European Commission

Sectoral Study:

Analysis of the provisions of maritime cabotage services in Japan

October 2022

Project reference: EuropeAid/139634/DH/SER/JP Support facility for the implementation of EU-Japan Economic Partnership Agreement (EPA)

Acknowledgments from the author

This report was funded by the European Union (EU) Delegation to Japan. We are thankful to several offshore wind sector experts in Japan that were consulted for this study under *Chatham House* rules and for the input received during a seminar held by the EU Delegation to Japan on June 6, 2022. Further, we would like to acknowledge the contributions from Junko Suetomi (Baker & McKenzie) and Lyckle Griek (EU-Japan Centre for Industrial Cooperation) for their support with legal analysis and the translation of key documents.

This report represents the status of the Japanese offshore wind sector through June 2022.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

Japan's offshore wind power (OWP) sector is set to expand significantly in the coming decades as the country aims to construct 30-45 GW of new offshore wind capacity by 2040 in support of its goal of attaining carbon neutrality by 2050. Among other factors, this will require that Japan secure sufficient access to the specialised vessels necessary for the construction, operation and maintenance of OWP facilities.

The limited domestic supply of such vessels in Japan suggests the use of foreign-flagged vessels. However, foreign-flagged vessels are prohibited from operating in the sector under Japanese cabotage laws (Japanese Ships Act).

This study examines the potential implications of these cabotage restrictions on the Japanese OWP sector and discusses potential strategies for EU operators to support sector development. Using desk research and feedback obtained through expert consultations,[1] we assess the extent to which Japan's current and anticipated[2] supply of OWP vessels is sufficient for meeting projected vessel demand. Focusing on wind turbine installation vessels (WTIVs) the approach consists of: (i) assessing first-order vessel and turbine criteria; (ii) estimating the potential supply capacity of these vessels; and (iii) constructing scenarios related to projected market demand.

The report is organised as follows:
- **Section 2** provides and overview of the Japanese OWP market;
- **Section 3** assesses Japan's vessel supply and demand and includes an overview of the global supply that could be used to supplement the country's possible vessel deficit;
- **Section 4** details Japan's restrictions related to cabotage and the rules for reflagging and includes an overview of cabotage within the EU for comparison with Japanese practices;
- **Section 5** summarises the implications of Japan's cabotage restrictions and provides recommendations;
- **Section 6** (Appendix) describes the methodological approach used to estimate vessel supply and demand.

2. The Japanese Offshore Wind Market

The Japanese market for OWP is expected to grow significantly over the next several decades as the country seeks to meet its goals of reducing greenhouse gas (GHG) emissions 46% by 2030[3] and attaining carbon-neutrality by 2050. In support of these objectives, GOJ has announced its intention to introduce 10 gigawatt (GW) of OWP generating capacity by 2030 and 30-45 GW by 2040.[4] If realised, this would make Japan's offshore wind market one of the largest in the world by capacity.[5]

[1] A limited set of sector experts were consulted for this study and feedback was elicited during a workshop held by the EU Delegation to Japan on 6 June 2022. To ensure confidentiality, names are omitted from the report.

[2] As announced by vessel operators in public reporting and press releases.

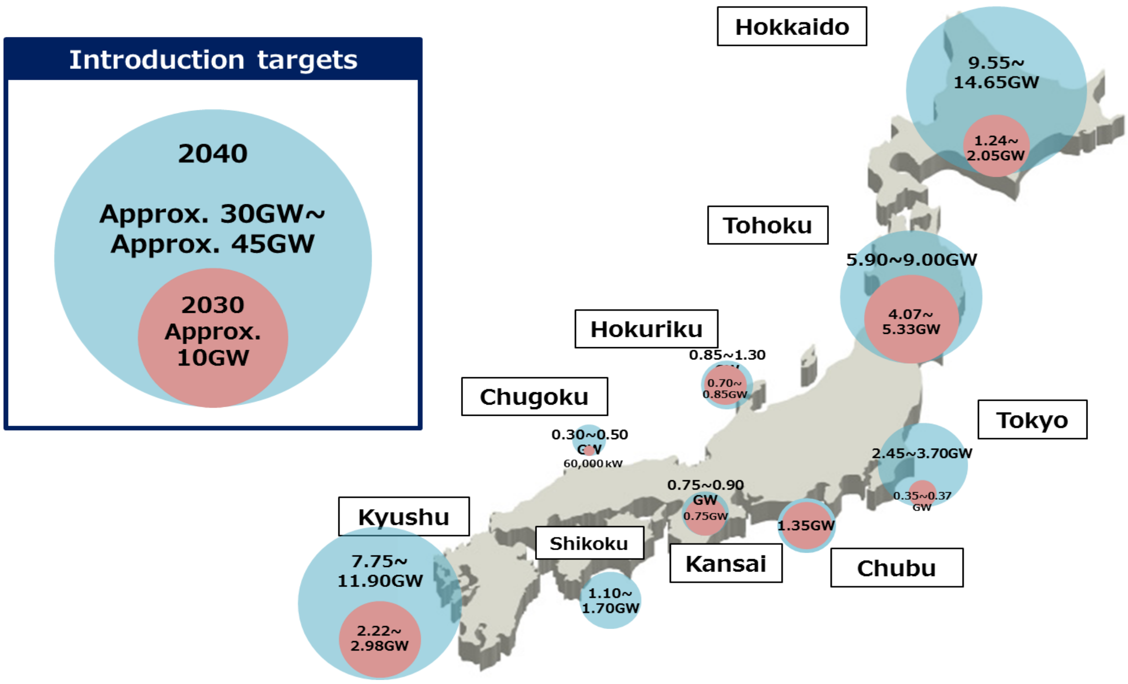
[3] Compared with 2013 levels.

[4] Notably, GOJ uses the term "introduction target" (導入目標) for its OWP capacity targets, which is based on the total capacity tendered through auctions rather than operational capacity.

[5]Public-Private Council on Enhancement of Industrial Competitiveness for Offshore Wind Power Generation (2020), based on the IEA Offshore Wind Outlook 2019 (Public Policy Scenario)

While OWP development is expected to occur throughout Japan's coastal regions, GOJ has specifically identified the country's northern (Hokkaido and Tohoku) and southern (Kyushu) regions as the most suitable for OWP (Figure 1).

Figure 1. Japan's OWP development targets by region



Source: Re-printed from Public-Private Council on Enhancement of Industrial Competitiveness for Offshore Wind Power Generation (2020)[6]

Across these regions, Japan is expected to rely on a combination of fixed-bottom and floating substructures to reach these targets. Environmental impact assessments (EIAs) have identified a total resource potential of 30.1 GW that is suitable in principle for fixed-bottom substructures.[7] Because of the limited shallow water sites offshore Japan (90 percent of Japan's OWP resource are in waters deeper than 50 meters), floating offshore wind (FOW) is anticipated to play a large role in the Japanese OWP sector development with over 140 GW of FOW potential.[8] The floating substructure sector is currently at a multi-turbine demonstration status globally and in Japan and expected to enter a commercial phase globally in the mid- to late-2020s. Japan currently has four FOW demonstration projects operating with a range of 0.006-12 MW in installed capacity.[9]

[6] In order to facilitate investment in relevant infrastructure such as grids and ports, the public-private council created this map to show the areas around Japan where OWP generation capacity are expected to be introduced. Figures for 2030 are based on projects that are undergoing an environmental impact assessment (EIA) (as of November 2020), including some projects for which the EIA has already been completed. Figures for 2040 are based on LCOE and other data from the NEDO Report on the Support Project for the Development of Floating Wind Farms (Study of Offshore Wind Power Generation Costs), reviews by experts, and the status of EIAs by power producers. In preparing this map, the longer-term potential of floating farms was not factored in.

[7] Agency for Natural Resources and Energy (2020); MLIT Ports and Harbors Bureau (2017); InfraBiz (2021)

[8] Principle Power (2021)

[9] Musial et al. (2021)

Japan's *Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities* ('the Marine Renewable Energy Act') empowers the Ministry of Economy, Trade and Industry (METI) and Ministry of Land, Infrastructure, Transport and Tourism (MLIT) with the ability to utilise the country's maritime areas towards OWP development and designate locations for public tendering. Areas targeted for offshore wind development are categorised according to their readiness and suitability to be opened to such procedures (Figure 2).

Figure 2. Categories of OWP development zones in Japan

Area in a certain preparatory phase	Potential area undergoes initial research, consultations and surveying in order to determine its suitability for OWP development
Promising Area	Area that meets basic requirements for OWP development is officially designated as 'Promising Area'; Council is formed (consisting of members of the MLIT, METI, MAFF, local government and relevant experts and academics) and additional research is undertaken
Promotion Area	Once all issues identified by the Council are resolved, the area is designated a 'promotion area' and opened to public tender

Source: Adapted from MREA.

In its goal to introduce 10 GW of offshore wind capacity by 2030, GOJ is aiming to tender an average of 1 GW of offshore capacity annually. GOJ has thus far adhered to this target and announced four promotion areas with a cumulative capacity of 2.06 GW as of May 2022 (Table 1). The additional OWP capacity that will be tendered in the coming years remains uncertain. EIAs conducted to date amount to 26.6 GW of offshore wind potential in addition to the four existing promotion areas – almost entirely from nearshore fixed-bottom sources.

Table 1. Japan's assessed OWP by location, type and capacity (in GW) (as of May 2022)

Promotion Areas			***Promising Areas***			***Preparatory Areas***		
Zone	**Prefecture**	**Capacity (GW)**	**Zone**	**Prefecture**	**Capacity (GW)**	**Zone**	**Prefecture**	**EIA assessed capacity (GW)**
Goto*	Nagasaki	0.02	Sea of Japan (North)	Aomori	0.3	Ishikari	Hokkaido	6.81 (7 sites)[10]
Noshiro-Mitane-Oga	Akita	0.48	Sea of Japan (South)	Aomori	0.6	Ganwu-Minami Shiribeshi	Hokkaido	Not available
Yuihonjo (North & South)	Akita	0.82	Eshima-Saikai	Nagasaki	0.3	Shimamaki	Hokkaido	Not available

[10] This capacity represents the cumulative amount assessed across 7 sites within the zone.

Choshi	Chiba	0.39	Oga-Katagami-Akita	Akita	0.21	Hiyama	Hokkaido	1.72 (2 sites)
Happo-Noshiro	Akita	0.36	Yuza	Yamagata	0.45	Matsumae	Hokkaido	Not available
			Murakami-Tainai	Niigata	0.36	Mutsu Bay	Aomori	0.88 (2 sites)
			Isumi	Chiba	0.41	Kuji*	Iwate	Not available
						Awara	Fukui	0.90 (3 sites)
						Hibikinada	Fukuoka	0.23 (2 sites)
						Karatsu	Saga	2.83 (7 sites)

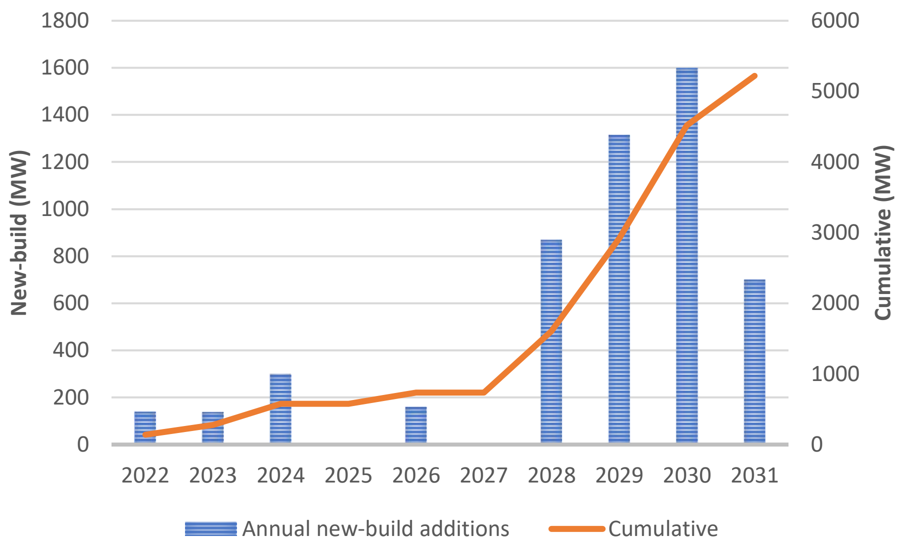
	Total	**Promotion areas**	**Promising areas**	**Preparatory areas**
Capacity Tendered	**2.06**	**2.06**	**-**	**-**
Likely to be tendered in coming rounds[11]	**2.63**	**-**	**2.63**	**-**
Assessed but not yet tendered[12]	**26.60**	**4.79**	**8.43**	**13.37**
Total	**31.28**	**6.85**	**11.06**	**13.37**

Note: (*) denotes FOW-designated site.
Source: Agency for Natural Resources and Energy (2020); MLIT Ports and Harbors Bureau (2017); InfraBiz (2021).

