Challenges and Opportunities of Major Maintenance for Floating Offshore Wind

World Forum Offshore Wind (WFO)

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Cover: Photo courtesy of BW Ideol (V. Joncheray), *Floatgen demonstrator*

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Acknowledgments

WFO’s 75+ members represent the entire offshore wind value chain including but not limited to utility companies, manufacturers, service firms, consultancies and other non-profit organizations.

This document is the result of one year’s worth of monthly discussions between participating WFO members during meetings of WFO’s Floating Offshore Wind Committee on the topic of floating wind operation and maintenance concepts. WFO would like to thank everyone who has contributed their time and expertise during the discussions and interviews carried out for this study.

Disclaimer

Foreword

For over a decade, most talks about floating offshore wind have been focusing on technical and economic viability; economic viability often associated with CAPEX per floating unit, per MW, etc.
These CAPEX concerns have been further highlighted as tenders for commercial-scale floating wind started to appear and binding offers needed to be submitted.

Floating wind OPEX (and thus O&M strategies and methods) have been carefully analyzed and optimized over these last few years by the very rare floating wind technology providers benefiting from a return on experience operating full-scale floating wind assets; best practices and cost modeling have been developed by these leading players and pioneers; monitoring data collected over several years has started to be used for preventative maintenance strategies, and so on.

We have come a long way but a lot remains to be accomplished if we want to achieve the cost and risk reduction targets required to equal (and even improve on) the LCOE of bottom-fixed wind by the end of this decade. Undermining the importance of O&M would be a grave mistake and I am very pleased that very early on, O&M became one of our Floating Offshore Wind Committee's priorities. The links of the O&M Subcommittee with the ones on insurance, mooring solutions as well as cables and floating substations are also obvious and do confirm that one cannot look at floating wind without a true, systemic approach and without the input from knowledgeable representatives of the entire value chain.

I thank the Subcommittee's Chair and the dozens of members that have been meeting every month to deliver what will without a doubt contribute to a better understanding of the challenges our growing industry faces and the solutions and best practices hands-on experts are exploring. Theoretical approches and desktop studies have their merits but nothing beats the keen eye and experience from the world's largest and most international gathering of floating wind experts. This white paper on O&M is the first of many more to come.

Bruno G. GESCHIER
Chairman of WFO's Floating Offshore Wind Committee
Chief Sales & Marketing Officer of BW Ideol
Chairman of FOWT's Scientific and Technical Committee
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Table of Contents

Acronyms and Definitions

WFO – World Forum Offshore Wind
FOWC – WFO Floating Offshore Wind Committee
O&M – Operation & Maintenance
FOW – Floating offshore wind
FOWT – Floating offshore wind turbine
MC – Major component
MCR – Major component replacement (alternatively called “major repairs”, “major corrective”)
Major component – heavy components such as blades and gearboxes
Minor repair/corrective – Maintenance activities not involving a major component replacement and typically only requiring a crew transfer vessel to be present
OEM(s) – Original Equipment Manufacturer(s)
Offsite – Designation for onshore conditions
Onshore - Dry-dock or inshore
Onsite – Designation for offshore conditions (at project site)
WTG – Wind turbine generator
IRR – Internal rate of return
NPV – Net present value
TLP – Tension Leg Platform
SOV – Service operation vessel
CTV – Crew transfer vessel
EPCI – Engineering, Procurement, Construction and Installation (contract)
CAPEX – Capital expenditure
OPEX – Operating expense

1 Introduction – Floating Wind O&M

Like all renewable energy projects, floating offshore wind (FOW) requires operation and maintenance (O&M) strategies that are tailored to the technology's characteristics. Due to the nature of floating wind farms, the maintenance strategy is complex and challenging but it also brings about opportunity to optimize the business case.

Floating wind farms are going to be located further away from the shore, and the logistics and workability aspects will bring about extensive and prolonged maintenance challenges. From a technical standpoint, risks and their associated mitigation plans must be considered. From an economic standpoint, the cost of operation as well as the cost of lost revenue from time without electricity generation of the floating system(s) will influence the chosen maintenance strategy.

