The Supply Chain Study of Offshore Wind Industry in Taiwan

28, Feburary, 2022

Abstract

The Asia-Pacific region has emerged as a flourishing market for offshore wind in recent years, with Taiwan being a front-runner in the region, benefiting from development objectives and supportive policy frameworks determined at an early stage. With a three-phase strategy to guide offshore wind development, the Government is targeting 5.6GW of installed capacity by 2025, 20.6GW by 2035, which has attracted significant investment from leading wind developers, such as Denmark's Ørsted, Copenhagen Infrastructure Partners (CIP), Japanese utility JERA Energy, Australia-headquartered Macquarie's Green Investment Group and Canada-based Northland Power. For Taiwan, developing offshore wind is not only a matter of building energy security, but one of industrial development. To foster a local offshore wind supply chain, local content rules, known as the *Industrial Revelance Program (IRP)*, have been announced and updated to promote local manufacture of wind turbine components and balance of plant (BOP) systems in Taiwan. Top turbine makers, Vestas and SGRE, have secured local partners and set up nacelle assembly facilities in Taiwan. Turbine component and BOP system suppliers, as well as marine engineering specialists, have also invested in new factories, established branch offices, or enhanced local collaboration to capture local market shares.

Taiwan has made great strides over the years, supply chain gaps, however, remain in the current landscape, particularly in the areas of marine engineering, floating foundation technology, and operation and maintenance (O&M). Existing marine engineering vendors in Taiwan lack relevant experience in offshore wind, and only two wind farms—Swancor Renewable Energy's Formosa 1 and Taipower's Changhua Demonstration Project Phase 1—have entered the O&M period, suggesting a nascent O&M sector with limited expertise. Drawing on the assessment on the local supply chain capabilities, the study has identified these areas as

weaknesses in Taiwan's offshore wind supply chain readiness, which presents opportunities for UK-based suppliers to enter the Taiwan market, and secure contracts in the upcoming Zonal Development phase.

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1. Introduction

This research report on Taiwan's offshore wind supply chain is part of a study commissioned by the British Office in Taipei. It presents a detailed assessment of the strengths and weaknesses in Taiwan's offshore wind supply chain, serving as a source for UK suppliers to identify potential business sectors and develop business strategy accordingly.

Taiwan is at an early stage of offshore wind development. On the policy front, the Government announced the *Four-year Wind Power Promotion Plan* in 2017, setting a target of 5.6GW of installed offshore wind capacity by 2025. The Government also plans to allocate 1.5GW capacity each year, for a total of 15 GW for 2026 to 2035. In Phase 2 – Potential Sites and Phase 3 – Zonal Development, developers are required to meet localization requirements by satisfying the criteria of industrial relevance, and commit to fostering local manufacturing competence in offshore wind.

As of early 2022, Taiwan's offshore wind industry has developed track records in supplying underwater foundations, towers, and onshore electrical facilities (delivered for wpd's Yunlin, Ørsted's Greater Changhua 1&2a, and CIP's Changfang and Xidao Phase I Wind Farms). A number of wind turbine components are also being produced at the moment, indicating the industry is steadily building up its capacity.

The report seeks to investigate Taiwan's offshore wind supply chain, review existing suppliers, analyse its capabilities and current track records, and explore market potential for UK players. The full research scope covers WTG components, foundations (both fixed and floating), onshore electrical facilities, subsea cables, offshore substations, marine engineering (installation), and operation and maintenance. Related service sectors, such as legal consultancy, professional training, R&D and engineering consulting, are also considered.

The data and information for this report comes from materials obtained in

conferences, seminars, symposiums, exhibitions, overseas delegation visits, as well as from secondary sources, such as journal articles, survey reports, and technical studies.

The report begins with an introduction of the research background, methodology and research scope, followed by a detailed discussion of Taiwan's offshore wind market, covering the present status and potential, relevant regulatory framework and port facilities. An analysis of the supply chain is then presented with a deep-dive into a number of topics: project development and management, wind turbine, balance of plant, marine engineering, operation and maintenance services, and skill training, legal, financial and other support services. The subsequent section intends to review the business activities of local and foreign entities in Taiwan, in order to capture the status of Taiwan's supply chain and identify weaknesses, through which areas of opportunity for UK suppliers are explored. Further discussion on supply chain gaps and recommendations are provided at the end.

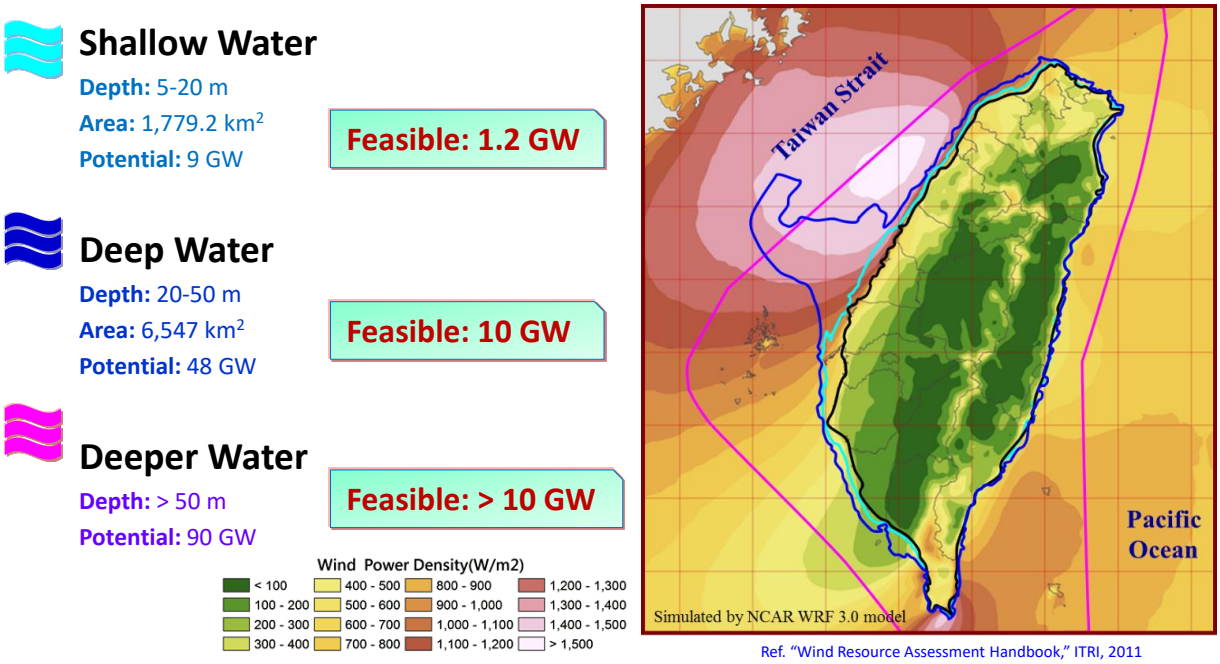
2. The Market Environment of Taiwan Offshore Wind

2.1 Market Status and Future Growth

The Taiwan Strait is subject to strong effects of northeast monsoon and southwest monsoon during winter and summer respectively each year. After the Moon Festival in September, the northeast monsoon season begins and lasts until March and April next year, affecting local climate for nearly half a year. The already strong wind from the northeast monsoon, coupled with the channeling (also known as Venturi) effect from the mountains on both sides of the Taiwan Strait, results in wind acceleration through the tight channel created between mountain ranges. Based on the data captured by Taipower's met mast off the coast of Changhua in central Taiwan, the annual average wind speed in 2018 is 9.61 m/s, and could go as high as 12.29 m/s during the northeast monsoon season, or drop to 6.90 m/s during the non-monsoon period. The ideal wind conditions make the Taiwan Strait home to many of the world's top sites for wind deployment. According to the Bureau of Energy (BOE) of the Ministry of Economic Affairs (MOEA), around 1.2GW can be developed from sites with a water depth between 5-20 meters, over 10GW for depth between 20-50 meters, and more than 10GW for water depth over 50 meters, as shown in Figure 1.

The Taiwanese government's scheme for developing offshore wind in Taiwan consists of three phases: Demonstration Incentive Program (subsidies to encourage industry investment), Potential Sites (sites open for application), and Zonal Development (government-led efforts for further industrial development), with a national target to install 5.6GW of offshore wind power by 2025. The policy is expected to generate an output value of NT$1.2 trillion and 20,000 jobs. In 2015, the BOE announced the *Directions of Zone Application for Planning*, as well as 36 potential sites available for commercial offshore wind development (Figure 2). Twenty-five out of the 36 potential sites are distributed along the west coasts of

Changhua and Yunlin, whose average annual wind speed ranges from 8 m/s near the coast, to 9 m/s at the territorial sea baseline of 12 nautical miles. The rest are scattered in Taoyuan, Hsinchu, Miaoli and other counties and cities, with an annual wind speed average of 8 m/s, also showing great potential for development.



Ref. "Wind Resource Assessment Handbook," ITRI, 2011

Figure 1 Taiwan Offshore Wind Potential

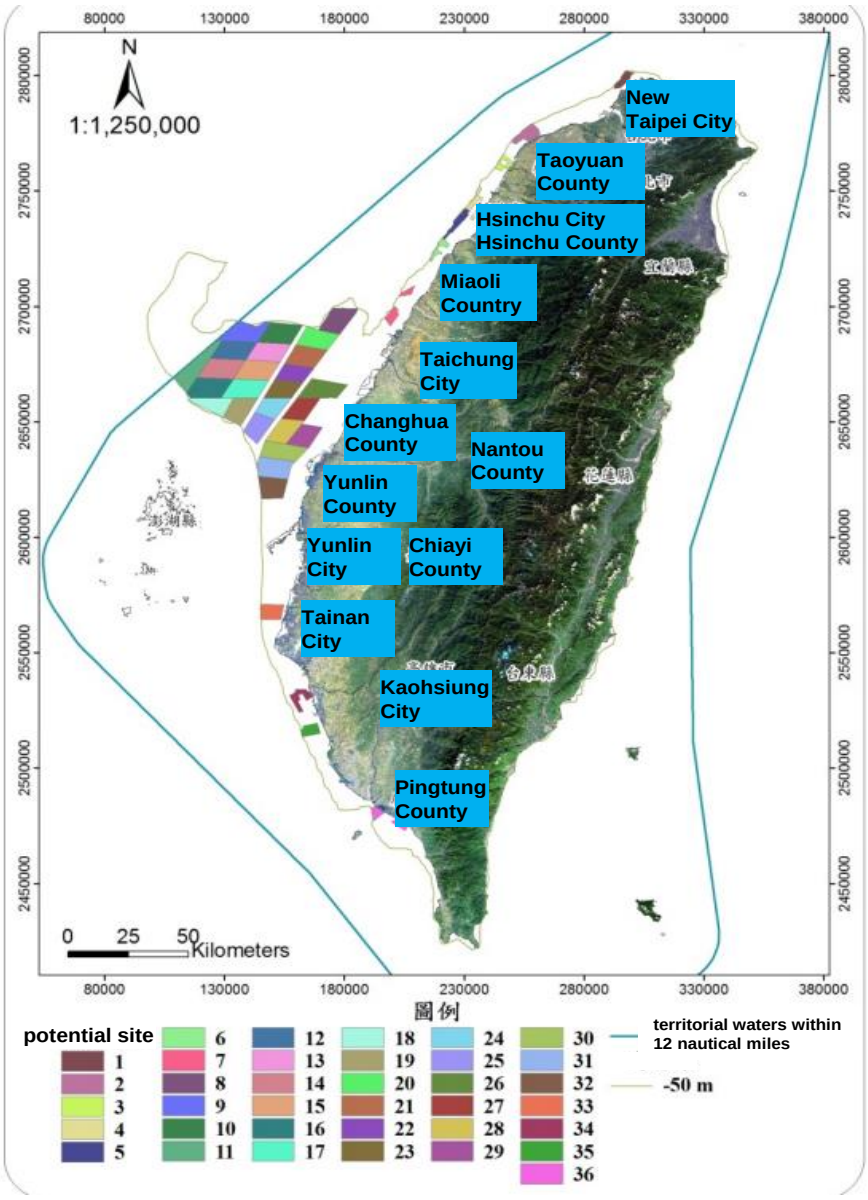


Figure 2 Taiwan Offshore Wind Phase 2 Potential Sites

In April 2018, the BOE announced the selection results of Phase 2, awarding capacity to 7 developers including TPC, CSC, Swancor, Ørsted, wpd, NPI and CIP, with a total of 10 projects. Looking at the geographical distribution of these projects, the greater Changhua area claims the highest capacity with 2,400MW (62.6%), followed by Yunlin with 708MW (18.4%), Miaoli with 378MW (9.9%) and Taoyuan with 350MW (9.1%). The auction results were announced later, in June 2018, and winners include Hai Long 2 (awarded 232 MW, at NT$2.2245/kWh) and Hai Long 3

(awarded 512 MW, at NT$2.5025/kWh) from the Hai Long Offshore Wind Farm Project, Greater Changhua 2b (awarded 337.1 MW, at NT$2.5480/kWh) and Greater Changhua 4 (awarded 582.9 MW, at NT$2.5481/kWh).