With only 2 GW of capacity tendered to date, deriving a projection of a future deployment timeline for Japan's OWP development is challenging. In support of its *6th Strategic Energy Plan*, Japan's Agency for Natural Resources and Energy estimates that as much as 5 GW of newly constructed OWP capacity could become operational by 2030.[13] This outcome is in line with annual projections by WoodMacKenzie (Diao, 2021), which estimate that 5.2 GW of new-build additions will become operational by 2031 (Figure 3). Due to the rapidly evolving situation in Japan's OWP sector, projections beyond this period are very limited and uncertain.[14]

[11] Based on government estimates of capacity expected from 'Promising Areas' (Agency for Natural Resources, 2020; MLIT Ports and Harbors Bureau, 2017).
[12] At this point, it cannot be determined whether this capacity will be tendered in the future. With respect to promotion areas, EIAs have identified significantly greater capacity than that opened to tender. It is, however, similarly unclear as to whether this capacity will be developed in future rounds.
[13] Agency for Natural Resources and Energy (2021). This figure represents their ambitious projections. In their conservative scenario, they estimate 1-3 GW of new capacity becoming operational by 2030.
[14] Towards this end, it should be noted that detailed (annual) projections for future Japanese OWP development are extremely sparse (even for the period prior to 2030).

Figure 3. Japan's projected OWP capacity, 2022-2031 (by year and cumulatively)



Source: WoodMacKenzie (Diao, 2021)

3. Assessment of the supply of vessels necessary for Japan's OWP development

For Japan to meet the government's OWP targets, it will require access to specialised vessels that are used in the construction, operation and maintenance of OWP facilities. This section assesses the extent to which the current and future vessel supply is sufficient for meeting projected demand. Beginning with a brief introduction to vessel types used in the offshore wind sector (Section 3.1), the section then proceeds with an inventory of all relevant vessels in Japan currently operating, under construction or in a reflagging process (Section 3.2), followed by an assessment of Japan's projected vessel supply and demand from 2022-2040 (Section 3.3). It concludes with an overview of the global supply of WTIVs and a discussion of the role that EU vessel owners could play in potentially alleviating future supply shortages in the Japanese OWP market (Section 3.4).

3.1. Vessels used in the offshore wind sector

A fleet of specialised vessels is required across the entirety of an OWP facility's life cycle – including surveying, installation, post-construction operation and maintenance (O&M) and decommissioning (Table 2). While some of these vessels are phase- and industry-specific, others can be used during various lifecycle stages and be drawn from fleets that also service other industrial and maritime sectors. The optimal vessel choice depends on a range of factors, including the OWP substructure type (i.e., fixed-bottom or floating); the size of the Wind Turbine Generators (WTGs) being installed; water depth and distance from shore; port and logistical infrastructure; the oceanic (e.g., wave height), soil types, weather and geophysical conditions, and potential seismic activity.

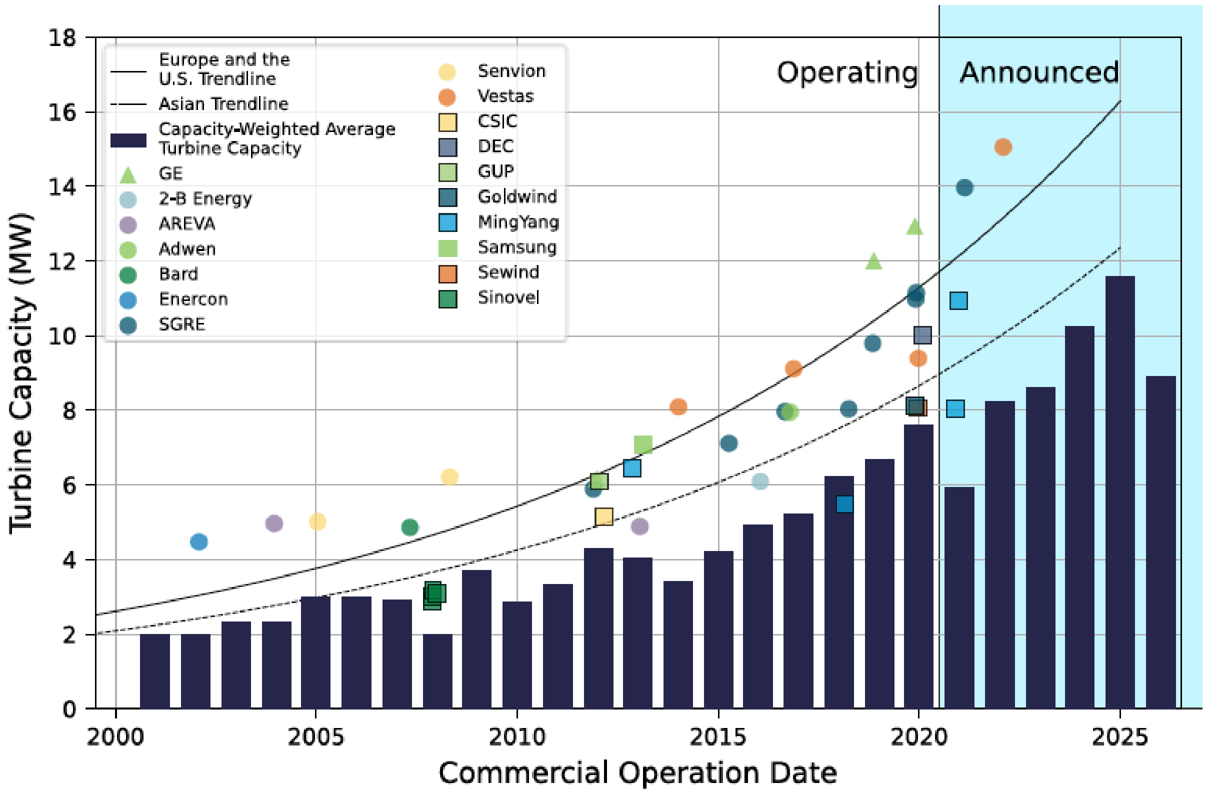
Table 2. Vessels used in OWP development

Phase	Activity	Description	Vessels used
Pre-construction	Surveying	Specialist vessels for geophysical and geotechnical surveys of the seabed to determine appropriateness of the site and inform subsequent construction activities	Environmental survey vessels Geophysical survey vessels Geotechnical survey vessels Jack-up vessels (for surveying purposes) equipped with drilling equipment
Construction	Foundation installation (fixed-bottom WTG only)	Vessels that transport the foundations and install them to the seabed. The choice of vessel is driven by a number of factors including deck space and lift capacity, with heavier foundations requiring vessels equipped with cranes with greater lift capacity.	Heavy lift vessels (HLVs) Floating sheerleg vessels WTIVs Construction support vessels
	Substation installation	Vessels that transport and lift the offshore substation and position it onto the pre-installed foundation. (Can typically be done by vessels that service other sectors).	Sheerleg crane vessels Barges HLVs Semisubmersible vessels Construction support vessels
	Subsea Cable installation	Vessels that lay the inter-array which connects the substation to the turbines as well as the export cable to grid; vessels that lay protective coverings to secure cables to the seabed	Specialty cable lay vessel; multipurpose supply vessel (MPSV) with carousel Construction support vessels
	Turbine installation	Vessels that transport the turbines and – for fixed-bottom turbines – mount them onto the foundation. Methods for installation vary according to substructure type, the turbine supplier and relative size of the WTG and vessel. Fixed-bottom installation is typically undertaken by jack-up vessels such as *WTIVs* due to the need for a stable platform. Floating turbines are pre-assembled in a port area and then transported to the installation site using *long-haul tugs* and *anchor-handling tug supply* (AHTS) vessels	WTIV (fixed-bottom substructures) Long-haul tug boats (floating substructures) AHTS vessels (floating substructures) Semisubmersible vessel (floating substructure) Construction support vessel
Post-construction	O&M	Vessels that provide regular maintenance and servicing to the wind turbines and cables once in operation	WTIV Jack-up barge Service Operation Vessels (SOVs) Crew Transfer Vessels (CTVs)
	Removal	Vessels that remove the WTGs, foundations, substation and cables upon decommissioning of the OWP facility	Heavy lift vessel WTIVs CTVs

Source: BVG Associates (2019).

Because of their limited global supply and technical capabilities tailored for the OWP sector, WTIVs and cable-laying vessels (CLVs) are often considered the most likely to lead to bottlenecks during the construction process and are, therefore, the primary focus of the subsequent analysis. WTIVs, in particular, have become the preferred sector solution for fixed-bottom turbine installation given the significant efficiency gains provided through their ability to reduce installation time and handle multiple tasks (thereby eliminating the need to contract multiple vessels).[15] Because WTGs continue to increase in size (Figure 4), greater demand is, in turn, placed on developing new vessels that can accommodate the greater crane hook height and lifting needs.[16]

Figure 4. Trends in turbine capacity (2001-2026)



Source: Re-printed from Musial et al. (2021).

3.2. Inventory of OWP vessels in Japan

The Japanese fleet of WTIVs and CLVs is shown in Table 3.[17] This includes all known vessels currently in operation as well as those under construction or in the process of reflagging (from a foreign flag to Japanese flag). A review of this inventory and consultation with industry experts suggests Japan's fleet of CLVs – including those under development – are relatively likely sufficient to meet Japan's future demand. That said, this is of course dependent upon whether these CLVs will be delivered to market on time and some uncertainty remains and careful monitoring of progress with CLV construction is prudent. Because of the anticipated higher likelihood of a supply shortage, the analysis in the following sections focuses on WTIVs.

[15] Lisne (2021)

[16] Although WTIVs are not needed for FOW installation, the expected continued dominance of fixed-bottom installations over the medium-term implies that their supply will remain a salient issue over the coming years.

[17] The approach used for identifying these vessels is described in the methodological appendix provided in Section 6.

Table 3. Japanese WTIVs and CLVs (in operation, under construction, or in reflagging process)

WTIVs				**CLVs**		
Name	**Owner**	**Status**	**WTG installation capacity**	**Name**	**Owner**	**Status**
CP-8001	Penta-Ocean Construction	In operation	10 MW	TBD	Toyo Construction	TBD
CP-16001	Penta-Ocean Construction	In operation	12 MW	TBD	Sumitomo & Seaway7 (JV)	TBD
Seajacks Zaratan	Seajacks Japan LLC (Eneti)†	In operation	10 MW	TBD	Penta Ocean	TBD
TBD	Shimizu Corporation	Delivery in 2022*	15 MW			
TBD	Obayashi Corp. & Toa Construction	Delivery in 2023*	10 MW			
Sea Challenger	Penta-Ocean & DEME (JV)‡	Delivery in 2025*	12 MW*			
TBD	NYK & Van Oord‡	Delivery 2028*	12 MW*			

* Denotes assumed values based on expert consultations and press reports; † denotes reflagged vessel; ‡ denotes vessel in the process of reflagging
Source: Press reports and publicly available vessel specification sheets; offshoreWIND.biz (2022); 4C Offshore (2022a & 2022b).

Able to operate in depths of up to 65 metres and equipped with a powerful crane with a maximum lift capacity of 2500 tonnes that can reach 158 metres in height, the Shimizu vessel is anticipated to become one of the world's most advanced WTIVs once delivered (expected October 2022), capable of transporting and installing next generation fixed-bottom turbines up to 15 MW as well as their foundations.[18]

In addition, it is noteworthy that Japan's fleet of WTIVs is anticipated to feature at least three foreign vessels reflagged to service the Japanese OWP market. This includes the *Seajacks Zaratan* vessel that was reflagged by the Monaco-headquartered firm Eneti in 2021 and currently operating in the Japanese market;[19] DEME's *Sea Challenger* (based in Belgium) that is currently in the process of reflagging to Japan through a joint venture with the Japanese company Penta-Ocean Construction (expected to be completed in 2025);[20] and a presently unnamed WTIV owned by the Dutch company Van Oord that will be reflagged in partnership with the Japanese firm NYK Lines (expected to be completed in 2028).[21]

3.3. Assessment of Japan's WTIV supply and demand between 2022-2040

To estimate the expected supply and demand of vessels related to OWP construction in Japan, we used the following approach, which is described in greater detail in the methodological appendix provided in Section 6.

