catapult
Offshore Renewable Energy

STRATEGIC ASSESSMENT OF PORT CAPACITY IN CHILE

Learnings from the United Kingdom for the Biobío Region

PN000864-RPT-OR2-CL-4

Author: Andrew Yardley

Date: 24/08/2026

In partnership with:

Department for Business & Trade

DISCLAIMER

Whilst the information contained in this report has been prepared and collated in good faith, ORE Catapult makes no representation or warranty (express or implied) as to the accuracy or completeness of the information contained herein nor shall we be liable for any loss or damage resultant from reliance on same.

DOCUMENT HISTORY

Revision	Date	Prepared by	Checked by	Approved by	Revision History
Rev 1	25/03/2026	Andrew Yardley	Cesar Diaz		
Rev 2	26/03/2026	Andrew Yardley	Cesar Diaz	Rebecca Simmonds	
Rev 3	01/05/2026	Andrew Yardley	Cesar Diaz		
Rev 4	13/07/2026	Andrew Yardley	Cesar Diaz		
Rev 5	24/08/2026	Andrew Yardley	Cesar Diaz		Public

Field	Detail
Report Title	Strategic Assessment of Port Capacity in Chile
Status	Public
Document Reference	PN000864-RPT-OR2-CL-4 Rev 5

EXECUTIVE SUMMARY

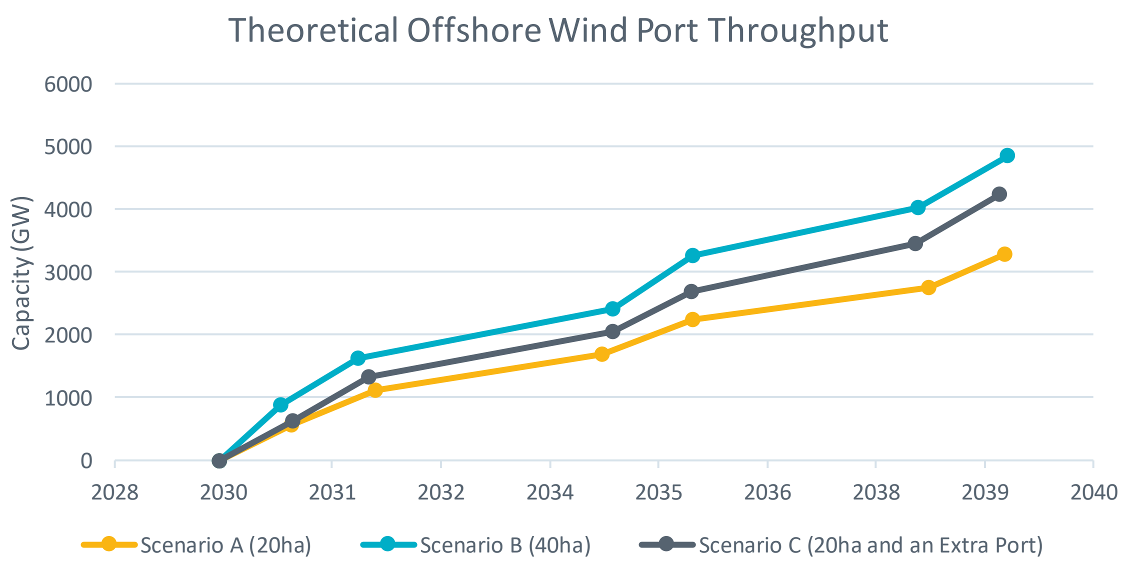
Noting that ports are a key bottleneck for the development of the offshore wind (OSW) industry, the Offshore Renewable Energy Catapult are working with the UK Government's Department for Business and Trade to investigate the potential barriers and benefits of offshore wind port development in Chile, with a focus on the key region of Biobío.

Biobío hosts several large ports that could be used in the offshore wind industry. They are currently mostly utilised for shipping, which limits available space for OSW. Ports would likely need to receive investment to undergo development to host the integration of modern floating turbines, and laydown space is still a limiting factor. Notable opportunities lie in the ports such as San Vicente, Lirquén, and in Coronel. The site of Huachipato in Talcahuano is also promising for its large area and proximity to nearby ports and projects.

The UK has gained valuable experience in the construction of modern floating wind farms that inform technical criteria of a suitable port, shared in this report. Using this experience, modelling was performed to understand the capacities of ports to support a pipeline in the region. Given 20 hectares available for OSW at an existing port, up to 585 MW could be deployed in a season in Biobío, given weather constraints. This is consistent with throughputs seen internationally.

Port size is one of several variables that dictate the throughput of the port. The number of projects available to use the port depends on several other factors, including consents, supply chain, and a financial arrangement for offtake (such as CfDs, in the UK). Based on examples abroad, it is assumed a maximum of three projects utilise the ports between 2030-2040.

The following three scenarios were tested: a single port of 20ha (Scenario A), a single port of 40ha (Scenario B), a two ports of 20ha using one as storage overflow (Scenario C). The model results show that three 2-year projects could deliver up to 3.4 GW if using a 20ha port, and up to 5 GW if using a 40ha port. The larger port means that extra batches are not required, allowing for efficient integration of turbines at the quayside. Using two ports is slightly less flexible than one large port, meaning that only up to 4.4 GW is made possible in that scenario.

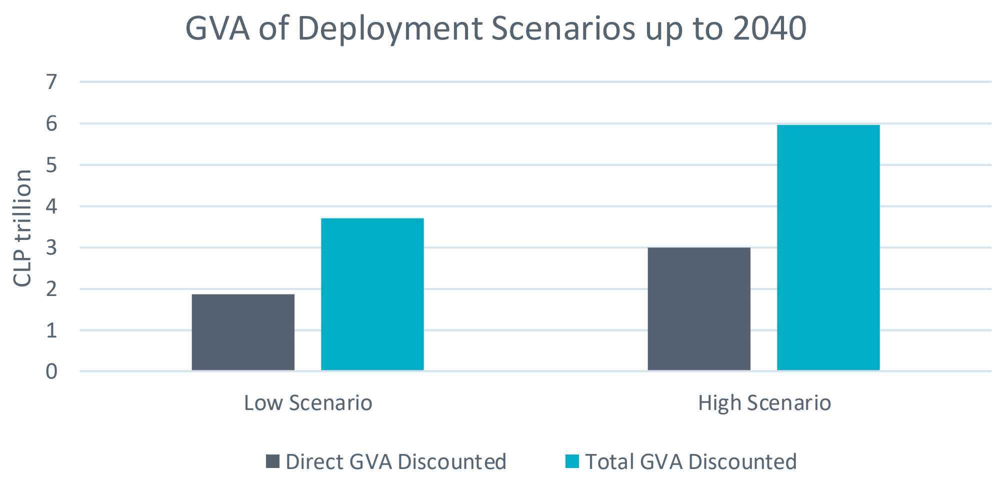


These scenarios are designed to complement those considered in wider scenario assessments, such as those funded by the World Bank, to add detail on what could be necessary for ports to deliver a 'medium growth' scenario needed to achieve around 5 GW of offshore wind by 2040 (fulfilled in Scenario B above). For a low growth scenario, 1.5 GW by 2040 could likely be achieved with minimal development to current ports, but installation would need to be done so at a pace which would likely be unprofitable for investors without ports that can allow for faster timescales.

Current UK projects show that 'wet storage' – nearby areas of sheltered sea used for the temporary placement of floating foundations – will be crucial in delivering projects at a rate that is profitable to developers. Making sure that consenting processes are in place and that wet storage areas do not conflict with shipping routes will be critical in making sure that timelines like the one above can be met. Getting concessions for port operators appear not to be a major barrier for public ports, which operate on up to 30-year concessions but have the flexibility to change objectives every five years.

A major benefit of the OSW industry is the creation of jobs and economic activity. Economic impact in Biobío is estimated through Gross Value Added (GVA), which tracks the amount of project spend that stays in the country across different sectors. Using the cost of a recently developed offshore wind port in the UK, the economic impact of the port development itself is estimated to be approximately 54.7 billion directly, and 79.9 billion Chilean pesos in total.

Including the cost of the three potential offshore wind projects that the development of the port unlocks, total potential GVA ranges from CLP 3.7–6 trillion. This includes the money that is spent on components, installation and operation, and all of the indirect costs that the supply chain has to spend in order to meet their commitments.



Economic impact would be a success for local communities, but the offshore wind industry must also learn to coexist with fisheries, which the UK has done by establishing processes for communication and if necessary, compensation. Developers have also shown commitments to give back to communities through charity work and skill development programs.

In general, a few examples of port developments in the UK can assist in showing how offshore wind can enable regional economic development through the industry, particularly in the town of Grimsby, which had seen economic decline from the loss of fisheries. This was enabled with certainty of projects in a particular area which justified investment in the local supply chain and port infrastructure. Government grants and freeport zones have been crucial elsewhere in enabling FOW ports like the Port of Cromarty Firth, from which the world's largest grid-connected FOW farm was installed.

NOMENCLATURE

ABP	Associated British Ports
ASMAR	Astilleros y Maestranzas de la Armada
C&I	Construction & Installation
CAPEX	Capital Expenditure
CfD	Contracts for Difference
CTV	Crew Transfer Vessel
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables Group
FOW	Floating Offshore Wind
FOWCoE	Floating Offshore Wind Centre of Excellence
FOWT	Floating Offshore Wind Turbine
GDP	Gross Domestic Product
GVA	Gross Value Added
IO	Input-Output
JUV	Jack Up Vessel
LCOE	Levelised Cost of Energy
MoT	Ministry of Transport
NPV	Net Present Value
O&M	Operations & Maintenance
ONS	Office for National Statistics
OPEX	Operational Expenditure
OSW	Offshore Wind
PPP	Public Private Partnership
Ro-Ro	Roll-on Roll-off
SOWPA	Scottish Offshore Wind Ports Alliance
SPMT	Self-Propelled Modular Transporters
TTP	Tow-To-Port
WTIV	Wind Turbine Installation Vessel

CONTENTS

1 INTRODUCTION

ORE Catapult are working with the UK Department of Business and Trade to help support the development of the offshore wind (OSW) industry in several emerging markets. Chile is one of these markets. The offshore wind industry in Chile is in a nascent stage, and authorities have been actively exploring the opportunities of the industry, particularly in the region of Biobío.

In order for the OSW industry to deploy commercial-scale projects, several elements will be necessary, including appropriate policy and regulation, a skilled workforce, and a robust transmission system to offtake the energy. Another crucial piece of infrastructure is ports, which will need to adhere to specific requirements in order to be used for storage and assembly of floating offshore turbines.

ORE Catapult have conducted work exploring the requirements, capacity, strategic barriers, and potential benefits of developing an offshore wind port capability in the region of Biobío in Chile. The result of this report is to inform the investment case for the development of OSW ports in Chile, outlining some of the benefits and risks to be considered from the UK's experience in deploying 16 GW of OSW to date and 36 GW total installed capacity in the pipeline.

The following report includes three key learnings from the UK applied to the Chilean context:

1. The strategic considerations for developing an offshore wind port, including indicative deployment scenarios modelled for the region of Biobío.
2. The economic impact of an offshore wind marshalling port based on the experience of UK stakeholders.
3. A summary of the chief technical requirements for an offshore wind marshalling port, and associated considerations for the installation of future floating offshore wind farms, which are included as an appendix.