Furthermore, dimensions of wind turbines are growing which means major components (MC) are going to be heavier and positioned at greater heights. Nowadays, wind farm installation vessels are used to install bottom-fixed structures and are based on jack-up technologies. Because floating wind farms are located in deeper waters, it will often not be possible to use the jack-up principle at the floating wind farm location.

With reference to **Figure 1**, a few different possible strategies have to be considered for Major Components Replacement (MCR),[1] namely:

(i) **Floating-to-floating**: this scenario relates to offshore overhaul, meaning that the replacement is going to be entirely carried out onsite. A heavy lift vessel working at the wind farm site is equipped with cranage that can transfer components to and from the FOWT (floating offshore wind turbine) directly. This requires an important and prompt evolution of the maritime industry to speed up with new design in order to provide vessels and solutions capable of carrying out the replacement operations in a floating-to-floating setup. These need to be efficient, quick and operating directly by the floating wind unit.

(ii) **Tow-to-port**: this relates to onshore (dry-dock or inshore) overhaul, meaning that the replacement is going to be executed onshore, thus offsite, after having carried out a reversed-installation process and towed the unit to the harbor. The FOWT is towed by readily available and relatively inexpensive vessels and then repaired with cranage in onshore-type weather. This procedure might be complex, lengthy and costly, both in terms of operations as well as downtime, and also requires MCR capabilities at the O&M sites (which is not always the case). Nevertheless, as long as the floating-to-floating solution cannot yet rely on a newly developed maritime/vessel industry, this is currently the main option considered in the floating wind business cases.

(iii) **Tow-to-shore**: this is a somewhat hybrid solution combining the reverse-installation procedure of the tow-to-port strategy although the unit is towed closer to shore where a fixed jack-up vessel is installed (i.e. vessel with fixed support structures). This strategy can be typically considered in case of suitable project conditions (geography, floater

[1] These definitions do not include all other (minor) correctives accessible directly onsite.

design) and/or synergies with other bottom-fixed assets. This strategy may be more costly due to the rental of the jack-up vessel in comparison to an onshore crane.

(iv) **Self-hoisting equipment**: this solution aims to have the replacement of major components done by new self-hosting or climbing cranes without utilizing other vessels than support barge-type (or similar) at the site or involving expensive tow-to-port operations. The adoption of different types of crane technology / vessel combinations are now being discussed as the technological development progresses and new companies approach the market. This opens up discussion around lifting capacity, operations time at sea, responsibilities among Original Equipment Manufacturers (OEMs), etc.

