CARBON TRUST | OFFSHORE WIND

REPORT

Unlocking the potential

Challenges and opportunities for South Korean offshore wind supply chain

December 2023

In partnership with

Plan 1.5

Acknowledgments

The Carbon Trust and Plan 1.5 wrote this report based on an impartial analysis of primary and secondary sources, including expert interviews.

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For the avoidance of doubt, this report expresses independent views of the authors.

Who we are

The Carbon Trust

Our mission is to accelerate the move to a decarbonised future.

We have been climate pioneers for more than 20 years, partnering with leading businesses, governments and financial institutions globally.

From strategic planning and target setting to activation and communication - we are your expert guide to turn your climate ambition into impact.

We are one global network of 400 experts with offices in the UK, the Netherlands, South Africa, China, Singapore and Mexico. To date, we have helped set 200+ science-based targets and guided 3,000+ organisations in 70 countries on their route to Net Zero.

Plan 1.5

Plan 1.5 is a non-profit organization that focuses on policy advocacy for stronger and more effective climate policies in Korea. Plan 1.5 is established based on the strategic observation that policy engagement is the most urgently needed missing piece in the climate activism scene. Plan 1.5 seeks to effectively strengthen climate policies and expand and empower the climate movement in Korea and beyond.

The Carbon Trust's mission is to accelerate the move to a decarbonised future.

Plan 1.5 aims to align Korea's greenhouse gas reduction pathway with the 1.5 degrees target

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Abbreviations

AI	Artificial Intelligence
CfD	Contract for Difference
DPPAs	Direct Power Purchase Agreement
EBL	Electricity Business License
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
FIT	Feed-in-Tariff
FTE	Full Time Equivalent
GESI	Green Energy Strategy Institute
GW	Gigawatt
GWEC	Global Wind Energy Council
GWO	Global Wind Organisation
KAIST	Korea Advanced Institute of Science and Technology
KEPCO	Korea Electric Power Corporation
KETEP	Korean Energy Technology Evaluation and Planning
KPX	Korea Power Exchange
LCOE	Levelised Cost of Energy
LCR	Local Content Requirements
LiDAR	Light Detection and Ranging
METI	Ministry of Economy, Trade and Industry
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOTIE	Ministry of Trade, Industry and Energy
MOU	Memorandum of Understanding
MW	Megawatt
OEMs	Original Equipment Manufacturers
OSW	Offshore Wind
PPA	Power Purchase Agreement
PWOP	Public Waters Occupancy Permit
R&D	Research and development
RECs	Renewable Energy Certificates
ROV	Remotely Operated Vehicle
RPS	Renewable Portfolio Standard
STEM	Science, Technology, Engineering and Maths
WISET	Women in Science, Engineering and Technology
WTIV	Wind Turbine Installation Vessel

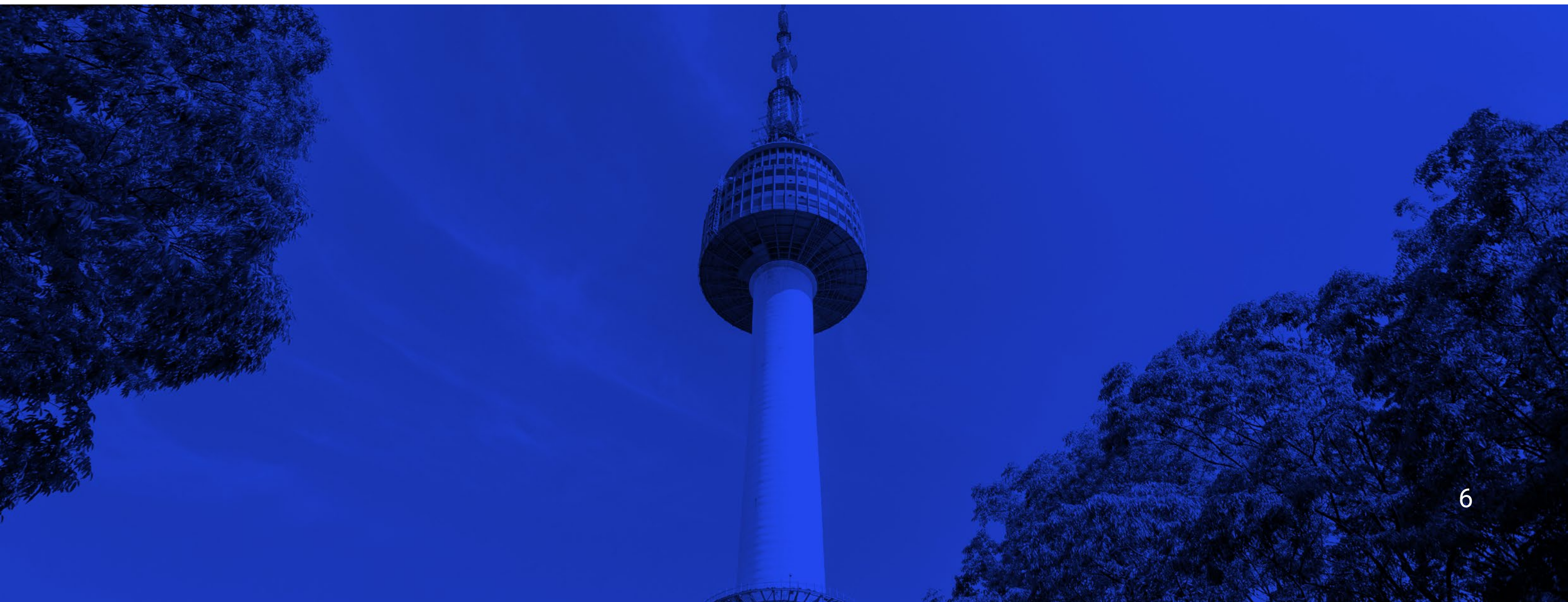
Executive summary

South Korea's Offshore Wind (OSW) industry is rapidly evolving to support the nation's transition towards a cleaner and more sustainable energy future. The government's 2017 commitment to achieving 20% solar and wind power generation by 2030, along with the ambitious goal of installing 14.3GW of OSW capacity by the same year, marks a defining moment in South Korea's energy landscape. However, as of 2023, the country only has 140MW of installed fixed bottom OSW capacity, highlighting the significant effort required to reach the 14.3GW target.

Crucial to achieving this target is the readiness of the OSW supply chain, responsible for delivering the components and services vital for the construction of OSW projects. South Korea's local supply chain, while promising, requires substantial development to meet the demands of the Renewable Energy 3020 Implementation Plan. As such, this report provides an in depth analysis of South Korea's OSW supply chain and assesses its readiness to meet these targets.

Key insights

- The current South Korean offshore wind pipeline is extremely healthy. Reviewing the pipeline suggests that **South Korea has sufficient capacity in the pipeline to meet the 14.3GW by 2030 target**, and to reach nearly 25GW by 2035. Whilst the pipeline is healthy, these deployment targets will be met only if these projects in early development can progress to construction and operation with wider supportive policy frameworks and adequate supply chain support.
- **The cumulative investment required to achieve nearly 25GW of installed capacity is projected to be in excess of £80 billion** (approximately KRW 132 trillion) by 2035. This substantial investment represents a significant opportunity for the local supply chain.
- While South Korea demonstrates significant potential in the floating OSW sector, **the majority of construction activities through 2035 are expected to focus on fixed bottom OSW installations.**
- Currently, **the local supply chain is still nascent** with the largest amount of specialisation from local companies seen in the development and consenting stages, indicating the potential to grow across other parts of the supply chain such as installation, commissioning, turbine supply, balance of plant, and operations and maintenance.
- Local firms do demonstrate existing **strengths across tower supply, secondary steel works, electrical systems, and cable and substation manufacture** from their involvement in onshore wind as well as OSW adjacent sectors such as shipbuilding.
- Challenges within the supply chain include **technical capability deficiencies** in turbine supply (blades and nacelle) when compared to international competitors. The Balance of Plant segment might face **competition from low cost alternatives** originating from other countries.



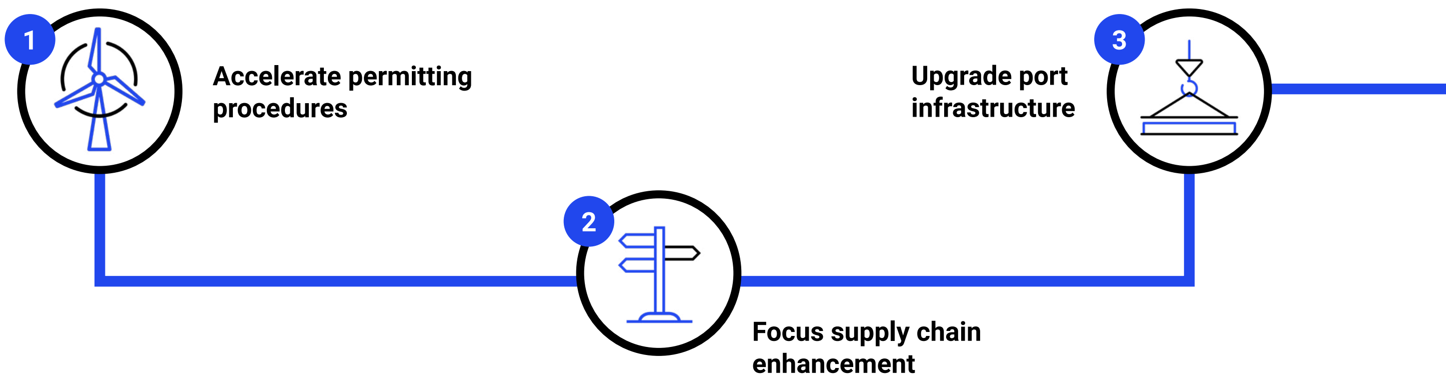
- Multiple ports in South Korea are **capable of providing services for both offshore wind installation, and operations and maintenance.** However, **further infrastructure upgrades to specialise ports for offshore wind construction** will be necessary to optimise operations and minimise the Levelized Cost of Energy (LCOE).
- The OSW industry presents an **opportunity to create over 150,000 direct jobs by 2035** from the domestic pipeline alone, benefitting both the local and international workforce. In order to enable a greater proportion of these jobs to be established locally, investment in retraining programmes to facilitate an effective skills transition will be vital.

Recommendations

To fully realise the potential of South Korea's OSW market, the report proposes the following recommendations for the South Korean government:

1. **Accelerate permitting procedures to deliver a stable construction pipeline and increase market certainty:** Whilst the pipeline for OSW projects in South Korea is healthy, there is uncertainty around permitting requirements that can discourage investment in the supply chain. The most important element for promoting OSW supply chain growth in South Korea is to establish a clear construction pipeline of projects, with consistent demand for supply chain services and predictable, streamlined administrative processes that support timely and efficient deployment of OSW projects in the pipeline. The key barrier at present to achieving this is slow and uncertain permitting procedures. If a streamlined approach is implemented, then a transition mechanism should be considered to manage projects that are progressing under current permitting procedures.
2. **Focused supply chain enhancement to capture local and regional opportunities:** South Korea's supply chain is well positioned to support the wider Asian region in OSW development, and at present competition from regional competitors is limited. However, regional competitors are acting to grow their own supply chains, and delay in this sector could mean that South Korea misses the regional export opportunity.

   Capitalising on supply chain strengths by creating technology roadmaps, particularly in areas such as data analytics and digitalization can drive innovation and efficiency. It is important to allocate substantial resources to research and development in critical areas such as floating wind, substructure mass fabrication, and port infrastructure to drive innovation and competitiveness.
3. **Deliver required port infrastructure upgrades:** Despite the large opportunity for South Korean ports, specific challenges emerge as a result of limited facilities, particularly for staging. To prevent



infrastructure bottlenecks, prompt development of installation ports is necessary. Current plans for offshore wind expansion are limited to Mokpo, which insufficiently meets projected demands. Urgent discussions for ports in Gunsan, Ulsan, and Incheon are necessary to align planning and implementation development of ports with OSW installation schedules.

4. **Create a skills development plan and upskill local workforce to support OSW projects:** Collaborate with academia and training institutions to establish a comprehensive skills development plan tailored to meet the evolving OSW industry's requirements, with a particular emphasis on maritime and marine skills. This will enable the local workforce to meet growing supply chain needs.

5. **Strategic approach for promotion of local supply chain competitiveness:** Whilst objectives for local supply chain content and community benefits are common for governments when implementing OSW policy, decisions to implement such policy should be cognisant of the trade-offs that they can bring. Flexibility in supply choice for project developers can support faster deployment, reduced costs, higher reliability, and reduced environmental impact. International examples show that implementing strict local content requirements can decelerate OSW development. A strategic approach is required for LCR in consideration of the balance between efficient deployment of OSW and enhancing the competitiveness of local supply chain, as well as softer approaches such as inclusion of supply chain plans.

Developing and implementing policies that empower local suppliers to deliver cost effective components, meet demanding timelines, scale their production capacity, and innovate to drive competitiveness is vital. Policies should be aware of technology transfer needs from international markets where local capability is lower, including supporting international Original Equipment Manufacturers (OEMs) to develop local manufacturing facilities and creating local jobs where necessary.

Upskill local force through skills development plans

Promote local supply chain competitiveness

1. Introduction

The offshore wind (OSW) industry in South Korea is rapidly emerging as a key player in the country's transition towards a cleaner and more sustainable energy future. In 2017, the Korean government announced its intention to increase the share of solar and wind power generation up to 20 percent by 2030 in the Renewable Energy 3020 Implementation Plan. The government also set a separate goal of installing 12GW of OSW by 2030.[1] The target has been expanded to 14.3GW by 2030 in the 10th Basic Plan on Electricity Supply and Demand (**the "Plan"**), which was released in January 2023.[2]

Since then, the government has been updating these policy goals as part of its broader efforts to revise its climate and energy policies. As of 2023, South Korea has around 140MW of installed fixed bottom OSW, with the largest individual project being the 60MW Southwest Offshore Demonstration.[3] Therefore, almost the entire 14.3GW capacity is still required to be constructed before 2030 to meet this target.

A critical component in the delivery capability of this target will be the supply chain, which will be required to deliver the components and services to build OSW projects to 2030 and beyond. The South Korea local supply chain is well-positioned to play a significant role in meeting this target, but it still requires significant development. To support this endeavour, the Carbon Trust has partnered with Plan 1.5 to assess the supply chain readiness of the South Korean OSW industry in realising the ambitious OSW target set forth in the Plan.

This study is delivered in the context of a global supply chain bottleneck. The OSW sector has established a global supply chain, but extremely high demand has meant that the supply chain is constrained, with long lead times for projects. Manufacturers are facing financial difficulties due to multiple factors including high inflation; increasing costs of raw materials; and capital expenditure squeezing profit margins.

Across various markets, slow and inconsistent permitting timelines are creating delays, and projects are not being constructed to their proposed schedules, which creates uncertainty on project timings and longevity. In addition, there is a global skills shortage, with less time to grow the workforce, facilities, and innovations. Therefore, measures to improve supply chains within local markets can ease global supply chain pressures and facilitate OSW market growth.

This report serves as an assessment of the OSW supply chain in South Korea and proposes measures that should be taken to realise the objectives of the Plan. By analysing the current state of the industry and identifying the key opportunities and challenges, this report aims to provide valuable insights and actionable recommendations for both policymakers and industry stakeholders to act upon.

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[1] MOTIE, "Offshore Wind Development Plan", 17 July 2020 [KOR]

[2] Electric Power Journal, "Targets 28.9% of renewable energy generation, including wind power, in 2036", 12 January 12 2023 [KOR]

[33] Source: 4COffshore Database

The objectives of the report are to:

- **Explore the current status of the OSW market in South Korea**: This report examines various aspects such as the state of the industry, relevant policies in South Korea, and the OSW farm development process to add context to the recommendations.

- **Assess the supply chain readiness to realise the objectives of the Plan**: The primary objective of this report is to assess the supply chain readiness of the OSW industry in South Korea in realising the Plan. It aims to evaluate the current state of the supply chain, identify gaps and opportunities, and propose measures to enhance its capabilities and capacities to reach ambitious OSW installation targets.

- **Identify opportunities and challenges**: By mapping and analysing the OSW supply chain, evaluating infrastructure, assessing labour and skills, and reviewing community benefits, the report aims to identify opportunities for growth, potential challenges, and areas that require improvement. This information can help stakeholders make informed decisions and take necessary actions to address these opportunities and challenges effectively.

- **Learn from international experiences**: The report includes a review of lessons and initiatives implemented in other OSW markets. By learning from international experiences and identifying best practices, the report aims to provide insights that can strengthen the domestic supply chain in South Korea.

- **Provide actionable recommendations**: Based on the analysis and findings, the report concludes with a set of recommendations. These recommendations are intended to guide policymakers and industry players in implementing suitable strategies and policies to maximise the potential of the South Korean OSW market. The goal is to provide actionable steps that can foster the growth and development of the industry while addressing the identified opportunities and challenges.

2. Market overview of the South Korean offshore wind industry

Key takeaways

- ✓ **National targets:** In 2017 the South Korean Government set ambitious targets for renewables, aiming for 20% by 2030, which includes 16.5GW of wind power capacity to be added. A specific target for OSW was recently updated under the 10^{th} Basic Plan on Electricity Supply and Demand at 14.3GW by 2030.
- ✓ **High technical potential and healthy pipeline:** South Korea's OSW market has a significant technical potential, estimated at 624GW and primarily driven by floating OSW. The study's analysis suggests that South Korea has a sufficient development pipeline to meet and exceed the government's targets and reach a total installed capacity of nearly 25GW by 2035, which will require substantial investment of over KRW 132 trillion during this period. This signals robust growth prospects and a significant contribution to renewable energy transition and economic expansion. There is clear interest in the South Korean market and projects in development, and therefore barriers are not a lack of pipeline, but rather slow development procedures and lack of available delivery infrastructure.
- ✓ **Rapid growth expectations:** The country's OSW capacity, though currently low at 139.8MW from 6 operational projects, is slated for significant growth with 84 licensed projects totalling 27.67GW of planned capacity.
- ✓ **Challenging project development processes:** OSW project development in South Korea involves a lengthy and complex process spanning site selection, permitting, and negotiation stages for offtake, taking an estimated 7-10 years or more, posing a key challenge for timely deployment. Changes in the development processes are being discussed, and management of this uncertainty, and projects that have progressed under the current regime will be important in avoiding delivery delays.
- ✓ **South Korea's emerging role in the global OSW market:** The country's advancement in both fixed bottom and floating OSW technologies demonstrates South Korea's potential to emerge as a key player in the global OSW market, alongside its strengths in shipbuilding, maritime infrastructure, and domestic manufacturing which can be further boosted by government support to foster a skilled workforce.

Renewable energy targets

In 2017, the Government announced the Renewable Energy 3020 Implementation Plan and set the renewables target at 20% by 2030 in recognition of the limited role played by renewables (7%) in the power sector. Under this plan, 16.5GW capacity of wind power was to be added by 2030.

A specific target for OSW was established in July 2020 in the Offshore Wind Development

Strategy, at 12GW by 2030. The Government established the three pillars of the strategy:

i. Government-led site development;
ii. Enhancing environmental integrity and local acceptability; and
iii. Promoting industry competitiveness in connection with large scale projects.

These targets were subsequently reflected in 9th Basic Plan on Electricity Supply and Demand, the master policy plan for the power sector covering 2020 – 2034. The 9th Basic Plan set the renewables target at 22.2% and wind power capacity at 27.7GW by 2034. The plan also indicated that Government-led large scale OSW projects, including Saemangeum (3GW, 2025), Seonamhae (2.4GW, 2028), Sinan (8.2GW, 2030) will need to be built on schedule.

In the same year, the Government published the 4th Renewable Energy Basic Plan, setting out detailed investment plans for research and development required to achieve the renewable energy targets and to promote related industry. Particularly on OSW, (i) securing competitiveness in key component supply, (ii) development of ultra-large capacity wind turbine, and (iii) development of floating systems were identified as key objectives of the plan.

The 10th Basic Plan on Electricity Supply and Demand ("the Plan") was announced in January 2023 by the new administration that took office in 2022. The Plan was criticised due to its decision to lower the renewable energy target to 21.6% by 2030, representing a step back from the previous target of 30.2% in the enhanced Nationally Determined Contribution in 2021.

Nevertheless, the Plan still retained its projections for wind power capacity, with an estimation of 29.3GW by 2030 and 34.1GW by 2036, and **set a separate goal of installing 14.3GW of OSW by 2030.** The Plan also laid out concrete steps to provide transmission and substation facilities for Sinan and Southwestern Coast OSW projects by 2029, and set specific policy objectives for OSW such as:

i. scale up wind turbine capacity and strengthen domestic production capability for key components,
ii. develop dedicated ports for OSW, and
iii. promote the O&M service industry.

Operational offshore wind capacity

As of 2023, OSW fully commissioned capacity in South Korea stands at 139.8MW, with six operational projects as outlined in Table 1.

Table 1: Fully commissioned and decommissioned offshore wind projects in South Korea[4]

Wind farm name	Capacity (MW)	Year commissioned	Region
Gunsan 4.3MW Demo	4.3	2021	Jeollabukdo
Gunsan Port – KEPRI Suction Bucket Demonstrator	3	2016	Jeollabukdo
Southwest Offshore Demonstration	60	2017	Jeollabukdo
Tamra	30	2015	Jeju
Yeonggwang Baeksu	8	2022	Jeollanamdo
Yeonggwang Wind (nearshore)	34.5	2018	Jeollanamdo
Ulsan 750 kW floating demonstrator (decommissioned)	0.75	2020	Ulsan
Woljeong Demonstration (decommissioned)	5	2012	Jeju

This low installed capacity to date ranks South Korea outside of the top ten OSW markets globally for installed capacity. Globally, several markets lead the way in installed capacity, notably China, the United Kingdom, and Germany (**Figure 1**).

As of December 2022, electricity business licenses (EBL) were issued to 70 planned OSW projects, with a total capacity of 21,270 MW. The majority of these planned projects are located in Jeollanamdo (53.9%, 11,157MW), followed by Busan-Ulsan area (33.5%, 6,931 MW), Geyonggi-Incheon area (753.5MW), Chungcheongnamdo (714MW), Gyeongsangnamdo (585.9MW), Jeollabukdo (568.1MW), and Jejudo (565MW). Sinan area in the Southwestern coast (Jeollanamdo) hosts largest number of projects, and floating OSW projects plans are mostly located in the Ulsan area. **Based on further decisions by the Electricity Committee in 2023, 14 more projects reflecting another 6.4GW acquired EBLs, resulting in a total of 84 projects representing 27.67GW**.

In addition to the permitted projects, wind measurement equipment is operational in 184 sites (as of 2021), and a total of 60 projects (approx. 18.7GW in capacity) have either applied for an electricity business license or are in preparation of applying as of August 2022.[5]

[4] Source: 4COffshore Database.

[5] National Federation of Fisheries Cooperatives, "Fishermen nationwide predicted a struggle with offshore wind" (Press Release), 3 October 2022 [KOR]

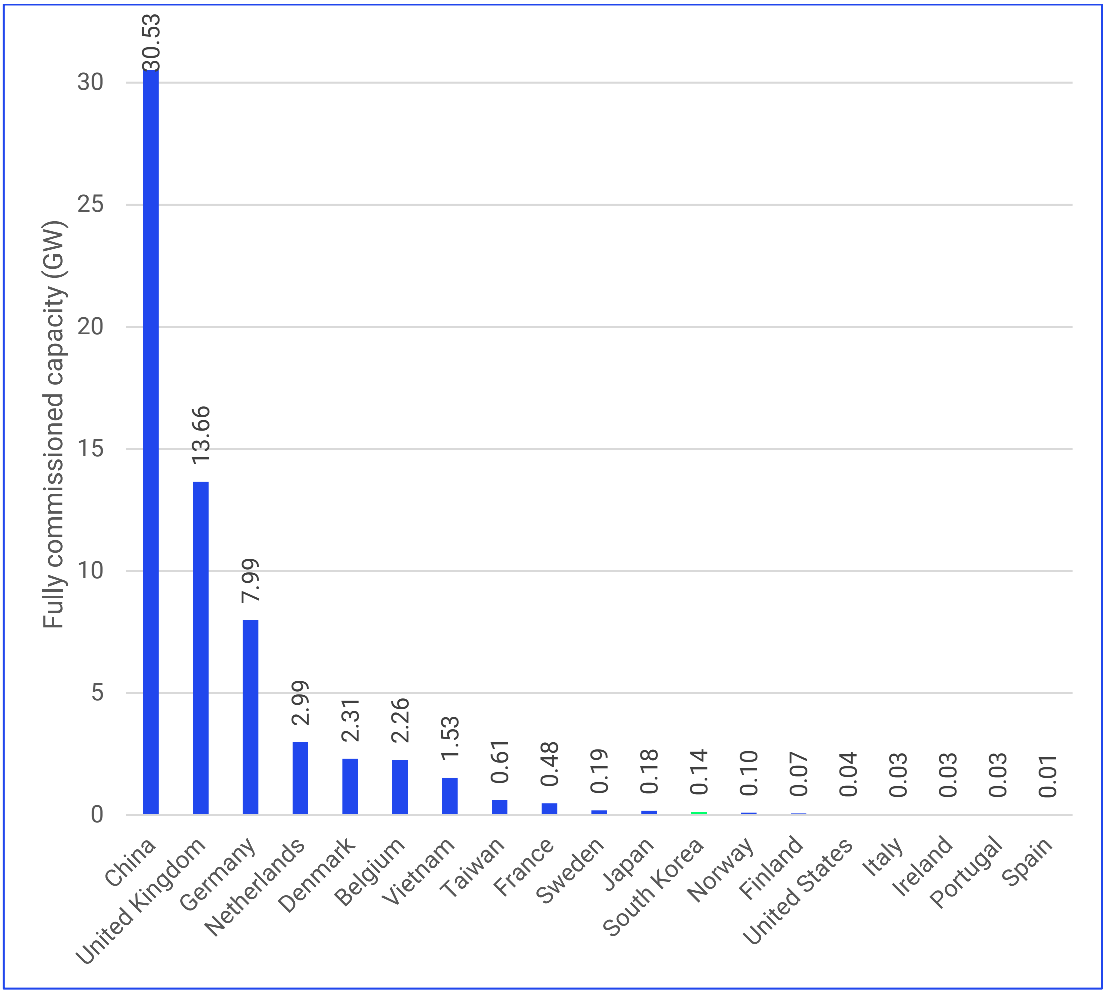

Figure 1: Fully commissioned offshore wind capacity by country (September 2023)[6]

South Korea offshore wind incentive mechanisms

The Renewable Portfolio Standard (RPS) is the most important incentive mechanism for renewable energy generation in South Korea. In Korea, support for renewable energy sources was first introduced with a Feed-in-Tariff (FIT) mechanism in 2002. The RPS was introduced in 2012 in order to increase efficiency of the support scheme through market mechanisms. Under the RPS, large conventional power producers are required to meet a certain percentage of their total power generation with renewables. This is achieved either by operating renewable generation sources or by purchasing Renewable Energy Certificates (RECs) per MWh.

RECs can be sold in addition to electricity generated as an additional revenue stream. Therefore, the profitability of renewable energy projects are largely determined by the volume of RECs generated through the project and the price of RECs.

REC multipliers are given to provide additional support and revenue generation opportunity to less mature technologies. Currently, the volume of RECs generated by OSW power projects differ by project types. A REC multiplier coefficient of 2.0 is applied to OSW projects located in tidal land or within sea walls. OSW

[6] Source: 4COffshore.

projects located in open water are given weighted value of 2.5.

Further addition can be made to the weighted value if the OSW project is (i) larger than 3MW and (ii) more than 1% of the project is owned by the local community residents.[7] The addition is calculated based on water depth and connection distance of each project site (further details can be found in the **Table 2**).

Previously, a REC coefficient bonus was given to projects where more than 50% of the parts were produced domestically[8], under the rule commonly referred as Local Content Requirement (LCR). However, the incentive was removed by the Ministry of Trade, Industry and Energy (MOTIE) in March 2023. Some domestic players have expressed concerns that removal of LCR incentives will pose significant threat to the industry.[9]

Table 2: Renewable Energy Certificate (REC) estimates for various OSW project types.

OSW Project criteria	REC multiplier 1)	Number of RECs with 100 MWh generated	Estimated revenue 2)
Located within tidal land and sea walls	2.0	= 2.0 * 100 = **200 RECs**	148 £/MWh 224,000 KRW/MWh
Located in open water	2.9	= 2.5 * 100 = **250 RECs**	191 £/MWh 315,100 KRW/MWh
Located in open water (Capacity > 3MW, Community Ownership > 1%)	2.975	= 2.975 * 100 **= 297.5 RECs**	195 £/MWh 321,025 KRW/MWh
Located in open water (Capacity > 3MW, Community Ownership > 4%)	3.2	= 3.2 * 100 **= 320 RECs**	206 £/MWh 338,800 KRW/MWh

1) Water depth (25m), Length of transmission line (10km) is assumed.
2) SMP+1REC is assumed at 165,000 KRW/MWh, which was the lowest bid suggested in 2022 auction. SMP is assumed at 86,000 KRW/MWh, which was the criteria suggested in 2022 auction.

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[7] Ministry of Trade, Industry and Energy, Offshore Wind Power Guideline, 2023 [KOR]

[8] Further explanation on RECs is provided in Chapter 7.

[9] Kuktoilbo, "Wind industry fears industry slump due to abolition of LCR ", 3 April 2023 [KOR]

Alongside the removal of LCR, MOTIE have introduced an auction scheme for wind power within the RPS scheme. A certain portion of RPS capacity will be reserved to be allocated by auctions to be held once per year. Wind power projects, both onshore and offshore, that have completed environmental impact assessments are eligible for entering the bids.

In the first round of bids held in September 2022, 550MW in capacity was open for bids with the highest price cap of 169,500 KRW/MWh (~£102/MWh). 613MW (15 bids) of onshore and 99MW (1 bid) of offshore applied and, as a result, 8 projects were awarded totalling 374.4MW.[10] 1,900MW in capacity is open for bids this year, of which 1,500MW is allocated for OSW. The highest price cap was not suggested this year.[11]

South Korea offshore wind development process

South Korea operates a developer-led development approach for OSW projects. The OSW development process in South Korea is summarised in **Figure 2**.

[10] Ministry of Trade, Industry and Energy, "Introduction of a competitive bidding system for wind power generation"(press release), September 2022; Korea Energy Agency, "Bidding results of fixed price contract", 15 November 2002 [KOR]

[11] Korea Energy Agency, "Wind Power Fixed Price Competitive Bidding Notice", 12 October 2023 [KOR]

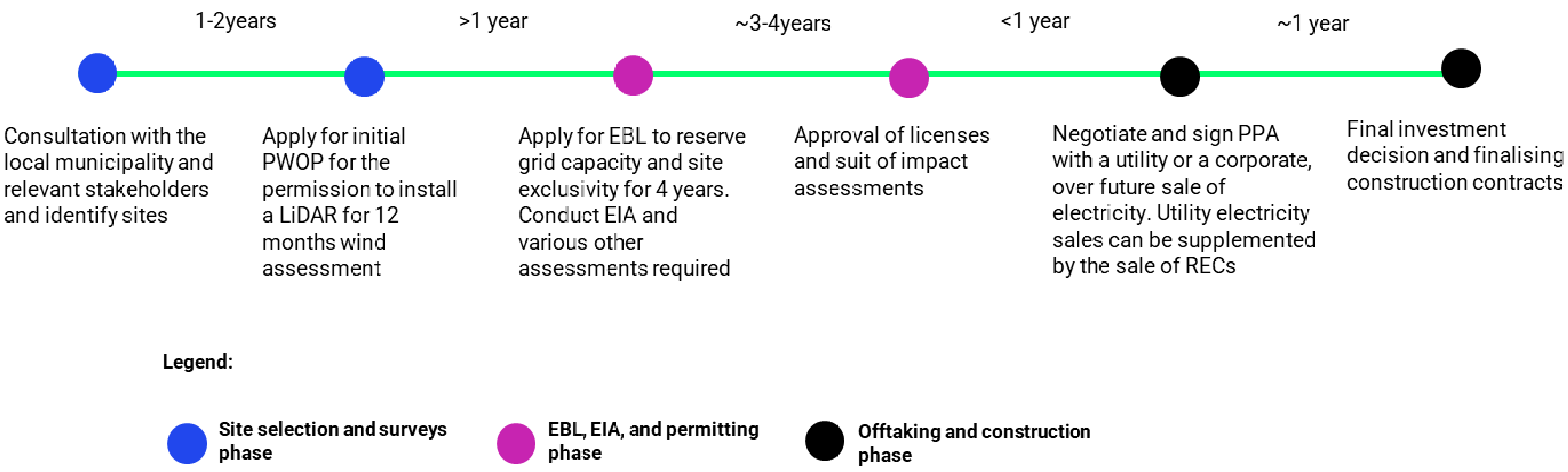


Figure 2: Typical OSW project development process in South Korea[12]

[12] Source: 4COffshore, Carbon Trust/Plan 1.5 internal research

Site selection and surveys

The first stage is the site selection and surveys phase, which involves consultations with local municipalities and relevant stakeholders. Feasibility studies and wind measurements are conducted during this phase, which may take approximately 1 to 2 years. Then, developers are required to apply for an initial **Public Waters Occupancy Permit (PWOP)** to install a Light Detection and Ranging (LiDAR) system for a 12-month wind resource assessment.

The government charges an annual fee for granting the PWOP, typically ranging from 0.25% to 0.5% of the price of the adjoining land. This fee is not expected to be very high as the adjoining land is usually underdeveloped and price of the land can be as little as USD 1/m^2, and one example for an OSW project in Incheon had a fee of USD 30 per annum.

Permitting

Developers need to secure an Electricity Business License (EBL), which provides them with a four-year site exclusivity for development and secure grid capacity. It is important to note that developers must obtain approval for various permits, including grid connection, military impact, radio wave impact, navigation safety impact, inspection of buried cultural heritage, Environmental Impact Assessment (EIA), wind turbine certification, actual PWOP (different from initial PWOP), and construction plan approval. The application and approval process for these permits and assessments can take up to 5 years.

The permitting process for OSW projects is governed by the Electric Utility Act which prescribes the following steps:

i. installation of wind measurement equipment;
ii. securing an electricity generation permit;
iii. securing specific permits required for zoning regulations;
iv. approval for construction plans; and
v. completion of inspection and verification.

However, most OSW power projects are eligible for a special process that is applied to large scale projects under the Electric Power Source Development Promotion Act, which provides a consolidated process for various zoning regulation permits.[13]

Offtake

In the final stage, developers are required to negotiate power purchase agreements (PPAs) with interested parties. Currently, there are two primary offtake mechanisms for OSW projects in South Korea: selling electricity to a utility or entering into direct power purchase agreements (DPPAs) with corporate entities. Under the former method, electricity generators can sell their power at spot prices on the wholesale power market, known as the Korea Power Exchange (KPX), to the sole buyer, Korea Electric Power Corporation (KEPCO), who then supplies the energy to end users. As previously mentioned, this sale will be supplemented by the sale of RECs.

However, energy providers who enter DPPAs cannot benefit from the trade of RECs, as they are not issued or allowed to sell them. Once the offtake mechanism is determined and finalised, the construction process can commence.

[13] Ministry of Trade, Industry and Energy, Offshore Wind Power Guideline, 2023 [KOR]

The process outlined in Figure 2 can take more than 10 years to complete (a typical estimate is 7-10 years), which is one of the key challenges for timely and efficient deployment of OSW and risks South Korea missing key deployment targets.

If permitting procedures are updated, projects in the current process must be managed sensibly to avoid delivery delay.

There has been criticism that the duration of 7-10 years for the OSW permitting process in South Korea is too long.[14] In response to the criticism, a legislative bill proposing a simplified process for OSW, commonly referred as the "One-Stop Shop Bill," has been discussed in the National Assembly since 2021. However, a number of issues around the bill still remain unresolved among the Government ministries, National Assembly, and key stakeholders including National Federation of Fisheries Cooperative, Korea Wind Energy Industry, and the civil society groups.

Whilst the proposed procedural updates are positive for industry and will be supportive of reaching long-term targets and streamlining project development timelines, any policy change creates uncertainty that should be managed appropriately to avoid delaying project delivery.

Notably, in South Korea, more than sixty projects have secured an EBL and therefore have made some progress within current permitting procedures. **To progress towards 2030 deployment targets, it is critical that these projects are not delayed with the transition to a new permitting regime.** Projects that have made significant progress within the current permitting regime should not lose this progress during the transition.

Establishing extensive, open and early consultation coupled with clear communication with industry can support the management of a policy transition. Implementation of a specific transition mechanism should be considered to manage these projects. This mechanism should provide sufficient flexibility that enables industry to select a preferred approach that can reduce any risk of delays to projects. This approach can foster an environment of engagement and transparency with stakeholders and avoids the risk of unexpected developments.

Other OSW markets have undertaken similar policy changes, requiring an interim transition mechanism to support projects that have made progress under previous regimes. Notably, during the change in OSW subsidy support schemes from the Renewables Obligation to the Contracts for Difference scheme in the UK, an interim solution titled Final Investment Decision enabling for Renewables (FIDeR) was implemented as a buffer solution for projects that had progressed with development under the previous regime.

In the South Korean context, it is important to recognise that there are a large number of projects that have made some progress towards permitting under the current regime and therefore need to be treated appropriately.

[14] Herald Economics, "Korea's wind power project waiting seven years for nine ministries and 25 licenses to operate", 17 September 2022; http://biz.heraldcorp.com/view.php?ud=20220907000505 E2News, "Wind industry fears economic slowdown due to complicated licensing", 23 November 2020 [KOR]

2.1. South Korea has sufficient project pipeline to meet the 2030 deployment target, but this will not be reached without implementation of supportive policy and infrastructure

Despite relatively low installed capacity at present, the South Korean OSW market exhibits immense technical potential for growth. According to the Global Wind Energy Council (GWEC), the technical potential of floating OSW in South Korea is estimated to be seven times greater than that of fixed bottom OSW, with a technical potential of 546GW for floating OSW and 78GW for fixed bottom OSW, the combined potential reaches an impressive 624GW.[15]

Currently, both fixed bottom and floating OSW technologies are being actively explored and developed in South Korea. Most of the deployed and planned projects are fixed bottom wind farms located off the southwestern and southern coasts of the country. However, the market is witnessing a growing interest in floating OSW projects due to the country's deeper waters.

Given the large number of projects that are in development, optimistically assuming that those projects in development are constructed on time and with estimated capacity, **South Korea has sufficient development pipeline to meet and exceed its 14.3 GW target in the Plan (Figure 3), and reach a total installed capacity of almost 25 GW by 2035.** The existence of such a robust pipeline presents a positive outlook for the nation's OSW industry, provided that the supply chain is adequately supported to meet this ambitious growth. Whilst the industry is ready with sufficient pipeline, these targets will not be met without supportive policy and infrastructure. These are not yet in place, but must be implemented to reach deployment projections.

Whilst South Korea displays significant potential for floating OSW, the majority of construction to 2035 is expected to be fixed bottom OSW. **Based on Figure 3, 15.54GW of fixed bottom OSW and 9.43GW of floating OSW is expected to be installed by 2035**.

The cumulative investment required to construct this capacity is expected to be over £80 billion (~KRW 132 trillion) by 2035 (Figure 4). This huge investment will generate a significant opportunity for the local supply chain. As the sector continues to mature and more substantial projects come into play, the cumulative investment is poised to make a substantial contribution to the country's renewable energy transition and economic growth.

These figures are a projection based on the current pipeline. However, this projection will only be met with favouring market conditions, policy support, and infrastructure upgrades. Nonetheless, the projected investment and deployment figures demonstrate a strong commitment towards the growth and long-term sustainability of the South Korean OSW industry.

