Strategic Port Planning: Key to Sweden's Offshore Wind Future

Offshore Wind Ports

Port infrastructure plays a crucial role in the logistics of offshore wind construction. The different components for the offshore wind farm will be transported to a selected port close to site to store and prepare the components for installation. The supply chain and port activities will depend on multiple factors such as foundation technology, supply chain, vessel access and port capacity. Figure 1 illustrates the transportation and installation of components via the staging port, along with the vessels involved in the process.

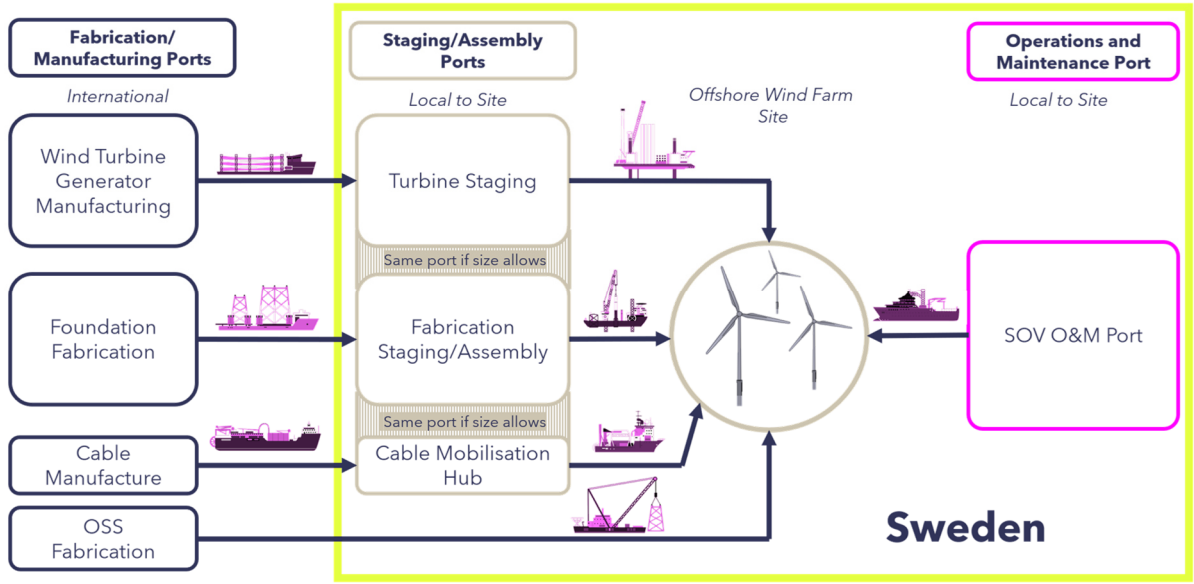

Figure 1 - Component flow and vessel types across different stages of offshore wind projects.

The vessels used for transporting and installing these components set specific criteria for port access. The delivery and installation schedule, combined with the overall supply chain strategy, further dictate the onshore port requirements.

Swedish Offshore Wind Development

The development of offshore wind in Swedish waters has accelerated, with numerous projects advancing towards procurement, although no new offshore wind farms have been constructed in over a decade.

As of July 2024, 25 offshore wind projects in the Swedish Exclusive Economic Zone (EEZ) have submitted permit applications, with additional projects within the territorial sea and in earlier phases. In total, 113 GW of offshore wind capacity is being developed in Sweden. The distribution of offshore wind projects across the Swedish grid areas, along with the stages of project development, is illustrated in Figure 2.

