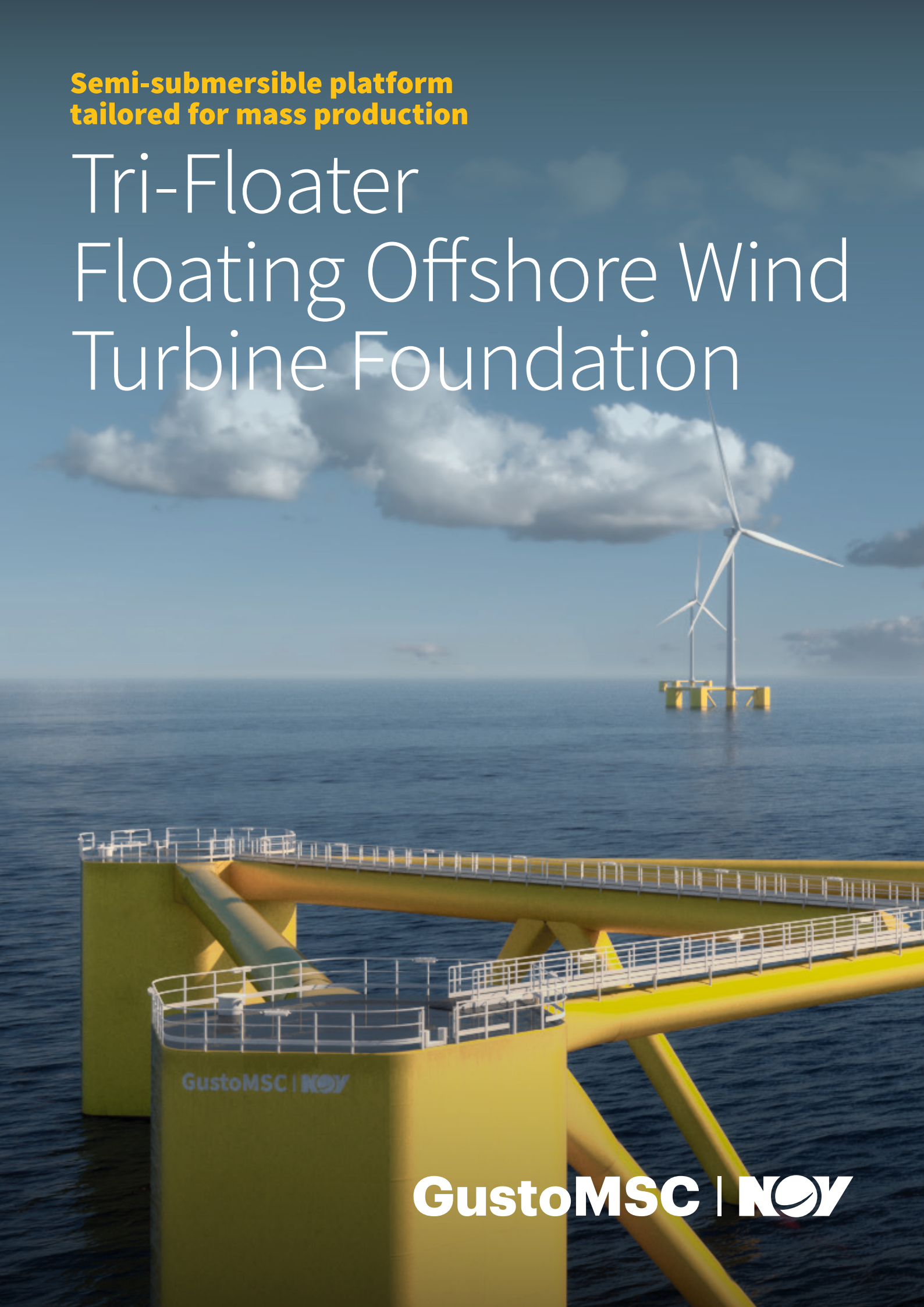
Semi-submersible platform tailored for mass production

Tri-Floater Floating Offshore Wind Turbine Foundation



GustoMSC | NOV

Floating Offshore Wind Turbine Foundation

To prepare for the large scale deployment of Floating Offshore Wind Turbines (FOWTs) with ever growing wind turbine sizes, GustoMSC presents the Tri-Floater design: a highly scalable modular foundation with outstanding performance while optimized for efficient production and assembly using existing supply chains.