[15] GWEC, Offshore Wind Technical Potential, June 2021 - link

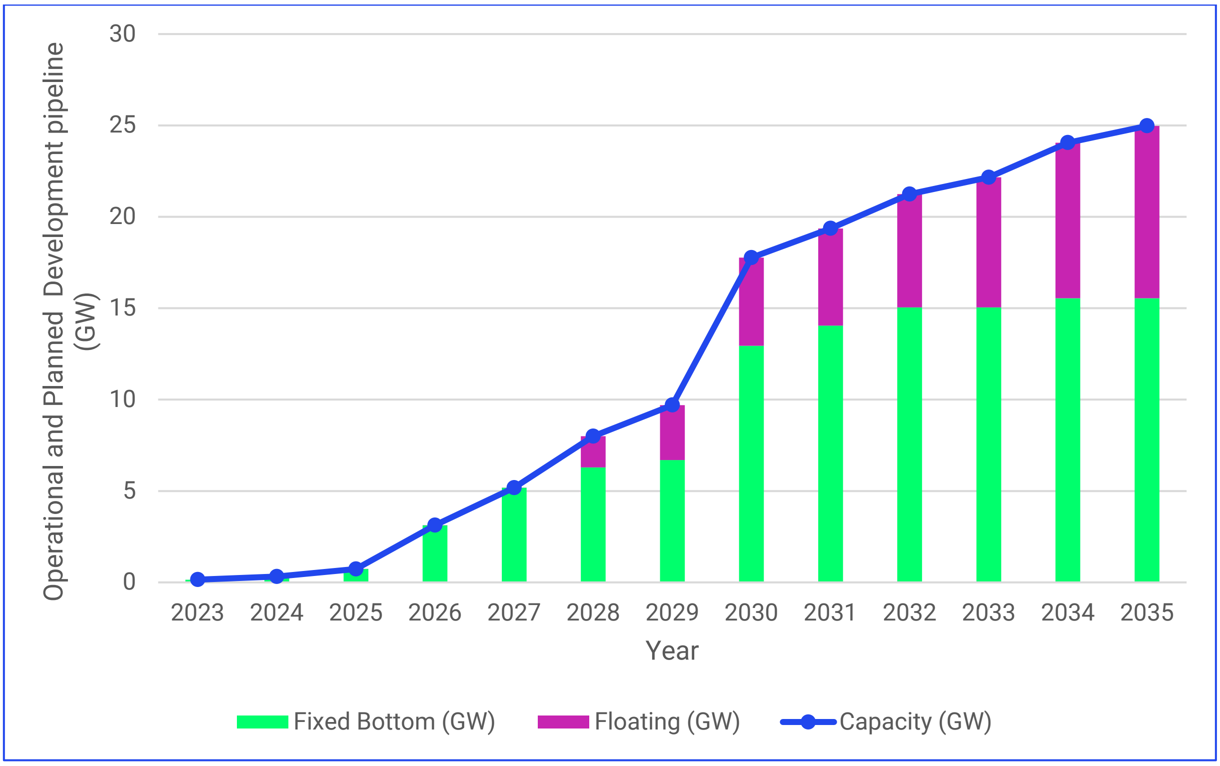


Figure 3: Operational and planned development pipeline of OSW farms in South Korea to 2035

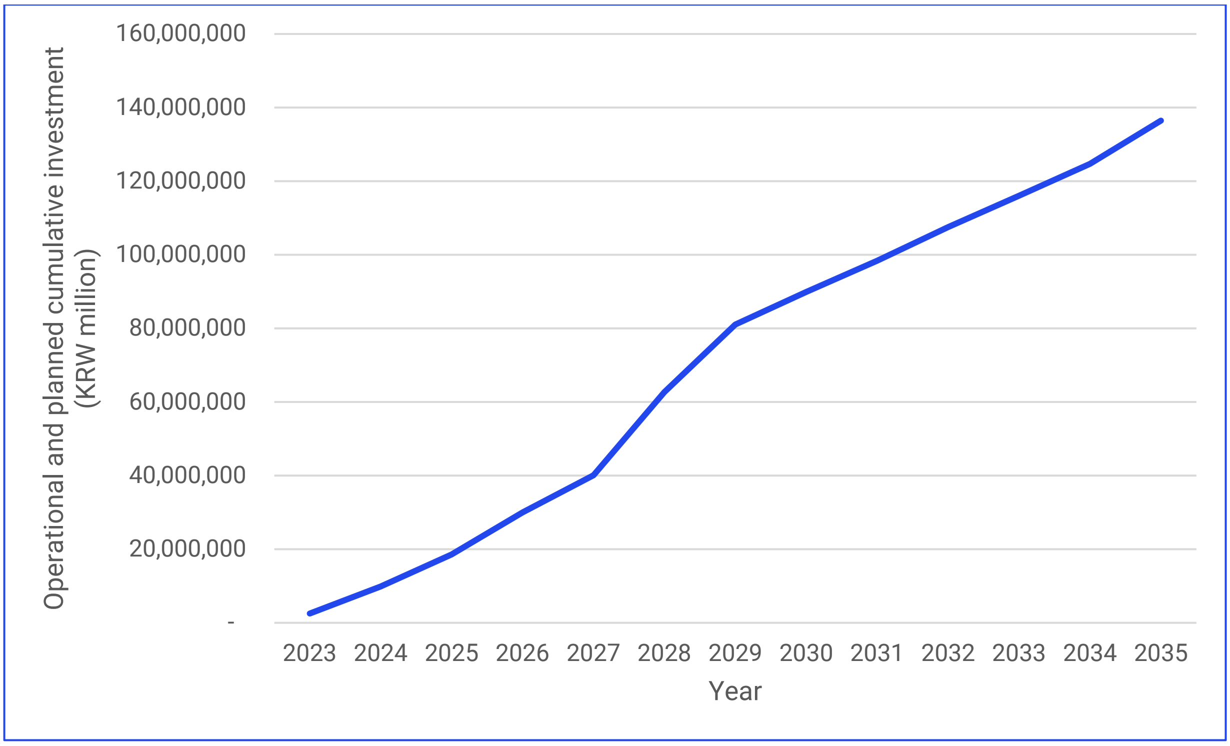
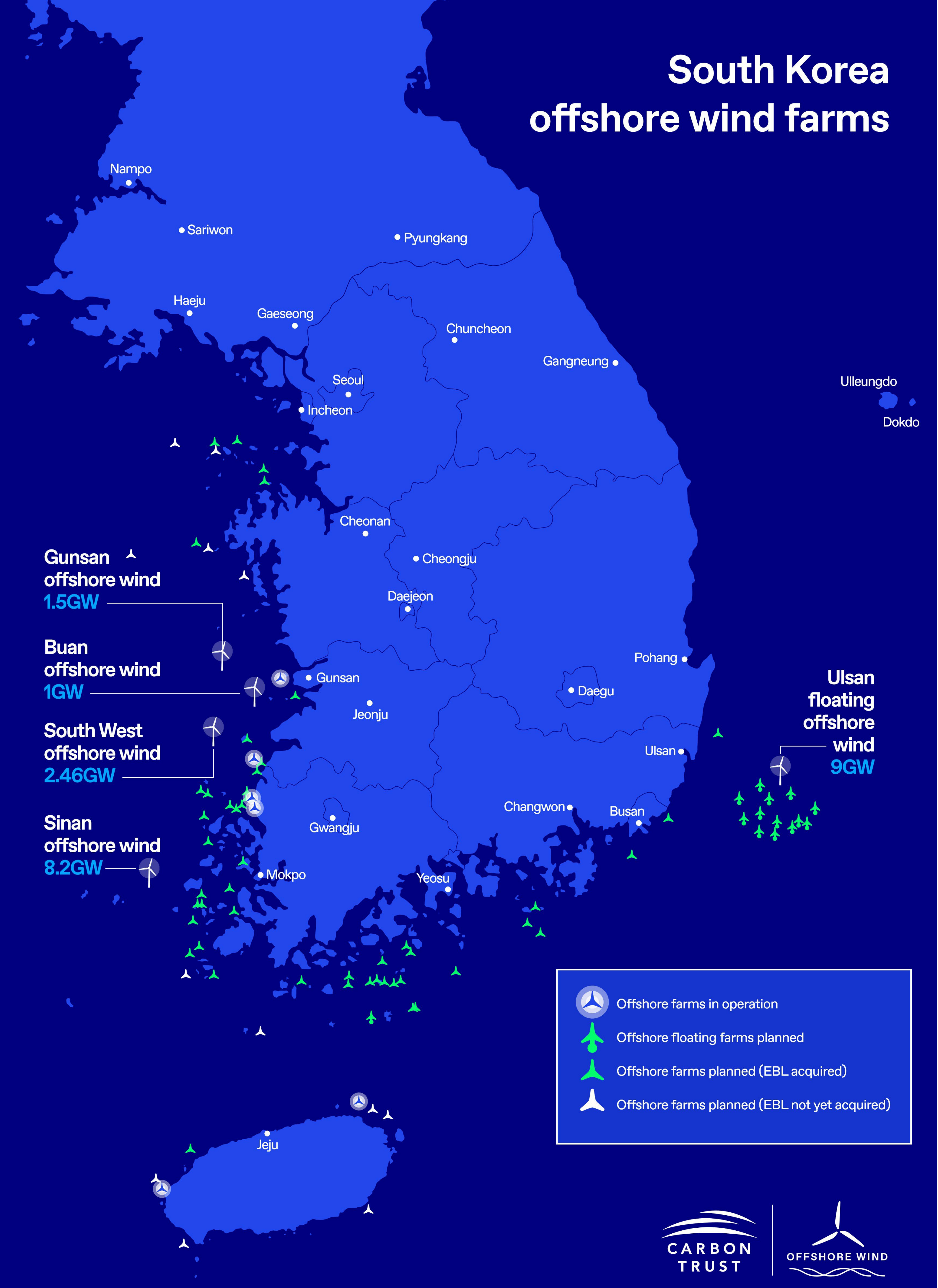


Figure 4: Operational and planned cumulative investment pipeline of OSW farms in South Korea by 2035

South Korea offshore wind farms



CARBON TRUST | OFFSHORE WIND

Source: Korea wind energy industry association (accessed 1 Feb 2023) http://www.kweia.or.kr

3. Supply chain assessment

Key takeaways

- ✓ **Local supply chain at its nascency:** 61% of the 224 South Korean companies in the OSW industry evaluated in this study specialise in the Development and Consenting stage, reflecting the nascency of the market. Activity in other stages of the OSW life cycle is expected to grow as the industry matures.
- ✓ **Challenges in local turbine capacity:** While local suppliers have installed turbines for South Korean projects, their capacity lags behind global leaders which poses a challenge for OSW deployment. Partnerships between local and international companies are being established to bridge this technological gap.
- ✓ **Local capabilities in tower supply and foundation structures:** South Korea's core strength lies in tower supply with local companies expanding their manufacturing capacities, although they might face increasing competition from Chinese manufacturers due to technological barriers in this sector. South Korea's strengths in secondary steel works and electrical systems can also be leveraged in the manufacturing of foundation structures, despite growing competition from Chinese manufacturers.
- ✓ **Installation vessel challenges and infrastructure requirements:** While Korean shipbuilders have capacity in wind turbine installation vessels (WTIVs), the country has limited domestic installation vessel capacity. The shortage of installation vessels and dedicated ports presents significant challenges, necessitating urgent infrastructure improvements to support stable growth in the OSW supply chain.

An objective of this report is to provide an assessment of the South Korea OSW supply chain to deliver the project pipeline outlined in Section 1.1. The successful delivery of this pipeline hinges upon the ability of the supply chain to provide the required components and services to construct OSW projects. These components and services are required throughout the entire lifetime of the projects, from development through to decommissioning.

OSW has developed into a global industry, and it is common for international supply chain companies to export components and services into an alternative market. **This analysis does not assess the ability of the international supply chain to play a role in South Korea's OSW projects, but instead makes an assessment of the capability of South Korean supply chain organisations.**

The assessment considers the role that South Korean companies have played in delivering the installed capacity to date, the role of South Korean companies in contracted work to deliver the current pipeline, and an assessment of organisations that have expressed a capability of delivering OSW components and services.

3.1. Local supply chain played the major role in early South Korean offshore wind projects

There are six fully commissioned OSW farm projects in South Korea, of which the largest capacity is 60MW. These projects are predominantly demonstration scale in nature and are not representative of capacities expected out to 2030 and 2035, with the mean project capacity expected to be around 300MW in 2030 and 350MW in 2035.

The early projects delivered show a high proportion of local content. Based on available data, 77% of supply chain companies involved in fully commissioned South Korean OSW farms are South Korean companies (**Figure 5**). Furthermore, the turbines for these projects were all from either Unison or Doosan – two South Korean wind turbine manufacturers.

Additional supply chain involvement for these projects came from Netherlands, Malaysia, Germany, USA, Finland, Denmark, France, Japan, and Spain.

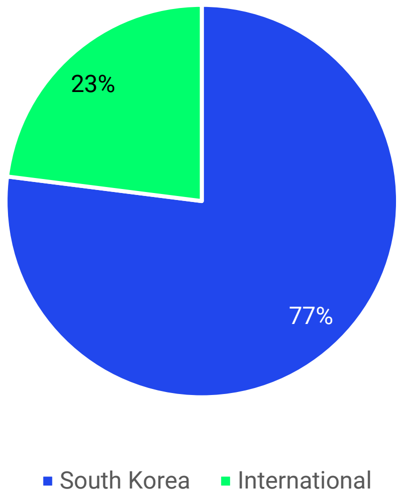


Figure 5: Percentage of organisations involved in fully commissioned South Korean offshore wind projects[16]

3.2. South Korean companies are expected to continue to play a significant role in coming projects

Two further projects have been identified as either in construction, or at a pre-construction stage: Hallym Offshore Wind Power Demonstration and Sinan – SK E&S – phase 1. Each of these projects have an estimated capacity of 100MW.

Based on available data, 64% of supply chain companies involved in these projects are South Korean companies. There is additional involvement from Netherlands, Malaysia, Germany, USA, Finland, Denmark, France, Japan, and Spain (**Figure 6**).

[16] Source: 4C Offshore

Notably, whilst Doosan are expected to be the wind turbine supplier for one of these projects, Siemens Gamesa are expected to provide 10MW turbines for the Sinan project.

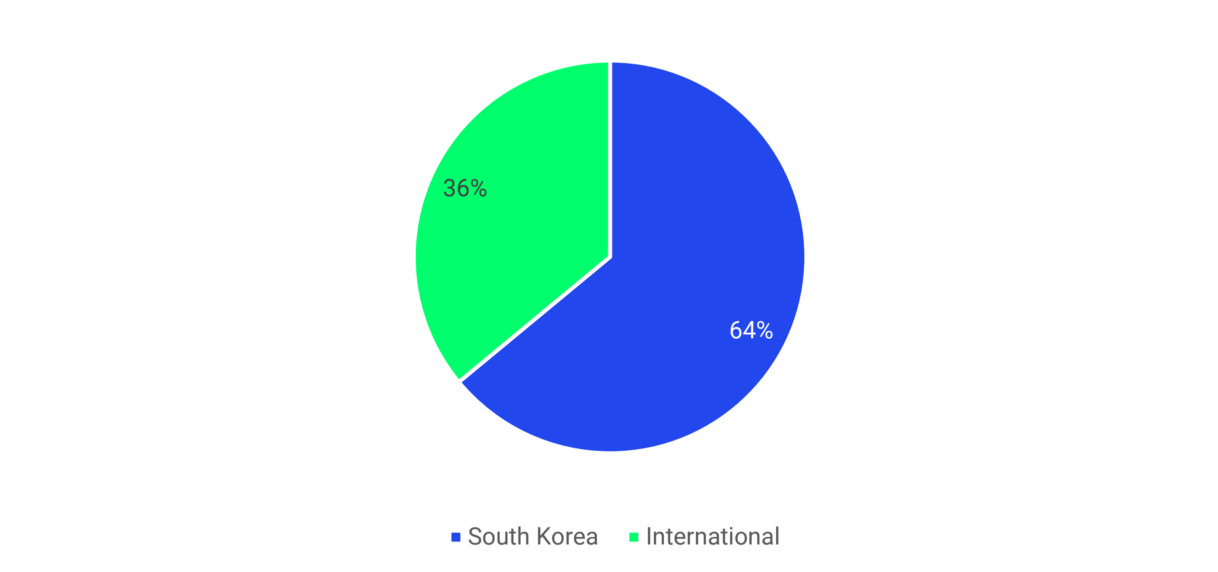


Figure 6: Percentage of organisations involved in South Korean offshore wind projects in construction or at pre-construction stage[17]

3.3. Categorisation of offshore wind supply needs by life cycle stage

For the purposes of this study, the supply chain has been categorised into six categories, and subsequent sub-categories for specific components and services. The categories included are:

- Development and consent
- Turbine supply
- Balance of plant supply
- Installation and commissioning
- Operations and maintenance
- Decommissioning

Each of these has subsequently been further subcategorised into components or services for the analysis. These subcategories are portrayed in **Table 3**. Whilst it would be possible to increase the specificity of subcategories beyond those selected, it became clear during the analysis that the level of specificity of suppliers was such that the higher-level subcategories used was more beneficial to the analysis.

[17] Source: 4C Offshore.

Table 3: Offshore wind value chain breakdown used for supply chain analysis

Development & consent	Turbine supply	Balance of plant supply	Installation & commissioning	Operations & maintenance	Decommissioning
Developer	Blades, Nacelle, Rotor	Anchors and mooring system (floating)	Cable installation	Maintenance and inspection services	Decommissioning services
Design	Small components	Electrical systems	Foundation installation	O&M ports	
Site investigation and environmental surveys	Towers	Foundation / Offshore substation structures	Installation equipment, vessels and support services	Vessels and equipment	
Owner / investor		Subsea cables	Installation ports and logistics		
Research & development		Other components	Onshore works		
			Substation installation		

OSW project cost breakdown

The proportional cost breakdown for a 1GW floating OSW farm with a 25-year operating life is displayed in Figure 7. Whilst operations and maintenance costs are the most significant, balance of plant costs are the second largest, due to the high costs of floating substructures (estimated at £960,000/MW).

A fixed bottom wind farm comparison is included in Figure 8. It can be seen that operations and maintenance require the greatest costs over the entire operating life of the wind farm, as these costs are accumulated over 25 years of operation. From a local market perspective, this is positive, as the operations base will be located in the country of operation, and therefore the majority of this investment can be captured locally[18]. Turbine supply comprises the second most significant cost.

[18] There may be requirements for international involvement for specific repairs, skilled technicians and component replacements, if these cannot be found locally.

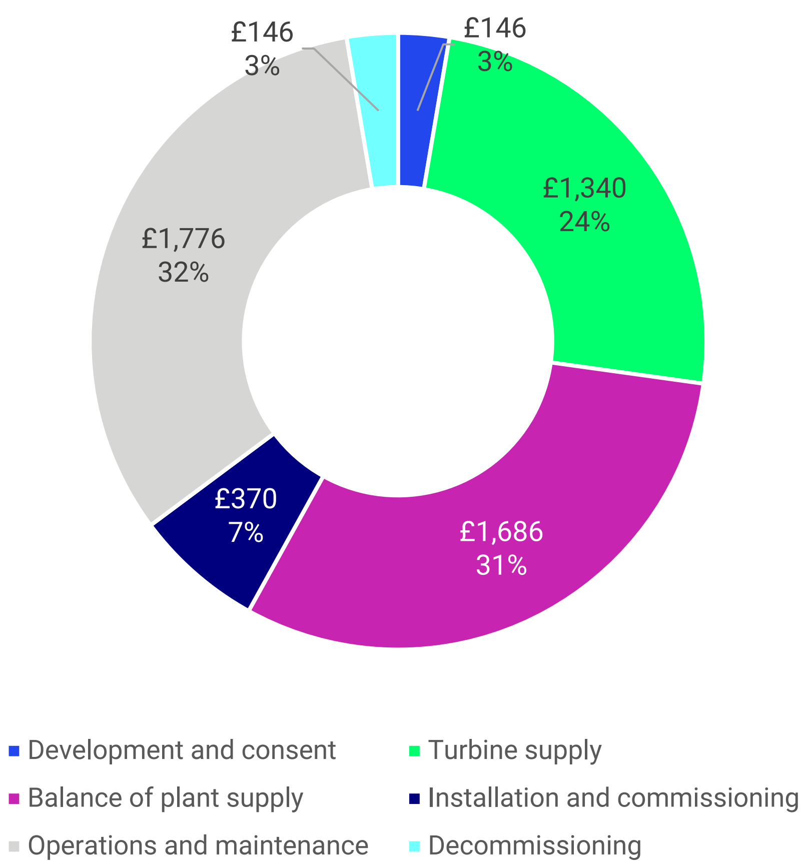


Figure 7: Cost breakdown by life cycle area for a 1GW floating offshore wind farm with a 25-year operating life (in £ million/GW, %)[19]

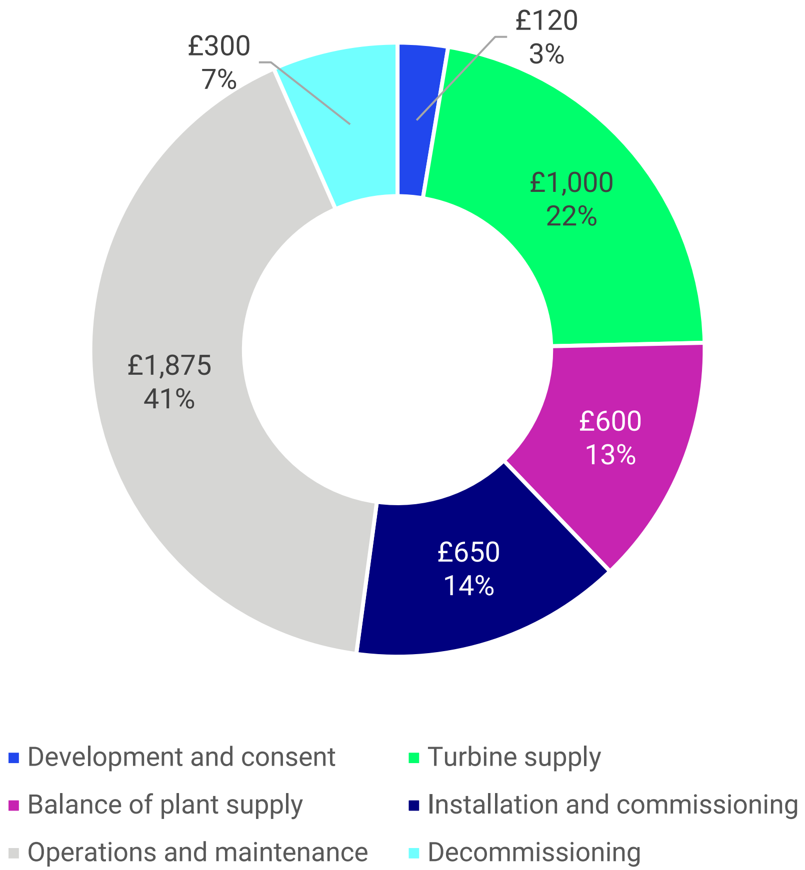


Figure 8: Cost breakdown by life cycle area for a 1GW fixed bottom offshore wind farm with a 25-year operating life (in £ million/GW, %)[20]

[19] The Crown Estate, Guide to an offshore wind farm, 2019 - link

[20] The Crown Estate, Guide to a floating offshore wind farm, 2023 - link

3.4. Analysis results: South Korean supply chain in strong starting position to support OSW industry

The study assessed 224 South Korean companies operating in the OSW industry. Each company was categorised as providing a component or service (**Table 3**). Where companies engaged in multiple activities, for the purposes of analysis a primary activity was selected to prevent duplication. Given the small extant project capacity in South Korea, the figure of 224 companies already with capabilities in the OSW sector is a promising starting point to support the future pipeline.

Whilst a figure of more than 200 companies ready to operate in the OSW sector is promising given the nascency of the sector in South Korea, for an individual wind farm in a new market, at least 200 suppliers may be engaged – as experienced by Ørsted during construction of Greater Changhua 1 & 2a (605.2MW and 294.8MW respectively).

The results reveal that the company landscape mirrors the nascent stages of the OSW market's development. Notably, approximately 61% of the surveyed companies are specialised in the Development and Consenting supply chain segment, increasing confidence in the ability to service the large number of projects in the development pipeline.

A distribution is observed among Installation and Commissioning, Turbine Supply, Balance of Plant, and Operations and Maintenance, where each supply chain segment is contributing a smaller share to the evolving ecosystem. It is noteworthy that, currently, no companies specialise in the Decommissioning segment. However, it is anticipated that as the South Korean OSW market matures, the supply chain landscape will undergo significant evolution and create more players in different specialised areas.

This section analyses the South Korean OSW supply chain in six life cycle sectors: (i) development and consent, (ii) turbine supply, (iii) balance of plant supply, (iv) installation and commissioning, (v) operations and maintenance, and (vi) decommissioning. The result of the assessment is indicated in three levels, high, medium and low.

The assessment of the "Current Supply Chain" in the tables below indicates the capabilities of respective sectors to meet the immediate needs for the projects in the pipeline, and the assessment of the "Expected Opportunities" indicates the growth potential and expected capabilities of the sectors assuming that the OSW deployment takes place in accordance with the policy target.

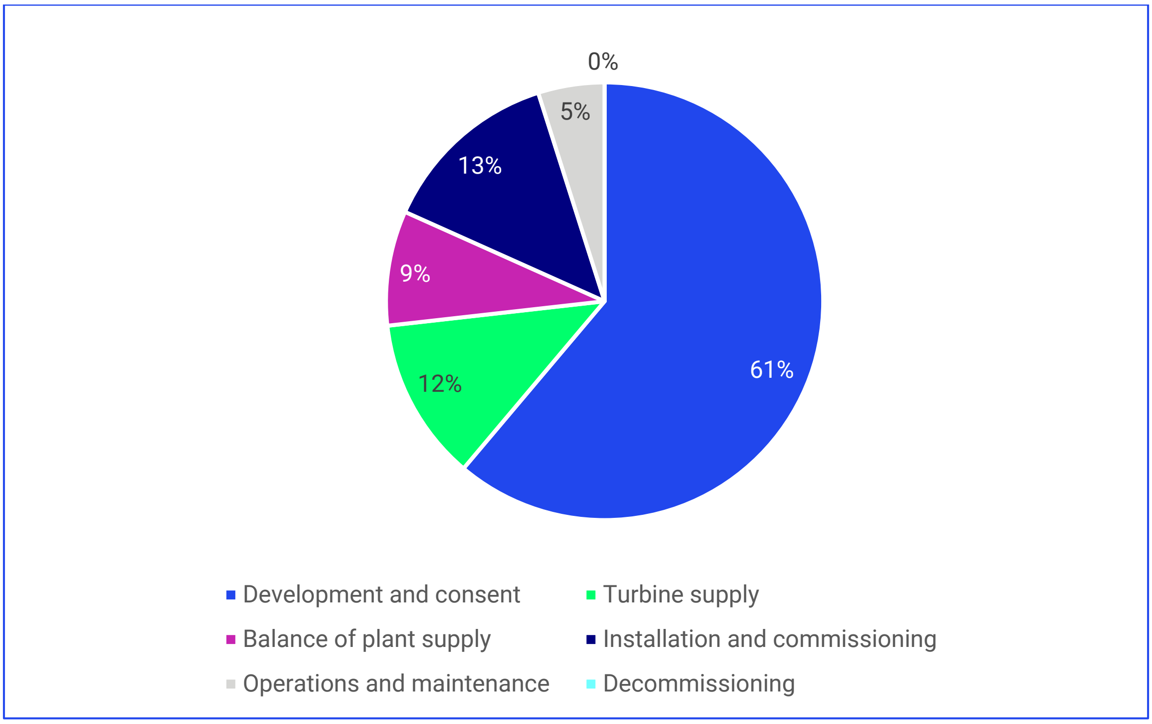


Figure 9: Research of South Korean companies with offshore wind capabilities categorised by life cycle sector

Development and consent

As demonstrated in Table 4, development and consenting services comprise the smallest cost of the categories included over a full operating lifetime. However, these costs are still significant, and occur prior to construction, when there is less certainty over the success of the project.

The following specialist areas are key to the development and consenting stage of an OSW, with existing companies in South Korea capable of carrying out the environmental, geotechnical and geophysical surveys required by the OSW industry with some already having significant OSW experience.

Table 4: Specialist areas of development and consenting

Subcategories	Includes	Current South Korean supply	Expected opportunity for South Korea
Developer	Developer; Project management	High	High
Design	Engineering design; consulting	Low	Medium – near-term High – long-term

Site investigation and environmental surveys	Environmental Impact Assessments; Monitoring technologies; Measurement campaigns (including LiDAR); Environmental surveys (e.g., aerial and vessel monitoring for seabirds and marine mammals); geophysical and geotechnical surveys (e.g., technical benthic and pelagic studies)	Low	Medium – near-term High – long-term
Owner / investor	Owners (non-developers)	High	High
Research & development		Low	High

Typically, the overall management of project development is undertaken by the developer (or otherwise contracted project manager). Many of the niche services, e.g., environmental surveying, may be provided by smaller, specialised service providers. Given that many projects in South Korea are in the development stages, and therefore the near-term opportunity is very large for these suppliers.

As of 2023, a total of 84 projects across the nation have reached the electricity business license (EBL) phase[21], meaning that the developers possess significant experience and capabilities in the field. However, no large-scale (>100MW) OSW project has reached completion in South Korea to date, which means the industry still lacks experience and expertise in the actual design, site investigation and environmental surveys that typically place after the EBL phase. This knowledge gap is expected to be filled as the projects progress and opportunities for Korean players will increase over time.

Korea Institute of Energy Technology Evaluation and Planning (KETEP), a government-run research institute, has been in charge of research and development around OSW. However, industry stakeholders have pointed out that there are significant R&D needs for South Korea to narrow the technological cap to global leaders, especially for turbine components. Stakeholders suggest that the government should take a larger role in expanding the market size to induce R&D from the private sector.

[21] 70 projects received EBLs as of December 2022. In 2023, Electricity Committee decisions to date note 14 more projects resulting in a total of 84 projects with EBLs.

Turbine supply

Subcategories	Includes	Current South Korean supply	Expected opportunity for South Korea	Comment
Blades, nacelle, rotor	Blade manufacture, composite manufacturer, full turbine OEM	Medium	Medium – near-term High – long-term	Key challenge remains some technical capability deficiencies to international competitors
Small components	Bearings, Flanges, Forged metal components, Bolts and nuts, Clutch, Brake, Cooling system, Gearbox, Generator, Inverters	Medium	Medium – near-term High – long-term	Limited market penetration for certain key components with high technological hurdle
Towers	Tower manufacturer	High	High	CS Wind is the global leader in tower manufacturing

Manufacturing turbine components is a complex endeavour, demanding specialised and costly facilities. The substantial project pipeline in the market plays a pivotal role in justifying investments in these manufacturing facilities. Developers often opt to collaborate with existing suppliers for these intricate components. Notably, international giants like Siemens Gamesa and Vestas have already expressed their interest in investing in South Korea. While South Korea holds substantial potential in this area, the journey towards full supply chain maturity is anticipated to span several years.

As mentioned previously, all of the OSW turbines that have been installed in South Korea to date were from two South Korean suppliers: Doosan and Unison. However, the turbine sizes installed were of lower capacity than those offered by global leading turbine suppliers. Of 48 turbines installed offshore to date in South Korea, only two of these exceed 3MW in capacity, 1 x 4.3MW Unison turbine and 1 x 8.0MW Doosan turbine.[22]

Globally, turbines are available commercially at 15MW in Europe with suppliers GE, Siemens Gamesa and Vestas, whilst in China the world's largest installed turbine stands at 16MW.[23] Further, global suppliers are ahead of Korean suppliers in terms of control software for the turbines as they have collected large pool of operational data and experience over the years.

[22] 4C Offshore

[23] Offshorewind.biz, CTG installing world's largest wind turbine offshore China, 2023 - link

This technological disadvantage of local suppliers has been touted as a bottleneck towards OSW deployment in South Korea. Korean suppliers are making efforts to bridge this technological gap with a strong domestic base.

Doosan Enerbility signed a binding framework agreement with Siemens Gamesa for a strategic partnership for the South Korean OSW market February 2023. Doosan will assemble Siemens Gamesa's OSW turbine nacelles in a Doosan facility currently in the design phase, undertake turbine assembly for Siemens Gamesa machines in staging harbours as well as the offshore construction of projects using Siemens Gamesa machines, and perform offshore service on selected orders involving Siemens Gamesa machines.[24]

Unison is currently developing a 10MW model with R&D support from the government, and has announced plans to build supply chain for nacelle and blade in collaboration with the Chinese MingYang Smart Energy Group.[25] MingYang has also recently secured an order from Woori Technology to supply OSW turbines for the Aphae 80MW project in South Korea, marking its entry into the South Korean market as the first Chinese OEM.[26] From a local supply chain perspective, it can be assumed that future OSW farms will be served by a wider range of suppliers including international suppliers.

Table 5: Largest capacity turbines by manufacturer (Korean wind turbine manufacturers are behind global leaders in turbine development)

Manufacturer	Largest capacity turbine available according to company website	Model name
Doosan	8MW	DS205-8MW
Unison	4.3MW	U151
Hyosung	5.0MW	HS139
Hyundai Heavy Industries	5.5MW	HQ5500
Vestas	15MW	V236-15.0MW
General Electric (GE)	14MW	Haliade-X
Siemens Gamesa	14MW nominal (up to 15MW capacity with Power Boost)	SG 14-222 DD
MingYang	16MW	MySE 16.0-242 MySE 18.X-28.X MySE 22MW

[24] Siemens Gamesa, Siemens Gamesa and Doosan Enerbility sign historic offshore wind partnership framework agreement for South Korea, February 2023 - link

[25] Unison secured $4billion investment from Mingyang group, link

[26] ReNEWS, Mingyang seals 80 MW South Korean deal, November 2023, link

	18MW (in development)[27] 22MW (in development)[28]	
Goldwind	16MW	GWH252-16MW

In March 2023, Vestas signed a memorandum of understanding (MoU) with Seoul Metropolitan City to support skills development in the area and business activities. The MoU recognised Vestas' plan to relocate its APAC headquarters to Seoul.[29] Similarly, Siemens Gamesa have agreed a partnership with Doosan Enerbility to share knowledge on OSW turbine nacelle assembly, offshore construction and offshore service contracts, envisaging installation from 2026 onwards.[30]

In other components, Taewoong and Shilla are also major players of forged parts such as flanges and bearings. Shilla is currently supplying bearings to global turbine manufacturers such as GE, Goldwind, Kenersys, and Taewoong holds 30% of the global flange market as of 2019.[31] However, South Korean suppliers have limited capabilities regarding designing and manufacturing certain key components including blades, large bearings and gear box. KETEP estimates Korean suppliers are 3-5 years behind the global leaders for these components.[32]

At present, Korea's key strength is with tower supply. CS Wind is the global leader in tower structure manufacturing. Despite being a Korean company, it only had manufacturing facilities outside of Korea. Now, CS Wind is building a new manufacturing facility in Korea. Dongguk S&C is supplying tower to GE and Siemens. Dongguk S&C's manufacturing capacity, which stood at 95,000 ton/p.a. in 2021, is expanding as the company is building a new facility in Pohang.[33]

This strength in structural components is supported by Korea's experience in the steel industry (e.g., POSCO and Hyundai Steel), which can support turbine tower manufacturers. However, the industry experts in Korea point out that the sector is likely to face increased competition from the Chinese manufacturers as the technology hurdle is low.

[27] Offshorewind.biz, Mingyang goes beyond 18 MW with new offshore wind turbine, 2023 - link

[28] ReNews, MingYang launches 22 MW offshore turbine, 2023 - link

[29] ReNEWS.biz, Vestas signs Seoul MoU, 2023 - link

[30] Siemens Gamesa, 2023 - link

[31] KDB Bank, 2022 - link

[32] KETEP, 4th Energy Basic Plan wind power innovation roadmap, 2020

[33] ETNEWS, 2022 - link

Fact Box 1: Wind turbine market share in South Korea

As of 2022, total of 115 projects, 1,863MW of wind power is currently in operation in Korea. 106 of these projects, 1,657MW is onshore wind, and 10 projects, 146.3MW is OSW.

In terms of ownership, 57 projects (1,097MW, 60.7%) are owned by private power producers, followed by 28 projects owned by public utility GenCos (568MW, 31.5%). 10 projects (39.6MW, 2.1%) are owned by local governments and 22 projects (102.1MW, 5.7%) are owned by others, including research institutes, academic institutions and local communities.

In terms of turbine supply chain, Vestas has the largest market share (32.39%) followed by Unison (15.44%) and Doosan Enerbility (13.72%). Total share between domestic manufacturer and foreign manufacturer is 45.1% and 54.9%, respectively. The manufacturers identified in bold in the table below are Korean.

No	Manufacturer	Capacity	Units	Market share by capacity
1	Vestas	584.3 MW	241	31%
2	**Unison**	278.6 MW	151	15%
3	**Doosan Enerbility**	247.5 MW	80	13%
4	SGRE	221.8 MW	62	12%
5	**Hyundai Electric**	130.8 MW	71	10 %
6	Acciona	64.5 MW	43	3.5%
7	**Hanjin Industry**	60.0 MW	34	3.2%
8	Enercon	51.0 MW	16	2.7%
9	Alstom (GE)	48.0 MW	16	2.6%
10	**Hyosung**	37.3 MW	19	2%
11	**Hanwha Ocean**	34.0 MW	17	1.8%
12	Mitsubishi	19.8 MW	10	1.1%
13	**Samsung Heavy Industry**	17.5 MW	7	0.9%
14	**STX Heavy Industry**	5.5 MW	3	0.3%
15	DMS	2.0 MW	1	0.1%
16	Siva	0.5 MW	2	0.03%
17	NPS	0.4 MW	4	0.02%
	TOTAL	**1,803.5 MW**	**777**	**100%**

Balance of plant supply

Subcategory	Includes	Current South Korean supply	Expected opportunity for South Korea	Comment
Anchors and mooring system (floating)	Anchors; Mooring	Low	Medium	General capacity exists but limited experience for floating OSW
Electrical systems	All electrical systems	Medium	High	Robust general capacity but limited design capability for OSW
Foundation / Offshore substation structures	Fixed foundations (monopiles, jackets, etc.); Floating foundations; Secondary steel	High	High	Key challenge may be low-cost alternatives from other countries providing competition.
Subsea cables	Array cables; Export cables	High	High	LS Cable have good capability. Competitive market and cables often sourced internationally.
Other components	Corrosion protection	Medium	Medium	

Large balance of plant components also requires large facilities and significant investment. The success of suppliers hinges on achieving a certain scale, rendering entry into this market challenging without clear indications of market demand. South Korea's potential lies notably in secondary steel works or the provision of electrical systems. Leveraging existing steel fabrication facilities and companies, these areas present opportunities for growth with minimal or feasible adaptation.

South Korea currently has a competitive edge in foundation structure manufacturing in terms of both capacity and technology. SK Oceanplant and Hyundai Engineering & Steel Industries are leading this sector along with former shipbuilders that have pivoted their business towards foundation structure. The foundation structure sector is likely to face increasing competition from the Chinese manufacturers going forward but considering that these products are sensitive to transportation cost due to its weight, Korean suppliers may be able to maintain their competitiveness in the growing domestic market with appropriate investment in research and development.

Subsea cable is another area that Korean suppliers are showing significant competence, led by LS Cable. LS Cable is a world leader in offshore cables and has played a role in OSW projects across eight countries.[34] Other major players include Iljin and Taihan Cable & Solution.

Korean electrical systems manufacturers also have good potential in the OSW supply chain. HD Electric and Hyosung Heavy Industry are strong players in electrical systems market and will be able to service the needs for generally applicable components and substations. However, they are relying on overseas providers for OSW-specific design, which will need to be complemented with R&D going forward.

Installation and commissioning

Subcategory	Includes	Current South Korean supply	Expected opportunity for South Korea	Comment
Cable installation	Array cable installation; Export cable installation	Medium	High	
Foundation installation	Foundation installation (e.g., Monopile/jacket)	Medium	High	
Installation equipment, vessels and support services	WTG installation vessels, other installation vessels and support	Low	Med – near term High – long term	
Installation ports and logistics	Specialist ports and logistics services	Low	Med – near term High – long term	
Onshore works	Onshore construction specialised for offshore wind	Low	High	Lack of specialist companies, but capability expected to be high
Substation installation	Specialised substation installation	Low	High	

It is expected in South Korea that installation and commissioning will be led by large construction and engineering companies. Examples such as SK Ecoplant, Hyundai E&C, Kolon Global, Hanwha Construction, Daewoo E&C are the leading names in this field. There is sufficient expertise existing in these companies from similar industries, e.g., onshore and offshore construction, that it is expected to be difficult for new entrants. **A key challenge in**

[34] 4C Offshore

this area is that very few projects have been completed to date and OSW is a new field for these companies. Whilst these companies do not have a strong track record at present, they have all indicated their ambition to expand their OSW capabilities.

Korea's strong track record in shipbuilding is relevant to the installation and commissioning space. Notably there is significant experience in construction of wind turbine installation vessels (WTIVs), e.g., through Hanwha Ocean. Hanwha Ocean already has a sizeable track record of building WTIVs for its global customers. Hanwha Ocean (previously named as Daewoo Shipbuilding & Marine Engineering) had delivered two WTIVs to its subsidiary in 2009.[35] It had secured a contract with Eneti, a company providing OSW installation vessel services, to construct 2 WTIVs in May 2021. These vessels are capable of installing 14-15MW turbines. Eneti chose to place another shipbuilding order with Hanwha Ocean in October 2023.[36] Two other shipbuilding giants – Korea Shipbuilding and Offshore Engineering and Samsung Heavy Industries are also looking into WTIVs and related projects.

However, despite Korea's strong capacity in building WTIVs, there is very limited capacity for installation vessels in the Korean supply chain. Recently, Hyundai Steel Industries became the first Korean company to own and operate a WTIV,[37] which is the only WTIV owned and operated in the country. As the Korean shipbuilders are mainly servicing WTIV needs from overseas market and bringing in WTIVs from distant locations are often financially unviable, many industry experts point out that WTIV shortage may turn out to be one of the most important bottlenecks for Korean OSW deployment.

As will be discussed in detail in Chapter 4 of this report, lack of dedicated OSW installation ports also poses significant challenge. Although the Government has announced plans to develop installation ports, the proposed capacity is insufficient to meet the planned OSW capacity. Prompt planning and execution of port infrastructure improvement is required to ensure stable growth of OSW supply chain in Korea.