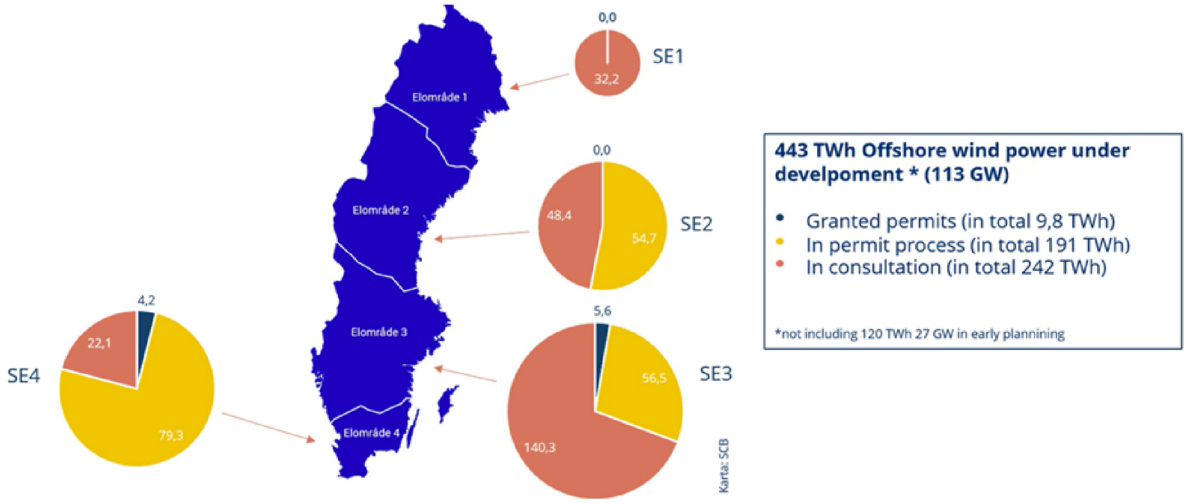

Figure 2 - Overview of offshore wind project sizes in Sweden and their regional distribution within the grid. (Source: Svensk vindenergi)

This growing industry will significantly increase the demand for port facilities, with components requiring storage at staging ports and operational and maintenance (O&M) ports in later project stages.

Swedish Port Facilities and Offshore Wind Hubs

Offshore wind projects are expanding across Swedish waters, with ports located nearby being the preferred hubs for these developments. However, many of Sweden's ports face challenges in accommodating offshore wind logistics today due to several factors:

- **Port size limitations**: Many ports are too small to handle the logistics of offshore wind projects.
- **Lengthy development processes**: The long timelines for developing offshore wind projects slow down progress.
- **Permit procedures**: Extended approval processes for port upgrades add further delays.
- **Project volume**: The large number of offshore wind projects in development makes it difficult for port owners to predict which ones will move forward, complicating planning efforts.

The proximity to the offshore wind project and port characteristics are key factors in determining the suitability and each port will need to be assessed against key criteria to determine suitability for supporting offshore wind projects. Suitable storage area is a key screening factor for port suitability and is the focus of this scope. A full-scale assessment would also include vessel access factors as seen in Figure 3.

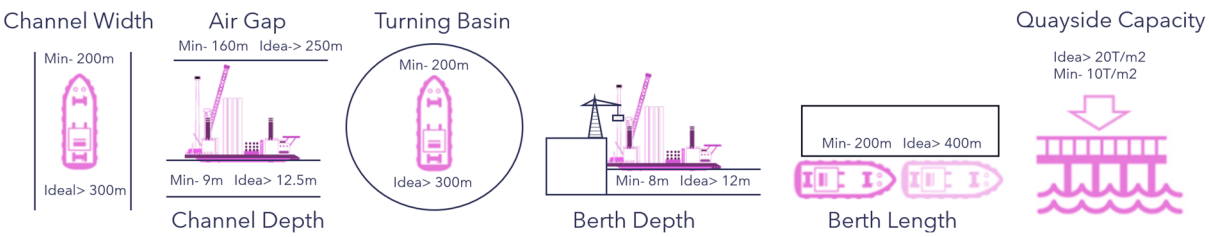

Figure 3 -Required port characteristics for a staging port.

For this study, a few of Sweden's largest ports, located near offshore wind development hubs, were selected to showcase the opportunity for staging ports. Figure 4 shows Swedish ports, existing and offshore wind projects under development, and the selected ports evaluated in this study.

The selected ports are:

- Port of Gothenburg - The biggest in Sweden and used for many industries.
- Port of Trelleborg – The Port of Trelleborg is among the biggest in Sweden with a designated area for offshore wind storage amounting to approx. 6ha.
- Port of Gävle - The bay of Gävle has one of the highest densities of offshore wind projects in Sweden, making the port strategic as a staging area for offshore wind.