Starting from 2020, benefiting from successful domestic containment of COVID-19, global supply chain reshuffles and worldwide semiconductor market growth, coupled with returning investment from overseas, Taiwan's economy has seen accelerate growth, and the demand for electricity is expected to rise further. In response, the Government plans to adjust its future renewable energy target to reflect energy demand patterns and renewable energy power generation. That said, the 2025 target of 5.6GW in offshore wind capacity remains unchanged. In 2021, the Government announced the *Directions of Application for Offshore Wind Zonal Development* for Phase 3, aiming to add 1.5GW capacity each year from 2026 to 2035, with the cumulative installed capacity projected to reach 20.6GW by 2035.

Looking at the current installed capacity, the first phase of Swancor’s demonstration project was commissioned in 2017 with two turbines. In 2019, the first offshore wind farm in Taiwan, Formosa I, was inaugurated off the coast of Miaoli, with an installation capacity of 120MW. The Taipower Phase I Demonstration Wind Farm off the coast of Changhua was also launched and connected to grid by the end of August 2021, adding another 109.2MW, while wpd’s Yunlin Offshore Wind Farm already installed 88MW. As of the end of 2021, the cumulative installed capacity of offshore wind power in Taiwan totaled 325.2MW. In 2022, as development activities of Formosa 2, Greater Changhua 1&2a, Yunlin, and Changfang Phase 1 are expected to pick up pace, newly added capacity for the year is forcast to reach 1.9GW (Figure 3).

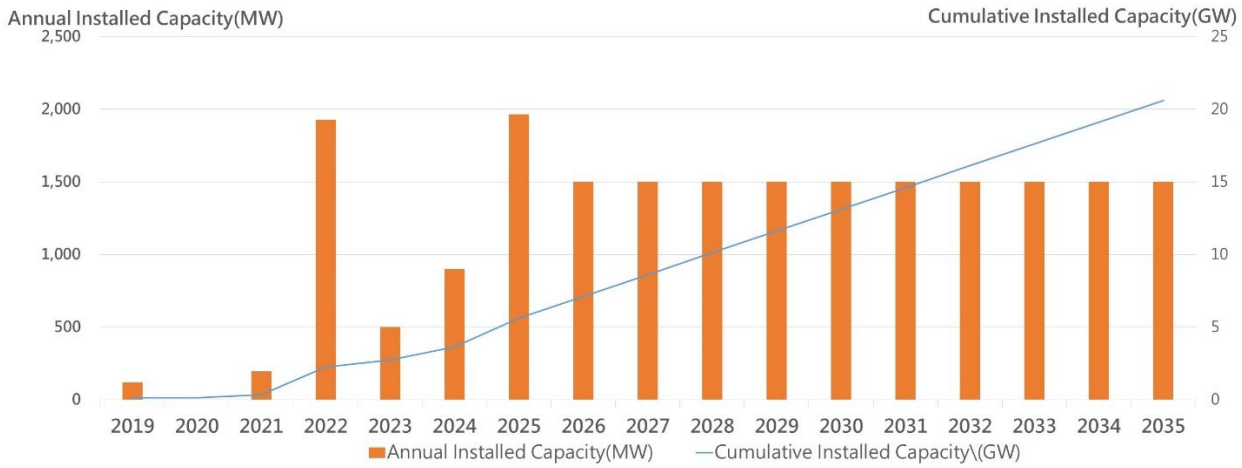


Figure 3 Annual and cumulative installed offshore wind capacity

Table 1 shows the development status of all offshore wind farms for Phase 1 and 2 of Taiwan's offshore wind development. The Covid-19 pandemic has led to changes in sailing schedule and caused delays for wind project construction, as Taiwan's Central Epidemic Command Center (CECC) has imposed stricter border control measures and quarantine rules for international arrivals, and suspended entry of foreign nationals without a valid visa. Those allowed entry under special conditions are required to follow current quarantine rules. The delays were further aggravated by the global health crisis. For example, Saipem and Sembcorp, the Formosa 2 project's international foundation contractors, have been impacted by COVID-19 challenges in Malaysia, Indonesia, and Singapore, resulting in personnel mobilization difficulties and manufacturing delays. The scheduled arrival of work vessels for Yunling I was delayed after reports of infected crew members. The delivery of construction equipment for the wind farm was also delayed due to outbreaks in other countries.

Despite strong commitment to localization, Ørsted's wind farms are seeing less-than-optimal learning curves, particularly in the area of foundation, a component being produced for the first time in Taiwan. The developer has encountered a number of challenges, including performance gaps in welding, painting, testing technology and quality control between local suppliers and international leaders, insufficient supply of construction

vessels, personnel, and disruption from northeast monsoon wind; all of which makes grid connection in 2021 rather unattainable.

Table 1 Projects Status of Phase 1 and Phase 2[1]

Developer	Offshore Wind Farm	Cap (MW)	COD	Turibne Supplier	Foundation Supplier	Maritime Contractor	On Shore Substation Contractor
SRE	Formosa I	128	2017	SGRE 4MW	EEW(Monopile)	JDN	Fortune
			2019	SGRE 6MW			
	Formosa II	378	2020	SGRE 8MW	• Sembcorp Marine • Saipem		Fortune
WPD	Yunlin I	360[2]	2022	SGRE 8MW	Steelwind	• Fred. Olsen Windcarrier • Jumbo • Sapura	GE
	Yunlin II	348[3]	2022		FHI		GE
Ørsted	Greater Changhua 1	605.2	2022	SGRE 8MW	• SDMS • Samkang • Hyundai Engineering&Steel Industries	• Seajackets • Heerema Marine • Van Oord	Star Energy
	Greater Changhua 2a	294.8					
	Greater Changhua 2b	337.1	2025	TBC, 8-16MW (SGRE 14MW)	TBC	TBC	TBC
	Greater Changhua 4	582.9					
CIP	Changfeng I	100	2022	Vestas9.5MW	• Samkang • CWP	• Seaway 7 • Boskalis	TECO
	Changfeng II	452	2023				
	Xidao	48	2023				
CSC	Zhong Neng	300	2024	Vestas9.5MW	SDMS	• Seaway 7 • CDWE	TECO
TPC	TPC Phase 1	110	2021	Hitachi 5.2 MW	Samkang	JDN	CHEM
	TPC Phase 2	300	2024	Vestas9.5MW	CWP	TBC	Star Energy
NPI	Hai Long 2A	300	2024	SGRE 14MW	TBC	CDWE	TECO
	Hai Long 2B	232	2025	SGRE 14MW	Samkang	CDWE	TECO
	Hai Long 3	512					

[1] Source：MOEA

[2] After a site suitability assessment by wpd, Yunlin 1 is adjusted to 320MW for optimized wind turbine deployment and maximum installed capacity.

[3] Yunlin 2 is adjusted to 320MW, see reason above.

2.2 Policy Frameworks

2.2.1 Zonal development

On July 23, 2021, the BOE announced the *Directions of Application for Offshore Wind Zonal Development*, identifying the “green zones” available for development, and sensitive "red zones" to avoid, as suggested by other government agencies. (The red zones include the northern fishing grounds, important habitats of marine wildlife—such as white dolphins—along the western coast, the intertidal zone, the north-south navigation channel and other areas of concern.) The application process for Phase 3 is different than that of Phase 2. Previously, prior to the Environmental Impact Assessment (EIA) review, the applicant is required to obtain consent letters from 8 relevant competent authorities, which is a time-consuming process. To streamline the administrative process, the *Directions* stipulates that in Phase 3, the MOEA may invite relevant authorities of aviation, radar, military control, construction ban, ship safety, aquatic plant and animal breeding and conservation areas, fishery rights and mining rights, to form a committee and jointly review the application.

Once the application passes the committee's review by meeting the eligibility criteria and being in compliance with all regulatory authorities, it will be recorded by the MOEA and forwarded to the Environmental Protection Administration (EPA) for review, which primarily deals with environmental and ecological issues. In any case, the applicant should first pass the joint review and obtain preliminary EPA approval, before participating in the selection process. In submitting application documents, the applicant is required by the BOE to disclose each layer in the ownership structure. Even an entity with only 1% of the ownership has to submit a valid business registration certificate, a measure designed to prevent capital of Chinese entities or controversial shareholders from entering Taiwan.

On August 19, 2021, the BOE announced the *Directions for Allocating Installation Capacity of Offshore Wind Zonal Development*, confirming that 15GW will be released between 2026 and 2035, under which 9 GW will be released for Stage 1, between 2026 and 2031. (The 9GW will be divided into three portions; each is 3 GW.) Under the *Directions*, the selection process is separated into two parts. The first part is a Qualification Review of the developer's technical capability, financial capability, and industrial relevance (localization requirement). Only a developer with a qualified application is eligible to participate in the second part, i.e. the Competitive Auction. The capacity will be allocated to winning parties based on the bid price and the wind farm connection date. The remaining 6GW will be released from 2032 to 2035 (Stage 2), and the allocation rules for Stage 2 will be announced separately, taking into consideration the results of Stage 1 and global market trends.

The applicant should first obtain site planning documentation in accordance with the MOEA's *Directions of Application for Offshore Wind Zonal Development*, and obtain approval at the EIA Task Force's preliminary review and TPC's grid connection review before participating in the Zonal Development selection process. In addition, the capacity allocation for a single wind farm and the same developer is capped at 500 MW, plus additional 100 MW of capacity, depending on conditions such as wind farm integrity, development benefits, domestic industrial capacity, and grid-connection capacity.

Having considered the cost of green energy and the maturity of private green energy trading market, the BOE set NT$2.49/kWh as the upper limit of the bid price for Stage 1 in Zonal Development and NT$0/kWh as the lower limit. For subsequent rounds, the capacity-weighted average of all bids received in the previous round will be used as the price ceiling and the lower limit will remain at NT$0/kWh.

2.2.2 Taiwan offshore wind regulations

Other laws and regulations related to offshore wind exist. In 2019, the Bureau of Standards, Metrology and Inspection of MOEA (referred to as BSMI) announced the *Offshore Wind Farm Project Certification Review and Demonstration Counseling Guidelines*, stating that developers with the commercial operations date by 2024, within six months after obtaining the electricity enterprise license, are required to submit an application along with required documents to the BSMI for a project certification review. The Ministry of Labor also announced guidelines for worker health and safety on offshore wind farms, and the nation's *Labor Standards Act* covers personnel involved in construction, operation and maintenance of offshore wind farms. Starting from March 19, 2020, Taiwan imposed an entry ban on all foreign nationals (including Chinese, Hong Kong and Macao nationals). Although the CECC has started easing entry restrictions, a 14-day quarantine is still required for all incoming arrivals. For personnel involved in marine engineering work on offshore wind farms (including crew members and technicians), there is a need to travel to and from the wind farm for service purposes, which could lead to complicated entry and quarantine issues. In order to lessen the impact of Covid control measures on project delivery, the developer could submit an application for embarkation/disembarkation according to the *Offshore Wind Covid-19 Control and Prevention Program*. Developers failing to comply with the control measures in personnel management may be subject to penalties according to the BOE's *Covid-19 Control Measures for Offshore Wind*. On November 2, 2020, the Executive Yuan approved the *National Credit Guarantee Scheme*, designed to provide credit guarantee to local enterprises (including joint ventures of domestic and foreign firms and subsidiaries of foreign enterprises in Taiwan), developers, manufacturers and marine engineering companies. The application process is open until December 31, 2025.