Operations and maintenance

Subcategory	Includes	Current South Korean supply	Expected opportunity for South Korea	Comment
Maintenance and inspection services	Blade inspection; online monitoring of components; cable monitoring; electrical systems monitoring;	Medium	High	
O&M ports	Specialised ports for offshore wind services	Med	High	

[35]The Guru, 10 trillion won worth of offshore wind ships will be released this year...Hanwha Ocean, Samsung Heavy Industries Smiles, 17 June 2023 - link

[36] iMarine, Hanwha Ocean Inks Contract for Newbuild WTIV, 30 October 2023 - link

[37] Steel & Metal News, Hyundai Steel Industries will deploy offshore wind power installation ships for the first time in Korea, 16 June 2023 -link

Vessels and equipment	O&M vessels	Low	High	

For operations and maintenance, it can be expected that a substantial proportion will be procured locally as the O&M base will be located locally to minimise costs and ease logistics. However, for highly specialised O&M components, equipment and services, it will require some time and experience for localisation. At present, there is a low amount of specialisation by South Korean companies to provide O&M services, likely due to the low operational capacity. As operational capacity increases, then the number of services providers will need to increase to provide sufficient capacity.

Likewise, the current capacity for O&M ports, vessels, and equipment is not high due to low operational capacity. However, as will be discussed in detail in **Chapter 4**, many ports across the country satisfy the physical characteristics to function as O&M ports, providing a good foundation for such services to grow quickly once the OSW capacity in operation expands.

Decommissioning

Subcategory	Includes	Current South Korean supply	Expected opportunity for South Korea	Comment
Decommissioning services	All specialised decommissioning services	Low	High	Lack of specialisation at present due to low requirement until end of operational projects.

The decommissioning supply chain area is currently in its nascent stages, uncharted in terms of commercial-scale execution and not an immediate priority for South Korea. Indeed, no companies found during the research specialised in decommissioning services. This is expected as South Korea is still a new OSW market and decommissioning service will be needed only at the end of the wind farm operational lifetime (around 25 years). Nevertheless, in South Korea, the existing installation and commissioning players could potentially emerge as viable players in this market over the long haul, leveraging its well-established port infrastructure and the availability of local vessel resources.

3.5. Current supply and opportunity for South Korea

Based on the review of operating companies, an assessment has been made on the current supply available in South Korea. This does not consider the differences in technical capacity and quality between South Korean companies and international organisations, and it may be that decisions around cost, availability, and quality would determine the selection of a supplier for a project. In addition, an assessment of the potential opportunity in South Korea has been made.

Given that there are few areas of real deficiency in capability in South Korea, and presently limited competition regionally, there is a high opportunity for most components and services. This opportunity will not necessarily be realised and will require an increase in the number and capacity of suppliers. It is also assumed that component and service quality match competitive standards in terms of both price and quality. Supportive policies are necessary for these opportunities to be realised.

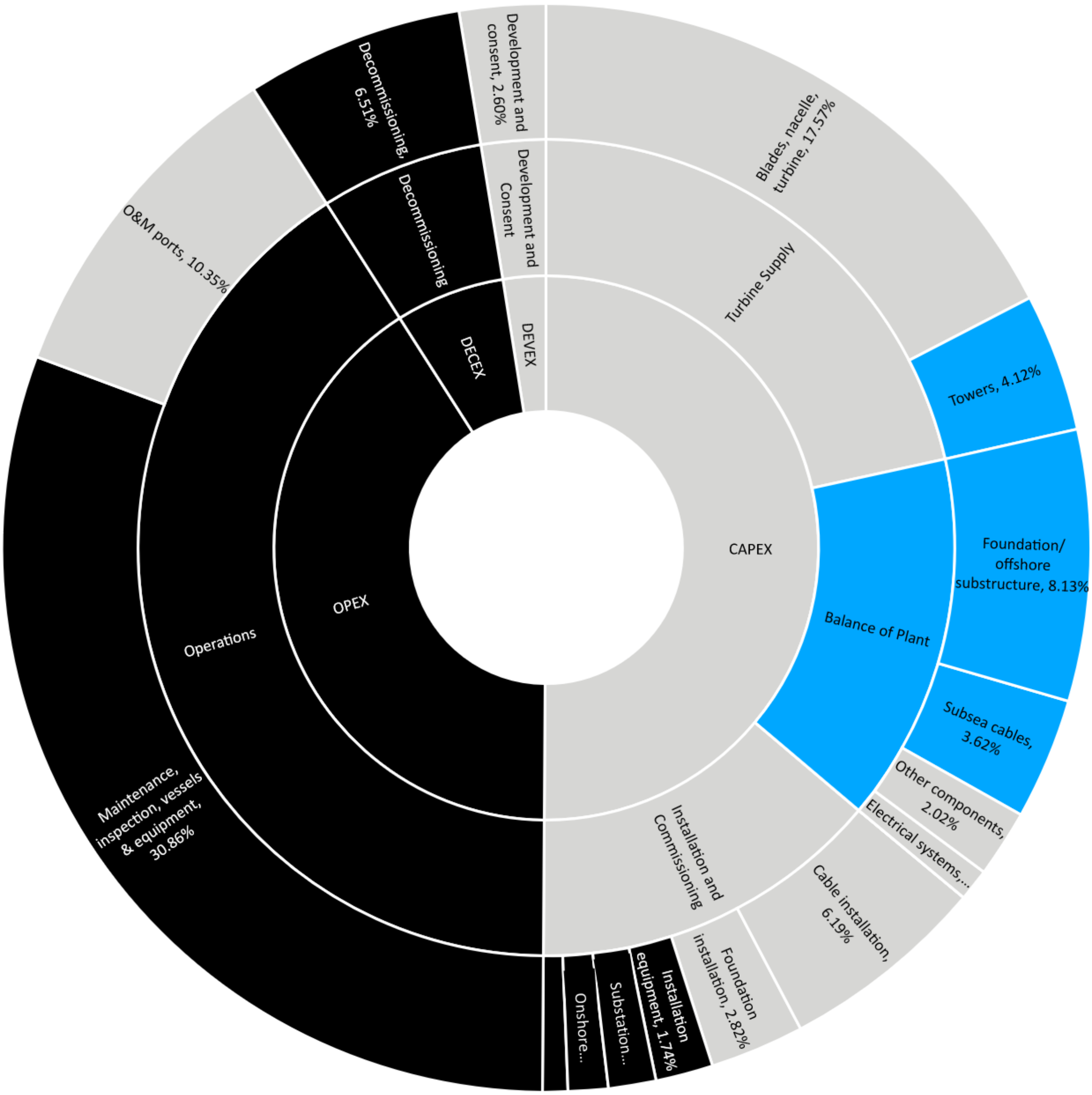


Figure 10: Current supply in South Korea (percentage values show typical cost breakdown for an OSW project). Blue = high, Grey = medium, Black = low.

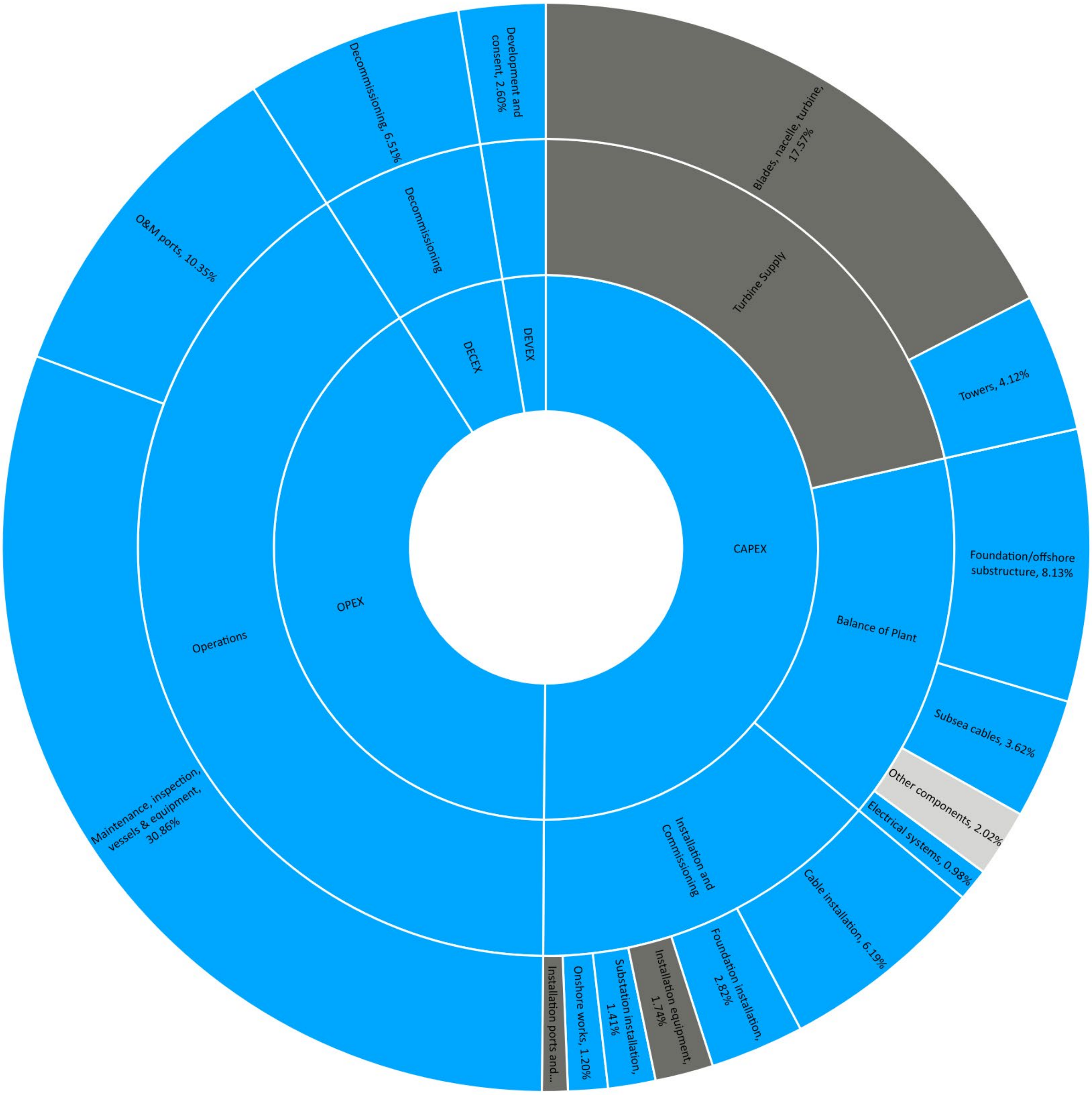


Figure 11: Opportunity for South Korea (percentage values show typical cost breakdown for an OSW). Blue = high, Dark Grey = medium-near term, high-long term, Light Grey = medium, Black = low.

3.6. Summary: South Korean supply chain is preparing for an influx of projects, and with sufficient investment, has the technical capability to capture a large proportion of the value chain

Whilst the South Korean supply chain played a leading role in early projects, with 77% of supply contracts observed, this was largely due to the small scale of such projects that made supply requirements easier to deliver. For upcoming projects, the local supply chain is expected to continue to play a key role, with 64% of supply contracts observed. However, there are some notable key areas where international suppliers are expected to play an increasing role.

For wind turbine generators (WTG) supply, international OEMs are expected to play a greater role in upcoming projects due to increased technical capability, which enables international OEMs to offer higher capacity turbines and therefore reduced project LCOE. In such cases, technology transfer is required to enable local manufacturers to capture future contracts within the market. In order to support this transfer, creation of partnerships between international and local OEMs has been observed.

The study reviewed 224 companies active in South Korea across the OSW supply chain to measure the current supply capability for components and services required to deliver OSW farms. **The results reflected the greatest amount of extant activity across Development and Consenting, reflecting the current high pipeline but low deployment rate in South Korea.** A qualitative assessment of the opportunity for South Korea revealed a high opportunity across nearly all components and services, backed by experience in similar industries, and presently low regional competition. On a technical basis, South Korea operates from a relatively high starting point for a nascent market, with several world leading suppliers of OSW components. The future opportunity is promising across most component and service areas.

Whether this opportunity is captured by local suppliers will be influenced by the ability of projects that are currently in the pipeline to be deployed according to planned timeframes. South Korea is presently operating in a region of relatively low extant supply chain competition. However, other nations within the region, including Japan, Taiwan, and Vietnam, have ambitions to develop local and regional supply chains.

In order for South Korean companies to capture a larger percentage of this regional market, it is expected that the delivery of a stable pipeline within South Korea itself will enable manufacturers to upskill and increase in capacity to be able to deliver services regionally as well as domestically.

4. Port infrastructure assessment

Key takeaways

- ✓ **Leveraging existing port infrastructure:** Leveraging South Korea's existing port infrastructure from other industries, such as shipbuilding, is a strength and opportunity for the OSW market. The key challenge for leveraging existing port infrastructure is availability of extant ports.
- ✓ **Potential for specialised OSW installation ports:** The number of existing large ports in South Korea demonstrate potential to act as OSW installation ports should they specialise to serve the OSW industry. Technical capability of ports to act in this way exists, although low availability means that specialisation is required.
- ✓ **Challenging upgrades for deep water ports:** Where infrastructure upgrades are required for staging ports, limited deep water ports required for floating OSW staging is highlighted as the key difficulty.
- ✓ **Readiness for ports for OSW operations and maintenance:** There are a good number of ports that have the technical capability to serve as OSW operations and maintenance ports without requiring significant infrastructure upgrades.

The objectives of this section are to assess the potential for current Korean ports to service OSW development and identify any key areas for further port infrastructure to meet OSW market needs.

Ports act as focal points during the installation, operation, and decommissioning of OSW farms. Therefore, port infrastructure that is able to provide these services presents an economic opportunity for a market. A factor in the success of European OSW growth is the fact that port infrastructure capitalised on the commercial opportunity presented on OSW.

Ports may require specialist upgrades for best capability to service OSW operations, and the specifications required will depend on the technology types that are utilised.

Requirements differ between fixed and floating operations. Therefore, there may be a requirement for investment in port infrastructure to provide the best services for OSW operations. According to WindEurope's Offshore Wind Ports Platform, investing in port infrastructure can also reduce the levelised cost of energy (LCOE) by up to 5.3%.[38] Cost reduction can be realised through lower transport costs, and increased installation speed should the port parameters ease installation processes. As specialised vessels command high daily charter rates, increased efficiency of installation can provide significant cost savings.

[38] WindEurope, Investments in port facilities could help offshore wind cut costs by 5.3%, 2018 - link

Port activities are summarised into five key areas:

1. **Staging**: is the process of storing OSW farm components port side from when they are delivered from the manufacturing facility prior to being delivered to site for installation. Staging is dependent on sufficient distance between the wind farm and manufacturing facility allowing the coordination of installation to be handled at a closer port. Pre-assembly of wind turbine components (usually tower sections) may also be done during the staging period. Unloading & loading of vessels with components will require certain infrastructure such as handling equipment (e.g., cranes) and prepared loadbearing storage area.

2. **Manufacturing**: is the production of the different types of components required to install and operate a wind farm including foundations, transition pieces, towers, nacelles, blades, export cables and electrical substations. Manufacturing requires factory space with specialised equipment, labour and raw material. If a manufacturing facility is close to a wind farm project, the components could be delivered direct to site reducing the needs for a staging port.

3. **Staging plus manufacturing**: incorporates the two activities at one port which maximises the benefit to a wind farm project that is close to the port. Cost savings during construction can also be expected under this scenario.

4. **Cluster**: refers to a port that can provide staging, multiple manufacturing facilities, a logistical network set up to facilitate OSW, and act as O&M base.

5. **Operations and maintenance**: A port that is capable of providing a base for the operational phase of the wind farm providing office and workshop space along with a certain level of storage.

The role of ports differs for fixed bottom and floating OSW, with floating OSW more onerous from a port perspective. For fixed bottom OSW, ports are used for manufacturing and transportation. Components may be manufactured locally or internationally and then brought to a port for staging and installation. In floating OSW, the WTGs themselves and floating substructures may be assembled at the port before being towed to the wind farm location, dependent on the fabrication strategy.[39]

4.1. Port review of sixteen key ports in South Korea

In South Korea, pursuant to the Harbor Act, ports are designated into two categories based on whether foreign vessels are allowed entry:

i. **Trade Ports** used for international trade and transportation where foreign vessels can enter and anchor. Trade ports have customs, quarantine, immigration, and bonded warehouse functions.

ii. **Coastal Ports** mainly used for domestic trade and transportation.

These two categories are again divided into **National Ports** and **Regional Ports**, depending on whether the management is handled by the

[39] Royal Haskoning DHV, Wind: An opportunity for ports, 2023 - link

central government or the municipal government.

As part of the assessment of the South Korean OSW market, this section intends to provide an assessment of current port infrastructure and its ability to support OSW development. The port data was collected from publicly available information from the National Logistics Information Centre and Port Authority websites. Additional information on the port features was provided the Ministry of Land, Infrastructure and Transport through the National Assembly. In total 16 ports have been assessed. Detailed information on the ports can be found in **Appendix 1**.

Port name	National ports policy category	Max water depth (m)	Distance from nearest OSW project (km)[40]	Site area (m^2)	Brief description
Busan	National trade port	18 m	2-5 km	11,501,000 m^2	Busan Port is the largest trading port in Korea located in Busan Metropolitan City. It is operated by the Busan Port Authority and ranks first in trade volume and volume in Korea. As of 2020, it has a processing capacity of 22 million TEU, and is the world's 5th largest container port in terms of cargo volume. It handles 57% of Korea's total maritime export cargo, 75% of container cargo, and 34% of national seafood production.
Daesan	National trade port	12 m	55 km	830,000 m^2	Daesan Port was designated as a trade port in 1991 and has operated mainly as a port facility for petrochemical companies. It now also operates passenger vessels.
Donghae	National trade port	13 m	2-10 km	1,324,000 m^2	Donghae Port, which is located in eastern part of Korea, is the largest trading port in Gangwon-do and mainly trades cement, bituminous coal and limestone. The LS Cable & System plant that produces subsea cables is located nearby.
Gunsan	National trade port	14 m	10 km	5,682,000 m^2	Initially opened to transport grain produced in the Honam plains, the port eventually had its facilities upgraded and various equipment modernised thanks to the increased volume of transported goods, and since the 1990s more trade with China and Russia has led to the development of Gunjang Port shinhang (new port). It consists of several ports which are currently reorganised to increase operational efficiency. It will be developed in connection with Saemangeum Port nearby.
Gwangyang	National trade port	23.5 m	2-30 km	11,890,000 m^2	Gwangyang Port is considered as naturally blessed port with a favourable port environment where the water is calm and requires no breakwater. It has grown to an integrated port with great growth potential with an extensive and wide background industries.

[40] Includes planned wind farms as well as those in operation.

Port name	National ports policy category	Max water depth (m)	Distance from nearest OSW project (km)[40]	Site area (m^2)	Brief description
Gyeongin	National trade port	10 m	80 km	1,600,000 m^2	Gyeongin Port serves as a hub of logistics in Seoul and northern Gyeonggi-do. It also acts as a multiple use port that connects inland areas with the sea. Gyeongin Port is composed of Incheon Port International Passenger Terminal ("Incheon Terminal"), which is located in the coastal city of Incheon, Gimpo Passenger Terminal ("Gimpo Terminal"), which is located in the inland city of Gimpo, and Gyeongin Ara Waterway that connects both terminals. Gyeongin Ara Waterway, running 18 kilometres, is 6.3 meters deep and 47-80 meters wide.
Hadong	Regional trade port	20 m	<60 km	N/A	Hadong Port is located on the Southern coast of South Korea. It was designated as a trade port in Dec 2010. Currently, it supports coal supply for the Hadong Thermal Power Plant and adjacent industrial complexes.
Incheon	National trade port	20 m	70 km	15,588,000 m^2	Incheon Port is the largest port on the west coast of South Korea. The shallow water depth and extreme tidal range of the west coast made it difficult for large ships to enter and exit the port. However, the construction of New Port in Songdo International City has made it possible for large ships to dock freely. In November 2022, Incheon Metropolitan City and Incheon Port Authority announced that they considered New Port (specifically, eastern area of 1-2) as a candidate for an OSW manufacturing port and South Port (specifically, E1CT and SICT) as an OSW O&M port.
Jeju	Regional trade port	12 m	All OSW projects planned or installed in the Jeju area is in the accessible range of Jeju port	752,791 m^2	Jeju Port is located on the northern coast of Jeju Island, connecting the island with the mainland. Jeju Port handles 70% of the shipments between the island and the mainland, and its role is growing in the greater region as increasing number of international cruise lines are setting their course to Jeju. The Government has announced plans to expand Jeju port by building a new port facility right next to the existing port by 2040.

Port name	National ports policy category	Max water depth (m)	Distance from nearest OSW project (km)[40]	Site area (m^2)	Brief description
Jinhae	Regional trade port	11 m	<30 km	217, 301 m^2	Jinhae Port is located in the Southeastern coast of South Korea. Jinhae Port was developed in the 60s with chemical industry grew in the region and has been the centre of South Korea's naval forces. In 2023, Changwon city took over the management authority of the port with plans to revamp the port's logistical and leisure functions.
Masan	National trade port	14 m	40 km	1,529,000 m^2	Masan Port, located in the well protected Bay of Masan, serves as the gateway of neighbouring Changwon National Industries Complex with annual cargo volume of over 10 million tons. It is also the port of call for regular liner services between Korea and Japan, Southeast Asia and Northeast Asia.
Mokpo	National trade port	12 m	2-30 km	2,505,000 m^2	Mokpo Port has served the core industries in the Southwest region as one of major national trade ports of South Korea. It is also a centre of islands tourism. There is a plan to establish "a steel pier" in the front of the port's rear complex around the New Port and use it as a support pier for OSW power.
Pohang	National trade port	19.5 m	10-50 km	2,992,000 m^2	Pohang Port is located in the southeastern part of the Korean Peninsula and serves as a gateway to Daegu and Gyeongsangbukdo and consists of three ports. The new port supports steel industrial complexes such as POSCO, the old port handles sand and oil, and Yeongilman Port, developed in 2009, is used as a container terminal.
Pyeongtaek-Dangjin	National trade port	22.5 m	80 km	6,501,000 m^2	Pyeongtaek-Dangjin Port is a large trade port extending from Pyeongtaek-si, Gyeonggi-do, to Dangjin-si, Chungcheongnam-do, through Asan Bay. Pyeongtaek-Dangjin Port is mainly composed of East, West, Songak and Godae piers. Pyeongtaek-Dangjin Port, which is the closest port to China, has been selected as one of the three national policy ports and five national development projects and has achieved continuous growth. Pyeongtaek-Dangjin Port is gathering point for ships bound for China's southern special economic zones such as

Port name	National ports policy category	Max water depth (m)	Distance from nearest OSW project (km)[40]	Site area (m^2)	Brief description
					Shanghai and Guangzhou, as well as Taiwan and Hong Kong. As a result, much of Incheon Port's cargo volume has been transferred to Pyeongtaek-Dangjin Port.
Samcheonpo	Regional trade port	16.5 m	<50 km	488,000 m^2	Samcheonpo Port is located on the Southern coast of South Korea, connecting the Western Coast and the Southern Coast of Soth Korea. It was designated as a trade port in 1966 and is currently handling mineral exports and fuel imports for thermal power plant in the area.
Ulsan	National trade port	18 m	80 km	3,504,000 m^2	It is one of the largest ports in Korea established as the largest industrial complex in Korea was developed. Currently, it ranks first in liquid cargo handling nationwide, third in port cargo volume, and second in ship arrival nationwide. As of 2018, 202.78 million tons of goods were processed at Ulsan Port for one year, and the monthly volume was 18.57 million tons. (489,815 TEUs) At Ulsan Port, liquid cargo accounts for 80% of the total cargo, and 32% of the nation's liquid cargo is handled here. Cars produced by Hyundai Motor Company and various ships built by Hyundai Mipo Dockyard are exported from Ulsan Port to all over the world.

4.2. Port readiness assessment

Based on reviewing the key characteristics and specifications of ports in South Korea, it is possible to undertake a readiness assessment as to their capability to support the five outlined port operations in OSW development.

It is not common for ports that have not been specialised for OSW with specific investment to be able to provide all relevant functions, and success stories such as Cuxhaven, Bremerhaven or Hull required significant investment before meeting the capabilities of today.

In South Korea, although there is limited extant operational capacity of OSW, a history of nautical trade and port infrastructure means that it is hypothesised that some capability already exists without specific investment. **The objective of this readiness assessment is to determine whether port infrastructure upgrades may be required and to give an indication of present readiness levels of port infrastructure to provide required services.**

To undertake the readiness assessment, key criteria have been assessed for installation and O&M requirements from OSW ports for both fixed bottom and floating OSW.[41] A port is deemed as having the highest level of readiness if it is able to service both technologies.[42] Ports that do not meet all requirements may be able to play a role as an installation port for some components (e.g., cables, mooring system for floating OSW, etc.).

Table 6: Installation port requirements.

Characteristic	Ideal requirement	Comment
Port physical characteristics		
Port depth	9-20m	Shallower ports applicable to fixed bottom OSW. Up to 20m may be required for semi-submersible floating installation vessels
Approach Channel Depth	>20m >7m (>90% of the time)	Greater depths may be required for floating OSW.
Quay Length	200-500 m	200-300m may be suitable for fixed bottom OSW, but up to 500m may be required for floating OSW
Quay Loadbearing Capacity	15 – 100t/m^2	
Heavy lift quay side area	3,000 m^2	
Seabed suitability	ISO 19905-1 Assessment for Jack Up vessel	To demonstrate a port's capability to allow jack up, an ISO 19905-1 Assessment for Jack Up vessels should be

[41] Carbon Trust, Harnessing our potential, 2020 - link

[42] Guide to a floating offshore wind farm, 2023 - link

		completed with positive results or corrective actions to improve the seabed are identified and completed to ensure safe jack up of such vessels.
Component handling equipment	Lo-Lo: Heavy Lift (>2 x 80T cranes)	
Storage loadbearing capacity	6t/m^2	
Laydown and pre-assembly space	15-20 ha	Required for lay down and pre-assembly of turbines (for floating OSW with turbines assembled at port).
Wet storage space (floating OSW only)	10-12 ha	For storing floating substructures prior to assembly.
Overhead clearance to sea	100m	To allow vertical shipment of towers
Overhead clearance to sea (if WTGs assembled at port)	No restrictions	Required to allow tow-out of turbines with tip heights well in excess of 200m
Port connectivity		
Distance from wind farm	<150km	The closer the distance, the lower the installation cost (through reduced vessel hire time etc.)
Distance from key component suppliers		Not included in readiness assessment but will play a role in selecting ports for specific projects.
Distance from road	Direct access	
Distance from rail network	Direct access	
Distance from heliports	On site	
Port layout		
Space availability	Staging – 12ha Manufacturing – 8ha Staging + manufacturing – 20ha Cluster – 24ha	
Workshop area	Present	
Office facilities	Present	
Potential for expansion	Present	

Table 7: Operations & maintenance port requirements.

Characteristic	Ideal requirement	Comment

Port physical characteristic		
Port depth	>3m	
Quay length	200m	
Loadbearing capacity	5 t/m^2	
Port connectivity		
Distance from wind farm	<60km	O&M bases for individual projects must be located at nearby ports.
Distance from road	Direct access	
Distance from rail networks	Direct access	
Distance from heliports	On site	
Port layout		
Storage space availability	2000 m^2	Due to a lack of information on current space availability of ports, this analysis has not been included below.
Workshop area	Present	
Office facilities	Present	

Based on these requirements, a readiness assessment has been completed in **Table 8** and **Table 9**. Whilst not all requirements are included in the readiness assessment, more information on specific ports can be found in **Appendix 1**.[43]

[43] Quay loadbearing capacity criteria was excluded from the analysis due to lack of data availability.

Table 8: Installation phase readiness assessment.

Legend: Blue = High; Grey = Medium; Black = Low, White = Not Applicable

Criteria	Requirement	Busan	Daesan	Donghae	Gunsan	Gwangyang	Gyeongin	Hadong	Incheon	Jeju	Jinhae	Masan	Mokpo	Pohang	Pyeongtaek-Dangjin	Samcheonpo	Ulsan
Physical characteristics																	
Max port depth	>20m >9m																
Approach channel depth	>20m >7m (90% of the time)											[44]					[45]
Quay length	>500m >200m																
Heavy lift quay side area	3,000 m^2																
Port connectivity																	
Distance from wind farm	<150km																
Distance from road	Direct Access Indirect Access																
Distance from rail networks	Direct Access Indirect Access																
Distance from Airport	Onsite Within 15km																

[44] No designated approach channel.

[45] No designated approach channel.

Table 9: Operations & maintenance phase readiness assessment.

Legend: Blue = High; Grey = Medium; Black = Low; White = Not Applicable

Criteria	Requirement	Busan	Daesan	Donghae	Gunsan	Gwangyang	Gyeongin	Hadong	Incheon	Jeju	Jinhae	Masan	Mokpo	Pohan	Pyeongtaek-Dangjin	Samcheonpo	Ulsan
Physical characteristics																	
Port Depth	3m	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
Quay Length	30m	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
Port connectivity																	
Distance from wind farm	<60km <80km	Blue	Blue	Blue	Blue	Blue	Grey	Blue	Grey	Blue	Blue	Blue	Blue	Blue	Grey	Blue	Blue
Access to Road Network	Direct Access Indirect Access	Blue	Grey	Blue	Blue	Blue	Blue	Grey	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
Access to Rail Network	Direct Access Indirect Access	Blue	Grey	Blue	Grey	Grey	Grey	Grey	Grey	White	Grey	Grey	Grey	Blue	Grey	Grey	Blue
Proximity to Airports	Onsite Within 15km	Grey	Black	Black	Grey	Black	Black	Black	Black	Black	Black	Black	Black	Grey	Black	Black	Grey

4.3. South Korean ports display offshore wind potential, yet require upgrades to prevent deployment delays

The readiness assessment can be used as a basis for evaluating the capability of ports to perform services in the five key areas. **The result of the readiness assessment shows that many ports in South Korea possess the physical characteristics required for servicing OSW. Notably, most of the ports are currently capable of functioning as operations and maintenance**, meaning that there is robust potential in port infrastructure for servicing O&M needs with minimal investment as long as their availability is secured.

Major ports including Busan, Incheon, Mokpo, Ulsan, Pohang and Gunsan appear to have significant potential for servicing manufacturing and staging needs. However, particularly for staging ports that require significant quay length, port depth, loadbearing capacity, and storage area, these results are only indicative of the potential capability to be used for OSW because most of these facilities are currently occupied with other functions and have very limited availability.

As a result, construction of additional port capacity is needed to meet the need for staging ports. Currently, no port in South Korea is functioning as a staging port for OSW, and according to the 4th Port Basic Plan (2021-2030) by the Ministry of Oceans and Fisheries, Mokpo is the only port with an official expansion plan dedicated to OSW functions. This could create a serious bottleneck for the OSW supply chain because OSW deployment cannot take place without appropriate port infrastructures.

According to the 2023 research by NEXT Group, five ports in the country are prime candidates for staging: Mokpo, Ulsan, Gunsan, Incheon, and Haenam. As mentioned above, an expansion plan is being implemented for Mokpo in accordance with the 4th Port Basic Plan, and Haenam is being developed by private parties as a part of Haenam Hwaweon Industrial Complex project[46] and will be used to meet the OSW needs for the Southeastern region in addition to Mokpo. However, for the other three ports, incorporating OSW functions to the port expansion plans are only being discussed at this point and has not been finalised.

The research also rightly pointed out that even if these five ports are developed as staging ports, additional ports may be required to meet the 2030 target for OSW deployment.[47] Considering that port construction also takes time, planning and implementation of port infrastructure must take place as soon as possible in order to prevent delays.

[46] NEXT Group, Are ports ready: The need for port plan to ensure timely deployment offshore wind, 3 Oct 2023. [KOR]

[47] Id.

Table 10: Potential Staging Ports in South Korea[48]

	Mokpo	Haenam	Ulsan	Gunsan	Incheon
Completion Date	1H 2024	2H 2026	2027-2028	N/A	2029
Storage Area (ha)	23.8	110	24.5	6.1	31
Quay Loadbearing Capacity	32	8	N/A	N/A	N/A
Vertical Clearance	Unrestricted	Unrestricted	Unrestricted	Unrestricted	Unrestricted
Port Depth	12	15	14	N/A	N/A
Berth No.	2	2	2	N/A	2
Quay Length	500	600	610	N/A	600-700

4.4. Expanding South Korea's ports and investing in floating wind technologies is crucial to improve prospects for future offshore wind projects

South Korea has a robust port infrastructure that can be potentially used for OSW development. There are several ports capable of providing services for OSW installation, and many with capabilities to provide support for operations and maintenance.

However, considering that the existing port capacity is preoccupied, developing new ports, particularly for staging purposes, appears to be a very important task for South Korea. As the installation phase of the projects in the pipeline is expected to begin around 2026, proactive planning and implementation of staging port development is highly recommended to avoid bottleneck around port infrastructure.

An additional challenge identified is with regard to the port depths that may be required for large floating substructures. The required depth utilised in the readiness assessment is 20m. For some floating substructure types, notably spar-buoys, greater port depths may be required for installation in an upright position. In South Korea, whilst there is a significant pipeline of fixed bottom projects, farther into the future a greater increase in the pipeline of floating projects will require investment in deep water port upgrades to enable this transition.

Allocating significant resource into the R&D around floating wind is recommended, especially towards substructure mass fabrication, port requirements (draft, available area, lifting capacity), substructure and turbine assembly, weather window restrictions, substructure-cable dynamics, heavy maintenance or inspection and maintenance of the mooring system. In addition, a development plan for the possible fabrication of floating wind substructures at a port on the south / southwest coast of South Korea is recommended.

[48] Id.

5. Labour and skills requirements

Key takeaways

- ✓ **Labour challenges:** South Korea's OSW sector can tap into skilled labour from offshore oil and gas, shipbuilding, and construction, though challenges exist due to the small size of the former and the need for significant training to transition workers from shipbuilding and construction.
- ✓ **Engineering shortages:** There is a shortage of mechanical and electrical engineers, which may impact the growth potential of the OSW sector. However, the number of graduates with engineering degrees has grown over recent years and may address the shortage facing technical occupations.
- ✓ **Apprenticeships:** Apprenticeships in South Korea are less popular compared to OECD countries, indicating a need for increased incentives to encourage participation. There is also a notable absence of apprenticeships tailored to maritime and marine skills which are important to the growth of the OSW sector.
- ✓ **Job creation potential:** Implementing 25GW of OSW by 2035 may create over 150,000 direct jobs. However, the extent of local job creation will hinge on policy support and effective skills transition across the value chain.
- ✓ **Workforce development:** Urgent actions to support the local workforce to meet OSW industry demands include creating a skills development plan, funding training and apprenticeships, and collaboration with academia. Further strategies involve introducing relevant degree fields, incentivising students to pursue engineering, identifying skills required to support the energy transition, encouraging STEM studies, and establishing a talent network for industry employment.

The OSW industry demands a diverse workforce with jobs in both transferrable and specialist disciplines. This workforce therefore requires a range of specific skills. The following section aims to outline the skill requirements of each area of the OSW supply chain, sub-divided into the core supply chain areas:

- Development and consent
- Turbine supply
- Balance of plant supply
- Installation and commissioning
- Operations and maintenance
- Decommissioning

A breakdown of applicable skills and qualifications for each part of the supply chain is provided below.

Supply chain	University degree	Apprentice level	Certifications
Development and consent	Oceanography, hydrography, geophysics, environmental sciences, ecology, biology, marine biology, meteorology, economics, engineering, project management, graphic design, law, accounting and taxation, finance and insurance	Marine logistics, drilling operators and engineering technicians	Maritime and vessel crew

<table>
<tr><td>Turbine supply</td><td rowspan="2">Manufacturing production engineering, structural engineering, textile technologies, civil engineering, mechanical engineering, fabrication engineering, design, marine engineering, geophysics, environmental science, electrical engineering and product design engineering</td><td rowspan="2">Welding, plating, fabrication, blasting, electricians, engineering technicians, metal fabrication, manufacturing engineering, plant assembly and construction</td><td rowspan="2"></td></tr>
<tr><td>Balance of plant supply</td></tr>
<tr><td>Installation and commissioning</td><td>Engineering, naval architecture, marine engineering, product design, electrical engineering, mechanical engineering, project management and geophysics</td><td>Marine and naval logistics, engineering technicians, ROV operation and drill operation</td><td>Diving, maritime, vessel crew, crane operation and HGV drivers</td></tr>
<tr><td>Operations and maintenance</td><td>Electrical engineering, mechanical engineering, QSHE and marine biology</td><td>Electrical, instrumentation, engineering technicians (specifically working at high voltage) and marine logistics</td><td>Diving, maritime, vessel crew and helicopter pilot</td></tr>
<tr><td>Decommissioning</td><td>Project management, mechanical engineering, electrical engineering, quality, safety, health and environment, and naval architecture</td><td>Naval and marine logistics, electricians</td><td>Diving, vessel crew, crane operation, HGV drivers and engineering technicians</td></tr>
</table>

5.1. Labour shortages and a limited pool of workers with transferable skills for offshore wind will require investment in upskilling workers from alternative sectors

OSW can open important opportunities for the South Korean industry. South Korean companies are already playing a market leading role in manufacturing tower and foundation structures, which is closely connected to its strength in the steel industry. With the increasing demand for green steel around wind power projects, OSW can provide the long-needed push for the transition of the carbon intensive steel industry in the country. In addition, South Korean shipbuilders are global majors pioneering the market for specialised wind power installation vessels. Further, KETEP assessed that Korean heavy industry is already capable of manufacturing more than 20 key components of OSW including tower, blade, and gear box.

5.1.1. Key sectors with offshore wind capabilities

In order to evaluate the capacity of the labour market to support OSW projects in South Korea, and identify areas where skills gaps and shortages exist, the relevant skill sets available in OSW adjacent sectors has been analysed. Specifically, sectors such as Shipbuilding, Oil and Gas and Construction emphasise skill sets related to marine engineering and design; surveying; construction, installation, maintenance, and repair; procurement; quality control; project management; workplace safety and health among others are considered applicable to OSW.

The table below maps out the skills typically required by the OSW industry and identifies the parts of the supply chain most likely to benefit from the relevant skills from comparable industries. The level of skills transferability between OSW and its adjacent sectors is rated as high, medium and low. This categorisation is made using a qualitative assessment and is determined based on the following criteria:

- **High:** if the skills are directly transferable between OSW and the comparable sector (i.e. no further formal training is required);
- **Medium:** if there is scope for the comparable sector's skills to be adapted to meet the OSW needs through on the job training or certifications without the requirement to pursue new technical degrees;
- **Low:** if there is no clear overlap between the comparable sector's skills and OSW, and significant time and resources will be required to develop the skill set through formal education and training.

Table 11: Level of skills transferability between OSW and its adjacent sectors

Legend: Blue = High; Grey = Medium; Black = Low; White = Not Applicable

OSW supply chain	OSW skill requirements	Shipbuilding	Oil & Gas	Construction
Development and consent	Financial analyst	High	High	
	Geotechnical experts	Low	High	
	Civil engineers	High	High	Medium
	Physicists and weather data experts		High	
Turbine supply Balance of plant	Material engineers	High	High	Medium
	Factory workers	Medium		
	Marketing and sales	High	High	
	Administrative and accountant	High	High	
	Design and R&D engineers	Medium	Medium	Medium
	Cable plough operators		High	
Installation and Commissioning	Trenching remote operating vehicle operators	Medium	High	
	Jetting systems operators		High	
Operation and Maintenance	Civil workers	Medium	High	Medium
	Site security and cleaning personnel	High	High	High
	Helicopter pilots		High	
Decommissioning	Truck drivers	High	High	High
Cross-cutting	Legal, regulatory, taxation experts	Medium	Medium	Low
	Mechanical engineers	Medium	High	Medium
	Electrical and electronic engineers	Medium	High	Medium
	Logistic experts	Medium	Medium	Medium
	Ship crew	Medium	Medium	
	Naval engineers	Medium	High	
	Quality, health and safety	High	High	Medium
	Drilling system operators	Medium	High	Low
	Technicians	Medium	High	Medium

	Telecommunications and computer engineers			
	Environmental and marine biology experts			
	Crane operators			
	Industrial engineers			

Oil and Gas

The offshore oil and gas industry has the greatest overlap with OSW given the high relevance of many skilled roles including engineers, geoscientists, technicians, mariners, divers and ship crew. However, the offshore oil and gas sector is relatively small in South Korea, thus limiting the number of transferrable skills that could be made available to OSW. That is, South Korea has a small amount of domestic oil and gas reserves and the workforce therefore lack the necessary experience and skills in oil and gas exploration that would be relevant for OSW. In addition, overseas operations of large companies such as Korea National Oil Corporation and Korea Gas Corporation focus on their role as investors or offtakers rather than any activity in project development.

Shipbuilding

As one of the leading shipbuilders in the world, South Korea employs approximately 120,000 workers as of 2020[49]. However, a recent rise in shipbuilding orders has resulted in a shortage of labour as workers employed in the industry at its peak in 2014 have left due to its dangerous work environment and relatively lower pay compared to growing areas such as battery factories or semiconductor plants for example. Key skills in shipbuilding relevant to OSW include marine engineering to design and build marine vessels, electrical systems installation and maintenance, project management, quality control and assurance.