The Tri-Floater design is characterized by a combination of excellent motion performance at nacelle level, fit for mass production and local assembly. Once constructed, its stability properties, suitability for shallow port access and low-risk installation, disconnection and access procedures provides a robust operational profile. Operation and maintenance is minimized through a lean design with limited active components onboard and advance monitoring capabilities.

Integrated NOV technologies

GustoMSC is part of the NOV family of companies and leverages the expertise of multiple reputable NOV brands, to offer an integrated solution to the market. For the Tri-Floater mooring design, GustoMSC is closely collaborating with APL, a world leader in permanent mooring designs and delivery. Furthermore, NOV companies such as BLM (mooring equipment), M/D Totco (condition monitoring platform) and others are bringing their extensive knowledge into the Tri-Floater design making it a state-of-the-art integrated design geared for long term performance.

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Low Motion Envelope

The semi-submersible hull shape ensures natural periods of motion outside the range of wave periods. This results in a low motion envelope and limited accelerations at the wind turbine nacelle.

Innovative Assembly

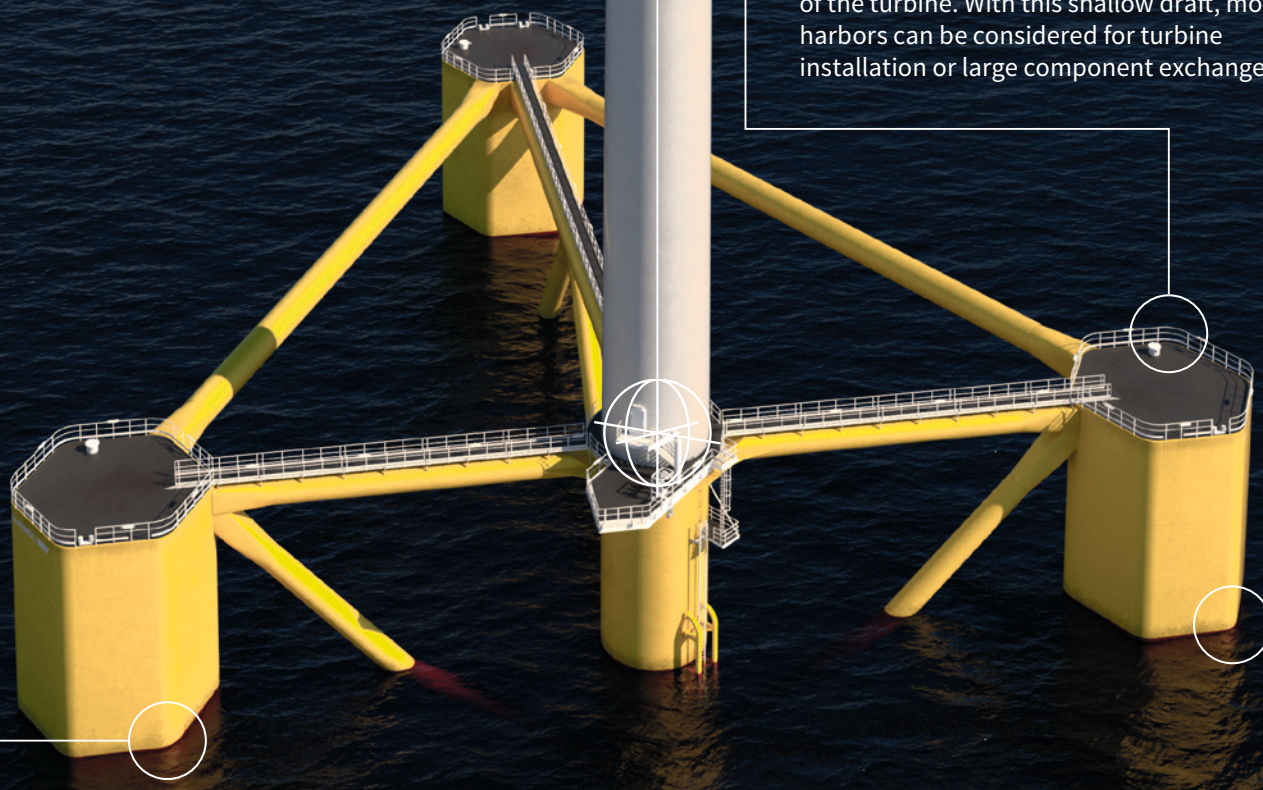
The assembly process of the Tri-Floater is optimized for simple fit-up and automated welding, allowing efficient local final assembly.

Construction & Assembly

Modular design based on automated production techniques of a wide supply chain for optimized manufacturing and local final assembly.