The study explores the '*why'* for offshore wind ports by highlighting the potential economic impact for ports and offshore wind farms in the region of Biobío, and the '*how*'. These efforts complement efforts from wider scenario assessments such as one funded by the World Bank, to understand different development pathways for the offshore wind industry in this country, aiming to be published in 2026.

Ports are used both for operations and maintenance (O&M) and for construction and installation (C&I). This report focuses primarily on ports used for installation, with the main use being as marshalling ports, where components are stored and where the turbine is integrated or shipped off to site. These ports have the most challenging business case, being capital intensive, needing lots of space, and having only a few potential clients to sell to. OSW in Chile will primarily be floating offshore wind (FOW), which has its own unique set of requirements and challenges for ports.

2 THE POTENTIAL OF OFFSHORE WIND PORTS IN BIOBÍO

The southern region of Biobío is currently at the centre of the nascent offshore wind industry in Chile. With high wind speeds close to shore, and areas of accessible water depth, developers are viewing the region as Chile's most promising location for the technology. The area is home to five separate commercial offshore wind projects, all in the development and planning stage.

Offshore wind has been noted as a potential source of long-term and high-skilled employment in the area and is an active area of interest for the national government. Ports are a key element of this workforce and offshore wind pipeline, so the port infrastructure is a crucial area to investigate.

The following section details key context on the possible use of ports for offshore wind in Biobío, detailing the current context of ports in the region and potential for use in offshore wind, and a scenario analysis of potential deployment of offshore wind from different port development scenarios.

2.1 Ports in the Biobío region

As an industrial hub, there are several active ports in the Biobío region that have potential for use in the offshore wind industry. Figure 1 shows the layout of some key sites in the area with potential usage in OSW. All would likely require some development to be suitable for either storage of components or integration of floating turbines.

The Port of San Vicente in Talcahuano is the most likely site for marshalling activities, being the major cargo port in the area and having been active in discussions with authorities and OSW developers. The port is publicly owned, and privately operated by Talcahuano Ports, with concession for the operation being renewed from 2030 with a maximum concession period of 30 years. [1] [2]

Though offshore wind will not necessary be included within the terms of the following concession, the Ministry of Transport (MoT) has the ability to include this as a direction for the port even after the concession is put in place. Both the operator and the MoT are open to using the port for OSW, but the nature of that use is not currently formalised, with possible suggestions including the adaptation of part of the current laydown area used for storage, or possibly an extension of the port around the bay to create a dedicated FOW terminal. San Vicente is currently heavily occupied with container traffic, which may make adaptation of a small part of the current 25ha yard area insufficient for a commercial-scale OSW installation.

Two privately owned ports exist nearby with Lirquén in the North and Coronel in the South. Both are used for the transport of cargo, with Coronel having a focus on forestry and links to the nearby coal plant. Lirquén has been used for the import of onshore wind components and has expressed interest in the OSW industry. Though smaller, the experience of these ports makes them good candidates for use in the industry, particularly in the case of multi-port strategies where a port such as Lirquén could be utilised for temporary storage.

The publicly owned Astilleros y Maestranzas de la Armada (ASMAR) shipbuilding facility is also well placed to support the FOW industry. The facility has two dry docks used for shipbuilding and repairs, which could be adapted for FOW integration. Shipbuilding sites have been utilised in other emerging markets such as South Korea, where ports have been fully utilised by other industries. In these cases, shipbuilding sites were more costly options for developers but were ultimately also better equipped for installation operations than alternatives.

The Huachipato site itself is also an opportunity for development. Part of the large area of the site could make for useful storage space of components, provided it is not fully utilised by current plans for green steel production.

Figure 1: Map of Biobío region with relevant ports.

2.2 Modelling Offshore Wind Deployment in Biobío

ORE Catapult's in-house ports and logistics model was utilised to understand how different port development scenarios might result in the deployment of offshore wind farms in the region. The model was used to determine the potential throughput rates at ports in the region as well as the overall potential deployment up to 2040. This modelling looks at the potential capacity that the ports could deliver. The analysis can be used to compare what conditions are needed to target a certain installed capacity.

One of the key constraints in the region is weather. Weather is important for operation but also for construction, as high winds could result in difficulties for lifting operations. Because of this, developers would try to complete most operations during the calmest season.

The typical limit for lifting operations is 9-12 m/s. If the weather is expected to be above this point within the duration of an upcoming operation, that operation will likely be delayed until a suitable weather window becomes available. Figure 2 shows an example weather pattern in the region of Biobío, with higher winds between November and February. As a result, operations are likely to occur between March and October.

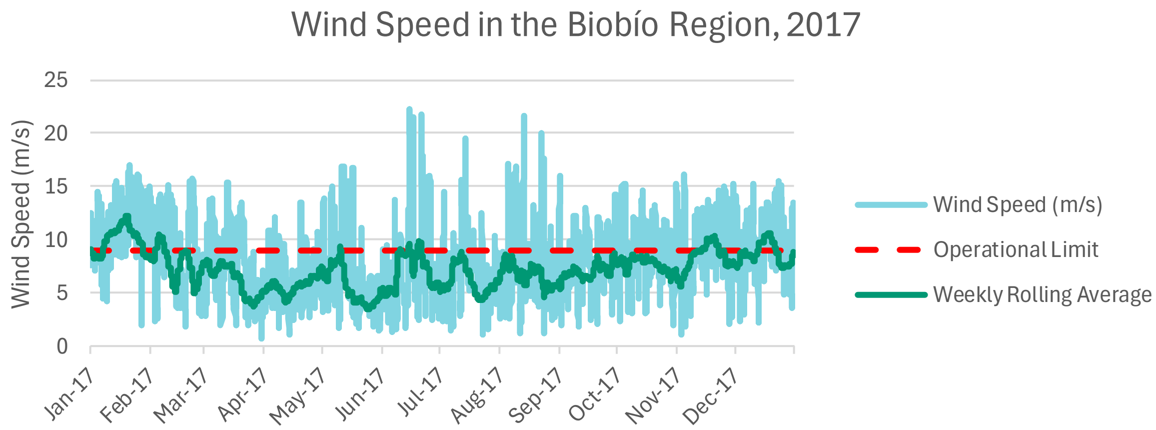


Figure 2: Wind speed from ERA5 for a location near the Port of San Vicente, along with rolling 7-day average and 9m/s operational limit.

Modelling shows that the primary bottlenecks for port throughput regarding OSW are laydown space and distance to site.

Laydown space dictates the number of turbines that are ready to be integrated at any one time. Consider the size of each major component, detailed in Table 1. Assuming a 15 MW turbine, one full turbine set necessitates approximately 2700sqm of laydown space (0.27ha). This means that a port with 10ha of laydown space can store at most 37 turbines. Considering the requirements of manoeuvrability at the port, this would likely allow for less than half of this.

Table 1: Expected component sizes of a 15MW turbine.

Component	Length	Width	Sqm
Blade	100	4	1200
Nacelle	25	12	300
Tower	120	10	1200

If a port is too small to store all the components for one project, then the turbines will have to be delivered and installed in separate batches.

The throughput capacity is also limited by the time taken to perform lifts of components, manoeuvre components around the site, and to assemble the tower and turbine from its separate sections. Each lift will take multiple hours once safety checks and planning are factored in, meaning that a port will look to minimise the number of lifts done on each component.

When modelled for a 20ha port in Chile, it was estimated that the port could deliver a project of 585 MW within a year, assuming nearby wet storage is utilised. Such a timeline is highly dependent on the supply chain to deliver all the components to port in time and deliver foundations to available storage in time for integration. Stiesdal independently claim that they have a concept for a floating foundation that could deliver 1 GW in a single season, though this has not yet been proven. [3]

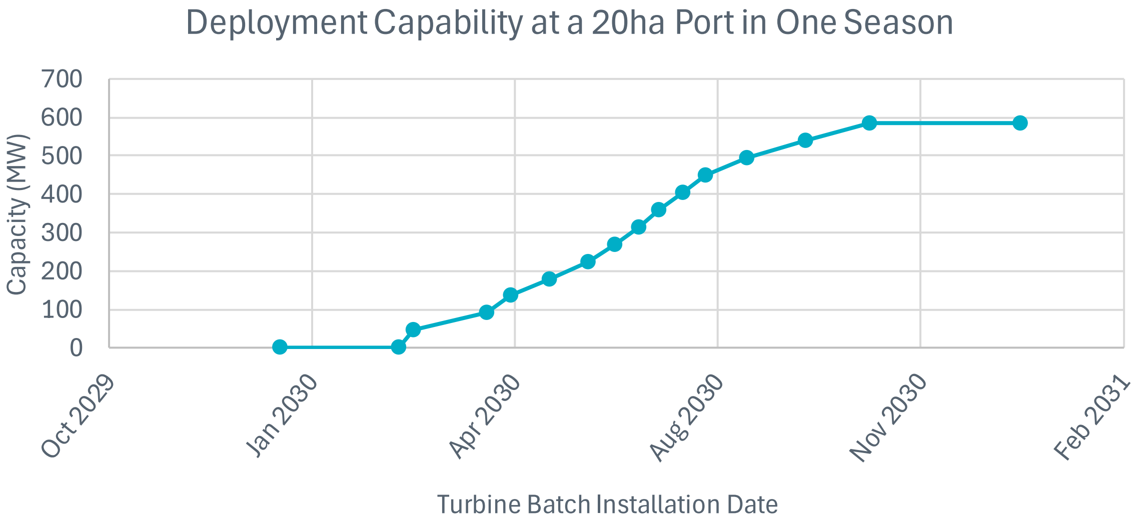


Figure 3: Deployment of 585 MW from a 20ha port, assuming no delays from supply chain.

The final factor to consider is the distance of the port to the wind farm. The general rule of thumb is that a marshalling port should be <120 nautical miles from the farm (about 220km). Using the model to simulate installation of a 600 MW farm, eliminating the distance factor to the farm saved approximately a month of installation time, as shown in Figure 4. This could easily be the difference between installing in two seasons as opposed to one, which could be a large cost saving.