First, estimates of Japan's future offshore wind development were derived from a combination of annual projections by WoodMacKenzie (Diao, 2021) and the Carbon Trust (2020) and GOJ targets for the period

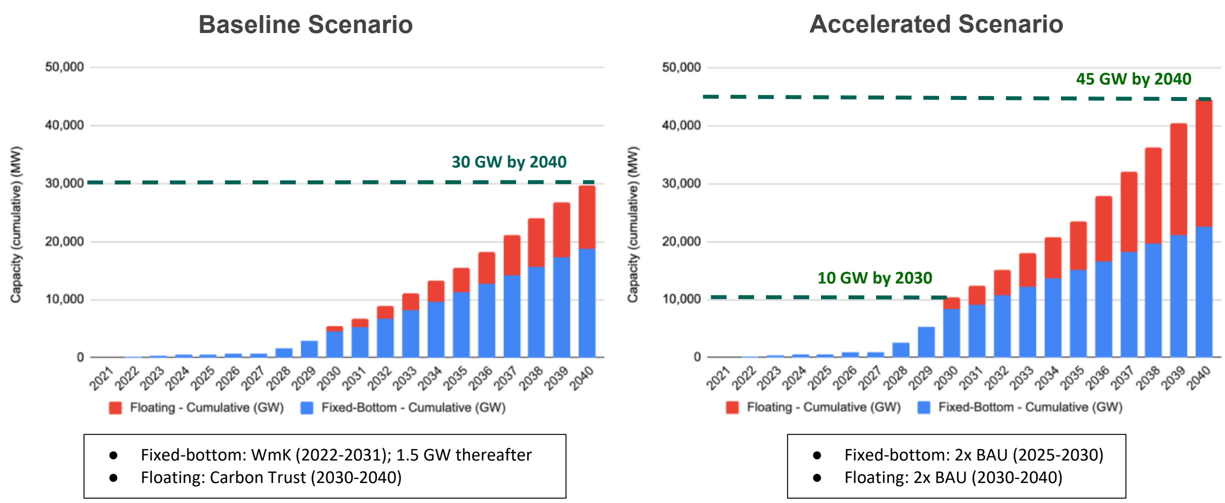
[18] Shimizu (2019); Cadeler (2020)
[19] Eneti (2020)
[20] Durakovic (2021)
[21] NYK (2020)

2022-2040. These, in turn, were used to construct two deployment scenarios that represent a possible range of outcomes from Japan's OWP targets:

- a **Baseline Scenario**, which assumes that Japan constructs 5.5 GW of new offshore wind capacity by 2030 (short of its 10 GW target) and 30 GW by 2040 (the lower-bound range of its 2040 target); and
- an **Accelerated Scenario**, which assumes that Japan develops 10 GW by 2030 and 45 GW by 2040 (the upper-bound range of its 2040 target).

Across both scenarios, it is assumed that floating OWP substructures attain commercial-scale deployment in Japan from 2030 onwards. The annual and cumulative installation under both scenarios – both from fixed-bottom and floating sources is shown in Figure 5.

Figure 5. Japan's projected OWP development under the Baseline and Accelerated scenarios



Source: WoodMacKenzie [WmK] (Diao, 2022) and Carbon Trust (2020).

Second, the annual installation capacity (in MW) of each WTIV identified in Table 3 has been calculated using Equation 1 in the methodological appendix and applying the following assumptions that were derived through expert consultation and a review of relevant literature:

i) that construction activities in Japan are limited to 7 months per year;[22]
ii) that the maximum turbine sizes that will be installed over the study's period of analysis are 9.5 MW from 2022 to 2027; 12 MW from 2028 to 2030; and 15 MW from 2031 to 2040;[23]

[22] Expert feedback indicates that construction activities are typically very limited during Japan's typhoon season (approximately September-November) and in the winter months. While the severity and timing of these constraints may differ by location, the study applies a standard 7-month construction season for all OWP construction due to the lack of precise information on future OWP development.

[23] Recent tender results have revealed that the Mitsubishi-led consortia intend to use GE's Haliade-X turbines with a rating of 12.6 MW (the largest typhoon-rated turbine currently available in markets) on their projects that will become operational over the period 2028-2030. Prior to this period, there is no indication that any of the OWP projects in Japan's pipeline will be installing turbines larger than 9.6 MW in size. Assumptions regarding the deployment of 15 MW WTGs are in line with wider industry expectations pursuant to the envisaged timeline for when these next generation turbines will become widely available.

iii) that the time required to install an individual turbine will range from 2 to 4 days on average;[24]
iv) that future vessels under construction or in the process of reflagging will be delivered to the Japanese market in the year currently projected while those in operation will not undergo upgrades that would allow them to install larger WTGs than currently possible;[25] and
v) that all vessels identified and in operation will be available when needed and are not scheduled for other activities (e.g., outside of Japan or the OWP sector).

As variation in turbine installation time could significantly impact the estimates for supply, each market development scenario is assessed separately under the assumption that each WTG requires, respectively, two and four days to install. This results in the annual WTIV installation capacities shown in Table 4.

Table 4. WTIV installation capacity, by period and installation time

Period	Assumed WTG rating	**Annual vessel installation capacity (MW)**	
		2-day installation period	4-day installation period
2022-2027	9.5 MW	1,011	506
2028-2030	12 MW	1,278	639
2031-2040	15 MW	1,597	798

Source: Author's estimates

Vessel demand for each year is calculated by taking that year's estimated annual fixed-bottom deployment volume (represented in Figure 5) and dividing it by the vessel installation capacities provided in Table 4. These estimates are then rounded up to the nearest integer and plotted against the available supply of vessels (Table 3) to derive vessel demand, supply, and any resulting deficit (

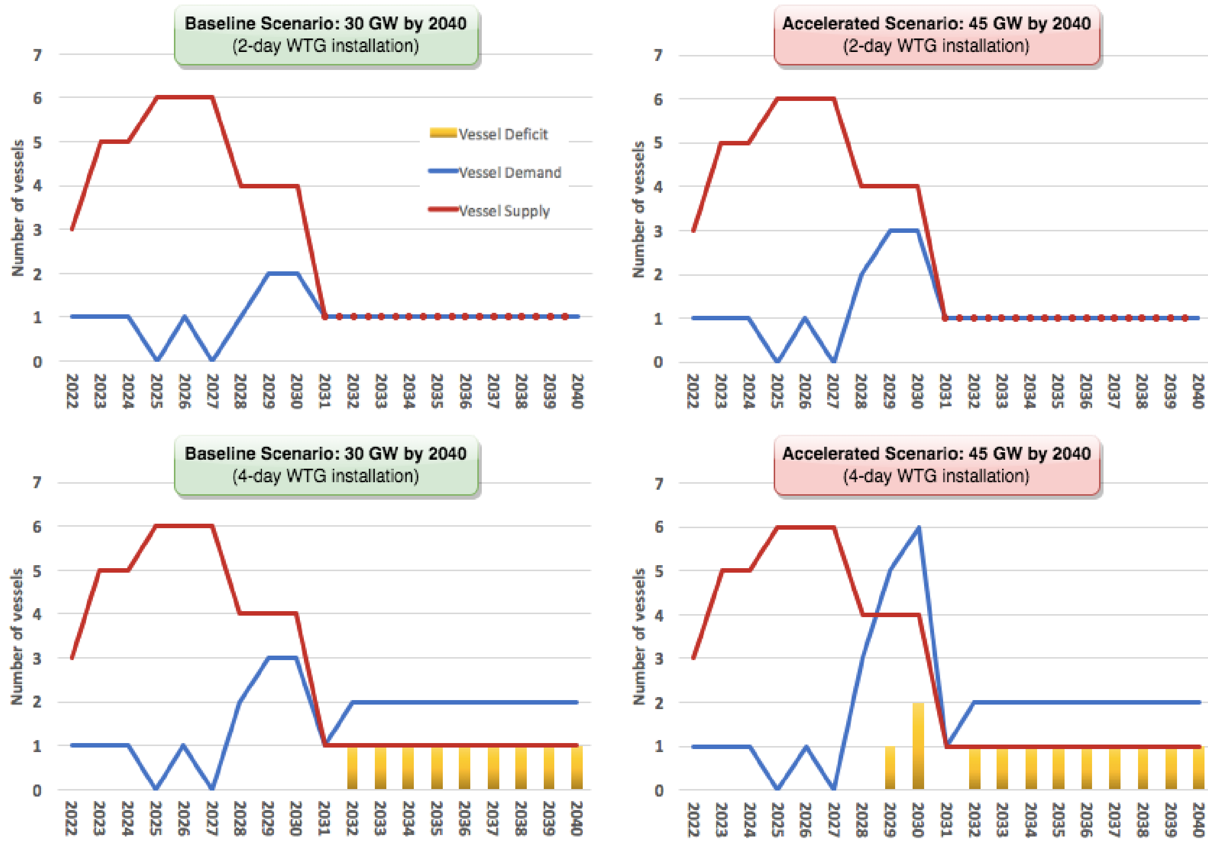
Figure **6**).[26]

Figure 6. Supply and demand for WTIVs in Japan's offshore wind sector, 2022-2040

[24] Experts interviewed during the study suggest that an average of 2-3 days are likely to be needed to install a single turbine or foundation in Japan, but that this may vary due to a range of factors such as, e.g., distance from shore, turbine and foundation size, vessel deck space and weather conditions. This estimate is largely consistent with values used in other analyses. Blocket et al. (2021), for example, use an estimate of 2 days for installation of fixed-bottom WTGs in the United States, while Shields et al. (2022) estimate that installation of an individual WTG/foundation requires 36 hours. BVG Associates (2019), provide an estimated range 1-4 days for turbine installation.

[25] Unless proposed upgrades have already been announced [i.e., in the case of the Sea Challenger that is undergoing reflagging procedures and already declared that it will upgrade its crane before entry (See, e.g., Durakovic, 2021)]. In principle, vessels can invest in upgrades to their cranes that would allow them to potentially install larger turbines. In practice, however, the extent of these upgrades is limited and often less optimal than new vessel construction that could allow for additional improvements to other important features such as deck space and operational depth.

[26] Vessel supply is constrained by a vessel's projected operational date and the WTG size expected to be installed in a given year. For example, if 12 MW turbines are expected to be installed in a given year, those WTIVs unable to install WTGs larger than 10 MW are excluded from the available vessel supply.



Source: Author's estimates

The extent to which the fleet of Japanese-flagged WTIVs is sufficient for meeting the country's demand varies according to the scale and speed of Japan's offshore wind development and, in particular, the time required for turbine installation. Prior to 2032, it is projected that the Japanese vessel fleet is likely sufficient for meeting demand, though this is contingent on two outcomes: i) the identified foreign-flagged WTIVs successfully completing the reflagging process and entering the market as scheduled; and ii) installation duration that, on average, require only two-days per turbine and foundation, respectively. The duration of installation in Japan is complicated by non-homogenous soils (including silt, sand, and rock) and seismic activity. While uncertainty remains as to how significant of a challenge this presents for OWP installation in different regions of Japan, there is some chance that the time for surveying and installation and the weight of foundations (i.e., resulting in different requirements for installation equipment and vessel choice) might exceed those common in other offshore wind markets and that heavier foundations might be needed. Further, the crewing of OWP vessels with Japanese nationals that have dedicated training and experience is severely limited and insufficient. Given the global demand for experienced crews and if not addressed, the crewing of vessels (even if available in sufficient supply) could result in a severe bottleneck, project delays and a higher risk of installation in Japan.

If these two conditions cannot be met, Japan would be exposed to a potential WTIV supply shortage. This is likely possible after 2030, when Japan is reliant on a single WTIV capable for the likely installation of

15-MW turbines and large monopiles.[27] Rather, it is likely that at least 2-3 WTIVs are needed in the 2030s to install 15-MW+ turbines to serve demand, particularly if there are years with deployment that exceeds 1,500 MW.[28] A shortage of WTIVs can result in major delays of project commencement because of the average construction time of approximately 3 years (in addition to the time needed for vessel design, planning and financing).[29] Although there is still time to increase supply by constructing or reflagging additional vessels, a shortage of WTIVs could lead to significant construction delays and associated cost overruns. Such an outcome could, in turn, undermine GOJ's goal of accelerating commercial operation dates.

3.4. The global supply of WTIVs

In response to potential shortage of WTIVs, Japan could seek to increase the number of foreign-flagged vessels entering the market. Towards this end, Table 5 provides an inventory of the global supply of WTIVs (in operation and under construction) that are capable of installing turbines with a rating of 10 MW and greater. As demonstrated, European operators maintain a dominant position within the industry – with nearly 60 percent of all vessels EU-owned or -flagged (excluding vessels from China).[30]

Table 5. Global fleet of WTIVs considered capable of installing WTGs ≥10 MW (excluding China and Japan)

Vessel Name	Operator	Country	Flag	Max lift (t)	Max hook height (m)	WTG install capacity	Status	Expected delivery
MPI Adventure	Van Oord	Netherlands	Netherlands	1,000	105	10 MW	In operation	-
Wind Enterprise	Ziton A/S	Denmark	Denmark	1,000	102	10 MW	In operation	-
Blue Tern	Fred Olsen Windcarrier	Norway	Malta	1,200	127	10 MW	In operation	-
Innovation	GeoSea (DEME)	Belgium	Germany	1,500	122.5	10 MW	In operation	-
Vole au vent	Jan De Nul	Belgium	Luxembourg	1,500	115	10 MW	In operation	-
Aeolus	Van Oord	Netherlands	Netherlands	1,600	130	10 MW	In operation	-
Seajacks Scylla	Eneti	Monaco	Panama	1,500	132	10 MW	In operation	-
Sea Installer	GeoSea (DEME)	Belgium	Denmark	1,600	159	12 MW	In operation	-