Shallow Draft

With the positioning of the turbine in the middle between two columns, the Tri-Floater has a shallow draft in port during and after installation of the turbine. With this shallow draft, more harbors can be considered for turbine installation or large component exchange.



Maximizing Revenues Minimizing Costs

Outstanding performance

The Tri-Floater is based on more than 20 years of R&D on semi-submersible applications for floating offshore wind turbines at GustoMSC. All these efforts are further backed by GustoMSC's extensive track record in semi-submersible design with more than 50 new build references, an unparalleled track record in the industry.

By intelligently optimizing the topology of the Tri-Floater, its motion behavior is characterized by low accelerations and low inertial loads applied on to the turbine. The resulting design is highly scalable, structurally efficient, and easy to optimize for individual site conditions and wind turbine specifics. All this is accomplished while boasting a low overall weight and associated cost.

Modular platform for efficient mass production

Recognizing the high unit volumes that are required to make the floating wind industry an enabler for renewable energy production at scale, efficient manufacturing has been an absolute priority in the design of the Tri-Floater. The Tri-Floater is therefore a modular design, in which the individual columns are connected by an efficient bracing system with a smart connection philosophy. This enables optimization of each module separately and allowing the leveraging of multiple existing supply chains as well as introducing flexibility into project logistics without impairing overall performance.

Hexagonal buoyancy columns

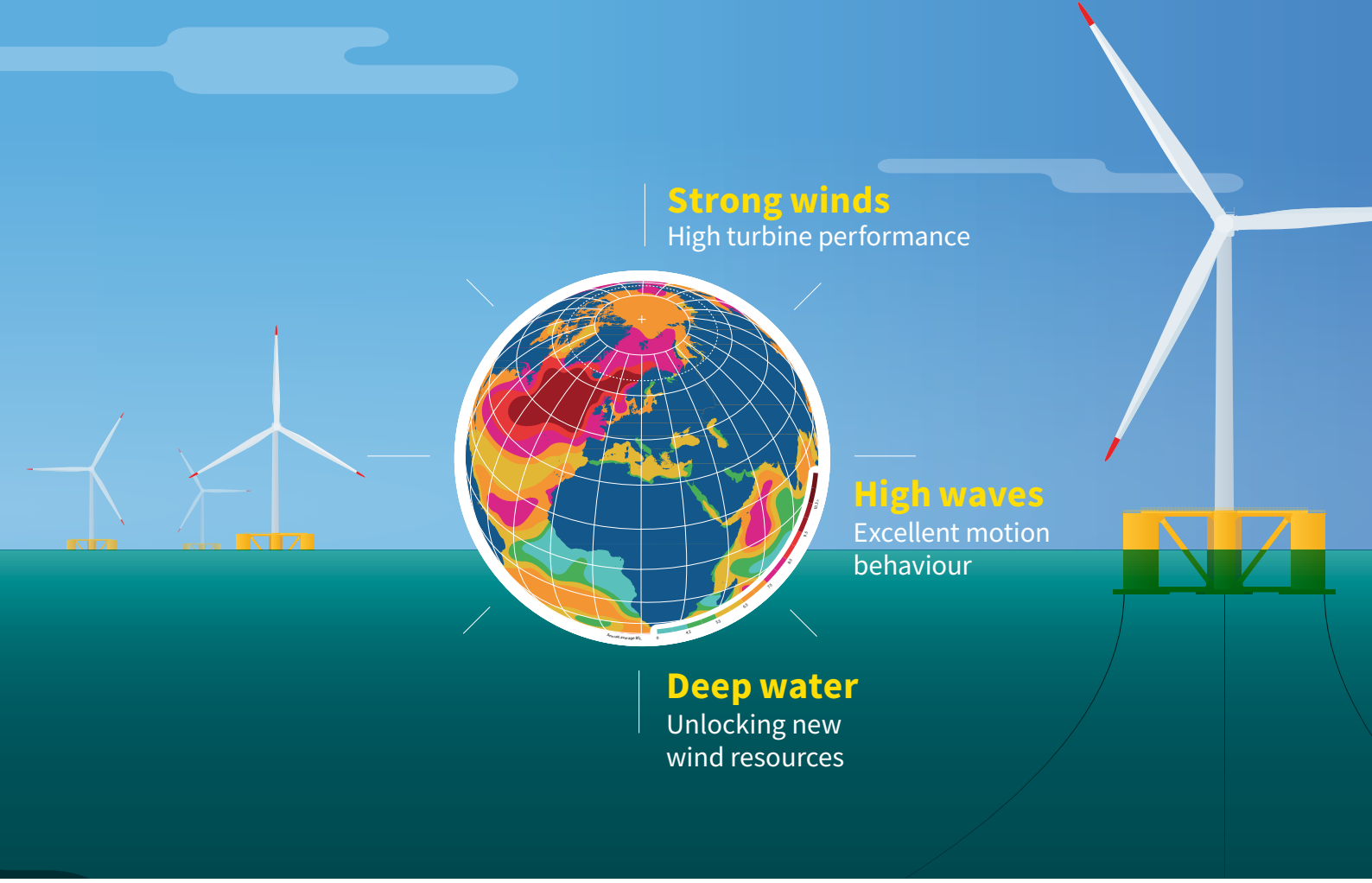
The buoyancy columns of the Tri-Floater are designed for low weight and maximized volume, while still allowing for efficient production. The best structural arrangement to achieve this feature is to use thin steel plates reinforced with longitudinal stiffeners and transverse girders. This type of structural arrangement is commonly used in the shipbuilding industry. The hexagonal shape of the Tri-Floater buoyancy columns maximizes the flat plate area, which can be efficiently produced on fully automated flat panel lines. This allows the buoyancy columns to be produced at a high throughput and low cost with excellent quality.

