Floating Wind – Marine O&M Considerations

Bo Jardine
Global Category Manager – Marine
Shell

Organized by FWE Quest Offshore

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Floating Wind – Marine O&M Considerations

- Offshore Renewables, in particular Floating Wind, represents one of the greatest areas for growth in offshore marine sector within the past 100 years, with Developers, their Supporting OEMs, and Vessel Owner/Operators all working to advance new floating solutions, supporting technologies and operational paradigms to ensure they can deliver their technical and commercial promises.
- Unique challenges face both the renewables and marine industries as it relates to the Operations & Maintenance (O&M) of floating wind farms, however through industry collaboration many of these challenges can likely be mitigated or solved.
- Developers, their Supporting OEMs, and Vessel Owner/Operators will likely in future require fit for purpose new vessels and supporting logistics infrastructure to ensure commercial success in floating wind.

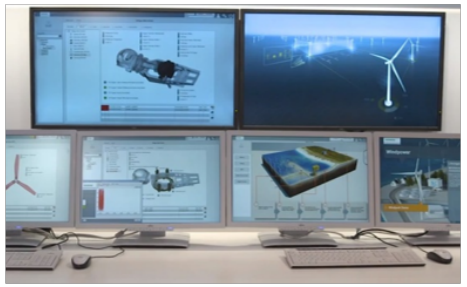
Floating Wind = Huge Potential

Floating Wind – Marine O&M Considerations

Industry experience and knowledge as required to deliver floating wind exists, but challenges remain.

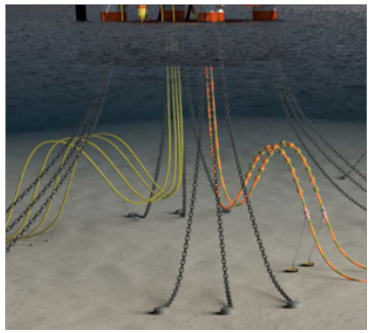
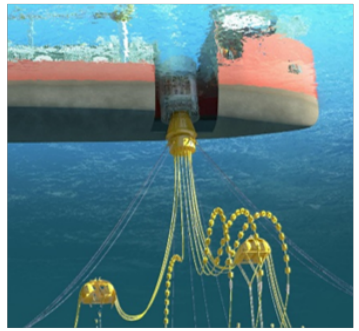
OFFSHORE WIND INDUSTRY



KEY CHALLENGE

OIL AND GAS INDUSTRY

To adapt best practices of two existent industries in one environment

To drive design optimization towards operational excellence at minimal cost and risk

Floating Wind – Marine O&M Considerations

Where are we today?

- Since installation of the first floating wind turbine in 2009 until recently, the primarily focus of industry has been on the R&D of floating wind solutions, proof of concept demonstrators and small-scale pilot farms to show the wider viability of floating wind.
- This focus however is now shifting as Wind Developers move towards developing commercial scale floating wind farms with target on 'Winning Projects in the Pipeline'.
- There still however is no real industry standardization on floating wind turbine solution designs, with numerous concepts in the marketplace.
- In many instances bespoke marine support solutions are required to support in the deployment and later O&M of floating wind.
- Much of the knowledge comes from the O&G sector, notably as relates to subjects like towage and offshore mooring solutions.

Floating Wind Solutions – So Many Options

Floating Wind – Marine O&M Considerations

What does O&M look like?

- Until recently many Developers, supporting OEMs and Vessel Owner/ Operators focused on utilizing known marine vessel solutions and support technologies to get the job done, reverting to 'Tow to Port' as the solution for O&M.
- The 'Tow to Port' scenario however is no longer a sustainable solution from either a technical or economic standpoint. Floating wind developments are moving further from shore, the number installed turbines capacity is expanding, and the complexity and size of turbines is growing.
- The marine vessel solutions needed to support floating wind O&M, including those required for deployment of new in-situ maintenance solutions, could perhaps said to be said to be trailing behind in development. Perhaps in part due to focus on use of known marine solutions.
- There are, however, great technological advancements being made on the in the development of potentially viable in-situ field maintenance solutions (i.e. Unique solutions for component/blade installation and replacement at nacelle, Modular Roaming Cranes (MRCs) / self-hoisting cranes, robotic maintenance solutions, etc).