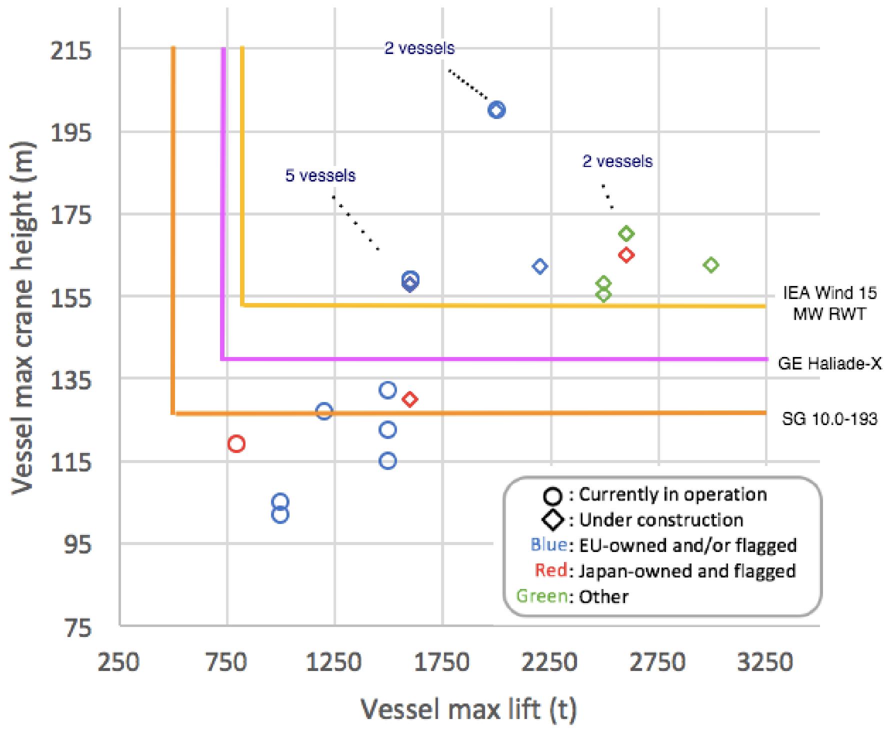
[27] Although a deficit is only projected in the 4-day turbine installation scenarios, additional calculations show that a deficit would also arise from 2032-2040 in both scenarios if the installation period were increased to an average of only 2.5 days.
[28] In the formal WTIV demand-supply analysis, a constant installation capacity of 1,500 MW (Baseline Scenario) and twice the BAU scenario (Accelerated Scenario) after 2030 was assumed because not much is about the annual installation capacity. While the formal analysis suggests the need for one WTIV after 2030, we indicate here that 2-3 WTIVs are likely to be needed because of fluctuations in annual installations in any single year. While this would suggest a shortfall, we acknowledge that there is also still sufficient time for the procurement and construction of additional WTIVs to be placed in service by 2030 to service demand.
[29] Shields et al. (2022).
[30] Assessments of global WTIV supply generally compile lists separately for China and the rest of the world as the latter is effectively considered a closed market.

Bold Tern	Fred Olsen Windcarrier	Norway	Malta	1,600	157.5	15 MW	Upgrading	2022
Voltaire	Jan De Nul	Belgium	Luxembourg	3,000	162.5	15 MW	Under construction	2022
TBD	OIM Wind	Norway	NIS or US Coast Guard	2,600	165	15 MW	Under construction	2022
Seaway Ventus	Seaway 7 ASA	Norway	tbd	2,500	155.4	15 MW	Under construction	2023
Charybdis	Consortium led by Dominion Energy	USA	USA	2,200	162	15 MW	Under construction	2023 (Q4)
Brave Tern	Fred Olsen Windcarrier	Norway	Malta	1,600	157.5	15 MW	Upgrading	2024
Name TBD	Havfram	Norway	tbd	tbc	150	20 MW	Under construction	2024
Name TBD	Havfram	Norway	tbd	tbc	150	20 MW	Under construction	2024
Name TBD	Van Oord	Netherlands	Netherlands	3000	tbc	20 MW	Under construction	2024
Wind Orca	Cadeler	Denmark	Denmark	1600	159	15 MW	Upgrading	2024 (Q1)
Wind Osprey	Cadeler	Denmark	Denmark	1600	159	15 MW	Upgrading	2024 (Q1)
Name TBD	Cadeler	Denmark	tbd	2000	200	20 MW	Under construction	2024 (Q3)
Name TBD	Eneti	Monaco	tbd	2600	170	15 MW	Under construction	2024 (Q3)
name TBD	Maersk Supply Service	Denmark	tbd	tbc	tbc	15 MW	Under construction	2025
Name TBD	Cadeler	Denmark	tbd	2000	200	20 MW	Under construction	2025 (Q1)
Name TBD	Eneti	Monaco	tbd	2600	170	15 MW	Under construction	2025 (Q2)
Name TBD	Cadeler	Denmark	tbd	tbc	tbc	20 MW	Under construction	2026

Source: Press releases and publicly available vessel spec sheets; offshoreWIND.biz (2022); 4C Offshore (2022a).

While a range of factors are relevant to WTIV choice, two critical dimensions are the vessel's crane height and maximum lift capacity, which indicate its ability to install different turbine sizes.
Figure 7 highlights the limited number of existing and planned vessels that are capable of installing next generation turbines. Although the Shimizu vessel will be one of the few vessels capable of installing WTGs in excess of 12 MW, the majority of these WTIVs are EU-owned or flagged.

Figure 7. Global WTIV fleet (excluding China), by WTG installation capacity & ownership



Source: Adapted from Musial et al. (2020).
*Note: Three EU vessels capable of installing WTGs ≥ 15MW that are currently under construction have been excluded from this chart because hook-heights have not yet been announced.

4. Restrictions related to maritime cabotage and reflagging

Although EU vessels are well-positioned to support Japanese OWP development and compensate for any shortages in supply, their ability to do so is obstructed by the presence of laws that restrict coastal shipping to Japanese-flagged vessels. This section provides an overview of Japan's legal framework related to this practice (including the rules for reflagging) and compares this to cabotage provisions in the EU.

4.1. General intent and purpose of cabotage

Maritime cabotage (also referred to as coastal shipping) refers to the transport of passengers and goods between two seaports that are located in the same country.[31] These services are generally excluded from trade liberalisation commitments and most countries maintain laws that reserve provision of cabotage to vessels that meet specific nationality requirements – i.e., vessels that are domestically-owned, -flagged, and/or crewed by nationally-licensed seafarers.

The motivations underlying cabotage typically include:

[31] UNCTAD (2017)

- National security concerns (e.g., maintaining a domestic-ship building industry and ensuring access to shipments of strategic goods during times of conflict and natural disasters);
- Economic objectives (e.g., facilitating international trade, improving a nation's balance-of-payments and shielding the local shipping industry from competition); and
- Socio-economic objectives (e.g., promoting employment of local seafarers, maintaining labour standards, and ensuring provision of service routes to isolated and underserved locations).

Depending on a country's specific rules related to cabotage, these restrictions can also apply to the offshore wind sector, limiting the ability of foreign vessels to engage in construction, operation and maintenance activities of OWP facilities. Offshore wind farms located in a country's territorial waters, for example, may legally be classified as domestic ports, making the transfer of turbines, cables, crew and other materials from the mainland subject to cabotage rules.

4.2. Maritime cabotage rules and restrictions in Japan

Under Article 3 of the Ships Act (Act No. 46 of 1899, rev. 1991), only Japanese-flagged vessels are permitted to call at closed ports or perform cabotage of goods and passengers.[32] With the MLIT designating an OWP facility in Japan's territorial waters as a "closed port", all foreign-flagged vessels are effectively barred from engaging in Japan's offshore wind sector unless opting to go through the process of reflagging (described in Section 4.3).[33]

While Article 3 of the Ships Act allows foreign vessels to engage in cabotage provided they apply for and receive 'Special Permission' (特許) from the MLIT, the rules governing this process lack clarity. Article 3.2 of the *Ordinance for Enforcement of the Ship Act* provides that when a person (i.e., an applicant) intends to obtain Special Permission, it shall submit an application to the competent maritime authority.[34] As described in the official guidance published by the MLIT (the 'Guidance for Special Permission'),[35] when a person (an applicant) intends to obtain Special Permission to call at a 'closed port' in Japan, it shall submit the application together with required documents to the competent maritime authority (i.e. the regional transport bureau or the MLIT) no later than one week prior to the date at which it plans to call at the 'closed port'.

The Guidance for Special Permission lists a certificate of vessel's nationality (*senpaku kokuseki shousho*) as the required document to be attached to the application. Inquiries placed with MLIT additionally suggest that the applicant should submit a list of cargo and crew on board the vessel. In practice, however, the documents that should be submitted together with the application largely depend on the specific facts of the case, including, among others, the type of the vessel, the business plan to be carried out by such vessel, whether the foreign-flag vessel can be substituted by a Japan-flag vessel for such transportation, as well as history of marine transportation in a foreign country carried out by the

[32] Ships Act, Article 3. A 'port call' refers to the certified arrival of a vessel at a Japanese maritime port. In Japan, ports may be classified as being either open or closed, with only Japanese-flagged vessels permitted to call at closed ports.
[33] Baker McKenzie (2019)
[34] With respect to a 'closed port', the regional transport bureau (*chihou unyu kyokucho*) which has jurisdiction over such 'closed port' should be the competent maritime authority. If there are multiple jurisdictions over the 'closed port', it shall be the International Shipping Division of the Maritime Bureau of the MLIT.
[35] Available (in Japanese) via: https://www.mlit.go.jp/onestop/031/images/031-015.pdf. Inquiries placed with the MLIT indicate that no other officially published material related to cabotage regulations exist other than the Guidance for the Special Permission.

applicant. These ambiguities make it important for an applicant to confirm all requirements with the competent maritime authority through prior consultation before making the formal application.

Although the Guidance for Special Permission states that the competent official will make efforts to issue a decision within two weeks following submission,[36] inquiries with the MLIT suggest that the process of prior consultations will generally take several months to complete. These dates are not binding and the process related to OWP vessels is further complicated by the lack of experience in dealing with such cases.[37]

Once received, Special Permission applications will be decided on a case-by-case basis and will be at the sole discretion of the MLIT. In connection with this, the Guidance for Special Permission states that its decision will be based on the following criteria: (a) that the foreign-flagged vessel's transportation between ports or calling at a closed port would not cause any hindrance to secure and stable transport in Japan; (b) that the foreign-flagged vessel's transportation between ports or calling at a closed port would not cause any hindrance to the transportation of goods and passengers by Japanese maritime operators; and (c) that the foreign-flagged vessel's transportation between ports or calling at a closed port would not violate any other laws and regulations. In practice, however, the case-by-case nature of these evaluations leads the MLIT to rely on additional criteria. These may include:

i) whether a Japanese-flagged vessel is able to perform the cabotage services for which special permission has been requested;
ii) the risks associated with over-reliance on foreign-flagged vessels to provide the service in question; and
iii) the potential impacts on Japanese operators that may arise from either granting or failing to grant special permission.

The issue, however, is that seemingly no formal rules have been established as to how these criteria are applied and evaluated and about the duration for evaluation. This lack of transparency makes it challenging for potential applicants to predict whether their requests will be granted; increases uncertainty for firms during the OWP support regime tendering process; and provides the MLIT with broad discretionary authority that could, in principle, be applied in a manner that discriminates against foreign firms seeking to enter the Japanese OWP market.

Inquiries made to the MLIT regarding how these items are evaluated, moreover, suggest that evaluations are made with respect to the situation *as it exists at the date of commencement* of the cabotage services. This effectively makes it impossible for specialised OWP vessels such as WTIVs to obtain Special Permission since there is a practical necessity to make arrangements well in advance of the expected commencement of work. To this end, the official of the MLIT consulted asserted that the timing could not be brought forward since the competent maritime authority must base its determination on granting Special Permission according to the circumstances that exist at the date for when the OWP-related work will commence.

[36] The Guidelines for Special Permission note that efforts will be made to rule on an application within 1 week for vessels calling at a 'closed port' in Japan or 2 weeks for vessels carrying out transportation of cargo or passengers between 'ports' in Japan.
[37] Though difficult to predict, we expect that the overall process could take six months to a year to complete and could vary according to the individual interpretations of the maritime authority handling the application.