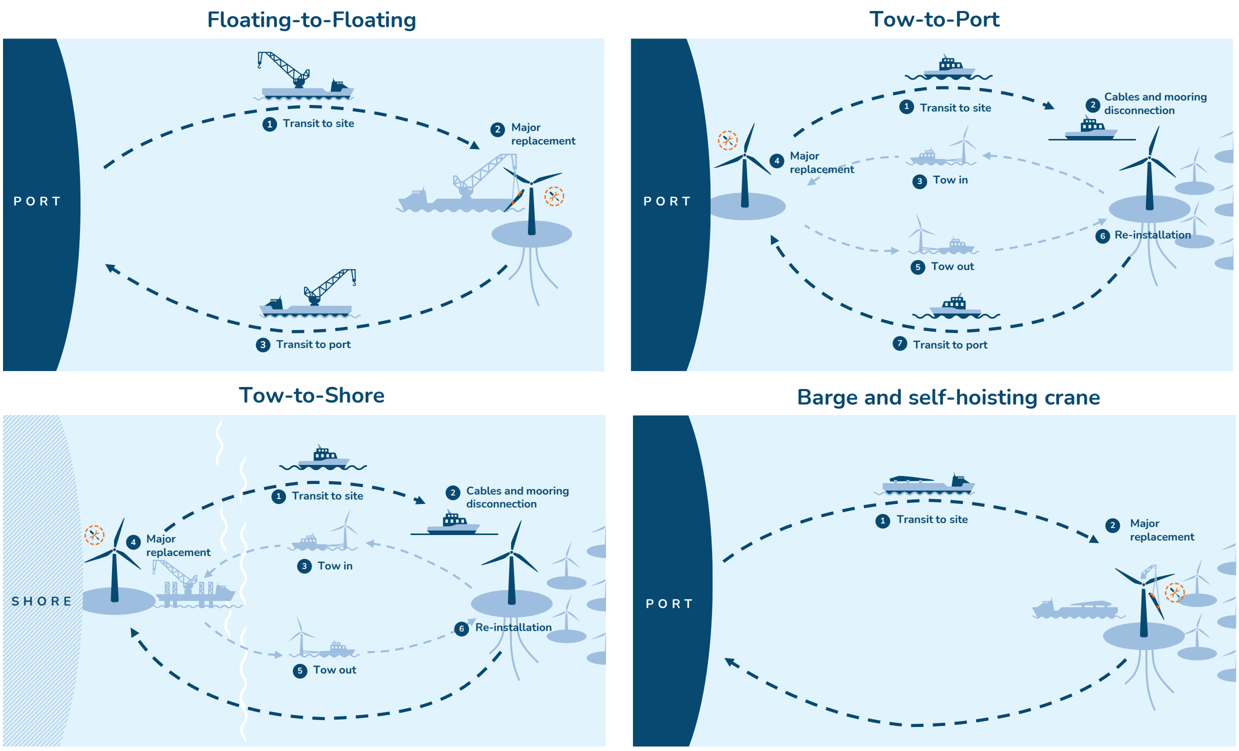

***Figure 1**. Floating Wind Major Component Replacement Options (PEAK Wind visuals®)*

The O&M Subcommittee was founded as part of the Floating Offshore Wind Committee (FOWC) under the auspices of the World Forum Offshore Wind (WFO). By fostering knowledge exchange between members representing all sectors of the FOW industry, the O&M Subcommittee aims to build a detection vehicle for challenges and opportunities in floating wind O&M. Along with the WFO FOWC Insurance, Moorings and Cables & Floating Substation Subcommittees, the forum aims to shape a general voice for the industry through a project management lens.

Throughout the WFO Floating Offshore Wind O&M Subcommittee meetings and interviews, professionals with experience working on offshore wind projects (including floating) gave their practical insight on the challenges and opportunities of each maintenance strategy. In particular, the forum highlighted:

- **Given today's scale of floating wind projects and available technology, offsite maintenance applications (tow-to-port, tow-to-shore) would be most feasible for major component replacements in the short-term**. However, as projects increase in volume (turbine capacity and number), the cranes and vessels used in offsite approaches will have to scale up accordingly. In a longer-term future with GW projects, onsite approaches would be expected to handle large component repairs.
- **Because of the many parameters to take into account, developing the appropriate O&M strategy is very project-specific**. Floater design is an obvious and especially important factor **[Figure 3].** This analysis therefore covers the general implications of each maintenance concept in order to show how the industry is thinking and working towards commercial-scale floating wind MCR.
- **Research and investments are required to advance the development of new technologies that can conduct the anticipated onsite and offsite repairs for commercial-scale floating offshore wind.** A clear pipeline of large-scale projects is needed to motivate capable players, e.g., the shipping industry, to develop such assets which ultimately have the potential to disrupt and transform current beliefs in MCR operations.
- **It is important to consider O&M issues alongside the early technological, financial, and logistics aspects of a floating wind project**, e.g. during the design phase and project contracts. The O&M discussions in the Subcommittee revealed the need to better integrate project sub-packages as well as improve communication between developers, OEMs, suppliers and other relevant actors.

1.1 Offsite

Offsite repair means disconnecting the FOWT system from the project site and towing it to a secondary area (port or area close to shore) for the major repair.

1.1.1 Tow-to-port

Based on the current state of technology, tow-to-port is considered the most accessible approach for the early floating wind projects provided onshore facilities are available. Findings from the ORE Catapult and Carbon Trust show that tow-to-port is currently the lowest cost and most feasible option for major FOW repairs.[2] However, the tools applicable for tow-to-port will have to scale in tandem with the increasing turbine size. Currently, suitable cranage for larger assets remains scarce.

