PELASTAR FLOATING WIND TURBINE

ENGINEERED TO OPTIMIZE THE COMMERCIAL COST OF ENERGY FOR DEEP WATER ENERGY
PELASTAR – AN OPTIMIZED WIND FARM SOLUTION

Reduce capital and O&M costs to develop the lowest LCOE Floating Offshore Wind Turbine Farm:

- Minimize floating foundation hull steel weight.
- Minimize hydrodynamic response and mooring loads.
- Maximize turbine availability.
- Provide robust foundation and mooring for severe weather.
- Optimize cost for commercial scale operations (not a single demonstrator).

A tension leg platform (TLP) meets these requirements.
TENSION LEG PLATFORM TECHNOLOGY HISTORY

Originates from deep water oil & gas technology in the 1980s.

- Suited for water depths greater than 1,000 ft.
- Allows onshore assembly.
- Lower mass than other floating solutions.
- No active ballast required.
- Stiff mooring results in reduced response to waves.
  - Higher turbine efficiency
  - Reduced dynamic loading on turbine components

SeaStar TLP installed in 1998
PELASTAR TENSION LEG PLATFORM OVERVIEW

Project History:
• 2009 – Carbon Trust Award
• 2011 – DOE Funding
• 2012 – ETI FEED-level Design

Project Highlights:
• Supports a 6 MW turbine.
• DNV-GL approved Basis of Design and FEED-level design.
• 1:50 scale model test performed with software validation and reviewed by DNV-GL.
PELASTAR INNOVATIVE TECHNOLOGY

- Centralized buoyancy type TLP minimizes wave loads and therefore mooring loads.
- 5-arm design reduces cost from previous 6-tendon designs.
- 5-arm design provides redundancy to survive loss of one tendon.
- 5-arm design distributes and lowers peak tendon loads during a hydrodynamic slack event.
- Synthetic tendon design is cost-effective and robust.
MOORING TECHNOLOGY INNOVATION

Synthetic Tendon Development

• Developed with DSM and FibreMax.
• High strength to survive slack-line events in extreme weather conditions.
• Cables allow initial creep and then set to minimize life-cycle tendon length adjustments.

Moored Response Motions

• Tank testing validates significantly reduced angular response motions.
TLP WIND FARM MOORING BENEFITS

Traditional Catenary Mooring
- Extensive footprint.
- Significant seabed impact.
- Catenary mooring requires significant chain lengths.
- Interference between mooring and power grid.

TLP Vertical Tendon Mooring
- Compact footprint.
- Minimal impact on seabed.
- Minimal impact on fishing ops.
- Efficient power grid connection.
OFFSHORE INSTALLATION CONCEPT

- Existing offshore dynamic position (DP) crane vessels.
  - Turbine and TLP foundation loaded on vessel for transit to site.
  - Crane lifts TLP foundation on site.
  - Foundation ballasted and tendons connected.
  - Foundation de-ballasted and tendon tensions verified.
  - Crane hook releases from foundation.
  - Crane lifts turbine onto foundation and secured.
- Allows onshore assembly of TLP tower and turbine.
- Allows onshore commissioning of turbine.
### SCALABLE SOLUTION

<table>
<thead>
<tr>
<th></th>
<th>6 MW</th>
<th>12 MW</th>
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<tbody>
<tr>
<td>Water Depth (LAT)</td>
<td>55 m</td>
<td>100 m</td>
</tr>
<tr>
<td>Rotor Diameter</td>
<td>150 m</td>
<td>220 m</td>
</tr>
<tr>
<td>Hub Height (above LAT)</td>
<td>108 m</td>
<td>137 m</td>
</tr>
<tr>
<td>Tower Weight</td>
<td>450 mt</td>
<td>1,350 mt</td>
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