4.3. Vessel flagging rules and re-flagging procedures in Japan

In the absence of special permission to engage in cabotage, foreign vessels seeking to enter the Japanese OWP market would be required to undergo reflagging procedures. This requires that a vessel be Japanese-owned and -registered as well as crewed by Japanese-licensed seafarers.[38] As described in the Text Box 1, it is estimated that this process takes more than a year for a WTIV to complete due to the various number of inspections required as well as the Marine Bureau's limited experience with reflagging specialised WTIVs.[39]

From an EU perspective, reflagging in Japan involves considerable risk. This is due both to the costs and time involved in changing a ship's flag and registration, as well as the requirements to staff the vessel's crew with Japanese-licensed seafarers. According to industry representatives, this latter issue is particularly problematic. Not only does this increase operating costs, but it also exposes operators to potential staffing shortages since the supply of Japanese seafarers trained to operate and crew WTIVs is several limited and insufficient currently.[40] This is exacerbated by the fact that there is only one Global Wind Organization (GWO) training centre for OWP in Japan.[41]

Despite the difficulties and risks encountered in the process, it should, however, be noted that reflagging is possible and has been pursued by several foreign OWP operators. Eneti, for example, has already successfully reflagged its WTIV *Seajacks Zaratan*, while Belgium's DEME Group and the Netherlands' Van Oord have each initiated the process to reflag one of their WTIVs to enter the Japanese market.[42] In most cases, these operators have established a partnership with a local company to jointly explore opportunities in the Japanese OWP market and concluded agreements to transfer a 51 percent equity stake while leaving vessel staffing responsibilities and reflagging procedures to the Japanese partner.[43]

Box 1. Procedural requirements for reflagging a vessel in Japan[44]

According to the MLIT's Inspection and Measurement Division of the Marine Bureau, the reflagging process in Japan requires:

a) registration and measurement of the foreign vessel in accordance with the Ships Act
b) vessel inspection to ensure compliance with all relevant standards set forth in, *inter alia*, the Ship Safety Law (Art. 32) and the Law Concerning Prevention of Marine Pollution and Maritime Disasters

[38] Article 1 of the Ships Act specifies that a Japanese vessel's owner must be (i) a Japanese authority; (ii) a Japanese citizen; (iii) a company incorporated under the law of Japan with all its representatives and at least 2/3 of its executive officers being Japanese nationals; or (iv) an entity other than a company as described in point (iii) all of whose representatives are Japanese nationals.
[39] Stakeholder consultation feedback
[40] RWE Renewables Japan (2021).
[41] RWE Renewables Japan (2021). Note that this Training Center is target towards offshore wind professionals and it is not clear whether this specifically also includes vessel crews.
[42] DEME has announced that it will reflag its vessel *Sea Challenger* and will undergo a crane upgrade (Durakovic, 2021). Van Oord has not publicly announced which of its vessels will undergo the reflagging process (NYK, 2020).
[43] DEME and Van Oord have respectively partnered with Penta-Ocean and NYK Lines. While unclear, the Monaco-headquartered Eneti appears to have maintained full control over its vessel by transferring ownership to its Japanese subsidiary 'Seajacks 3 Japan LLC' (Eneti, 2020).
[44] MLIT (2022)

a) Registration and measurement

To satisfy requirements related to vessel registration and measurement, the following documents must be submitted to the Maritime Bureau that has jurisdiction over the vessel's port of registry[45]:

- application for measurement of the vessel's total tonnage
- application for vessel number/signal code for unregistered vessels
- application for issuance of the international tonnage certificate
- all relevant ship drawings and diagrams that detail, *inter alia*, the ship hull dimensions (or table of offsets), the general arrangement, the central sectional view, the construction profile and plan, and maps of the upper section

Additionally, an on-site measurement will be conducted to confirm the size of the vessel and its total tonnage.

b) Vessel inspection

As a part of the vessel inspection process, the applicant must submit:

- applications for issuance of all required vessel inspection certificates (submitted to the Maritime Bureau that has jurisdiction over the vessel's location), including all requested diagrams and specifications related to ship dimension/layout and equipment
- The list of stores and equipment on board (submitted to the Maritime Bureau's Inspection and Measurement Division)

The inspection will consist of a review of the vessel's submitted drawings to verify that the layout complies with relevant technical and safety standards. In the inspection of the vessel stores and equipment, the analysis will focus on whether the installed equipment meets the relevant technical standards. The responsible authority will also conduct an on-site inspection of the vessel to determine that it meets all required technical standards and that all installed equipment meets the relevant safety standards. Where a vessel is seeking industrial classification, the inspections are conducted by the relevant ship classification society.

Following approval of the above applications and inspections (and once vessel ownership has been transferred to a qualifying Japanese entity), the vessel will be registered with the Ministry of Justice and entered into the ship registry by the Maritime Bureau of the MLIT. The following documents will then be issued:

- Vessel Nationality Certificate
- International Tonnage Certificate
- Vessel Inspection Certificate
- Vessel Inspection Ledger
- Certificate for international treaties

[45] i.e., the regional transport bureau in general practice

The reflagging procedure is estimated to take 3-4 months for common vessels (such as a regular freighter) and more than 1 year for speciality vessels such as a WTIV. The fees are ¥1 million (€7,440) (not including the registration tax).

4.4. Maritime cabotage in the EU

Under Regulation 3557/92 ('the EU cabotage rules'), cabotage was liberalised across the EU in 1993. As a result, vessels that are registered in and flying the flag of any EU Member State are free to engage in cabotage services in any other Member State.[46] This applies to work related to OWP which is classified as an 'off-shore supply service' under the EU cabotage rules.[47]

Cabotage rules related to non-EU-flagged vessels, by contrast, are determined by individual Member States and the level of access afforded to these vessels varies. Some Member States, for example, permit foreign-flagged vessels to perform cabotage services within their territorial waters without limitation while others maintain some form of restriction.

Among Member States that restrict foreign provision of cabotage services, however, several notable differences exist in comparison to Japan. Unlike in Japan, for example, the EU does not impose domestic ownership requirements on foreign-vessels as part of the reflagging process. This implies that a foreign vessel that reflags to the EU would be able to perform cabotage services across the entire EU market without relinquishing ownership to a domestic entity given the internal liberalisation afforded by the EU cabotage rules.[48]

In instances where cabotage restrictions do exist, it is generally the case that these are less restrictive than Japan. Germany, as an example, places general cabotage restrictions on non-EU vessels (with the exception of Norway), but waives all restrictions related to shipments of goods or passengers from a German port to an offshore area located outside of its coastal waters (i.e., for any maritime area located more than 12 nautical miles from the German coastline). In instances where cabotage restrictions apply (such as in the case of an offshore wind farm located within coastal waters), vessels can seek a waiver – either for a single voyage or annually – through an easily accessible and straightforward online application (or via email). Decisions related to this request are made within 5 working days and based on clearly defined criteria. Specifically, the competent authority[49] shall base their decision on an assessment of whether the service could alternatively be carried out by an EU-flagged vessel (the so-called 'shipping space capacity verification' criterion). Procedurally, this assessment is made by reviewing an online portal where EU-flagged vessels can register their interest to transport the goods or services for which the cabotage waiver is being requested. If no such interest is expressed by an EU-flagged vessel, the cabotage waiver request will be approved.[50]

---

[46] The EU cabotage rules went into full effect in 2000 pursuant to adjustment periods afforded to certain services and Member States.

[47] Within the EU cabotage rules, offshore supply services are defined as 'the carriage of passengers or goods by sea between any port in a Member State and installations of structures situation on the continental shelf of that Member State'.

[48] Among EU Member States, there are several flag-of-convenience countries (i.e., Cyprus and Malta), which maintain open registries that allow ship owners to flag their ship in that nation while providing lower taxes and less stringent regulations on local ownership or nationality requirements of crew members.

[49] Generaldirektion Wasserstraßen und Schiffahrt (GDWS)

[50] https://www.deutsche-flagge.de/en/german-flag/cabotage-equivalence/cabotage/cabotage

In comparing the case of Germany with Japan, both countries maintain restrictions on the provision of cabotage services by foreign-flagged vessels while also permitting these vessels to apply for waivers to this restriction. Moreover, in both countries these waiver requests are evaluated – at least partially – according to extent that the cabotage can alternatively be provided by a domestically-flagged vessel. However, whereas Japan fails to clearly define the criteria used in making this determination, Germany seems to have established relatively clear and objective rules related to its evaluation process. Japan might benefit from adopting similar procedures to those utilized in Germany for the issuing of waivers that enhance the transparency and planning certainty to ensure an adequate and timely supply of vessel solutions.

5. Implications and recommendations

Japan's restrictions on cabotage have a number of implications. For EU OWP vessel owners and operators, these restrictions effectively require that they reflag the vessel to comply with the Ships Act.[51] Although reflagging is possible, the process imposes significant challenges on EU operators in the form of:

i) lengthy time requirements to complete the process (in excess of one year);
ii) equity requirements that require owners to transfer a majority stake in the vessel to a Japanese partner; and
iii) requirements to employ seafarers that are Japanese nationals and Japanese-licensed (who may be limited in number given bottlenecks in globally accredited training programmes for OWP personnel).

These challenges might deter EU firms from participating in the Japanese OWP market. Ultimately, the limited flexibility in using foreign-flagged vessels could result in higher OWP costs (and tender prices) for Japanese rate payers and a delay when GOJ's offshore wind and renewables targets will be met. While the analysis in Section 3.3 suggests that Japan's projected fleet of WTIVs could be sufficient for meeting demand over the coming decade, the available supply poses a risk by limiting the rate (e.g., MW/year) at which Japan is able to expand its OWP capacity. In the 2030's it is likely that at least 2-3 additional WTIVs equipped to handle 15-MW+ turbines and foundations are needed. The potential vessel shortage could be further exacerbated by the continued upscaling trend in WTGs and the limited supply of vessels globally that are equipped to handle the latest WTG rating. Only the Shimizu vessel seems equipped for the installation of turbines with a rating of 15 MW (and perhaps larger) and foundations, once constructed. Even in the rather unlikely event that a single WTIV is sufficient for meeting Japan's OWP development needs in the future, reliance on a single vessel would expose the sector to greater risk of construction delays while also subjecting developers to the perils of limited competition in the vessel supply market.

Under consideration of the long lead-times in planning and constructing some of the world's largest vessels, it seems prudent to consider future vessel demand and anticipated supply carefully. Establishing a more transparent and predictable regulatory environment that improves market access for foreign

[51] Alternative approaches such as the "Vineyard Model" used by EU vessels as a means of operating in the US Market due to restrictions under the Jones Act are not possible in Japan. This is due to the *Law Concerning Navigation of Foreign Vessels* (Act No. 64 of 2008), which places general restrictions on the operation of foreign vessels in Japanese territorial waters without MLIT consent. While approval is possible for foreign-flagged surveying vessels, similar allowances have not been formally promulgated related to OWP construction and O&M activities.

entities to support the Japanese OWP market could be a viable strategy to ensure Japan's continued OWP and renewables expansion.[52]

Recommendations

We make a few recommendations on cabotage provisions in Japan's OWP sector. These have been informed by a review of cabotage regulations in Japan and Europe, press reporting on the Japanese OWP market, and a limited set of interviews with European offshore wind sector participants in the Japanese market:

- *Remove restrictions on cabotage for offshore wind-related services*. To ensure the continued and uninterrupted supply of vessels critical to the construction, operation and maintenance of OWP facilities in Japan, GOJ could consider improving market access for foreign-flagged vessels. An option to accomplish this effectively would be to remove the restrictions related to cabotage – either by expressly exempting OWP-related services from cabotage restrictions; classifying OWP sites as 'open ports'; or by designating OWP promotional areas as special economic zones – similar to Okinawa – wherein cabotage rules are liberalised. The Japanese market already has a competitive disadvantage compared to other global OWP markets because of (among others) smaller project sizes, regulatory uncertainty, and an insufficient port and marshalling area. Alleviating the concern around sufficient OWP vessel supply might increase the confidence and investments made by domestic and foreign companies into the Japanese OWP sector.

- *Clarify the rules regarding 'Special Permission' to engage in cabotage*. In the absence of a removal of cabotage restrictions for OWP-related services, MLIT could consider clarifying the rules for evaluating applications for Special Permission to engage in cabotage and more clearly define the criteria upon which their decisions are based. In this respect, MLIT could consider the provisions that are utilised in Germany (Section 4.4), which is characterised by the following features:

    - Accessibility – the German government provides an online application with minimal requirements available in English
    - Specificity – the circumstances under which an application is required are clearly specified
    - Flexibility – applications can be requested for a single voyage or for the remainder of the calendar year and are renewable
    - Objectivity – the criteria for evaluating an application are defined and objectively measured (i.e., the 'shipping space capacity verification')
    - Predictability – the application response time is clearly established and limited in duration, with officials required to respond within 5 working days

  While MLIT has some discretionary power in whether these criteria are met by an application, we highlight that its practice of assessing these criteria only on a case-by-case basis and without clearly making available details on how the criteria can successfully be met, seemingly results in EU operators not regarding the 'Special Permission' as a viable pathway to support the Japanese OWP sector. As another practical matter, the MLIT's timeline for submissions and reviews of applications would also need to be revised to make Special Permission a feasible option for foreign-flagged

[52] See, e.g., Kyodo News (2022) and Kåberger and Zissler (2022).

WTIVs. OWP developers generally need to secure the services of these vessels well in advance of the start of construction activities (potentially 2 to 3 years prior). However, the MLIT has asserted that the timing of Special Permission applications cannot be submitted or ruled upon at such an early date since the competent maritime authority must base its decision on the circumstances that exist as of the commencement date of work. This practice does not seem to be adequate for the offshore wind sector and we propose a determination by MLIT be made well in advance of the start of construction of a WTIV.

- *Increase the number of OWP training facilities and course offerings*. Vessel operators seeking to enter the Japanese OWP market are reportedly constrained by a very limited number of Japanese nationals qualified to operate and crew specialised vessels such as WTIVs. At present, there is only one GWO-accredited institution offering instruction related to OWP, exacerbating this supply shortage. As foreign vessels are required to employ Japanese seafarers as part of the market entry requirements, it is critical that there be sufficient supply in order for these vessels to successfully adhere to requirements under the Ships Act. This could be achieved by relaxing the regulations around using Japanese nationals only as seafarers and/or extending the training programs and recruitment activities for seafarers in the offshore wind sector, perhaps through collaboration with EU entities and companies.