From a maritime operational perspective, a tow-to-port operation is complex involving many risks from the disconnection, moving in and out of field and heavy lift operations **[Figure 1]**. In addition to the associated safety, equipment and environmental risks (= cost of operation), the interruption in electricity generation caused by disconnection of the FOWT is of especially

[2] ORE Catapult (2018); Carbon Trust (2021); Minutes of Meetings SC O&M 29 January 2021. The ORE Catapult (2018) study found favourable results for using tow-to-port on semi-submersibles (using a cost model) whereas the Carbon Trust (2021) study found that enabling technologies for tow-to-port were particularly promising for semi-submersibles.

great concern to project developers and insurers (= cost of downtime). There is a need for innovations in moorings and electrical connectors that allow for quick connection-disconnection and/or limits loss of production to the position(s) that failed in order to reduce downtime and loss of revenue.

Lack of extensive FOWT-specific lessons learned on disconnection and reconnection procedures also poses contractual and certification issues related to the asset involved. The need of de-risking the operation by defining specific procedures (e.g. handling mooring lines and electric cable on site by buoyancy modules during the repair time), is key for the acceptance of such MCR strategy by the project's business case (e.g. insurance). WFO participants with solutions in this area have recently started to build such operational track records.

An alternative for securing theoretical redundancy is to control spare parts: considering the predictive models for failure, having the correct parts and detailed plans for large correctives ready can help reduce downtime. The deployment of standing assets from the harbour-side (i.e. overplanting) can also be considered; however, this solution is much more subject to debate given the implications of tending to additional FOWTs.

1.1.2 Tow-to-shore

This strategy has very geographic- and floater-specific applications. For instance, "fjords" along the coast of Norway can be considered suitable sheltered areas for floaters with large drafts. These deep-water inlets have so far been useful for the assembly of the spar floaters of Hywind Scotland using a semi-submersible vessel.[3]

In a different scenario, the potential synergy of using jack-up vessels already at sea is based on the very specific condition of the FOW farm being located in proximity with a bottom-fixed farm and using floaters with lower drafts (e.g. semi-submersible). Lastly, floating sheerleg cranes that have a history in bridge construction works are being explored for floating wind applications.

Tow-to-shore may also be challenging from a consenting point of view as the project would have to obtain authorization to work outside the designated project area and potentially coordinate with different marine space users. There is also the question of how to fix the FOWT system at the sheltered area: one demonstration project used an expensive mooring system, but this may not be a replicable solution for future projects given costs and permitting issues.

In a rather distant future where large arrays of floating wind turbines are installed, developing floating dry docks that can accommodate additional units may be considered. Today, the equivalent of floating (shipyard) docks in oil & gas is considered relatively expensive. In discussing the longer-term picture of MCR for commercial-scale floating arrays, major service providers were envisioned to handle these assets further offshore while local facilities may be more appropriate for dry-docks closer to shore. Submersible heavy-lift vessels were also

[3] Siemens Gamesa (2017); Baldock et al. (2014)

proposed as an alternative to a dry-dock due to their motion compatibility and commercial availability.

*collaboration/cluster strategies might be valuable

WTG: Wind turbine generator; IRR: Internal rate of return; NPV: Net present value; CAPEX: Capital expenditure; OPEX: Operating expense

Figure 2. *Additional Ideas for Offsite Maintenance*

Three main challenges to the ideas involving large and/or additional assets were identified:

1) **Maintaining positive net present value:** From the developer point of view, the net present value is of primary concern. It may be difficult to justify the increase in capital expenditure (CAPEX) of standing assets for a relatively small reduction in downtime. In addition, if arrays are to decrease in size due to increased turbine capacity, it would be more difficult to obtain positive net present value (NPV) with overplanting.
2) **Obtaining consent**: Consenting for standing assets at the port or repair activities at a secondary area closer to shore is an additional risk to the project.
3) **Navigating offshore conditions:** Floating dry-docks located offshore are a high CAPEX unit and would be subject to many limitations from restricted weather windows and motion compatibility. Insurance companies may also request shallow water depths for repair. Lastly, deploying overplanted assets may pose additional risks, e.g. in consenting, upkeep, and installation.

