

INSIDE

MAY 2017 #27

INGENUITY INSIDE OUT

GustoMSC

THE PIONEERS OF OFFSHORE ENGINEERING

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PREFACE

INGENUITY INSIDE OUT



The strong cost reduction targets in the offshore oil & gas and offshore wind industries continue to put pressure on the expenditure for offshore operations. Differentiating, cost saving and efficiency are our clients' main drivers when looking for new business opportunities, and we can help achieve those objectives in many ways, ranging from consultancy engineering work and delivery of designs and equipment to various operational support services.

Designs

As designers of mobile offshore units and suppliers of offshore equipment, we cooperate with owners on their wish lists, and provide insight into the cost impact of these design and operational requirements. This creates fine-tuned and well-balanced new build units, enabling the owners to differentiate from their competition and optimize their capital investment versus their operational cost.

GustoMSC's series of proprietary designs for mobile offshore units are based on our interpretation of developing market requirements, such as the NG-9800C-US introduced in this InSide issue, a wind turbine installation unit specifically tailored to the infrastructure and wind development areas in America. The proprietary designs can of course be fully customized to owner or mission equipment specific requirements. Alternatively, we develop bespoke designs to any set of requirements, in close cooperation with owners and with their best interests at heart.

Upgrades

Although the current downturn may provide attractive prices for new builds, there are not many new build programs foreseen. Many owners are working on upgrading their existing fleets, again to differentiate from competition and to offer lower overall cost. At GustoMSC, we have developed upgrade concepts, and we are engaged with owners to develop specific upgrades to increase drillship functionality, as well as upgrades for the other product types in our portfolio. Fine examples are the upgrades to the NG-9000C wind turbine installation vessels we engineered, including crane boom extensions and leg extensions. I am honored that in this edition of InSide Even Larsen, CEO at Fred. Olsen Windcarrier, has been so kind to reflect on the offshore wind market, the successes of his company and the contribution of the two upgraded NG-9000C installation vessels in their fleet.

The upgrade of accommodation jack-up Haven has been a particular challenge. We initially expected that only a new build CJ70 jack-up would be suitable for the conditions at the Johan Sverdrup field. However, after bringing all our expertise to the project and by closely cooperating with other specialized companies, an upgrade concept with large suction caissons and stronger legs finally came out as the most suitable solution in view of delivery time and cost. This case, featured in this edition of our InSide magazine, has clearly proven our ability to be unbiased towards only new-build solutions and to apply our expertise in the best interest of our clients.

Operational support

For many owners of mobile offshore units, we provide support to optimize their operations. This can either be maintenance and training services for equipment we supplied, or engineering consultancy services aimed at extending the operating conditions and uptime of mobile offshore units. With these services, we are often able to extend the capabilities of mobile offshore units beyond their original design envelope.

One of our clients recently expressed his company's strong preference for their mobile offshore units to be designed by a "design house" or specialized engineering consultancy firm. The primary reason for this preference, besides access to proven expertise and flexible cooperation, was their positive experience of full lifetime and high quality engineering consultancy support. In addition, many years after delivery there is still access to the fundamental backgrounds of the mobile offshore unit's design and operating envelopes. I was very pleased to learn this client's view, because it dovetails 100% with GustoMSC's business model:

'Offering technical services across the full lifetime of mobile offshore units and offshore equipment.'

Enjoy reading this new edition of InSide magazine and please contact us for any offshore engineering challenge you may have.

Nils van Nood
CEO GustoMSC

UP-TO-DATE



UPGRADE ACCOMMODATION JACK-UP HAVEN FOR JOHAN SVERDRUP FIELD

In September 2015, Statoil awarded a contract to Jacktel AS, a subsidiary of Master Marine, for providing accommodation services on the Johan Sverdrup Field (phase 1). The accommodation jack-up Haven will provide bed capacity and catering services for 400 project personnel. However, the water depth and foundation conditions at Johan Sverdrup surpass the original design capabilities of Haven.

With first Statoil, the field operator, and subsequently Master Marine, the jack-up owner, as clients, GustoMSC investigated the possibilities for upgrading Haven in a concept and pre-engineering phase. This was followed by an engineering phase from December 2015 to July 2016 led by Statoil to fully mature the preferred concept. Haven is to

be equipped with four large suction caissons and longer stronger legs. Once equipped with four large suction caissons, the majority of the environmental loading is borne by the foundation, limiting the amount of hull reinforcements to a minimum.

The legs will be upgraded by partly re-using existing leg sections and adding 92 m of new stronger leg sections. This brings the total leg length excluding suction caissons from the original 131 m to 165 m.

The total upgrade project is a combined engineering effort of three subcontractors responsible for the engineering: The Norwegian Geotechnical Institute (NGI), Semar and GustoMSC. GustoMSC was



responsible for the Site Specific Assessment, the enhanced Site Specific Assessment as per Statoil requirements, leg design including detailed Finite Element verification of leg and connection to suction caisson, structural analysis of leg to hull interface and primary hull structure, fatigue assessment, vessel impact study and installation conditions.

The new legs sections and suction caissons are currently being fabricated by Lamprell. The Haven is estimated to be on site in June 2018.

More information on the Haven upgrade on page 20.

Sebastian Hermans
Expert Engineer

WIND LIFT I FIT FOR NEW OPERATIONS

In April this year, the technical management of Wind Lift I was transferred from Wulf Seetransporte to Harren & Partner. Deutsche Offshore Consult (DOC) is in charge of the commercial management of Wind lift I and coordinated the transfer. The unit has been in operation since 2010 in wind installation and maintenance. GustoMSC provided the NG-5300 basic design, the hydraulic jacking system and the 500 ton Heavy Duty/ High Outreach offshore crane of Wind Lift I.

In the period prior to the transfer of ownership, DOC and Harren & Partner are working on preparing the vessel and crew to create a solid base for the vessel so that she will be ready, reliable and fit for new operations.

As a part of this preparation, the vessel, jacking system and crane were inspected by GustoMSC.

To increase the capabilities and efficiency of the Wind Lift I, GustoMSC provided advice on possible modifications and upgrades such as leg extensions, integration of a tagline system, crane boom extension and data logging.