While shipbuilding also offers several relevant roles for OSW, albeit with greater investment required for training and upskilling compared to the oil and gas sector, it is a key contributor to the South Korean economy and its current shortage of local workers may limit the scale of transfer to OSW.

Construction

Construction is a key contributor to South Korea's economy, employing over 741,000 workers as of 2023[50]. 15% of employees in the South Korean construction industry are foreign nationals due to a shortage of local workers as there is decreasing local interest towards manual labour. While the construction sector more generally has a fewer number of roles that are directly relevant to the OSW sector, construction workers specific to energy, industrial or manufacturing settings such as Engineering, Procurement and Construction (EPC) companies are expected to have the biggest potential for transferable skill sets to support the construction of OSW farms.

Alternative sectors

Other sectors that may be less directly aligned with the skills required by OSW but are facing an increasing risk of redundancy could also be

[49] Hanikyoreh, July 2022. Korea tops world in shipbuilding orders – but workers are opting for better paying, safer gigs – link.

[50] The Korea Herald, August 2023. Foreigners make up 14.8% of Korea's construction industry workers – link

considered to enable an effective green jobs and skills transition. For example, given the decarbonisation of the heat, transport and electricity sector, high risk occupations that are likely to be made redundant due to the transition should be identified now and an assessment to determine skills transfer should be made. Given the technical skills required in these sectors, there could be a significant potential to upskill those who are at most risk of livelihoods displacement such as conventional power plant operators and workers.

For example, targeted training programmes established between power plants that are being retired or repurposed and new OSW projects provide an effective route to equip the workforce with the necessary skills.

A recent case of this is Ravenswood Generating Station, a 2,480MW fossil fuel plant in the United States, that will be replaced with 1,400MW of OSW power and is currently transitioning their fossil fuel power plant workers to operate OSW equipment. Jobs that plant workers will transition into include operating the OSW project's control room, handling spare parts for servicing wind turbines and other logistic functions. Attentive Energy One, a joint venture between Total Energies and Rise Light and Power, made an agreement with a labour union to retain, retrain and upskill Ravenswood's plant workers so that they can transition to work on new renewable energy equipment and an operations and maintenance hub that can support up to 3GW of OSW.[51]

5.2. Workforce challenges and strategies for South Korea's offshore wind industry growth

A landscape assessment of the relevant skills of the current workforce and recent graduates entering the labour market has been conducted to determine the market's potential for delivering the current South Korean OSW portfolio.

5.2.1. Labour supply statistics by relevant occupations

Table 12 below summarises data obtained from the Ministry of Employment and Labour[52] and highlights the current statistics on occupations relevant to the OSW supply chain in South Korea.

Table 12: Breakdown of workers employed in industries relevant to offshore wind (July 2023)

Industry	Total workers employed	% of total employment
Manufacturing	3,737,380	18.8%
Manufacturing of basic metals	161,300	0.8%
Manufacturing of electronic components	397,462	2.0%
Manufacture of other machinery and equipment	462,256	2.3%
Maintenance and repair services of industrial machinery and equipment	44,079	0.2%

[51] Electrek, July 2023. In a US first, fossil fuel power plant workers will be retrained for offshore wind – link.

[52] MOEL Survey. Labor Force Survey at Establishments – link.

Electricity, gas, steam and air conditioning supply	66,403	0.3%
Construction	1,470,895	7.4%
General construction	450,077	2.3%
Specialised construction activities	1,020,818	5.1%
Land transport and transport via pipelines	403,758	2.0%
Information and communication	789,251	4.0%
Architectural, engineering and other scientific technical services	374,402	1.9%
Business facilities management and business support services; rental and leasing activities	1,237,753	6.2%
Business support services	850,808	4.3%

The employment data demonstrates that of the sectors with skill sets relevant to OSW, the manufacturing and construction sectors offer the largest manpower. However, data from recruitment agencies[53] in Korea note that mechanical and electrical engineering occupations are facing the biggest shortage. For example, South Korea had 230,000 job vacancies in June 2022 primarily in the industrial sector, with shipbuilding and manufacturing industries taking the biggest hit in terms of labour shortages[54]. To deal with the skills shortage in this sector and others, the government is opening its immigration policies to encourage skilled immigrants to work in South Korea.

This has implications for the potential growth of the OSW industry as the workforce is heavily weighted in the engineering sector throughout the supply chain, but primarily in installation, commissioning, operations and maintenance. As such, the short supply of these skills in the South Korean market will need to be addressed urgently to support the growth of the OSW sector. Other support skills related to logistics, administration and business support, or legal, regulatory and taxation support are not facing shortages and can support initial activities such as development and consenting, turbine supply and balance of the plant to some extent.

5.2.2. Regional labour markets

Following the review of the current South Korean labour market and the shortage of skills associated with the OSW supply chain, this section identifies the extent to which tapping into new graduates and the unemployment market can deliver the necessary OSW workforce needed and its potential for bridging the identified skills shortages gaps.

[53] Wage Centre, Shortage occupations in South Korea - Link

[54] Expat.com, South Korea: These sectors are currently facing labour shortages. Link

Table 13: Unemployment in South Korea by province (2022)[55]

Province	Unemployed Persons (15 years and older)	Unemployment Rate (15 years and older) (%)
Seoul	161,000	3.1
Busan	49,000	2.8
Daegu	30,000	2.3
Incheon	41,000	2.5
Gwangju	18,000	2.4
Daejeon	12,000	1.4
Ulsan	17,000	2.9
Sejong	3,000	1.5
Gyeonggido	185,000	2.4
Gangwondo	21,000	2.4
Chungcheongbukdo	15,000	1.5
Chungcheongnamdo	21,000	1.6
Jeollabukdo	15,000	1.5
Jeollanamdo	14,000	1.4
Gyeongsangbukdo	35,000	2.3
Gyeongsangnamdo	47,000	2.6
Jejudo	7,000	1.7
South Korea	**692,000**	**2.4%**

South Korea's unemployment rate was at one of its lowest levels at 2.50% in May 2023 (since unemployment figures were first reported in 1999) and has since increased to 2.8% in July 2023. South Korea has maintained an average unemployment rate of 3.60%[56]. From the table above, it is evident that the unemployment ranges from 1.4% in Daejeon (12,000 people) to 3.1% in Seoul (161,000 people).

Table 14: Highest level of education attained by province as a % of the economically active population (2023)[57]

Province	Elementary school or below	Secondary school	High school	Junior college	University
Seoul	3%	5%	30%	12%	51%
Busan	5%	9%	36%	13%	36%
Daegu	6%	7%	35%	18%	35%
Incheon	4%	6%	46%	15%	29%
Gwangju	5%	6%	37%	17%	35%
Daejeon	4%	6%	30%	13%	47%

[55] KOSIS - link

[56] CEIC Data. South Korea's Unemployment Rate – link

[57] KOSIS - link

Ulsan	4%	5%	43%	17%	31%
Sejong	5%	4%	22%	11%	59%
Gyeonggido	3%	5%	39%	15%	38%
Gangwondo	12%	10%	38%	11%	29%
Chungcheongbukdo	10%	9%	39%	15%	27%
Chungcheongnamdo	12%	9%	40%	13%	26%
Jeollabukdo	13%	9%	37%	11%	30%
Jeollanamdo	16%	10%	37%	13%	24%
Gyeongsangbukdo	13%	11%	39%	14%	24%
Gyeongsangnamdo	8%	9%	39%	15%	30%
Jejudo	6%	6%	35%	20%	33%
South Korea	**6%**	**7%**	**37%**	**14%**	**37%**

Based on the educational attainment in the whole of South Korea, 6% of citizens have elementary education or below, 7% secondary education, 37% high school education, 14% junior college, and 37% hold a university degree or above. With almost 50% of South Korean citizens not undertaking higher education qualifications, there is great potential for the country to put measures in place to incentivise education and training beyond the secondary level. In terms of provinces, Sejong, Seoul and Daejeon have the largest concentration of people with the appropriate levels of qualifications for an industry like OSW.

5.2.3. Higher education

Universities, colleges and institutes of technology supply the labour market with graduates crucial to the OSW industry. **Table 15** outlines the number of people graduating from South Korean institutions with higher education degrees relevant to employment within the OSW supply chain.

Table 15: Higher education qualifications from South Korean institutions in 2021 in subjects relevant to offshore wind

Relevant Field of Study	Undergraduate Qualification (2021)	Postgraduate Qualification (2021)	Total Higher Education Awards (2021)	5-year trend (2017 – 2021)
Engineering				
Civil construction engineering	4,360	821	5,181	-5%
Urban engineering	939	209	1,148	0%
Transportation Engineering	408	112	520	6%
Aerial Engineering	1,738	323	2,061	8%
Ocean Engineering	1,922	239	2,161	-11%
Mechanical Engineering	10,582	1,611	12,193	7%
Metallurgical Engineering	123	35	158	-5%
Automobile Engineering	1,002	102	1,104	15%
Electrical Engineering	3,745	355	4,100	4%
Electronic Engineering	9,979	1,865	11,844	2%
Control & Measurement Engineering	644	62	706	-8%
Optical Engineering	686	73	759	-11%
Energy Engineering	2,160	589	2,749	15%
Semiconductor & Ceramic Engineering	477	134	611	10%
Textile Engineering	296	54	350	-5%
New Materials Engineering	4,501	1,055	5,556	1%

Material Engineering	1,226	312	1,538	14%
Industrial Engineering	3,553	486	4,039	-2%
Chemical Engineering	5,240	1,049	6,289	5%
Mechatronics Engineering	1,244	190	1,434	7%
Applied Engineering	2,299	607	2,906	12%
General Engineering	430	75	505	27%
Information, Communication Technology				
Computer Science & Engineering	10,445	1,291	11,736	10%
Software	3,250	292	3,542	68%
Information & Communication Engineering	6,851	981	7,832	0%
Math and Science				
Mathematics	2,478	234	2,712	-8%
Statistics	2,070	344	2,414	-11%
Physics & Science	1,817	607	2,424	-13%
Astronomy & Meteorological Studies	281	87	368	-13%
Earth Science & Geography	758	111	869	-9%
General Natural Sciences	150	-	150	-27%
Architecture				
Architecture Equipment Engineering	3,302	387	3,689	1%
Architecture	3,377	330	3,707	-2%
Landscape Architecture	792	94	886	-13%
Business and law				
Business Administration	30,181	3,399	33,580	-6%
Economics	7,109	441	7,550	-11%
Tourism	2,621	194	2,815	18%
Advertising Creation	1,783	80	1,863	-21%
Finance, Accounting & Taxation	4,415	243	4,658	-10%
International Trade & Distribution	7,380	532	7,912	-10%
General Economics & Commerce	365	-	365	-33%
Law	4,034	547	4,581	-28%

The fields of study with the largest number of undergraduate qualifications included Business Administration, Mechanical Engineering, Computer Science and Engineering, and Electronic Engineering. Post graduate qualifications also follow a similar trend in terms of popularity of subjects. The fields of study with the greatest decline in awards over a 5-year period are Economics and Commerce, Law, and General Natural Sciences, while the fields with the greatest increase over the same period are Software, General Engineering, Tourism, and Material Engineering. **The majority of the engineering degrees have seen an overall positive trend over the 5-year period which suggests that the growth of the OSW industry can be partially supported by new graduates.**

5.2.4. Apprenticeships

Apprentices play a vital role in the OSW industry, in particular in the procurement, manufacturing, operation and maintenance supply chain areas, in job roles such as engineering technicians as well as manual labourers. As well as this, apprenticeships provide a pathway to further study for higher level qualifications in the likes of engineering.

As of May 2019, 93,437 apprentices participated across 30,580 training courses provided by training centres, companies, apprenticeship schools, and Industry Professional Practices. The machinery sector accounted for 36.2% of all training courses followed by electricity and electronics (13.7%), information and communications (11.3%), business, accounting and administration (8.9%). For apprenticeships offered by companies, the majority are provided by SMEs (94%) with less than 300 employees.

Table 16 outlines the number of apprenticeship courses relevant or transferrable to the OSW industry in 2019.

Table 16: Apprenticeship courses in South Korea in 2019 relevant to offshore wind[58]

Category	Number of courses	Proportion of total courses
Machinery	11,067	36.2%
Electricity/Electronics	4,200	13.7%
Information and Communication	3,446	11.3%
Business, Accounting, Administration	2,734	8.9%
Materials	1,671	5.5%
Construction	591	1.9%
Environment, Energy, Safety	217	0.7%

While the apprenticeships do cover some of the skills required for OSW, particularly to support turbine supply, balance of plant and installation parts of the supply chain, the schemes are less popular in South Korea compared to other OECD countries. For example, in 2012 only 2% of students enrolled in upper secondary and post-secondary education (16-25 years old) were part of an apprenticeship programme, which was below the OECD average of 6%. Of the OECD countries, only the United States, Italy and Japan fell below Korea in the rankings, while Germany and Austria rank the highest with almost 35% of their students in upper secondary and post-secondary education part of apprenticeships.[59] As such, the government may need to offer more incentives to encourage apprenticeships to ease the school-to-work transition.

In addition, there is a lack of apprenticeships relating specifically to maritime and marine skills. To deliver the South Korean OSW portfolio, the supply chain would benefit from the introduction and development of these kinds of marine apprenticeship schemes as well as those in specialist areas such as drill and remote operating vehicles.

[58] KRIVET, Apprenticeship in Korea 2019 – link

[59] OECD iLibrary. Investing in Youth : Korea – link

5.3. Training initiatives and collaborations driving South Korea's OSW workforce development

In addition to leveraging on existing skills of the South Korean labour market that are relevant to OSW, this section provides examples of existing OSW specific training programmes also available to the market. **These programmes are a mix of safety focused trainings run by technical specialists, university programmes, and on-the-job trainings run by OSW developers.**

TÜV SÜD Korea Global Wind Organisation (GWO) training centre[60]: The first Basic Safety Training Course for on-site workers of the OSW power industry took place between January and February 2023. The trainings will run monthly and cover first aid, manual handling, fire awareness and working at heights.

Korea Advanced Institute of Science and Technology (KAIST)[61]: KAIST along with the Technical University of Denmark are offering a double undergraduate degree on OSW energy. The degree covers provides in depth knowledge of aerodynamics, aero-elasticity, mechanics, grid connection, power systems, hydrodynamics, offshore structure design, and wind farm planning.

Equinor and Jeju National University[62]: The two organisations signed a MOU in February 2023 to foster OSW experts in the Jeju region by building a talent pool for the industry. Equinor will support lectures and internship programmes related to OSW, while Jeju National University will prepare an OSW curriculum and support practical course programmes.

Ocean Wind and Ulsan Metropolitan City[63]: Ocean Winds, a joint venture between EDP Renewables and Engie SA, and Ulsan have signed a letter of intent under which the city will support and cooperate with the OSW energy firm in the development, operation and maintenance of the KF Wind project in return for Ocean Winds to assist in the technology transfer, manpower training and job creation in the Ulsan area.

While these programmes are specific to certain regions or demographics, they are valuable resources to develop the labour market with the necessary skill sets to support the growth of the OSW industry in South Korea.

60 TÜV SÜD, February 2023, TÜV SÜD Launches GWO Basic Safety Training Course for Offshore Wind Power Industry Employees – link

61 DTU. Offshore Wind Energy (KAIST) - joint international programme – link

62 Equinor, February 2023. Equinor Korea and Jeju National University Sign MoU to nurture offshore wind expertise in Jeju region – link

63 Renewables Now. Ulsan backs Ocean Winds, Aker's Korea Floating Wing Project – link

5.4. South Korea's offshore wind supply chain offers substantial employment opportunities, influenced by policy shifts, workforce dynamics, and technological advancements

5.4.1. Offshore wind job creation potential for the South Korean labour market

The OSW supply chain has the potential for significant and diverse employment opportunities. **Table 17 below details the breakdown of labour requirements for each supply chain area to build out nearly 25GW in South Korea by 2035 (as calculated in Figure 3), based on IRENA estimates of labour days required over the life cycle of a typical 500MW OSW farm.**[64] It should be noted that the IRENA estimates are based on direct jobs creation potential and does not include indirect or induced jobs, suggesting that the total jobs creation potential goes well beyond the figures suggested below.

The inclusion of both indirect jobs (jobs in secondary industries which supply the primary industry sector) and induced jobs (jobs resulting from spending wages earned in the primary industries) would typically increase job numbers by 100 - 350%.[65]

Table 17: Total workforce required to deliver ~25GW by 2035

Area of supply chain	Estimated jobs supported by ~25GW
Planning & Development	1,526
Procurement	935
Manufacturing	120,316
Transport & Logistics	415
Installation & Connection	15,193
Operation & Maintenance	4,817
Decommissioning	9,361
Total	**152,563**

[64] IRENA, 2018. Renewable energy benefits - link

IRENA's study estimated that the development of a typical 500 MW offshore wind farm equates to 2.1 million person-days in total (or 12.31 person-years per MW), and this was further broken down by different types of human resources required by activity. Specifically, the study estimates 1.06% of the estimated 2.1 million person-days will be for planning and development, 0.32% for procurement, 55.73% for manufacturing, 0.10% for transport and logistics, 10.56% for installation and connection, 27.89% for operations and maintenance, and 4.34% for decommissioning. A bottom-up approach was used by IRENA to estimate the breakdown of human resources in terms of the specific roles that will be required to carry out the broader value chain processes.

[65] Institute for Sustainable Futures. Calculating Global Energy Sector Jobs – link

For South Korea, implementing almost 25GW of OSW energy by 2035 has the potential to create 152,563 direct jobs across the entire lifecycle of the projects. The majority of jobs (~122,776) are expected to be created within the first 6 to 7 years (2023 – 2030) under the planning and development, procurement and manufacturing phases. Up to 4,817 permanent jobs can be created across the operations and maintenance phase over the 25-year lifecycle of wind farms developed, while 9,361 jobs can be created during the decommissioning stage between 2058 – 2060.

It is important to highlight that the estimated jobs created is based on the expectation that South Korea is able to install almost 25GW of OSW capacity by 2035, and that exceeding this can result in even more employment opportunities. It should also be noted that the maximum jobs creation potential of 152,563 jobs will not be realised by the local workforce, and a proportion is expected to be based internationally.

The expected proportion of jobs that can be fulfilled by South Korea based workers will directly depend on the types of policies that are created to support local employment. For example, a study by the New York State Energy Research and Development Authority[66] on US job creation noted that two-thirds of the jobs required over the lifetime of an OSW farm would be localised and fulfilled by US based workers. Based on this figure, South Korea could expect up to 101,709 direct jobs to be created locally. However, it is not reasonable to assume that the same proportion can apply to South Korea due to differences in market strengths across the value chain.

Jobs within the installation and commissioning, and operation and maintenance parts of the supply chain areas are predominantly based in the vicinity of the host port. Therefore, these opportunities have the potential to directly impact and benefit the local area. Given the strong local manufacturing capability in South Korea, a significant portion of the 120,316 employment opportunities created during the manufacturing stage are expected to be based locally. However, if policy is not well balanced (ignoring local job creation or prioritising it too much in place of cost reduction which can reduce the ability to meet build out targets and ultimately result in fewer total jobs), then perhaps a smaller proportion of these jobs would be based in South Korea.

The number of opportunities to be filled can be drawn from sectors with similar skill sets, recent graduates entering the labour market, and re-training programmes for those unemployed. This reiterates the need for further investment in the supply chain to manage an effective skills transition and realise the job opportunities that OSW presents in South Korea.

5.4.2. Additional considerations

The South Korean labour market is subject to multiple uncertainty factors that have the potential to affect the size and distribution of the occupations and skillsets within the workforce. The relevant skill sets among the workforce identified to deliver the South Korean OSW portfolio are therefore subject to these uncertainty factors as well as factors that could affect the demand for employment within the OSW supply chain. These factors include:

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[66] GWEC, April 2021. Wind can power 3.3 million new jobs over next five years – link

Policy change: Policy has the power to influence the speed of deployment of the OSW portfolio and the extent to which the portfolio is delivered by amending elements like permitting and licensing, grid infrastructure, renewable energy targets, auction mechanisms etc. Policy also plays a big part in ensuring the attractiveness of OSW to investors, through financial incentives and risk mitigation mechanisms that serve to provide greater confidence to investors on the viability of the sector. Policy can also hugely influence the uptake of relevant apprenticeships and degrees through incentives, scholarship, grants, partnerships, and industry collaborations.

Migration: There is also risk to changes in the workforce resulting from South Korean residents opting to take their skills abroad and enter employment outside of the country, as well as changes in immigration to the country. Current net migration stands at 168,000 as of 2022[67]. That is, the number of people of foreign nationality moving to South Korea came in at 192,000, while those moving out of the country

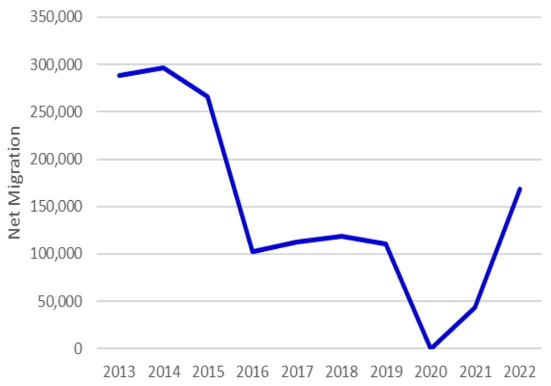


Figure 12: Net annual migration (2012 - 2022)

stood at 19,000. 33.4% of foreign nationals (64,128) came to South Korea for employment purposes. **Figure 12** illustrates the declining trend in net migration between 2014 to 2020[68], exacerbated by COVID-19 in 2020. However, this trend has since reversed with 2022 seeing a spike in both the number of people arriving and leaving the country increasing significantly.

Female representation: The current global drive for increased female representation in Science, Technology, Engineering and Maths (STEM) subjects has the potential to benefit South Korea's national labour shortage of engineers and scientists and hugely benefit the OSW sector. According to the annual report from the Korean Foundation for Women in Science, Engineering and Technology (WISET) published in October 2022, women only accounted for 21.17% of total students majoring in science and engineering in higher education[69]. As such, there is opportunity to expand on the workforce available to the OSW industry by removing the barriers limiting women's participation in STEM related subjects and occupations.

Demographic changes: According to the OECD[70], South Korea has been facing low birth rates since 2015 and is expected to see the elderly represent more than 20% of the entire population by 2025. The elderly dependency ratio (percentage ratio of over 65-year-olds and 15–64-year-old population) is estimated to reach 72% by 2050, compared to 18% in 2014. As a result, the South Korean population is also decreasing, with the country reporting its first natural decline in population in 2020 and is expected to shed 19 million in the working age population from 2020 to 2067.

These demographic changes are expected to have an impact on the availability of labour across the entire economy and therefore impact

[67] The Korea Herald, July 2023. Net migration to Korea spikes in 2022 – link

[68] The World Bank. Net migration – Korea, Rep – link

[69] The Korea Times, March 2023. More women needed and awaited in Korea's field of science, technology – link

[70] OECD iLibrary. Adapting Regional Policy in Korea: Preparing Regions for Demographic Change – link

the growth potential of the OSW sector unless the population decline is alleviated by increasing immigration trends.

Technological Changes: These have the potential to alter the skills requirements within the industry. An example of this is advancement in turbine design, which could increase turbine reliability and therefore reduce the frequency of maintenance and the requirement for maintenance workers. There is also potential for reduced requirements of on-site human work through a move to the likes of artificial intelligence (AI) and robotics, however this would also hold the potential for an increase in data analytic requirements.

The technological progress is creating further opportunities for value creation in industries such as OSW but also for businesses to serve this and other industries. The digital transformation, robotics and artificial intelligence markets will be more in demand by OSW players that seek either to supply to specific needs of the industry or to leverage the value potential of their assets, processes and resources.

There are good indicators that South Korea could be well placed to materialise these opportunities. The country is known as one of the most automated countries, with the world's highest robot density in manufacturing industries at 932 robots per 10,000 employees[71]. The country also ranks 5th among 132 economies in the Global Innovation Index 2021[72] based on its advanced infrastructure, high quality institutions, human capital and research capabilities, market and business sophistication, knowledge and technology outputs.

5.5. Targeted training, expanded apprenticeships, and collaboration between industry and educational institutions is necessary to bridge the skills gap

5.5.1. Recommendations

From the review of the current labour market's skills shortages and the supply of talent to the market, it can be concluded that the number of workers potentially transitioning from OSW adjacent industries, and from education and training systems is not expected to be enough to meet growing demand. In order to prevent skills shortages severely impacting OSW development, strategic measures must be taken. There are many opportunities for South Korea to develop and implement strategies to address these shortages. The most pressing of these should include:

- Preparing a **skills development plan** to ensure the skills and people requirements of OSW are met. This can include the creation of a '**Competency Framework**' for OSW to ensure the skills development required to deliver an OSW industry in South Korea. Involve academia and training bodies to ensure the correct initiatives are in place to meet requirements.

- **Funding training and introducing new apprenticeships** in skills related to OSW, in particular, marine and maritime skills, welding, crane drivers, HGV drivers and specialist areas such as drill and ROV operation.

In addition, there are many other strategies which would significantly support development

[71] Nextrends Asia, August 2022. Robots roll into South Korea, making it the most automated country in the world - link

[72] Global Innovation Index 2021, Republic of Korea – link

of the industry, which are recommended for adoption:

- Working with higher education bodies to **introduce new degree fields of study** in areas linked to offshore renewables such as environmental protection technology and marine related subjects.

- Facilitating the engagement between **industry employers and educational institutions** to incentivise students to remain in education beyond secondary level and enter engineering related degrees.

- Identifying **high risk occupations that are likely to be made redundant** due to the energy transition and identify upskilling potential for the deployment of OSW. Putting in place and promoting initiatives to **encourage students to study relevant STEM subjects**.

- Setting targets to **increase the number of women in STEM** subjects.

  Putting in place and promoting an initiative that acts as a **talent network for the industry**, which looks to bring together employers and those seeking employment.

5.5.2. Lessons from international best practice

A selection of case studies are detailed below, identifying successful mechanisms and strategies implemented in other countries to promote skills transfer and training on OSW that could be replicated by South Korea.

Country	Example of successful training programmes and initiatives
UK	**Supergen Offshore Renewable Energy Hub** Programme set up by the Engineering and Physical Sciences Research Council in 2001 to provide leadership for academic research on key offshore renewable energy areas such as wind power. The Hub connects academia, industry, policy and public stakeholders to inspire innovation, with resources such as funding, facilities, web-based tools, and online engagement platforms.
UK	**Offshore Renewable Energy Catapult** OREC is an innovation centre for offshore renewable energy, bringing together leading UK research and expertise to support the development of skills and knowledge. OREC promotes collaborative partnerships to address barriers to the deployment of OSW. They have often published on the skills challenge and created resources or partnerships to address them.
Denmark	**Danish Research Consortium for Wind Energy** A partnership between key universities with the objective of training highly skilled people in addition to achieving research goals. The consortium has published strategies and recommendations for how the Danish wind industry can prioritise and excel in certain research fields. The consortium serves as the backbone of network activities within the research community, coordinating research and educational activities to support the development of highly skilled workers.
Denmark	**State of Green** A public-private partnership, serving as a one-stop shop for Denmark's green energy transition. The partnership fosters strong collaboration and communication across key stakeholders to support the OSW industry (among other key green industries). The

	organisation has highlighted projects that are addressing the skills need in the country, such as a mapping project for green competencies in the Danish labour market.
Taiwan	**Industry-led education** The development of the Taiwanese OSW workforce has closely been supported by the Maritime Technology Innovation Centre in collaboration with international developers and companies such as Maersk. MTIC and Maersk have been actively expanding the GWO training courses in Taiwan. Separately, MTIC has also signed MoUs with Siemens Gamesa Renewable Energy, Ørsted, Vestech Taiwan, Taiwan Cogeneration Corporation and Taiwan Marine Heavy Industry to provide training for the domestic industry. Meanwhile, international organisations such as Ørsted, Siemens Gamesa Renewable Energy, and Arup have also funded and facilitated training support for Taiwanese workers. For example, Ørsted has funded training for Taiwanese technicians to go on secondment to the UK to develop their knowledge in technical aspects of OSW farm operations and to learn the operational safety standards of Ørsted. This is the first-of-its-kind training secondment programme. The aim is for 22 O&M technicians to receive training from this programme, and the first ten Wind Turbine Generator technicians have been sent. The programme is eight months long, and ahead of going to the UK, the technicians completed their onboarding and language programmes, as well as the GWO safety and technical training in Taiwan. Arup was appointed by the Taiwanese government, through the Industrial Technology Research Institute to support local developers. The services include extensive OSW training courses, technical design reviews, quality assurance, project management, and the development of technical protocols for the Taiwanese OSW industry in accordance with international standards.

In summary, best practices from the case studies that could be relevant for South Korea to advance the OSW sector and cultivate a skilled workforce to support its growth include:

- Establishing **collaborative innovation hubs** that connect academia, industry and government to drive research and innovation on OSW;
- Developing **industry-led education initiatives** in collaboration with international companies that aim to provide practical trainings to support workers to transition into the OSW industry;
- Creating **research consortiums** comprising of public and private sector stakeholders to carry out studies addressing critical OSW market barriers and identifying strategies to develop the local workforce to alleviate these barriers.

6. Delivering socio-economic and environmental benefits from offshore wind

Key takeaways

- ✓ **OSW projects offer an opportunity to deliver wider socio-economic benefits:** South Korea can replicate global OSW industry practices that enable job creation and promote stakeholder engagement. Successful examples include Orsted's investments in Grimsby, UK and La Gan offshore wind project in Vietnam, as well as compensation schemes in Denmark which are more common in onshore wind projects due to their direct impact on communities.

- ✓ **OSW projects can be encouraged to deliver environmental benefits:** Strategies to improve ecological impacts from OSW projects include innovative approaches such as nature-inclusive tenders, ecosystem restoration, and compensation schemes. For example, the Netherlands implemented OSW auction rounds using non-price criteria, while Orsted's ReCoral project in Taiwan aims to support natural coral growth on turbine foundations. Similarly, the UK increasingly requires developers to provide environmental compensation measures to fund habitat restoration.

- ✓ **South Korea has existing policies to promote community involvement:** Existing regulations in South Korea such as the Power Development Promotion Act and Occupation of Public Waters Act enforce community involvement and benefit sharing. Examples of profit-sharing between renewable energy project developers and communities to promote the local economy are evident in Jeju Island and Sinan County.

- ✓ **Options for community benefit schemes:** South Korea can promote community benefit schemes using both voluntary measures and mandatory policies. Mandates on community ownership, local content policies, and requiring OSW developers to contribute towards community funds and support local training schemes are potential options to promote socio-economic benefits, enhance community engagement and promote skills development in a nascent OSW industry.

- ✓ **Socio-economic and environmental benefits need to be considered within wider OSW strategy**: Where there are cost and delivery implications of such benefit schemes, this may influence LCOE or delivery schedules and therefore trade-off against other policy objectives. Policymakers should consider such trade-offs when establishing policy.

OSW offers vast potential to support wide socio-economic benefits. Foremost, OSW provides a clean source of electricity generation that can support the transition of a nation to Net-Zero and mitigate the impacts of climate change. In addition, OSW's position as large, capital intensive infrastructure projects create supply chain and job opportunities as outlined in the previous chapters of this report.

Given this opportunity, individual OSW markets are looking to maximise such benefits of OSW. In this section, some of these benefits are outlined, and may broadly fall into three categories:

- **Involuntary benefits** – those that occur automatically with OSW deployment;
- **Voluntary benefits** – those that developers provide outside of the planning and licensing processes; and
- **Mandatory mitigation and compensation** - schemes etc., that attempt to mitigate the impacts for those that may be negatively affected by OSW development.

The benefits and strategies deployed can be utilised in the South Korean context to deliver OSW in a way that benefits a larger number of people in the long-term, to secure buy-in from stakeholders external to the industry itself and therefore support long-term sustainable development.

Whilst delivering additional socio-economic benefits can support long-term sustainable industry development, it is important to note that delivery of additional benefits that may have financial implications may affect project cost and delivery timelines, which must be considered in terms of wider OSW strategy.

Moreover, it may be important to consider the communities that may be most affected by OSW development, and therefore where such benefits should be targeted. Communities in geographical proximity to a renewable energy development tend to desire more direct benefits because of the local impact of a project. In the case of OSW, these communities are primarily those who house the port from which the wind farm development is carried out, and the relevant stakeholders are those who live and work in this local area. In South Korea, these are primarily the fishing communities whose fishing grounds are affected by OSW projects.

Although wider socio-economic benefits from OSW developments are highlighted in this section, this study focuses on benefits to the local community specifically resulting from the OSW supply chain. Potential stakeholders and therefore prime recipients of supply chain community benefits have been identified as:

- Local residents
- Local workforce
- Municipal government
- South Korean Government

6.1. Offshore wind projects can be designed to promote socio-economic and environmental benefits

In order to materialise opportunities for community benefits, South Korea must put in place strategies to encourage good practice within the industry and assess if there are requirements for the introduction of formal legislation. The mechanisms outlined below highlight some of the potential opportunities for ensuring the delivery of community benefits based on positive experiences of the global OSW industry that can be replicated in South Korea.

6.1.1. Involuntary socio-economic benefits of offshore wind projects

OSW projects may create socio-economic benefits to some degree automatically without specific focus on this aspect, and the degree to which this is captured may depend on mandatory requirements and specific projects.[73] [74] [75]

Three such examples of these benefits are:

- Job creation potential;
- Restructuring and development of coastal communities; and
- Tourism industry benefits of OSW farms.

Job creation potential: Promotion of OSW power is expected to have significant economic benefits to the national economy and local communities by creating jobs because of its close connection with heavy industries such as shipbuilding, machinery, and steel, as well as construction industry. For example, Greenpeace estimated that the annual employment effect of OSW (20.2/MW) and PV (20.4/MW) is significantly higher than conventional energy sources such as coal (16.64/MW), nuclear (13.7/MW), and gas (4.84/MW).[76]

Example from Bin Thuan Province, Vietnam[77]: The 3.5GW La Gan offshore wind project is expected to create over 1,000 direct jobs every year once the wind farm is fully operational, with the operations and maintenance phase expected to be responsible for creating employment opportunities for the local community. A local O&M base will be set up in the province and create jobs related to on-site inspections, performance monitoring, corrective and preventative maintenance, marine coordination, health and safety management, compliance, and government coordination. To cultivate local talent, the developer will be initiating programs related to "Green Collar" trainings for local communities.

Restructuring and development of coastal communities[78]: Ørsted's investments in Grimsby, UK, which is a coastal city and fishing port, include GBP 10 million in the development of an Operations and Maintenance Centre which has created new jobs requiring high qualifications. Ørsted has also partnered with the Grimsby Institute and Furness College in Barrow-in-Furness to provide a three-year internship programme for wind turbine technicians.

Tourism industry benefits from OSW farms: In the UK, the development of OSW farms has created a new industry for OSW tourism. Whilst OSW may have historically been hypothesised to negatively affect the tourism industry, the opposite has been observed in the UK, where tourists may visit areas where they can observe OSW farms, and take boat trips to tour wind farm sites. [79]

6.1.2. Community benefit funds

Community benefit funds are financial programmes created by developers as a formal benefits package to local communities. Such funds may either be mandatory if required or may voluntarily offered by developers. Some developers are also known to not offer any formal benefits packages as the belief is that the benefits will come in the form of employment during the construction and

[73] renews.biz, November 2019. Denmark changes renewables compensation – link

[74] State of Green, November 2021. From NIMBY to PIMBY – link

[75] Danish Energy Agency, Promoting onshore wind energy – link

[76] Greenpeace, Outlook on employment effects of a Global Energy Transition, 2018

[77] La Gan Wind, Offshore wind will bring new opportunities to Binh Thuan province – link

[78] Orsted. Rnewable Energy Solutions - link

[79] The Economic, Britain's offshore wind farms attract tourists, 2023 - link

operation phases of the wind farm[80]. Examples are included below:

Examples of schemes to support the development of the community impacted by OSW projects

- **Denmark's Green Fund Scheme:** The municipal government also manages a fund that requires renewable energy plant owners to pay the relevant municipality a one-off sum of 1,700-22,000 EUR per MW. The funds will be used by municipalities to benefit local areas near newly built renewable energy plants. In Denmark, there are further compensation requirements for onshore renewables, including compensation for depreciation on residential property values caused by wind farms and additional compensation for those that live within very short distances from onshore wind farms. Further explanation is provided in **Appendix 2.** It should be noted that OSW farm locations are usually multiple kilometres offshore at a minimum, extending to well over 100 km offshore, and therefore such impacts are lower than for onshore wind farms and may not be required.

- **Hornsea's Community Benefit Fund[81]:** Ørsted has committed to providing GBP 700,000 per year over an initial 10-year period from the Hornsea Three offshore wind farm development, subject to Ørsted making a positive financial investment decision to develop the project. Ørsted also provides funding to the East Coast Community Fund, which has awarded over GBP 2.2 million to 170 community and environmental projects over 5 years to support those living withing the coastal funding zone. Examples of community projects funded include buildings and facilities, sports and recreation activities, environmental and wildlife projects, STEM education and skills.

In terms of how much compensation is typically provided by wind developers to the community, this varies by developer and often the benefits packages can be ad hoc in the form of one-off in-kind payments, bursary or education schemes and in some cases in the form of an annual community fund. Further examples of compensation provided by developers or required by policy in the UK are provided below:

[80] Energy Policy, June 2017. Understanding community benefit payments from renewable energy development – link

[81] Orsted. Hornsea 3 Community Benefit Fund Consultation – link

Developer / Region / Policy	Amount of compensation	Duration of compensation
Brenig Wind Ltd Community Benefit Fund[82]	GBP 4 million in total paid to the community	25 years
Scotland (for onshore projects)[83]	GBP 5000/MW installed capacity per year paid to the host communities	Over the 20 – 25 years of the operation and management stages of development
Highland Council policy[84]	Developers should provide GBP 5000/MW installed capacity per year for offshore renewables projects	Over the 20 – 25 years of the operation and management stages of development
Aberdeen Offshore Wind Community Benefits Fund[85]	GBP 150,000 per year or GBP 3 million in total (GBP 1500/MW per year) to support environmentally sustainable community facilities	20 years
Beatrice Offshore Windfarm Limited's Community Benefits Fund[86]	GBP 300,000 per year or GBP 6 million in total (GBP 500/MW per year) to support projects that empower communities and build sustainable places	20 years

6.1.3. Engagement with commercial fisheries

A key challenge in developing OSW in South Korea is opposition from commercial fisheries. This challenge is not unique to South Korea, and there are several learnings from international experience that can support collaboration and enable benefits to be realised.

[82] BBC News. July 2021. Offshore wind farm compensation 'sounds like bribery' – link
[83] Community Benefits and UK Offshore Wind Farms: evolving convergence in a divergent practice – link
[84] Energy Policy, June 2017. Understanding community benefit payments from renewable energy development – link
[85] Community Benefits and UK Offshore Wind Farms: evolving convergence in a divergent practice – link
[86] Community Benefits and UK Offshore Wind Farms: evolving convergence in a divergent practice – link

Offshore wind collaboration with the fishing industry

A key challenge expected in developing offshore wind in South Korea is opposition from commercial fisheries. This challenge is not unique to South Korea, and there are several learnings from international experience that can support collaboration and enable benefits to be realised.

For example, SSE Renewables[78] recently outlined their plans to better co-exist with fisheries when building and developing offshore wind projects. The plan focuses on 'The Three C's':

- Communication – transparent and effective communication of activities
- Collaboration – development of mitigation and operation strategies with input from the fisheries sector
- Co-existence – understanding conflicting viewpoints and achieving a synergetic approach to co-existence.

Collaboration in a meaningful way can deliver multiple benefits:

- **Employment**: A Company Fishing Liaison Officer is employed to maintain timely communication with fishers regarding project development activities. In addition, fishing vessels may be employed to support survey works, and act as guard vessels.
- **Cooperation agreements:** Offer support and guidance to fishers who may lose access to their regular grounds temporarily during pre-construction and construction works or face loss or damage of gear. In such cases, SSE Renewables has established a claims process for affected fishers who can work with the Fishing Liaison Officer to be appropriately compensated.
- **Access to data**: Sharing geophysical survey data prior to construction, and timely survey data during operation to fisheries to aid decision-making.
- **Service requirements**: Requirements for services including scouting surveys and post-construction trials (including over trawl), fisheries impact assessments, acting as guard vessels, amongst other opportunities.

Offshore wind may also increase fish populations to support the fishing industry:

- Evidence undertaken in Belgium for two commercial fish species indicates that offshore wind turbines attract fish, provide shelter and food and can play a significant role in the fish life cycle. In this way, offshore wind farms can act as refuge and recovery areas to replenish overfished areas.

6.1.4. Encouraging environmental benefits of offshore wind projects

Examples of voluntary and mandatory measures that have been put in place to enhance the ecological impacts of OSW projects to benefit the community are provided below.