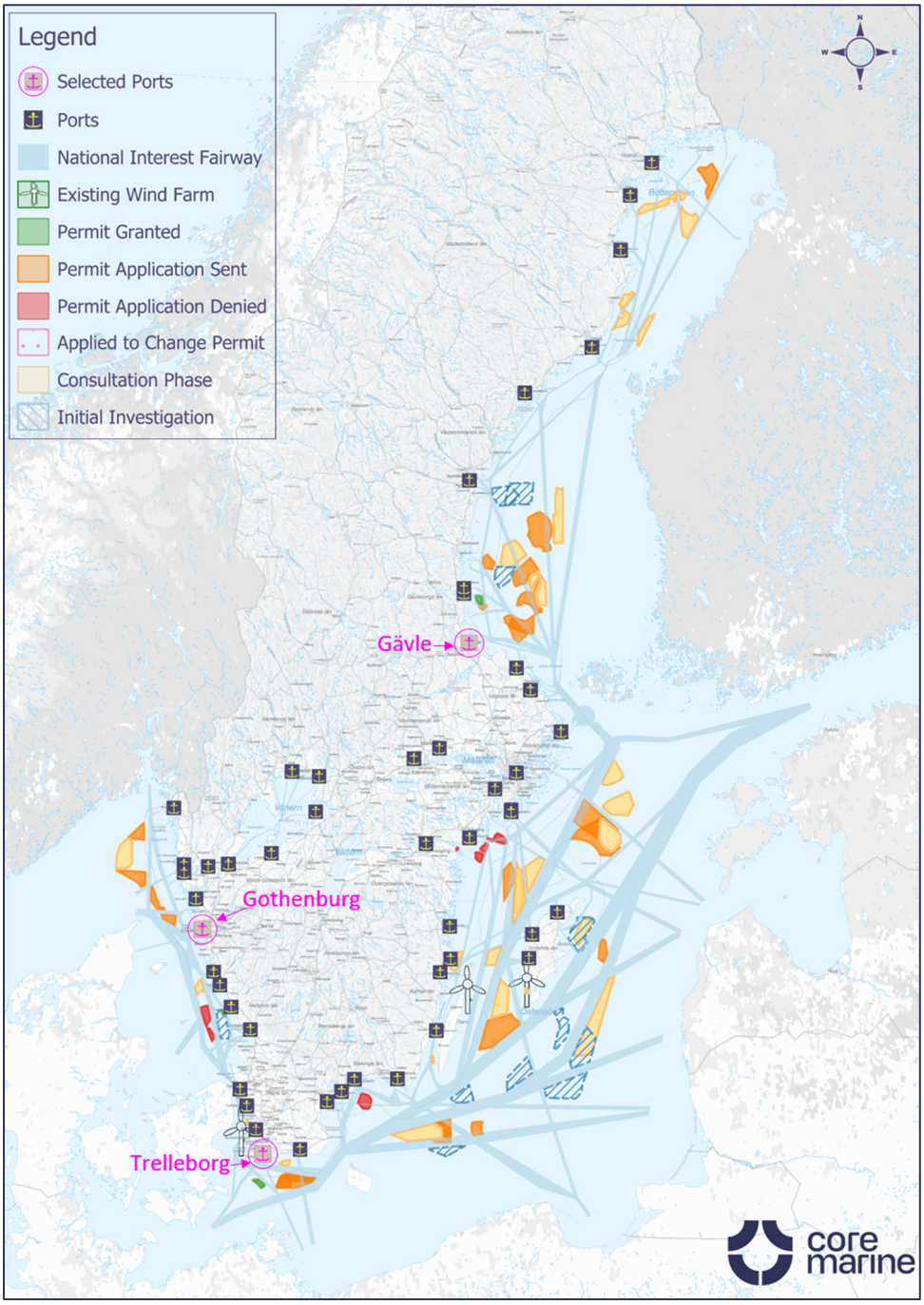

Figure 4 - Overview of Swedish ports, offshore wind projects, and selected study ports. (Source: Lantmäteriet, vindbrukskollen)

Example Wind Farm

An example offshore wind farm configuration in Sweden has been used to assess needed storage area in the ports. A nominal 1GW project with current technology has been used for this assessment. Component sizes of next generation turbines and ever larger projects will lead to increased requirements on ports. Table 1 shows the example used in the study.

Table 1 - Example offshore wind farm

Parameter	Value
Number of Turbines	70
Turbine Size	15 MW
Foundation Type	Monopile

Method

The storage area requirements in the port will be determined by the influx and outflux of components in the staging port as seen in Figure 5.