As an independent designer, GustoMSC has long-standing experience with the design aspects of mobile offshore units. Our Customer Service department offers inspections, maintenance, supply of spare parts, training and operational support services. Together with our engineering services these services enable owners to extend the boundaries of what is possible with their units and continuously improve their operations and maximize asset return.

Frank Scheffer
Manager Customer Service



GUSTOMSC INTRODUCES THE NG-5500X-LD DESIGN



Last March at SPE/IADC Drilling in The Hague, GustoMSC launched its latest design in the successful series of self-propelled jack-up designs, the NG series. The NG-5500X-LD is a solution for light drilling and well intervention in a large number of mature fields in the Southern North Sea, Middle East and South East Asia. The conditions of these fields are characterized by water depths of up to 50 to 80 meters depending on the region. Until now, this was the domain of classic drilling jack-ups and tender barges with associated day rates and operational restrictions. With the light drilling cantilever, the NG-5500X-LD bridges the gap between the successful shallow to mid-water service units and the fully-fledged drilling rigs.

The light drilling rig will ensure high utilization as it can serve a variety of brown field needs, such as light drilling, well intervention and

plugging and abandonment. The large clean main deck (approx. 1,200 m²) allows for flexible use while the cantilever featuring the X-Y Skidding System provides a large drilling envelope of 18.3 m x 7.9 m (60 ft x 26 ft). With 250 tons (550 kips) of hook load at 60 ft and up to 350 tons (770 kips) at 50 ft, the rig can truly perform light drilling operations with a drilling depth of 12,000 ft.

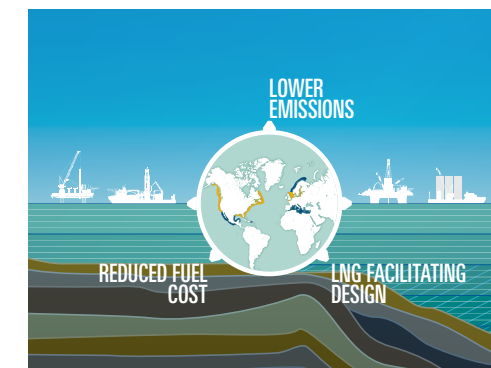
As with all NG series designs, one of the key features of the NG-5500X-LD is that it is designed with appropriate survival capabilities in mind. It means that the unit can remain offshore when adverse weather conditions occur. The ability to stay on location results in more workable days, optimum efficiency and a minimum of non-productive hours during operational charters.

Rutger Baan
Commercial Director

A BUSINESS CASE FOR LNG-FUELED MOBILE OFFSHORE UNITS

The maritime industry is experiencing increasingly strict global and local emission limits, mainly due to a continuing rise in environmental awareness and subsequent political initiatives. Hence, lowering emissions, reducing fuel consumption and the overall growth of alternative power generation are clear current, and future, maritime developments.

GustoMSC has been monitoring the development of LNG (Liquefied Natural Gas) as a marine fuel for several years, culminating in a recently finished LNG R&D project for its design portfolio. The accompanying report concludes that feasible LNG applications are possible when all technical, operational and economic aspects are considered at an early stage. Various possibilities exist to optimize designs, business cases and supply chains. All of these require careful alignment with the unit's design and operations.



Of the units considered, the Dynamically Positioned vessels and semi-submersible showed the highest potential for fuel cost savings. Offshore wind installation was identified as a promising market for implementation of LNG as a fuel, due to its predictable operational profile and associated shore bases. When implemented correctly, the result can be significant savings in fuel costs and emissions over a unit's lifetime, as well as futureproofing with regard to new ECAs, emission quota and increased global uptake of natural gas.

Douwe de Jong
Naval Architect

AGENDA

1 – 4 MAY 2017 OTC HOUSTON HOUSTON

Stand 4848
we launch a white paper: Euryale moonpool – innovative naval architecture design enables full dual drilling accessibility on a drillship
Author: Sjoerd Hendriks, Pieter de Man & Govert Zijderfeld (GustoMSC BV), C. van Diemen (Pacific Drilling)

6 – 8 JUNE 2017 OFFSHORE WIND ENERGY LONDON

Stand N-G60
Paper: On the Scalability of TIV's for next generation of Wind Turbines
Author: Andries Hofman (GustoMSC BV)

11 – 13 JULY 2017 OGA KUALA LUMPUR

Participation in Dutch Pavilion

24 – 25 OCTOBER 2017 IADC ADVANCED RIG TECHNOLOGY AMSTERDAM

Paper: Enabling SIMOPS on jack-ups
Author: Han Tiebout & Goof Zijderfeld (GustoMSC BV)
Paper: Euryale moonpool; naval architectural novelty unlocks drilling technology potential on a drillship
Author: Sjoerd Hendriks (GustoMSC BV), co-authors: Pieter de Man, Goof Zijderfeld & Dimitris Chalkias (GustoMSC BV)

13 – 16 NOVEMBER 2017 ADIPEC ABU DHABI

Participation in Dutch Pavilion

JOINING FORCES

KEY FOR THE ENERGY TRANSITION

'PROFESSIONAL COOPERATION BRINGS US SO MUCH: NEW TECHNICAL CHALLENGES, NEW DISCIPLINES, NEW NETWORKS.'

Fons Huijs
Technology Coordinator Hydrodynamics
GustoMSC

'TO BE HONEST, AS ENERGY EXPERTS WE DIDN'T KNOW MUCH ABOUT MARINE TECHNOLOGIES LIKE FLOATING STRUCTURES. WE LEARNED A LOT — AND ARE STILL LEARNING.'

Feike Savenije
Coordinator R&D Line Support Structures
ECN

The offshore wind industry is maturing and wind farm developers together with the companies in the supply chain are achieving significant reductions in the cost of offshore wind energy. Governments recognize the need for an energy transition and are planning to invest in the offshore wind energy sector. This not only requires clear political choices but also looking at new partnerships and cooperation.

Ranging from small start-ups with smart ideas to established companies with complex challenges or technology institutes with innovative technology, GustoMSC is joining forces with all parties across the industry chain to jointly enable pioneering offshore technology in the renewable wind energy field. Thanks to close relationships with industry players, GustoMSC is actively contributing to enabling the energy transition at sea: over 70 percent of all offshore wind turbines in Europe is installed using GustoMSC designed installation jack-ups and vessels. Multi-disciplinary cooperation is essential in the rapidly growing offshore renewable market.