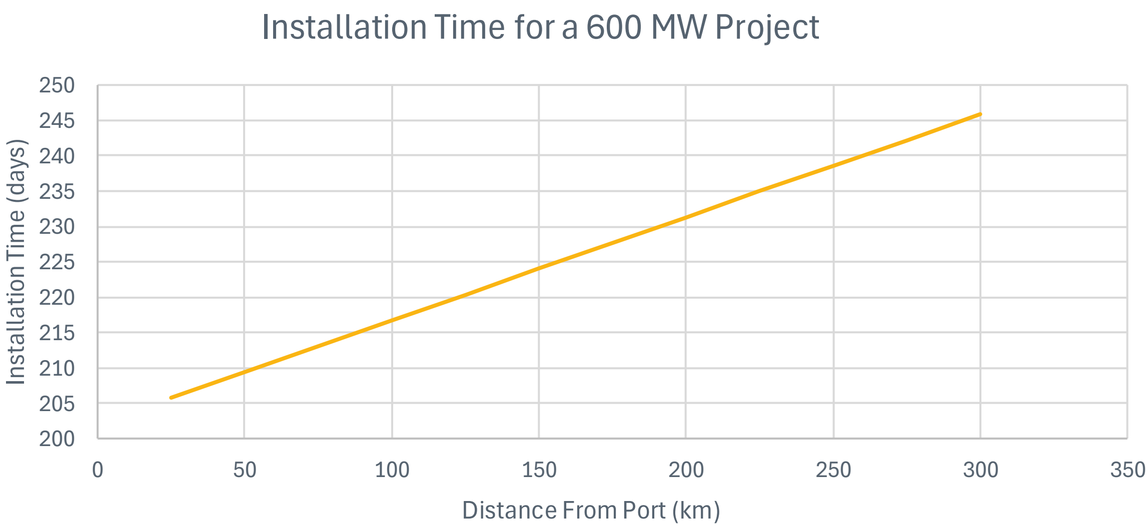


Figure 4: Installation time versus distance to port.

The model was utilised to investigate how different port developments may result in more or less offshore wind deployed over time. The following three scenarios were tested:

1. Scenario A: A single port (San Vicente) with development permitting 20 hectares of laydown space for OSW and one berth utilised.
2. Scenario B: A single port (San Vicente) with high development allowing use of 40 hectares and two berths.
3. Scenario C: One port (San Vicente) for integration with moderate laydown space (20ha) and a second location (e.g. Huachipato) for short term component storage (also 20ha).

Port size dictates the throughput of the port. The number of projects available to use the port depends on several other factors, including consents, supply chain, and a financial arrangement for offtake. It is assumed that three projects utilise the ports between 2030-2040, which would be a positive outcome for industry. Projects are unlikely to extend installation beyond a 2-year period because offshore wind is a highly capital-intensive industry and revenue is needed as soon as possible after investment in order to make returns before debt obligations grow. Projects of this size in the UK are generally completed in this period of time.

The pipeline of specific projects planned for Biobío is not used as an input in the model, but projects in the region do exist to utilise the port in even the highest deployment scenario.

The model results in Figure 5 shows that three 2-year projects could deliver up to 3.4 GW in Scenario A, and up to 5 GW in Scenario B. The larger port means that extra batches are not required, allowing for efficient integration of turbines at the quayside. Using two ports is slightly less flexible than one large port, meaning that only up to 4.4 GW is made possible in that scenario.

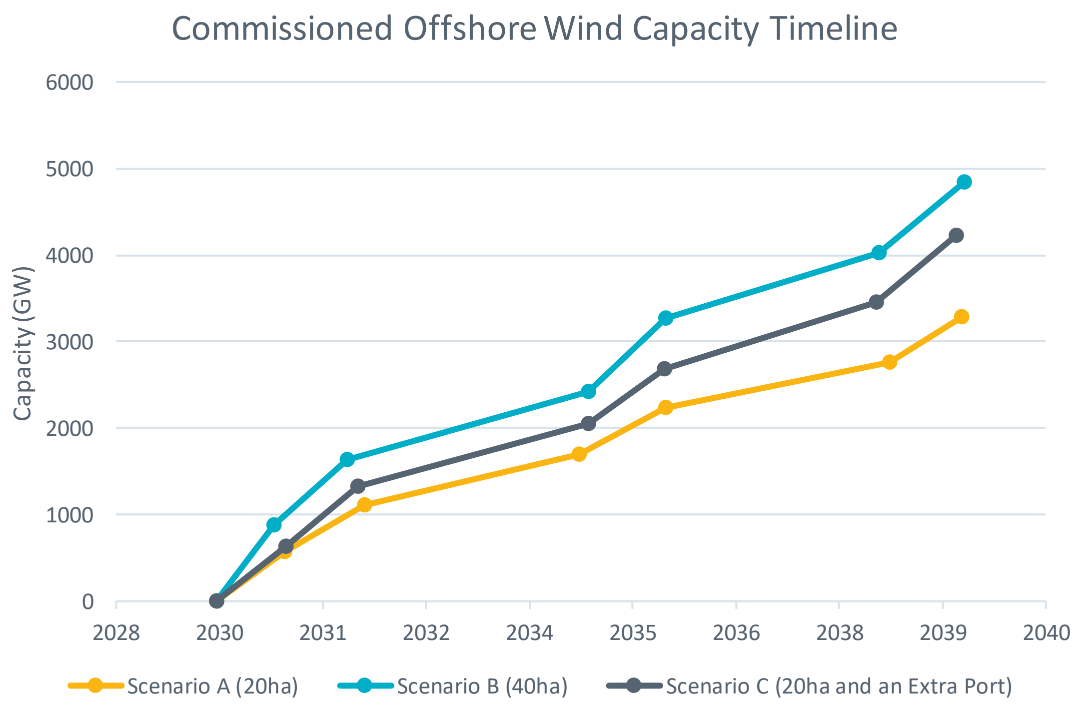


Figure 5: Deployment timeline for three port scenarios in the region of Biobío, if three 2-year installations are made possible.

These deployment scenarios complement those in wider scenario assessments like the one funded by the World Bank to add detail on what could be necessary for ports to deliver a 'medium growth' scenario that would achieve 5 GW of offshore wind by 2040. The low growth scenario of 1.5 GW by 2040 could likely be achieved with minimal development to current ports, but installation would need to be done so at a pace which would likely be unprofitable for investors.

2.3 Risks and Dependencies

Risks to the pipeline should also be considered as a fundamental part of the commercial case for the offshore wind port. Such risks include:

- Supply chain – developers need assurances that components can be delivered on schedule.
- Transmission infrastructure – aside from ports, transmission is the key infrastructure required to offtake commercial-scale offshore energy, meaning that consenting for potential line upgrades needs to align with project schedules.
- Environmental and social – robust environmental investigation is needed to make sure that wind farms will not significantly disrupt the marine ecosystem. There also needs to be consultation with communities and fisheries to ensure that locals are satisfied with plans and that any disruption to industry is appropriately compensated.
- Financial certainty – developers will need financial certainty of offtake to make investment decisions, which is often provided globally through revenue support mechanisms such as Contracts for Difference (CfDs) or state subsidies.

Aside from possible risks to the demand pipeline for ports, there are other risks more directly related to the ports.

At the ground level, the local community should also demonstrate buy-in for the project, and pushback from communities does present a risk for project delivery. Modern wind turbines are very large, looming structures, and can create a strong visual impression when temporarily placed near land, particularly after assembly in the case of FOW. As this is the case, it is best to conduct community engagement early and understand the public view on having the infrastructure nearby.

In the UK, a lack of early community engagement and education has resulted in challenges for plans of a wet storage area in the Moray Firth Bay in Scotland, the Moray FLOW Park. The project is helmed by UK-based Offshore Solutions Group (OSG) who have a 2-year lease to investigate the potential area as a temporary storage site for floating substructures. The project made headlines after campaigners rallied hundreds of local residents to a public meeting on the topic in Findhorn in the North of Scotland, where OSG pulled out of the meeting after receiving anonymous threats. [4] [5] The meeting went ahead and was reportedly very civilised but raised key concerns from the community over plans for the nearby seabed, which could have been avoided with better and earlier communication with residents on what the project would entail.

The challenge is reportedly having a wider impact on the willingness of local authorities to consent temporary storage of substructures in the bay, which has no proven consenting process in Scotland and could create issues for floating projects in the pipeline. In England, this is not expected to pose a barrier as processes are more robust for offshore consenting. A direct learning from the UK in this regard is that the consenting process for temporary wet storage sites should be made clear to developers at an early stage and that plans should be communicated clearly to nearby residents.

Another key local stakeholder for offshore wind ports are fisheries. The UK experienced initial pushback from fisheries in response to the OSW industry. Despite fisheries having declined in prominence within the country since the 20th Century, they still form a key part of the social fabric, with links to deep rooted identity to this day. It is possible that offshore windfarms could disrupt certain fisheries by claiming areas of the sea, and in some cases communication between fisheries and wind farm developers has been known to be poor. [6] However, fishing can also successfully coexist with OSW. It does so in the UK, where some fisheries have even operated within farms, using demersal trawl gear in cable-free corridors between turbines. The UK is in fact the only country in Europe that does not actively prohibit fishing among wind farms, instead offering safety zones around turbines and having operators manage communication with vessels in the farm. [7]

In 2002, the two industries made a concerted effort to promote coexistence by establishing the Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW). According to the group "FLOWW's objectives are to discuss effectively on issues arising from the interaction of the fishing industry and offshore renewables activity, share and develop best practice, and liaise with other sectors with interests in the marine environment." [8] As a result, the group have created a 'Best Practice Guidance' for settlements and communication. [9]

In markets with a large fishing industry, small ports can often be fully utilised for these means, without much free space available to expand into a novel industry such as OSW. Where space is not available, concessions may have to be made with existing users of the port. This particularly applies to O&M ports, which are generally much smaller and nearer to the farm.

3 ECONOMIC IMPACT

One of the major benefits of offshore wind development in Chile is expected to be regional economic development that comes with an OSW supply chain. For example, jobs will be created through the development of infrastructure and the management and operation of assets. Case studies in Europe suggests that 1 GW of offshore wind can create from 1,000-2,000 jobs, and that in offshore wind there are triple the number of jobs, per GW, compared to fossil fuels, according to industry insiders. [10] [11] [12]

The region of Biobío has a strong industrial heritage, with historical ties to the forestry, fishing, steel, and coal industries. Job losses in the coal industry in the late 20th century caused some economic hardship for the region, and the previous Chilean government had pledged to continue aggressively phasing out the use of coal by 2040 at the latest. [13]

As a result, the region has faced another economic blow recently with the shutdown of the Huachipato steel mill in Talcahuano – Chile's largest steel plant – reportedly affecting 2,700 workers directly and a further 20,000 indirectly. [14] The decision came to shut down the plant since it could not compete with the price of imported steel from China. In order to stop the shutdown having wider economic ramifications, the local government are working on an economic strengthening plan in the Local Government Plan Biobío 2050. This has been merged with the previous government's Plan de Fortalecimiento Industrial del Biobío, which included incentives to hire workers affected by the shutdown and accelerated various public infrastructure projects. [15] [16] The plan also committed $10 million USD to implement a technology centre dedicated to the energy transition and the development of renewable energy, including green hydrogen.

Quantifying the potential economic impact of offshore wind in the region is key to understanding how offshore wind can benefit Biobío.

The economic activity created by an industry, sector, or region can be measured by Gross Value Added (GVA). Every domestic investment leads to a ripple effect which creates a need for further products and services in the economy. There are three types of economic effects that can be estimated in GVA terms:

1. Direct GVA is the value add generated by the project's own production, including any contractors directly related to the project work.
2. Indirect GVA accounts for the wider supply-chain effects from the investment, such as on transport services, utilities, and goods procured to meet the project's demand.
3. Finally, induced GVA is the economic activity created when employees supported by direct and indirect activity spend their wages, such as on retail, housing, and education.

Type 1 effects include direct and indirect effects, and Type 2 effects include the induced effects also.