Shallow draft in port

The innovative (patent pending) column arrangement of the Tri-Floater – in which the wind turbine is located between two buoyancy columns – results in minimal water ballast requirements, ensuring an ultra-shallow draft of less than 10 m for all temporary conditions with the wind turbine installed. As a result, a wide range of port infrastructure becomes available for the various construction, installation, and O&M activities during the complete project lifecycle.

Site optimized

While modularity focuses on standardized manufacturing processes, the size and shape of the Tri-Floater and local details like plate thicknesses are optimized for site and turbine specifics. This allows the Tri-Floater to achieve a highly competitive weight and cost for semi-submersible topologies.



Flexible supply chain

Because the Tri-Floater can be split into three major component types, a flexible supply chain can be proposed, all based on existing supply chains:

- The hexagonal stiffened thin-walled buoyancy columns are optimized for automated panel production lines widely available within the shipbuilding industry.
- The unstiffened thick-walled column supporting the wind turbine column is a continuation of the wind turbine tower. The highly optimized manufacturing facilities of monopile fabricators and wind turbine tower supply chain can be leveraged for efficient manufacturing.
- The bracings are typical of the jacket industry, which is also characterized by high production efficiencies.

Local final assembly

Floating wind farms are designed for areas characterized by high winds and associated weather conditions. To reduce risks associated with prolonged ocean tows, the floater assembly site must typically be located relatively close to the wind farm location. Thanks to its shallow draft in port, the Tri-Floater can be assembled in harbors with low water depth. The Tri-Floater uses an innovative assembly method (patent pending) where the braces are connected to the floater via flat plate connections only, greatly simplifying the fit-up and welding process. This enables an efficient assembly process by local workforces.

Disconnection without loss of power production

Floating wind turbines are typically expected to be arranged in cable arrays of roughly 5 units in serial connection to simplify the subsea HV cable layout. This means that if a single floater within the array is disconnected, e.g., during a tow-to-port scenario, the remaining units within the array are disconnected as well and cannot deliver power to the grid.

Thanks to the innovative Cable Hang-off Assembly designed by APL (patent pending), the Tri-Floater can be safely disconnected while maintaining a closed electrical circuit, allowing the remaining units on the array to deliver power to the grid. The cable hang-off assembly can be safely lowered to the seabed through a specifically designed I-tube, without the risk of a kink in the cable in the process. Reconnection is also a relatively simple process where the cable hang-off assembly is winched back through the I-tube and reconnected to the wind turbine switch gear. This solution enables efficient disconnection and tow-to-port operations for major component replacements.

Optimized mooring system

The mooring system of the Tri-Floater is designed by APL, a sister company with vast experience in permanent mooring systems. The mooring design is composed of predominantly synthetic ropes, which can be manufactured at scale, have excellent fatigue properties and benefits in terms of offshore handling. Accordingly, chain length is minimized. The mooring system can either use driven or drilled piles or suction anchors and is suitable for the implementation of a shared anchor philosophy.

The Pioneers of Offshore Engineering

GustoMSC is recognized for providing advanced design & engineering consultancy for mobile offshore units and reliable equipment. In close cooperation with our clients, we translate experience, science and technical knowledge into realistic and innovative ideas. In this way, GustoMSC enables and supports safe and efficient operations at sea, contributing to a sustainable future.

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