- *Conduct dedicated soil and seismic studies and make data available to bidders ahead of tender*. Japan's offshore soil conditions (including silt, sand, and rock) and seismic activity present a particular challenge for OWP foundation installation. While the degree to which this impacts WTIV and HLV needs is still somewhat uncertain across Japan's OWP regions, an improved understanding of the soil types and seismic activity can inform foundation requirements, installation duration, and eventually, WTIV needs. The GOJ could explore to conduct soil investigations (e.g., site-specific response analyses) and seismic studies ahead of tendering to ensure bids are informed by these conditions and to better evaluate future WTIV and HLV needs (e.g., jack-up vs. semi-jacked installation vessel solutions).

- *Continue to foster partnership opportunities between Japanese and EU vessel companies*. Japan and EU companies have contributed to each other's OWP sector expansion. To ensure an optimal vessel supply across the EU and Japanese markets, partnership opportunities should be fostered for providing vessel services to global OWP markets, crew trainings, and ancillary services.

6. Appendix: Methodology for estimating Japanese vessel supply and demand

6.1. Approach for estimating vessel supply

Identifying the supply of Japanese-flagged vessels

To estimate the supply of vessels capable of carrying out installation activities in Japan's offshore wind sector, we compiled a list of all relevant vessels that are active, under construction and scheduled to enter the Japanese market. This has been accomplished using a range of sources including (i) vessel operators' websites; (ii) the offshoreWIND.biz vessel database; (iii) offshore wind industry news providers; (iv) stakeholder consultations; and (v) 4C Offshore's vessel databases.[53]

During the data gathering process, all relevant information on the vessels identified has been collected and incorporated into a database including, among other factors, the vessel's installation capacity (i.e., in terms of specifications relevant to the turbine rating and/or foundation size that vessels are capable of installing), ownership, flag, and date of entry into the market.

To estimate vessel supply, assumptions were made regarding the fixed-bottom turbine ratings that will be installed in Japan over the period of analysis (2022-2040). This is important because the vessels identified may not be capable of installing fixed-bottom WTGs beyond a certain rating and could be inadequate for meeting future demand once developers shift to larger turbines.[54]

Towards this end, the following assumptions were made with respect to the turbine ratings that will be installed between 2022-2040:

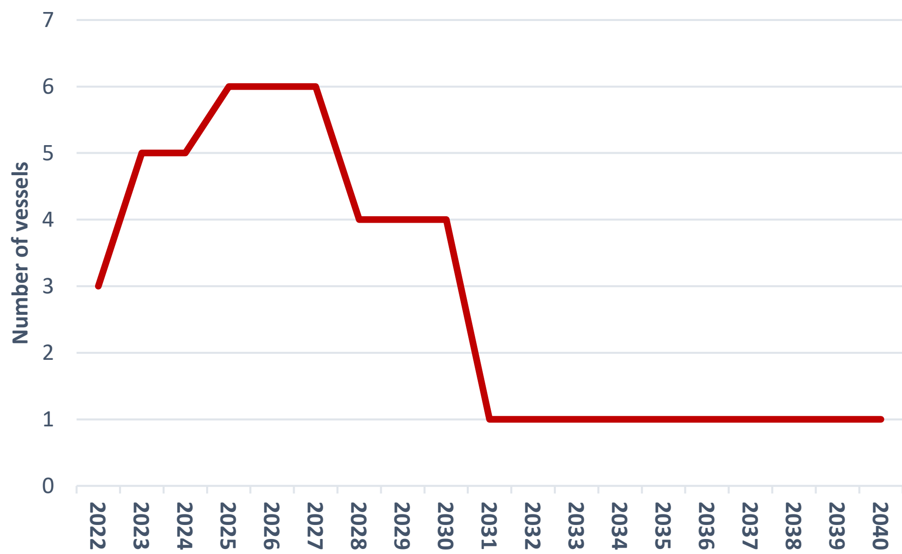
- ≤ 9.5 MW from 2022-2027;
- 12 MW 2028-2030; and
- 15 MW 2030-2040.[55]

The final step in determining the supply of vessels in Japan for each year of the analysis requires evaluating the extent to which each identified vessel meets the following criteria: (a) it is expected to be in operation in the year of analysis; and (b) it is capable of installing WTGs of the rating assumed to be installed that year. Vessels that do not meet either of these criteria are excluded from the supply available for that year and not included in Equation 1.

The inventory of vessels identified as capable of installing WTGs with a rating of at least 10 MW have been provided in Table 3 of the report. These vessels – based on the specified criteria related to availability and installation capacity and the assumptions regarding WTG rating – result in the vessel supply curve depicted in Figure 8.

[53] A limited set of sector experts were consulted for this study and feedback was elicited during a seminar held by the EU Delegation to Japan on 6 June, 2022.
[54] For example, if a WTIV operating in Japan is only capable of installing WTGs of 10 MW or smaller, it would not be reasonable to include it in the supply equation once it is assumed that the Japanese market will be deploying WTGs of size 12 MW (unless that vessel invests in upgrades to its crane's lifting capacity). While it might be possible for some of Japan's WTIVs to upgrade, the analysis does not include this possibility given the difficulties inherent in verifying such an assertion.
[55] These assumptions are based on a combination of desk research and stakeholder consultations. Recent tender results have revealed that the Mitsubishi-led consortia intend to use GE's Haliade-X turbines with a rating of 12.6 MW (the largest typhoon rated turbine currently available in markets) on their projects that will become operational over the period 2028-2030. Prior to this period, there is no indication that any of the OWP projects in Japan's pipeline will be installing turbines larger than 9.6 MW in size. Assumptions regarding 15 MW WTGs are in line with wider industry expectations pursuant to the envisaged timeline for when these next generation turbines will become widely deployed.

Figure 8. WTIV supply in Japan (2022-2040)



Source: Author's estimates

Estimating vessels' annual installation capacity

To estimate these vessels' potential for meeting demand, the next step is to determine their annual installation capacity with respect to fixed-bottom turbines. This is done using the equation from Blocket et al. (2021), which measures a vessel's annual installation capacity (in total MW) as a function of (i) the maximum WTG rating it is capable of installing; (ii) the number of days per year that it is capable of operating due to weather and environmental restrictions; and (iii) the number of days needed to install a turbine:[56]

***Equation 1**:*

$$Annual\ Vessel\ Install\ Capacity\ in\ MW = \frac{365 * Operational\ Window}{Number\ of\ Days\ to\ Install\ WTG} * Assumed\ WTG\ Size$$

The cumulative installation capacity in a given year is then derived by taking the value from this equation and multiplying it by the number of vessels available in that year (as shown in Figure 8).

In calculating Equation 1, the following values have been assigned to each of the parameters:

- Operational period – 7 months per year;[57]
- Number of days needed to install WTGs – 2 or 4 days;[58]

[56] Bocklet et al. 2021

[57] Based on feedback received in expert consultations. The experts indicated that construction activities are typically very limited during Japan's typhoon season (September-November) and in the winter months.

[58] Experts interviewed during the study suggest that an average of 2-3 days are likely to be needed to install a single turbine or foundation, respectively, but that this may vary due to a range of factors such as, e.g., distance from shore, turbine and foundation size, vessel deck space and weather conditions. This estimate is largely consistent with values used in other analyses. Blocket et

- Assumed WTG size – 9.5 MW (2022-2027); 12 MW (2028-2030); 15 MW (2031-2040).[59]

Because of the uncertainty regarding the number of days needed to install a turbine and foundation, the analysis incorporates a sensitivity that, assumes a 4-day installation window for a single WTG or foundation, respectively. Based on these assumptions, Equation 1 yields the annual installation capacities for a WTIV expressed in Table 6.

Table 6. Vessel installation capacity by period and installation time

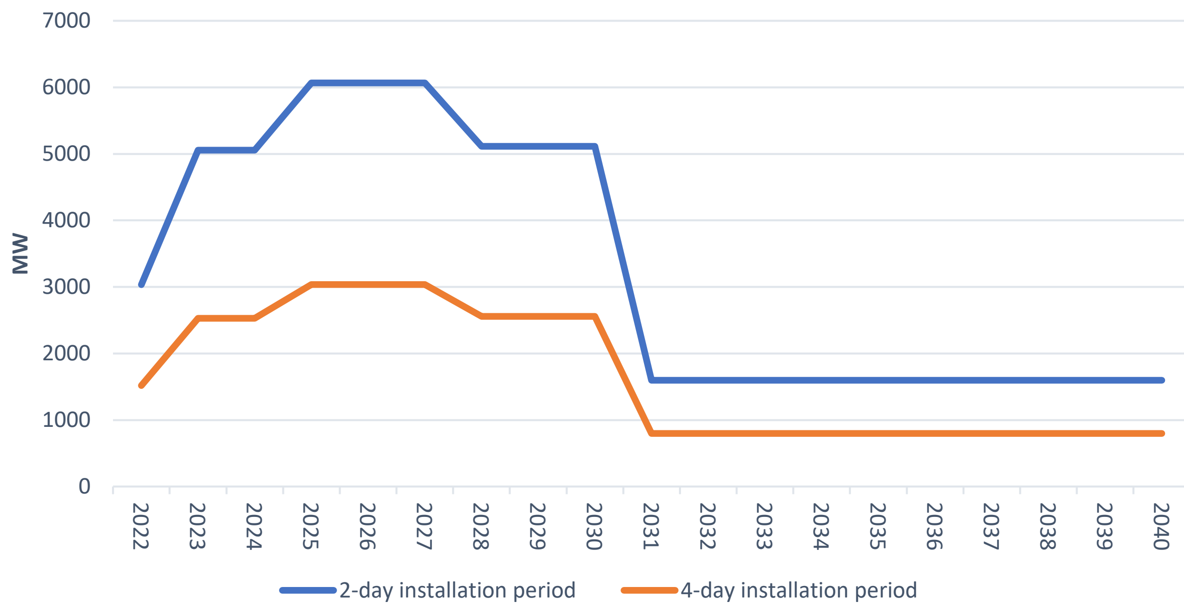
Period	Assumed WTG rating	**Vessel annual installation capacity (MW)**	
		2-day installation period	4-day installation period
2022-2027	9.5 MW	1011	506
2028-2030	12 MW	1278	639
2031-2040	15 MW	1597	798

These estimates, in turn, result in the cumulative annual installation capacity depicted in Figure 8.

al. (2021), for example, use an estimate of 2 days for installation of fixed-bottom WTGs in the United States, while Shields et al. (2022) estimate that installation of an individual WTG/foundation requires 36 hours. BVG Associates (2019), provide an estimated range 1-4 days as period needed to install a turbine.

[59] These estimates are based on a combination of current market data and projections regarding the future. The results of the first round of tendering, which saw Mitsubishi-led consortia win each of the three large-scale commercial projects, will all use GE Haliade-X turbines with a capacity of 12.6 MW. As these are scheduled to become operational between 2028-2030, it is assumed that this will be the size of WTGs used over the period. Similarly, it is not expected that turbines of this size will be installed in the Japanese market prior to this date. Prior to 2028, therefore, the largest WTGs installed in Japan are projected to be 9.5 MW (as observed in the Hibiki-nada offshore wind farm currently under construction). While some WTGs installed prior to 2028 will undoubtedly be smaller than 9.5 MW (as in the case of the Akita-Noshiro Port project that is installing Vestas V117 WTGs with 4.2 MW capacity), the 9.5 MW estimate will be used to reflect total vessel installation capacity over this period. From 2031, it is assumed that WTGs of 15 MW will become commercially viable and utilised in all fixed-bottom construction projects in Japan. This is an assumption applied in other similar analyses such as Bocklet et al. (2021) and is conservative in comparison to, e.g., Shields et al. (2022), which assume installation of 18 MW WTGs during this period.

Figure 9. Cumulative WTIV installation capacity in Japan by year: 2022-2040 (in MW)60



Source: Author's estimates

6.2. Approach to estimating vessel demand

Estimating Japan's OWP market development

To estimate Japan's future vessel demand, we obtained projections for the country's expected OWP development. Gathering this data, is challenging for a number of reasons. Detailed projections on Japan's future offshore wind development are largely incomplete or unavailable – particularly past 2030 – due to the limited number of tenders awarded to date as well as the rapidly evolving nature of Japan's OWP market and its regulatory regime. While GOJ has announced targets for 2030 and 2040, very little indication is available as to the annual development that will occur throughout this period and almost no information is publicly available with respect to the expected breakdown between fixed and floating OWP. Most published projections that do exist, moreover, are either limited in their time horizon; provide estimates for only several milestone years (e.g., 2030, 2035 and 2040); or out-dated and not reflective of recent developments.

We estimated future OWP deployment through a combination of GOJ's sector targets provided in the *Vision for Offshore Wind Power Industry* and by relying on projections by *WoodMacKenzie (Diao, 2021)* and the *Carbon Trust (2021)*. As discussed in Section 2 of this report, the GOJ targets include:

- 10 GW of capacity tendered by 2030; and

[60] Each vessel's annual installation capacity is limited to the WTG rating that is assumed to be installed in that year regardless of whether it is capable of installing higher-rated turbines. For example, while the unnamed Shimizu vessel that is slated to enter the market in 2023 is capable of installing 15 MW turbines, its total installation capacity is restricted to 9.5 MW WTGs between 2023-2027 and 12 MW WTGs between 2028-2030.

- 30-45 GW of capacity tendered by 2040.