Two partners, two technologies

One of our longstanding partnerships is with the Energy Research Centre of the Netherlands (ECN). On the topic of floating offshore wind turbines, GustoMSC and ECN have been closely cooperating since 2002. Fons Huijs, technology coordinator Hydrodynamics at GustoMSC, explains: "Through this cooperation, the wind turbine knowledge of ECN allowed us to understand the need for an efficient floating foundation design." In a joint effort, existing software tools were coupled to enable state-of-the-art simulations for floating offshore wind turbines. These tools were used to design a cost competitive floating foundation for wind turbines: the GustoMSC Tri-Floater. This semi-submersible floater, optimised for efficient manufacturing, installation, operations and maintenance, was combined with a wind turbine equipped with advanced ECN control algorithms. This smart control system reduces the floater motions and tower fatigue loads, while maintaining optimal power production.

Feike Savenije, coordinator R&D Line Support Structures at ECN: "With this technology, the cost of energy for floating wind turbines can be greatly reduced, opening up exploitation of the vast amounts of wind resources in deep water areas."

New challenges

The development of the GustoMSC Tri-Floater is a good example of successful professional cooperation, leading to new projects as well. "We are currently working together with Delft University of Technology, WMC, MARIN and EOLFI in a research and development project named S4VAWT", Huijs says. "The aim is to design a semi-submersible floater for a vertical axis wind turbine and to assess the technical and economic feasibility."

Vertical axis wind turbines have a lower efficiency than the commonly used horizontal axis wind turbines, but they offer a number of essential advantages for floating applications. Savenije: "The centre of gravity is located lower, which is beneficial for the stability of the floating system. Furthermore, the vertical axis wind turbine allows for larger motions and inclinations of the floater during power production." This results in a smaller floater, with at least 15 percent steel weight reduction for the same wind turbine power.

The main question is whether the total cost of energy for the vertical axis floating wind turbine is competitive compared to the horizontal axis wind turbine. In this project, ECN contributes expertise regarding aerodynamics, control and numerical simulations. GustoMSC designs the floater and mooring system. Huijs: "We expect to present our final results later this year".

Valuable insights

The cooperation with ECN is not only limited to technology. Savenije: "We have an extensive network in the wind energy business, while GustoMSC has strong ties with the offshore industry. Through cooperation, valuable market insights are acquired and shared while networks are broadened." This is reflected in GustoMSC's involvement in the industrial advisory board of ECN Wind. Huijs: "By joining forces, ECN and GustoMSC contribute to enabling the energy transition at sea."

POWER AT SEA

OFFSHORE WIND ENERGY

A FAST CHANGING MARKET

At the end of 2016, Europe's cumulative installed offshore wind capacity reached 12,631 MW, across a total of 3,589 wind turbines. Including sites with partial grid-connection, there are now 81 offshore wind farms in 10 European countries. By 2020, offshore wind is projected to even grow to a total installed capacity of 24.6 GW.

Logically, the average rated capacity of turbines follow that trend. The capacity of turbines installed in 2016 was 4.8 MW, 15.4% larger than 2015. Even 8 MW turbines were installed and sending power at sea for the first time this year, reflecting the rapid pace of technological development.

Technology push

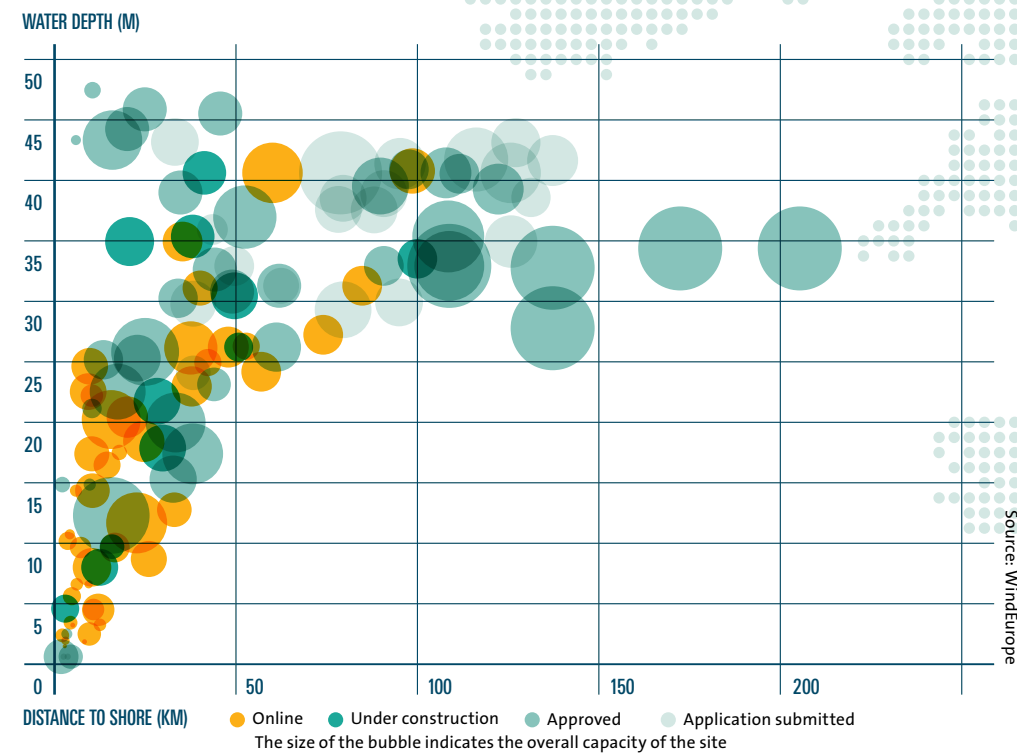
This growing turbine capacity also pushes the boundaries of accessibility. See the graph below left: the average water depth of offshore wind farms where work has been carried out and the average distance to shore for those projects show increasing values in recent years.

Another interesting development is the shift from onshore to offshore. See the graph below right: nowadays about 80% of the turbines are located onshore, 20% offshore. As projected, this ratio will become about 50 / 50% in 2030.