In the UK, the Office for National Statistics (ONS) publishes information to help calculate Type 1 effects, with the latest referring to 2022. ONS has over time decided not to publish Type 2 multipliers, and its legitimacy is not universally agreed as it may lead to double counting of effects with other markets.

GVA multipliers are calculated using Input-Output (IO) tables which show the flow of money between sectors in the economy. For the purpose of calculating the economic impact of OSW ports in Chile, ORE Catapult calculated GVA multipliers using IO tables published by the Chilean Central Bank. [17]

To estimate the economic impact of a port investment, the effect can be split across the development and operation phase of the port.

Throughout development of the port, the investment will largely be spent directly on construction. The spend profile of the construction phase can be mapped with the appropriate multiplier to calculate the expected direct and indirect effects from the investment. This shows that for each peso spent on the port, how many pesos of value are created in the wider supply chain.

The development will make construction of new wind farms possible, meaning that the investment will unlock economic benefits beyond those from construction. However, the uncertainty of the project pipeline in the surrounding area creates the need to model multiple deployment scenarios. Appropriate negative externality assumptions, such as leakage, deadweight and displacement effects should be applied. These ensure that the model accounts for money invested which is leaving the country such as to foreign shareholders.

Unlike the port development, the costs of an offshore wind farm contribute to a wide range of sectors. The ORE Catapult Offshore Wind Deployment GVA Model maps individual cost elements to the sector in which they apply. This allows the correct multipliers to be used to calculate the direct and indirect GVA of specific activities.

The costs of an indicative offshore windfarm are calculated using ORE Catapult's in-house Levelised Cost of Energy (LCOE) model. LCOE represents the net present cost of each MWh produced from a power plant, calculated as the total costs divided by the lifetime energy generation. The inputs to the model are displayed in Figure 6. On the numerator, costs cover expenditure for development (DEVEX), capital (CAPEX), operations (OPEX), and decommissioning (DECEX).

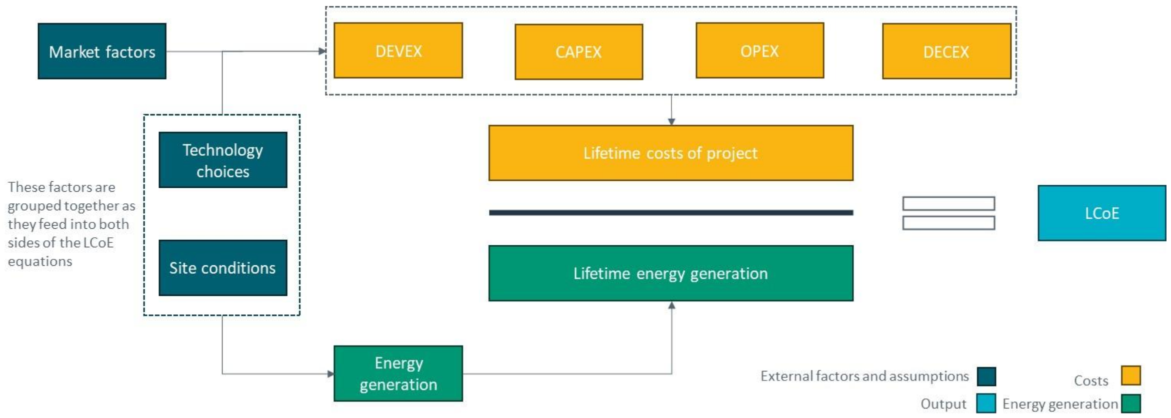


Figure 6: Diagram showing the workings of the LCOE model.

Cost components of offshore wind can be mapped to relevant industrial codes so that data can be used to calculate the GVA makeup of each cost. For example, 'Array Cables' could be mapped to the 'Electrical Equipment' industry. Some components in each cost category will be procured from outside the country, but only domestically sourced share of expenditure is used to calculate domestic GVA. To estimate the project costs that are spent domestically, assumptions around forecasted local content will need to be made.

3.1 Example GVA for a Port in Chile

To estimate the cost of offshore wind port development, an example from the UK is used. The port of Cromarty Firth in Scotland – previously used for fixed-bottom wind and oil & gas – have committed to invest £155 million to construct a 650m quay wall and develop laydown space to handle floating offshore wind components. Applying the purchasing power of Chile and converting, this could equate to a development that costs approximately CLP 92 billion[1].

Costs will be specific to the current port and nearby environmental conditions. The costs quoted here do not necessarily represent the needs of Chilean ports but will give stakeholders an indication of the scale of potential impacts.

Firstly, the potential economic impact of the construction phase could be estimated by applying GVA multipliers to the construction spend profile shown in Table 2.

Table 2: Construction spend discounted by year.

Year	2028	2029	Total
Construction Spend (CLP)	46bn	46bn	92bn
Discounted Cashflow (CLP)	46bn	44.4bn	90.4bn

It is assumed there is no deadweight, meaning that construction is unlikely to go ahead elsewhere in the counterfactual example. There is assumed to be some displacement from other parts of the economy and leakage of profits to other countries (10% for each). Applying the GVA multipliers to this value gives the expected contribution of the project to Gross Domestic Product (GDP). The GDP contribution of the port development is calculated to be approximately 54.7 billion directly, and 79.9 billion in total (Table 3).

Table 3: Expected direct and indirect GVA from the construction of a theoretical port.

	Port Construction
Total Direct GVA (CLP)	54.7 billion
Total Indirect GVA (CLP)	25.1 billion
Total GVA (CLP)	79.9 billion

Improvements from the harbour may also provide a property value uplift in the local area as evidenced by similar developments globally. The development overall acts as a catalyst for economic development in the region but it would also unlock economic activity from the expenditure of users at the port.

Unlocked economic activity will be delivered through the timely delivery of offshore wind projects in the Biobío region including some of the five active projects present. Port scenarios A (low) and B (high) modelled above in Figure 5 are used, assuming three projects are delivered from the port development within ten years.

In the high-output scenario, a decade of projects in the region could see approximately 5 GW delivered. This would necessitate project schedules aligning with no delays from the supply chain, which has proven to be unlikely from projects in the UK and elsewhere.

A lower-output scenario would provide a greater buffer between smaller projects, totalling 3.4 GW.

[1] GBP £1 = CHP 1,212, but accounting purchasing power something costing £1 in the UK would cost CHP 594. [34]

Assumptions also need to be made about the local content in offshore wind farms in Chile. In the short term, major components are likely to be imported from parts of Asia or from Europe, though steel structures such as towers could be produced domestically in the future. Electrical components including substations and cables could see domestic growth once the project pipeline builds, as could foundation manufacturing. Project management, development, and operations are expected to occur primarily in-country. The assumptions used for present and future local content are shown in Table 4.

Table 4: Chile local content assumptions for different cost components of an offshore wind farm installed in territorial waters.

Component	2027 Local Content Estimate	2040 Local Content Estimate
Blades	0%	0%
Nacelle	0%	30%
WTG Tower	0%	30%
Turbine Subtotal	**0%**	**26%**
Foundations	15%	30%
Transition piece	15%	30%
Foundations Subtotal	**15%**	**30%**
Array Cable Supply	30%	50%
Offshore Substation	30%	50%
Export Cable Supply	30%	50%
Onshore Substation	30%	50%
Electrical Subtotal	**30%**	**50%**
Turbine Installation & Commissioning	40%	70%
Foundations Installation	40%	70%
Array Cable Installation	40%	70%
Offshore Substation Installation	40%	70%
Export Cable Installation	40%	70%
Installation Subtotal	**40%**	**70%**
Project Management	70%	70%
Insurance	70%	70%
Contingency	70%	70%
Other CAPEX Subtotal	**70%**	**70%**
CAPEX Weighted Average	**22%**	**42%**
Scheduled O&M	85%	85%
Unscheduled O&M	65%	65%
Other OPEX	85%	100%
OPEX Weighted Average	**74%**	**80%**
Development	**75%**	**75%**

Using the GVA model, it was found that during construction, the total GVA for a 1.5GW built in 2040 is expected to be approximately CLP 2.07 trillion, with CAPEX accounting for CLP 1.15 trillion of that. Component manufacturing for the turbine is expected make up a large chunk of this by 2040 (43%), followed by electrical works (31%) and project management and development services (26%). This breakdown is shown in Figure 7.

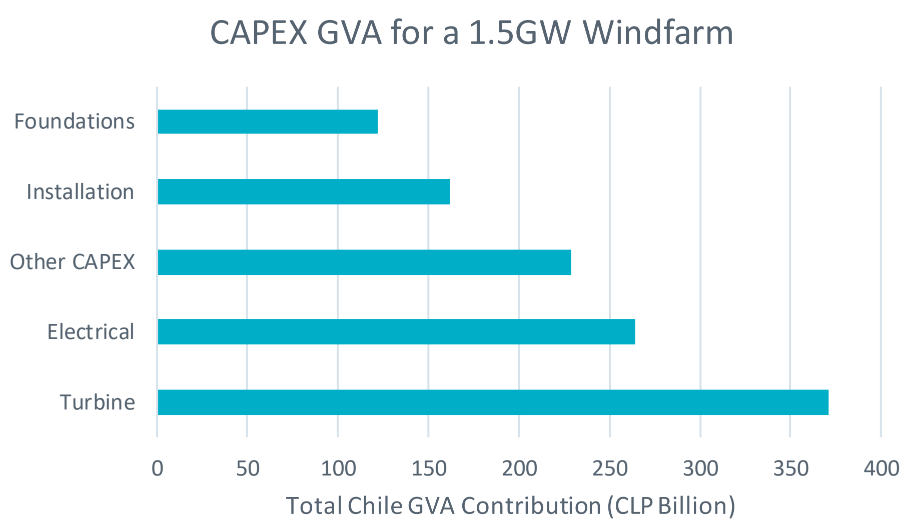


Figure 7: Breakdown of CAPEX GVA for a 1.5 GW Windfarm in 2026 prices, with local content assumptions made for 2040.

The direct and total GVA of all offshore wind projects built from the port from 2030 to 2040 is shown in Figure 8.

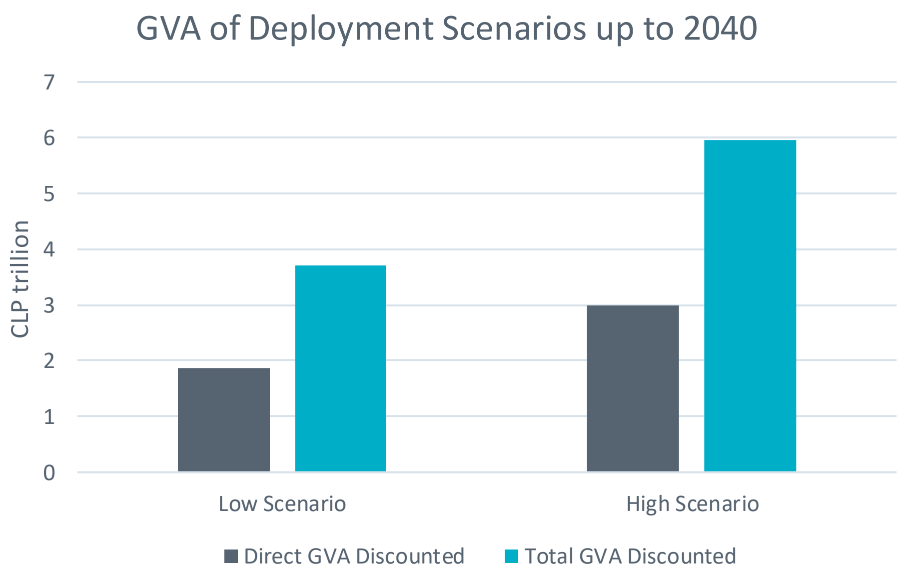


Figure 8: Direct and total (including indirect) GVA from offshore wind farms installed from the port up until 2040.