2.3 Considerations of Industrial Relevance Requirements

2.3.1 Industrial relevance requirements

For the Government, developing offshore wind is not only about ensuring energy security, but for driving industrial growth, and building Taiwan as a supply and expertise hub for the flourishing Asia offshore wind market. In 2018, referencing the *Directions for Allocating Installed Capacity of Offshore Wind Potential Zones* promulgated by the BOE, the Industrial Development Bureau (IDB) of the MOEA developed a policy framework to promote supply chain localization, listing critical development items for localization for different phases: tower, foundations and onshore power facilities for the Preparation Phase (2021-2022), another 14 items such as blades, castings, and nacelle assembly for Phase 1 (2023) and Phase 2 (2024-2025). Developers awarded contracts during Phase 2 (Zone Application for Planning) are required to submit their detailed IRP plan along with relevant formal or conditional commercial contracts within the specified time limit. If a Taiwanese supplier fails to deliver in time due to poor product quality or a production scheduling issue, the Government will ask the developer to propose a plan for support. If the developer fails to fulfill their IRP commitments, the MOEA may, in accordance with the administrative contract entered between both parties, confiscate the performance bond previously paid by the developer, cut the feed-in-tariff price, or terminate the administrative contract in the event of a substantial breach.

On December 6, 2021, the MOEA introduced the Industrial Relevance Program for Zonal Development, labeling 25 critical development items required for localization, and 56 items for “bonus points”. The required items are mostly the same as in the previous phase, with a few new additions such as onshore cable and engineering design service. The full list is presented in Table 2.

Table 2 Zonal Development IRP

Item	Power Facility	Foundation	Wind Turbine	Maritime Engineering	Design Service
Critical Development Item	Onshore Substation 1. Transformer 2. Switchgear 3. Switchboard 4. Cable	Type1 : Monopile ➢ Main Pipe ➢ Transition Piece Type2 : Jacket Transition Piece Main Pipe ➢ Pin Pile	1. Nacelle Assembly 2. Tower 3. Transformer 4. Switchgear 5. Spinner cover and Nacelle cover 6. Cable 7. Casting of Hub and Nacelle bed frame 8. PCS and UPS 9. Blade 10. fastener 11. Resin	1. Survey vessel engineering service 2. Drillship engineering services 3. Foundation Installation vessel engineering 4. Turbine installation vessel engineering service 5. Cable-laying vessel engineering services 6. Operation and maintenance Vessel engineering service (CTV, SOV, multipurpose vessel)	1. Tower and foundation related design 2. Offshore substation related design 3. Cable laying related desgin
	Local-sourced items **over 60%** of the applied **capacity** are awarded **bonus point(s)**.			**Newly added: design service. For engineering services, local firms shall have at least 50% of involvement. For marine engineering services, Taiwanese vessels should be given priority.**	

2.4 Ports and Other Infrastructure

In Taiwan, the Taipei Port, Taichung Port and Kaohsiung Xingda Port are positioned as major base ports for offshore wind. However, to accommodate the rapid expansion of offshore wind, the Kaohsiung Port and Anping Port in Tainan have also expanded their business to support the offshore wind industry. These ports (except for Xingda Port) are all commercial ports under the jurisdiction of the Maritime Port Bureau of the Ministry of Transportation and Communications, and operated by the Taiwan International Ports Corporation (TIPC). Figure 4 illustrates the existing major ports in Taiwan and their functions. Detailed description of each port is presented below.

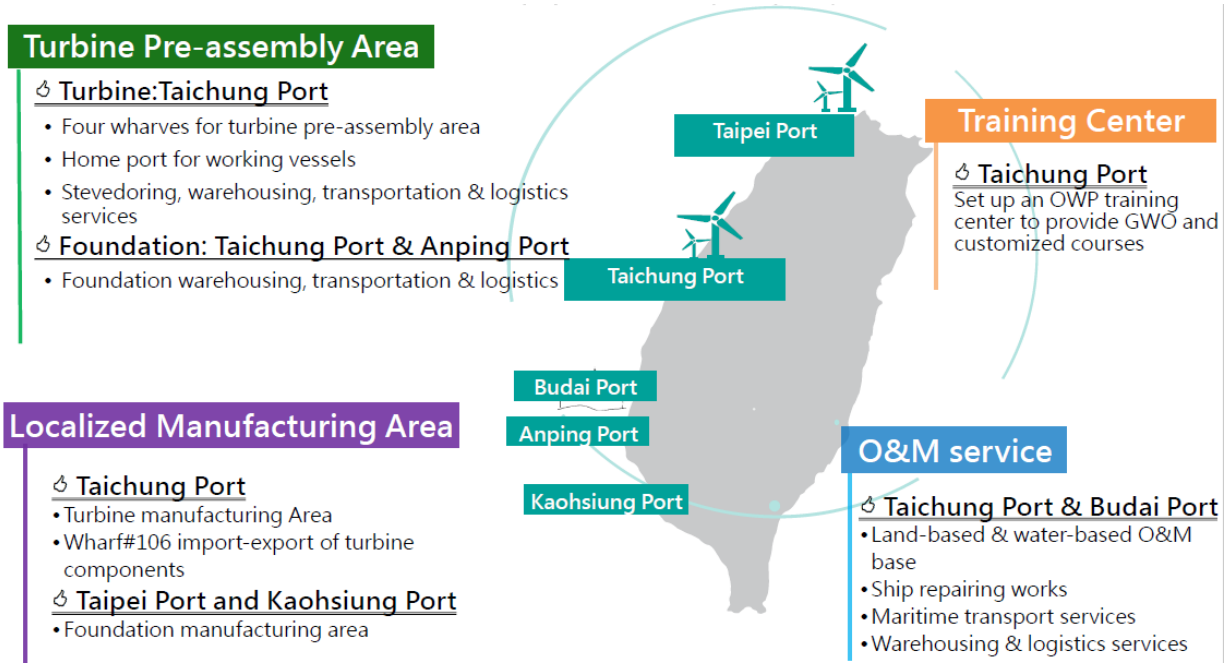


Figure 4 The Overview of Ports And Functions in Taiwan

2.4.1 Taipei Port

Taipei Port is regarded as a specific foundation production base for offshore wind industry. Among all the facilities, Wharf S09 of Taipei Port is the only heavy cargo wharf dedicated to offshore wind power in northern Taiwan. The wharf is 320 meters long with a water depth of 16 meters and load capacity of 20t/m^2. It can berth 10,000-ton offshore wind vessels. In

addition, S9-1, S7-1 and S8-1, 25.02 hectares in total, are used as storage areas for foundations and large components. Currently, Century Iron and Steel Industrial Co., Ltd has rented the heavy cargo wharf and the production hinterland nearby, which are 21.06 hectares, for foundation production, planning to build 3 factories, East Wharf, South Wharf Phase I and South Wharf Phase II. On the other hand, TIPC planned to utilize partial areas in south wharf for SOV O&M berths and bases, which will be established in 2025.

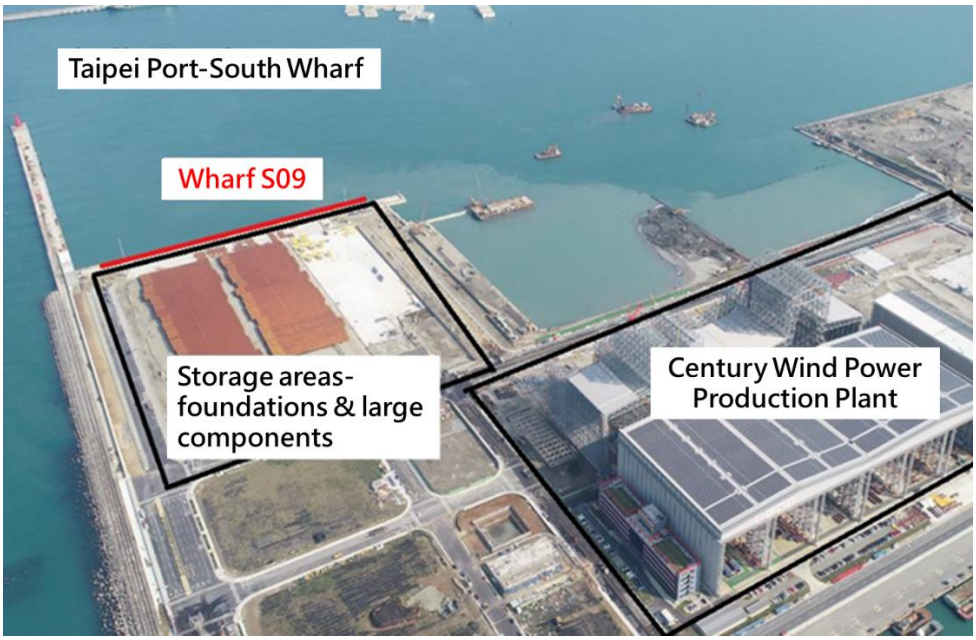


Figure 5 Taipei Port-Foundation Fabrication and Logistics Site

2.4.2 Taichung Port

Taichung Port is planned to be an assembly wharf and industrial zone. Wharf 2 is 250 meters in length (13.4 hectares in total with 104 meters for heavy cargo, load capacity 10 t/m^2) and is leased by Formosa 1 and Formosa 2 as assembly areas. Wharf 5A and 5B are 400 meters in length (12.8 hectares in total, load capacity 50 t/m^2) and are leased by TPC Phase 1 and Phase 2, Yunlin and Hai Long Wind Farms. Wharf 36 is 340 meters in length (25 hectares in total, load capacity 20-40 t/m^2) and is leased by Greater Changhua, Changfang Phase 2, Xidao and Zhong Neng Wind Farms. Wharf 106 is 450 meters in length (6.9 hectares in total with 425 meters of heavy cargo, load capacity 10-40 t/m^2) and is leased by

Changfang Phase 1. As for the industrial zone, Industrial Zone (II), (III) and Wharf 42 and 43 are already in planning and have attracted nacelle assembly (SGRE, Vestas), tower (CS Wind/Ching-Fong), blade (Tien-Li) and hub(Yeongguan) vendors to set up factories in the area. In addition, work boat basin and shallow water basin (5.7 hectares), and new reclamation and revetment at Industrial Zone (I) (3.6 hectares) have been planned as the O&M base (see Figure 7 for details).