Examples of incentivising positive ecological impacts to be built into offshore wind project design considerations

Nature-inclusive tenders[87] [88]: The Netherlands has run 2 offshore auction rounds using qualitative (non-price) criteria in which bidders had to demonstrate that they can mitigate or restore the impact of the OSW farm on maritime diversity by ensuring that birds can safely fly in between the turbines and have piling techniques included in the construction phase to minimise the impact on marine habitats. The auctions required developers to pay for the right to build the wind farms, and the government will use this money to ensure that wind farms are designed with consideration to the environment and other activities in the North Sea.

For example, the project that won the latest auction round – Ecowende – which will have an installed capacity of 760MW, will be ensuring that the design and construction of their wind farm has positive ecological impacts by:

- Creating a corridor for birds by placing the wind turbines far apart;
- Using innovative foundation techniques for wind turbines that minimise the impact on marine mammals and marine life;
- Placing natural reef structures on the seabed to stimulate biodiversity; and
- Working with a group of scientists and experts to implement dozens of innovative solutions and evaluate existing knowledge gaps about the ecological impact of OSW.

Using non-price criteria encourages innovation to address broader issues such as biodiversity protection and community engagement as noted below.

[87] Orsted. Net Positive biodiversity impact – link

[88] Ecowende. – link

Non-price criteria in auctions can incentivise community benefits in mature markets

The use of non-price criteria in tender auctions is common in offshore wind markets globally. Track record of delivery can be used as an evaluation criterion in emerging markets to increase confidence of early projects being delivered.

There is an increasing trend, e.g., in Netherlands, Germany, and interest in the UK, of including non-price criteria to support wider community benefits such as ecological protection or benefit, and supply chain development.

Industry have generally been supportive of non-price criteria, as this can reduce the pressure for cost reduction and the 'race to the bottom' that has ensued in some mature markets. For example, SSE Renewables have released a position paper on non-price criteria, which recognises the role of non-price criteria in delivering projects on time, on budget, and that provide long term value to society and the environment.

Given the global context of supply chain pressures, inflation, and rising costs, introduction of non-price criteria to select projects can ease the pressure on cost reduction by focusing on alternative objectives. The UK's recent experience, where zero bids were received for offshore wind in the recent Contracts for Difference Allocation Round 5 (link), with price as the only selection factor, demonstrate how a focus on alternative objectives could support increased interest and deployment.

For emerging markets, it is important to consider whether there is sufficient market competition and capability to introduce non-price criteria focused on community benefits. In the near-term for South Korea, the focus should be on delivering larger commercial-scale projects that are already in the pipeline.

Whilst non-price criteria offers opportunity to prioritise objectives other than cost, the additional complexity of introducing non-price criteria means that attention should be given to designing the criteria well, including introduction consultation phases, to avoid any unforeseen negative consequences.

Examples of ecosystem restoration efforts by offshore wind developers

Net-positive biodiversity[89]**:** Ørsted's ReCoral project, which is a proof-of-concept trial in partnership with the Penghu Marine Biology Research Centre aims to support natural coral growth on the foundations of OSW turbines on the Greater Changhua OSW farms in Taiwan. As turbine foundations can enable corals to have good access to light while being protected from extreme temperatures, the project is currently testing and refining how coral health could be further improved in these structures.

Examples of ecosystem compensation schemes

Environmental compensation[90]**:** In the UK, OSW developers are increasingly required to provide environmental compensation measures to

[89] Orsted. Net Positive biodiversity impact – link

[90] The Crown Estate, June 2023. The Crown Estate and Offshore Wind Industry Council launch £3.5m project – link

offset the potential negative impacts of their projects. The funds are typically used to support protected habitats or species in locations that may be separate to where a specific development has been proposed. In order to take a more coordinated and strategic approach to environmental compensation, the Crown Estate and the Offshore Wind Industry Council launched a GBP 3.5 million research project which aims to improve the shared understanding of environmental compensation options relating to offshore wind's interface with nature, and better coordinate the consenting process for OSW projects. The research project expects to provide insights on how compensation can support:

- Provision of artificial nesting for seabirds – this could be onshore or offshore, such as building nesting structures on disused oil and gas platforms;
- Habitat restoration and creation;
- Predation reduction – this can involve exclusion zones around protected seabird colonies and biosecurity programmes to improve seabird breeding success;
- Removal of defunct infrastructure.

For example, the development consent order for Hornsea 3[91] included a requirement for ecological compensation measures for a vulnerable seabird species whose population could be affected by wind farms. The compensation plan is focusing on providing artificial nesting structures for the birds that are bespoke to the landscape characteristics of each location.

Figure 13: Hornsea 3 artificial nest boxes for kittiwakes (*Rissa tridactyla*).

[91] Orsted, Kittiwake compensation – link

6.2. Community engagement and benefit-sharing programs are encouraged in South Korea

6.2.1. Community involvement under the relevant laws

Some of the laws applicable to OSW projects require community involvement in the permitting procedure to consider community concerns and increase the acceptability. The Power Development Promotion Act requires that the project developer collect opinion from the community in order to apply for approval of the Implementation Plan. More importantly, the Occupation of Public Waters Act prescribes that the applicant for a Public Water Occupation Permit must acquire consent of the relevant members of the community, including local residents and fishing community.

Other laws provide community benefit programs to balance the interest of the impacted communities in the form of (i) compensation for losses, (ii) community support, and (iii) benefit sharing. If an OSW project results in limitation of fishing activities, such losses can be claimed against the project developer under the Land Compensation Act, which should be paid prior to the construction unless otherwise agreed between the parties.

Community support such as welfare facilities, local business development support, and financial aid is defined under the Special Act on Support for Areas Adjacent to Power Generation Facilities and Special Act on Support for Areas Adjacent to Power Transmission Facilities. Finally, the Renewable Energy Act promotes community benefit sharing by providing additional RECs to projects where the local residents participate as investors.

Case Studies (Community Engagement and Consultation Processes)

Community involvement and benefit sharing often occur outside the requirements or procedures prescribed in the law in the form of voluntary arrangements or agreements between the project developer and the community, or the local government. For example, Jeollanamdo (8.2GW) and Jeollabukdo (2.4GW), the two regions hosting the largest planned OSW capacity, are underdeveloped regions that can benefit from the economic boost from OSW industry. Because OSW requires coordination with local communities and infrastructure in the construction phase and long-term maintenance and management during operation phase, OSW projects can have a positive impact on the local economy.

In this section, two cases are presented as examples in practice. The first is Jeju, where community benefit sharing was implemented for the first time. In Jeju’s model, the operators provide voluntary donations and Jeju government operates various programmes to promote renewable energy in the region including local communities. Meanwhile, Sinan County recently took a more direct approach by providing cash payments to local communities.

Jeju Island

Jeju, a volcanic island located in the southern sea of the Korean peninsula, has long been famed for its wind. In September 2015, Tamna Marine Wind Power (30 MW), the first OSW project was completed in Jeju. As of 2022, approximately 295 MW of wind power generators are in operation in Jeju. Jeju has the goal of supplying 450 MW (onshore) and 1,895 MW (offshore) by 2030.

In Jeju, civil society advocated for public management of its natural resources. Encouraged by such movements, public management of wind resources is declared in accordance with the Special Act for the establishment of Jeju Special Self-Governing Province and the creation of an international free city (Article 304 (1)). In accordance with this provision and the Ordinance on Permission and Designation of Wind Power Projects, wind power developers are required to submit a profit-sharing plan with the main focus of donating a certain portion of its revenue (17.5% of net profit or 7% of sales revenue recommended).

Jeju Provincial Government created the 'Wind Resource Sharing Fund' with the donations from wind power developers according to their profit-sharing plan. The fund is managed by Jeju Provincial Government and is used for implementation of a wide range of projects such as renewable energy R&D support, energy support for vulnerable groups, and renewable energy education/promotion, instead of being directly provided to local residents. From 2017 to 2021, the total amount of 22 billion won was raised for this fund, and the donation paid by the business operator accounted for about 8 billion won.

Some criticised Jeju's practices for lowering the motivation for business development due to unconditional demand for profit sharing. However, it also played a positive role in improving residents' acceptance towards wind power projects. For this reason, these cases are being studied and replicated by other local governments around the country.

Sinan County

Sinan County has access to the best sunlight and wind conditions in the southwest coast. The county aims to install 10GW of renewable energy by 2030 (incl. 8.2GW of offshore wind). Despite the abundant renewable energy potential, there was a problem of severe opposition from local residents and a fear of a lack of community return due to the fact that most of projects are promoted by large companies located outside the region. In 2018, Sinan County enacted an Ordinance on sharing profits from the development of renewable energy and institutionalised the profit-sharing scheme. New and renewable energy businesses such as solar and wind power businesses are required to submit a "development profit sharing plan," and the county decides whether to support the development of certain projects in consideration of such plan.

The key is to designate more than 30% of the project company (SPC)'s stake or more than 4% of the total project cost as 'resident participation shares'. Only local cooperatives consisting of local residents near the project site and the county can buy those shares and claim dividends. In areas where renewable energy projects are not located, 'sunshine child allowances' are paid to children under the age of 18 with dividends (400,000 won per person per year, paid in two instalments).

Dividends are paid in local voucher called "1004 Island Gift Certificates" to make sure the money stays in the local economy. New residents for the local communities are also assigned the same right for the resident participation share. The county expects its population to rebound again with this measure.

6.3. Recommended strategies for government and industry to promote community involvement in offshore wind

6.3.1. Key drivers for providing community benefits

Community benefit schemes are beneficial for both the community in the local area of the wind farm as well as the OSW developers. They facilitate a positive relationship between the two parties and allow sharing of the economic benefits of capturing a nation's wind resource. For the communities, the benefits allow for essential socio-economic development. For the project developers, delivering the benefits are in their interest in order to gain local public acceptance and support for the project.

Development of community benefit schemes are typically a voluntary act by the developer, usually following 'good practice' guides laid out by local authorities. Community benefit schemes have the potential to be statutory, with regulations imposed by local or national authorities. Preference on how communities receive and distribute community benefits through funding mechanisms will be project and community dependent.

Outside of the supply chain, the development of an OSW project has multiple wider community socio-economic benefits, including:

- Contribution to charitable causes
- Development and support of natural capital, e.g. upgrades to areas of cultural or environmental interest
- Educational support
- Environmental support
- Local business support
- Combating fuel poverty through local electricity discounts
- Creation and development of local facilities or services
- Support for local tourism facilities i.e. museums or visitor centres
- Building capacity in the community
- Support for local marine management issues
- Support for and development of women's empowerment networks

6.3.2. Strategies to promote community benefits in South Korea

While South Korea can promote voluntary schemes to encourage OSW developers to support the local community through stakeholder engagement, investment, hiring local workers, environmental conservation initiatives etc, mandatory policies may be necessary to promote significant benefits given that the OSW industry is still relatively nascent. Examples of mandatory policies with scope for further development across the OSW sector include:

Local ownership

As noted in the Sinan County example, community ownership provides benefits through revenues generated from partial ownership of the wind farm. The profit is shared across the community, administered by local authorities or independent community panels or trusts. Depending on the circumstances the shareholding is usually minority but has the potential to be majority if a cooperative is developed with local utility companies.[92] Local ownership can also ensure a greater commitment to minimise negative impacts of OSW projects, and owners are more likely to engage with the community to address concerns.

Local community funds

As described in the Jeju Island example, these are pre-agreed annual payments made by the developer to affected communities during the operating lifetime of an OSW farm. The fund is set up using payments from the specific offshore project. The fund can then be used by the community to support initiatives and projects that directly benefit community groups such as schools, NGOs and local councils. Local groups can apply for funding, and depending on the agreed model, funding decisions are made by either the developer, local authorities or an independent community panel or trust. In a similar way, developers of wind farms can also pay into pre-existing funds that were not set up for the specific offshore project, such as regional development funds and wildlife/nature trusts.[93]

Local training schemes

As OSW projects demand a strong skill set among the workforce, there is a need to provide local training schemes to better prepare workers. By incentivising OSW developers to provide local workers with new skills and qualifications, the workers can gain access to higher wages which in turn can promote economic growth. This can benefit the strength of the local supply chain and reduce dependence on imported skilled labour.

[92] State of Green, Wind Turbine Co-operatives (Middelgrunden Vindmøllelaug) – link

[93] Innogy. Gwynt-y-mr Fund – link

7. Local content review of international markets

Key takeaways

- ✓ **Need for balanced policies:** While local content requirements (LCR) are commonly used by governments, including South Korea, it is not often the best means to ensure long-term, robust growth of the OSW market. If used, LCR must align with broader policy objectives in OSW development, considering trade-offs such as the impact of deployment rates, project costs, reliability, environmental impact, and community benefits. Achieving a balance between local content and other objectives is crucial for the sustainable growth of the OSW industry.
- ✓ **Varied local content requirement approaches:** The approaches towards local content requirements across the UK, France, Japan and Taiwan demonstrate varying success levels, with the UK's market-driven approach resulting in significant OSW deployment while France's emphasis on early local content requirements caused delays in project development.
- ✓ **Effective local content adoption strategies:** Effective implementation of local content requirements will require balanced policies that foster growth while managing costs, ensuring reliability, and minimising negative environmental impacts. These measures include financial support, incentive schemes such as tax credits, clear exit mechanisms to phase out local content requirements once the supply chain matures, and the requirement for supply chain plans to be submitted as part of bids to demonstrate how developers aim to increase local content.
- ✓ **Local content incentives in South Korea:** South Korea's local content strategy has seen recent reversals as the REC bonus based on local content was rescinded in place of a new bidding market, which drew criticism from the domestic wind energy industry for not encouraging the development of vital domestic components. The reintroduction of the REC bonus could drive long-term reductions in wind power costs by promoting domestic industries, particularly those producing key components like turbine systems. However, these incentives should only be applied on a temporary basis.
- ✓ **Improving South Korea's bid scoring standards:** The introduction of new bid scoring standards in South Korea currently lack clarity on local content requirements and can benefit from quantifiable assessment criteria and further transparency.

Local content requirements are the obligation to utilise domestic supply chain companies to provide certain components or services for an OSW farm project. There are several methods to implement these requirements, e.g., these may be structured to require a certain percentage of total components, or total spend for local companies. Alternative strategies may be to provide incentives for use of local content, rather than obligations, other procedural process, or remove all obligations.

The benefits of local content requirements (LCR) are that they can spur local job creation, promote technology transfer and the development of local industry clusters, with the aim of building a stronger domestic manufacturing base to support the sustainable growth of the OSW sector. LCR can also reduce the supply chain's exposure to external shocks that might be impacting the global market.

However, LCR can deter market competition and efficiency, and result in an increase in electricity prices by preventing cost competitive imports to enter the market. As a result, the competitiveness of OSW projects may suffer if developers are not able to access low-cost, reliable components because they are not yet available in the domestic supply chain. Whether the costs outweigh the benefits will depend on how the LCR policy is developed, its level of restrictiveness, and whether there are other policies in place to alleviate its negative impacts.

The inclusion of the role of LCR in this report is warranted due to its frequent utilisation as a government strategy within the OSW industry. Governments often implement LCR in various ways, and South Korea has also made attempts in this direction as well. However, it is important to emphasise that while LCR holds significance, it should not be the primary focus.

Rather, the emphasis should be on cultivating a sustainable pipeline of OSW projects that considers factors related to cost, reliability, speed of deployment, environmental impacts and community benefits among other aspects. This is more likely to ensure a long-term and robust development of the OSW sector, going beyond the immediate requirements of local content and instead fostering a conducive environment to promote growth and stability in the industry.

7.1. Local content must be considered in the context of alternative policy objectives.

Local content, and the development of a local supply chain may be one policy objective but does not operate in isolation with other objectives. For example, policymakers may have multiple objectives:

- Encourage development of a local supply chain;
- Encourage fast deployment of OSW to meet capacity targets;
- Encourage OSW generation at the lowest cost;
- Support high reliability of OSW generation;
- Minimise environmental impact of OSW projects; and
- Maximise community benefits of OSW projects.

Whilst these are common objectives, these objectives are non-exhaustive, and there may be additional objectives.

These objectives cannot be viewed in isolation, as prioritisation of one particular objective will trade-off against other objectives, and this wider viewpoint is particularly important from the perspective of local content requirements.

Worked explanations of how these trade-offs may manifest in the case of LCR are provided in **Table 18.**

Table 18: Trade-offs between local content and alternative policy objectives.

Alternative policy objective	Potential trade-offs with local content requirements
Encourage fast deployment of OSW to meet capacity targets	• Waiting for local manufacturing facilities to be constructed and new entrants to emerge will slow deployment rates. • Reducing supply choice for developers will increase prevalence of supply chain bottlenecks and slow deployment.
Encourage OSW generation at the lowest cost	• Reducing supply choice and competition between local and international suppliers could increase project costs.
Support high reliability of OSW generation	• If local suppliers have lower experience levels than international suppliers, or operate at lower quality levels, then reliability may be negatively affected.
Minimise environmental impact of OSW projects	• If local suppliers have lower experience levels than international suppliers, or do not offer a similar array of more environmentally conscious components, than environmental impact may be affected. • If local supply costs are higher, developers may be forced to reduce costs elsewhere in projects to deliver feasible projects, which could impact environmental and social benefits.
Maximise community benefits of OSW projects	• If local supply costs are higher, developers may be forced to reduce costs elsewhere in projects to deliver feasible projects, which could impact environmental and social benefits.

It Is critical, when considering implementation of local content requirements, to consider the impact against alternative policy objectives. Experience internationally of where such impacts have not been sufficiently considered demonstrate key learnings from which South Korea can benefit.

7.2. Strict local content mandates in global offshore wind policies risk costly setbacks for the sector's growth

In nearly all markets, utilising OSW development to foster economic benefits, create jobs, and utilise local manufacturing capability is a key objective. Markets tend to build and leverage their local capacity and know-how as much as possible. To support achieving this objective, local content is often mandated to a specific level by policy. However, such requirements have provided mixed results, and such measures need careful design to avoid negative impacts on project cost, timeframes and market attraction.

Case studies of how these policies have evolved in the UK, France, Japan and Taiwan have been included in **Appendix 3:**. The approaches outlined come with differing levels of success which the South Korean market can learn from. It's clear that the UK approach has been the most successful to date from the perspective of deployment, with the highest installed capacity of the four cases observed. UK placed priority in cost reduction to ensure a secure development pipeline, allowing the supply chain to mature with growing OSW capacity and build up over time to eventually provide up to 50% UK content. This also led to the UK establishing itself as the largest OSW market in the world for a period, with record low prices. France's experience on the other hand notes how restrictive LCR can slow down the development of the OSW market by requiring local manufacturing facilities for major components to be built first which was time consuming and very costly.

7.3. Balancing local content requirements in offshore wind: recommendations for effective implementation

From a project perspective, developers may wish to select suppliers based on their market competitiveness according to price, delivery timelines, and quality. Logistically, choosing local suppliers may support quicker timelines and lower transport costs, and this may aid competitiveness of local suppliers. If the government aims to increase the composition of local supplier participation in OSW projects, they should first establish policies that support the development of supplier competitiveness. Specifically, policies should support local suppliers to:

i. Provide components at the lowest possible cost;
ii. Meet tight timelines set by developers to manufacture and deliver necessary components;
iii. Develop capacity to increase the scale of production to meet developer demands;
iv. Innovate and provide new technology solutions.

If policies imposing LCR are used from the outset, considerations should be in place to ensure that a balance is struck between supporting local supply chain growth, fostering community benefits, managing cost competitiveness, ensuring reliability and fast deployment of components, all while limiting the associated carbon footprint and environmental impacts. Recommendations for developing appropriate LCR policies include:

1. **Complementary financial mechanisms:** LCR policies often enable smaller, inexperienced players to enter the market. While this is important to support the growth of the domestic supply chain, these players are unlikely to be cost competitive from the outset until they gain more maturity and economies of scale. As such, high costs will be passed on to developers and to end consumers if not managed early. To manage this risk, governments imposing LCR policies should provide concessional financing options to players across the OSW value chain to reduce the expected cost burden.

2. **Removing CAPEX allocation requirements and punitive measures:** LCR mandates often require developers to commit to allocating a certain (often excessive) proportion of the CAPEX of developing the wind farm towards local content and hold

them to punitive measures for non-compliance. These mandates often result in developers being forced to secure their components from less capable local players who may not be the most cost competitive or lack the necessary capacity to serve the market demand, resulting in the risk of significant project delays. The requirements to have a minimum level of local content should therefore be avoided, and instead developers can be evaluated in terms of their plans to collaborate with local players and source locally manufactured equipment most suitable for the project needs.

3. **Wider incentives:** Organic growth in the local content of the supply chain should be prioritised where possible using incentive schemes such as tax credits to promote the growth of small local component manufacturers, public funding for research and development, and training schemes to develop the capacity of the local workforce. Without these incentives, the domestic supply chain will not be fully equipped to support the growth of the OSW market if and when LCR policies are put in place. Organic growth of the supply chain is also expected to inspire confidence among international developers to establish OSW projects in the market given the likelihood of accessing a cost competitive domestic supply chain.

4. **Exit mechanisms:** LCR should not be developed as a permanent policy and should embed a level of flexibility to ensure that the necessary exist mechanisms are in place to phase out any stringent requirements as and when local content in the OSW supply chain reaches a certain level. This should also be clearly communicated to ensure that local and international players plan accordingly and prepare to face wider market competition in the future in terms of its impact on cost and capacity.

5. **Supply chain plans:** OSW developers should be encouraged to submit supply chain plans as part of the tender requirements, which places a quantifiable value on the importance of the supply chain and local content. The plans could be used as tools to identify the specific weaknesses in the local supply chain that need to be addressed in order to increase local content. This data can be used as the basis to create technology roadmaps that can further identify measures to improve local content across the supply chain.

7.4. Implications on South Korea's local content strategy

Different countries have approached the issue of local content requirements in OSW with mixed results, often navigating a delicate balance between imposing strict policies that can hinder OSW growth due to an immature market's inability to meet these requirements, or offering too much flexibility, which may not encourage local supply chain investment and lead to heavy reliance on international players. South Korea is currently grappling with similar challenges as outlined below given that it had previously implemented and subsequently revoked its local content incentives. Therefore, a more balanced approach is recommended to guide the country's future local content strategy.

7.4.1. Overview of local content policies in Korea

Renewable Energy Certificates (RECs) Bonus

Large Power Producers (exceeding 500MW capacity excluding renewable energy) are subject to the Renewable Portfolio Standards ("RPS") where they are required to supply certain percentage of their total power production by renewable energy.[94] Under the RPS, renewable energy producers are issued Renewable Energy Certificates ("RECs") for the amount of electricity produced. Large Power Producers can meet their RPS obligation by either installing and operating renewable energy capacity, or by purchasing RECs from renewable energy producers.

The amount of renewable energy (MWh) is not the only element that determines the amount of REC issued. RPS regulations provide a weighting schedule for REC issuance where more RECs are given to renewable projects that contribute to environment, technological development, and promotion of relevant industries. Currently, the base (minimum) weighted value of 2.5 (coastal OSW has a weighted value of 2.0) can be applied to OSW, which is the highest value among various renewable energy sources.

The weighted value for OSW is based on [(compounded weight value for connection distance + compounded weight value for water depth) – base weight value]. The connection distance refers to the straight-line distance from the shoreline and the nearest power generator in the project. However, for OSW projects where more than 50% of its part are produced domestically, the RPS authority has the discretion to add 50% of the distance between the power generators within the project to the connection distance, which makes it easier for the project to achieve higher weighted value for RECs.

As shown in the table below, the 50% threshold for local content is determined based on the five main components: turbine, blade, tower, sub-structure, and internal cable network. The turbine component is again divided into 13 subcategories.

Table 19: Local content percentage points by component

Component		Percentage (%)
Turbine		**36.4**
Turbine sub-components	Nacelle & Hub Assembly	12.2
	Nacelle housing	1.8
	Gear box	8.2
	Generator	2.4
	Coupling	0.6
	Power converter	3.2
	Transformer	2.2
	Drive shaft	1.4
	Yaw drive	0.7
	Yaw bearing	1.3

[94] The regulation accepts both "new energy" as well as "renewable energy", which includes fuel cell and IGCC which does not necessarily reduce carbon dioxide emission. However, the majority of the RPS obligations are met through PV and wind.

	Pitch drive	0.6
	Pitch bearing	1.2
	Brake	0.6
Blade		**14.3**
Tower		**12.7**
Sub-structure		**30.0**
Internal Network Cable		**6.6**
Total		**100**

On 7 April 2023, the Korea Energy Agency which is the RPS authority, amended its rules and announced that additional connection distance will not be applied based on local content for wind projects that participate in bidding for fixed price contracts. Korea Energy Agency explained that REC bonus is no longer necessary as bidding market for wind has become available since Sep 2022, and that local content standards may give rise to trade related legal issues.

Competitive Bidding Score Standards

Large Power Producers can choose to enter into fixed price contracts with renewable producers in order to meet its obligations under the RPS which is selected through the competitive bidding process administered by the Korea Energy Agency. The scoring standards for the bidding stipulates that 60% of the score will be quantitatively assessed by the bidding price, and the remaining 40% of the score will be determined based on review of the project proposal. The project proposal review portion is comprised of local community acceptability (8%), contribution to industry and economy (16%), domestic track record (4%), project progress (4%), and grid acceptability (8%).

The largest element, contribution to industry and economy, includes (i) contribution to industry ecosystem (domestic supply chain and economy), (ii) innovative efforts (iii) domestic investment and/or job creation. Scoring is done in five steps: "Excellent" receives full score of 16, "Fair (8)", "Average (4)", "Insufficient (2)", and "Very Insufficient (0).

According to the "Wind Power Fixed Price Competitive Bidding Notice" dated 12 Oct 2023, Korea Energy Agency further explains that "contribution to industry and economy" is a qualitative assessment of the following:

- Contribution to domestic economy: Bid participating companies' (SPC shareholders and partners in wind power projects) investment track record and plans for (i) main machine, sub-structure manufacturing and construction infrastructure and (ii) operation and management sector infrastructure.
- Contribution to domestic supply chain: contribution to establishment of domestic supply chain in relation to (i) main components (rotor-nacelle assembly, tower, sub-structure, electric cable system, installation & construction) used in the construction process of a wind farm and (ii) the operations and maintenance of wind power.

7.4.2. Suggestions for local content policies

Creating a Stable Market Demand

Our analysis on the South Korean OSW regulatory regime, supply chain, and local contents policies shows that the most important factor in promoting OSW industry in Korea is creating a steady and stable market demand in accordance with the policy target.

Many players in the Korean manufacturing industry already possesses competitiveness in various components within the OSW supply chain, and the construction industry holds significant capability relevant to installation of OSW. However, due to low and unstable demand in the domestic market caused by excessive regulatory hurdles and unclear policy signals, they have not been able to gain requisite experience or make investments in technology, equipment, and facility.

For this reason, the most effective means to promote OSW industry in Korea and to enhance the competitiveness of local contents at this point is to present a clear roadmap in accordance with the OSW target and establish fair and efficient mechanism to implement the policy target.

The government needs to understand 'economies of scale' must be achieved in order to decrease the production cost and increase market competitiveness and must prioritise creating a larger market for OSW. The OSW target under the government's plan presents a sizeable opportunity for the industry, but there are many hurdles that are limiting the market potential. Despite the ambitious target, actual progress of the projects in the pipeline is significantly delayed by regulatory hurdles and most projects still remain at planning stage. Uncertainty around the infrastructure, such as staging/installation ports and grid connection, also needs to be resolved to trigger investment and growth in the domestic supply chain.

As noted above, local content requirement or incentives can play a complementary role to assist and accelerate the growth of domestic OSW supply chain if implemented in balance with broader policy objectives. In this context, suggestions are made to the REC Bonus and Competitive Bidding Score Standards because these measures were either in place or were implemented before. However, incentives for domestic production can take various forms including tax benefits or green financing programs, which should be further explored as policy options.

REC Bonus

As explained above, the REC bonus based on local contents has been effectively repealed in April 2023, as the wind power projects are supposed to participate in the new fixed price bidding market introduced in 2022. This abrupt change was met with immediate objections from the domestic wind power industry which argued that many major economies are actively protecting and promoting their domestic industry through various measures including LCR. Some criticised the Korean government for repealing the REC bonus in the absence of a WTO complaint, arguing that the IRA in the U.S. and the CRMA in the EU are effectively no different from it. KWEIA criticised that "all of the ongoing discussions with Vestas, GE, and Siemens to host investments in Korea is critically jeopardised because of this policy change."

However, the REC bonus scheme had been criticised for not being effective in creating incentives for developing key components for domestic players.[95] The most important target for technology development is the turbine

[95] NEXT Group, How to improve the domestic offshore wind LCR system, 5 Jan 2023. [KOR]

system because reducing the LCOE of wind power largely depends on developing wind turbine systems with larger turbines. Larger turbine not only lowers the turbine price per unit of capacity, but also reduces the number of turbines in the same-sized wind farm, reducing non-turbine equipment costs, grid connection costs, transportation costs, installation costs, etc.

However, the 50% threshold in the REC bonus scheme could be met without using domestically produced turbine systems. Domestic suppliers for tower (12.7% local content percentage points) and sub-structure (30% local content percentage points) already have sufficient cost competitiveness both in terms of technology and transport cost. For these components, project developers are likely to choose domestic products without any incentives. Because 42.7% can be met with these two categories, it was not difficult to reach the 50% threshold by adding some small components that can be procured in the domestic market.

Re-introduction of the REC bonus can contribute to achieving a reduction of wind power LCOE in the long term by promoting the domestic industry for key components, including turbine systems. However, in such a case, the local content threshold should be increased to cover the turbine systems, so that the incentives are able to reach the target industry sectors. Also, the appropriate level of weighted value needs to be re-assessed to match the increased initial project costs resulting from using the domestic supply chain.

Competitive Bidding Score Standards

"Contribution to industry and economy" is a critical element in the wind power competitive bidding process as it takes up 16 out of 100 points in the scoring standards. However, the detailed scoring criteria for this element is vague and provides little transparency or visibility for the bidders, particularly in determining how much local content should be procured for the project in order to qualify for a high score.

To improve the transparency and effectiveness of the current scheme, the scoring standards need to be revised. It should incorporate a quantitative assessment for local content instead of a qualitative one, and the scoring scale should be carefully designed to be able to promote a domestic supply chain without delaying the deployment of new OSW capacity. Further, local content incentives, including REC bonus, should only be applied on a temporary basis insofar as such incentives contribute to the expansion of wind power through the promotion of a domestic supply chain and result in cost reduction effects.

8. Conclusion and recommendations

Our key recommendations, expanded in more detail below are:

1. Acceleration of permitting processes
2. Focused supply chain enhancement
3. Ports infrastructure upgrades
4. Skills development
5. Promoting local supply chain competitiveness

Potential of the South Korean Offshore Wind Market

Main Opportunities

South Korea has significant growth potential, with its aspiration to reach 14.3GW by 2030. Currently, 139.8MW of fully commissioned OSW capacity exists and is spread across six projects, laying the foundation for future expansion. This study estimates that the current pipeline has the potential to grow to nearly 25GW by 2035, and the cumulative investment required to achieve and operate this is projected to exceed £80 billion. This significant capital inflow presents a substantial opportunity for the local supply chain.

OSW projects in South Korea have shown a remarkable percentage of local content. As per available data, approximately 77% of supply chain companies involved in fully commissioned South Korean OSW farms are domestic firms. The landscape of these companies reflects the nascent stages of the market's development, with most companies specialising in the Development and Consenting supply chain segment. At present, South Korea's strengths lie in tower supply. In addition, existing capabilities across secondary steel works, electrical systems, cable and substation design, and wind turbine installation vessels provide a strong foundation to support the growth of the OSW industry.

South Korea's OSW sector can also draw on skilled labour from various industries. The offshore oil and gas industry holds significant relevance, offering expertise in roles like engineers, geoscientists, technicians, mariners, divers, and ship crew. However, the limited size of the local offshore oil and gas sector poses a challenge for skills transfer. The shipbuilding sector, while offering relevant roles for OSW, requires greater investment for training and upskilling the workforce to effectively transition to the new industry. The construction sector also contributes transferable skill sets, particularly from workers in energy, industrial, or manufacturing settings. Other sectors that are not directly aligned with OSW such as fossil-fuel based power generation are facing an increasing risk of redundancy and could also be considered to enable an effective green jobs and skills transition.

The South Korean OSW industry's growth presents the potential to create 152,563 direct jobs across the entire lifecycle of the projects, with the majority (approximately 122,776 jobs) expected to be generated in the first 6 to 7 years (2023 – 2030). Permanent jobs (up to 4,817) can be created during the operations and maintenance phase over a 25-year period, and 9,361 jobs may emerge during the decommissioning stage between 2058 and 2060. It is important to note that while the maximum job creation potential is substantial, a proportion of these jobs may be filled internationally, underlining the need for workforce development and planning.

Main Challenges

Whilst South Korea demonstrates a very healthy pipeline of OSW projects with both domestic and international developers interested, the clear challenge remains in converting these projects into operational OSW farms. Notable **challenges have been identified in the**

extensive permitting process, in addition to potential **supply chain capacity constraints**.

South Korea boasts a strong foundation in port infrastructure, which can cater to OSW installation and support for operations and maintenance. While the ports have the technical capability, potential challenges include the **need for infrastructure upgrades to optimise port operations** and minimise LCOE. A notable challenge arises concerning port depths, especially for large floating substructures, which could require greater depths than the currently available facilities offer. Thus, preparing for the transition to floating projects will necessitate investment in deep-water port upgrades.

Another **challenge relates to effectively transitioning workers from various sectors into the OSW industry** in order to maximise the sector's potential for job creation and sustainable growth. Focus on workforce planning to ensure the availability of skilled labour as the industry expands will be a challenge and will require developing transferable skills through retraining programs to fully harness the job opportunities presented by OSW in South Korea. Investing in a skilled workforce can address additional challenges facing local suppliers such as deficiencies in technical capabilities compared to international competitors for blades and nacelles for example or competing against lower-cost alternatives for foundations from other international suppliers.

Recommendations

In assessing the OSW supply chain in South Korea and recognising the many benefits the sector will bring, the below recommendations should be considered by decision makers to enable the delivery of at least 25GW by 2035 alongside growing a significant local supply chain.

1. Accelerate permitting procedures to deliver a stable construction pipeline and increase market certainty, including appropriate management of projects that have already obtained EBLs	
Challenge addressed	At present, South Korea has a healthy pipeline of projects. Should this pipeline enter construction with a certain and stable pipeline then the South Korean supply chain opportunity is very large. Delivering this market certainty in order that supply chain, both local and international, can invest in required infrastructure and workforce in South Korea is the most important action for the South Korean OSW at present. The deployment pipeline portrayed within this report assumes that more than 60 projects are able to be permitted, installed, and commissioned before 2035. This number may be optimistic based on current permitting timelines, and therefore focus should be placed on reducing timelines to support growth. The slow permitting process has already been the focus of much discussion in South Korea, and potential updates to streamline this process have been outlined. Should these changes be implemented for future projects, it is important the projects that are proceeding with current permitting procedures are managed sensibly during this transition phase, and that progress made to date for these projects is not lost.
Key actor(s)	South Korea government.
Action required and implementation options	• Publish a clear proposal, incorporating industry consultation for a future, streamlined, permitting approach. Such an approach should be delivered with flexibility for projects that are proceeding at present. • Consult with industry on a transitional approach for projects that are currently proceeding through permitting procedures, to ensure that progress in developing these projects is not lost, and to increase certainty of process for developers. • Consider formal implementation of transition mechanism for such projects. This could be optional so that developers can determine if they wish to choose one approach rather than another.
Timeframe	As soon as possible

2. Focused supply chain enhancement to capture local and regional opportunity	
Challenge addressed	This report outlines a clear opportunity for the South Korean supply chain to capture with regard to OSW development. Ensuring that supply chain is enabled to support early projects and build expertise will be key in capturing this long-term opportunity. South Korea's supply chain is well positioned to support the wider Asian region in OSW development, and at present competition from regional competitors is limited. However, regional competitors are acting to grow their own supply chains, and delay in this sector could mean that South Korea misses the regional export opportunity.
Key actor(s)	South Korea government.
Action required and implementation options	**Supply chain plans:** The South Korean Government could consider the inclusion of comprehensive supply chain plans within the OSW sector. These plans should assign quantifiable value to the importance of the supply chain and local content. They can serve as invaluable tools for identifying specific weaknesses within the local supply chain that require addressing, thereby increasing local content in OSW projects. **Technology roadmaps:** Leverage the existing strengths within South Korea's supply chain for OSW by identifying specific technological aspects and formulating technology roadmaps that capitalise on these strengths, particularly in areas such as data analytics and digitalization. **Research and development:** Allocate significant resources to research and development, particularly in floating wind, encompassing substructure mass fabrication, port requirements, substructure and turbine assembly, weather window restrictions, substructure-cable dynamics, heavy maintenance, and mooring system inspections. Progress a development plan for the potential fabrication of floating wind substructures at a South Korean port on the south/southwest coast.
Timeframe	2-3 years

3. Deliver required port infrastructure upgrades	
Challenge addressed	The assessment of the port infrastructure in South Korea showed good potential of the ports across the country to be used for OSW development. However, limited availability of existing facilities creates a challenge, particularly for staging requirements. Installation port development needs to take place in a timely manner to prevent bottlenecks at the port infrastructure.
Key actor(s)	South Korea Government
Action required and implementation options	**Port Development Planning**: The Government is responsible for planning and developing port infrastructure across the nation. Currently, expansion for OSW function is only planned for Mokpo in the Southwest, which falls significantly short of meeting the pipeline needs. The Government needs to promptly process the ongoing discussions for OSW port expansion for Gunsan, Ulsan, and Incheon, and further develop additional ports to ensure that port infrastructure accommodates the planned OSW capacity. Considering that the installation phase of many projects is expected in a few years, port development planning should take place immediately and the schedule of implementation and construction should be aligned with the OSW installation timeline.
Timeframe	1-5 years

4. Create a skills development plan and upskill local workforce to support OSW projects	
Challenge addressed	While several dominant sectors in South Korea such as shipbuilding and construction provide a workforce with a similar skill set that can be leveraged for OSW, there is a risk that the number of workers available to transition to OSW may not be sufficient to meet the OSW sector's growth potential. The report identifies measures to prevent skills shortages from severely limiting OSW development in the country and promote a conducive environment for workers to upskill themselves by accessing suitable education and training programmes.
Key actor(s)	South Korean government, industry associations, universities, OSW developers
Action required and implementation options	• Create a **comprehensive skills development plan** to ensure that the industry's skills requirements are met. Engage academia and training bodies to collaboratively design initiatives that cater to the specific demands of the OSW sector. • Fund training and consider the **establishment of apprenticeship schemes**, particularly in the maritime and marine skills sector, including specialised areas like drill and remotely operated vehicle (ROV) operation. These schemes can facilitate the transfer of skills and knowledge to meet the OSW industry's workforce needs. • Create a **'Competency Framework' for OSW**, outlining the required skill development pathways essential to building a robust OSW industry in South Korea. This framework will serve as a foundation for skills development programs. • Identify high-risk occupations that may become redundant due to the energy transition and the growth of OSW. Develop **upskilling initiatives** that can redeploy workers into the OSW sector, ensuring a smoother and more inclusive transition. • Recognise the insufficiency of workers transitioning from offshore wind-adjacent industries and educational systems to meet growing demand. Strategic measures should be taken, including **promoting STEM subjects**, increasing the number of women in STEM fields, and facilitating collaboration between industry employers and educational institutions. • Expand degree fields in offshore renewables and marine-related subjects. Create a **talent network** that connects industry employers with potential workers.
Timeframe	As soon as possible

5. Strategic approach for promotion of local supply chain competitiveness	
Challenge addressed	As South Korea had previously implemented and subsequently revoked its local content policies, there is a risk that the design of existing and future policies overlook the importance of developing a competitive local supply chain. The report therefore identifies policy measures that can promote local supplier capabilities to better serve the OSW market without compromising on cost competitiveness or reliability among other factors.
Key actor(s)	South Korean government
Action required and implementation options	• The South Korean government should adopt a proactive approach by incorporating **non-price criteria** into OSW auctions. This criteria can serve as a positive precursor to promoting sustainable and environmentally responsible OSW projects. By including criteria such as environmental impact, community engagement, and technological innovation, the government can encourage the adoption of best practices within the industry. • Develop policies that support **supplier competitiveness**, focusing on improving their ability to reduce costs, incentivise timely delivery, increase capacity to scale production to meet demand, and encourage innovation. • **Ensure flexibility in approaches:** strict local content requirements have caused issue and delayed deployment in alternative markets. Local content policy should be carefully considered and introduced with flexibility to enable developers to access a wide range of suppliers if required for delivery. Introducing a consultation phase prior to new policy approaches is important for this. • If local content requirement policies are reconsidered for South Korea, then it is important to integrate **complementary financial mechanisms** such as concessional financing options to support local suppliers to manage costs, **avoid punitive measures** in the case that suppliers do not meet local content, and **provide wider incentives** such as tax credits, public funding for R&D, and training schemes to promote the organic growth of the domestic supply chain. In addition, policies promoting local content should include exit mechanisms to ensure flexibility and a clear plan for phasing out stringent requirements as local content levels mature.
Timeframe	2-3 years

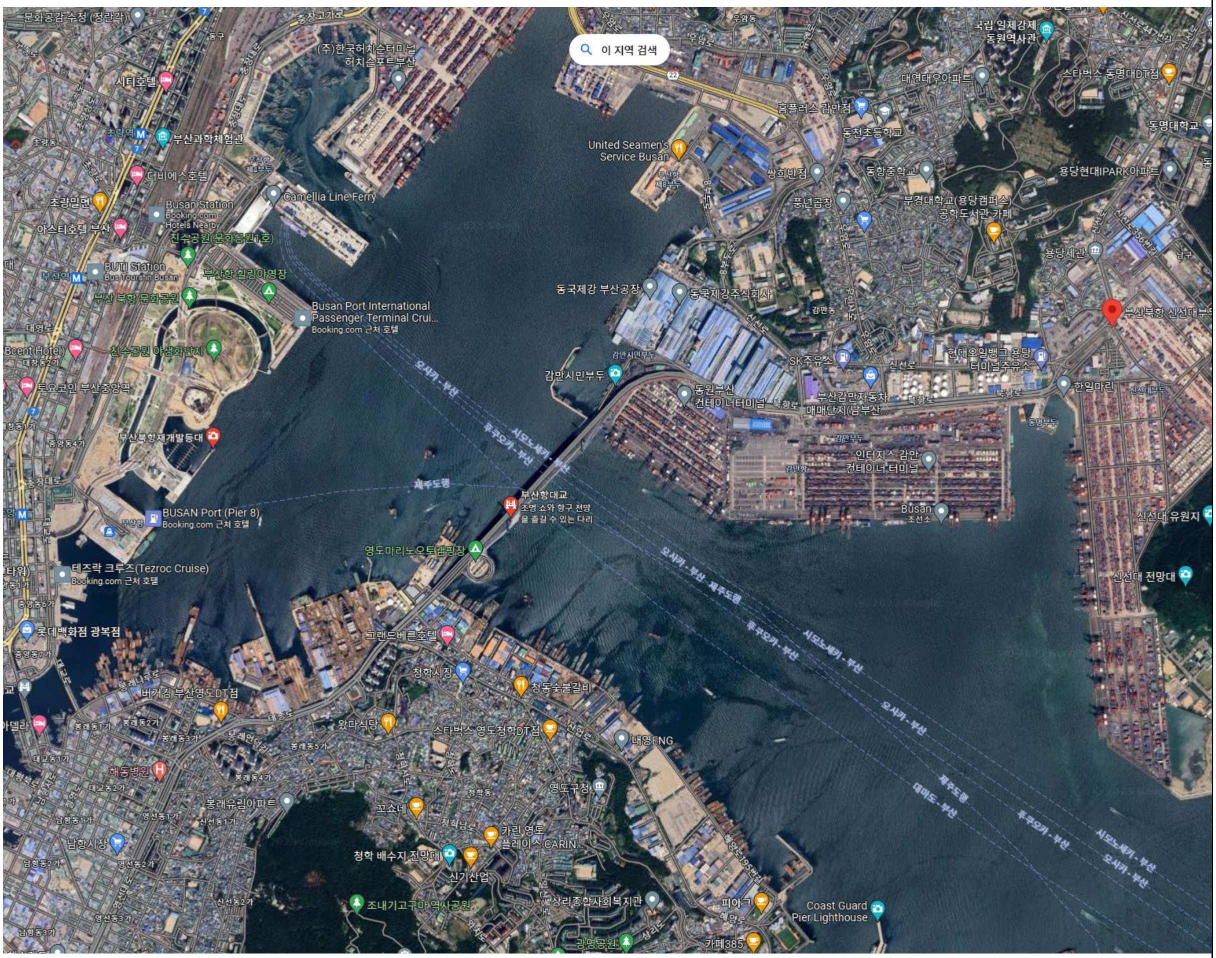
These recommendations underscore the need for a collaborative effort involving government, industry, academia, and the workforce to tap into the immense potential of OSW while ensuring long-term success and local benefit.