The total potential GVA ranges from CLP 3.7–6 trillion. These values are summarised in Table 5.

Table 5: Direct and total cumulative discounted GVA for offshore wind projects installed using a port in Biobío up to 2040 under low and high deployment scenarios.

	Direct GVA (CLP)	Total GVA (CLP)
Low Scenario	1863 billion	3712 billion
High Scenario	2990 billion	5955 billion

Demonstrating this positive economic impact is key to generating buy-in for the port development and making the case for investment from financiers.

4 CASE STUDIES FROM THE UNITED KINGDOM

There are several use cases from the United Kingdom that highlight the development of offshore wind ports in the UK. Some share close similarities to the situation in Biobío, and they can provide tangible evidence of the effects of deploying OSW.

4.1 Port of Grimsby, England

The Port of Grimsby, in the Northeast of England, is today a major hub for the O&M of windfarms in the area. Run by Associated British Ports (ABP), the port is also a large importer of cars and maintains its connection to the formerly dominant fishing industry. Given its strategic location next to one of the largest clusters of projects in the UK, including some of the frontrunners in the country, the port is home to some of the largest UK O&M bases for multiple large operators including RWE, Ørsted, and XceCo.

In the 1970s, the 'Cod Wars' between the UK and Iceland accelerated the decline of the once bustling fishing industry in the coastal town. [18] Grimsby consequently saw multiple decades of economic decline and high unemployment rates. However, in the 2000s, the town adapted and has since become the largest Operations & Maintenance base for Offshore Wind in the UK, employing several hundred people. The nearby Green Port Hull, a hub of manufacturing and logistics, including the Siemens Gamesa blade factory, employs around 1,000 people in the area directly, and creates an estimated 627 jobs indirectly. [19]

The most important factors in Grimsby's success as an O&M port are its close proximity to several projects and its large amount of industrial space near the quayside, much of which has become unused after a downturn in the fishing industry that preceded the 21st Century. The port also benefits from a long quayside and water depth suitable for servicing both the crew transfer vessels (CTVs) and the large special operations vessels (SOVs) that frequent the port.

The investment for the port and nearby marshalling ports was made possible through concerted efforts to create a regional cluster of offshore wind farms, ensuring a pipeline of near-term work for the ports following construction. National policy certainty was therefore the enabling factor for port authorities and local councils to mobilise capital, land assembly and permissions.

Operations at the port have steadily grown with the increase in farms in the area, servicing nine operational wind farms from the port and a total of 4.9GW of capacity. The first of these farms, Lynn and Inner Dowsing, became operational in 2009, and the most recent, Hornsea 2, became operational in 2022.

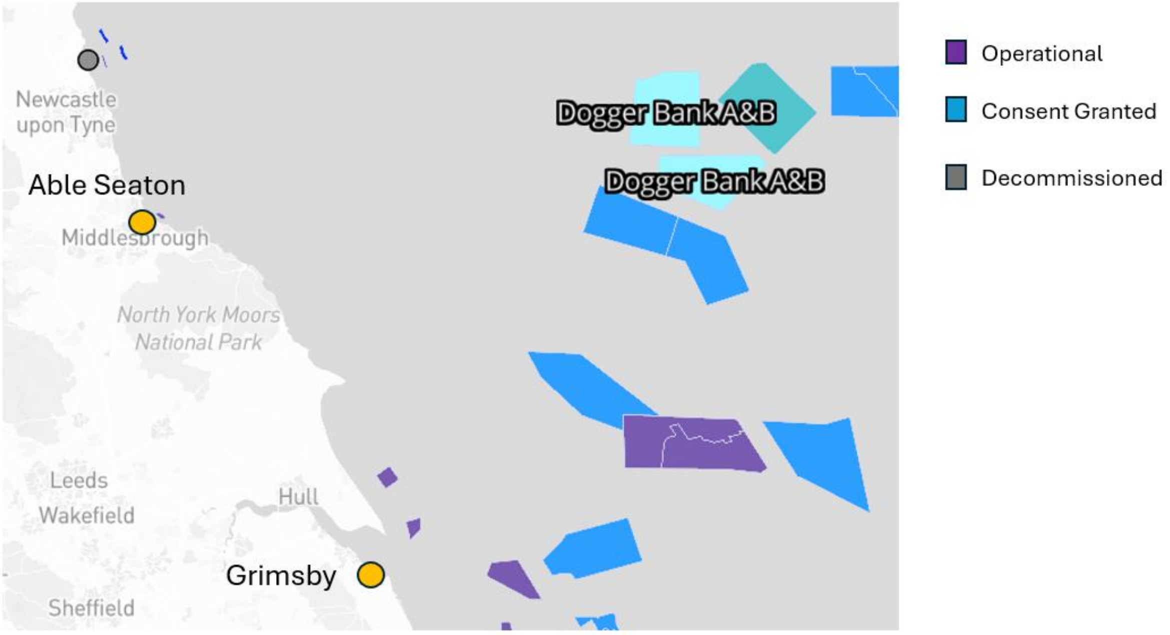


Figure 9: Locations of Grimsby, Able Seaton, and surrounding projects. Map sourced from Esgian.

Grimsby Port became an O&M hub through a series of investments which upgraded it to become suitable for the purpose. In 2014, ABP invested £5 million to install a new lock system for the port. [20] Since then, Ørsted have invested over £14 million in their 'East Coast Hub' for O&M. [21] Other major offshore wind contributors with current O&M facilities at the port include RWE, EDF and XceCo.

The port represents not only a success for the wind industry, but the local community. According to the independent report commissioned by the UK Government, are 520 people currently employed at the East Coast Hub in the Humber; 230 directly employed by Ørsted and the remaining being long term operations and maintenance contractors. [22] A further 300 people are expected to gain employments with the needs of new windfarms in the area up to 2030.

Figure 10: Overview of the Port of Grimsby. Courtesy: Grimsby Fish Market

4.2 Port of Cromarty Firth, Scotland

The Port of Cromarty Firth is a multi-use port in the North of Scotland, catering to the O&G, offshore wind, and hydrogen sectors. The Cromarty Firth has naturally sheltered waters which give it access all year round, and a total of 11ha laydown space capable of storing large wind turbine components.

The port was used for marshalling parts of three commercial-scale wind farms, Beatrice, Moray East and Moray West, and was also used for integration of the UK's first floating offshore wind farm, the Kincardine Offshore Wind Farm. The farm consists of five Vestas 9.5MW and one Vestas 2MW turbine, totalling 50 MW. Kincardine is the world's largest grid-connected floating project, developed by Flotation Energy.

The Port of Cromarty Firth is a trust port, which means that it is managed by a board of members of the local community which aim to reinvest any profit into the port and the region. The port has gradually reinvested over £50 million over the last seven years into land extension, deep water berths and sheltered anchorages that will better service the floating offshore wind industry.

Recognising the opportunity of the floating offshore wind industry in Scotland, the UK Government are also granting over £55 million to the port to further develop its capabilities as a FOW hub. The grant was delivered through the FLOWMIS scheme, which offered a total of £160 million in grant funding to support strategically important FOW ports. The grant is likely to be used alongside further investment from other sources of finance.

The area has been enabled as a hub for the offshore renewables industry through its distinction as a green freeport zone. In this zone normal tax and customs rules do not apply in full. Goods imported to the site pay no upfront import duty meaning that they can be shipped to site without those fees. Tax sites within the zone also offer reliefs on stamp duty, business rates and have enhanced capital allowances for plant and machinery. FOW developers have stated that the freeport makes the project possible, with possible customs payments being enough to make projects unprofitable otherwise.

4.3 Port of Talbot, Wales

The area of Talbot in Wales has shared a striking resemblance to the economic story of Biobío in recent years. Once a highly industrial hub of activity, the area has seen economic decline across recent decades. In 2024, one of the major employers in the area, Tata Steel, was forced to shut down the UK's last blast furnace, forcing the loss of 2,800 local jobs. [23] Tata Steel, in collaboration with the UK and Welsh governments, are investing over £1.25 billion to pivot to a green electric arc furnace and reopen the plant.

Another key element of the area's transition to a green economy is the development of a state-of-the-art floating offshore wind port that would service projects in the Celtic Sea. The project is in its early stages but has been shortlisted for some grant funding under the UK Government's floating Offshore Wind and Manufacturing Investment Scheme (FLOWMIS). [24]

Recent delays to projects in the Celtic Sea have shown that demand certainty is key to fuel the business case for offshore wind ports. Local project success in future auction rounds is likely needed to give the port investors confidence that the development can secure a return on investment. The UK Crown Estate launched a Celtic Sea specific leasing round which is expected to generate a regional pipeline for nearby ports to support the commercial case for development. [25]

5 CONCLUSION

Offshore wind port infrastructure is a significant investment that creates a distinct opportunity for regional economic development. In Biobío, the shutdown of the Huachipato steel plant has led to significant job losses for the region, but the nascent floating offshore wind industry presents a prospect for recovering some employment, including at any potential offshore wind port.

In the region of Biobío, several ports exist with opportunities to develop and adapt to be used for the integration of floating offshore turbines. Other considerations must include the need for wet storage in the area, and need for a port which can conduct repairs on operational turbines, the key factor being a sheltered area with quayside of appropriate depth.

At the strategic level, the targets of authorities and developers must match the requirements of the ports. Modelling of indicative output scenarios considering the ports in Biobío showed that a port with 20ha of laydown space could be capable of delivering up to 585 MW of FOW annually based on weather windows in the area. Other opportunities exist for multi-port strategies and increased development to maximise port throughput.

Economically, projects will lead to economic growth for the region, both through the port development itself and any potential offshore wind farms that can be unlocked through the enabling of the port. This can be quantified through a GVA analysis, indicating the domestic investment that will result from projects at the port. Processing three projects through 10 years in Biobío, the modelling indicated port development could unlock between 3.7 and 6 trillion Chilean pesos from projects developed over the decade.

There are further learnings that can be taken from the UK's experience in deploying an OSW pipeline that today amounts to 37 GW in expected projects by 2030. Economic development has been seen from hubs of offshore wind activity, particularly in the town of Grimsby, which had seen economic decline from the loss of fisheries. This was enabled with certainty of projects in a particular area which justified investment in the local supply chain and port infrastructure. Government grants and freeport zones have been crucial elsewhere in enabling FOW ports like the Port of Cromarty Firth, from which the world's largest grid-connected FOW farm was installed.