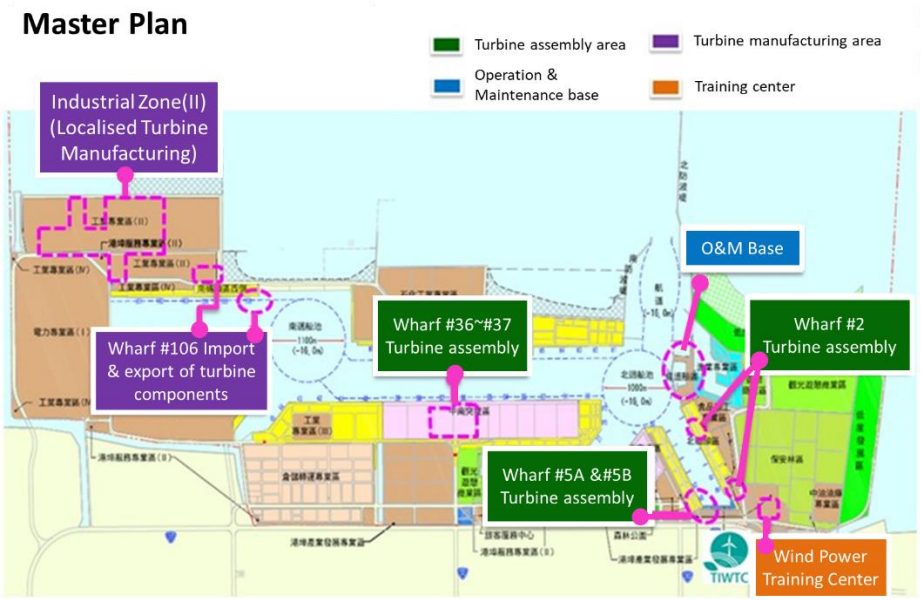


Figure 6 The Plan and Function of Taichung Port

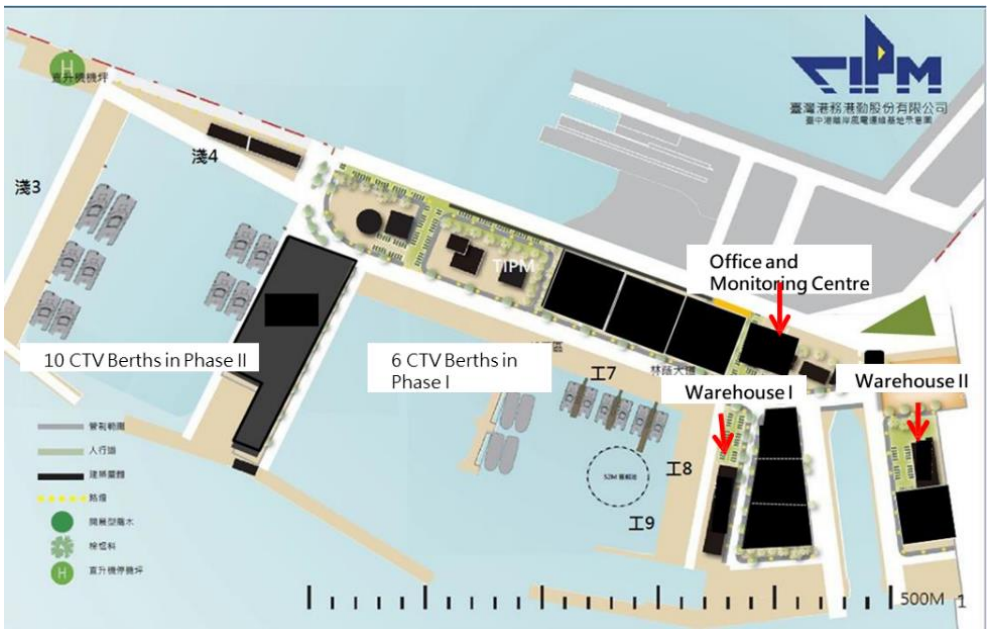


Figure 7 The O&M Base in Taichung Port

2.4.3 Xingda Port

Kaohsiung Xingda Port is planned as a special area for foundation manufacturing with Sing Da Marine Structure (SDMS) investing in the construction of jacket foundation production lines. The base covers an area of approx. 27 hectares, of which the heavy cargo wharf is 210 meters long with load capacity 30 t/m^2. The storage area for finished goods is 8.4 hectares and is capable of storing approx. 40 sets of jacket foundations.

Figure 8 The Plan and Function of Xingda Port

2.4.4 Kaohsiung Port

Currently, Kaohsiung Port serves as the production, storage and transportation base for underwater foundations. Part of A5-A, A5-D and A5-E of the Kaohsiung Intercontinental Container Terminal Phase 1, section A and C of the hinterland of Wharf #75 (1.2 hectares), A9 (3 hectares) and D1 (2.7 hectares) of the South Star (Nanxing) Project are designated as pre-assembly and storage areas, and will be available for use starting from Q3, 2023. In addition, the Nanxing project area A5 (2.5 hectares) and A6 (2.5 hectares) will also be established as manufacturing areas, available for use from Q1, 2039. At present, CTCI Machinery Corporation (CTCI), a foundation manufacturer, has set up a facility in the Nanxing Project Area and the Intercontinental Container Terminal Phase 1, using the areas for foundation fabrication. In the future, Ming Rong Yuan Business (MRY) will also set up production lines at the hinterland of Wharf #75.

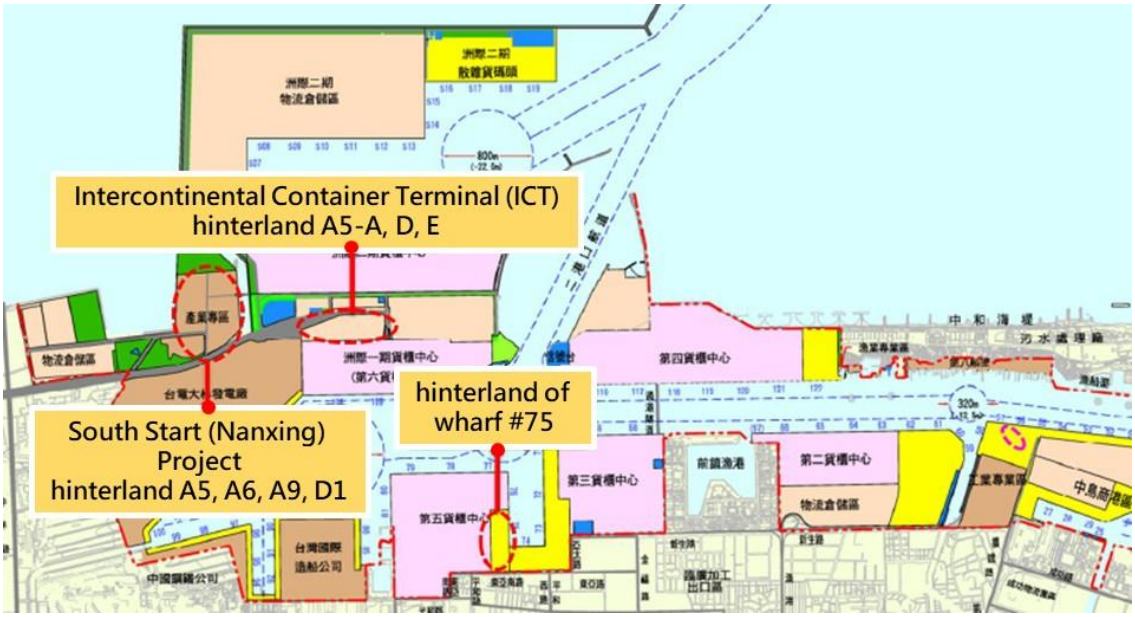


Figure 9 The Plan and Function of Kaohsiung Port

2.4.5 Anping Port

At the moment, Anping Port is planned as a storage and transportation port for foundations, primarily utilizing Wharf No. 10, 16, 17, 18 and their hinterland, as well as the hinterland of Wharf No. 11 and 12 for such purpose, with a total of 19.05 hectares. Currently, wpd's Yunlin project is using Anping Port to store and transport foundations, while MRY is now in talks with Anping Port about property leasing.

Figure 10 The Plan and Function of Anping Port

3. Supply Chain Assessment

3.1 Project Development and Management

In Taiwan, much of the project development and management, such as site investigations and wind farm design, is undertaken internally by the developers. However, metocean and geotechnical surveys, as well as engineering design and supervision are usually contracted to local suppliers, including RCG, T. Y. Lin International Taiwan and Unitech New Energy Engineering. MOH Associates Inc is awarded a contract by Ørsted for the design of the O&M base for the Greater Changhua Offshore Wind Farms.

3.1.1 Wind farm design

Local engineering technology service firms in Taiwan are inexperienced in the design of offshore wind farms and underwater foundations, and therefore, the majority of them contract with foreign design companies. The general consultant of the TPC Wind Farm Phase 1 is jointly contracted by SinoTech Engineering Consultants, Ltd. and NIRAS, with COWI responsible for underwater foundation design and K2 electrical design. SinoTech Engineering Consultants, Ltd. has also participated in Formosa 1 and Formosa 2 Wind Farms whereas CECI and Rambol have collaborated in underwater foundation design of CIP wind farms. The general consultant of TPC Phase 2 is contracted by DNV and JGIBSIN Engineers, Ltd. Swancor Renewable Energy works with Sinotech Engineering Consultants, Inc. or sea state analysis and underwater steel structure and anti-corrosion concept design of Formosa 4 Wind Farm, and assists Sinotech Engineering Consultants, Inc. with the technology transfer of COWI.

3.1.2 Topographic Survey & Geologic Drilling

Fugro, Gardline, JAVAOFFSHORE and GEOQUIP have participated in

soil/rock sampling and T/CPT/PS-logging testing in the offshore waters of Zhunan and Penghu in Taiwan. PDE Offshore Corporation is a joint venture of PFEC, Dragon Prince Hydro-Survey Enterprise Co. and EGS. It owns the first marine geological survey vessel, Geo Energy, in Taiwan, specializing in offshore wind farm site surveys and offshore drilling operations. Local maritime survey company IOVTEC and Fugro Corporation established a joint venture, Fugro IOVTEC, in Taiwan to provide geotechnical and geophysical survey, cable route survey and marine construction support and other services to assist in various underwater surveys and support before and after the construction of offshore wind farms.

3.2 Wind Turbine

Siemens Gamesa Renewable Energy (SGRE) and Vestas are leading WTG suppliers in Taiwan offshore wind industry. Below content focuses on their business activities in Taiwan and the capabilities of their local partners regarding the components.

3.2.1 Blades and materials

Taiwan is one of the top four carbon fibre producing countries in the world, with great potential and opportunities to support blade manufacture for the offshore market. Taiwan Composites Association (TCA) and Taiwan Advanced Composite Center (TACC) are both key enablers in the composite material supply and downstream product industries.

Tien-Li is the only offshore wind turbine blade factory of Vestas in the Asia-Pacific region and is capable of producing 85-meter blades. Tien-Li's factory in Taichung Port occupies an area of 21 hectares and has an annual production capacity of approx. 180 blades. The site has kept some space which will be available for expansion, in order to get involved in the production of blade with more than 100 meters in length.

Blade materials of Swansor have entered the supply chain of two major

international WTG suppliers. To be more specific, Swansor is a resin supplier of offshore wind turbine blades for SGRE. This firm also supplies pultruded carbon plates, resin, adhesives and other blade materials to Vestas. Swansor's production lines are located in Nangang Industrial Park, Nantou. In order to follow the global trend of Net Zero Emissions, Swancor not only develops recycle materials with European clients, but also conduct R&D projects by themselves, focusing on resins and other composite materials. The projects are currently in laboratory stage.

3.2.2 Turbine components

SGRE, cooperating with Ørsted, established the first offshore wind turbine nacelle assembly plant outside of Europe in the Industrial Zone (II) of Taichung Port. The plant is 30,000m^2. SG 8.0-167 DD wind turbines will be assembled in this plant after the construction is constructed in July 2021. SGRE also plans to expand the nacelle assembly plant in 2022, which is considered as Nacelle 2.0. The expansion will cover two new production line plants, introducing more advanced assembly facilities, and a warehouse to cope with the expansion of wind turbines and market capacity.

Vestas will work together with Fortune Electric Extra High Voltage Co., Ltd. and utilise a 5,000m^2 factory area in Taichung Port as the V174 wind turbine assembly and operation site. Wind turbine hub assembly, the final assembly and testing of relevant nacelle components will also be carried out in this plant. The plant is expected to be completed by Q3 of 2022.

Overall analysis regaring other WTG components in Taiwan are discussed in the below section.

- Transformer：Shihlin Electric has collaborated with Hitachi ABB Power Grids Finland Oy and will manufacture key transformer components at Shilin Electric Hsinchu Plant for wind turbines such as Vestas V174-9.5 MW.