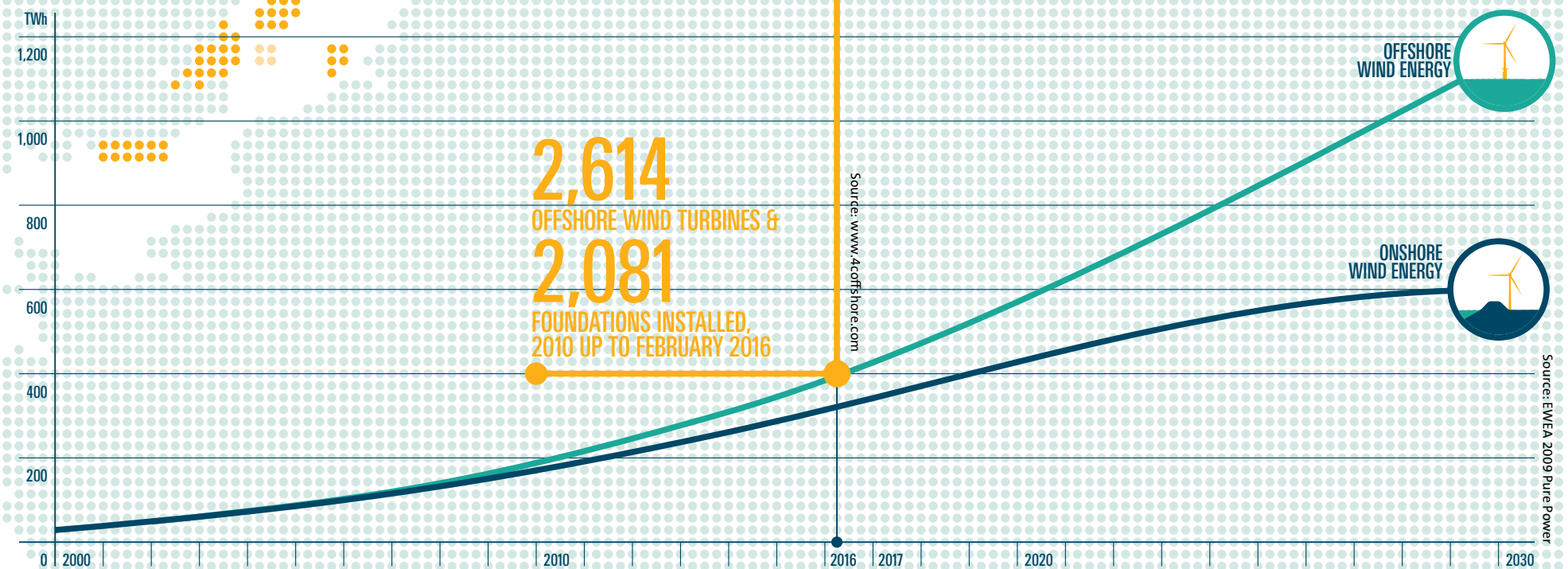
Source: The European offshore wind industry: Key trends and statistics 2016, Wind Europe

Installation platforms at sea are key in order to carry out the necessary installation work in an efficient and safe manner. GustoMSC is market leader in jack-up designs and associated equipment for offshore wind construction.

WATER DEPTH IN RELATION TO DISTANCE FROM SHORE OF BOTTOM FIXED WIND FARMS BY DEVELOPMENT STATUS

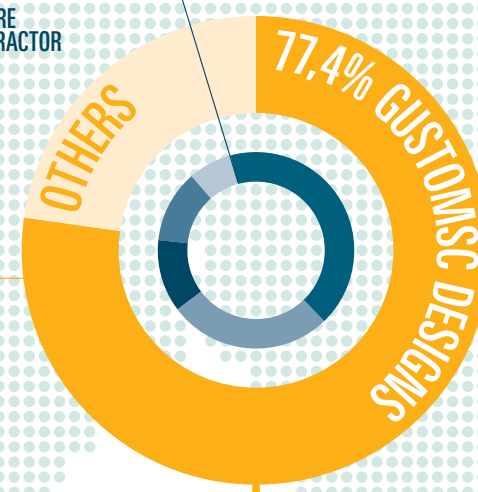


DEVELOPMENT AND PROJECTION OF ON- AND OFFSHORE WIND FARMS



INSTALLATION OF OFFSHORE WIND TURBINES BY CONTRACTOR

- 42% A2SEA
- 27% MPI Offshore
- 12% Fred. Olsen Windcarrier
- 12% Seajacks
- 7% Others

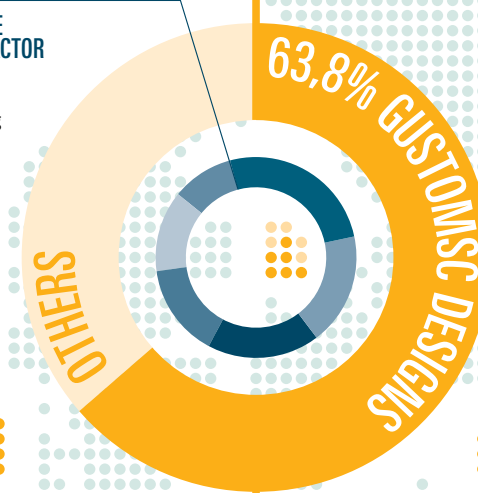


NG-9000C 32% SEA INSTALLER, SEA CHALLENGER BRAVE TERN AND BOLD TERN



INSTALLATION OF TURBINE FOUNDATIONS BY CONTRACTOR

- 26% Geo Sea
- 18% Ballast Nedam
- 18% Seaway Heavy Lifting
- 15% MPI Offshore
- 13% Boskalis
- 10% Others



OLEG STRASHNOV



OPERATING SERVICE SUPPORT SEEING IS BELIEVING

Completing the support in the full life cycle of the units, we offer a wide range of engineering services providing operational support and consultancy assistance to our clients. These services enable owners to extend the boundaries of what is possible with their units and continuously improve their operations and maximize asset return.