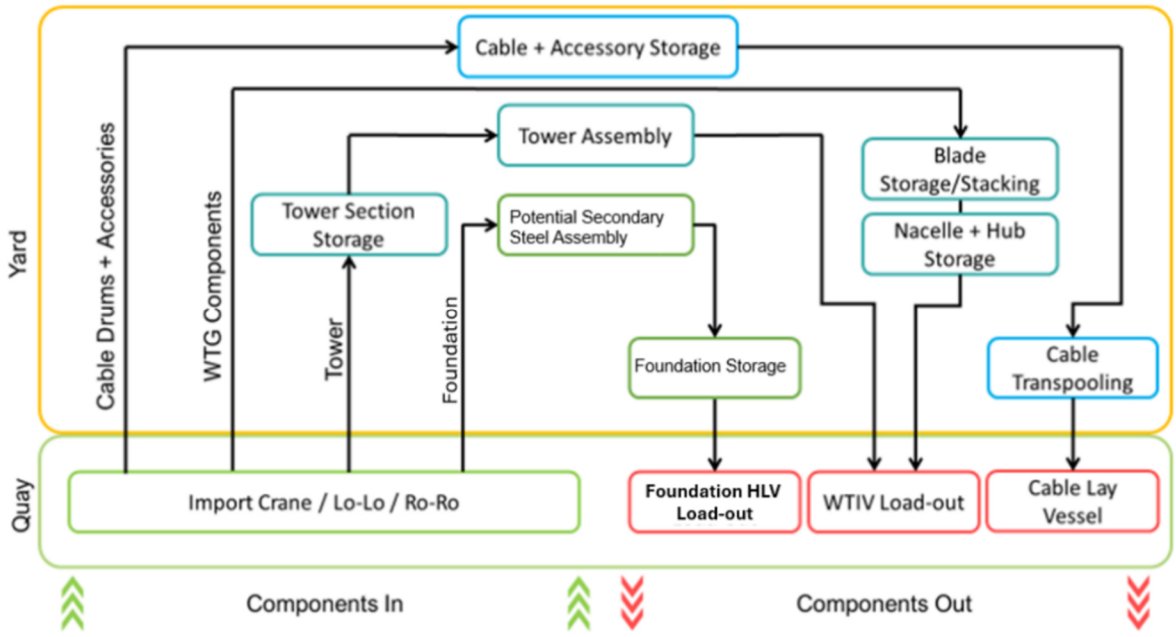

Figure 5 – Flow of components through a staging port.

Storage requirements are influenced by factors such as:

- circulation space for handling
- component storage buffer in port before installation
- foundation type
- stacking of components
- storage layout
- turbine size.

To estimate the storage area needs for a staging and assembly port in Sweden, CoreMarine used its port logistics tool, developed to simulate the entire port execution phase, including influx, storage, outflux, and installation of components.

The simulation tracks components and vessel activities in port over time and accounts for:

- delivery rates
- installation rates
- weather conditions
- wind farm size.

Results

Using CoreMarine´s port logistics tool, multiple different scenarios are quickly simulated and compared to identify risks, assess the impact on the overall installation phase, and determine the required storage area. Three scenarios have been simulated to estimate the impact on installation time and port logistics and the results are summarized in Table 2.

Figure 6 outlines the storage build up over time and total project delivery schedule, this highlights the risks associated with increases in required storage area.

Table 2 Summary of simulation scenarios and their outcomes.

Scenario	Unconstrained	Constrained Port Area	Constrained Installation Season
Simulation configuration	Port area is unconstrained and optimized installation schedule.	Storage area constrained to **15ha**.	Storage area unconstrained, but the installation season is restricted to exclude winter campaigns.
Outcome	• Required storage area of **25ha**. • The project builds up a buffer of components in port to allow an uninterrupted installation program.	• Installation time is extended. • The component buffer in port is reduced. • Project delivery schedule increases and impacts the required deliveries from the supply chain.	• Required storage area of **20ha**. • The installation time is extended. • The delivery schedule must be altered. • Increased risk of component buildup in the port due to a halt in installation.

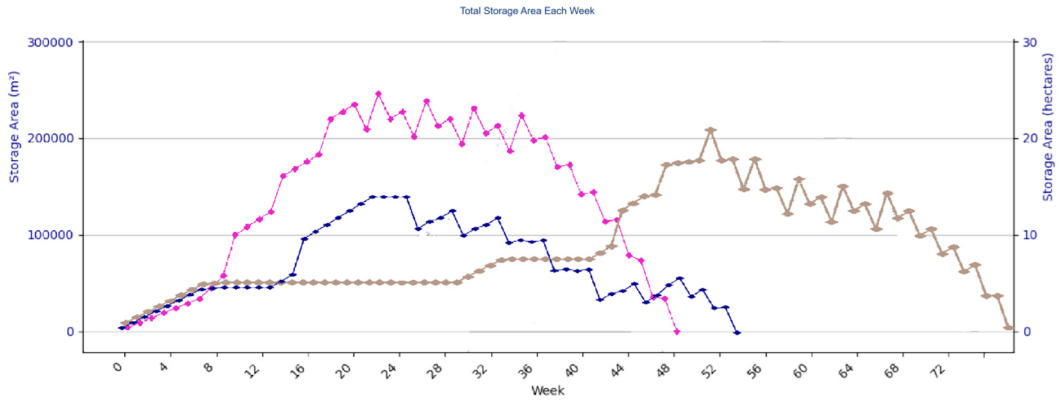

Figure 6 - Comparison of different installation schedules and need storage area in the port. Pink-unconstrained storage space, Brown-Limited installation season, Blue-15ha storage area.