1.2 Onsite

Onsite repair means performing the major component replacement at the project site with the help of specialized vessels and cranage.

1.2.1 Floating-to-floating

Like for bottom-fixed offshore wind, onsite solutions can be used for minor correctives. However, as the floating wind array ages, the needs for maintenance increase. For this reason, tow-to-port may not be a feasible strategy when dealing with major correctives (e.g. blade exchanges) or multiple, large FOWTs. Rather, supporting vessels that can perform maintenance onsite are considered more suitable though not yet fully developed and commercialized.

The current volume of projects does not justify the investment by service providers, shipbuilders, offshore crane companies and other typical suppliers to accelerate the building of required vessels for floating-to-floating lifts. While government interest in floating wind – portrayed mostly by targets and announcements – suggests a relatively eager industry for a technology still at the pre-commercial stage, increased support and market visibility is needed for supply chains to form.

Nevertheless, multiple Subcommittee participant organizations are currently researching and/or discussing onsite key components exchange with other players. Developing multi-purpose vessels that can address both installation and O&M as well as bottom-fixed in addition to floating wind could help reduce their costs. New business-models could also help grow a market for these large assets, e.g. by consolidating long-term contracts between developers so that projects can benefit from synergies regarding logistics (e.g. using the same vessels).

1.2.2 Self-hoisting equipment

Self-hoisting cranes are already used for onshore projects and multiple members of the forum are investigating their applications for offshore wind. However, the main concern with self-hoisting cranes for floating offshore wind is whether they are able to lift major components at the height of the turbine and distance from the tower base (which is increased due to the floater).

There are two layers of complexity to this approach, the first being the lift of the major component from the self-hoisting crane assuming that the crane is already embedded in the turbine. The second level of complexity occurs if the crane is not embedded, therefore necessitating an additional operation to equip the turbine with the crane. In both cases, the technology is not yet proven for dynamic lifts and remains an interesting development.

In-the-field solutions for minor correctives are also required to improve the worker environment, particularly in the areas of:

- **Access to tower:** additional points and better bolting connections to facilitate climbing and work.
- **Weather windows**: motion measurement and compensation for human access. Improvements to the accuracy of forecasting would complement such efforts to increase the weather limits of operation.
- **The weight of equipment:** multi-purpose designs to reduce the number and weight of tools; available equipment directly on the floater.

1.3 Decision Parameters

The Subcommittee meetings and interviews provided many different insights on what to consider for future commercial-scale floating O&M. All of these parameters can be evaluated in a project-specific analysis and inform the best maintenance strategy.