SEAJACKS SCYLLA PROVIDING KEY ANALYSIS FOR SAFE OPERATION

Seajacks Scylla is a GustoMSC designed NG-14000X, a self-propelled jack-up equipped with a 1,500 t leg-encircling crane. The Scylla started on her first job early 2017, taking part in the installation of wind turbines at the Veja Mate offshore wind farm in Germany. GustoMSC assisted Offshore WindForce VOF and Seajacks in their preparations by providing motion analysis, station-keeping analysis and hull-strength analysis.



HAVEN SITE-SPECIFIC AND LEG LENGTHENING

As of June 2018, Master Marine's jack-up Haven will provide accommodation services at the Johan Sverdrup field, operated by Statoil. The water depth and foundation conditions at this field surpass the original design capabilities of Haven. Together with Statoil and Master Marine, GustoMSC investigated the possibilities for upgrading Haven. The engineering was finalized in 2016. Haven is to be equipped with four large suction caissons and longer, stronger legs. The legs are upgraded by partly re-using existing leg sections and adding 92 m of new stronger leg sections. This brings the total leg length excluding suction caissons from the original 131 m to 165 m. The new leg sections and suction caissons are currently being fabricated by Lamprell.

BALDER EXTENDED FLY-JIB

In 2001, the Balder vessel was equipped with additional J-lay capabilities for deep water subsea pipelines. To enable the positioning of special spool pieces in the 98 meters tall J-lay tower (while maintaining pipeline tension), a new articulated fly-jib arrangement was designed to replace the original box girder type jib of the port side crane. The 500 short tons auxiliary hoist was re-integrated into the fly-jib and the capacity was increased to 1,000 metric tons. An additional derrick winch was installed in the A-frame to enable the adjustment of the angular position of the fly-jib.





CAESAR FROM CABLE TO PIPE LAY VESSEL

The Lewek Centurion, former Helix Caesar, was converted from a cable layer into a S-lay pipelay vessel in 2008 - 2009. GustoMSC carried out the basic design of the vessel conversion for the Helix in 2006. The conversion was a very comprehensive project, including jumboization of the hull, integration of pipe storage, handling and fabrication facilities, as well as integration of the deep water stinger and its handling system. Additionally, the accommodation block was replaced with a larger one and all the vessel's marine and electrical systems were upgraded for its new use. Especially challenging parts of the design were the stability and strength of the upgraded vessel. Extensive analysis by GustoMSC experts, and special solutions, were needed to make the Lewek Centurion a very compact, but highly capable deep water S-lay vessel.

SEA INSTALLER BOOM LENGTHENING

Three of the 800 t leg cranes delivered by GustoMSC were upgraded in 2016.

For the Sea Installer of A2SEA, an NG-9000C design, the boom was lengthened by 20 m with a removable insert truss structure, the A-frame height was increased and the main hoist winch was replaced. This resulted in a lifting capacity of 900 t with original boom length and 700 t with the elongated boom using the truss insert.



BOLD TERN BOOM LENGTHENING

Fred. Olsen's Bold Tern and Brave Tern cranes were modified to be able to execute installation work for the largest wind turbines available at present and in the near future. The height of the A-frames was increased and the booms were prepared to receive an insert truss structure for effective elongation of the boom. The Bold Tern had already received an insert truss to lengthen the boom by 20 m. The lifting capacity with the extended boom is 640 t.



SOLITAIRE STINGER HANDLING SYSTEM

When Allseas upgraded the Solitaire with increased tensioner capacity and a new deep water stinger, they turned to GustoMSC in 2005 for the required changes and upgrades

to the aft ship and stinger handling system of the Solitaire. The scope of the upgrade included the design of the stinger handling system including underwater lateral guidance and creating additional buoyancy in the aft ship. The fast track nature of the upgrade and the client's wish to incorporate already available structures and equipment required all the ingenuity of GustoMSC's project team to make this upgrade a success.

The stinger handling system was designed into the existing vessel structure and an already existing cantilever support structure. This work was combined with integrating an uplift prevention system to avoid slack wires in the stinger handling system. This required an intricate design and analysis approach, integrating the in-depth hydrodynamic and mechanical skills of our engineers.

In parallel, sponsons were designed to increase buoyancy aft, integrated with the stinger underwater support structures. Designed to fit the curved aft ship lines of the Solitaire and again integrating the various disciplines at GustoMSC, these structures were designed in a very short time using 3D laser scanned data to meet the tight project deadlines.



37,135 SQFT

NG-9800C-US THE LARGEST US WORKHORSE

In the European offshore wind energy market, the four NG-9000C wind turbine installation jack-ups, Sea Installer, Sea Challenger, Brave Tern and Bold Tern, have together installed a total of 830 wind turbines from 2010 to 2016, accounting for a record height of 32% of the total installed number of turbines. The first five US offshore wind turbines were installed by the Brave Tern, the first NG-9000C in operation. This seasoned unit has a new larger sister, tailored for the conditions in the US, the NG-9800C-US.

Designed to operate in the American offshore wind waters, the NG-9800C-US is the most capable and efficient wind turbine installation jack-up for the US market. Its capabilities can also be implemented in wind turbine installations in other regions such as Taiwan, Japan and the North Sea. The NG-9800-US can be built at several shipyards in the US making it Jones Act compliant and it is therefore able to operate freely from US ports and shorebases. This design allows entry to the port of New Bedford, which houses the first facility in America designed to support the construction, assembly, and deployment of offshore wind projects on the US East Coast.

Based on the proven technology and unique performance of the NG-9000C series, this jack-up is capable of providing fully loaded transits to offshore locations and installing future turbines in the North East coast. Like the other GustoMSC NG jack-ups, the NG-9800C-US is a four-legged, self-propelled, self-elevating unit that moves autonomously, without the need for tug assistance. This US workhorse features a continuous hydraulic jacking system providing high redundancy and flexibility during jacking. It is characterized by a large versatile open deck space, a leg encircling crane with a high reach and capacity and includes an accommodation with state-of-the-art facilities. The design is fully compliant with SNAME recommended practices.

The four-leg design enables a fast and secure pre-loading, creates the ability to remain offshore longer and enhances the operational envelop in harsher weather and survival conditions. This results in more workable days and ensures optimal efficiency, safety and minimal non-productive hours during operational charters, leading to a high utilization rate and better return on investment.

The NG-9800C-US is a stable, solid and safe platform for delivery of a wide range of services throughout the total life cycle of an offshore wind farm, oil & gas applications.