- Switchgear：Shihlin Electric has collaborated with Mitsubishi Electric Europe BV to provide 66 kV high-voltage switchgears, which will be assembled and tested at Shilin Electric Hsinchu plant. The first batch of finished products is expected to be shipped in 2022.

- Power conversion system/UPS: KK Wind Solutions has invested in an assembly plant for the lower part of the nacelle in Changhua Coastal Industrial Park. The construction of this plant completed in the end of 2021 and this plant has been under operation since 2022. In the future, it will be used to produce power conversion modules and uninterruptible power systems for wind turbines such as Vestas V174-9.5 MW.

- Nacelle cover/spinner cover：Atech Composites and Fassmer established a joint venture, Fassmer Atech Composites Taiwan, to manufacture composite products in Siaogang, Kaohsiung. At present, it has obtained DNV-GL APQP4 Wind certification.

- Cable：Walsin Lihwa currently uses the company's existing production lines to produce wind turbine cables in its Xinzhuang plant.

- Casting：Yeongguan has invested NT$5.22 billion in the Industrial Zone (II) of Taichung Port to build a large-scale factory to integrate the casting, processing and coating processes, eyeing on large-scale wind turbines of 10 MW or above which will be the mainstream in the future. The plant can be completed and ready for production in 2022. By 2025, the annual output is expected to reach 8 to 10 tons. At present, Yeongguan is the casting supplier for WTG suppliers, such as SGRE and Vestas.

- Fastener：Boltun uses its Tainan plant to produce fasteners for V174 wind turbines.

- Gearbox：Formosa Heavy Industries (FHI) was involved in 2MW WTG gearbox fabrication. However, FHI has no intention in tapping into

offshore wind industry owing to unsatisfacitary ecomonic benefis.

- Generator：At present, TECO has conducted preliminary collaboration with foreign companies to develop stator and rotor manufacturing capacities.

3.2.3 Tower

Tower is one of the items in preparation phase in Potential Site. With the promotion of industrial policy, globally leading tower manufacturer, CS Wind, has collaborated with Taiwanese local manufacturer Chin-Fong through intellectual property authorization and technology transfer, with Chinfong (TW) providing its existing factory in Taichung Port to set up the tower production line and recruiting local employees for tower production. By dispatching Korean senior managers and Vietnamese experienced tecnicians to Taiwan, CS Wind assists in cultivating professional talents for tower manufacturing to strengthen the local talent pool. The production line is designed to produce tower segments with a diameter of up to 7 meters. Currently, it has delivered SG 8.0-167DD and Vestas V174-9.5MW towers. The design of production line space will be further adjusted in the future to meet the requirements of producing towers of more powerful WTGs, such as SG 14-222DD.

In addition, Taiwanese local manufacturer Century Huaxin Wind Energy Co., Ltd. and European tower manufacturer Welcon will build a tower production line in Taichung Port as will. The collaboration will be carried out in a professional division of labor manner. Welcon Taiwan will be responsible for technology transfer and taking international orders whereas Century Huaxin will be responsible for manufacturing. It is estimated that the factory can produce tower segments with a diameter of up to 10 meters. Together, the companies aim at the 8MW-15MW wind turbine tower market in the Asia-Pacific region.

3.3 Balance of Plant

3.3.1 Foundations

The foundation technology for offshore wind farms takes inspiration from offshore oil drilling foundations, an area where Taiwan's engineering industry has no track record to date. Nevertheless, Taiwanese suppliers have considerable industrial expertise and experience in other sectors of high relevance, such as pressure tank fabrication, shipbuilding and manufacture and processing of steel structures. Formosa Heavy Industries (FHI), Tai-Shing Engineering and Construction, have both developed strong track records in supplying petrochemical pressure tanks. Such experiences could translate into readiness in producing fixed-bottom foundations. Technical capacity to produce floating foundations could be driven by future policy objectives.

Taiwan has built production capacities for diverse types of foundations, such as monopile foundations, jacket foundations, pinpiles and other products. Century Wind Power, established by local steel structure giant Century Iron and Steel Industrial Co. Ltd., abbreviated as CT, is the main foundation supplier in northern Taiwan. The company established a joint venture with leading Danish company Bladt Industries to learn welding assembly technology and project management. Century Wind Power now uses Taipei Port as its main production base, and together with other local suppliers, including Wanchi Steel Industrial Co, APEX Wind Power Equipment Manufacturing Company, Far East Machinery, CT (Taoyuan Plant, Yunlin Plant), FHI, TCT Construction, MRY and Century Huaxin Wind Energy. They have formed an industrial cluster in northern Taiwan, jointly investing in the manufacture of jacket foundations. The size of contracts awarded to the cluster is equal to almost 40% of all development capacity (2.4GW) with localization requirements.

In southern Taiwan, SDMS, a subsidiary of CSC, leads the development by setting up its production base in Maritime Technology Innovation Center of Xingda Port for jacket foundation production. Technologies are

transferred by Nervion. SDMS, along with more than 20 local Tier2 and Tier3 suppliers in Taiwan, establishes a local jacket foundation production cluster. SDMS' in-house assembly is divided into three semi-finished product sections: transition piece, upper structure and lower structure, and the final major assembly consists of 15 stations. At present, SDMS is producing 6 jacket foundations for Ørsted's Greater Changhua 1&2a, with delivery expected at the end of December 2021. Another 31 jacket foundations need to be supplied for China Steel's Zhong Neng Wind Farm. In addition to SDMS, CTCI and CSBC are also suppliers in southern Taiwan with capacity to produce pinpiles and transition pieces. MRY supplied 4 pinpiles for Taipower Phase I Wind Farm with a good track record. As the foundation market continues to flourish, the company has established a subsidiary, Ming Rong Yuan New Energy (MRY NE), to expand its business in this sector.

In central Taiwan, there are also Formosa Heavy Industries, Tai-Shing Engineering and Construction Co., Ltd., Century Huaxin, CS Wind (tower manufacturer) and APEX Wind Power Equipment Manufacturing Company Limited, etc. with supply capacities for monopile foundations, pinpiles and foundation components. Among these firms, Formosa Heavy Industries cooperated with Steelwind Nordenham in the fabrication of monopiles, supplying 40 monopiles for wpd's Yunlin Offshore Wind Project. Formosa Heavy Industries is also one of the pinpile suppliers of Greater Changhua 1&2a Offshore Wind Project.

Looking at anti-corrosion coating, local suppliers CSBC Coating Solution and Fermo Enterprise Corporation, both supply chain partners of SDMS, have delivered corrosion protection solutions for Ørsted's Greater Changhua project. Hempel, a foreign entity, is currently a supplier of paint materials in Taiwan.

Turninig to floating foundations, Taiwan has no floating projets yet. Neither do any of the fabricators have track records. However, Century Wind Power and CSBC intend to engage in the manufacturing of floating foundations. CSBC has been chosen as the partner of Floatation Energy

and two parties signed a MOU in 2021. CSBC has its own wharves and was participated in floating-relevant projects, showing that they have strong interest in engaging floating offshore wind projects. It was expected that by establishing partnership and cooperation between these two firms, a new type of floating foundation which suits Taiwanese marine condition more can be developed. It is also hoped that CSBC could leverage its own technical capabilities to supply floating foundations, contributing to Taiwan's supply track record. As for floating foundation and other key items, such as sea anchors and steel mooring chains, there has been no Taiwanese supply to offshore wind to date. However, due to the large size and high transportation costs of these two items, there is advantage of keeping production locally. More suppliers with potential can be expected to invest in trial production and capacity building.

3.3.2. Subsea cables

In Taiwan, the industry has no track records and delivery in the fabrication of sea cables. However, Taya Electric Wire& Cable Co., Ltd. and Walsin Lihwa Corp are capable of supplying 66kV cables. Both JDR and LS Cable have entered the Taiwanese market, with LS Cable as the largest supplier. On the other hand, several local Taiwanese companies established a joint venture, Taiwan Submarine Cable. The company is currently looking for a suitable site and plants to collaborate with leading international companies to compete in the Zonal Development market. Regarding the cable protection system, Tekmar Energy is the supplier in Taiwanese industry.

3.3.3. Offshore substations

The offshore substation can be divided into two parts, topsides that house electrical systems, and substructures for supporting the transition piece and steel structures. Offshore substation platforms are usually installed on monopiles or jacket structures. Depending on the client's intended use and specific design, topsides are in general a two- to four-story high structure, incorporating key electrical systems, including transformers,

gas-insulated switchgear, power compensation systems, control systems and auxiliary systems.

Currently, there are only two offshore wind projects, Greater Changhua 1&2a and Hailong, have the demands to set up offshore substations in the projects. Additionally, offshore substation is not included in the Industrial Revelance Program in Potential Site Phase. This resulted in that the two projects abovementioned outsourced offshore substations to other APAC suppliers. Singaporean manufacturer won the contract of offshore substation for Greater Changhua 1&2a Offshore Wind Project from Ørsted, whereas the consortium of Semco Maritime and PTSC M&C was chosen to be the supplier of offshore substation for Hailong Offshore Wind Project. The substation will be manufactured in Vũng Tàu, Vietnam.

As the engineering technique level of offshore substation is relatively high, domestic suppliers have not established any track records and delivery yet. However, regarding the lower steel structure, both Century Wind Power and CSBC have intention to be the suppliers in the future projects. Century Wind Power has the capacity to manufacture main steel components for offshore substations and for the topside. It will use the Taipei Port S7-1 site (expected to be completed in November 2022) as the assembly site for the fabrication of offshore substations. As for secondary components for offshore substations (such as climbing ladders, etc.) and heavy electrical equipment, it needs to be contracted with other local suppliers and large heavy electrical firms. CSBC, together with Semco Maritime and Bladt Industries, discussed in 2017 on collaborating offshore substation steel components, and a letter of intent was signed as a result. However, no actual collaboration has been conducted so far. CSBC, after self-assessment, believes that it cases the capacity of manufacturing the topside of steel components, but requires technology transfer from international manufacturers. The production site is planned near the wharf of the CSBC plant. Products will be transported to the wharf upon completion and no additional storage area is planned. In addition, offshore substations are overtly large in size, the spraying method will refer to the

approach done by leading international firms, which is spray coating in the outdoors.

Turning to the heavy electrical equipment for offshore substations, at present, no actual production and delivery of heavy electrical equipment for offshore substations has been done in Taiwan. However, major international offshore substation suppliers, including Hitachi ABB Power Grids, Siemens Energy, and GE Renewable Energy, have been active in deploying the local market. Local heavy electrical equipment supplier Fortune Electric has discussed the possibility of technology transfer and producing offshore substation heavy electrical equipment in Taiwan with GE Renewable Energy, including 66kV/240kV GIS gas insulated switchgear and 66kV/240kV transformers. Fortune Electric already has the capacities of designing and manufacturing medium and low voltage switchgears used in offshore substations. Delta Electronics, Inc. has the design and manufacturing capabilities for WTG converters, and intends to manufacture products for power conversion systems in offshore substations. Delta will soon obtain the specifications of power conversion systems of offshore substations in the first quarter in 2023, and will proceed to product design, R&D and verification. It is expected that Delta will accomplish the prototype and finish the testing and verification process.

In the Zonal Development phase, the Government plans to further encourage local manufacture of offshore substations (including steel structures and part of electrical systems) and consider it as a bonus item under the IRP. As Taiwan is new to offshore substations, technology transfer and collaboration with international players could be anticipated. Equipment deployed at sea needs to withstand impacts, saltwater corrosion and additional loads, and as a result will be required to meet more stringent certification standards.

3.3.4. Onshore transmission

Currently, Fortune Electric, GE Corporation, Star Energy and TECO are

the main players in onshore substation turnkey projects in Taiwan, and key electromechanical components of the onshore substations are produced by local suppliers. For instance, the main suppliers of transformers are Fortune Electric and Shihlin Electric; and switchgears are mainly supplied by Chung-Hsin Electric and Machinery Manufacturing Corp., TECO, Nan-ya Plastics and Fortune Electric. Switchboards are primarily supplied by Chung-Hsin Electric and Machinery Manufacturing Corp., TECO and Fortune Electric.

