Large scale floating wind projects: Tension Leg Platforms & the case for offshore in-situ maintenance strategies

Floating Wind Solutions 2022
Operations & Maintenance session
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Bram Pek
Bluewater Energy Services

• Privately owned, independent group of companies founded in 1978
• 40 years of engineering and operations of permanently moored systems
• ~1000 employees (onshore & offshore)
• Owner & operator of FPSOs
• Harsh environments
Bluewater: Design, Build & Operate

Practical Project Execution Experience

Design → Build → Operate

Practical Operational Experience
FPSOs in operation in Scotland

Aoka Mizu

Bleo Holm

Hæwene Brim
Hook-up / hook-off
Weather windows considerations

- Distances to port of planned projects are significant
- Tow-out requires long weather windows

- Year round installation becomes risky
Floating Offshore Wind TLP

- Bottom fixed wind turbines
- Lightweight floater
- Simple structure
- Offshore installation of WTG
- Deep-draft legs
- No mooring lines on the seabed
- No active ballast systems

Focus on logistics:

- Separate supply chains for WTGs and foundations to control risk
- Learnings from bottom fixed projects
Separate supply chains

Foundations

- foundation
- transition

Installation campaign #1

WTGs

- tower
- nacelle
- 3# blades

Installation campaign #2

- foundation
- transition

Installation campaign #1

- tower
- nacelle
- 3# blades

Installation campaign #2
Impact on ports logistics

- Port congestion avoided
- Wet storage not required
- Efficient use of quayside for storage of TLPs
- Simple assembly of modules
TLP storage
Pre-installation of floating foundations
Pre-installation of floating foundations
Floating installation of WTGs
Floating-to-floating WTG installation
New floating WTG installation concepts
Quick connection method

Single slip joint

Double slip joint

Wedge connection

alternative solutions blade flange connection
### Tow-out vs offshore build-up

For non-sheltered floating wind sites

<table>
<thead>
<tr>
<th>tow-out</th>
<th>offshore build-up</th>
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<td><strong>pro’s</strong></td>
<td><strong>pro’s</strong></td>
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<td>• low cost solution for 1 off</td>
<td>• year-round installation of foundations &amp; WTGs</td>
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<tr>
<td>• cost effective for short distance to port</td>
<td>• optimized supply chains</td>
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<td>• efficient for large scale parks</td>
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<table>
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<th>con’s</th>
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<td>• stability required during tow to avoid WTG accelerations</td>
<td>• offshore in-situ maintenance strategies required</td>
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<td>• weather downtimes for long towing distances</td>
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<td>• hook-up / hook-off high risk</td>
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<td>• crane operations required in port</td>
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Bottom fixed offshore wind maintenance
Offshore in-situ blade exchange

• Connect maintenance vessel to TLP on Dynamic Positioning, removing horizontal relative moments
• Heave compensation tooling, removing, vertical relative motions

Seaqualize tool In-hook Balanced Heave Compensation
Forward looking weather systems

Only short timeframes required for installation & maintenance activities

Several solutions available in the market
- Forecasting of environmental conditions
- Prediction of weather conditions 4 – 5 minutes
- Forecasting of metocean conditions can be refined using hindcasts
**In-situ maintenance crane**

**Deployable crane for in-situ blade & component change out**
- Mounted on the floating foundation
- No heavy crane supports in nacelle or around tower
- No relative motions during maintenance
- Self erecting crane
- Support ring around tower for horizontal stability only
Conclusion

1. Tow-out of FOW systems is risky, in particular in harsh sites

2. LCOE main drivers trade-off

3. In-situ maintenance solutions need to be developed now