Jan-Mark Meeuwisse
Commercial Director

SELF-PROPELLED 11 KNOTS & DP2

Cost savings by eliminating support vessels, reduced mobilization time. Full control entering ports and reducing risk by precise and safe navigation.

LARGE MAIN CRANE CAPACITY MAX. 1,500 T

1,653 US SHT
Leg encircling with outreach 32 m (104 ft) and lifting height 115 m (377 ft) above main deck.

HIGH NUMBER OF JACKING CYCLES > 3,000 MOVES

For daily jacking moves, 150 per year, with a positive engagement jacking system.

MAXIMUM WATER DEPTH MAX. 92 M

302 FT LEG LENGTH
With 69 m (226 ft) leg length under the hull, enabling operations in 60 m (195 ft) water depth.

FREE DECK SPACE 3,450 M²

37,135 SQFT
3 monopiles, 3 jackets, 6 of 6 MW turbines and blades, or 5 of 8 MW turbines, including mission equipment.

VARIABLE LOAD 6,400 T

7,055 US SHT
Large variable load in transit and in operational jacked-up condition.

INTERVIEW FRED. OLSEN WINDCARRIER

PLAYING THE BEST CARD IN THE OFFSHORE WIND MARKET



Fred. Olsen Windcarrier (FOW) is a leading provider of tailored and flexible services for the transport, installation and maintenance of wind turbines for offshore wind farms. The company decided to enter the Wind Turbine Installation (WTI) market in 2008 and has built up an impressive track record including the recent installation of the US's first offshore wind farm. Even Larsen is CEO at FOW. In this interview we would like to shine a light on how FOW adopts its operations and vessels to the changing demands and requirements of a maturing market.

When you first entered the offshore wind market in 2008, many new companies were entering this market as well. So there was fierce competition right from the beginning. How did you experience that?

'I think it is important to mention that our company has been involved in the renewable wind industry since 1994 although initially mainly in the onshore wind market. So there is a strong commitment on the part of our owners with respect to renewable energy. And combining this with our shipping and offshore heritage, it was the right move for them to take advantage of the opportunity that they identified: a growing offshore wind market in Europe and a significant lack of installation capacity. They saw that industrialization was required for this market to develop in the right direction.

Because of this heritage, we didn't really experience fierce competition when we entered the market. Competition became more intense later when the oil price started to fall and jack-ups, which were initially intended for the oil and gas market, were transferred to the offshore wind market.

Looking at our current proposition in offshore wind, there has been a rapid increase in wind turbine size in recent years and therefore foundations have also become larger and heavier. These foundations are too deep for our vessels today, so we are now concentrating on the wind turbine market, wind turbine installation, the main components exchange and general servicing of wind turbines. The capacities of the current installation equipment will certainly become a limiting factor for future turbines in a period of seven to ten years, but in the short term these capacities are sufficient.

Furthermore, with our proposition we aim to reduce the overall Levelized Cost of Electricity (LCOE) by having the most effective means to install turbines, constantly improving our processes and becoming even more efficient in our operations. As far as this goes, the GustoMSC NG-9000C is really the perfect vessel for us enabling the cost efficient installation of wind turbines. In that respect, I think that there is a considerable demand for the NG-9000C in the market. They are very efficient.'



Fred. Olsen Windcarrier's Brave Tern installing wind turbines on the Bard Offshore 1 wind farm, located 100 kilometres (62 mi) northwest of the isle Borkum in 40m (130 ft) deep water (2013).

Does the price pressure influence your choice with regard to any new build developments?

'The rates are lower, which is an important development. It forces us to focus on keeping our costs as low as possible and to operate as efficiently as possible. We don't think new build is viable at the current price levels because the rates are simply too low. At present, we have an extreme focus on utilization because we need to have a high utilization on the vessels to operate as cost efficiently as possible. This is also why we focus strongly on the service market because this is a constant ongoing market.'

GustoMSC and FOW were posed with some technological challenges. You were very actively involved in maturing the design that we proposed. It was a very fruitful joint development and we certainly appreciated your input. Could you elaborate on how GustoMSC met your requirements in the beginning and how did the relationship with GustoMSC develop since the delivery of the first two units?

'We had the impression that GustoMSC really understood the market and you came up with a very good proposal and took a proactive approach. You saw what was needed and came up with a new design which had many of the elements that are important for the next generation vessels from an industrialization perspective.'

It has been a very close relationship from day one because, after half a year of operation, we saw that the next

generation of turbines was coming and already back in 2013, we started discussions with GustoMSC regarding the possibilities to extend the vessel in order to be capable of handling the next generation wind turbines.

At present, I can state that the vessels Bold Tern and Brave Tern are really the core of our proposition today and they will be for several years to come as further adjustments can be made to the vessels to carry more load and to be able to handle the bigger wind turbines which are expected to be the new standard in the future. The upgrades that have been carried out in the meantime allow us to be in position for the next generation of larger turbines.'

What other changes, new requirements or innovations do you envisage or believe to be necessary in the foreseeable future in order to meet future market expectations?

'I don't think it will be possible to build a new vessel to satisfy future requirements without an increase in day rates. Sustainable day rates are a precondition for further development. In addition, long-term contracts of at least five years are required to justify investments in new vessels with additional capabilities.'

Technical innovations should focus on keeping the vessels efficient in operation, on a better distribution on the vessel by moving the components, increasing robustness, higher wind speeds for installation and reducing the downtime on the vessel.



Even Larsen
CEO Fred. Olsen Windcarrier

Larsen has been with Fred. Olsen Windcarrier since 2013, where he worked on innovation and product development before becoming project manager for the Global Tech 1 Project. In 2014, Larsen became Head of Commercial and Projects.

Larsen is qualified as a Naval Architect and holds a Master's degree in Marine Hydrodynamics.

We believe that there is a need in the market also on the vessel side for an increase in scale. We know that we cannot survive as a small player on our own. We also see many vessels designed for the oil and gas market entering the offshore wind market. But what we also see is that wind turbine installation vessels are becoming more specialized.'

Can you reveal Fred. Olsen Windcarrier global market interests?