While the UK's track record may help to inform stakeholders in Biobío, its present situation also shares distinct similarities with the region in certain respects. The area of Talbot in Wales has seen its blast furnace closed, leading to the loss of 2,800 jobs in the region. Part of the economic development plan considered is the development of the local port to establish a FOW port in the area. The lessons from the UK show that the commercial case for the port depends on the certainty of a regional pipeline and the right financial incentives, but that investment can unlock significant economic activity in a region that needs it most.

The UK is supporting the vision of Port Talbot and other ports to unlock economic impact through a focused leasing round to create a regional pipeline and scaling up its revenue support scheme. It is also leveraging grant schemes and public loans across the UK to ensure that the financial case for the port is viable.

APPENDIX 1 TECHNICAL CRITERIA

Technical viability is the primary and non-negotiable criterion for an offshore wind marshalling port. Regardless of strategic alignment or commercial interest, a port must first be physically capable of accommodating the vessels, components and operational requirements of offshore wind projects.

This includes sufficient water depth and berth length for installation vessels, adequate quay load-bearing capacity for heavy turbine components and cranes, appropriate ground conditions for large laydown areas, and safe navigational access without restrictive air draft or tidal constraints. If these baseline engineering and marine requirements cannot be met—either within the existing footprint or through feasible upgrade works—the port is unlikely to be considered by developers. Technical suitability therefore acts as an initial gateway filter before economic, commercial or financial considerations can be meaningfully assessed.

Within a technical assessment, it is important to distinguish between fixed-bottom and floating offshore wind, as each has materially different infrastructure requirements. Fixed-bottom projects typically require extensive heavy-lift quays, high bearing capacities for monopiles or jackets, and large contiguous storage areas for blades, nacelles and towers, with efficient load-out directly onto installation vessels. In contrast, floating wind places greater emphasis on deep-water access, wet storage or assembly areas, and infrastructure capable of supporting the integration and tow-out of fully assembled floating substructures. Floating projects may require deeper basins, greater manoeuvring space, and mooring or anchoring integration facilities rather than purely heavy quayside strengthening. As a result, ports targeting floating wind may face different capital priorities and cost profiles compared to those focused on conventional fixed-bottom marshalling.

Broadly, there are three types of port used in offshore wind:

- Manufacturing ports for major components – foundations, towers, blades, and nacelles.
- Marshalling ports for coordinating the inventory and distribution of components immediately prior to installation. These ports will also be needed for electrical infrastructure such as substations
- Operations & Maintenance (O&M) ports, which are required near the wind farm to manage its operation throughout its lifetime.

This report chiefly addressed marshalling ports, but O&M ports will also be important as Chile scales up its offshore wind industry. Regular operation can be controlled within a smaller port, needing only a single berth and a facility for operation and storage. Major replacement of FOW is more complicated, and marshalling ports may be used for these operations, as discussed below.

Manufacturing ports may also be utilised in Chile, but proximity to site will be less important. For early projects, it is likely that major components are imported, but if the supply chain is able to cease the opportunities for component manufacturing in Chile, then ports with manufacturing facilities will be needed to offload goods prior to installation.

Ports will also be needed for other parts of the installation process, including for the fabrication and storage of substation topsides, and the storage of cables.

6.1 Logistics of an Offshore Wind Marshalling Port

The requirements of an offshore wind marshalling port ultimately depend on the needs and practices of offshore wind installation.

Offshore wind construction is a complex logistics process involving the serial manufacture, transport, integration, and installation of very large components. Ports form key nodal junctions within this process, and their design and location determine the efficiency and throughput of the process, effectively limiting the annual deployment or throughput capacity (GW/year).

Components such as blades or towers are manufactured at a dedicated quayside ‘manufacturing port’ before being shipped to the marshalling port on a barge. They are typically manufactured and shipped in batches from separate ports which each have a manufacturing facility produce one component type. A wide variety of commercial shipping vessels are used for moving components between ports, often requiring bespoke and expensive sea fastening fixtures which are not always reused. Port operators will need to make sure that these vessels can be catered for at port, and that components can be safely offloaded.

In traditional fixed-bottom wind farms, components are stored at the marshalling port temporarily prior to being loaded onto a specialised Wind Turbine Installation Vessel (WTIV), which is a type of Jack Up Vessel (JUV). JUVs ‘jack-up’ by lowering metal ‘legs’ onto the seabed, giving the vessel stability to lift components with onboard cranes. WTIVs are expensive, specialised vessels which command rates of over $500k per day, though this price has been subjected to spikes from demand. [26]

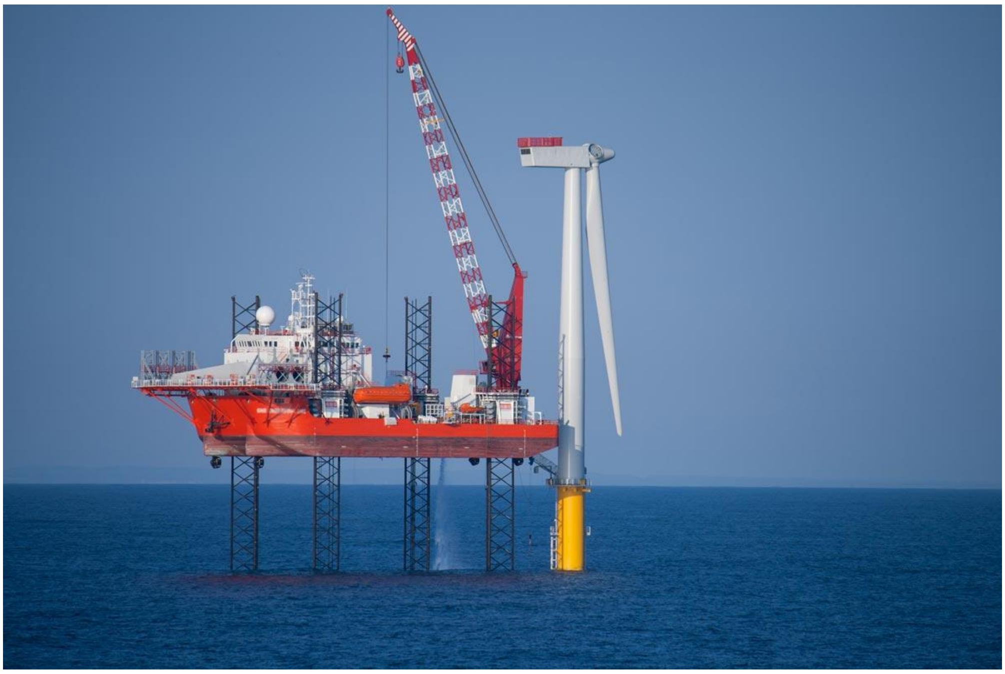


Figure 11: Installation of blades by a JUV. [27]

The WTIV carries out the offshore construction of the wind turbine, typically transporting the components for between four or six turbines at a time, before returning to the marshalling port to collect another batch of components.

This offshore wind farm Construction and Installation (C&I) workflow (Figure 12) has been proven extensively and is almost universally employed for fixed turbines, however there are questions about the efficiency of this approach, and whether it can be scaled up to achieve deployment targets as many countries around the world seek to reach targets for 2030.

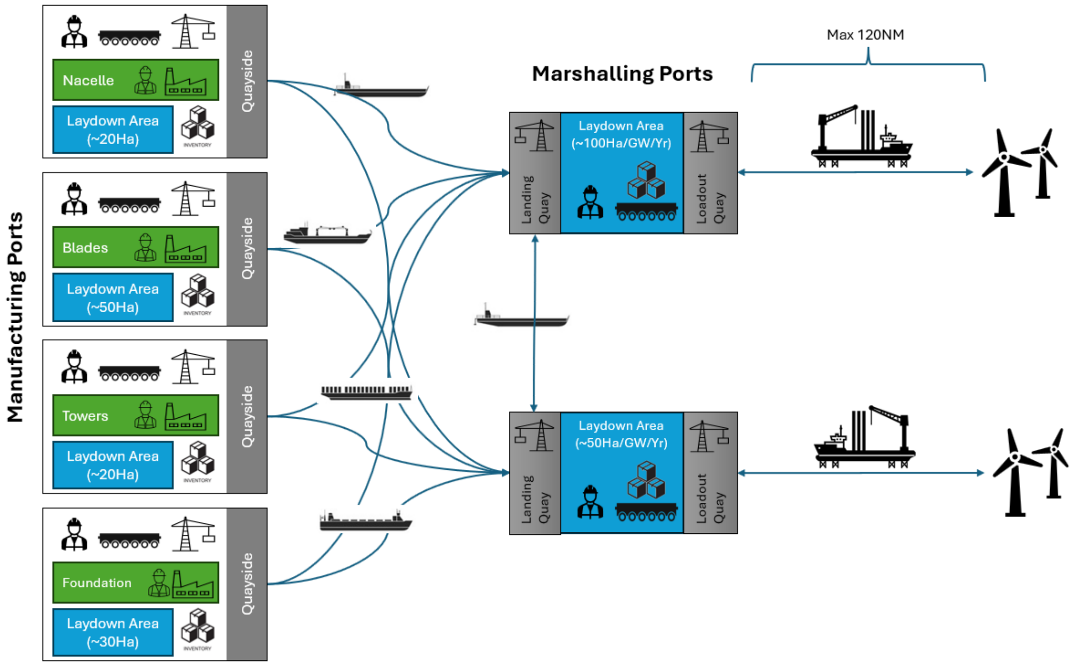


Figure 12: Diagram of the typical installation process.

For floating wind, the installation workflow operates differently from the established procedures used in fixed-bottom installation, due to the need to transport large floating foundations over sea that cannot easily be transported or lifted to be stored on land.

Floating foundations will need to be towed or shipped to port, likely using tugs or specialised barges that can lower foundations into the water upon arrival. It is generally agreed that foundations will need 'wet storage' near the port.

6.2 Criteria for an Offshore Wind Port

The spatial requirements of the port depend on the shape of the port itself. Table 6 shows the minimum requirements of an OSW marshalling port, which may be different for fixed and floating farms.

Table 6: Requirements for an OSW marshalling port, including information from ORE Catapult and the Carbon Trust. [28]

Characteristic	Requirement - Fixed	Requirement - FOW	Comment
Port depth	9m	12-20m	Dependent on floater type.
Approach channel depth	7m	11-18m	Dependent on floater type.
Berth Quay length	200-300 m	400-500m	
Quay loadbearing capacity	>25te/sqm		
Heavy lift quay side area	1,500 sqm		Per berth
Seabed suitability	ISO 19905-1		Assessment of suitability for Jack Up vessel
Component handling equipment	Lo-Lo: Heavy Lift (>2 x 80te cranes)		
Storage loadbearing capacity	>10te/sqm		
Minimum laydown space	Staging – 10ha for 100 MW Manufacturing - 7ha for 100 MW		Requirements increase with size of turbine and farm.
Wet storage space (floating OSW only)	N/A	10-12 ha	For storing floating substructures prior to assembly.
Overhead clearance to sea	100m	Unrestricted	To allow vertical shipment of towers.
Distance from wind farm	Ideally <150 nautical miles		Towing of FOWTs has been achieved up to 700km, at high cost.