3.4 Installation and Commissioning

3.4.1. Turbine, foundation, and offshore substation

Major engineering companies in Taiwan, such as Hung Hua Construction and Hwa Chi Construction, have developed track records in dredging and maritime construction, yet none in offshore wind farm installation or servicing. As a result, they usually expand its service into marine engineering through international collaboration. At present, major EPC contractors for turbine installation include CSBC-DEME Wind Engineering Co (referred to as CDWE, a joint venture between CSBC and DEME Offshore, awarded installation contract by Hai Long Wind Farm), UK's Seajacks (contracted to install turbines for Hai Long Wind Farm), Boskalis HwaChi Offshore Wind Taiwan (a joint venture between Hwa Chi Construction and Netherland-based Boskalis) and Jan De Nul (EPCI contractor for Taipower's Phase 1 Project).

The main operators in the foundation installation market include Boskalis HwaChi Offshore Wind Taiwan, CDWE, Fred. Olsen Ocean, Heerema Marine, Jumbo Offshore and Sapura Energy, while Keppel (for Ørsted) and Semco Maritime are primary contractors for offshore substation installation. As Taiwan currently lacks its own turbine installation fleet, overseas vessel operators are needed to support turbine installation. CDWE has commissioned a heavy lift vessel from CSBC, named "Green Jade," which will be used for transport and installation of foundations.

3.4.2. Subsea cable installation

Currently, subsea cable installation for offshore wind farms is undertaken mostly by EPC contractors, such as Jan De Nul, Seaway 7 and Van Oord. Dong Fang Offshore Co., Ltd., a subsidiary of Hung Hua Construction Co., is contracted to deliver cable installation through the horizontal directional drilling (HDD) method for wpd's Yunlin Wind Farm and Taipower Phase 1 Project. High Tien Offshore Co., Ltd, a local company just established in 2021, is expected to become another new entrant to the cable installation market in the near furture.

3.4.3. Support services/floater installation

The support and enabling services discussed in this section include onshore and offshore logistics services. Although Taiwan boasts several competent local logistics suppliers, none of them specialise in offshore logistics solutions. The market is currently dominated by overseas operators, including A-Leaf, Swire Energy Services, DHL, DSV, DWTEK, ENABL, Eunika, Boston Energy, Global Wind Service, Fairwind partners BMS Heavy Cranes A/S, Sevenstar, Muehlhan Wind Service, ProCon Wind Energy, Scan Global Logistics, Site Solution Partners, Vento Energy Support, and Certex UK. They primarily deliver logistics services, warehouse management, turbine pre-assembly, heavy lifting, electrical assembly support, asset management and assorted quayside services.

3.5 Operation, Maintenance, and Service

The first offshore wind farm in Taiwan, Formosa 1, has officially moved into the operation and maintenance (O&M) period since 2020, kick-starting Taiwan's nascent O&M industry. As an emerging offshore wind market, Taiwan's local O&M supply chain is still in its infancy, which presents significant development opportunities. Long-term business opportunities in the O&M sector, and the policy target of installing over 20GW in capacity, have encouraged engagement and investment from both international and local players.

The development of Taiwan's O&M supply chain for offshore wind is likely to follow the European model, where wind turbine manufacturers have a competitive advantage in providing turbine maintenance and repair, leaving on-site technical services for balance of palnt (BOP) the primary opportunity for interested suppliers. Local suppliers in Taiwan have established expertise in serving onshore wind projects, with a good track record in marine engineering. However, the lack of experience in offshore wind O&M has prompted local suppliers to engage international partners to enter the offshore O&M market.

The following sections discuss the development status and opportunities of the Taiwan market for wind turbines, balance of plant, offshore logistics and onshore services.

3.5.1. Turbine-related services

SGRE and Vestas are currently the major WTG suppliers in Taiwan, as Hitachi, which has withdrawn from the market, only supplies Taipower's demonstration wind farm. With Taiwan's nascent offshore wind market, a lack of independent service providers (ISPs), and newer turbine models adopted across wind farms, most developers choose to sign a long-term service agreement with the turbine manufacturer. As such, the turbine O&M market is at present dominated by WTG suppliers.

Commissioned to supply some of the earliest projects in Taiwan, SGRE has built a service team of dozens of professionals in Taiwan, and established a central service and spare parts warehouse at Taichung Port. The company also inaugurated a service accommodation transfer vessel (SATV), Ventus Formosa, in Taiwan. For its turbines, the inspection and maintenance work of the nacelle and electromechanical systems are carried out by the Siemens Gamesa team, while blade and tower inspections are undertaken by external vendors. In 2020, Nearthlab, a South Korean autonomous drone solution provider, was selected by SGRE to perform blade inspection for Formosa 1.

Vestas is expected to begin wind turbine installation in 2022, and O&M services in 2023. Vestas uses Changhua Fishing Port as its O&M port to serve Changfang, Xidao, Zhong Neng and Taipower Wind Farms, with relevant planning in progress.

3.5.2. Balance of plant-related services

The O&M of balance of plant is a major business opportunity in the Taiwan market. Although different wind farm operators' O&M strategies vary, services such as on-site inspection and repair of transition pieces, foundations, seabed and subsea cables, and offshore substations are mostly outsourced.

Different wind farms adopt a different approach to BOP management. Ørsted has an in-house team to maintain its assets. Management activities of wpd's Yunlin Wind Farm are contracted to Deutsche Windtechnik, while those of CIP and Zhong Neng Wind Farms are undertaken by Peak Wind. Formosa 1 Wind Farm is managed by Swancor Renewable Energy, who has been coordinating O&M works, at the same time responsible for managing its pool of local O&M service providers.

In Taiwan, several suppliers have been actively investing in new capacity for the O&M market. There are overseas companies such as CWind-Taiwan, a joint venture between IOVTEC and CWind, and UK-based James-Fisher. Taiwanese operators, such as Star Energy and Maxlines Offshore Services Inc., have been seeking potential local partners, as well as engaging international players for technical collaboration and strategic consortium to secure O&M contracts from developers.

When it comes to the technical capacity required for BOP maintenance, Taiwanese operators have the expertise in onshore substation O&M, structure painting, and corrosion inspection for foundations. However, there is little track record in maintaining electrical facilities of offshore substations, inspecting underwater structures, or detecting seabed and subsea cables, and no local operator is able to perform subsea cable

repair. In terms of O&M equipment, DWTEK Co., Ltd. is the only supplier in Taiwan that develops and produces ROVs in-house. The company also provides other underwater inspection solutions.

Overall, the O&M supply chain in Taiwan is still at a nascent stage. While local suppliers have a strong track record in onshore wind O&M and expertise in offshore engineering, the lack of relevant experience in offshore wind has emerged as the greatest challenge. It is suggested by developers that local suppliers first seek international partners and invest in local O&M capacity together, which presents an excellent opportunity for overseas companies to enter the Taiwan market.

3.5.3 Offshore logistics

Taiwan's local shipyards are capable of designing and producing crew transfer vessels (CTVs) for general inspection and basic part replacement, as evidenced by the two CTVs built by Lungteh Shipbuilding for TIPC, a state-owned port operation and management company. International procurement is another option. For example, Hong Hua Construction ordered four CTVs from the Dutch shipbuilder Damen Group, while some chose to purchase or lease existing ships from overseas operators.

For service operation vessels (SOVs), which are designed for sailing long-distances and servicing large-scale wind farms, there are currently TSS Pioneer, a purpose-built SOV commissioned by Ta San Shang Marine Co., Ltd., and time-chartered to Ørsted, as well as Pacific Constructor, purchased by Dong Fang Offshore from Singapore-based Swire Pacific Offshore.

At present, the only vessel capable of large component replacement is Green Jade, owned by CDWE. However, as the vessel is a floating, DP3 heavy lift and installation vessel, jack-up vessels still need to be sourced internationally when there is demand for replacing major turbine components.

As the number of commercial wind farms in Taiwan continues to rise,

demand for CTVs and SOVs is expected to increase further, presenting opportunities for international players to work with local suppliers on vessel design and manufacture, or sell or charter existing vessels to Taiwanese companies.

3.5.4 Onshore Service

Most developers use Taichung Port and Changhua Fishing Port as their O&M base. The only exception is wpd's Yunlin Wind Farm, which selected Budai Port in Chiayi County as the O&M port due to its close proximity to the site. CIP, Zhong Neng and Taipower Wind Farms intended to use the Changhua Fishing Port as the O&M center, while Ørsted, Formosa 1 & Formosa 2 Wind Farms use Taichung Port for the purpose. SGRE also selected Taichung Port as its center for service and spare parts logistics, where the turbine maker delivers long-term services to its customers in Taiwan. As a sheltered and natural port with vast hinterland and optimal clustering effect, the Taichung Port is an O&M port with promising potential. Changhua, on the other hand, is ideally positioned and close to several wind farms, which translates into advantages in transport and handling. Both Budai Port and Taichung Port are operated and managed by TIPC, while the Changhua Fishing Port is under the jurisdiction of the Changhua County Government. The Taiwan Government has invested in infrastructure upgrades across these ports to better serve the offshore wind industry.

3.6 Professional Training, Legal, Financial, and Other Supportive Service

3.6.1. Training services

Most offshore wind power practitioners are required to obtain GWO course completion certificates. At present, there are three main agencies in Taiwan that provide comprehensive GWO-BST and GWO-BTT training courses. Among them, Taiwan International Windpower Training, which is located in Taichung Port and is a joint venture of CWind Taiwan, TIPC,

CSC, CSBC, Taipower and SRE, etc., and Kaohsiung University of Science and Technology Qijin Campus have both established comprehensive training equipment, ready to provide GWO training courses to the industry. The Maritime Technology Innovation Center (MTIC) of MIRDC, on the other hand, has worked with internationally renowned training center Maersk Training to organize GWO training courses. MTIC has signed MOUs with SGRE, Ørsted, Vestech Taiwan, Taiwan Cogeneration Corporation and Taiwan Marine Heavy Industry on providing talent training talents for the industry. The Industry Pioneer Pilot Program of the Ministry of Labor also subsidizes relevant courses mentioned above.

Driven by Taiwan's offshore wind power industry policy, local demand for high-level welding, NDT, painting, project management and international legal professionals is increasing. In order to satisfy such demand, the government has adopted the "Guidance Program for Offshore Wind Power Underwater Foundation Industry Technology Upgrade", which is implemented by MIRDC. The goal is to guide the training and matching of underwater foundation high-level welders to ensure stable supply of high-level welders and establish a good talent training environment. This has apparently become the most primary approach to train high-level welders. In 2020, about 20 professions accomplished 6G/6GR training program. In addition, local industries and the academia such as Century Wind Power, CSBC and Kaohsiung University of Science and Technology have also engaged in the training high-level welders.

In addition to high-level welding, the number of NDT and painting professions are eager to be increased. CSBC Coating Solutions is primarily engaged in the training of professional painters. At present, the company provides internal training to its own technicians so that they can obtain FROSIO and NACE certificates. In the future, they will collaborate with focus collages (such as National Kaohsiung Marine University, National Sun Yat-sen University Continuing Education Center) to encourage student engagement and to strengthen the local talent pool. Quality inspection of foundations, towers and other steel components

requires NDT inspectors for ultrasonic or visual inspections. Currently, local Taiwanese industries mostly provide internal training or introduce foreign inspectors as seed teachers to transfer relevant skills to local workers and cultivate local talents.

