EERA DeepWind’18

WindBarge - Floating wind production at intermediate water depths

Reduce cost:
Easy to build
Easy to install
Maintain and decommission
TEAM

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Inventor, Prof II at Dep. Marin Technology. 32 yr. of experience in hydrodynamic and wind

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PhD at Dep. Marin Technology. Focusing on hydrodynamics and reliability.

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M.S.c in offshore construction from Dep. Marin Technology. Research on fatigue and global analysis of WindBarge

Fredrik S. Moen
Project Manager International rig management and shipyard experience
Single line mooring and weathervaning

No pretension
No swivel
Redundancy
Position kept by using yaw controller
Known principle
Standard turbine
WindBarge

- Floating wind barge – easy to install, maintain and decommission
- Water depths 40 – 100 meter
- Large marked within existing farms
- Possible to compete with fixed monopile foundations: more environmental friendly and lower cost
- Low draft - built in standard harbors or docks
- Increased production

Expected CAPEX WindBarge versus XL - Monopile
ME/MW - Water depth
Steel mass ratios compared with competitors

Reference monopile
- Turbine Vestas 164 - 8 MW
- Mass/MW ratio monopile = 244

WindBarge 8 MW
- Turbine Vestas 164 - 8 MW
- Mass/MW ratio WindBarge = 238
WindBarge – Sheltered access

- **Sheltered access** in the stern of the floater for maintenance vessels (example ESNA – daughter ship (SES))
- Increased weather window
- Target 2.5m Hs
Suction anchor – not new to the wind industry

- High vertical load capacity
- Safety factor of 2 -> 6 MN vertical load
- Anchor mass in order of 100 tonn
- Towing installation method
Main dimensions – 5 MW version (could be scaled to 8 MW – estimated 1700 ton steel)

Natural Periods
• Heave  7s
• Pitch  17s
• Roll    24.4s
Single Mooring Line (SML – system)
<table>
<thead>
<tr>
<th>Accept criteria</th>
<th>Comments</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact stability</td>
<td>DNV OS-J103. Different in roll/pitch due to weather vaning.</td>
<td>OK</td>
</tr>
<tr>
<td>Restoring moment</td>
<td>Max mean pitch angle &lt; 5 deg</td>
<td>OK</td>
</tr>
<tr>
<td>Nacelle acceleration</td>
<td>RMSE &lt; 0.2g, MPMV &lt; 0.6g</td>
<td>OK</td>
</tr>
<tr>
<td>High pitch-period</td>
<td>Maximized during optimization</td>
<td>OK</td>
</tr>
<tr>
<td>Yaw stability</td>
<td>Avoid fishtailing and maintain heading passively/actively</td>
<td>In progress</td>
</tr>
<tr>
<td>Mooring system</td>
<td>Single mooring line with buoys and electrical cable + suction anchor for unobstructed rotation</td>
<td>Initial design</td>
</tr>
<tr>
<td>Turbine support</td>
<td>5-8MW</td>
<td>OK</td>
</tr>
<tr>
<td>Maintenance access</td>
<td>Sheltered docking &lt; 2.5m Hs</td>
<td>Not verified</td>
</tr>
<tr>
<td>Structural capacity</td>
<td>Wave- and wind bending moments within the capacity of a simple barge design</td>
<td>In progress</td>
</tr>
<tr>
<td>ULS simulations</td>
<td>Verify barge behavior in extreme conditions</td>
<td>In progress</td>
</tr>
<tr>
<td>FLS simulations</td>
<td>Long-term FLS analyses with SCFs – find damage equivalent loads</td>
<td>Not started</td>
</tr>
</tbody>
</table>
Intact stability

- DNV requirements satisfied in pitch.
- In roll, it is assumed that 50% of the capacity is sufficient due to limited wind overturning moment.
Planed Projects

- Verification from simulations/model tests
- General design improvements
- Technology qualification
- LCOE – documentation
WindBarge
Economical floating wind production at intermediate water depths
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Metocean parameters