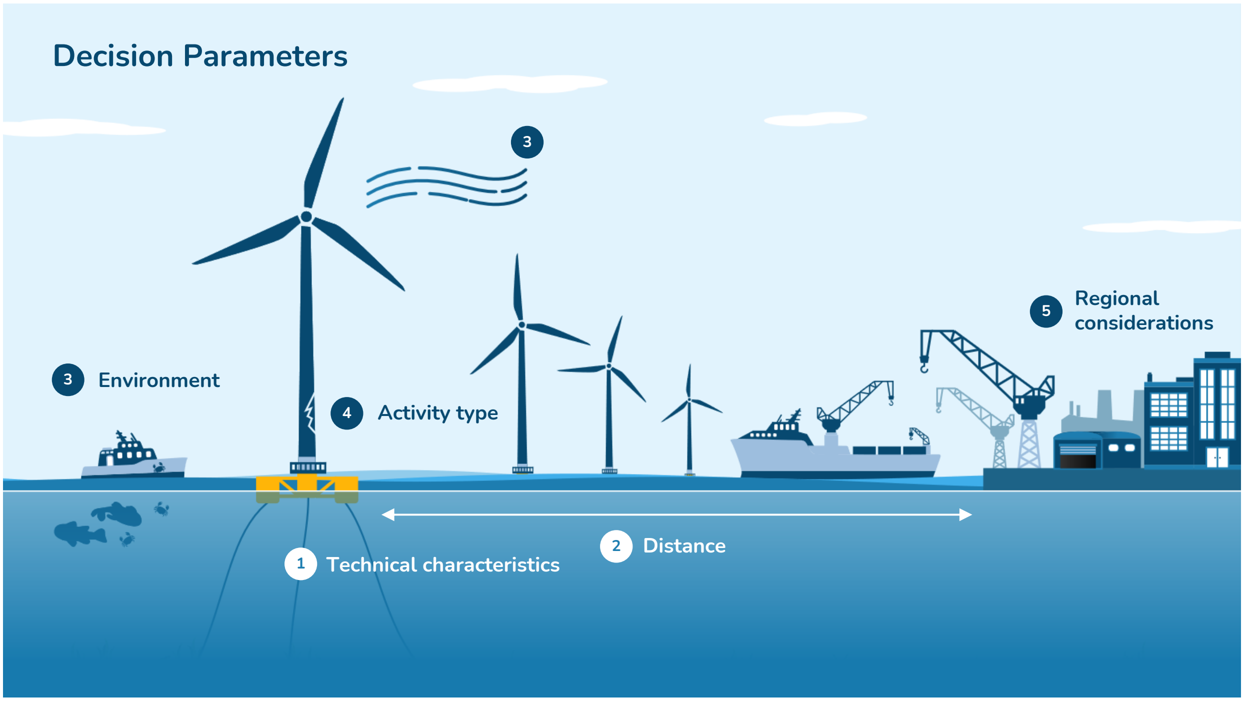

Figure 3a. *Illustration of Decision Parameters for FOW O&M*

1. **Technical characteristics** such as the floater design affects the accessibility, quick connection-disconnection system and workable water depth conditions for a towed repair. For example, spar-type foundations specifically require deeper waters for assembly and maintenance. The high vertical loads of mooring systems for Tension Leg Platforms (TLP) poses stability risks and higher costs during both installation and offsite maintenance.

2. **Distance:**
   - Long distances between the port and wind farm make offsite repairs riskier as weather windows need to be long enough.
   - A delay at the port can further extend an already long maintenance span.
   - SOVs may be more suitable for travelling the required distances than CTVs.

3. **Environment:**
   - Weather windows must be selected so that the impact of wind and wave on human exposure to motion and vessel & crane stability can still allow for maintenance.
   - When working in harbors across multiple countries, there could be restrictions on alien species that need to be taken into account in the towing process.

4. **Activity type:** Assuming all the MCR possibilities are equally valid and available, the nature of the repair (serial defect versus one-off repair) also drives the decision of the MCR approach.

5. **Regional considerations:**
   - Building suitable ports is a crucial element of both onsite and offsite floating offshore wind maintenance requirements.
   - Local contribution to this activity will depend on the materials (e.g. foundation type) and skills required for a given project.
   - WindEurope (2020) identified the need to upscale ports to reach volume in Europe.

6. **Cost-benefit analysis:** Ultimately, floating offshore wind projects need to be bankable. Especially for developers and investors, the NPV of the project is key. Initial investments in CAPEX (e.g. design factors) can affect the required amounts for the OPEX and ultimately the project NPV. Engaging with O&M stakeholders early on can help understand the effects of CAPEX investments on OPEX and vice-versa to ultimately settle with a CAPEX/OPEX structure that maximizes the business case.