Using 2022 to 2040 as the period of analysis, we assume that these targets are met. To reflect the range of outcomes included in the 2040 targets, two OWP deployment scenarios are formulated, which differ in the pace of deployment and the use of fixed and floating substructures:

1. ***Baseline Scenario:*** assumes 30 GW of capacity deployed by 2040 and comprised of:

- Fixed-bottom deployment from 2022-2031 that is based on annual projections from WoodMacKenzie (WMK) and 1.5 GW of fixed-bottom capacity annually from 2032-2040;[61]
- Floating offshore wind deployment that begins on a commercial-scale by 2030, using annual projections from Carbon Trust for the years 2030, 2035 and 2040.[62]

2. ***Accelerated Scenario:*** assumes 45 GW of capacity deployed by 2040 and comprised of:

- Fixed-bottom deployment based on the WMK projections for the period 2022-2025 (as well as for 2031) and a doubling of the annual WMK projections from 2026-2030 in order to construct a scenario that reaches 10 GW installed (rather than just tendered) by the end of the decade and 1.5 GW of annual fixed-bottom deployment from 2032-2040;
- A doubling of the annual projected floating offshore wind capacity compared to the baseline scenario throughout the period 2030-2040.

The annual deployment estimates for fixed and floating capacity that have been derived through this approach are reproduced in Table 7. Figures in blue represent those taken from WoodMacKenzie (Diao, 2021), while those in green are sourced directly from Carbon Trust (2020). Since floating wind projections from the latter are provided only for 2030, 2035 and 2040, projections for intervening years are derived through linear interpolation between these years. The result of this calculation is then used as the annual installation for each year in the applicable period.

Table 7. Market development scenarios for Japan's offshore wind sector, 2022-2040 (by year and source)

Year	Baseline: 30 GW by 2040				Accelerated: 45 GW by 2040			
	Fixed-bottom Installation (MW)	Fixed-Bottom - Cumulative (MW)	Floating Installation (MW)	Floating - Cumulative (GW)	Fixed-bottom Installati on (MW)	Fixed-Bottom - Cumulative (MW)	Floating Installation (MW)	Floating - Cumulative (MW)
2022	139	139	0	0	139	139	0	0
2023	138	277	0	0	138	277	0	0
2024	300	577	0	0	300	577	0	0
2025	0	577	0	0	0	577	0	0
2026	160	737	0	0	320	897	0	0
2027	0	737	0	0	0	897	0	0
2028	869	1606	0	0	1738	2635	0	0
2029	1315	2921	0	0	2630	5265	0	0

[61] WoodMacKenzie (Diao, 2021)
[62] Carbon Trust (2020)

2030	1599	4520	930	930	3198	8463	1860	1860
2031	700	5220	654	1584	700	9163	1308	3168
2032	1500	6720	654	2238	1500	10663	1308	4476
2033	1500	8220	654	2892	1500	12163	1308	5784
2034	1500	9720	654	3546	1500	13663	1308	7092
2035	1500	11220	654	4200	1500	15163	1308	8400
2036	1500	12720	1360	5560	1500	16663	2720	11120
2037	1500	14220	1360	6920	1500	18163	2720	13840
2038	1500	15720	1360	8280	1500	19663	2720	16560
2039	1500	17220	1360	9640	1500	21163	2720	19280
2040	1500	18720	1360	11000	1500	22663	2720	22000

Source: WoodMacKenzie (Diao, 2021), Carbon Trust (2020), author estimates
*Note: figures in blue sourced from WoodMacKenzie (Diao, 2021), while those in green are derived directly from Carbon Trust (2020).

Calculating vessel demand

To arrive at an estimate of vessel demand, the estimated OWP build-out established in the two market deployment scenarios are combined with the estimates of vessels' annual installation capacity estimated using Equation 1 and provided in Table 6. Calculating the vessel demand for each year is accomplished by taking that year's estimated annual fixed-bottom construction and dividing it by the vessel installation capacity and rounding up to the nearest integer.

$$Vessel\ demand\ in\ year\ (t) = \frac{Estimated\ fixed\ bottom\ construction\ in\ year\ (t)}{vessel\ installation\ capacity\ in\ year\ (t)}$$

These estimates are conducted for each market development scenario and across the range of assumed days needed to install an individual turbine to create four analytic scenarios.

- Scenario 1: Baseline market development scenario with an assumed installation time of 2 days
- Scenario 2: Baseline market development scenario with an assumed installation time of 4 days
- Scenario 3: Accelerated market development scenario with an assumed installation time of 2 days
- Scenario 4: Accelerated market development scenario with an assumed installation time of 4 days

All assumptions applied across these scenarios are summarised in Table 8.

Table 8. Summary of assumptions used in the supply and demand scenarios for Japanese OWP vessels (2022-2040)

		Scenario 1: 30-GW by 2040	**Scenario 2: 45-GW by 2040**
Fixed-bottom capacity	2022-2025	WKM projections	WKM projections
	2026-2030	WKM projections	Doubling of WKM projections
	2031	WKM projections	WKM projections
	2032-2040	1.5 GW/year	1.5 GW/year
Floating capacity	2022-2029	0 GW	0 GW
	2030-2040	Carbon Trust Projections	Doubling of projections
Assumed WTG Size	2022-2027	≤9.5 MW	
	2028-2030	12 MW	
	2031-2040	15 MW	
Operational window		210 days per year (7 months)	
Time needed to install a turbine		2 or 4 days	
Time needed to install a foundation		2 or 4 days	

6.3. Accounting for the installation of foundations in fixed-bottom construction

One of the elements that could impact the estimated supply of WTIVs in the Japanese market relates to whether these vessels will also be required for foundation installation (i.e., monopiles) activities. To account for this, the analysis estimates the total number of foundations that would be needed in each year, *t*, as necessarily corresponding to the number of turbines that will be installed in the subsequent year (*t+1*).[63] This is calculated by taking the total estimated fixed-bottom (FB) build-out in year *t+1* and dividing by the assumed WTG size for that year (rounding up to the nearest integer). The results of this approach are provided in Table 9.

$$Number\ of\ foundations\ installed\ in\ year\ t = \frac{Projected\ FB\ installation\ in\ year\ t+1}{Assumed\ WTG\ size\ in\ year\ t+1}$$

Table 9. Estimated number of WTGs and foundations to be installed annually in Japan (2022-2040)

Year		**Scenario 1: 30 GW by 2040**				**Scenario 2: 45 GW by 2040**			
	Assumed WTG size (MW)	Projected Fixed-bottom Installation (MW)	No. of WTGs needed	No. of foundations installed	Max Number of vessels needed[64]	Projected Fixed-bottom Installation (MW)	No. of WTGs needed	No. of foundations installed	Max Number of vessels needed[65]
2022	9.5	139	15	15	**1**	139	15	15	**1**

[63] Since the installation of a fixed-bottom turbine can only occur after the foundation has been installed, it is assumed that each turbine that is installed in a given year will have its foundation installed in the preceding year.
[64] Under an assumed install period of 4 days per foundation
[65] Under an assumed install period of 4 days per foundation

2023	9.5	138	15	32	**1**	138	15	32	**1**
2024	9.5	300	32	0	**0**	300	32	0	**0**
2025	9.5	0	0	17	**1**	0	0	34	**1**
2026	9.5	160	17	0	**0**	320	34	0	**0**
2027	9.5	0	0	73	**2**	0	0	145	**3**
2028	12	869	73	110	**3**	1738	145	220	**5**
2029	12	1315	110	134	**3**	2630	220	267	**6**
2030	12	1599	134	47	**1**	3198	267	47	**1**
2031	15	700	47	100	**2**	700	47	100	**2**
2032	15	1500	100	100	**2**	1500	100	100	**2**
2033	15	1500	100	100	**2**	1500	100	100	**2**
2034	15	1500	100	100	**2**	1500	100	100	**2**
2035	15	1500	100	100	**2**	1500	100	100	**2**
2036	15	1500	100	100	**2**	1500	100	100	**2**
2037	15	1500	100	100	**2**	1500	100	100	**2**
2038	15	1500	100	100	**2**	1500	100	100	**2**
2039	15	1500	100	100	**2**	1500	100	100	**2**
2040	15	1500	100	100	**2**	1500	100	100	**2**

Source: WoodMacKenzie (Diao, 2021), author's estimates

Based on these calculations, the estimated number of foundation installation vessels (FIVs) that would be needed is derived using the same assumptions as applied in Equation 1 with respect to the annual construction period (i.e., 7 months) and time needed to install foundations (i.e., 2 or 4 days).[66]

To establish a list of vessels capable of carrying out foundation installation activities in Japan, we collected all heavy lift vessels (HLVs), sheerleg crane vessels and WTIVs that meet the following criteria with respect to lifting capacity:

a) 2,000 tonnes for WTGs of 9.5-12 MW[67]
b) 2,500 tonnes for WTGs of 15 MW[68]

Six Japan-flagged HLVs/sheerleg crane vessels were identified as potentially being suitable for carrying out foundation installation for WTGs of at least 12 MW in size while four vessels are capable of installing foundations for 15 MW WTGs (Table 10). Note that if seismic activity and challenging soil conditions might require heavier foundation designs that could exceed the lifting capacities of the HLVs shown in Table 10.

[66] Since there is no projected deficit, results are reported only for the assumed 4-day installation period as this represents the maximum number of vessels that would be required.
[67] https://www.oedigital.com/news/485475-deme-offshore-to-install-giant-monopiles-for-baltic-sea-wind-farm; and Stakeholder consultations
[68] https://www.offshorewind.biz/2020/05/11/beyond-xxl-slim-monopiles-for-deep-water-wind-farms/

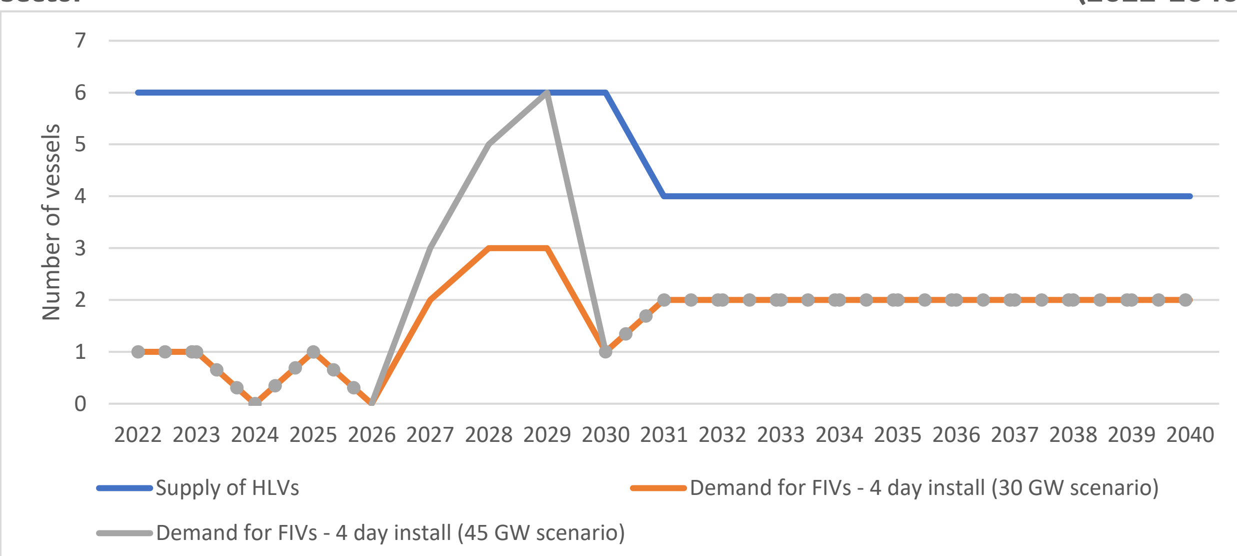
Table 10. Vessels identified for installing fixed-bottom turbine foundations (i.e., monopiles) in Japan

Vessel	**Owner**	**Lifting capacity (t)**	**Foundation install capacity (by WTG size)**
Kongo	Fukada Salvage & Marine Works Ltd	2050	Up to 12 MW
Suruga	Fukada Salvage & Marine Works Ltd	2200	Up to 12 MW
SHMZ (WTIV)	Shimizu Corporation	2500	Up to 15 MW
Fuji	Fukada Salvage & Marine Works Ltd	3000	Up to 15 MW
Musashi	Fukada Salvage & Marine Works Ltd	3700	Up to 15 MW
Yoshidago No. 50 (第50吉田号)	Yoshida	3700	Up to 15 MW
Kaisho	Yorigami Maritime Construction	4100	Up to 15 MW

Source: Press releases and publicly available vessel spec sheets; 4C Offshore (2022a).