3.6.2. Legal, financial, and other

Currently, a mix of both Taiwanese and overseas companies (or firms) are offering legal, project finance, insurance and other consultancy services to Taiwan's offshore wind market. Major law firms include Lee and Li, Attorneys-at-Law, KPMG, Baker McKenzie, Blanke Meier Evers, Linklaters, Tsar & Tsai Law Firm, Liang & Partners Law Offices. On project finance and insurance planning, the group of financial institutions involved in offshore wind include French BNP Paribas, Bank of Taiwan, Cathay Capital, Cathay Life, Cathay United Bank, global investment group CDPQ, Crédit Agricole, CTBC Bank, Deutsche Bank, DZ Bank, E. Sun Bank, First Bank, HSBC, Korea Development Bank, Land Bank, Mega Bank, Oversea-Chinese Banking Corporation, Siemens Bank, Société Générale, Standard Chartered Bank, Sumitomo Mitsui Banking Corporation, Taipei Fubon Commercial Bank, Taiwan Cooperative Bank, and Taiwan Life Insurance. In addition, leading insurance consulting companies like Aon, as well as Cathay Century Insurance and Fubon Insurance Company, have supplied insurance programs for construction, assets and liability coverage for Taiwan’s green energy sector.

3.6.3. Research and development capacities

Several universities and research institutes in Taiwan have been undertaking research and development (R&D) of offshore wind technologies, and the Government has also invested in gathering industry intelligence and enhancing R&D capacities. The Maritime Technology Innovation Center (MTIC) of MIRDC engages in a number of research programs related to offshore wind power, including the research and development of underwater vehicles, marine anti-corrosion technologies, marine biological resources, O&M technologies. The center houses six

laboratories, underwater vehicle R&D, marine anti-corrosion engineering, underwater structure inspection, aquatic intelligence, marine product development & testing and marine biological pre-treatment and high-pressure processing to strengthen Taiwan's R&D capabilities in offshore wind power and marine technologies. Thunder Tiger has worked with MIRDC in the R&D of medium and large underwater unmanned vehicles, which can be used in underwater survey for offshore wind farms in the future.

CR Classification Society, a local Taiwanese certification body, performs ship inspections and surveys, ship registry management and runs R&D programs on marine engineering. The Industrial Technology Research Institute (ITRI) supports government efforts in formulating rules for wind farm auctions and advising on relevant issues, while developing O&M and marine engineering technologies. The Metal Industries Research & Development Centre (MIRDC) is tasked with facilitating the implementation of IRP, and assisting local suppliers in building up capacities to drive global competitiveness.

Several Taiwanese research institutions have also been engaging their international (especially European) counterparts for transnational R&D projects, such as Carbon Trust, ORE Catapult, DTU, TNO and Fraunhofer IWES. For example, ORE Catapult and ITRI signed a *Memorandum of Cooperation on Offshore Wind Generation, Technology Cooperation, and Information Exchange*, paving the way for future collaboration on research projects on offshore wind O&M technology and turbine installation. The MIRDC has also partnered with TNO in launching a professional training program, designed to cultivate trainers for the local wind energy industry, and nurture more specialized personnel and talent.

3.7 Summary

Strong seasonal monsoons, ideal geographical location, and exceptional wind resources have made the Taiwan Strait one of the world's best sites for developing offshore wind energy. Data analysis has suggested that,

for both shallow and deep waters (>50 meters), the exploitable wind resources in the Taiwan Strait amount to over 20GW. As the world shifts towards renewable energy, the Taiwan government has developed a national strategy to guide offshore wind development, seeking to install 5.6GW offshore wind capacity by 2025 through three phases, namely the Demonstration Incentive Program, Potential Sites, and Zonal Development. As of the end of 2021, cumulative capacity has reached 325.2MW, which means around 20.2GW remains up for grabs by 2035. Although most wind farms awarded capacity during Phase 2 have already completed subcontracting, business opportunities still exist for future auction rounds and the potential 15GW market during Phase 3. In fact, several new developers have already entered the Taiwan market, such as Iberdrola, Marubeni, Taiwan Huanfeng Holding Co., Ltd., Taiya Renewable Energy, Steelcomp, and RWE. At the end of 2021, the Ministry of Economic Affairs of Taiwan announced the *Directions for Allocating Installation Capacity of Offshore Wind Zonal Development*, specifying the IRP policy framework for the Zonal Development phase. Most rules are a continuation of those applied in the previous phase, with a few bonus items added to provide developers with greater flexibility in planning localization strategy.

To drive the local offshore wind industry, the Taiwanese government has planned for Taipei Port, Taichung Port, Xingda Port, Anping Port and Kaohsiung Port to invest in relevant infrastructure, including planning industrial zones and O&M berths, building heavy-lift wharfs, and developing operation management guidelines, in order to better serve all stakeholders in the offshore wind ecosystem.

For the Government, offshore wind as a policy is not only an enabler for energy security, but a driver for industrial development. Developers are therefore required to propose and deliver their Industrial Relevance Programs during Phase 2 (Potential Sites), and provide supporting evidence for their localization efforts (e.g., formal commercial contracts). Supported by such policy framework, Phase 2 of Taiwan's offshore wind development has led to new and enhanced local supply capabilities and

proven track records of delivery. A summary of conclusions on each supply chain element is presented in Table 3. As indicated by the chart, after two phases of offshore wind development, local Taiwanese suppliers have established capacities across most supply categories through a variety of capacity-building strategies, which can be roughly categorized into three groups:

1. Local supplier investing in new capacity on its own; examples include Boltun (fasteners) and Swancor (blade resin). The products delivered by the two suppliers have also been internally approved by their turbine manufacturer clients.

2. Overseas leading company coming to Taiwan to invest in new facilities, take orders or operates business services, such as KK Wind Solutions, Jan De Nul and Peak Wind.

3. Foreign company and a local Taiwanese partner entering into a joint venture or engaging in technology transfer; examples include CS Wind Taiwan/Ching-Fong, Vestas/Tien-Li, Fassmer Atech, and CDWE. Technology introduced by foreign firms is an important source for the local industry to establish supply capabilities; such partnership also enables Taiwanese suppliers to gain experience of working with an international market leader, while familiarizing themselves with best practices and general rules for entering international contracts and business negotiations.

To date, Taiwan has developed track records in supplying towers and several wind turbine components (inside the nacelle). Nacelle assembly is led by WTG suppliers, and local blade production is currently going through a learning curve. As for BOP, Taiwanese suppliers are well-equipped to supply electrical systems for onshore projects, with sufficient capacity to deliver EPCI projects and key components. However, capacity needs to be built in the areas of subsea cables, offshore substations and foundations (both fixed and floating). In particular, as floating foundation has been labeled as a bonus item in the IRP policy for Zonal Development,

domestic companies will have to partner with leading international players to establish supply capabilities together. In the area of construction and installation, local suppliers only have expertise in hydraulic and dredging projects, but several global leading marine specialists, such as Boskalis, Jan De Nul and Seajacks, have started operations in Taiwan, mostly as EPCI contractors, to coordinate construction work and manage subcontractor relationships. Turning finally to O&M, most maintenance activities for turbines are undertaken by turbine makers, and as only two wind farms (Formosa 1, Taipower Phase 1) have moved into the O&M phase, the local supply chain is at an early stage of development, and most local service providers of BOP maintenance and logistics solutions, despite relevant industrial experience, do not have track records in offshore wind, which is considered the greatest challenge for the existing supply chain.

Table 3 Summary of Taiwan Offshroe Wind Industry Supply Chain Assessment

Category		Reliable on Local strength	Foreign engagement		Domestic industrial maturity[4]
			JV / Technical transfer with local firms	Independent investment/business	
Project Management			●	●	
WTG	Nacelle assembly			●	
	WTG components[5]	●	●	●	
	Tower		●		
	Blade and materials	●	●		
Balance of Plant	Foundations		●		
	Subsea cables			●	
	Offshore substations			●	
	Onshore transmission	●			
Installation and Commissioning	Turbine, foundation, and offshore substation installation		●	●	
	Subsea cable installation	●		●	
	Support services / floating turbine installation	●		●	
Operation, Maitenance and Services	Turbine-related services			●	
	Balance of plant-related services		●	●	
	Offshore logistics	●	●		

[4] Evaluation includes foreign investment in Taiwan in any means but does not include 100% outsourcing items, such as subsea cables and offshore substation.

[5] WTG componetns covers a wide range of components, such as UPS, nacelle cover, spinner cover, cables, fasteners, generator, switchgear, transformer, etc.

4. Opportunities for UK Companies

The detailed assessment of Taiwan's offshore wind supply chain, presented in the Chapter 3, has identified a few gaps in the current market, particularly in the areas of blades, foundation (floating), operation and maintenance of BOP, and offshore logistics. Drawing on the previous analysis, this chapter will discuss opportunities for UK-based companies in these sectors. Since O&M can be further divided into sub-categories, the sector is considered separately here, along with marine engineering.

4.1 For General Sectors

As suggested by the assessment outcome, with a supportive regulatory framework, the offshore wind industry in Taiwan has established certain core capabilities to deliver offshore projects. The following sections will explore the market potential in the supply of turbine, BOP and support services, and further identify the size of opportunity for UK suppliers. The analysis results are summarized in Table 4. The suppliers covered in the analysis include local Taiwanese suppliers, as well as overseas companies who have invested in local facilities or operations. The number of suppliers, supply track record in the offshore wind industry, and availability of expertise are represented by ●, while size of opportunity is expressed using colors: red for low market attractiveness, yellow for medium, and green for high market attractiveness. Discussions below will focus on items that are moderately and highly competitive (yellow and green).

1. Wind turbine

Blade: at present, only Vestas and its partner Tien-Li are manufacturing blades for its V174 turbine at the Industrial Zone (II) of Taichung Port. However, local manufacture of blades is still an IRP requirement for the upcoming Zonal Development phase, and since not all turbine manufacturers have finalized their localization strategies, and the existing

and maturing technology to produce V174 blades might not be applicable to V236 blades, there are opportunities for UK manufacturers in blade-related sectors to work with local suppliers on blade production, material development or inspection technology.

2. Balance of Plant

Foundation: for bottom-fixed foundations, Taiwan is now actively expanding its professional talent pool and building up welding and non-destructive testing capabilities. As for floating foundations, the Government has listed the component as a bonus item in the IRP framework for Zonal Development. The UK has experience in deploying floating wind at scale, and there is high possibility for UK suppliers to find a local strategic partner to develop floating foundation technology and serve the Taiwanese market.

In the area of marine engineering, local firms in Taiwan have track records in dredging and marine construction, yet lack experience in offshore wind. As a result, marine engineering projects are mainly led by overseas market leaders (e.g. Jan De Nul). Currently, a joint venture formed between Taiwanese Hua Chi Construction and Boskalis has entered the market, but looking at the overall availability of expertise, the industry still suffers from a substantial shortage of essential services for marine engineering and pre-assembly work at quayside, such as electrical system testing before load-out, quayside staging area planning and management, heavy-lifting operation, which presents significant opportunities for interested UK suppliers.

Table 4 The Opportunity Assessment-For General Sectors

Sector	Subsector	No. of supplier	Track Record	Capability	Market Opportunities
Project Development and Management	Wind farm deisgn	●●●	●●●●●	●●●●●	Low
	Topographic Survey & Geologic Drilling	●●	●●●	●●●●	Low
WTG	Blade and materials	●	●	●●	Medium
	Tower	●	●●●●●	●●●●●	Low
	Nacelle components and assembly	●●●	●●●	●●●	Low
Balance of Plant	Foundation	●●●	●●	●●	Medium
	Subsea cable	●●	●●●●●	●●●●●	Low
	Offshore substation	●●	●●●●●	●●●	Low
	Onshore transmission	●●●●	●●●●●	●●●●●	Low
Supportive services and capacities	Training services	●●	●●●●●	●●●●●	Low
	Legal, financial and others	●●	●●●●●	●●●●●	Low
	RD capacity	●●	●●●	●●	Medium

4.2 For O&M Sectors

Construction of offshore wind farms in Taiwan has been delayed by the Covid-19 pandemic, with Formosa 1 being the only project that started commercial operation by the end of 2021, meaning few market opportunities for O&M. Nevertheless, according to government estimates, current projects would be back on track with the planned schedule in 2023, and investing in the Taiwan market now offers a path to capture the market value when demand for O&M rises considerably in 2023 and 2024.