SOV: service operation vessel; CTV: crew transfer vessel

Figure 3b. *Description of Decision Parameters for FOW O&M*

1.4 Offsite Maintenance Analysis

Offsite maintenance is an opportunity to perform work in a controlled area and work with more readily available equipment than with floating-to-floating vessels and cranes working in dynamic conditions. **Figure 4** below summarizes some key considerations for particular procedures in an offsite operation:

PRACTICAL IMPLICATIONS	SOLUTIONS IDENTIFIED	ADDITIONAL RISKS IDENTIFIED
Cable connect / disconnect to maximize electrical continuity	Disconnectable turrets, Underwater connection boxes	Electrical protection, Marine growth on power cable*
Mooring line connect / disconnect	Reliable failure rate data on configurations and materials, Mooring fairleads, Temporary storing for tow-to-shore	Seabed disturbance, Permitting for placing lines on seabed
Tight weather windows for tow-in and tow-out	Floaters with high towing speed, Turbines with built-in stability during towing, Additional points for tower access, Weather forecasting	Type of damage that can impact ability for FOWT to be towed
Lifting capacity for high and heavy lifts at quayside	Scaled-up onshore cranes (dry-dock or inshore)	Port readiness in terms of available space, equipment, personnel and restrictions

*remote and autonomous systems can perform preparatory work like marine growth cleaning

Figure 4. *At-sea Implications of Offsite Maintenance*

The suitability of offsite maintenance is of course different from floater system and corresponding mooring configuration, with studies identifying semi-submersibles as benefiting most from tow-to-port technologies.[4]

It is important to stress the port requirements regarding size/depth, bearing capacity, cranage, and spare part availability crucial to an offsite strategy. In particular, Carbon Trust (2021) identified quay loadbearing capacity as one of the most important port requirements.[5] Integrating installation and O&M considerations at the early stages of a project indeed also involves port stakeholders who need to know how to adapt their landscape to fabricate, assemble, install and maintain – and ultimately support the industry of – floating wind turbines.

[4] Carbon Trust (2021), ORE Catapult (2018)

[5] Quay loadbearing capacity defined by Carbon Trust (2021): "Having appropriate shore facilities for loading and unloading large wind turbine components with bearing capacities of at least 10 tonnes/m^2."

2 O&M over the Project Lifetime

The promotion of new technologies is key for realizing the O&M needs of future floating wind projects. In addition, early engagement of O&M players in a floating offshore wind project can improve alignment across all project stakeholders and secure an optimal set-up for the entire duration of the project life.

2.1 Industry leaders need to push for the new technologies required for commercial floating wind

Major developers and floating platform technology providers have the capacity to push for innovations such as digital twinning solutions, quick connection-disconnection technology and to an extent floating-to-floating vessels etc. at the required scale. Applying new technologies as early as possible (e.g. on demonstration projects) can start a track record and benefit commercial projects sooner. Promoting research & development in vessel technology such as floating cranes and opened-up control strategies[6] is crucial to make onsite maintenance a feasible option in the future. In this scenario, designers would naturally compete to keep up with the innovation goals of developers and class societies would follow with certifications. In addition to developers, national and supranational governments also play a role in promoting new technologies through research grants and project financial support mechanisms, designated tenders etc.

OEMs have yet to more directly get involved in floating offshore wind challenges. For instance, risk-sharing was identified as an important way to overcome cost challenges for insurers and developers, but turbine suppliers should also participate in this allocation. In addition, some OEMs are already investing in turbine designs fitted for floating conditions. Current examples include GE's 12 MW concept and MingYang Smart Energy's 16 MW concept. Until commercial scale is achieved, however, floating offshore wind will most likely continue to apply bottom-fixed turbines, potentially with some minor modifications.

2.2 A more integrated design process is required to optimize systems and improve real-time monitoring operations

From an O&M and logistics concept perspective, settling O&M aspects at the design stage of a project could be achieved with early communication and coordination. Indeed, the earlier the O&M perspective can be integrated into the Energy, Procurement, Construction and Installation (EPCI) contract, the better influence it can have on the chosen O&M strategy. For example, relevant industry players engaging early with a developer can ensure that certain

[6] Minutes of Meetings O&M SC 19 May 2021 : The new-generation floating-to-floating lifting solutions will likely benefit from considering not merely a combination of vessel control (e.g. dynamic position – DP systems) with crane control (e.g. dynamic heave compensation), but in fact an integrated design of these in order to reach higher seakeeping efficiency, reduce the repair time, and thus be able to operate within narrower weather windows.

issues are not ignored in the CAPEX phase (e.g. marine growth, placement of chain adjuster) as well as bid for technologies that would pay off in the operating expense (OPEX) phase.