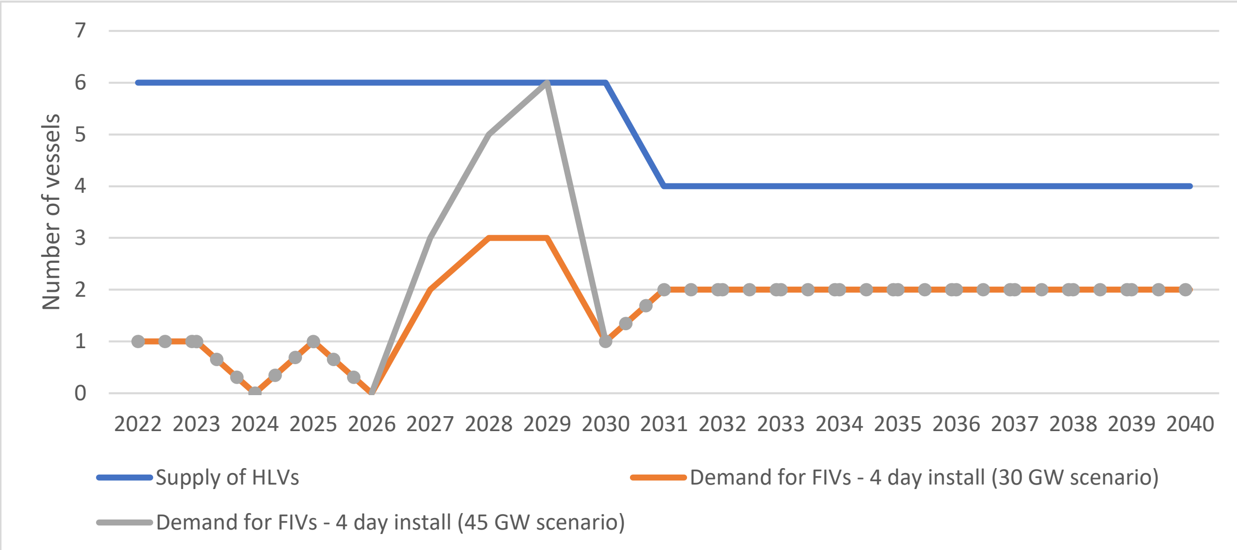
Using the same assumptions regarding the annual operational window for construction activities (i.e., 7 months) and time needed to install turbines (i.e., 2 or 4 days), we estimate that each of these FIVs would be able to install between 52 and 105 turbines per year. As observed in the relevant columns in Table 10, these HLVs/sheerleg crane vessels are expected to be sufficient for meeting Japan's foundation installation demands – even under a more ambitious scenario that assumes a longer period of time for foundation installation (

Figure **10. Supply and demand of foundation installation vessels in Japan's offshore wind sector (2022-2040)**



). Therefore, we assume that WTIVs such as the Shimizu vessel could undertake foundation installation activities in those years where there appears to be excess WTIV capacity. During periods of increased demand, the identified HLVs and sheerleg crane vessels could, in principle, assist in these responsibilities (though this is perhaps a suboptimal choice compared to tailored WTIVs).

Figure 10. Supply and demand of foundation installation vessels in Japan's offshore wind sector (2022-2040)[69]



Source: Author's estimates

[69] Note that the supply curve excludes WTIVs that are suitable for foundation installation work.

REFERENCES

4C Offshore. 2022a. Construction & Heavy Maintenance Database. https://www.4coffshore.com/vessels/construction-and-heavy-maintenance.html

4C Offshore. 2022b. Offshore Cable Installation Vessel Database. https://www.4coffshore.com/vessels/cable-installation-vessels.html

4C Offshore. 2022c. Offshore Wind Logistics Database. https://www.4coffshore.com/vessels/offshore-wind-logistics.html

Agency for Natural Resources and Energy. 2020. "Regarding wind power generation" (in Japanese). https://www.meti.go.jp/shingikai/santeii/pdf/063_02_00.pdf

Agency for Natural Resources and Energy. 2021. "Energy Supply and Demand Outlook for 2030" (Annex to the 6th Strategic Energy Policy) (in Japanese). https://www.meti.go.jp/press/2021/10/20211022005/20211022005-3.pdf

Ashurst. 2019. "Making headway in Japanese offshore wind". https://www.ashurst.com/en/news-and-insights/legal-updates/japanese-parliament-passes-offshore-wind-legislation

Ashurst. 2020. "Making headway in Japanese offshore wind – Auction guidelines face bidder scrutiny". https://www.ashurst.com/en/news-and-insights/legal-updates/making-headway-in-japanese-offshore-wind

Ashurst. 2021. "Making headway in Japanese offshore wind – bidder scrutiny of auction rules continues". https://www.ashurst.com/en/news-and-insights/legal-updates/making-headway-in-japanese-offshore-wind---bidder-scrutiny-of-auction-rules-continues/

Baker McKenzie. 2019. "Outlook for the Japanese Offshore Wind Market". Presentation for the Asia Wind Energy Association. https://www.asiawind.org/wp-content/uploads/2019/05/05-BAKER-MCKENZIE-Naoaki-Eguchi.pdf

Bocklet, Charles, Christian Herbosa, Greg Loweth, Matthew Griswold, Lauren Quickel, Roan Gideon, Jay Borkland, Rocky Weitz, Barbara Kates-Garnick, and Eric Hines. 2021. "Wind Turbine Installation Vessels: Global Supply Chain Impacts on the U.S. Offshore Wind Market". Offshore Power Research & Education Collaborative, OSPRE-2021-02.

BVG Associates. 2019. "Guide to an Offshore Wind Farm". https://www.thecrownestate.co.uk/media/2860/guide-to-offshore-wind-farm-2019.pdf

Cadeler. 2020. "Cadeler Company Presentation". https://www.cadeler.com/media/1569/2020-11-27-cadeler-company-presentation_vf.pdf

Carbon Trust. 2020. "Floating wind joint industry project. Phase II summary report". https://www.carbontrust.com/resources/floating-wind-joint-industry-project-phase-2-summary-report

Casaca, Ana Cristina Paixão and Dimitrios V. Lyridis. 2018. “Protectionist vs liberalised maritime cabotage policies: a review”. *Maritime Business Review*, 3(3): p. 210-242. https://www.emerald.com/insight/content/doi/10.1108/MABR-03-2018-0011/full/pdf

Diao, Chenyuan. 2021. “Asia Pacific offshore wind power outlook (WoodMacKenzie)”. Presented at Virtual Seminar of the Asian Wind Energy Association, 21 January 2021. https://www.asiawind.org/wp-content/uploads/2021/01/ASIA-WIND-ENERGY-ASSOCIATION-Presentation-Virtual-Seminar-21-January-2021-compressed.pdf.

Durakovic, Adnan. 2020. "Sea Challenger to Fly Japanese Flag as DEME and Penta-Ocean Complete Offshore Wind Tie-Up.” offshoreWind.biz: https://www.offshorewind.biz/2021/11/02/sea-challenger-to-fly-japanese-flag-as-deme-and-penta-ocean-complete-offshore-wind-tie-up/

Eneti. 2020. “Enetic Inc.: Prospectus Supplement”. https://www.eneti-inc.com/sec-filing/0001193125-21-330091/

Fukatsu, Koji. 2021. “Offshore wind power generation in Japan”. *Asia Business Law Journal*, 15 December 2021: https://law.asia/offshore-wind-power-generation-in-japan/

Goodwin, Hugh and Tomoko Nakajima. 2022. “Unique features of the offshore wind market in Japan”. Freshfields Brukhaus Deringer, https://transactions.freshfields.com/post/102hocg/unique-features-of-the-offshore-wind-market-in-japan

GWEC. 2021. Global Offshore Wind Turbine Installation Vessel Database. Global Wind Energy Council.

Heiligtag, Sven, Katsuhiro Sato, Benjamin Sauer and Koji Toyama. 2020. “Japan offshore wind: The ideal moment to build a vibrant industry.” https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/japan-offshore-wind-the-ideal-moment-to-build-a-vibrant-industry

InfraBiz. 2021. “Domestic planned capacity for offshore wind power generation exceeds 35 GW in total (Update 1).” https://infrabiz.co.jp/1873/

Kåberger, Tomas and Romain Zissler. 2022. “How Putin’s Attack in Ukraine Increases Electricity Prices in Japan”. Renewable Energy Institute: https://www.renewable-ei.org/en/activities/column/REupdate/20220318.php

Kim, Joseph, Chiyokazu Shindo, and Kyall Hill. 2021. “Japan”. In C. Knütel (ed.), *Offshore Wind Worldwide: Regulatory Framework in Selected Countries*. Hamburg: Hogan Lovells International LLP

Kyodo News. 2022. “Japan aims to speed up start of new offshore wind power plants”. https://english.kyodonews.net/news/2022/03/9e13148b7dc4-japan-aims-to-speed-up-start-of-new-offshore-wind-power-plants.html

Linklaters. 2020. Japan Offshore Wind (3rd Edition): Time to Bid. https://www.linklaters.com/en/insights/thought-leadership/asia-pacific-renewable-energy-insights-2020/japan-offshore-wind-report-third-edition

Lisne, Martin. 2021. 'Feeder vessels blow in to bridge offshore wind installation gap'. *TradeWinds*: https://www.tradewindsnews.com/opinion/feeder-vessels-blow-in-to-bridge-offshore-wind-installation-gap/2-1-1083879

MLIT. 2022. "Procedure of Inspection, Validation and Registration for re-flagging vessels under the Japanese law" (in Japanese). https://www.mlit.go.jp/maritime/content/001475421.pdf

MLIT Ports and Harbors Bureau. 2017. "Efforts to promote the introduction of offshore wind power generation" (in Japanese). https://www.mlit.go.jp/common/001441854.pdf

Musial, Walter, Philipp Beiter, Paul Spitsen, Jake Nunemaker, Vahan Gevorgian, Aubryn Cooperman, Rob Hammond, and Matt Shields. 2020. "2019 Offshore Wind Technology Data Update". NREL/TP-5000-77411. https://www.nrel.gov/docs/fy21osti/77411.pdf

Musial, Walter, Paul Spitsen, Philipp Beiter, Patrick Duffy, Melinda Marquis, Aubryn Cooperman, Rob Hammond, Matt Shields. 2021. "Offshore Wind Market Report: 2021 Edition" U.S. Department of Energy. https://www.energy.gov/eere/wind/articles/offshore-wind-market-report-2021-edition-released

Noma, Hironobu and Yusuke Murakami. 2019. "The race for offshore wind". https://www.iflr.com/article/b1lmxb6gjd9wyr/the-race-for-offshore-wind

NYK. 2020. "NYK and Van Oord Partnering to Own and Operate Offshore Wind Installation Vessel in Japan." https://www.nyk.com/english/news/2020/20200116_01.html

offshoreWIND.biz. 2022. Vessels. https://www.offshorewind.biz/vessels/

Principle Power. 2021. "Windfloat Japan". https://www.principlepower.com/projects/windfloat-japan

Public-Private Council on Enhancement of Industrial Competitiveness for Offshore Wind Power Generation. 2020. "Vision for Offshore Wind Power Industry (1st)". https://www.enecho.meti.go.jp/category/saving_and_new/saiene/yojo_furyoku/dl/vision/vision_first_en.pdf

PwC. 2020. 令和元年度エネルギー需給構造高度化対策に関する調査等事業（洋上風力発電の認定に係る費用分析等支援業務.

RWE Renewables Japan. 2021. "Issues in Offshore Wind Promotion" (in Japanese). Presentation to the Cabinet Office Comprehensive Inspection Task Force for Regulations on Renewable Energy, 21 September 2021. https://www8.cao.go.jp/kisei-kaikaku/kisei/conference/energy/20210921/210921energy04.pdf

Seajacks. N.d. "Seajacks Zaratan". https://www.seajacks.com/self-propelled-jack-up-vessels/seajacks-zaratan/

Shields, Matt, Ruth Marsh, Jeremy Stefek, Frank Oteri, Ross Gould, Noé Rouxel, Katherine Diaz, Javier Molinero, Abigayle Moser, Courtney Malvik, and Sam Tirone. *The Demand for a Domestic Offshore Wind Energy Supply Chain*. 2022. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-81602. https://www.nrel.gov/docs/fy22osti/81602.pdf

Shimizu. 2019. “Shimizu Begins Construction of the World’s Largest Self-Propelled SEP (Self-Elevating Platform) Vessel”. https://www.shimz.co.jp/en/company/about/news-release/2019/2019007.html

Skopljak, Nadja. 2020. “Van Oord Orders Nex-Gen Green Cable-Laying Vessel”. offshoreWind.biz: https://www.offshorewind.biz/2020/12/17/van-oord-orders-next-gen-green-cable-laying-vessel/

UNCTAD. 2017. *Rethinking maritime cabotage for improved connectivity*. Transport and Trade Facilitation Series, No. 9. UNCTAD/DTL/TLB/2017/1. https://unctad.org/system/files/official-document/dtltlb2017d1_en.pdf

Wakabayashi, Minako, and Gohshun Kawamura. 2022. “Corporate PPAs (No. 2) – Feed-in Premium to Start in April 2022.” *Japan Renewables Alert 58.* Orrick: https://www.orrick.com/en/Insights/2022/03/Japan-Renewables-Alert-58

WoodMacKenzie. 2022. Global wind power market outlook update: Q1/2022 (March 2022). Accessed through subscription

Luxembourg: Publications Office of the European Union, 2022

Publications Office of the European Union

Print ISBN 978-92-76-56959-6 doi: 10.2781/063327 NG-09-22-525-EN-C
PDF ISBN 978-92-76-56958-9 doi: 10.2781/238314 NG-09-22-525-EN-N