Assessment of O&M opportunities for wind turbines, BOP, offshore logistics and onshore services is summarized in Table 5. The suppliers covered in the evaluation include local Taiwanese suppliers, as well as overseas companies who have invested in local operations. The number of suppliers, supply track record in the offshore wind industry, and availability of expertise are represented by ●, while size of opportunity is expressed using colors: red for low market attractiveness, yellow for medium, and green for high market attractiveness. Discussions below will focus on items that are moderately and highly competitive (yellow and green).

Table 5 The Opportunity Assessment For Taiwan OWF O&M Sector

Sector	Subsector	No. of supplier	Track Record	Capability	Market Opportunities
Wind Turbine	Nacelle	●●	●●●●●	●●●●●	Low
	Blade	●●	●●	●●	High
	Tower	●●	●●	●●	High
	Spare Parts	●●	●●	●●	Low
Balance of Plant	Transition Piece	●●	●●●	●●●	High
	Corrosion Inspection	●●	●●●	●●●	Medium
	Foundation	●●	●●	●●	High
	Sea bed	●●●	●●●	●●●	Medium
	Cable	●●	●●●	●●●●	High
	Onshore Substation	●●●	●●●●	●●●●	Low
	Offshore Substation	●●	●●●	●●●	Medium

Offshore logistic	CTV	●●●	●●●	●●●	Medium
	SOV	●	●●●●	●●●●	Low
	Main Replacement Vessel	●●	●●●●	●●●●	Medium
Onshore Service	Port	●●	●●●	●●●	Low
	Warehouse	●●●	●●●●	●●●●	Low

1. Turbine O&M

(1) Blade: turbine manufacturers are able to provide UAV-based blade inspection and repair services. Although local expertise is available, there are only few suppliers, with no track record in offshore wind, which entails opportunities for UK suppliers.

(2) Spare parts and components: only a small fraction of local suppliers have become part of the turbine supply chain; most of whom do not have track records to date. However, since spare parts are purchased entirely by turbine manufacturers from their own global supply chain system, the size of the UK opportunity is small.

2. BOP

(1) Transition piece: Taiwanese suppliers have a good track record in delivering transition piece inspection and repair, as well as anti-corrosion coatings; however, such works are coordinated and led by foreign technicians. The industry's capacity is still being established.

(2) Corrosion inspection: there are Taiwanese specialists commissioned to design corrosion protection for offshore wind foundations. However, most underwater inspections in Taiwan are undertaken by divers, which presents market opportunities for service providers of ROV-based corrosion inspections.

(3) Foundation: asset managers prefer using ROVs for underwater inspection and maintenance. In Taiwan, only DWTEK has in-house ROV expertise, and few companies have invested in ROVs. As such, there is potential for providers of ROV-based foundation

inspection solutions to capture market shares.

(4) Offshore substation: Taiwanese electrical equipment manufacturers currently have no track record in offshore substation O&M, but equipment suppliers, such as Hitachi ABB, have been seeking local partners to support future O&M services for offshore substations.

(5) Seabed survey: Taiwanese survey specialists have been supporting the offshore wind industry with survey services and are capable of carrying out seabed surveys.

(6) Subsea cable inspection, maintenance and repair: there is no local Taiwanese supplier with experience in subsea cable inspection, maintenance or repair. That said, many overseas marine experts that set up companies in Taiwan, such as Boskalis, have the expertise to repair subsea cables.

3. Offshore logistics

(1) CTVs: several operators have invested in CTV capacity, but business opportunities still exist considering the growth potential of the market.

(2) SOVs: almost no Taiwanese companies has invested in construction or installation support vessels. Therefore, in the event of major component replacement, SOVs still need to be chartered from overseas sources.

5. Recommendations

5.1 Regarding Policy

Taiwan is currently in Phase 2, Potential Sites, with 5.2GW of offshore wind capacity yet to be installed. That said, as most projects have already secured their contractors at this stage, it is advised that interested overseas suppliers focus on wind farm auctions for 2025, and the Zonal Development phase from 2026 onwards (i.e., the 15GW to be released by 2035). Investment in O&M business, however, is not bound by such policy timeline. According to the *Directions for Allocating Installation Capacity of Offshore Wind Zonal Development* announced by MOEA, the developer will first go through a qualification review (including IRP review), and awarded developers are subject to regular reviews and audits by relevant authorities. For UK suppliers who sign contracts with developers for supply of items required for localization or bonus items, it is required to assist developers in providing relevant documentation and supporting evidence of local content. Regarding vessel use related to offshore wind farms in Zonal Development Phase, the Taiwanese government has specifically regulated that vessel of the ROC nationality should be used. If there are no ROC vessels, a vessel owned by a joint venture under the ROC laws between a Taiwanese company and a foreign company may be used. The Taiwanese company shall hold more than half of the shares of the joint venture, and the joint venture shall hold more than half of the ownership of the vessel.

5.2 For UK Firms

The supply chain opportunity assessment above has identified a number of potential areas for overseas market players in offshore wind. Among them, blades, a major turbine component, are primarily manufactured in-house by wind turbine manufacturers. As such, UK suppliers with relevant experience are advised to first engage in technology exchange on blade production, materials or inspection with Taiwanese counterparts. In the

long run, partnering with turbine makers remains a precondition for being part of the turbine supply chain. For floating foundations, Scotland-based floating wind specialist Flotation Energy (who has signed an MOU with Taiwan's largest ship builder CSBC in 2021) is the developer of Kincardine, the world's largest commercial floating project, and has a 10GW international floating wind pipeline. In addition, in January 2022, Crown Estate Scotland announced the winners of the ScotWind leasing auction, and nearly 70% of the successful projects are for floating wind. Therefore, in the coming years, Scotland could be a major hub for further development of floating foundation technology. If floating wind projects are selected during Taiwan's Zonal Development phase, UK specialists in floating wind are suggested to work with local suppliers in developing floating foundation designs customized to site conditions in Taiwan, and secure local supply partners for anchoring and mooring systems. Collaboration with Taiwanese universities (e.g., National Cheng Kung University, National Taiwan University) on research and certification on floating foundation types is also encouraged.

The UK has competitive expertise in marine engineering and O&M, which complements Taiwan's established strengths. Although turbine O&M is mostly undertaken by wind turbine manufacturers, the local supply chain still lacks experience in marine engineering, BOP maintenance and offshore logistics. UK suppliers intended to enter the Taiwanese market are therefore encouraged to connect with EPCI contractors to win subcontracts for engineering, support services or component or equipment supply, such as ROV solutions, inspection services and pre-assembly work. However, as Mandarin remains the dominant language used in communication and correspondence, language barriers could pose challenges for interested UK companies when working with local partners or practitioners.

Appendix

An Overall Table of Domestic Supply Chain

Sector		Supplier
Project development and Management		NIRAS
		COWI
		K2 Management
		Ramboll
		Fugro
		Gardline
		JAVA Offshore
		GEOQUIP
		CECI Engineering Consultants Inc., Taiwan
		GIBSIN Engineers, Ltd
		SINOTECH Engineering Consultants, Ltd.
		Pan Formosa Engineering Co., Ltd.
		Dragon Prince Hydro-survey Enterprise Co.
		PDE Offshore Corporation
		Fugro IOVTEC Co., Ltd
WTG	Nacelle	Siemens Gamesa Renewable Energy
		Vestas Offshore
	Tower	CS Wind/Ching-Fong
		Welcon
	Blade and materials	Tien-Li Offshore Wind Technology CO., LTD.
		Swancor
	Transformer	Shihlin Electric&Engineering Corp
	Switchgear	Shihlin Electric&Engineering Corp
	Power conversion system	KK Wind Solutions
	Uninterruptible Power Supply	KK Wind Solutions
	Spinner cover	Fassmer Atech Composites Taiwan Co., Ltd.
	Nacelle cover	Fassmer Atech Composites Taiwan Co., Ltd.
	Cables	Walsin Lihwa Corp
	Casting	Yeong Guan Energy Technology Group Co., Ltd

Sector		Supplier
WTG	Fastener	Boltun Corporation
	Generator	TECO Cooperation
Balance of Plant	Foundation	Century Wind Power Co. Ltd
		Sing Da Marine Structure
		CTCI Machinery Corporation
		Ming Rong Yuan New Energy Co., Ltd.
		Formosa Heavy Industries
		CSBC Corporation
		CSBC Coating Solutions Co., Ltd.
		Fermo Enterprise Corporation
	Subsea cables	JDR
		LS Cable
		Tekmar Energy
	Offshore substation	Keppel Offshore&Marine
		PTSC M&C
		Century Wind Power Co. Ltd
		CSBC Corporation
		Fortune Electric Co., Ltd
		Delta Electronics, Inc.
	Onshore Transmission	Fortune Electric Co., Ltd
		Star Energy
		GE Internatioanl Incorporation Taiwan Branch
		TECO Cooperation
		Shihlin Electric&Engineering Corp
		Chung-Hsin Electric &Machinery Manufacturing Corporation
Installation and Commissioning	WTG, foundation, subsea cables and offshore substation installation	CSBC-DEME Wind Engineering Co., Ltd.
		Boskalis HwaChi Offshore Wind Taiwan
		Seajacks Ltd
		Fred. Olsen Windcarrier
		Heerema Marine Contractors
		Jan De Nul Group
		Jumbo Offshore

Sector		Supplier
Installation and Commissioning	WTG, foundation, subsea cables and offshore substation installation	Sapura Energy Berhad
		Semco Maritime A/S
		Subsea 7
		Van Oord
		Dong Fang Offshore Co., Ltd
		Hign Tien Offshore Co., Ltd
	Supportive services	A-LEAF
		Swire Energy Services
		DHL
		DSV
		DWTEK
		ENABL
		Eunika
		Boston Energy
		Global Wind Service
		Fairwind Partners
		BMS Heavy Cranes A/S
		Sevenstar
		Muehlhan Wind Service
		Procon Wind Energy
		Scan Global Logistics
		Site Solution Partners
		Vento Energy Support
		Certex UK
Operation, Maintenance and service	Turbine-related	Siemens Gamesa Renewable Energy
		Vestas
		Nearthlab
	BOP services	Deutsche Windtechnik
		Peak Wind
		Swancor Renewable Energy
		James Fisher
		CWind Taiwan
		Star Energy
		Maxlines Offshore Services Inc.
		DWTEK Co., Ltd.
	Offshore Logistics	TIPC Marine Corporation

Sector		Supplier
Professional training, financial, legal and other supportive services	Training services	National Kaohsiung University of Science and Technology
		Metal Industries Research and Development Centre
		Taiwan International Windpower Training Corporation Ltd.
	Financial, legal management	Lee and Li, Attorneys-at-Law
		KPMG
		Backer McKenzie
		Blanke Meier Evers
		Linklaters
		Tsar & Tsai Law Firm
		Liang & Partners Law Offices
		AON
		BNP Paribas
		Bank of Taiwan
		Cathay Capital Private Equity
		Cathay Life Insurance
		Cathay United Bank
		Caisse de dépôt et placement du Québec
		Crédit Agricole
		CTBC Bank
		Deutsche Bank
		DZ Bank
		E.SUN Bank
		First Bank
		HSBC
		Korea Development Bank
		Lank Bank
		Mega Bank
		Oversea-Chinese Banking Corporation
		Siemens Bank
		Société Générale
		Standard Chartered
		Sumitomo Mitsui Banking Corporation
		Taipei Fubon Bank

Sector		Supplier
Professional training, financial, legal and other supportive services	Financial, legal management	Taiwan Life Insurance Co., Ltd.
		Taipei Fubon Bank
		Taiwan Cooperative Bank
	R&D	Metal Industries Research and Development Centre
		CR Classification Society
		Industrial Technology Research Institute