From a design perspective, the integration of turbines and floaters as well as vessels and their control systems at the design stage can help make systems more lightweight, reduce safety factors, and accommodate holistic monitoring operations – all which affect O&M practices in the project's lifetime. Data confidentiality of different components' behaviour is viewed as a bottleneck for deploying advanced monitoring technology for preventative maintenance like digital twinning at the larger wind farm scale. Collaboration between stakeholders will thus be necessary to make real-time monitoring operations possible, all within a framework of respecting intellectual property rights and preserving competition.

The future of floating offshore wind arrays is an opportunity to fully adopt a sytems engineering principle where elements of the project (CAPEX, OPEX, energy production and wake interaction etc.) are jointly examined and decided by stakeholders across the value chain.

2.3 Projects must approach new technologies without affecting the safety factor for insurability

From the insurance perspective, there is a lot of risk in insuring projects for which the O&M strategy applied, which may include new technologies and methodologies, is as a result new to the contractor. Rather, insurers like to see track record in the tools and methods applied.

To reconcile the advantages of using existing experience with the need to work with new technology, a project can consider:

1) **Experience from bottom-fixed or oil & gas** that should be used to the fullest to facilitate the underwriting of a project.
2) **Transparency** on the developer's side which is very important for insurers to properly evaluate project risks and mitigation strategies involving newer technology and/or materials.
3) **Risk-sharing** as a way to spread costs and risks of new maintenance approaches.
4) **Incorporating new technologies early on** but in a way that **increases the factor of safety** (or ensures some **redundancy**) to promote the spread of risk responsibility and improve the availability guarantee in a project contract.
5) **A spare parts concept** that secures a prompt replacement of the damaged or lost items, therefore **reducing the loss of energy production**.

3 First White Paper Preliminary Conclusions

At this point in time, offsite O&M for floating wind (tow-to-port, tow-to-shore) is considered most feasible for this generation of floating offshore wind projects because the technology and methodologies in this approach are known and more readily available. Nevertheless, developing an offsite plan will still require some technology innovations, e.g. in cranage for large turbines and quick connect-disconnect systems for mooring lines and dynamic cables, which at the moment are either scarce or at lower technology readiness levels **[Figure 4]**. Ultimately, the chosen maintenance approach for a given floating wind farm will be subject to various project-specific parameters including floater design, distance to port and associated weather window, harbour capacity and project cost-benefit analysis.

While the lean towards offsite maintenance in the short- to medium- term is a conclusion shared by other studies that reviewed O&M concepts for floating wind, the outcomes of the discussions in the WFO Floating Offshore Wind O&M Subcommittee showed pertinent interest in onsite repair strategies. These onsite approaches, namely floating-to-floating and self-hoisting equipment, are expected to perform major component exchanges in the longer term but require a serious evolution in the vessel and cranage industries. WFO participants have shared the floating crane vessels, self-hoisting equipment as well as analysis and modelling tools that their organisations are working on to fill this gap of necessary technology innovations.

The mobilisation of resources and investments to develop FOW O&M solutions requires capable actors to take the lead. Notably, OEMs, floating platform technology providers and developers were identified as the players that can and should spearhead the development of new floating wind O&M tools and solutions. At the same time, incorporating O&M considerations early on in the timeline of floating wind projects can influence the bidding of technologies and methodologies that could eventually pay off in the OPEX phase.

Commercial-scale floating wind projects will ask for a re-organisation of the ways project sub-packages communicate with each other and share information. The O&M phase is a gluing factor for all the different efforts involved in designing, building, insuring and commissioning a floating offshore wind project, and so studying its aspects at the pre-commercial stage of the industry we are in now will help achieve a sustainable large scale.

In a next step, the O&M Subcommittee will further investigate the available tools and methods needed to carry out specific operations in tow-to-port, e.g. available cranes for MCR or disconnection of electrical cable and mooring lines. Meetings will continue to explore new areas, for instance FOWT accessibility with helicopter.

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