'The US market is a very important market for us. FOW has a long history in the States and we installed the first US wind farm there in 2016 and we definitely want to strengthen our position in the US wind farm market. We also see very interesting developments in Asia which we are also following closely and we are evaluating how we will enter this market. We expect that these markets will also mature into more industrialized markets in line with the more mature European offshore wind market. An important aspect for global presence is that we always have to take the local interests and requirements into account. In the US, we must think like Americans. In Asia, we must think like the Asians. It is not possible to operate in these markets from Europe without a local presence.'

Is the offshore wind industry capable of outsmarting the oil and gas industry and by what measures and means will the offshore wind industry outsmart the oil and gas industry?

'Our business has a strong focus on logistics, efficient working methods and cost efficiency in all the different parts of our operations and, until recently, that was not necessarily required in the traditional oil and gas industry. So I think that we are better equipped to deal with the industrialization process in the offshore wind market. We have a strong focus on repetitive actions and smart logistic solutions. Moreover, we have always worked under very strong price pressure. We cannot allow ourselves to increase the day rates significantly, so we simply have had to work smart from day one. Hopefully that will be our strongest card when dealing with the competition from

the oil and gas companies entering the offshore wind market. In addition, the traditional oil and gas companies have some bad habits on the costs side and do not really have the strong focus on logistics that we have. So I think we should be able to outsmart them initially and we will have to work hard on staying one step ahead by using the right equipment for the job as further specialization is required as the industrialization process in the wind turbine installation market continues to unfold.'

'WE SIMPLY HAVE HAD TO WORK SMART FROM DAY ONE. HOPEFULLY THAT WILL BE OUR STRONGEST CARD WHEN DEALING WITH THE COMPETITION.'

Even Larsen
CEO Fred. Olsen Windcarrier

PIONEERING TECHNOLOGY

GustoMSC focuses on designing and engineering state-of-the-art technology that helps the offshore energy market move forward. In this article, we highlight our latest best-in-class solutions.



GALENE MOONPOOL

INCREASED OPERATING WINDOW

PATENT PENDING

The Galene moonpool is the latest in GustoMSC's development of innovative moonpool technologies. Together with the Callirrhoe moonpool, eliminating sloshing in large moonpools in transit, and the Euryale moonpool designed for fully redundant dual drilling, Galene supplements the set of technologies dedicated to enhancing moonpool related operations.

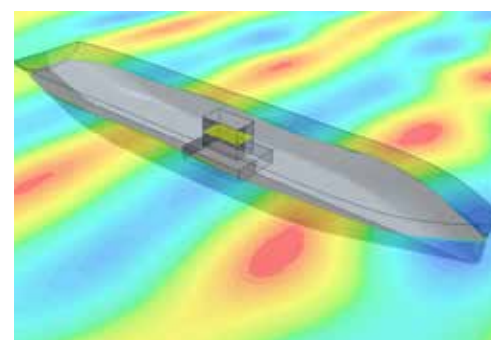
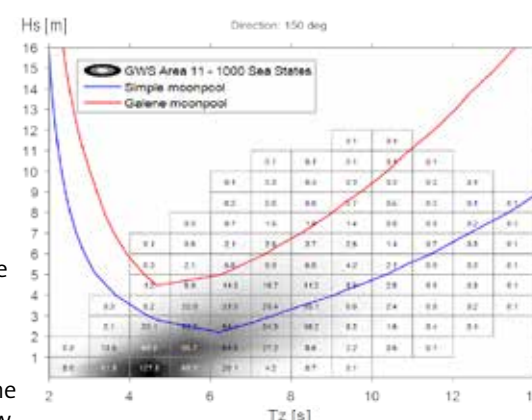
When offshore construction and drilling activities are performed by vessels, a moonpool is a good tool to increase the uptime in mild weather conditions versus over the side operations. A moonpool protects people and equipment from weather elements. The Galene moonpool is an enhancement to the conventional rectangular moonpool, increasing the operating window and reducing downtime.

Like the sea nymph after which it is named, Galene signifies calm and untroubled waters. Due to its special underwater shape, the water motions inside the moonpool are significantly decreased. It reduces the

response of the water by shifting the natural period of the moonpool to lower values and consequently reducing the response as wave spectra with lower peak periods have less energy. Furthermore, it reduces the peak of the water surface elevation Response Amplitude Operator (RAO) by separating the moonpool resonance response from the vessel motion resonant response. The uptime gain in operability can be as high as 13% compared to a conventional moonpool.

Additional to its superior performance, Galene is designed for operational flexibility with low operational cost and has a minimal impact on the initial construction costs as well. There are no protruding plates or plate stiffeners inside the moonpool and no moving doors or flaps. The moonpool is of a robust structural design and has limited surfaces for marine growth. The three moonpool technologies can either be implemented individually or they can be combined to render optimal results in a wide range of operational scenarios.

Dimitris Chalkias
Senior Engineer



ADD-ON SPUDCANS

Jack-ups are designed to withstand specific environmental conditions at a defined water depth in combination with certain types of soil conditions. A balanced design results in an almost full utilization of design elements under such conditions. Typical design elements used are the holding system (either the leg fixation system if present, or the jacking system), leg chord elements or the preload capacity. This means that if an owner wants to use the jack-up beyond the original design conditions, for example to operate in deeper water or in harsher conditions, some of these elements would have to be upgraded. However, these elements are always fully integrated into the overall design of the jack-up and thus an upgrade is always a very costly and often also a time-consuming affair.

A more simple way of upgrading the overall capacity of a jack-up is through the use of add-on spudcans. Add-on spudcans can be designed to replace the existing spudcan in the form of a new spudcan below the existing one at the bottom of the leg or as an extension of the original spudcan. The purpose of an add-on spudcan is generally twofold:

1. Limit the penetration, effectively reducing the free leg length;
2. Move part of the overall leg bending moment from the hull towards the spudcan, effectively reducing the load at hull level.

GUIDE LOAD MEASUREMENT OPERATING EFFICIENCY AND SAFETY



The first purpose is relatively simple and usually results in just an enlargement of the total horizontal projected area of the spudcan. In this case, the add-on can be a welded permanent structure, or if the owner wants to be able to go back to the original design, it will be designed to connect to the chords of the lower end of the legs, around the existing spudcan. The second purpose is a bit more complicated, as the add-on must now be able to attract overall leg bending moments. This usually means that the add-on must either be significantly bigger than the original spudcan or equipped with skirts, or a combination of both. The size and type of spudcan depend heavily on the soil conditions of the intended

area of operation. The end result is mostly in the shape of a replacement of the spudcan, but can also be executed as a permanent extension.