There should also be some consideration for future-proofing a port development as the requirements for servicing the industry change over time. In offshore wind, the size of components has grown significantly since the first large projects, and the standard size of turbine has grown from 2-3 MW to 15 MW. This growth has naturally increased the need for stronger quaysides and greater yard space, making some of the original ports that serviced offshore wind no longer fit for purpose, and moving the industry standard towards specialised ports that focus primarily on handling renewable logistics.

For fixed-bottom the needs of future turbines are generally understood as the industry is unlikely to move beyond turbines of 15-20 MW in the near future, but for floating wind the technology, which will likely needed in Chile, is still developing at pace. Changes to standard foundation type and size could have an impact on the setup of the port, the requirements for strength and size, and the equipment used to handle foundations. Developments across coming demonstration and commercial projects will be important to observe for prospective FOW ports while the industry moves to standardise technology and scale up operations.

Displayed in Figure 13 is a layout of a typical marshalling port, using the example of the Port of Esbjerg in Denmark, an Offshore Wind marshalling hub for the North Sea. Port operators estimate that the 450-hectare port could be used for marshalling approximately 4.5GW annually, at full capacity. Esbjerg is unique: an offshore wind port of this magnitude is infeasible and unnecessary for the Chilean offshore wind pipeline, as most project are served successfully by much smaller ports, but its scale is useful to show the necessary elements of a well-functioning offshore wind port.

Figure 13: Illustration of sections at a marshalling port, the Port of Esbjerg in Denmark. [29]

The layout shows the port to have the following features:

1. Berth(s): at least two, so loading and unloading can be done simultaneously. More berths allow for greater flexibility in operations, and for loading and unloading to be done in tandem.
2. Loading/Unloading Zone:
    a. Per berth, length of ~225m with at least 50m of room to operate behind it (11,250sqm)
    b. Water depth of >9m for fixed, and >12m for floating
3. Assembly Building: insulated hall for pre-assembly and storage of electrical components, taking up 1000sqm.
4. Warehouse: an uninsulated hall used for storage of smaller components, tools, and consumables, packed with racks and space for loading - 2000sqm
5. Facilities:
    a. Administration building to host offices for staff - ~1000sqm
    b. Support facilities for crew including locker rooms and welfare - ~2000sqm

c. Parking - ~2000sqm

This equates to 2 hectares of used space, with an additional 1.125 used for every extra berth beyond the first. The remainder of the space is used for component laydown storage and routes for manoeuvrability. At the least, this should require enough space for a set of turbine components laid down, with space in between each component, for appropriate vehicles to move them.

Nacelles will be stored in rows (Figure 14), with room nearby to position a crane and flatbed for transport. For fixed foundations, monopiles will be laid down horizontally and densely packed together, and jackets will be stored standing vertically. Blades are placed into dedicated stands, tightly packed together, lengthways, where possible. Towers may also be stored horizontally in up to three sections until they are assembled into one tower, after which they may be stored vertically, ready to be lifted on to the installation vessel.

Figure 14: Marshalling of nacelles for the DanTysk windfarm at the Port of Esbjerg. [30]

Given the requirements for manoeuvrability, it is expected that only one quarter to one third of the total laydown space may be fully utilised for components. Using blade stands to stack three together can reduce spatial requirements.

Space becomes a severely limiting factor when it comes to storing and moving components within the timeframes required for a project. In the European market, it is common for multiple ports to be used for marshalling a single project. For example, if space at nearby ports is limited, components can be stored at a larger staging port such as Esbjerg in Denmark. It is also common that different ports are used to stage different components of the farm such as the cables, foundations, and turbines.

In terms of cranage, requirements depend on the part of the installation process and the components being moved:

1. Load-out of components from manufacturing facilities onto transportation barges.

   This is done with a mix of cranes at the quayside and by using Roll-on/Roll-of (RoRo) methods for specifically designed vessels and SPMTs which drive the components into place.

2. Load-on of components from transportation barges into marshalling ports.

    As above, this can be done with a crane or RoRo.

3. Load-out of components from marshalling ports to installation vessel.

    If the crane is in place, it can save time to use the crane for lifting instead of the JUV itself. However, since the JUV is contracted for lifting components it will be capable of doing so without the crane.

Towers and nacelles will generally be loaded using RoRo or mobile cranes. Blades will require cranes due to their shape and length, with crawler or gantry cranes being the most practical for the type of lift required (see Figure 15). Monopiles could be rolled with an SPMT onto a barge, but modern jackets are generally lifted using large cranes including ring cranes, or those on JUVs. As components get larger and rolling operations become more challenging, there is scope for heavy-lift cranes to be used more widely in fixed offshore wind.

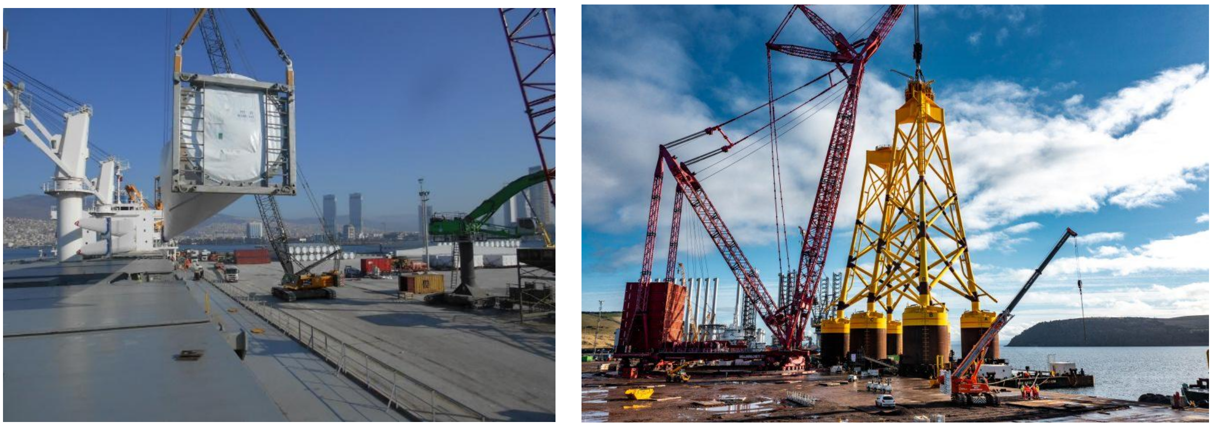


Figure 15: Loading of a blade onto a transport vessel (credit: Van Ameyde Marine [6]) and a jacket into the Port of Nigg (credit: SOWPA [32])

For floating wind, assembly operations are expected to occur at the quayside, as has been done for several demonstration projects. Handling the floating offshore wind turbine (FOWT) in place for the assembly operation presents several challenges. The FOWT must be securely held against the quayside, even in strong weather conditions. This requires bollards with significant capacity (150-200 tonnes), often spaced closely together to match the foundation's mooring points. Such bollards are rare in most ports and would likely need prior investment. Additionally, significant fendering is required to keep the foundation from the quayside, with analysis suggesting that a spacer barge may be the most optimal solution.

Lifting the components for assembly will also be a challenging aspect of the assembly operation due to the large masses involved, particularly for next-generation wind turbines of 15 MW and above. For large components, a ring crane will be needed to lift the components in place for connection. Ring cranes of the magnitude needed for lifting next-gen turbines are rare, and port developers may benefit from engaging crane providers at an early stage to procure them.

There are five instances in the public domain found of land-based ring cranes capable of lifting over 4,500 tonnes, supplied by Mammoet, Sarens, and Sany Heavy Industry. Input from an industry stakeholder also revealed that Sarens are developing an innovative technique for offloading semi-submersible foundations from a manufacturing facility into a dry dock using a combination of SPMTs (Self-Propelled Modular Transporters) and specialised gantry cranes. Mammoet also have a design on their books for a 10,000-tonne land-based crane (the SK10000). Although, there is no public news on the company taking this project forward since they took over ALE, the original designers, in 2020.

Companies such as Heavy Lift Projects have also designed specialised cranage for the offshore wind industry that are made to be modular for faster mobilisation. Companies like HLP expect that once demand for floating wind reaches commercial scale, the manufacturing demand for heavy lift cranes will be substantial.

6.3 Wet Storage for Floating Offshore Wind

Wet storage refers to the practice of storing large offshore wind components in the water, either temporarily or for extended periods, rather than onshore within the port.

Floating substructures require a lot of space to store and transferring them on to land will be logistically challenging. When a turbine is assembled, it is key that the next foundation is at the port ready for assembly. Otherwise, it will need to be transported at sea to the marshalling port, and this just-in-time assembly strategy leads to a high risk of delay from bad weather given the size of the component and the speed at which it gets transported.

It is therefore generally agreed within industry that wet storage is a necessary element of the floating offshore wind installation process to create a streamlined ‘assembly line’ for turbines. Slower installation timelines lead to delayed revenues which can make investment untenable. Figure 16 shows wet storage in the dry dock at the Port of Cromarty Firth being used prior to tow-out for the Kincardine wind farm.

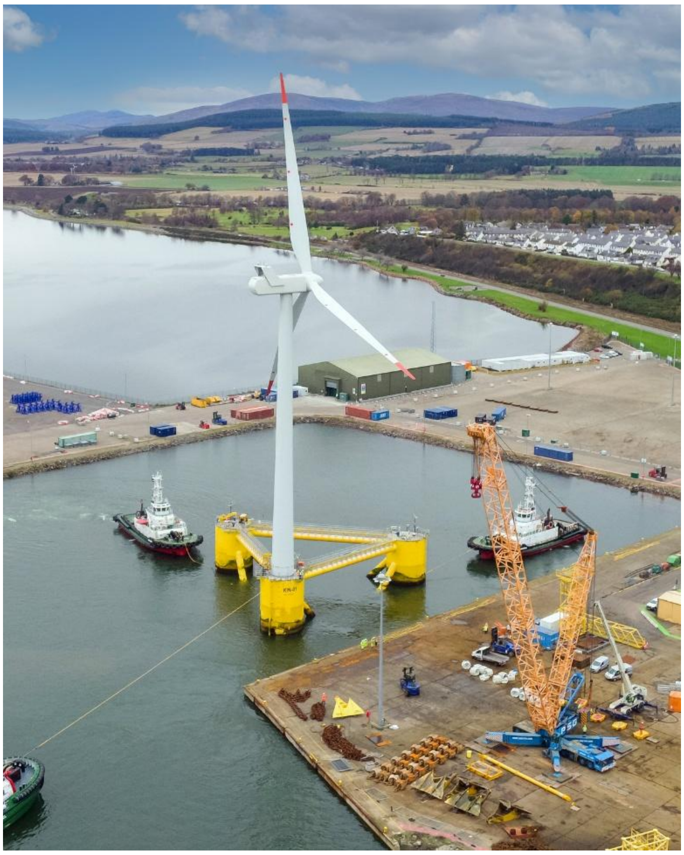


Figure 16: Wet storage of a turbine for the Kincardine project at the Port of Cromarty Firth. Courtesy: Kincardine Offshore Wind.

From a cost perspective, wet storage shifts expenditure from heavy civil reinforcement toward marine infrastructure and operational management. While it reduces the need for high-specification quays and extensive hardstanding, it introduces requirements for dredging, mooring systems, navigational safety measures, marine insurance, and ongoing monitoring. Managing any interaction with weather could also become more challenging, and operational logistics of tending to wet-stored components become much more complex.

