

Tri-Floater Floating Offshore Wind Turbine Foundation

Robust and Cost-Effective

GustoMSC | NOV



Floating Offshore Wind Turbine Foundation

Floating wind turbines are seen as key to unlocking the massive energy potential in global offshore deep water, where there are strong winds and bottom-founded structures are not economically feasible. GustoMSC is a market leader in the offshore wind installation vessels market and now aims to play a significant role in the floating foundation market as well. The Tri-Floater, a semi-submersible wind turbine foundation, has been designed by GustoMSC specifically for this purpose.

The GustoMSC Tri-Floater is a triangular semi-submersible with an offshore wind turbine column at the centre of one of its sides. The semi-sub structure is modular and can be tailored to fit any desired wind turbine. It is optimized for local environmental conditions and supply chain. It has good overall performance and has a shallow draft in port, thanks to its innovative arrangement and buoyant damper boxes. The Tri-Floater is designed to meet the needs of the floating offshore wind market.

With the updated Tri-Floater design, the focus of GustoMSC remains on easy manufacturing, optimizing for local and global supply chain, operations and maintenance.

Data available from the NREL 15 MW reference turbine showcases a competitive design under extreme environmental conditions.

Integrated NOV technologies

The Tri-Floater benefits from the wide range of innovative NOV technologies applicable to the floating wind market, such as OPB preventing mooring connectors, FRP walkways, advanced CBM and in-cloud data analytics. The Tri-Floater also relies on decades of past offshore experience from leading specialists like GustoMSC and NOV-APL, combining together insightful knowledge into a unique design. These technologies and know-how are brought into the core of the Tri-Floater design to achieve an efficient, fully integrated solution for floating wind.

Proven semi-submersible technology developed for the offshore oil & gas industry is applied to a completely new setting in a new industry. The Tri-Floater confirms some impressive claims.



Maximizing Revenues Minimizing Costs

Tri-Floater

Driven by the ever-growing size of turbines in the offshore wind industry, GustoMSC has updated its Tri-Floater design to improve the scalability of its foundation design in the floating offshore wind market. With the updated Tri-Floater design, GustoMSC remains having the focus on easy manufacturing, optimization of local and global supply chain and optimization of the operations and maintenance.

Being part of the NOV family of companies, GustoMSC makes use of the expertise of NOV APL, experts in complex mooring designs, to improve the floater behavior from a mooring perspective.

Custom build design

The Tri-Floater design is a custom build design, and scalable for any turbine sizing available today and in the near future, under any local environmental condition and seabed condition. Data available from the NREL 15 MW reference turbine showcases a competitive design under extreme environmental conditions.

Passive ballasting

The Tri-Floater is designed with a passive ballasting system. Minimizing the amount of marine auxiliaries on-board the floater limits the operational cost of the Tri-Floater for potential service responses of the auxiliaries at deep water locations. Which are often difficult to reach and for which crew transfer vessels are waiting for weather to transfer personnel.

Proven Technology

The Tri-Floater technology is based on GustoMSC's long experience and track record in oil and gas semi-submersible design. Additionally, during recent years several three-columns floating wind turbines have been installed and the performance of these semi-submersibles matched the expectations based on model tests and coupled simulations.

As the underwater shape is rather comparable with the Tri-Floater design, the same can be expected for the Tri-Floater. Thanks to the prototypes, three-column semi-submersible floating wind turbines can nowadays be considered as proven technology. GustoMSC has developed the Tri-Floater technology to such a level that it is ready for full scale offshore application, enabling the commercialization of floating offshore wind energy.

Easy fabrication

Making use of standard panel line welding and the tubular industry, the columns for the Tri-Floater can be fabricated at numerous shipyards and steel construction facilities. With the large quantities of foundations required in the future of the rapidly expanding floating wind industry, the combination of local with global block fabrication and local assembly facilities help to overcome the supply chain challenge.

The bracings of the structure are standard sized tubulars, supplied by the widely available tubular industry to the assembly site.

The column below the turbine is an extension of the turbine tower, used to transfer the loads from the turbine into the structure. This column is similar to solutions used in the fixed offshore wind industry.

Shallow draft

The turbine is positioned between the two aft columns of the Tri-Floater. This benefits an easy load out or launch of the structure in port of the assembly facility. Limited local draft is required, enabling more assembly facilities to be considered for the assembly work of these large structures.

In addition, the installation of the turbine with either an onshore crane from quayside or with an offshore crane on a jack-up, positioned just next to the Tri-Floater in port. Again, a limited water depth in port is required to support this activity, allowing more harbors to be considered for this work.

Strong winds

High turbine performance



High waves

Excellent motion behaviour

Deep water

Unlocking new wind resources

Main particulars for the 15 MW NREL reference wind turbine

Design significant wave height survival	13.5 m
Design significant wave height operational	10 m
Wind turbine rated power	15 MW
Rotor diameter	240 m
Hub height above SWL	143 m
Length overall	94 m
Beam overall	104 m
Operational draft	20 m
Harbor draft	8.5 m
Floater weight approx.	5,000 t
Wind turbine weight approx.	2,300 t

These particulars are for an example design case.

The Tri-Floater can be tailored to fit any desired turbine and optimized for local environmental conditions.

Gentle Motions

The semi-submersible hull shape ensures that the natural periods of motion are outside the range of wave periods. This results in gentle motions and limited accelerations at the wind turbine nacelle.

Construction & Assembly

The choice for either the hexagonal flat-plated structure or a tubular structure in a project maximizes the use of the supply chain of the global and local steel construction industry.



• **Innovative Mooring**

The mooring lines are connected at a high level on the floater, in order to minimize the wind overturning moment. This allows for a smaller and more cost effective floater.

• **Shallow Draft**

With positioning the turbine in the middle between two columns the Tri-Floater is at a limited draft in port during installation of the turbine. With this shallow draft more harbors can be considered for turbine installation.

The Pioneers of Offshore Engineering

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

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