively functions as an applicator for coating and does not engage in composite material manufacturing,

## Manufacturing and Quality

The manufacturing procedure adheres to:

**ISO 9001**

and other related protocols.

## Fabrication Duration

The typical lead time:

**1-2 months**

Corrosion protection by FBE in PV Coating

## Maintenance and Support

The maintenance and repair services are available for a duration of 6 months after installation.

## Future development

At present, there are no plans for the expansion of facility functions or enhancements to the existing facilities, including storage areas. Similarly, there is no information available regarding future aspirations or investment planning, particularly concerning the offshore wind industry.

## Track record

As of the current status, there haven't been any previous offshore wind projects supplied. Nevertheless, PV Coating has a successful track record in:

- Pipe Coating Services,
- Painting Services,
- Field Joint Coating Services
- Lab Testing Services, among others.

Currently, PV Coating is the only facility in Vietnam that provides Pipe Coating Services for the Oil & Gas Sector.

# Sadakim JSC

## General information

Road No.2, Bien Hoa 1 Industrial Zone, An Binh Ward, Bien Hoa City, Dong Nai.

Formed in 1973, with a tenure of 50 years in the Vietnamese market.

## Facilities

The manufacturing facility of this company spans

# 7 ha

primarily utilised for production, with an additional storage area measuring at

# 0.1 ha

Equipped with steel manufacturing capabilities, the facility focuses on steel-related production processes.

- welding
- cutting machines

## Capacities

The current annual steel production capacity of the facility stands at:

# 6000 t/year

**Sadakim company**

## Materials

The raw materials for company's operations are primarily sourced from.

Vietnam

## Manufacturing and Quality

The manufacturing processes adhere to multiple quality standards:

# ISO 9001

and other related protocols.

## Fabrication Duration

The typical lead time:

# 4 months

## Maintenance and Support

N/A

## Track record & Future development

N/A

# CS Wind

## General information

Road 2B, Phu My I Industrial Zone, Phu My Ward, Phu My Town, Ba Ria-Vung Tau Province, Vietnam

Formed in 2023 in the Vietnamese market.

## Facilities

The manufacturing facility of this company spans

**24.24 ha**

with up to 1200 tower sections can be stored.

An additional storage area being:

- Sai Gon International Port
- Thi Vai International Port

And transportation area being:

- Phu My Port

The factories have steel cutting, plate bending, welding machines.

## Capacities

The current annual steel processing capacity of the facility stands at:

**250,000 t/year**

With

**5000 sections/year**

tower sections manufactured.

Tower with diameter up to

**10 m**

Can be manufactured at CS Vietnam

## Materials

The raw materials for company's operations are primarily sourced from:

## Manufacturing and Quality

The manufacturing procedure adheres to:

**ISO 9001**

and other related protocols.

## Fabrication Duration

The typical lead time:

**21 weeks**

With 13 weeks for material delivery +8 weeks for productions.

## Maintenance and Support

Post-installation maintenance and repair services are not available.

## Future development

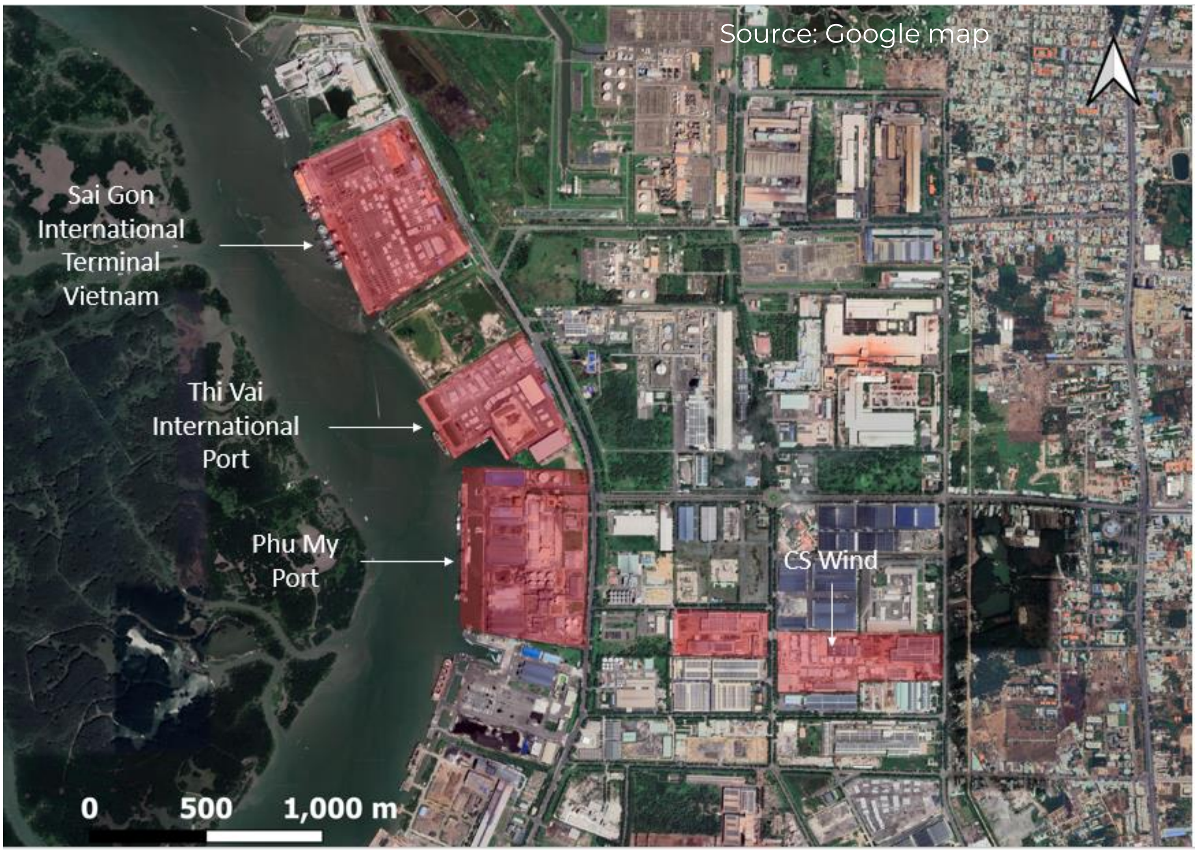
At present, CS Wind Vietnam has an expansion plan for next year aiming at producing wind towers, pin-piles, and some primary parts for offshore.

## Track record

CS Wind International has been manufacturing towers for 20 years, and established strong partnerships with major wind turbine OEMs, including Vestas, GE, Nordex, Siemens Gamesa, and developer Orsted.

No information of track record in Vietnam is provided.

## Facilities Layout




**CS Wind and its contracted ports**

## Keys Remarks

- CS Wind Vietnam has a strategic position situating near the ports which help it facilitating the storing and transporting, importing materials, and exporting products. With the appearance of CS Wind, the Thi Vai Port Cluster can also play an integral part in the offshore wind industry.

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