APPENDIX

Appendix 1: Port information

Busan Port
Ownership: Busan Port Authority (Ministry of Oceans and Fisheries) **National Ports Policy Category**: National trade port **Development Master Plan**: The 4th National Port Master Plan 2021 - 2030 (Review 2020) **Location**: LAT: 34.0788 LONG: 128.8332 **Brief Description**: Busan Port is the largest trading port in Korea located in Busan Metropolitan City. It is operated by the Busan Port Authority and ranks first in trade volume and volume in Korea. As of 2020, it has a processing capacity of 22 million TEU, and is the world's 5th largest container port in terms of cargo volume. It handles 57% of Korea's total maritime export cargo, 75% of container cargo, and 34% of national seafood production.

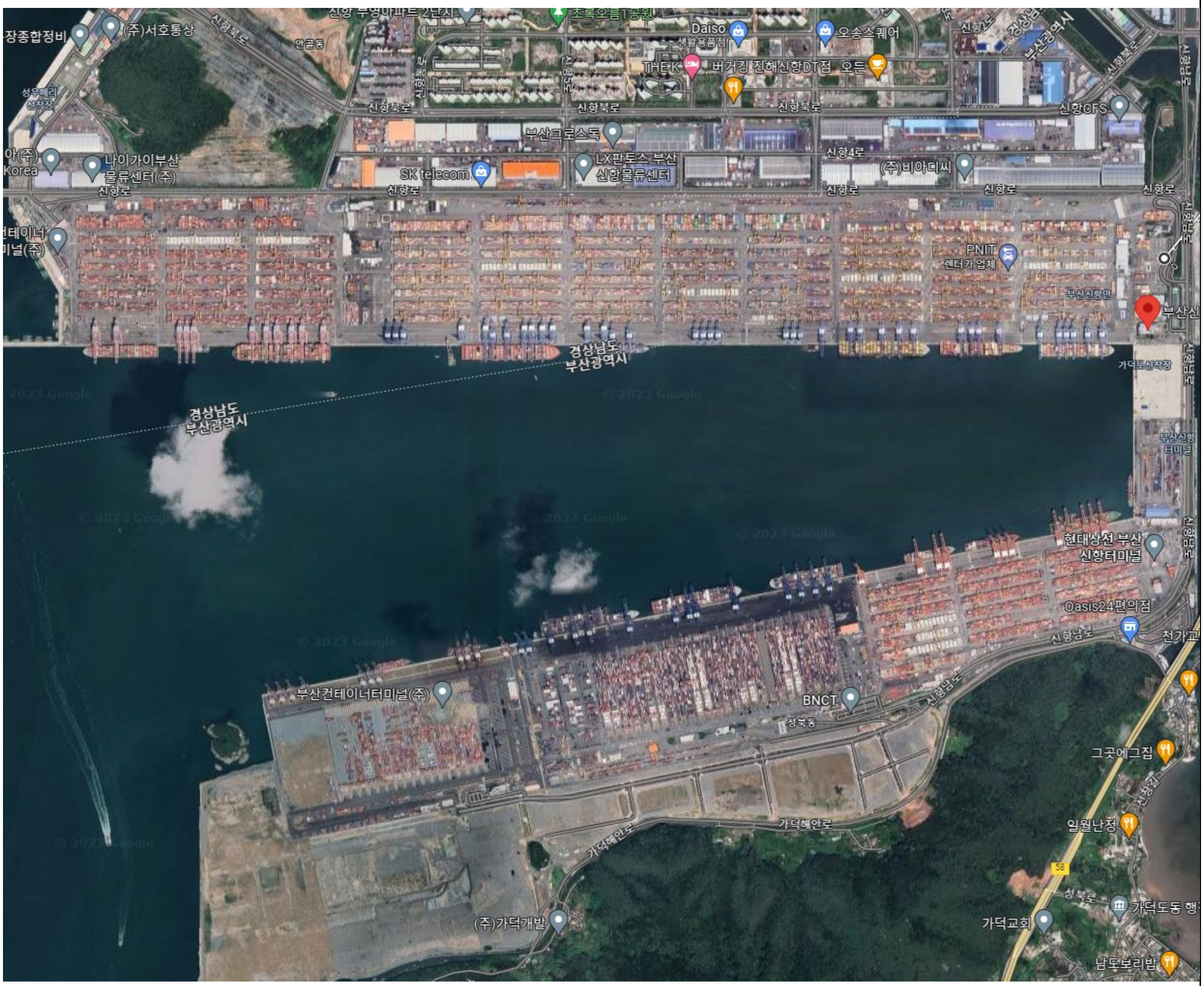
[North Port]



[Gamcheon Port]

[Dadaepo Port]

[New Port]

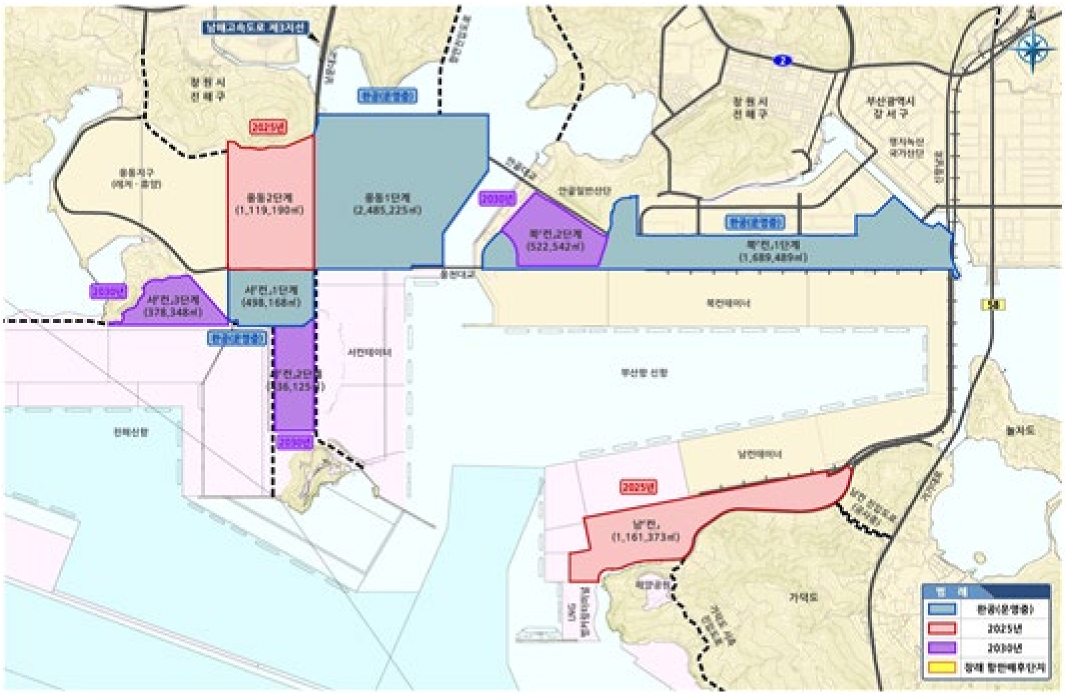


Port physical characteristics	Port Depth (Chart Datum)	North Port: 4~16m

		Gamcheon Port: 5.5~13m Dadaepo Port: 7.5m New Port: 6~18m
	Approach channel depth	No. 1 Channel: 15~40m No. 2 Channel: 14~34m No. 3 Channel: 13~33m No. 4 Channel: 6~10m No. 5 Channel: 16~17m Gaduk Channel: 16~35m
	Quay length	32,561m
	Unloading Capacity	447,243 kt
	Component handling equipment[96]	C/C: 132 units / 80~30.5t T/C: 406 units / 65~40t U/L: 3 units / 400T/H
	Site area	11,500,987.6 m^2
Ports connectivity	Distance from wind farm	About 2~5km (GIG, developer based in UK, is currently developing 136 MW of offshore wind)
	Sailing Distance from the key component suppliers	Incheon: 781km Gunsan: 621km Gwangyang: 188km Ulsan: 107km Pohang: 198km
	Distance from road	Direct access

[96] C/C : Container Crane, T/C : Transfer Crane, BTC : Bridge Type Crane, LLC : Level Luffing Crane, U/L : Unloader, S/U : Ship Unloader, t: ton, T/H: ton/hour

	Distance from rail networks	Direct access
	Distance from Airports	Gimhae International Airport: 15km by air / 25km by road Ulsan Airport: 75km by air / 100km by road
Ports Layout	Storage space availability	Warehouse: 9 units / 56,999 m^2
	Component laydown (staging) area availability	Open storage yard: 2,987,697m2
	Space availability: cluster	Port hinterland: 4,692,000m^2 / 67 companies / 2,514 employees
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	See the below map



- Blue: Port facilities completed and operating
- Red: Port facilities to be completed by 2025
- Purple: Port facilities to be completed by 2030
- Yellow: Hinterland to be developed in future

Daesan Port
Ownership: Daesan Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries) **National Ports Policy Category**: National trade port **Development Master Plan**: The 4th National Port Master Plan 2021 - 2030 (Review 2020) **Location**: LAT: 37.0142   LONG: 126.4207 **Brief Description**: Daesan Port is a trade port located in Seosan-si, Chungcheongnam-do. Since its designation as a trade port in October 1991, it has operated mainly as a port facility for petrochemical companies. With the construction of the Daesan Port International Passenger Terminal, the first international gateway in the Chungcheong-do, the port has grown into a port that can handle passengers and logistics simultaneously.

Port physical characteristics	Port Depth (Chart Datum)	1~4 Piers: 12m
	Approach channel depth	No. 1 Fairway: 13~40m No. 2 Fairway: 13~36m No. 3 Fairway: 10~33m
	Quay length	8,144m

	Unloading Capacity	18,885kt
	Component handling equipment	C/C: 1 unit / 24 units/H U/L: 7 units / 2,000~200T/H S/L: 2 units / 300T/H
	Site area	829,336.9m^2
Ports connectivity	Distance from wind farm	About 55km (Several major companies, including Ørsted, are planning to develop offshore wind projects off the coast of Incheon, though no wind farm currently exists)
	Sailing Distance from the key component suppliers	Gunsan: 211.14km Gwangyang: 640.79km Busan: 725.08km Ulsan: 776.64km Pohang: 867.61km
	Distance from road	Seohaean Highway: 38km via Dangjin I/C
	Distance from rail networks	Cheonan Asan Station: 93km by road
	Distance from Airports	Cheongju International Airport: 102km by air / 131km by road
Ports Layout	Storage space availability	Warehouse: 3 units / 8,571m^2
	Component laydown (staging) area availability	Open storage yard: 198,609m^2
	Space availability: cluster	--
	Workshop area	Yes
	Office facilities	Yes

	Potential for expansion	-

Donghae Port

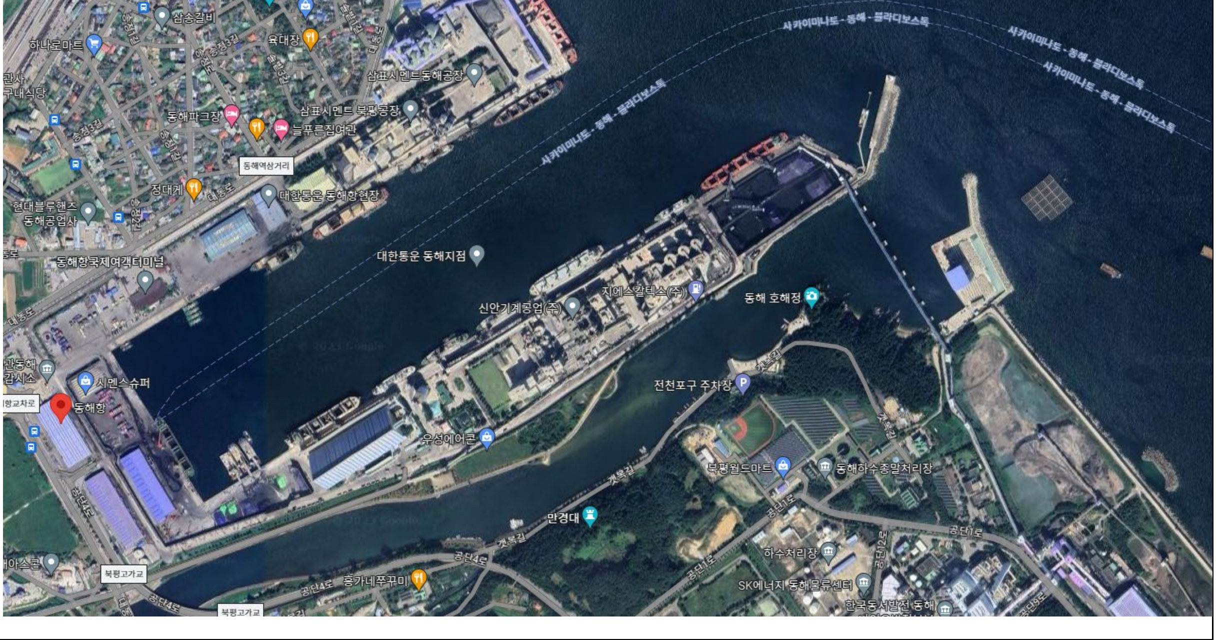
Ownership: Donghae Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries)

National Ports Policy Category: National trade port

Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)

Location: 37.4898, 129.1231

Brief Description: Donghae Port, which is located in eastern part of Korea, is the largest trading port in Gangwon-do and mainly trades cement, bituminous coal and limestone. The LS Cable & System plant that produces subsea cables is located nearby.



Port physical characteristics	Port Depth (Chart Datum)	North Pier: 9-12m Center Pier: 13m South Pier: 10~13m West Pier: 10m Coal Pier: 13m Oil Pier: 6.5m
	Approach channel depth	25.0~29m

	Quay length	4,477m
	Unloading Capacity	33,817kt
	Component handling equipment	U/L: 7 units / 2,400~400T/H S/L: 18 units / 2,000~3,00T/H
	Site area	1,324,416.0 m^2
Ports connectivity	Distance from wind farm	About 2~10km (Gangwon-do plans to build a floating offshore wind farm with a total capacity of 2GW in the east coast. The wind farm sites will be developed by 2024, and 10 demonstration complexes with a scale of 80MW will be constructed starting in 2025.)
	Sailing Distance from the key component suppliers	Incheon: 1036km Gwangyang: 489km Busan: 342km Ulsan: 268km Pohang: 181km
	Distance from road	Direct access
	Distance from rail networks	Direct Access
	Distance from Airports	YangYang International Airport: 75km by air / 90km by road Incheon International Airport: 236km by air / 305km by road
Ports Layout	Storage space availability	Warehouse: 9 units / 48,884m^2 Transit shed: 4 units / 66,157m^2
	Component laydown (staging) area availability	Open storage yard: 190,970m^2

	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	Yes. The government is establishing a plan to develop a new port by 2030 and create a hinterland complex nearby.

Gunsan Port
Ownership: Gunsan Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries) **National Ports Policy Category**: National trade port **Development Master Plan**: The 4th National Port Master Plan 2021 - 2030 (Review 2020) **Location**: LAT: 35.9707 LONG: 126.6174 **Brief Description**: Gunsan Port is located near the Geumgang river estuary, which can be found at the centre of the western coast of the Korean peninsula. Initially opened to transport grain produced in the Honam plains, the port eventually had its facilities upgraded and various equipment modernised thanks to the increased volume of transported goods, and since the 1990s more trade with China and Russia has led to the development of Gunjang Port shinhang (new port). It consists of several ports which are currently reorganised to increase operational efficiency. It will be developed in connection with Saemangeum Port nearby.

Port physical characteristics	Port Depth (Chart Datum)	Pier 1 : 9~11m Pier 2 : 7.5~11m Pier 3-5 : 11m Pier 6 : 12m Pier 7 : 12~14m Sand Pier : 7m Service Port : 4m International Passenger Ferry : 4~8m
	Approach channel depth	Main Channel: 10.5m Front Channel: 13.5m Ferry Channel: 7.5m
	Quay length	7,806m
	Unloading Capacity	30,070kt
	Component handling equipment	C/C : 2 units / 49units/H

		U/L : 5 units / 1,600~600T/H
	Site area	5,681,605.9 m^2
Ports connectivity	Distance from wind farm	About 10km (A large project site incl. Saemangeum offshore wind project is very closely located.)
	Sailing Distance from the key component suppliers	Incheon: 272.24km Gunsan: 0km Gwangyang: 605.84km Busan: 639.36km Ulsan: 690.93km Pohang: 781.89km
	Distance from road	Direct access
	Distance from rail networks	Gunsan Station: 14km by road
	Distance from Airports	Gunsan Airport: 10km by road Gwangju Airport: 127km by road Incheon International Airport: 233km by road
Ports Layout	Storage space availability	Warehouse: 31 units / 197,903m^2 Transit shed: 0 units
	Component laydown (staging) area availability	Open storage yard: 1,446,021m^2
	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	N/A

Gwangyang Port

Ownership: Yeosu Gwangyang Port Authority (Ministry of Oceans and Fisheries)

National Ports Policy Category: National trade port

Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)

Location: LAT: 34.9166   LONG: 127.6812

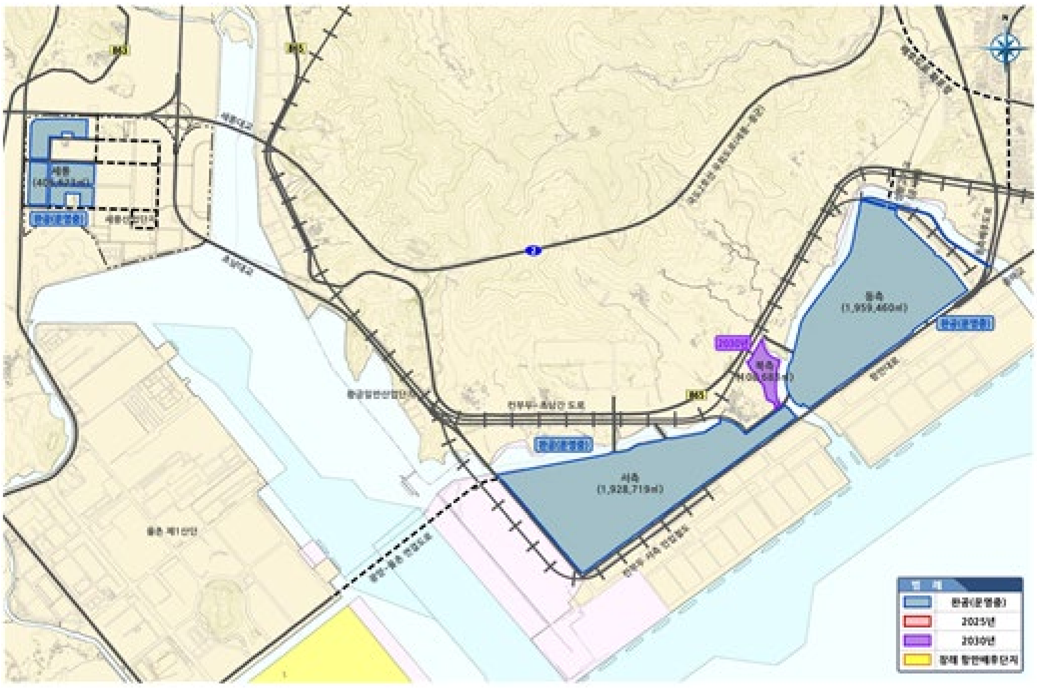
Brief Description: Gwangyang Port is considered as naturally blessed port with a favourable port environment where the water is calm and requires no breakwater. It has grown to an integrated port with great growth potential with an extensive and wide background industries.

Port physical characteristics	Port Depth (Chart Datum)	Gwangyang area : 5~23.5m Yeocheon area : 0.2~23.5m
	Approach channel depth	No. 1 Fairway: 28m No. 2 Fairway: 15m No. 3 Fairway: 23.5m No. 4 Fairway: 16m No. 2 Fairway: 8m Cement Pier Fairway: 16~35m

	Quay length	25,525m
	Unloading Capacity	211,238kt
	Component handling equipment[97]	C/C : 30 units / 61~40.6t T/C : 57 units / 100~40.6t BTC : 15 units / 50~31.25t H/C : 6 units / 33~30t U/L : 2 units / 3,000~500T/H S/L : 6 units / 2,400~500T/H
	Site area	11,889,955.6 m^2
Ports connectivity	Distance from wind farm	About 2~30km (Many project sites are located in neighbouring cities incl. Yeosu.)
	Sailing Distance from the key component suppliers	Incheon: 670.43km Gunsan: 542.63km Gwangyang: 0km Busan: 204.08km Ulsan: 257.03km Pohang: 348.67km
	Distance from road	Direct access
	Distance from rail networks	Mokpo Station: 1.3km by road
	Distance from Airports	Sacheon Airport: 60km by road Gimhae International Airport: 160km by road

[97] C/C: Container Crane, T/C: Transfer Crane, BTC: Bridge Type Crane, LLC: Level Luffing Crane, U/L: Unloader, S/U: Ship Unloader, t: ton, T/H: ton/hour

Ports Layout	Storage space availability	Warehouse: 10 units / 2,298,425m^2 Transit shed: 2 units / 7,402m^2
	Component laydown (staging) area availability	Open storage yard: 1,998,549m^2
	Space availability: cluster	Port hinterland: 3,874,000m^2 / 51 companies / 993 employees
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	See the below map



- Blue: Port facilities completed and operating
- Purple: Port facilities to be completed by 2030

Gyeongin Port
Ownership: Incheon Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries)
National Ports Policy Category: National trade port

Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)

Location: LAT: 37.5596   LONG: 126.6063 (coastal Incheon Terminal) / LAT: 37.5958   LONG: 126.7916 (inland Gimpo Terminal)

Brief Description: Gyeongin Port serves as a hub of logistics in Seoul and northern Gyeonggi-do. It also acts as a multiple use port that connects inland areas with the sea. Gyeongin Port is composed of Incheon Port International Passenger Terminal (”Incheon Terminal”), which is located in the coastal city of Incheon, Gimpo Passenger Terminal (”Gimpo Terminal”), which is located in the inland city of Gimpo, and Gyeongin Ara Waterway that connects both terminals. Gyeongin Ara Waterway, running 18 kilometers, is 6.3 meters deep and 47-80 meters wide.

[Incheon Terminal]

[Gimpo Terminal]

Port physical characteristics	Port Depth (Chart Datum)	Incheon Terminal: 5.7~10m Gimpo Terminal: 6.3m
	Approach channel depth	No. 1 Fairway: 8m
	Quay length	2,300m
	Unloading Capacity	8,837kt
	Component handling equipment[98]	C/C : 4 units / 40.6t T/C : 5 units / 40.6~40t
	Site area	1,600,428.9m^2
Ports connectivity	Distance from wind farm	About 80km (Several major companies, including Ørsted, are planning to develop offshore wind projects off the coast of

[98] C/C: Container Crane, T/C: Transfer Crane, BTC: Bridge Type Crane, LLC: Level Luffing Crane, U/L: Unloader, S/U: Ship Unloader, t: ton, T/H: ton/hour

		Incheon, though no wind farm currently exists)
	Sailing Distance from the key component suppliers	Gunsan: 253.66km
	Distance from road	Direct access
	Distance from rail networks	Incheon Station: 17km by road
	Distance from Airports	Incheon International Airport: 18km by air / 29km by road Gimpo International Airport: 17km by air / 23km by road
Ports Layout	Storage space availability	Warehouse: 2 units / 19,795m^2
	Component laydown (staging) area availability	Open storage yard: 688,330m^2
	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	N/A

Hadong Port

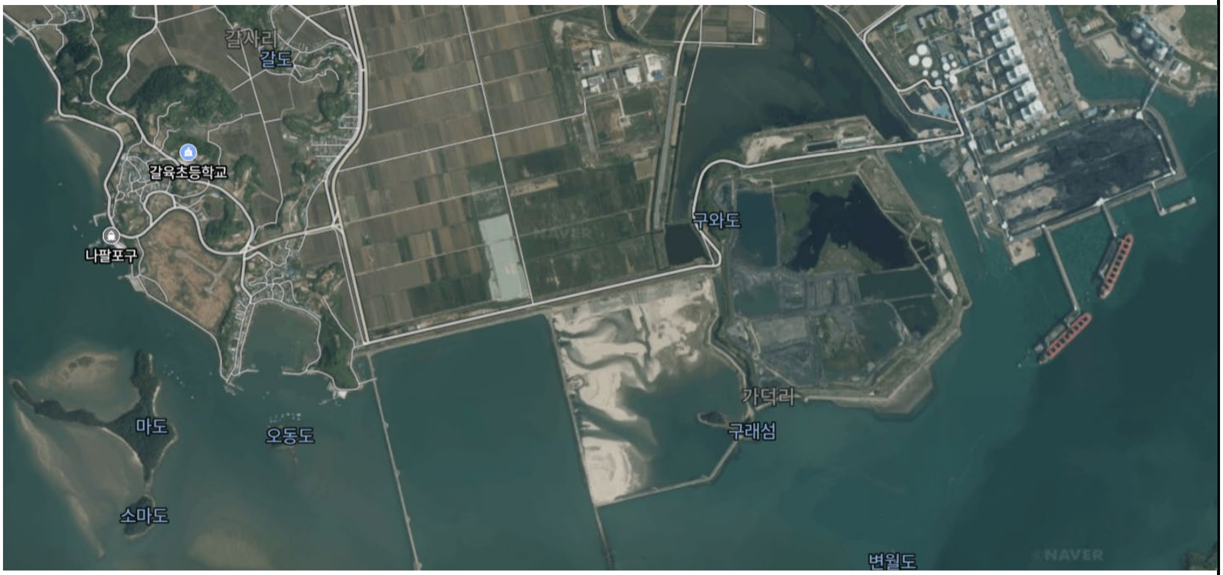
Structure: Gyeongsangnamdo Harbor Management Center (Gyeongsangnamdo Provincial Government)

National Ports Policy Category: Regional Trade Port

Development Master Plan: The 4th National Port Master Plan 2021-2030 (Review 2020)

Location: LAT: 34.9463N   LONG: 127.8238E

Brief Description: Hadong Port is located on the Southern coast of South Korea. It was designated as a trade port in Dec 2010. Currently, it supports coal supply for the Hadong Thermal Power Plant and adjacent industrial complexes.



Ports Physical Characteristics	Port Depth (Chart Datum)	10-20m (Hadong Power Port)
	Approach Channel Depth	18.5m
	Quay Length	612m
	Unloading Capacity (kT)	12,468
	Component handling equipment	S/L: 6 Units / 2,000-500T/H
	Site Area	N/A
Ports Connectivity	Distance from wind farm	3 planned offshore wind projects (Goheung, Yokji, Tongyoung Socho) in 60km radius
	Sailing Distance from the key component suppliers	Incheon: 690km Gunsan: 562km Gwangyang: 20km Busan: 185km Ulsan: 238km Pohang: 329km
	Distance from road	6km off Highway 10 via NR59 and NR19

	Distance from road/rail networks	18km from Hadong Railway Station
	Distance from Airports	Yeosu Airport: 22km by air/ 48km by road Sacheon Airport: 28km by air / 41km by road
Ports Layout	Storage space availability	N/A
	Component laydown (staging) area availability	Open Storage Yard: 223,160m^2
	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	Space available in the adjacent area but no specific plans for expansion to date

Incheon Port

Ownership: Incheon Port Authority (Ministry of Oceans and Fisheries)

National Ports Policy Category: National trade port

Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)

Location: LAT: 37.4618   LONG: 126.6259

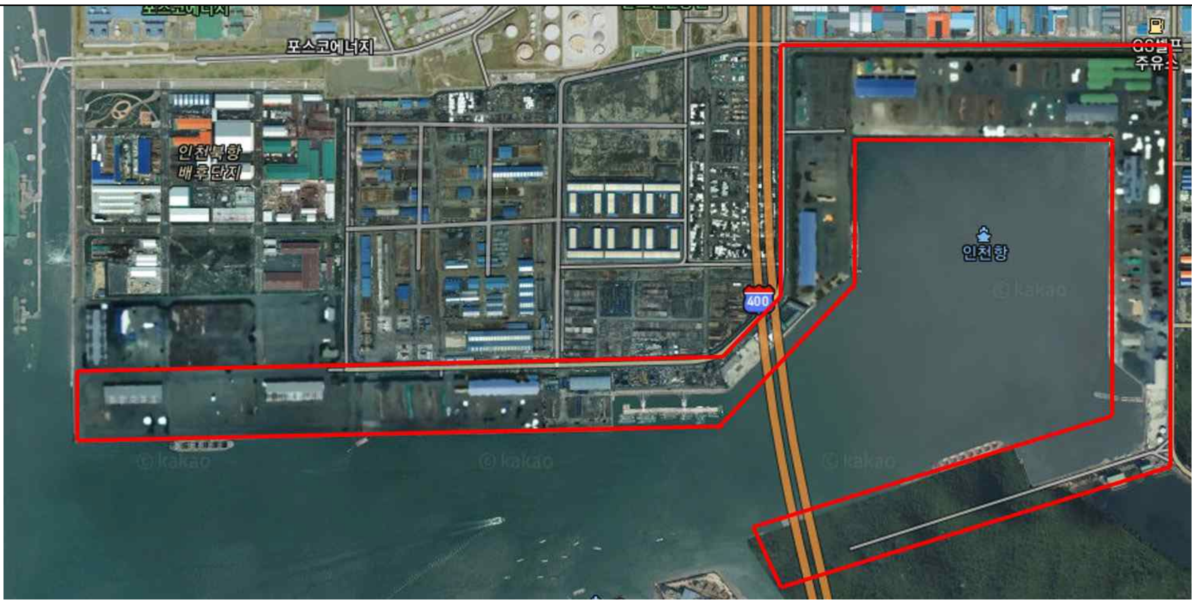
Brief Description: Incheon Port, which is operated by Incheon Port Authority, is the second largest national trade port in South Korea after Busan Port. This port is located in Incheon, a city on the coast directly bordering the west of Seoul and serves as the outer port of Seoul. Incheon Port is composed of several ports, including Inner Port, South Port, North Port and New Port.

Incheon Port is the largest port on the west coast of South Korea. The shallow water depth and extreme tidal range of the west coast made it difficult for large ships to enter and exit the port. However, the construction of New Port in Songdo International City has made it possible for large ships to dock freely.

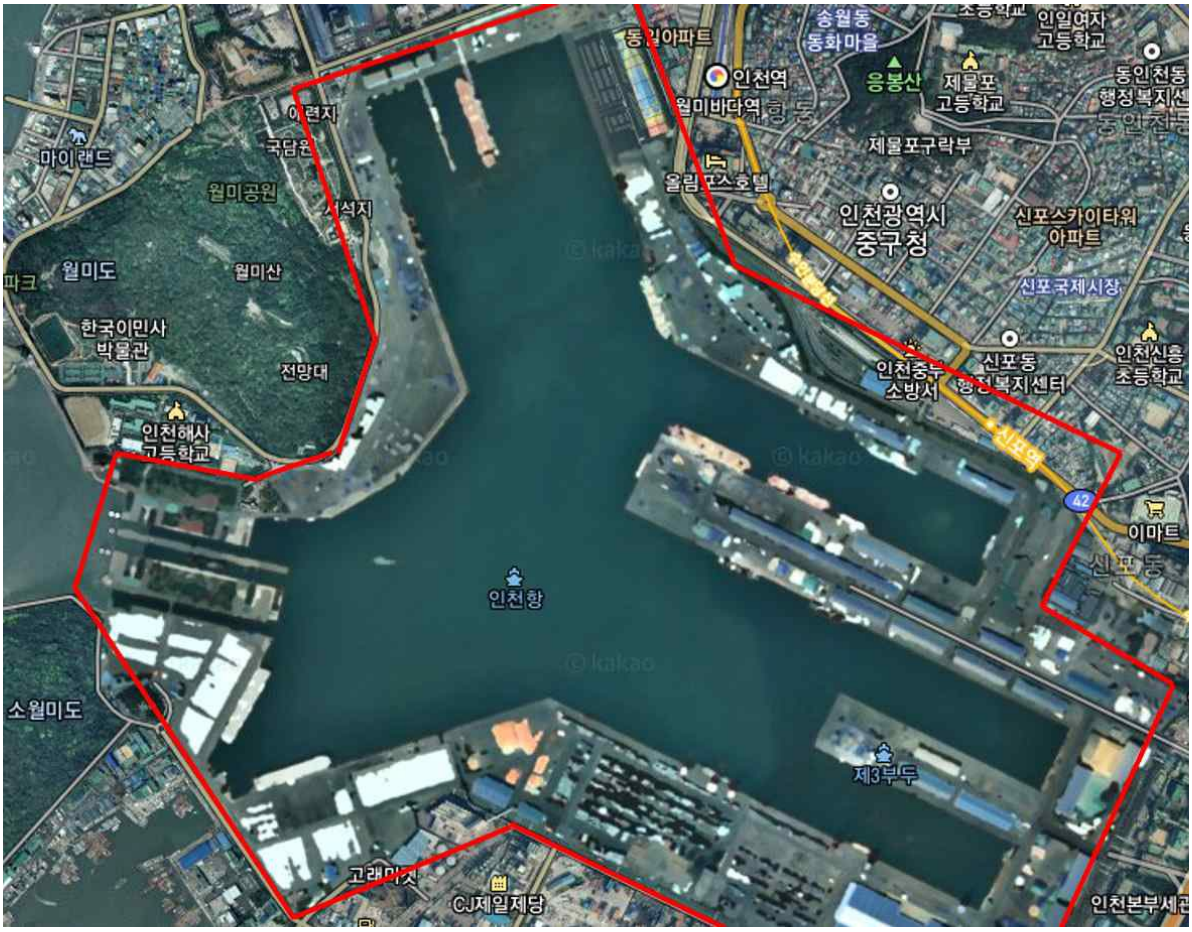
In November 2022, Incheon Metropolitan City and Incheon Port Authority announced that they considered New Port (specifically, eastern area of 1-2) as a candidate for an offshore wind manufacturing port and South Port (specifically, E1CT and SICT) as an offshore wind O&M port.
[Incheon Port (Overall)]


인천항 현황도
LOCATION MAP
인천항
동해
경인항
North Port
Inner Port
South Port
New Port
신항 II 단계
제1항로
제3항로
연안여객선항로
신항 부두 개발 계획
신항 배후부지 개발 계획
신항 배후단지 (214만m²)
북항 배후단지 북측(177천m²)
북항 배후단지 남측(565천m²)
아암물류 1단지 (961천m²)
아암물류 2단지 (2,626천m²)
신국제여객부두
인천월드마린센터(IWMC)
계양구
부평구
서구
중구
동구
남구
남동구
연수구

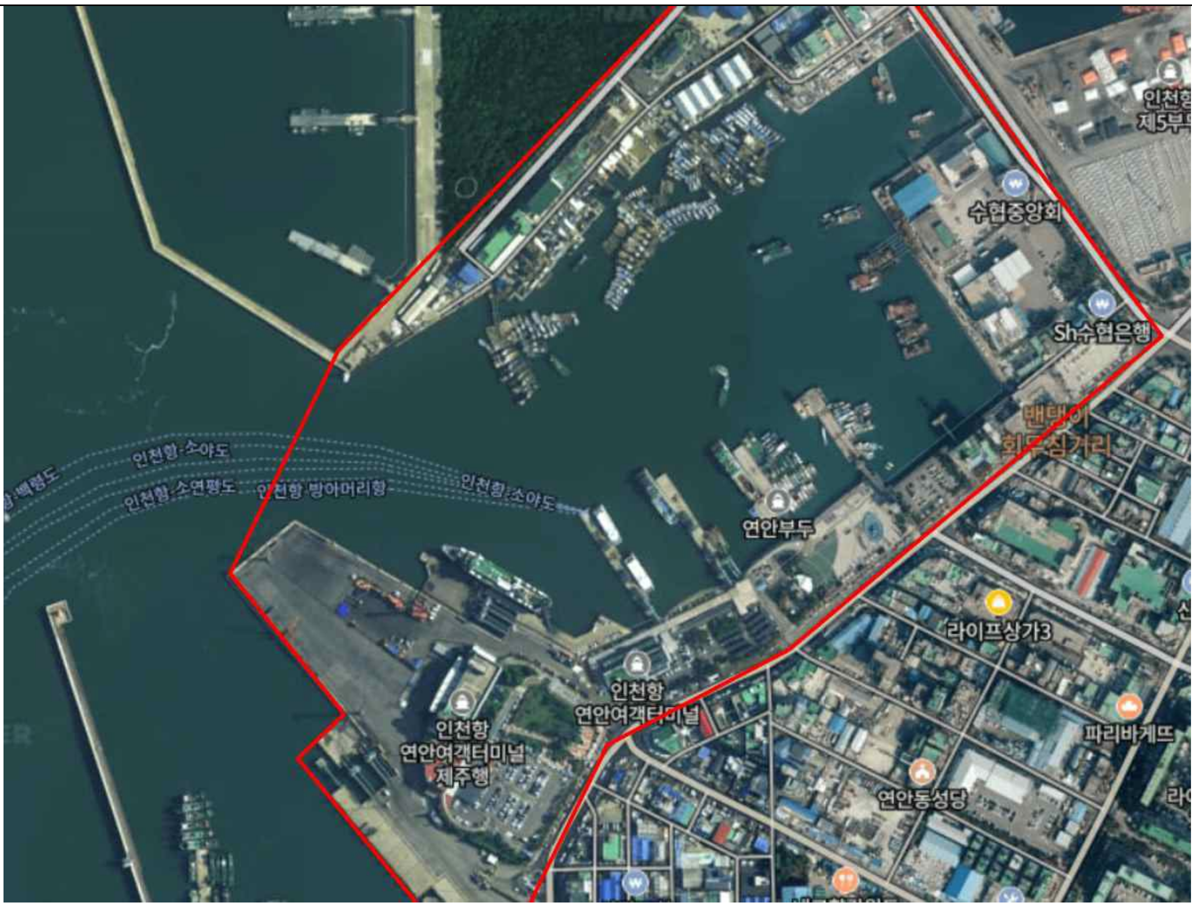
[North Port]