Required Storage Area in Selected Ports

The accompanying figures illustrate the relative storage area required in a few selected ports for a 1GW offshore wind project. Note that these areas must meet the necessary technical specifications to store offshore wind components, manage in-port logistics, and ensure vessel availability.

Figure 7 - The relative size needed for storage at the port of Gothenburg. This area is used for containers and designated areas for offshore wind components in the port would have to be investigated in cooperation with the port owner/operator.

Figure 8 - The relative size needed for storage at the port of Trelleborg. Much of this area is used for other purposes and additional designated areas for offshore wind components would have to be investigated in cooperation with the port owner/operator.

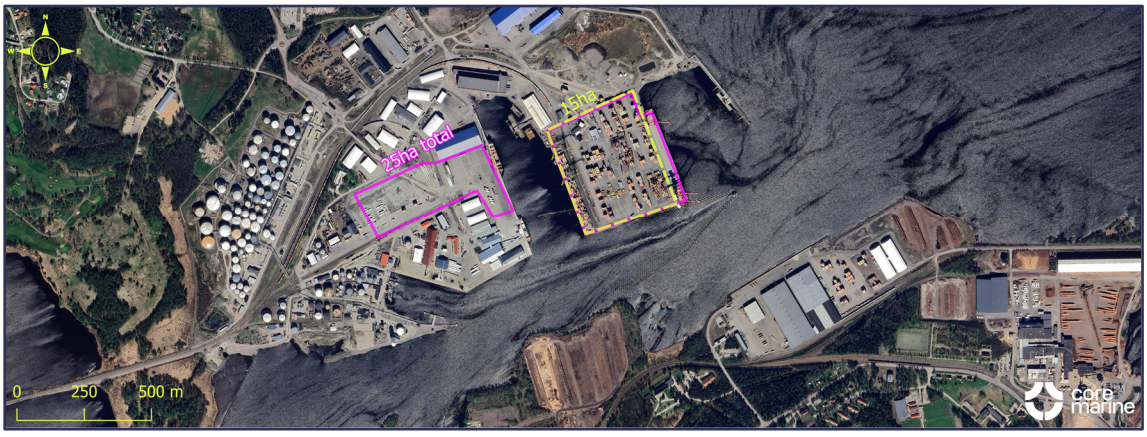

Figure 9 - The relative size needed for storage at the port of Gävle. Much of this area is used for containers and designated areas for offshore wind components would have to be investigated in cooperation with the port owner/operator.

Conclusion

The increasing number of offshore wind projects in Sweden, along with the scale of necessary vessels and components, poses significant challenges for Swedish developers and port owners. The simulation covered only one 1GW wind farm, but with 113GW of capacity of offshore wind under development in Sweden, the total demand on Swedish ports is substantial.

While operations and maintenance may be based in smaller ports, simulations indicate that a single offshore wind farm could require up to 25 hectares or more in staging port area, depending on the turbine size and foundation technology used. The current state of Swedish ports poses risks for developers, potentially leading to project terminations and financial losses. However, these risks can be mitigated through careful planning. CoreMarine's port logistics tool enables rapid scenario simulations, helping to identify constraints in planning.

Identified Risks:

- limited port infrastructure available, which may cause delays and higher costs
- larger future components requiring enhanced port capabilities
- necessary port upgrades may trigger environmental and planning issues, risking delays
- increased competition at both national and international levels could strain the supply chain, causing project delays
- delays in manufacturing or vessel availability could increase storage needs and project risks.

Risk Mitigations:

- early port and logistics assessment
- early planning and dialogue with port owners
- early securing of port areas
- optimizing installation schedule and port usage.

By effectively managing these risks, Swedish developers have a great opportunity to execute offshore wind projects from Swedish ports. Furthermore, if these challenges are addressed, Swedish port operators can play a crucial role in supporting and facilitating the country's offshore wind supply chain, positioning themselves to handle both national and international projects.

CoreMarine brings extensive experience in offshore wind, port logistics, and marine operations, with the ability to simulate port requirements across various scenarios. This capability provides a strong foundation for discussions with port owners and stakeholders, ensuring well-informed and strategic decisions.

To learn more about CoreMarine's capabilities and our port assessment tool, please contact us at fjp@core-marine.com.