All GustoMSC jack-ups are equipped with legs that are designed with the add-on spudcan in mind, giving owners of GustoMSC units the option to easily upgrade the capability or enlarge the area of operation of their rigs. When an owner has multiple units of the same type (for example the GustoMSC NG-2500X), a set of removable add-on spudcans can give a significant boost to the whole fleet of rigs.

Remco van der List
Design Manager Jack-ups

During some critical phases for a jack-up - such as touchdown, jacking, preloading and leg retrieval operations - the jacking operator can generally monitor the vertical loads in the leg via the feedback from the jacking system. However, vertical loads are in general not governing for the legs. Due to leg bottom impact, seabed slope, interaction with old spudcan footprints, initial leg sliding or soil fixity during leg retrieval, significant leg bending moments can be introduced. Leg bending moments, and consequential guide reaction loads are normally of bigger concern. This is why GustoMSC has developed the Guide Load Measurement (GLM) system.

Currently, most jack-ups with truss legs are outfitted with a Rack Phase Difference measurement (RPD) system, which allows the operators to monitor the leg bending moments to some extent. For RPD systems, typically the calibration, the accuracy for very stiff systems and the influence of engagement (or disengagement) of brakes or fixation systems are a challenge. A good RPD system can suffice for some operations. However, for the increased number of jacking cycles in the offshore renewable energy market, a more direct indication of actual guide loads is advantageous, providing more accuracy and enabling the monitoring of loads both in static

(jacking system on the breaks or on fixation system) and dynamic mode.

The GLM system directly measures the interface loads between leg and guide on each of the contact points. The summation and processing of the individual contact data points gives a resultant guide force and direction. Leg bending moments can be derived from the guide loads. Direct and accurate information on the actual load levels enables operators to safely perform preloading or leg retrieval operations, while comparing the occurring interface loads with the maximum allowable interface loads. The increased awareness of actual internal load levels improves safety and allows operators to judge utilization and safety levels on basis of real data, and adjust operations if required.

The GLM components are going through various testing cycles to ensure sufficient robustness and accuracy and a patent is pending. The system is expected to be operational in the course of 2017.

Andries Hofman
Expert Engineer

NOBLE LLOYD NOBLE PRODUCING 55,000 BARRELS OF OIL PER DAY

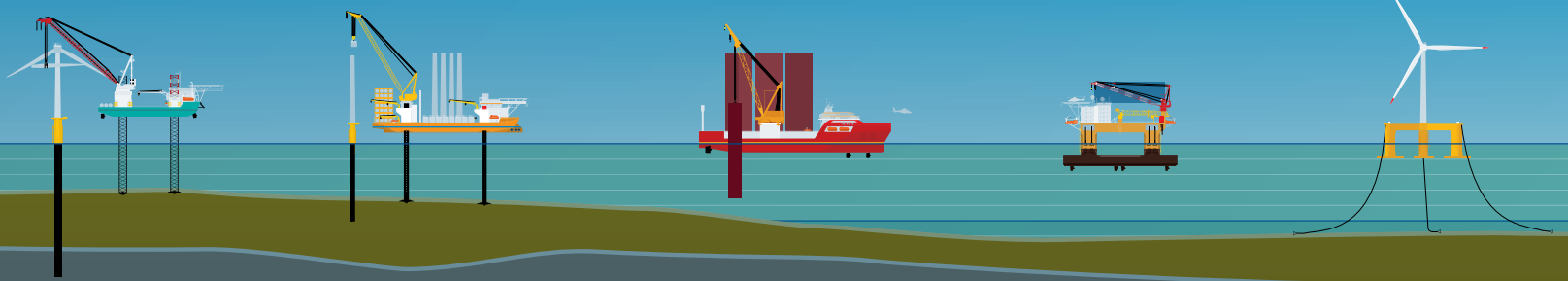


Noble Lloyd Noble is a harsh environment jack-up rig based on the GustoMSC CJ70 design as well as Statoil's 'Category J' specifications. The rig has an operational air gap of 69 meters and is capable of operating in a water depth of up to 150 meters (492 feet) in harsh environmental conditions. It boasts a maximum total drilling depth capacity of 10,000 meters (approximately 33,000 feet).

This largest jack-up rig in the world is currently positioned over the Mariner jacket which was installed in 2015. The first production wells will be drilled through a well deck on the jacket. Up to five wells will be drilled before the platform topside modules arrive mid-2017. In total up to 100 reservoir targets could be drilled over the lifetime of the Mariner field, based on the current development strategy.

The Mariner field is located on the East Shetland Platform of the UK North Sea, approximately 95 miles or 150 kilometers east of the Shetland Isles. The field will provide a long-term cash-flow over a 30-year field life. Production is expected to commence in 2018. The heavy oil field has reserves estimated at more than 250 million barrels of oil with an average plateau production of around 55,000 barrels per day.

THE PIONEERS OF OFFSHORE ENGINEERING



NG-5500X
SELF-PROPELLED
MULTI-PURPOSE JACK-UP
**DEEPER WATERS
& LIFE CYCLE
SUPPORT**

NG-9000C
SELF-PROPELLED
INSTALLATION JACK-UP
**EFFICIENT
INTEGRATED
LOGISTICS
SOLUTION**

ENSIS
HEAVY LIFT
CRANE VESSEL
**HUGE
TRANSPORT &
LIFTING
CAPACITY**

OCEAN500
ACCOMMODATION
SEMI-SUBMERSIBLE
**SAFE WORKING
& LIVING
ENVIRONMENT**

TRI-FLOATER
FLOATING WIND
TURBINE FOUNDATION
**ROBUST AND
COST-EFFECTIVE**

GustoMSC

GustoMSC is an independent, world renowned and leading design and engineering company, thanks to the vast knowledge and expertise of our dedicated professionals and our close relationships with the most influential players in the offshore market. We serve the offshore industry by providing best in class solutions for mobile offshore units.

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