[Inner Port]



[Coastal Port]


인천항 소야도
인천항 소연평도
인천항 방아머리항
인천항 소야도
수협중앙회
Sh수협은행
밴댕이
회무침거리
연안부두
라이프상가3
인천항
연안여객터미널
인천항
연안여객터미널
제주행
파리바게뜨
연안동성당

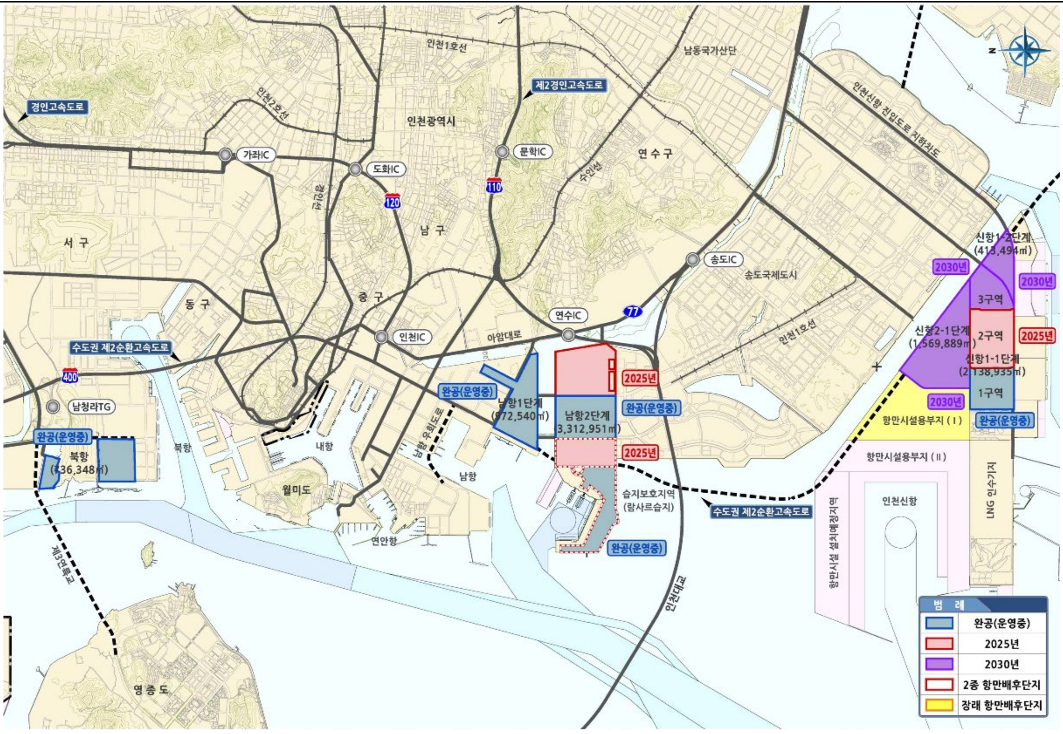
[South Port]

[New Port]

Port physical characteristics	Port Depth (Chart Datum)	Inner Port: 0.7~5m South Port: 3.5~16m

		Coastal Port: 7.5~11m North Port: 4.5~19m New Port: 14m Song-do: 5~14m Yeongheung-do: 20m
	Approach channel depth	East Channel: 13~30m West Channel: 11~50m No. 1 Fairway: 12~14m No. 2 Fairway: 8m No. 3 Fairway: 14m New Port Fairway: 16m
	Quay length	26,736m
	Unloading Capacity	144,204kt
	Component handling equipment	C/C: 21 units / 65~50t T/C: 83 units / 40.6~40t BTC: 7 units / 40.6~35t LLC: 1 unit / 35t U/L: 26 units / 2,400~120T/H S/L: 2 units / 500T/H
	Site area	15,588,236.8m^2
Ports connectivity	Distance from wind farm	About 70km (Several major companies, including Ørsted, are planning to develop offshore wind projects off the coast of Incheon, though no wind farm currently exists)
	Sailing Distance from the key component suppliers	Incheon: 0km Gunsan: 272.24km Gwangyang: 701.91km

		Busan: 785.71km Ulsan: 837.29km Pohang: 872.68km
	Distance from road	Direct access
	Distance from rail networks	Incheon Station: 4km by road East Incheon Station: 2.5km by road
	Distance from Airports	Incheon International Airport: 17km by air / 31km by road Gimpo International Airport: 18km by air / 31km by road
Ports Layout	Storage space availability	Warehouse: 4 units / 117,087m^2 Transit shed: 17 units / 85,749m^2
	Component laydown (staging) area availability	Open storage yard: 3,672,346m^2
	Space availability: cluster	Port hinterland: 3,554,000m^2 / 45 companies / 1,905 employees
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	See the below map



- Blue: Port facilities completed and operating
- Red: Port facilities to be completed by 2025
- Purple: Port facilities to be completed by 2030
- Yellow: Hinterland to be developed in future

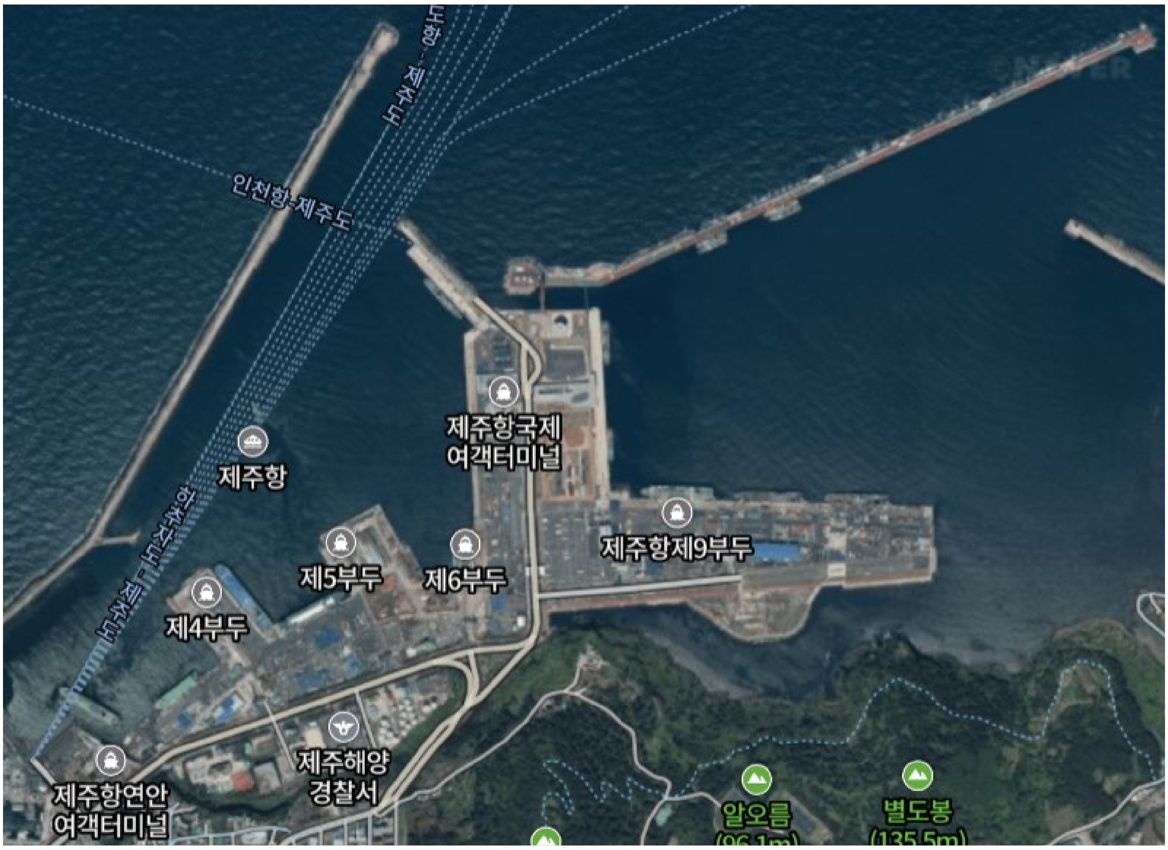
Jeju Port

Structure: Jeju Provincial Government **National Ports Policy Category:** Regional Trade Port

Development Master Plan: The 4th National Port Master Plan 2021-2030 (Review 2020)

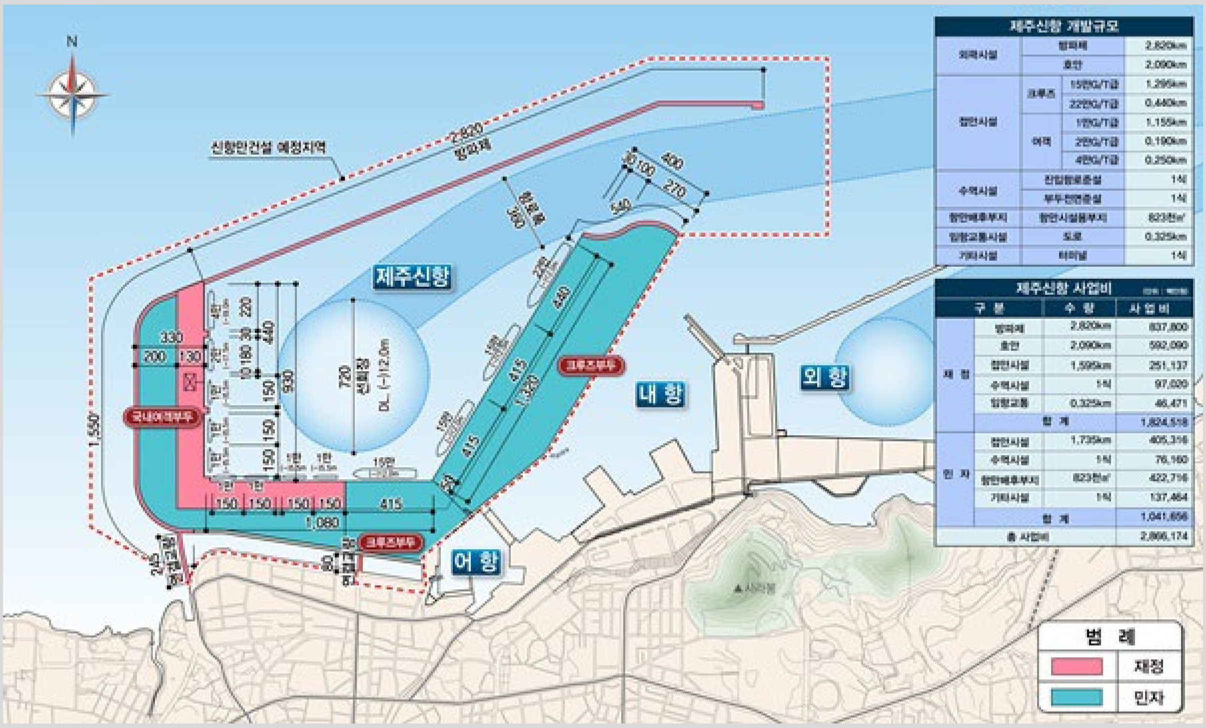
Location: LAT: 33.5213N LONG: 126.5363E

Brief Description: Jeju Port is located on the northern coast of Jeju Island, connecting the island with the mainland. Jeju Port handles 70% of the shipments between the island and the mainland, and its role is growing in the greater region as increasing number of international cruise lines are setting their course to Jeju. The Government has announced plans to expand Jeju port by building a new port facility right next to the existing port by 2040.



Ports Physical Characteristics	Port Depth (Chart Datum)	Fishing Port: 2-3m Inner Port (Upper): 5-11m Outer Port: 11.5-12m
	Approach Channel Depth	13m (Outer Port)
	Quay Length	3,518m
	Unloading Capacity (kT)	2,832
	Component handling equipment	N/A
	Site Area	752,7901m^2
Ports Connectivity	Distance from wind farm	All offshore wind projects planned or installed in the Jeju area is in the accessible range of Jeju port
	Sailing Distance from the key component suppliers	Incheon: 530km Gunsan: 401km

		Gwangyang: 233km Busan: 314km Ulsan: 362km Pohang: 301km
	Distance from road	Direct Access to all major roads in Jeju Island, but no road connection to mainland.
	Distance from rail networks	No railroad access.
	Distance from Airports	Jeju Airport: 4km by air / 5km by road
Ports Layout	Storage space availability	Warehouse: 3 Units, 6,971m^2
	Component laydown (staging) area availability	Open Storage Area 103,491m^2
	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	In 2019, the Government announced its plans to build additional port (Jeju New Port) right next to the exiting port facilities by 2040, as below.



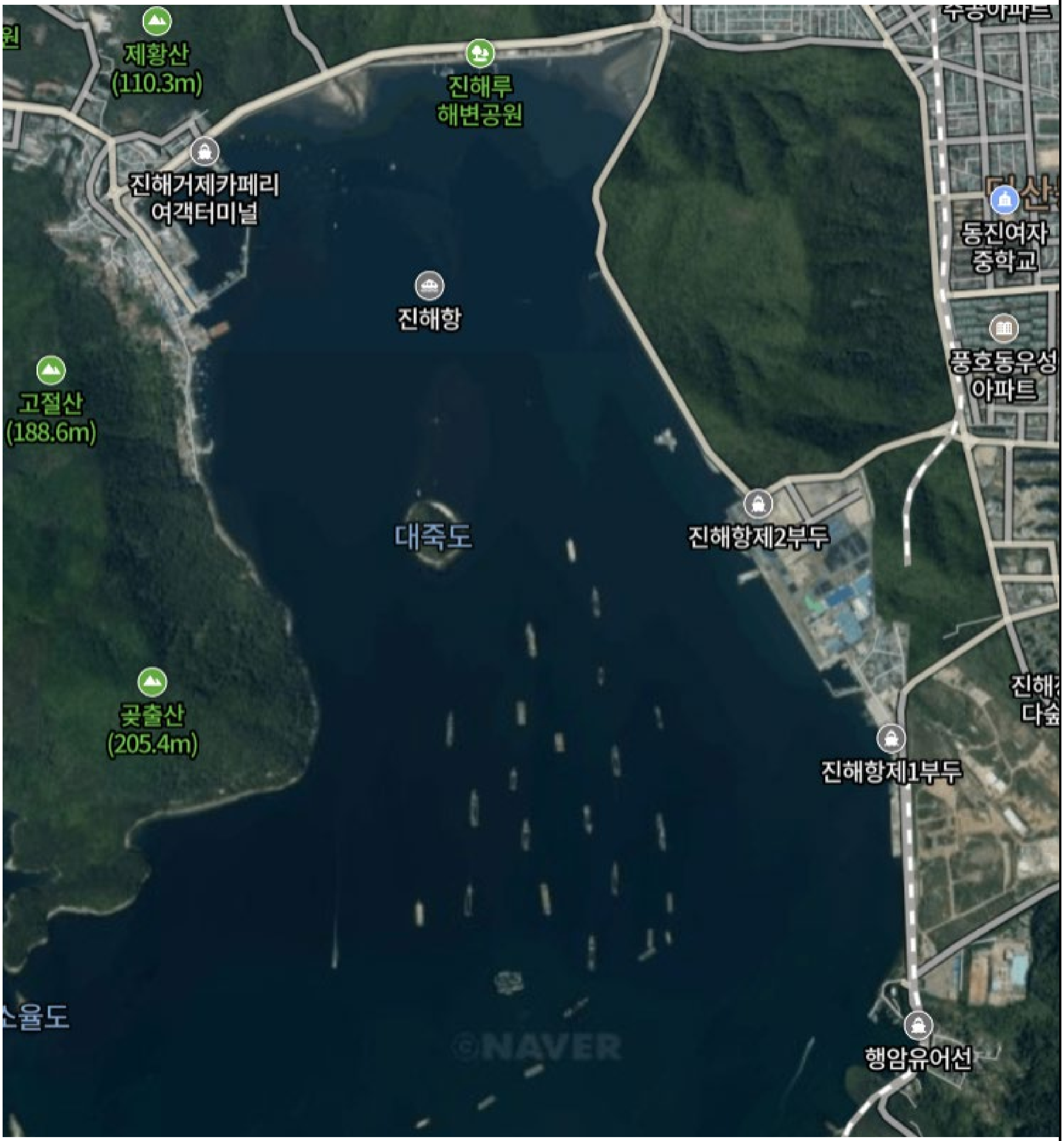
Jinhae Port

Structure: Changwon City Government **National Ports Policy Category:** Regional Trade Port

Development Master Plan: The 4th National Port Master Plan 2021-2030 (Review 2020)

Location: LAT: 35.1268N   LONG: 128.6994E

Brief Description: Jinhae Port is located in the Southeastern coast of South Korea. Jinhae Port was developed in the 60s with chemical industry grew in the region and has been the centre of South Korea’s naval forces. In 2023, Changwon city took over the management authority of the port with plans to revamp the port’s logistical and leisure functions.



Ports Physical Characteristics	Port Depth (Chart Datum)	5-11m
	Approach Channel Depth	No Designated Approach Channel
	Quay Length	1,293
	Unloading Capacity (kT)	4,530

	Component handling equipment	N/A
	Site area	217,301
Ports Connectivity	Distance from wind farm	Two planned offshore wind projects (Dadaepo and Cheongsapo) within 30km radius
	Sailing Distance from the key component suppliers	Incheon: 743km Gunsan: 625km Gwangyang: 191km Busan: 80km Ulsan: 133km Pohang: 225km
	Distance from road	Direct access to Highway 105
	Distance from rail networks	Direct access to railroad (rail connected from harbour to Jinhae St.)
	Distance from Airports	Gimhae Airport: 24km by air/ 37km by road
Ports Layout	Storage space availability	Warehouse: 1 Unit / 6.918m^2
	Component laydown (staging) area availability	Open Storage Yard 137,000m^2
	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	No pending plans for expansion

Masan Port

Ownership: Masan Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries)

National Ports Policy Category: National trade port

Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)

Location: LAT: 35.1901 LONG: 128.567

Brief Description: Masan Port, located in the well-protected Bay of Masan, serves as the gateway of neighboring Changwon National Industries Complex with annual cargo volume of over 10 million tons. It is also the port of call for regular liner services between Korea and Japan, South-east Asia and North-east Asia.

Port physical characteristics	Port Depth (Chart Datum)	Masan port : 4~14m
	Approach channel depth	No. 1 Fairway: 13m No. 2 Fairway: 11m
	Quay length	6,824m
	Unloading Capacity	19,719kt
	Component handling equipment	C/C: 2 units / 50~40t BTC : 5 units/ 500~40t

	Site area	1,529,281.0 m^2
Ports connectivity	Distance from wind farm	About 40km (A few project sites are located in neighbouring cities such as Tongyoung, Busan, etc.)
	Sailing Distance from the key component suppliers	Gwangyang: 191.59km Busan: 87.74km Ulsan: 139.76km Pohang: 231.77km
	Distance from road	Direct access
	Distance from rail networks	Masan Station: 5.3km by road Changwon Station: 8.8km by road
	Distance from Airports	Gimhae International Airport: 46km by road
Ports Layout	Storage space availability	Warehouse: 3 units / 20,945m^2 Transit shed: 1 unit / 2,643m^2
	Component laydown (staging) area availability	Open storage yard: 666,653m^2
	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	N/A

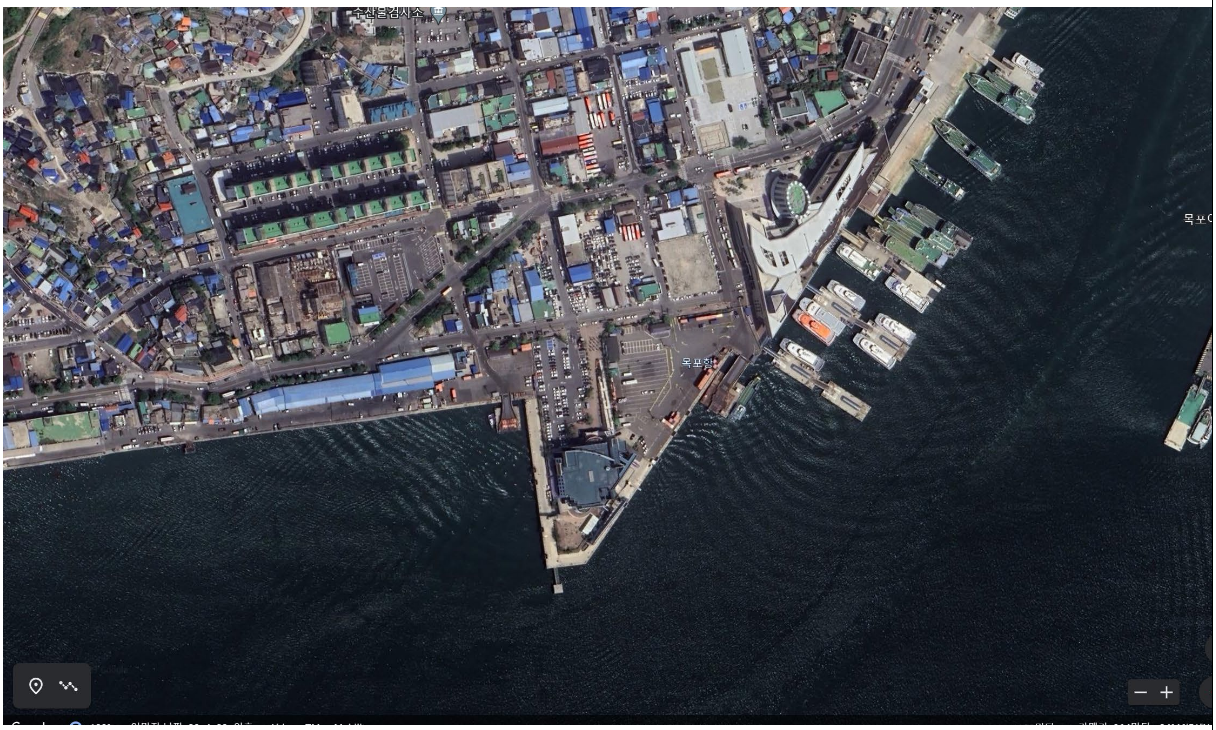
Mokpo Port
Ownership: Mokpo Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries)

National Ports Policy Category: National trade port

Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)

Location: LAT: 34.7815   LONG: 126.3835

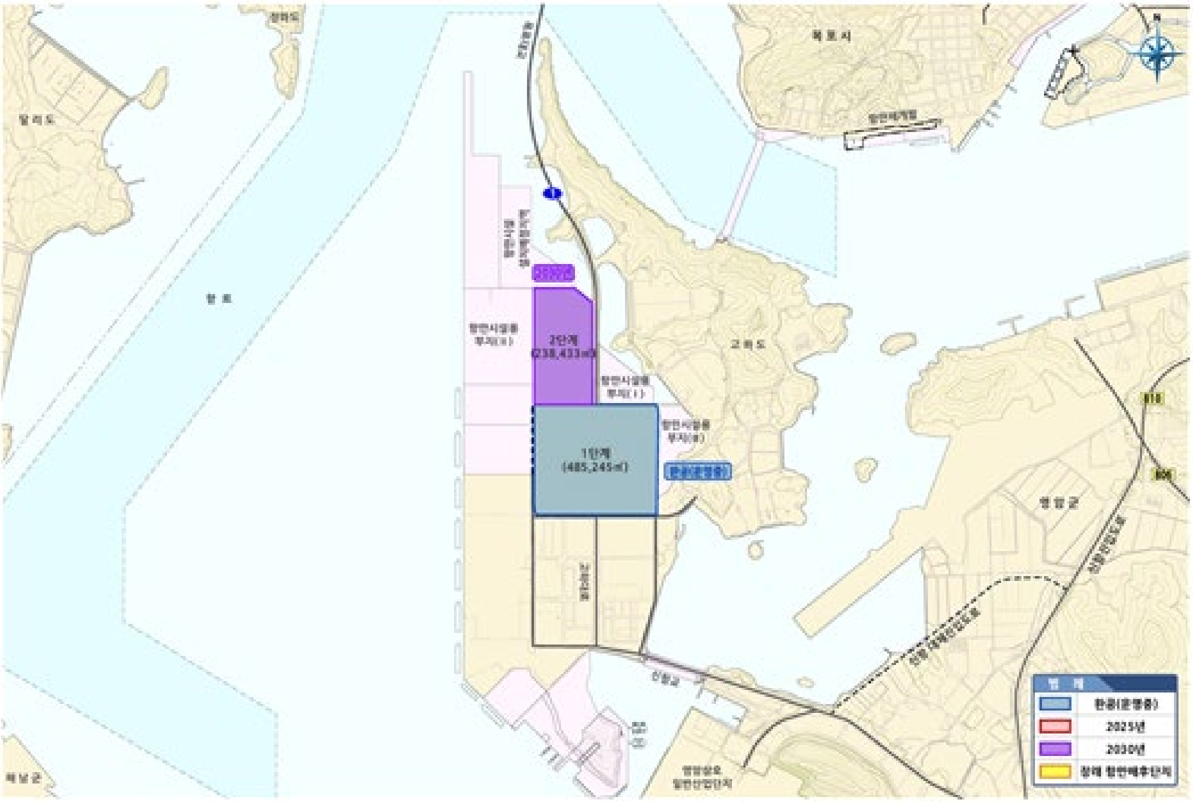
Brief Description: Mokpo Port has served the core industries in the Southwest region as one of major national trade ports of South Korea. It is also a centre of islands tourism. There is a plan to establish "a steel pier" in the front of the port's rear complex around the New Port and use it as a support pier for offshore wind power.



Port physical characteristics	Port Depth (Chart Datum)	Mokpo Port : 6~12m Mokpo New Port : 9.5~12m
	Approach channel depth	Main Channel: More than 13m
	Quay length	5,999m
	Unloading Capacity	20,955kt
	Component handling equipment[99]	C/C: 2 units / 40.6t T/C : 5 units / 40.6t

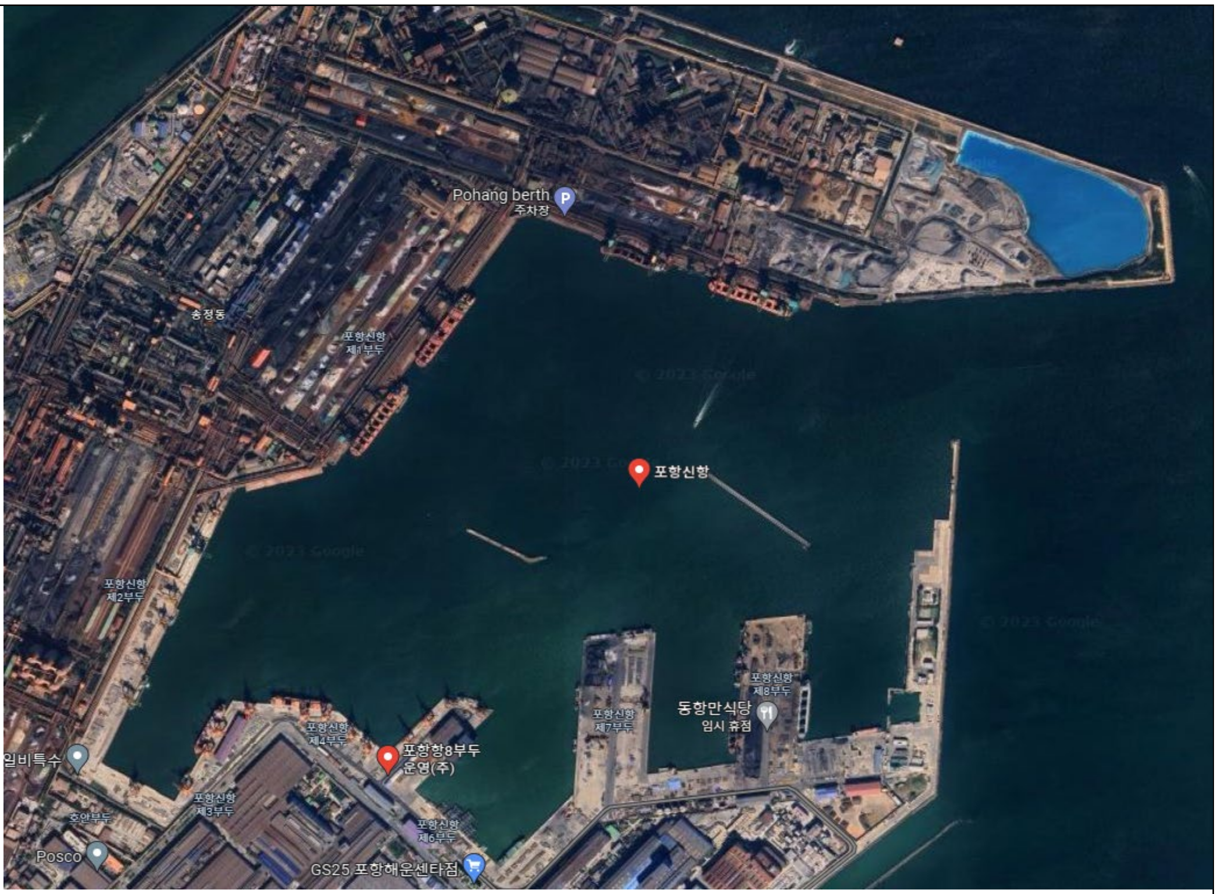
[99] C/C: Container Crane, T/C: Transfer Crane, BTC: Bridge Type Crane, LLC: Level Luffing Crane, U/L: Unloader, S/U: Ship Unloader, t: ton, T/H: ton/hour

		U/L: 1 unit / 25t
	Site area	2,504,510.5 m^2
Ports connectivity	Distance from wind farm	About 2-~30km (Many project sites are located nearby in Sinan, Haenam, Muan etc.)
	Sailing Distance from the key component suppliers	Incheon: 461.15km Gunsan: 331.51km Gwangyang: 418.56km Busan: 503.45km Ulsan: 555.01km Pohang: 645.98km
	Distance from road	Direct access
	Distance from rail networks	Mokpo Station: 1.3km by road
	Distance from Airports	Muan International Airport: 34km by road Gwangju Airport: 72km by road
Ports Layout	Storage space availability	Warehouse: 5 units / 19,504m^2 Transit shed: 0 units
	Component laydown (staging) area availability	Open storage yard: 749,422m^2
	Space availability: cluster	Port hinterland: 485,000m^2 (under development)
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	See the below map

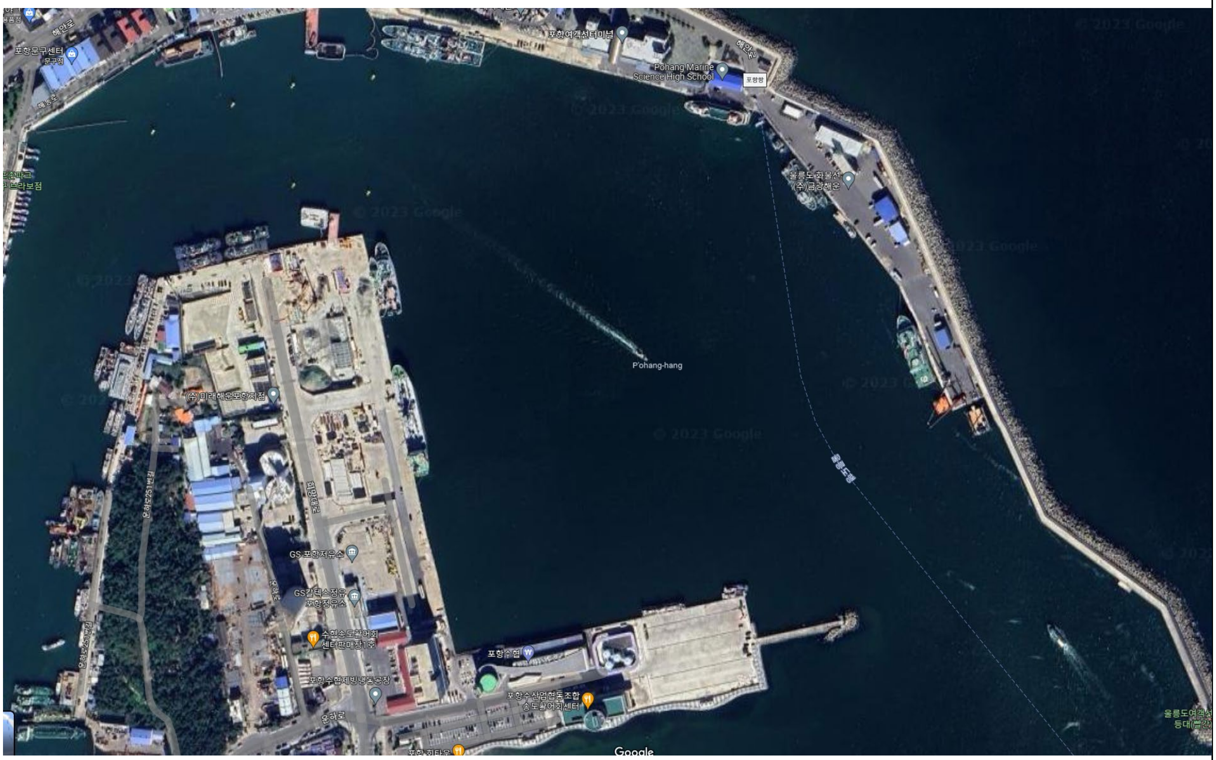


- Blue: Port facilities completed and operating
- Purple: Port facilities to be completed by 2030

Pohang Port
Ownership: Pohang Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries) **National Ports Policy Category**: National trade port **Development Master Plan**: The 4th National Port Master Plan 2021 - 2030 (Review 2020) **Location**: LAT: 36.0522   LONG: 129.3771 **Brief Description**: Pohang Port is located in the southeastern part of the Korean Peninsula and serves as a gateway to Daegu and Gyeongsangbukdo and consists of three ports. The new port supports steel industrial complexes such as POSCO, the old port handles sand and oil, and Yeongilman Port, developed in 2009, is used as a container terminal.
[New Port]



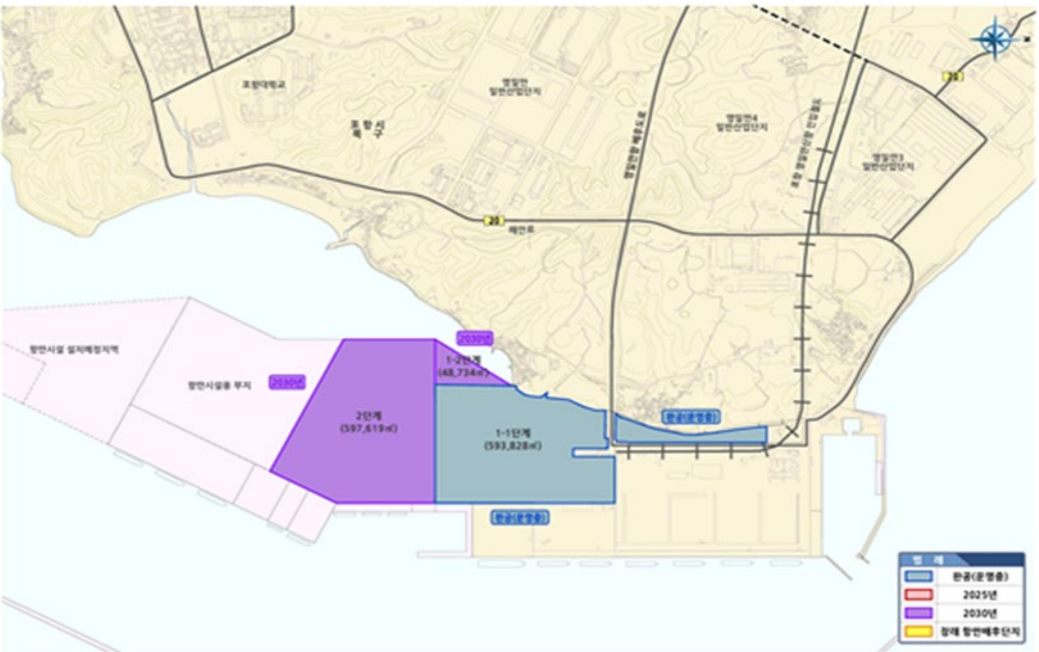
[Old Port]



[Youngilman Port]

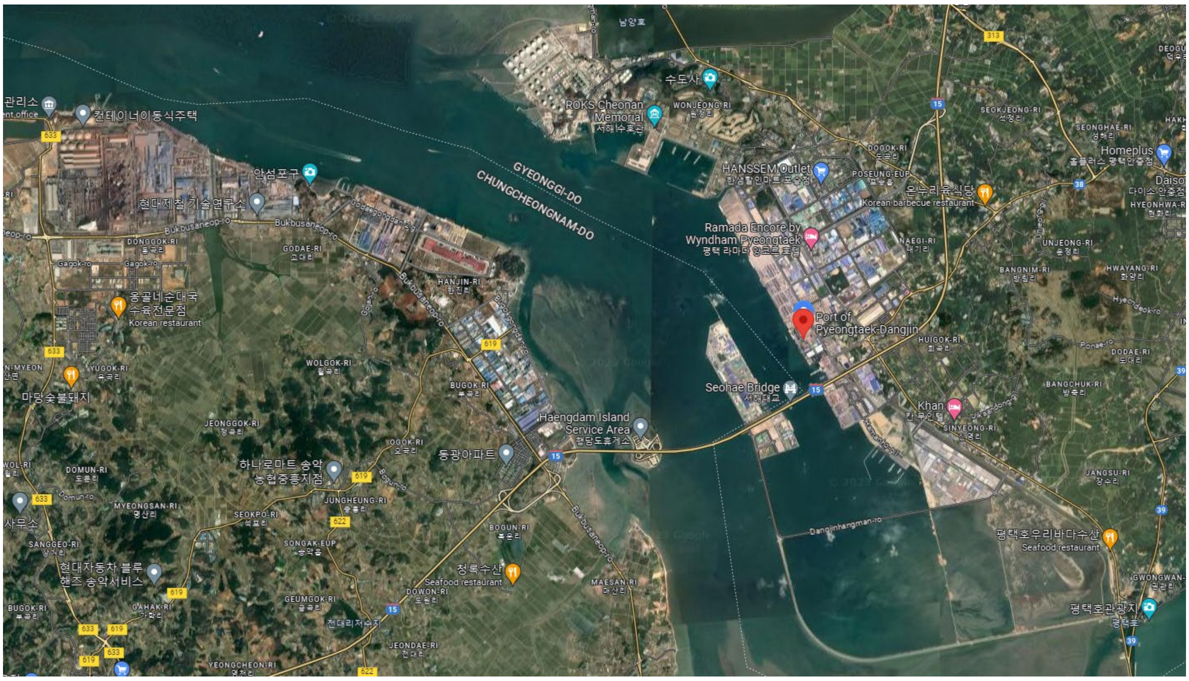
Port physical characteristics	Port Depth (Chart Datum)	New Port: 6.8~19.5m Old Port: 6.5~7.5m Youngilman Port: 10~11m
	Approach channel depth	New Port Channel: 15~20m Youngilman Port Channel: 20~25m
	Quay length	12,032m
	Unloading Capacity	95,559kt
	Component handling equipment	C/C: 2 units / 65t T/C: 5 units / 41t BTC: 17 units / 50~25t LLC: 5 unit / 45~25t U/L: 13 units / 3,000~1,500T/H S/L: 1 units / 650T/H

	Site area	2,991,549.3m²
Ports connectivity	Distance from wind farm	About 10km~50km (Several major companies, including POSCO. Xecacon Korea, Ørsted, CIP, are planning to develop projects)
	Sailing Distance from the key component suppliers	Incheon: 871km Gunsan: 771km Gwangyang: 347km Busan: 152km Ulsan: 134km
	Distance from road	Direct access
	Distance from rail networks	Direct access
	Distance from Airports	Ulsan Airport: 47km by air / 61km by road Gimhae International Airport: 102km by air / 126km by road Pohang Airport: 4km by air / 3km by road
Ports Layout	Storage space availability	Warehouse: 20 units / 65,848m²
	Component laydown (staging) area availability	Open storage yard: 1,406,915m²
	Space availability: cluster	Port hinterland: 594,000m² / 6 companies / 35 employees
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	See the below map



- Blue: Port facilities completed and operating
- Red: Port facilities to be completed by 2025
- Purple: Port facilities to be completed by 2030
- Yellow: Hinterland to be developed in future

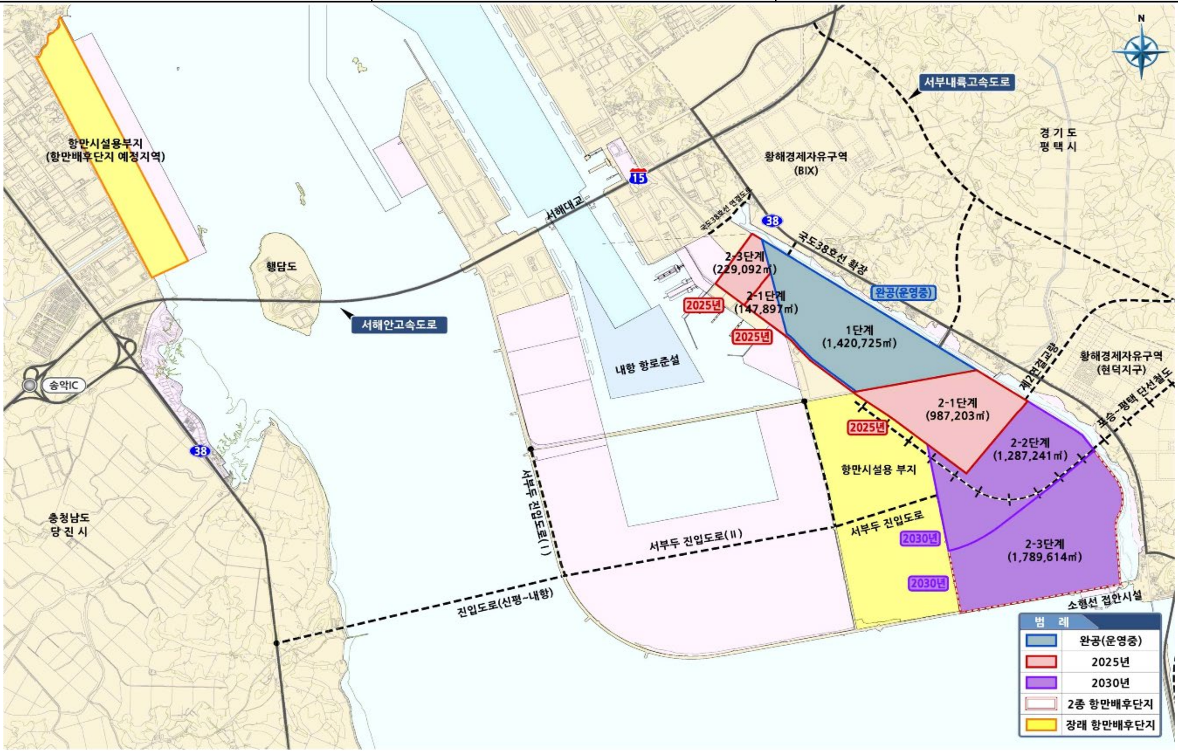
Pyeongtaek-Dangjin Port
Ownership: Pyeongtaek Regional Office of Oceans and Fisheries (Ministry of Oceans and Fisheries)
National Ports Policy Category: National trade port
Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)
Location: LAT: 37.9645 LONG: 126.8409
Brief Description: Pyeongtaek-Dangjin Port is a large trade port extending from Pyeongtaek-si, Gyeonggi-do, to Dangjin-si, Chungcheongnam-do, through Asan Bay. Pyeongtaek-Dangjin Port is mainly composed of East, West, Songak and Godae piers. Pyeongtaek-Dangjin Port, which is the closest port to China, has been selected as one of the three national policy ports and five national development projects and has achieved continuous growth. Pyeongtaek-Dangjin Port is gathering point for ships bound for China's southern special economic zones such as Shanghai and Guangzhou, as well as Taiwan and Hong Kong. As a result, much of Incheon Port's cargo volume has been transferred to Pyeongtaek-Dangjin Port.