6.4 Demands of Floating Offshore Wind Operations

The failure of a major component in a floating wind turbine is likely to require a Tow-To-Port (TTP) solution, which places an additional requirement for a port during the lifetime of a project that does not exist for fixed-bottom projects. The industry is working on innovate solutions to this problem. Although an in-situ replacement was successfully performed at the Kincardine test site, industry opinion is divided on the reproducibility of such interventions for other floating wind scenarios. The needs of a port servicing floating turbines would be similar those of a marshalling port, without the requirement of a large laydown space for batches of components.

A TTP operation is complex and requires the coordination of several parties for each of the operation's steps. Initially, the fault must be confirmed as requiring a TTP intervention, and the entire operation must be thoroughly planned. The actual operation involves several steps: (a) the disconnection of mooring lines and the dynamic cable, (b) the tow to port, (c) the in-port operations, and (d) the tow-out and reconnection of the mooring system and dynamic cables. There is heavy reliance on the availability of the quayside and necessary handling equipment at the port.

Once the vessels and cranes are identified, detailed engineering of the TTP process using those assets is required, along with contracting the service providers. This process is expected to take, in the most expedited case, 1-2 weeks, but could extend to as long as 4 months, potentially creating a large period of unavailability for the wind turbine. This makes for an uncertain commercial case for a port, so solutions should be established early on between developers and authorities.

It has also been suggested in industry that a specialised 'Major Component Replacement Hub' could be the shared responsibility of FOW operators, but the concept of such a 'TTP club' has not yet been fully explored in markets where commercial-scale FOW is emerging.

7 LIST OF FIGURES AND TABLES

8 REFERENCES

[1] Puerts de Talcahuano, [Online]. Available: https://www.puertotalcahuano.cl/.

[2] Mundo Maritimo, "Talcahuano Ports Focuses Efforts on the San Vicente Port Concession," 1 September 2025. [Online]. Available: https://www.mundomaritimo.net/noticias/talcahuano-ports-focuses-efforts-on-the-san-vicente-port-concession.

[3] Stiesdal Offshore, "TetraSub 5x1: Industrial Scale Now," November 2025. [Online]. Available: https://www.stiesdal.com/wp-content/uploads/2025/11/Stiesdal-Offshore-5x1-strategy-for-large-scale-floating-wind.pdf.

[4] Forres Gazette, "Hundreds across Moray and Nairn attend Moray Flow Park public meeting," 12 November 2025. [Online]. Available: https://www.forres-gazette.co.uk/news/passions-running-high-as-more-than-600-attend-moray-flow-p-419235/.

[5] The Scotsman, "Group behind controversial Moray FLOW-Park plans pull out of public meeting over 'safety concerns' for staff," 11 November 2025. [Online]. Available: https://www.scotsman.com/regions/aberdeen-and-north-east/moray-flow-park-meeting-safety-concerns-5395984.

[6] The Crown Estate, "Changes to fishing practices around the UK as a result of the development of offshore windfarms," August 2016. [Online].

[7] The Crown Estate, "Changes to fishing practices around the UK as a result of the development of offshore windfarm - Phase 1," August 2016. [Online]. Available: https://maritime-spatial-planning.ec.europa.eu/practices/changes-fishing-practices-around-uk-result-development-offshore-windfarm-phase-1#:~:text=This%20study,%20conducted%20by%20the,are%20not%20legally%20obliged%20to..

[8] The Crown Estate, "The Fishing Liaison with Offshore Wind and Wet Renewables Group," 2023. [Online]. Available: https://www.thecrownestate.co.uk/our-business/marine/the-fishing-liaison-with-offshore-wind-and-wet-renewables-group. [Accessed 20 February 2026].

[9] The Fishing Liaison with Offshore Wind and Wet Renewables, "Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds," August 2015. [Online].

[10] Cerulean Winds, "Aspen's Floating Wind Delivery Consortium to Deliver Thousands of Jobs and Billions in UK Investment," 12 May 2025. [Online]. Available: https://ceruleanwinds.com/aspens-floating-wind-delivery-consortium-to-deliver-thousands-of-jobs-and-billions-in-uk-investment/.

[11] UK Government, "Job estimates for wind generation by 2030: methodology note," 23 June 2025. [Online]. Available: https://www.gov.uk/government/publications/renewable-technologies-future-job-estimates-methodology/job-estimates-for-wind-generation-by-2030-methodology-note.

[12] RenewableUK, “Wind Industry Skills Intelligence Report,” June 2025. [Online]. Available: https://www.renewableuk.com/media/jvsdey0k/ruk-owic-offshore-wind-skills-report_2025.pdf.

[13] Argus Media, “Chile seeks investment to phase out coal plants,” 2 October 2025. [Online]. Available: https://www.argusmedia.com/en/news-and-insights/latest-market-news/2738407-chile-seeks-investment-to-phase-out-coal-plants.

[14] F. A. Bello, “Chile’s largest steel plant closes due to Chinese competition,” 17 September 2024. [Online]. Available: https://www.fundacionandresbello.org/en/news/chile-%F0%9F%87%A8%F0%9F%87%B1-news/chiles-largest-steel-plant-closes-due-to-chinese-competition/.

[15] A. E. Gabriela Brumatti, “Chile launches economic strengthening plan in wake of steelmaker Huachipato closure,” 19 September 2024. [Online]. Available: https://www.fastmarkets.com/insights/chile-launches-economic-strengthening-plan-in-wake-of-steelmaker-huachipato-closure/.

[16] Ministry of Economy, Development, and Tourism, “Plan de Fortalecimiento Industrial del Biobío,” 16 September 2024. [Online]. Available: https://www.economia.gob.cl/wp-content/uploads/2024/09/plan-de-fortalecimiento-industrial-del-biobio.pdf.

[17] Banco Central Chile, “Chile's National Accounts Parent Input - Output,” 2022. [Online]. Available: https://www.bcentral.cl/en/areas/statistics/matriz-insumo-producto/cuadros-mip-excel.

[18] Green Alliance, “Growing the UK’s coastal economy; Learning from the success of offshore wind in Grimsby,” November 2021. [Online]. Available: https://green-alliance.org.uk/wp-content/uploads/2021/11/Growing_the_UKs_coastal_economy.pdf.

[19] Aura Innovation, “Impact of Green Port Hull boosts growth of the local economy,” 6 December 2017. [Online]. Available: https://aura-innovation.co.uk/impact-of-green-port-hull-boosts-growth-of-the-local-economy-impact-of-green-port-hull-boosts-growth-of-the-local-economy/.

[20] OffshoreWind.biz, “Port of Grimsby Gets GBP 5 Mln to Become Offshore Wind Hub,” 05 February 2025. [Online]. Available: https://www.offshorewind.biz/2014/10/02/port-of-grimsby-gets-gbp-5-mln-to-become-offshore-wind-hub/.

[21] Ørsted, “Transforming coastal communities,” [Online]. Available: https://orsted.co.uk/energy-solutions/offshore-wind/transforming-communities.

[22] T. Pick, “Independent Report of the Offshore Wind Champion,” UK Government, 2023.

[23] Wales Online, “Full scale of Port Talbot redundancies at Tata Steel made public for the first time,” 1 October 2025. [Online]. Available: https://www.walesonline.co.uk/news/wales-news/full-scale-port-talbot-redundancies-32586198.

[24] Associated British Ports, “Future Port Talbot,” 2026. [Online]. Available: https://abports.co.uk/future-port-talbot/.

[25] The Crown Estate, “Floating Offshore Wind Leasing Round 5,” November 2025. [Online]. Available: https://www.thecrownestate.co.uk/our-business/marine/round-5.

[26] TradeWinds, “Rates hit $525,000 for turbine installation ships as activity survives headwinds, Clarksons says,” 9 December 2025. [Online]. Available: https://www.tradewindsnews.com/offshore/rates-hit-525-000-for-turbine-installation-ships-as-activity-survives-headwinds-clarksons-says/2-1-1913387.

[27] ABL Group, “Jack-Up & Wind Farm Installation Vessel Support,” [Online]. Available: https://abl-group.com/abl/consulting-and-engineering/jack-up-and-wind-farm-installation-vessel-support/.

[28] Carbon Trust, “Unlocking the potential: Challenges and opportunities for South Korean offshore wind supply chain,” 2023.

[29] MNRE, DEA, “India Offshore Wind Ports Study,” Centre of Excellence for Offshore Wind and Renewable Energy, 2023.

[30] Welt Documentary, “Wind Farm Assembly Off The Coast Of Sylt,” 2022. [Online]. Available: https://www.youtube.com/watch?v=RqdE53JhJ4E&t=1326s.

[31] Van Ameyde Marine, “Blade Runner - the Loading of Wind Turbine Blades on Bulk Carriers,” 9 August 2024. [Online]. Available: https://www.ameydemarine.com/news/blade-runner-the-loading-of-wind-turbine-blades-on-bulk-carriers-46947/. [Accessed 15 September 2025].

[32] Scottish Offshore Wind Ports Alliance, “Port of Nigg,” 2024. [Online]. Available: https://sowpa.co.uk/our-ports/port-of-nigg. [Accessed 15 September 2025].

[33] O. Catapult, “Tow To Port Offstation Management,” ORE Catapult, Glasgow, 2024.

[34] EPPI Centre, IMF, “CCEMG - EPPI-Centre Cost Converter, using IMF data,” 2024. [Online]. Available: https://eppi.ioe.ac.uk/costconversion/.

CATAPULT
Offshore Renewable Energy

GLASGOW

Inovo

ORE Catapult
121 George Street
Glasgow
G1 1RD

+44 (0) 333 004 1400

BLYTH

National Renewable Energy Centre

Offshore House
Albert Street
Blyth
Northumberland
NE24 1LZ

+44 (0) 1670 359555

LEVENMOUTH

Levenmouth Development Turbine

Energy Park Fife

Links Drive
Leven
Methil
Fife
KY8 3RA

GRIMSBY

O&M Centre of Excellence

ORE Catapult
Port Office
Cleethorpe Road
Grimsby
DN31 3LL

ABERDEEN

Floating Wind Innovation Centre (FLOWIC)

ORE Catapult
W-Zero-1
Energy Transition Zone
Altens Industrial Estate
Hareness Road
Aberdeen
AB12 3LE

CORNWALL

Hayle Marine Renewables Business Park

ORE Catapult
North Quay
Hayle
Cornwall
TR27 4DD

PEMBROKESHIRE

Marine Energy Engineering Centre of Excellence (MEECE)

Bridge Innovation Centre
Pembrokeshire Science & Technology Park
Pembroke Dock
Wales
SA72 6UN

LOWESTOFT

OrbisEnergy

ORE Catapult
Wilde Street
Lowestoft
Suffolk
NR32 1XH

EMAIL US
info@ore.catapult.org.uk

VISIT US
ore.catapult.org.uk

ENGAGE WITH US
Instagram: @ore.catapult
LinkedIn: Offshore Renewable Energy Catapult
Twitter: @ORECatapult
YouTube: @orecatapult