We have the right people, but do we have the best tools for the future?

Floating Wind – Marine O&M Considerations

Best practice from bottom-fixed OW

- Site replacement
- 30t to 80t components at +100m height
- JUV mobilization
- 3 to 5 day campaign

Challenges for Floating OW

- Floating to floating lifting operation
- Relative motions / load transfer and floater draught change during operation / crane reach
- +140m height (next WTG generation) and higher weights
- Reduced weather windows / further from shore
- Repair yard availability / space restrictions
- Towing and navigation restrictions/ growth in mooring requirements

Major replacement may require towing of FWT to Port or alternative solutions

What are the alternatives to Tow to Port?

FWT = Floating wind turbine

Floating Wind – Marine O&M Considerations

Today's Floating Wind Vessel Complement:

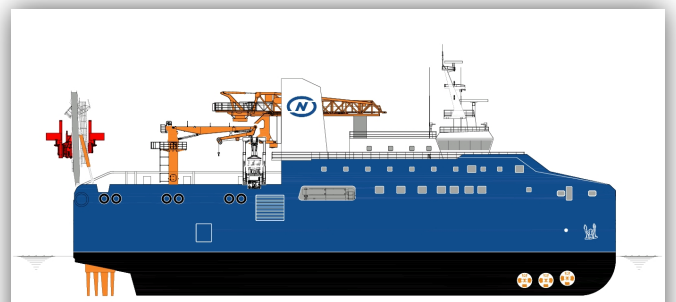
- Floating Wind, like its Fixed Wind, is expected to need vessels with the capabilities like those offered by Service Operation Vessels (SOVs) in order to deliver development needs potentially spanning from the front-end commissioning of wind turbines/OSPs through to long-term turbine O&M.
- Floating Wind, however unlike Fixed Wind, additionally requires the support of Anchor Handling Tugs (AHTs) and/or harbor tugs to manage mobilization, pre-lay of floater mooring solutions, towage of floating turbines to site, connection thereafter arrival to mooring, assist with cable connection, assure floater safety and integrity, etc. - *the list goes on.*
- Such AHTs may also perhaps even need to remaining on term dedicated contract for standby depending upon location and risk case (i.e. - vessel to floater collisions, floating away, partially compromised mooring, etc.)
- Furthermore, additional requirements may be potentially be placed upon supporting O&M vessels in order to facilitate carriage and field mobilization of specialist vessel O&M equipment (i.e. longer outreach cargo cranes to deploy emerging O&M technology solutions like self-hoisting turbine maintenance cranes).
- Subsea and feeder vessels may be required to support in pre/post inspection, hook-up, in field maintenance, more likely as turbines grow and developments move into more challenging locations.

Floating Wind – Marine O&M Considerations

Looking to the Future of O&M

Acknowledging the wide spread of supporting vessels required to safely and effectively deliver Floating Wind developments:

- Could there perhaps be a yet to be developed solution (vessel or otherwise) to better support floating wind developments versus what is employed today?
- To what degree might or should CO2 emissions of the total in field vessel spread drive discussion?
- Should floating wind developments perhaps consider a specialist multipurpose vessel capable of supporting its requirements?
- If so, to what degree could such a vessel be employed spanning from installation, commissioning, through to O&M and eventual field decommissioning?
- In what form might such a vessel or vessels emerge?
- Perhaps by merging known designs/ capabilities in form of a new class of Anchor Handling Tug & Service Operation Vessels (AHTSOV) or in form of an expanded Multi-Purpose Service Operation Vessel (MPSOV)?
- Are modularized vessel solutions perhaps an option?
- Who should drive such potential vessel solution developments, e.g. - OEMs, Vessel Owners/Operators, or Developers?