Port physical characteristics	Port Depth (Chart Datum)	East Pier: 12~15m West Pier: 12~14.5m Songak Pier: 6.5~22.5m Godae Pier: 7~14m Dolphin Pier: 5.6~15m Morae Pier: 5m
	Approach channel depth	Arrival fairway outside of port limit: 18m Departure fairway outside of port limit: 14m Fairway inside of port limit: 14m
	Quay length	14,424m
	Unloading Capacity	97,504kt
	Component handling equipment	C/C: 8 units / 50t T/C: 20 units / 40.6~40t BTC: 7 units / 50~3t LLC: 2 unit / 43t

		U/L: 19 units / 332~4.9T/H
	Site area	6,501,183.4m^2
Ports connectivity	Distance from wind farm	About 80km (Several major companies, including Ørsted, are planning to develop offshore wind projects off the coast of Incheon, though no wind farm currently exists)
	Sailing Distance from the key component suppliers	Gunsan: 264.84km Gwangyang: 694.50km Busan: 778.47km Ulsan: 830.70km Pohang: 921.67km
	Distance from road	Direct access
	Distance from rail networks	Pyeongtaek Station: 25km by road
	Distance from Airports	Incheon International Airport: 65km by air / 93km by road Gimpo International Airport: 66km by air / 86km by road Cheongju International Airport: 64km by air / 87km by road
Ports Layout	Storage space availability	Warehouse: 12 units / 115,707m^2
	Component laydown (staging) area availability	Open storage yard: 2,313,295m^2
	Space availability: cluster	Port hinterland: 1,420,000m^2 / 15 companies / 825 employees
	Workshop area	Yes
	Office facilities	Yes

	Potential for expansion	See the below map



- Blue: Port facilities completed and operating
- Red: Port facilities to be completed by 2025
- Purple: Port facilities to be completed by 2030
- Yellow: Hinterland to be developed in future

Samcheonpo Port

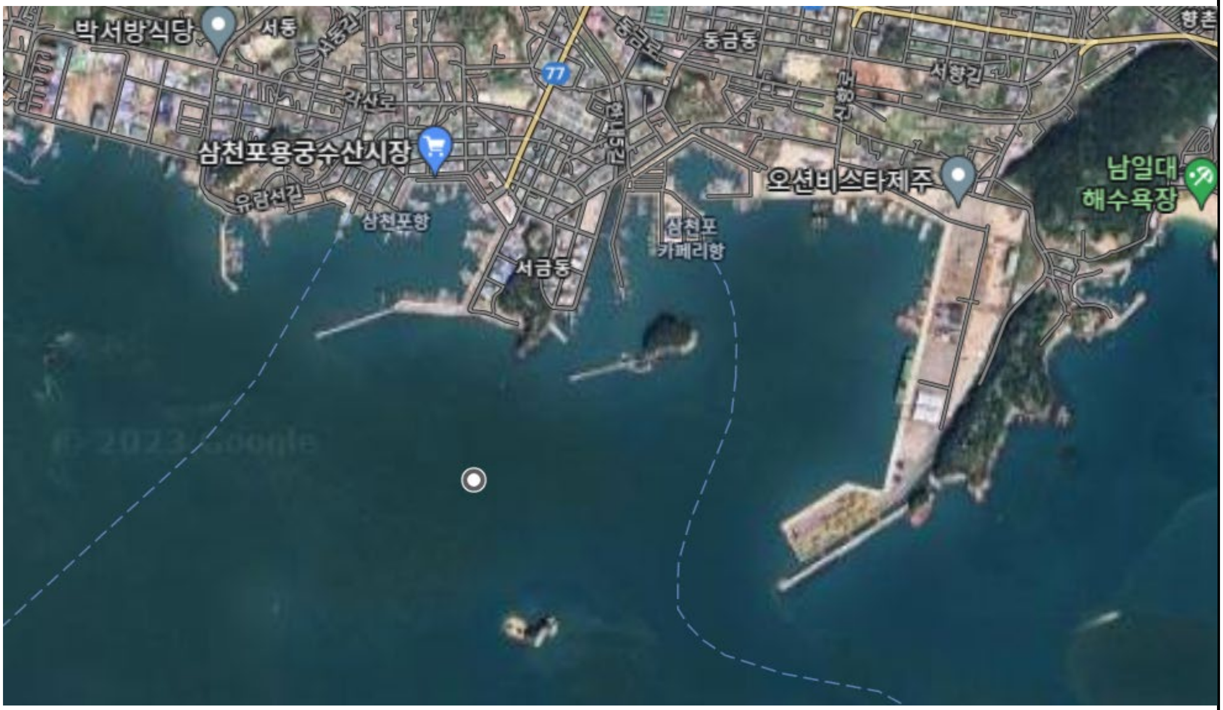
Structure: Gyeongsangnamdo Harbor Management Center (Gyeongsangnamdo Provincial Government)

National Ports Policy Category: Regional Trade Port

Development Master Plan: The 4th National Port Master Plan 2021-2030 (Review 2020)

Location: LAT: 34.927N   LONG: 127.0697E

Brief Description: Samcheonpo Port is located on the Southern coast of South Korea, connecting the Western Coast and the Southern Coast of Soth Korea. It was designated as a trade port in 1966 and is currently handling mineral exports and fuel imports for thermal power plant in the area.



Ports Physical Characteristics	Port Depth (Chart Datum)	Old Port: 3-4m New Port: 5-12m Samcheonpo Power Port: 13.5-16.5m
	Approach Channel Depth	No designated approach channel
	Quay Length	2,767
	Unloading Capacity (kT)	24,390
	Component handling equipment	U/L : 7 units / 2,400-200T/H S/L : 3 Units / 600-350T/H
	Site Area	487,893m^2
Ports Connectivity	Distance from wind farm	Three planned offshore wind projects (Tongyoung Socho, Yokji, Yokji Jwasari) within 50km radius
	Sailing Distance from the key component suppliers	Gwangyang: 69km Busan: 174km Ulsan: 238km

		Mokpo: 409km
	Distance from road	Direct access to Highway 10 via NR3
	Distance from rail networks	30km to Jinju Railway Station
	Distance from Airports	Sacheon Airport: 20km by air / 22km by road
Ports Layout	Storage space availability	N/A
	Component laydown (staging) area availability	Open storage yard: 166,119m^2
	Space availability: cluster	N/A
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	Limited with available space constrained and no pending plans for expansion

Ulsan Port

Ownership: Ulsan Port Authority

National Ports Policy Category: National trade port

Development Master Plan: The 4th National Port Master Plan 2021 - 2030 (Review 2020)

Location: 35.5204, 129.3732

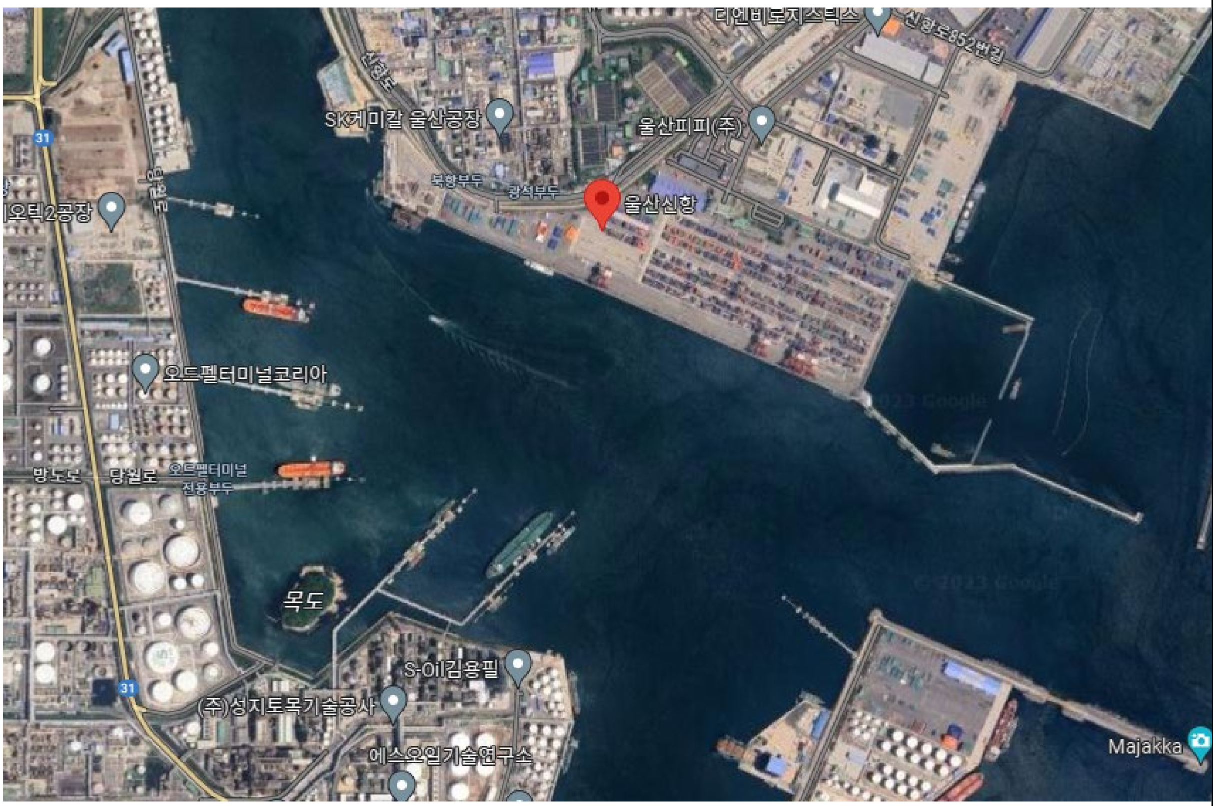
Brief Description: It is one of the largest ports in Korea established as the largest industrial complex in Korea was developed. Currently, it ranks first in liquid cargo handling nationwide, third in port cargo volume, and second in ship arrival nationwide.

As of 2018, 202.78 million tons of goods were processed at Ulsan Port for one year, and the monthly volume was 18.57 million tons. (489,815 TEUs)

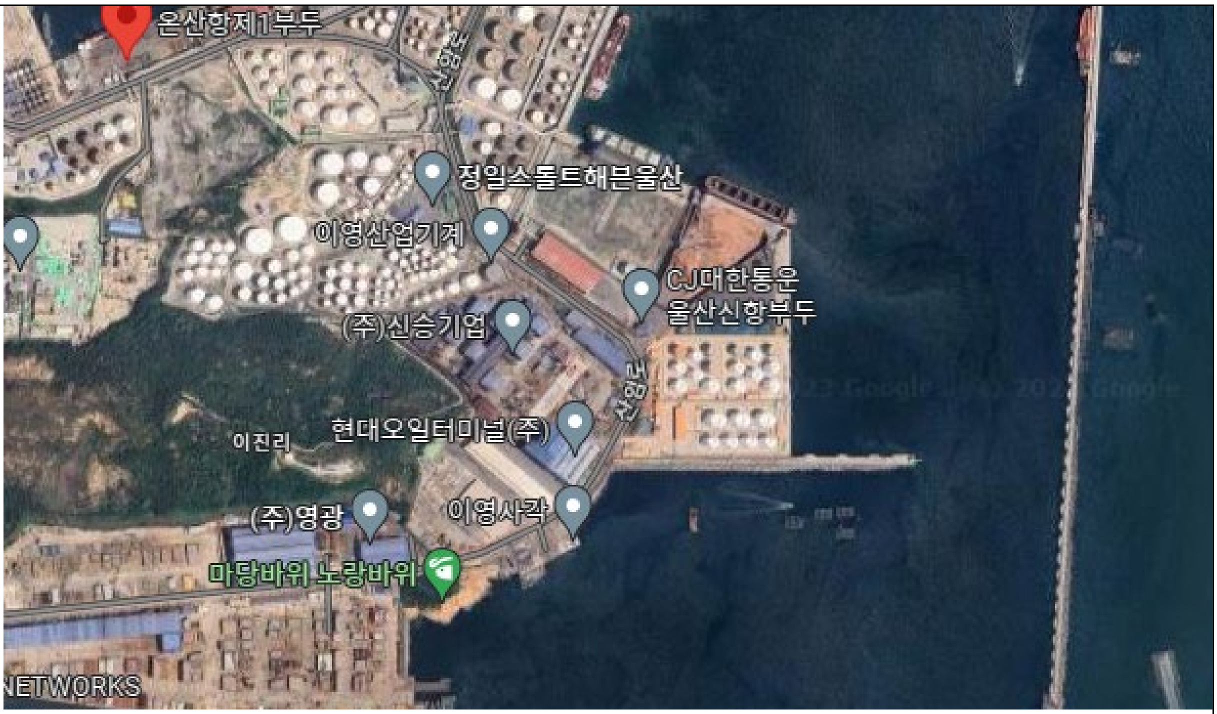
At Ulsan Port, liquid cargo accounts for 80% of the total cargo, and 32% of the nation's liquid cargo is handled here. Cars produced by Hyundai Motor Company and various ships built by Hyundai Mipo Dockyard are exported from Ulsan Port to all over the world.

[Ulsan Main Port]

[New Port]



[Onsan Port]



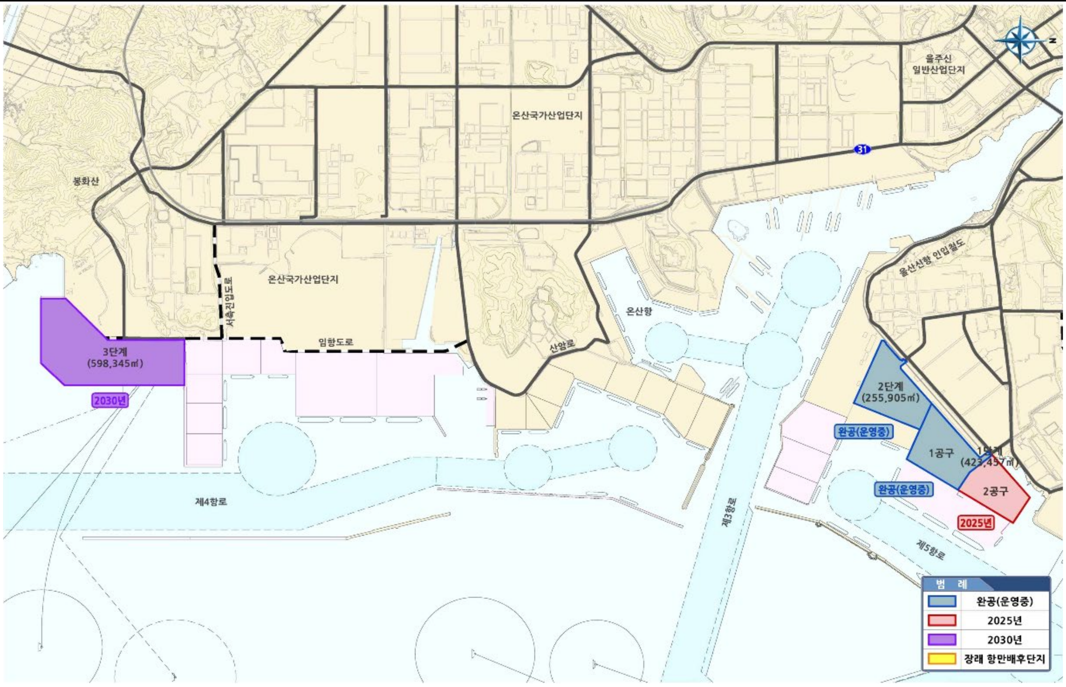
[Mipo Port]

Port physical characteristics	Port Depth (Chart Datum)	Main Port: 7~18m

		New Port: 7~14m Onsan Port: 9m Mipo Port: 7~16m
	Approach channel depth	1st Channel: 12~20m 2nd Channel: 13~14m 3rd Channel: 20~25m 4th Channel: 20~27m 5th Channel: 15~20m
	Quay length	20,521m
	Unloading Capacity	78,816kt
	Component handling equipment[100]	C/C: 7 units / 65~30.5t T/C: 17 units / 40.6~30.5t BTC: 1 units / 20t LLC: 1 unit / 500T/H U/L: 8 units / 1,200~500T/H
	Site area	3,503,515.8m^2
Ports connectivity	Distance from wind farm	The project site is located in the exclusive economic zone at a distance of 80 km from the coast, with a water depth of 175 to 275 m and a total site area of 240 km2.
	Sailing Distance from the key component suppliers	Incheon: 836km Busan: 70km Pohang: 132km Jinhae: 132km Gunsan: 690km

[100] C/C: Container Crane, T/C: Transfer Crane, BTC: Bridge Type Crane, LLC: Level Luffing Crane, U/L: Unloader, S/U: Ship Unloader, t: ton, T/H: ton/hour

	Distance from road	Direct access
	Distance from rail networks	Direct access
	Distance from Airports	Ulsan Airport: 15km by air, 17km by road Gimhae Airport: 49km by air, 68km by road Pohang Airport: 57km by air, 86km by road
Ports Layout	Storage space availability	Warehouse: 15 units / 124,488m^2
	Component laydown (staging) area availability	Open storage yard: 1,223,811m^2
	Space availability: cluster	Port hinterland: 686,000m2 7 companies / 281 employees
	Workshop area	Yes
	Office facilities	Yes
	Potential for expansion	See the below map



- Blue: Port facilities completed and operating
- Red: Port facilities to be completed by 2025
- Purple: Port facilities to be completed by 2030
- Yellow: Hinterland to be developed in future

Appendix 2: Onshore wind compensation schemes in Denmark – further detail

Mitigation and compensation schemes where offshore wind projects may affect the nearby community

It is important to note that the majority of compensation schemes are developed for onshore wind projects rather than offshore wind. This is because onshore wind projects tend to have a greater direct impact on local communities due to their closer proximity to housing and other inhabited areas. This proximity amplifies the potential damages to the community, making compensation more common for onshore wind projects. As such, the example below relates to onshore wind:

- **Denmark's Compensation Scheme:** Owners of wind farms are obliged to compensate the depreciation on residential property caused by windfarms (if the depreciation exceeds 1% of the property value). Project developers and the Danish transmission system operator are required to inform local citizens about the scheme through public meetings.

Examples of monetary incentives to promote community cooperation towards wind projects

As with monetary compensation schemes, incentives have also largely been provided to onshore wind farms as noted in the examples below:

- **Denmark's Annual Bonus:** The Danish Minister for Climate, Energy and Supply proposed a compensation scheme that is currently administered by the Danish Energy Agency which enables residents living within a distance of up to 8 times the height of the wind turbine at the site will receive an annual cash tax-free bonus. The bonus is based on a share of the production equivalent to 5kW which corresponds to DK 5000 (~KRW 950,000) annually for an onshore wind farm. The bonus is a means to acknowledge residents' cooperation and goodwill towards wind projects in their vicinity.
  It should be noted, that given the maximum distance to be eligible for this bonus is 8 times the height of the wind turbine, this bonus is not likely to be relevant for offshore wind farms. E.g., the Vestas V236-15.0 MW turbine has a height of 280 m, and therefore a property would need to be located within 2.24 km, which is unlikely.[101]
- **Denmark's Option to Buy Scheme:** This allows any property owner living near a wind turbine to sell their property to the turbine owner within a year from the wind project's first produced kilowatt hour.
- **Co-ownership**: To incentivise local support and involvement, Danish authorities offer green local guarantees to citizens that wish to buy their own wind turbines through a model of cooperative ownership.
- **Community engagement and events**[102] [103]**:** Ørsted also conducts pre-construction events through a series of public exhibition drop-in events across the proposed cable route for Hornsea Three. These events enable members of the community to learn more about the project and ask questions to experts to foster open and transparent communication.

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[101] Electrek, The world's most powerful wind turbine reaches 15 MW for the first time, 2023 - link
[102] https://hornseaproject3.co.uk/community-engagement/events
[103] https://www.sserenewables.com/media/1umnrwno/sse-renewables-fisheries-co-existance-report.pdf

Appendix 3: Local content requirements – case studies of international markets

Case studies on the use of local content requirements

United Kingdom

A market-driven and flexible approach to prioritise deployment and cost reduction

The UK has adopted a market-driven and flexible approach to local content. In the industry's early days, no binding local content targets were placed on offshore wind. The market developed significantly under this approach and the UK is now placed second globally, behind China, by installed capacity. The flexible approach taken was a crucial factor in this, even though there has been some criticism to the effect that greater economic benefit could have been achieved.

Currently, to secure off-take agreements under the Contract for Difference (CfD) regime, developers need to present their supply chain plans for proposed offshore wind projects. Again, the aim of the Supply Chain Plan under the CfD regime is not to place a binding target for local content, but to allow for open and competitive supply chains to grow as installed capacity grows, and promote sector innovation and skills. It was hoped that such an approach would drive down the cost of offshore wind and lower costs for consumers. The Electricity Market Reform's CfD Allocation Round 3, announced in October 2019, saw the strike price break £40/MWh (2012 real*) for delivery year 2023/2024 for offshore wind. The allocation to offshore wind represented a 67% decrease in strike price since CfD Round 1 and, given the prices came in under the reference prices, there will be no impact on the allocated government budget. This cost reduction was replicated in the CfD Allocation Round 4, with strike prices lower than that reached in Round 3.

The supply chain plan approach can be considered more lenient than strict local content requirements, which allows for a level of flexibility that enables projects to be delivered at an affordable cost to the consumer, and with significant local content present within offshore wind installation and operation stages. The UK approach has contributed to the maturity of the supply chain, which has also benefited from the general growth experienced in the OSW project pipeline over the years. These factors have contributed to maintaining the local content across the supply chain, although suppliers of key components such as turbines and foundations are not located in the UK which can be seen as a missed economic opportunity.

Figures from domestic offshore wind farms are indicating around 50% UK content, and the sector deal signed in early 2019 between government and the offshore wind industry committed to a 60% local content target by 2030.[104] The UK's ambitions for offshore wind and the level of activity in the market has led to significant investment in the local supply chain – for example, blade manufacturing facilities built in Hull (Siemens) and the Isle of Man (MHI Vestas).

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[104] University of Strathclyde. Offshore wind policies and local content: what can we learn from the UK's experience? – link

France

A high early emphasis on local content severely delayed deployment

France placed a much higher emphasis on local content in its initial tender rounds for offshore wind development (2012 and 2014), making it just as important as price in the competitive process. While no local content targets were issued, industrial plans were required as part of the tender for offshore wind capacity and used in the evaluation process with a 40% weighting. This meant that companies who committed to build significant local supply chain (manufacturing etc.) won in the first 2 tenders, but at costs significantly more than the price in other markets at that time (>€200/MWh).

The focus on local content severely delayed deployment in France. To date, only one out of the first 6 projects under Round 1 and 2 (480 MW out of 3GW) is operational, with the rest not yet completed, and nor has the full supply chain potential been realised. Significant investment in local manufacturing was made but it currently serves the wider offshore wind market – two examples include the GE manufacturing facilities in Cherbourg and Saint-Nazaire, which are producing the 107m blades and nacelles for the 12MW Haliade X.

In contrast to the first two tender rounds, local content rules were removed as an evaluation criterion for Round 3 (2016) for the 250 -750MW Dunkirk offshore wind farm. The winning price for 600MW at Dunkirk came in at €44/MWh representing a drastic reduction from the first two tenders with technology cost reduction also a factor in this. However, as this tender aligned more with the approach taken by the UK, similarity in prices were expected.

As of 2022, the French Government signed a sector deal with the offshore wind industry that aims to use 50% of local content in projects by 2035 based on good practice and voluntary commitments.[105] As the LCR is not legally binding and not explicitly integrated in the bid evaluation criteria, the risk of experiencing past challenges with high development costs is reduced. Therefore, France's shift from its initial emphasis on local content requirements within the tender process suggests that its original strategy was flawed.

[105] Wind Europe, March 2022. France commits to 40 GW offshore wind by 2050 – link

Japan

Local content forms a high proportion of bid evaluation criteria

Japan's "Vision for Offshore Wind Power Industry"[106] passed in December 2020 noted that the industry will aim to increase local content across the entire wind-power generation lifecycle to 60% by 2040. Local contribution is therefore a key component of the bid evaluation criteria whereby the developers' track record of engagements with stakeholders, the number of local employees who would be employed by the project, and the project's expected impact on the local and national economy is considered. Specifically, how developers perform in terms of local content development activities contributes towards 33% of their total score (40 points out of 120 points). The evaluation criteria for local content considers:[107] [108]

- Ability to cooperate with heads of administrative agencies (10 points): Track-record of coordinating with relevant government authorities, carrying out domestic offshore and onshore wind power projects, and other relevant coordination (includes overseas track record);
- Coordination and coexistence with the local associations and fisheries regarding the use of sea routes (10 points): Extent to which the plan demonstrates a clear method for ensuring dialogue with local fisheries and shipping companies;
- Impact on the local economy (10 points): Extent to which the bidder's plan will increase regional employment and promote regional investment and construction of regional production facilities;
- Impact on the national economy (10 points): Extent to which the bidder's plan will increase national employment and promote national investment and construction of domestic production facilities.

In parallel to local content requirements built into bid evaluation criteria, the Japanese government has also set out an intention to implement an 'Offshore Wind Power Talent Development Programme', which prioritises local content production and local job employment. In addition, the government plans to support capital investment through subsidies and tax breaks and promote matching of overseas and domestic companies as a means to strengthen local supplier competitiveness. This is expected to support the government's cost reduction targets for fixed bottom offshore wind generated power to 8-9 yen/kWh by 2030-2035, as per the "Vision for Offshore Wind Power Industry".

To date, the local content requirements have not faced backlash from industry. Following round 1 of the fixed bottom auction, Japan's Ministry of Economy, Trade and Industry (METI) and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) were required to revise the project feasibility criteria to remove.

[106] Overview of the Vision for Offshore Wind Power Industry, December 2020 – link
[107] Centre for local content innovation, March 2021. Trends in Local Content Requirements in Key Offshore Wind Markets – link
[108] European Commission, October 2022. Analysis of the offshore wind tender results in Japan – link

subjective elements to scoring.[109] However, there were no changes requested to the local contribution criteria.

Taiwan

New format local content requirements risk damaging the industry

The Taiwan government has been prioritising its localisation strategy which aims to consolidate the entire supply chain from turbine components to submarine cables to shipbuilding. The local content provisions in place in Taiwan have been a challenge to the OSW industry and have slowed market growth due to the difficulties faced by developers in finding sufficient local capability.[110]

For example, to participate in the 2022 OSW auctions, applicants were required to commit to locally procure 26 key development items set by Taiwan's Industrial Development Bureau for at least 60% of the project's proposed capacity. In addition, applicants could achieve at least 10 more points from locally procuring additional key development items as identified by the IDB or locally procure other items outside this list in order to be a qualified bidder. Non-compliance in delivering on the supply chain plan post the allocation of capacity would result in a 3% performance bond and $7 million New Taiwan dollars/100 MW forfeited per month. If there was a delay greater than 10 months, the 20-year FiT rate would be lowered.[111]

As part of these strict application requirements, the bid proposal requested the following information from developers on local content:

- How will you work during construction with local suppliers?
- How will engineering design involve local suppliers?
- How will your purchasing plan involve local suppliers?
- How will you cooperate/collaborate with local suppliers?
- What is your plan to encourage local industry to develop local talent/skills?

These requirements were deemed too strict by industry, who prefer greater flexibility in suppliers to increase feasibility of delivering projects. As a result of this backlash on the stringent local content requirements, the Taiwan's Energy Administration announcing provisional rules in September 2023 pertaining to the OSW auction round 3.2 whereby mandatory local content requirements have been removed.

This has been replaced with 21 optional items alongside a points system where bidders must score at least 70 points to be considered, which include 18 points each for the localisation of turbine foundations, blades and nacelles (54 points total), 14 points for locally sourced cables, among other items with different points allocated. Given that a scoring threshold has been defined for major components of OSW wind farms, it is evident that mandatory local content requirements still do exist.

Investigating the detail of the 'optional items', combined with the requirement to score a minimum of 70/100 points means that there

[109] Linklaters, August 2023. Japan Offshore Wind (5th Edition): Recalibration - link

[110] GWEC. Global Offshore Wind Report 2022 - link

[111] Centre for local content innovation, March 2021. Trends in Local Content Requirements in Key Offshore Wind Markets – link

may be less flexibility in the new approach than the previous approach.

Given the absence locally of some major turbine manufacturers (e.g., Siemens Gamesa, MHI Vestas), obtaining full points for the turbine may be difficult, meaning that aspects such as foundations and cables may need to be sourced locally, and with very few suppliers, this may restrict competition and create unavoidable bottlenecks and delay deployment.

As a result of the draft rules, there is uncertainty as to how developers will be able to achieve the minimum points requirement given the lack of fully localised turbine providers and capacity constraints. As a result, the new rules may risk project delay and mean that international developers focus attentions to other markers where local content rules are more flexible. This risk is genuine, and materialised in Taiwan previously, when Ørsted decided not to bid in the Taiwan Round 3 process due to limitations set by the regulation.[112]

Table 20: Taiwan auction round 3.2 draft localisation scoring. Bidders will need to score at least 70 points to be considered.[113]

Component / service	Points allocated for sourcing locally
Foundations	18
Blades	18
Nacelle	18
Cables	14
Tower	5
Power conversion system and uninterruptible power system	5
Hub casting and nacelle bottom casting	5
Nose cone and nacelle cowl	3
Turbine transformer	1
Turbine distribution panel	1
Turbine cable wiring	1
Turbine fastenings	1
Turbine blade resin	1
Turbine tower coating	1
Blade propeller system	1
Yaw system	1
Substation transformer	1
Substation switchgear	1
Substation distribution panel	1
Substation land cable wire	1
Engineering design services	2
Total	**100**

[112] ReNews, Ørsted will not bid in Taiwan Round 3 auction, 2022 - link

[113] Taiwan Energy Administration, 2023 - link

Comparison of policies and incentives to support the growth of domestic OSW supply chains

	Japan	Taiwan	UK	France
Local content requirements	Bids are scored using a 240 point system: - 120 points for supply prices with a floor of 3 yen/kWh - 120 points for wind farm construction capabilities - 80 points for project implementation capabilities - 40 points for local contribution Within the local contribution criteria, projects are required to demonstrate their track record of engagements with stakeholders, the number of employees to be employed by the project, and its expected impact on the local and national economy.	Taiwan's Energy Administration announced provisional rules for the OSW auction round 3.2, whereby applications will be judged based on technical expertise (60%) and financial credibility (40%). Mandatory local content requirements have been removed and replaced with 21 optional items alongside a points system where bidders must score at least 70 points to be considered, which include: - 18 points each for localisation of turbine foundations, blades and nacelles - 14 points for cables The intention behind the new rules is to enable developers to select items where the local supply chain is already mature, lowering prices and making the market more competitive.	As part of the Contract for Difference (CfD) auctions, bidders are required to submit a Supply Chain Plan for projects greater than 300 MW and must receive a score of 50% or more to qualify. Plans are evaluated in terms of their ability to: - Broaden the supply chain by supporting new entrants, reduce costs by encouraging competitive procurement processes, and minimise supply chain risks; - Promote innovation across each element of the project by deploying more efficient equipment, supporting less established suppliers and reducing the LCOE; - Invest in skills and training to meet the future needs of the project and avoid skills shortages.	While initial tender rounds placed a 40% weighting on local content based on the industrial plans submitted by developers, recent bids are evaluated across three phases: - Candidate selection, where developers pre-qualify based on their technical and financial capacities; - Competitive dialogue, where developers discuss how they aim to reduce project costs; - Tender submission and selection of the successful developer. Bids are scored out of 100 points, with price as the heaviest weighted criteria (75%), commitments to reduce environmental impact (15%), and support to social economic development (10%)[114]. It is expected that local content requirements will be evaluated under the latter criteria.
Penalties for non-adherence to LCR	Punitive – players disqualified from bidding for wind farms if they do not fulfil the LCR	Prior to round 3.2, a punitive clause concerning localisation was highly controversial as it included a NT$30 million fine. Later this was replaced by the demerit point system.	The scheme does not assign fines or penalties for failure to deliver a Supply Chain Plan. However, developers may be required to submit a Post Build Report to demonstrate that their commitments have been adhered to.	No penalties
Incentives to promote local content	- Offshore Wind Power Talent Development Programme to support the local workforce	- Demonstration Incentive Programme (subsidies to encourage industry investment in local	Multiple national and local supply chain schemes exist, including[117]: - Advanced Manufacturing Supply Chain	The government is set to pass the Green Industry Bill to support the supply chain and facilitate future growth, which will include grants to cover

[114] 4C Offshore, November 2022. Bidding Window Closes for First French Tender in Three Years - link
[117] HM Government, June 2014. Overview of Support for the Offshore Wind Industry – link

	- Subsidies and tax breaks to promote investment in CAPEX by local suppliers	demonstration projects)[115] - National Financing Guarantee Scheme where loans are provided to developers for the procurement of local goods and services, and to domestic equipment and service providers for export purposes[116]	Initiative, which is a funding competition to improve global competitiveness of UK firms by funding R&D, skills training and providing investment capital; - GROW: Offshore Wind, which supports SMEs to enter the OSW manufacturing supply chain; - Manufacturing Advisory Service supports manufacturers to improve productivity and grow.	productive CAPEX and R&D expenditure, and support investment in the industrial supply of renewable energy.
Impact of LCR on OSW build-out and timelines for deployment	Japan currently has 136 MW of OSW capacity installed as of 2022. The first round of auctions of 1.7GW capacity was won by Mitsubishi in 2021, and the second round of auctions for 1.8 GW were completed in June 2023 with the results expected to be announced in 2024. Given the pace of capacity awarded to date, the likelihood of achieving the government's target of 10GW of OSW capacity by 2030 is low. However, this is due to delays in the first-round auction process due to a lack of clarity on the evaluation criteria rather than related to LCR.[118]	Taiwan has 1GW of OSW installed capacity as of April 2023[119], which makes it unlikely to achieve its target of 5.6GW by 2025. A key factor contributing to the delay in OSW deployment is related to the government's stringent localisation policy which has extended the OSW development time and costs due to the lack of an adequate supply chain in Taiwan.[120]	The UK has 13.7 GW of operational OSW capacity, and has a target to reach 50GW by 2030. The industry's growth can be attributed to its flexible policies that focused on cost reduction rather than restrictive LCR policies.	France's first commercial-scale offshore wind farm (480 MW) started operations in November 2022. The country has faced significant delays in the development and commissioning of offshore wind projects that were first awarded in 2012 due to restrictive policies on LCR alongside lengthy awarding processes. The country has recently set a target of 40 GW by 2050 after implementing new regulatory frameworks and market incentives to expedite OSW development.
Impact of LCR on recent projects	Active efforts to develop local content in the country's OSW supply chain are in progress. Toshiba announced plans to establish a domestic supply chain for OSW power equipment alongside General	The restrictive LCR policies do not seem to have deterred foreign wind developers to enter the market, with Ørsted, Copenhagen Infrastructure Partners and Northland Power investing in projects. International turbine	It is reported that local content is almost 50% of the lifetime spend of a typical offshore wind farm in the UK. The typical contributions are from: - Operations, maintenance and service, where much	Local supply chains have slowly been established in France. For example, Normandy has a strong supply chain with Siemens Gamesa producing blades and nacelles for offshore wind turbines and GE

[115] Metal Industry Intelligence, February 2022. The Supply Chain Study of Offshore Wind Industry in Taiwan – link
[116] Industrial Development Bureau, Ministry of Economic Affairs, October 2021. Building an Industry: offshore wind in Taiwan. – link
[118] Reuters, December 2022. Japan resumes offshore wind power auctions with revised rules – link

[119] Euroview, July 2023. Taiwan's offshore wind round 3.1: Signs of hope? – link

[120] Commonwealth Magazine, June 2023. Taiwan offshore wind development faces headwinds – link

	Electric and plans to start production in 2026. The equipment supply chain will involve ~100 SMEs. This is part of a strategic partnership to localise GE's wind turbine manufacturing in Japan to improve competitiveness. GE will manufacture 134 turbines with13MW capacity each for the first 3 projects won by Mitsubishi, which Toshiba will assemble[121]. Toshiba will also build storage facilities for parts and establish a network to provide OSW operations and maintenance services.[122]	makers, Vestas and SGRE have secured local partners and set up nacelle assembly facilities in Taiwan. In addition, turbine component and balance of plant system suppliers, as well as marine engineering specialists have invested in new factories, established offices or enhanced local collaboration to capture a portion of the market share. However, developers are facing challenges as a result of localisation policies. For example, Ørsted faced performance gaps with the foundation which is being produced in Taiwan for the first time, with challenges related to welding, painting, testing technology, quality control and insufficient supply of construction vehicles[123]	of the activity is close to the wind farm site, - Installation and commissioning, where the UK has several leading marine contractors and equipment suppliers, and - Turbine, where most blades and some towers are supplied from the UK.[124]	also producing blades in its local factory.
Lessons learned	Japan's approach to LCR is not prescriptive, and it is possible that a combination of its flexible policies and supply chain incentives have been conducive towards the establishment of a strong partnership between Toshiba and GE to develop the domestic supply chain and create local employment opportunities.	The restrictions placed on LCR have resulted in delays in the deployment of OSW projects and rising costs due to a lack of a competitive domestic supply chain. While international component manufacturers have opened factories in Taiwan to meet localisation targets, there are still gaps in the domestic supply chain that make it difficult to meet industry growth targets.	Prioritising cost reduction to ensure a secure development pipeline of the supply chain alongside economic incentives and technical assistance schemes aimed at improving the local advanced manufacturing capabilities are key to supporting the organic build-up of local content in the OSW supply chain.	The lack of flexibility introduced by the French policies resulted in a slow and ineffective development of local content within the domestic supply chain, whereby factories established in the country were also used to serve wider markets. As such, the growth of the OSW market faced several significant and costly delays.

[121] CAN, July 2023. Toshiba, General Electric to build offshore wind equipment supply chain in Japan-Nikkei – link
[122] Power, July 2023. GE, Toshiba join to support Japan's offshore wind sector – link
[123] Metal Industry Intelligence, February 2022. The Supply Chain Study of Offshore Wind Industry in Taiwan – link

[124] Catapult, UK Content – link

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