Glosten

2019 FRENCH AMERICAN INNOVATION DAY BOSTON

ENGINEERED TO OPTIMIZE THE COMMERCIAL COST OF ENERGY FOR DEEP WATER ENERGY

PELASTAR FLOATING WIND TURBINE

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

SeaStar TLP installed in 1998

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

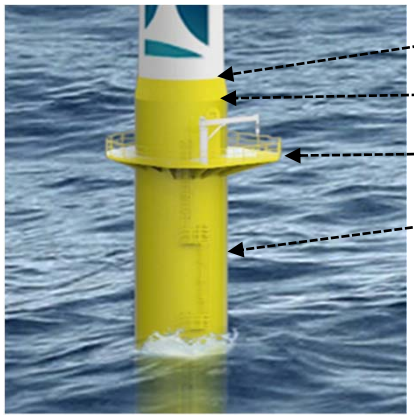
PELASTAR TENSION LEG PLATFORM OVERVIEW

Project History:

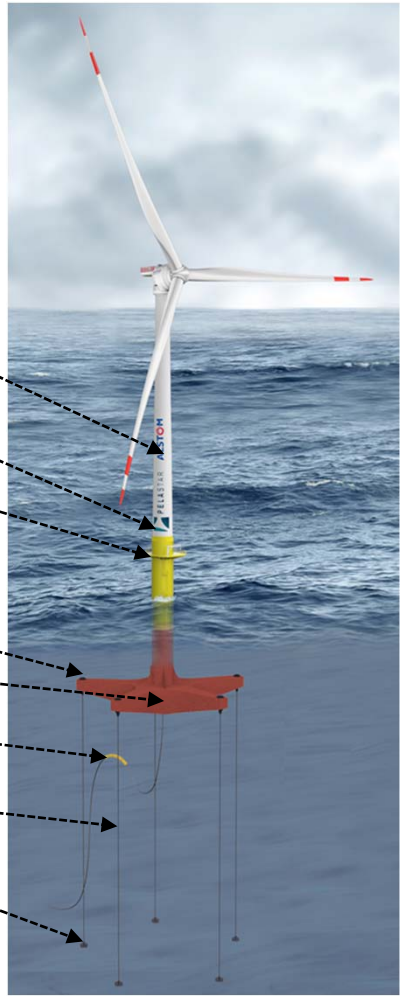
- **2009 – Carbon Trust Award**
- **2011 – DOE Funding**
- **2012 – ETI FEED-level Design**

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.**



Tower
Interface Flange
Transition Piece
Access Platform
Upper Column
5 Arms
Lower Hull
Export Cable
Tendons
Anchors



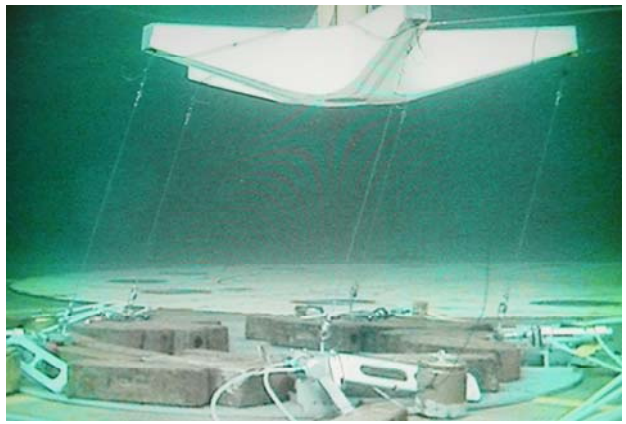
PELASTAR INNOVATIVE TECHNOLOGY

- 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

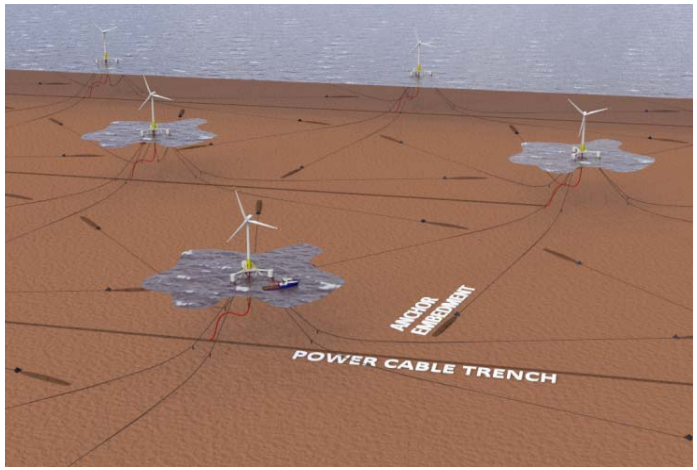
- Developed with DSM and FibreMax.
- High strength to survive slack-line events in extreme weather conditions.
- Cables allow initial creep and then set to minimize life-cycle tendon length adjustments.