Floating Wind – Marine O&M Considerations

Highlighting on Opportunities for Marine Technology Exchange

The Energy Industry and Maritime Sector's drive towards lower carbon footprint solutions and the rapid growth of the Offshore Renewables sector sets a near ideal stage for the rapid development and implementation of new technologies and ways of working across the entirety of the Maritime Industry, setting the stage for potential knowledge and technology exchange opportunities between Offshore Wind and Oil & Gas.

Examples include, but are not limited to:

- Energy Storage and Generation Solutions (*Battery ESS, Flywheel ESS, Solar, Fuel Cells, etc.*)
- Alternative Reduced or Zero Emissions Fuels, i.e. Biofuels, Methanol, LNG, Hydrogen (*various forms*)
- Crew Transfer Vessels and related technologies (*Active/ Passive stabilization, adaptive boat landings, etc.*)
- Service Operations Vessels, a.k.a. Multi-purpose Accommodation Vessels
- Marine Access Systems (*Walk-2-Work, Bring-2-Work, etc.*)
- In-Port and Offshore Power/ Charging (*Grid supplied power to vessels, offshore Power Utilities Buoys, etc.*)
- Vessel Digitalization/ IoT (*EFMS, Remote Sensors, etc.*)
- Digital Twin and Computational Fluid Dynamics (*CFD*) simulation
- Autonomous Surface Vessels, Augmented/ Remote Vessel Manning

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Highlighting on Opportunities for Marine Technology Exchange

Some examples where Shell have been or may in future cross-lever these technology exchanges include, but are not limited to:

- Battery ESS – Specification/ inclusion of containerized ESS solutions like the 'Battery On-Board' (BOB) solution and other battery ESS technologies as employed on O&G OSVs into potential future SOVs and CTVs. Such standardize approach to ESS application has potential to reduce industry cost on wider marine fleet battery ESS implementation
- Crew Transfer Vessels – Cross-transfer of technological knowledge/ needs/ solutions between OW & O&G. Shell Bulgaria has already employed a Damen FCS 2710 Wind Farm CTV for crew change to a rig and is presently exploring the wider use of CTVs to augment or replace helicopters for crew change; O&G via its higher operability needs (HS 2.5 - 3.0) has been leading the industry to field even more robust designs of CTVs (Examples include ESNA Aircat, BAR Technologies PROA, Marcello Penna Trimaran)
- Offshore Power Utilities (Charging) – High potential for industry cross collaboration towards the fielding of offshore charging/ mooring buoy solutions (aka Offshore Power Utilities) to support with the decarbonization of offshore developments spanning both renewables and O&G. Perhaps this could materialize in the form of simplified charging buoys. modularized systems with supplied power as dictated by application, e.g. power could be from renewable source (wind generation) or non-renewable source (production platform gas turbine).

Floating Wind – Marine O&M Considerations

Clear need to delivery lower emissions and in future net-zero emissions in operations

Floating Wind O&M Vessels ideally should be:

- Electrified and capable of being adapted to host whatever the future propulsion power source might be, perhaps even going so far as to be being designed in a modular fashion to ease/ speed powerplant installation and future upgrades (think battery energy storage, fuel cells, etc.)
- Capable of being plugged-in (a.k.a. cold-ironing) both while in port and potentially offshore as/when this technology is applied (i.e. via electrical charging via a buoy or another means offshore)
- Perhaps also be capable acting as host provider of electrical charging for visiting or resident supporting vessels, i.e. Crew Transfer Vessels (CTVs), Daughter Craft, Autonomous Survey/ Maintenance Vessels
- In future, fueled by hydrogen-based fuels; This could be liquid hydrogen and/or synthetic fuels, driven ultimately by regulation and industry sentiment with the maritime industry eventually converging around a hydrogen-based fuel needed for the scale of supply

"Shell believes hydrogen offers a promising solution to achieving net-zero emissions both in terms of immediate improvements of local air quality as well as meeting long-term climate goals"
–Paul Bogers, Shell VP of Hydrogen