Moored Response Motions

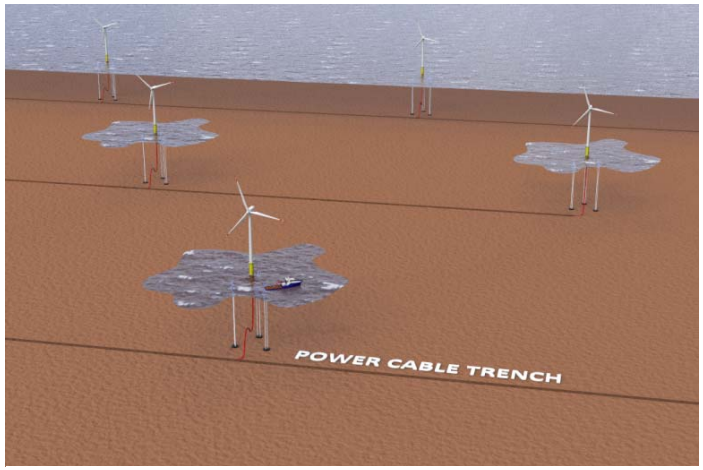
- Tank testing validates significantly reduced angular response motions.

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.



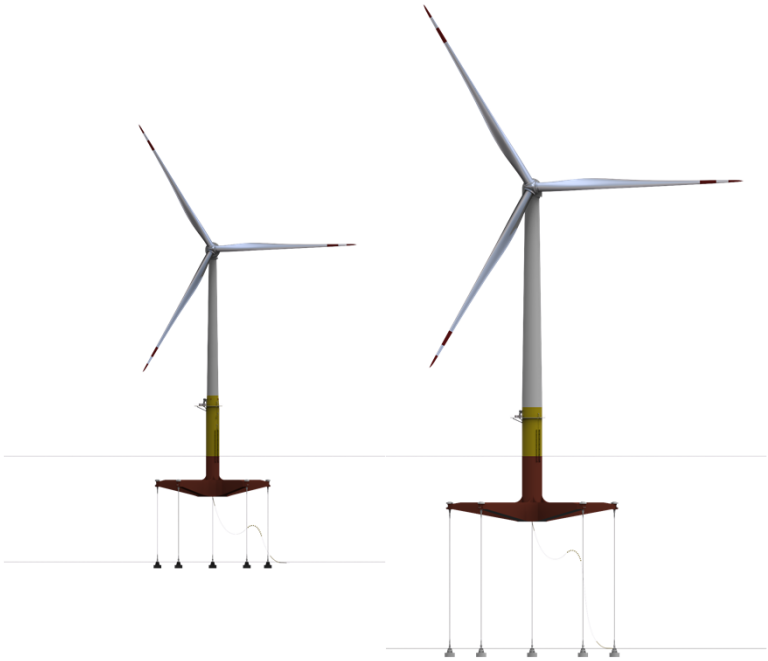
TLP Vertical Tendon Mooring

- 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



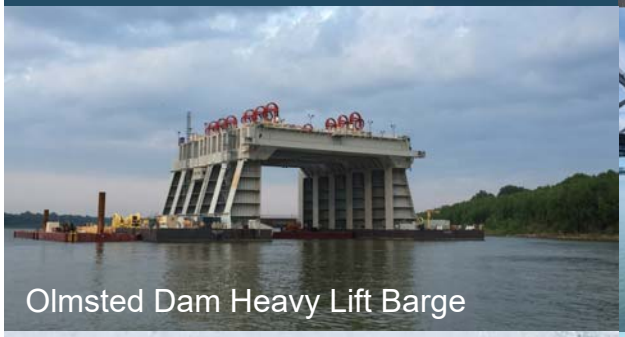
	6 MW	12 MW
Water Depth (LAT)	55 m	100 m
Rotor Diameter	150 m	220 m
Hub Height (above LAT)	108 m	137 m
Tower Weight	450 mt	1,350 mt

Glosten

Kyle Beattie, PE
kcbeattie@glosten.com
New Bedford, MA
Seattle, WA


Rocket Landing Vessel


Emergency Vessel Towing System


Olmsted Dam Heavy Lift Barge


Oakland Bay Bridge Demolition


Ice Capable Research Vessel


Foiling Passenger Vessel