# Powering offshore wind developments by LNG

The past decade has seen a period of large, evolutionary steps for the offshore wind market and the upcoming years are set to continue this trend. This will help to position wind power as a maturing player in the global energy mix. As economy of scale is driving up the size of turbines and wind farms, the offshore units used to install and maintain these offshore farms are evolving too.

The step-up in capacity of these units opens up possibilities to incorporate another dynamic, cleaner and evolving player in the energy mix; LNG or Liquefied Natural Gas, which is gaining traction as a fuel for various sectors of the offshore and maritime industry.

These industries are experiencing increasingly stricter global and local emission limits, mainly due to a continuing rise in environmental awareness and subsequent political initiatives. The most recent and perhaps far-reaching example of this is the global Sulphur cap of 0.5% on marine fuels, set to come into effect in 2020. Hence, lowering emissions, fuel consumption and the overall growth of alternative power generation is a prominent maritime development.

Offshore wind farm installation and maintenance operations offer favourable conditions for the use of LNG. This is due to the relatively high predictability of the operational profile and proximity of shore bases and deep sea ports, facilitating cost-effective LNG supply which minimises the design impact on offshore wind farm installation and maintenance units.

By means of concept design and business case driven optimisation, GustoMSC has been researching the potential LNG might offer for its portfolio of offshore installation units. The research methodology focused on looking beyond the technical aspects, to also include operational and economic considerations. Tailor-made solutions for LNG fuelled designs were derived for the GustoMSC Ensis design, a crane installation vessel specifically customised for monopole and foundation installation, and the GustoMSC NG-14000X wind turbine installation jack-up.

## Emission standards compliance: LNG

Wind farm installation units often operate in so-called ECAs (Emission Control Areas). Meeting the associated limits for Sulphur Oxides (SOx), Nitrous Oxides (NOx) and Particulate Matter (PM) emissions is therefore an important consideration both for units currently in operation, as well as new builds.

LNG is a solution that covers all the individual emission limits. An added advantage is the potentially lower cost of LNG compared to the typical fuels for mobile offshore units. When the implementation of the required equipment is given proper consideration in the design, the result can be significant savings over a unit's lifetime, as well as futureproofing with regard to new ECAs and emission quota.

## A critical look at autonomy and fuel flexibility

The main design/research method revolves around separating operational design parameters from design maxima. But what does this mean exactly?

Conventional liquid fuelled designs typically have fuel tanks that are integrated into the vessel's structure, and rarely drive the main dimensions of the vessel. Achieving a fuel capacity that can deal with the occasional large transit of substantially longer than normal offshore operation is therefore rarely difficult to include in the design.

Using similar autonomy requirements, when considering LNG as a fuel, can quickly prove problematic, as the fuel's energy density and cryogenic tanks quickly lead to tank arrangements that can start driving main design parameters, like main dimensions, weight and cost.

By analysing the average fuel need over many different trips, and optimising the LNG system accordingly, the overall design impact can be reduced significantly. The required autonomy/flexibility for those rare significantly longer trips can be achieved by going for a dual fuel arrangement and maintaining some liquid fuel capacity in the design. Dual fuel engines have been the most widely implemented types for gas fuelled vessel, when considering the past 10 years of new builds.

A similar approach can be taken for the total power plant aboard the unit. Typically, the offshore installation units are designed with a high level of station keeping redundancy with a significant associated maximum sea state, to ensure high and robust operability. Because of this, the actual power used is usually considerably lower than that installed. By only making part of the total power plant dual fuel capable – a part that still yields a high percentage of overall time operating on LNG - the impact that LNG has on the design can be reduced further.

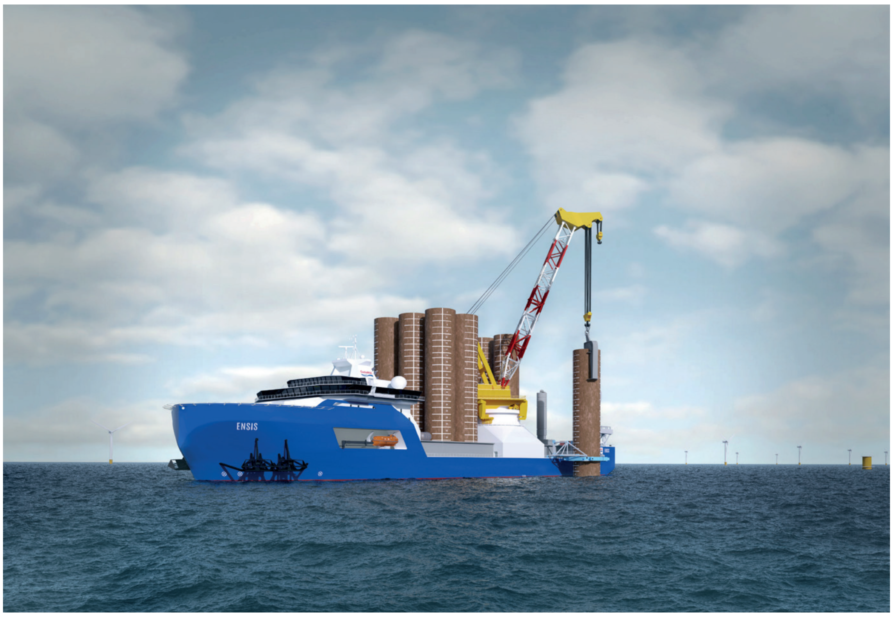
Thus, designing intelligently for average loads still means a high percentage of total time spent using LNG, but with a substantially lower investment; smaller tanks and less dual fuel engines.

## Logistics bunkering options

One of the main feasibility considerations for adopting LNG as a marine fuel is the supply. Though traded globally through the large scale LNG infrastructure, the small scale infrastructure required for bunkering is still being developed, either near strategic deep water ports or on an ad-hoc basis. Several solutions may be adopted depending on the unit and the operational area:

- Bunker vessel: inshore or offshore
- Truck to ship bunkering
- Local onshore buffer supplied by a bunkering vessel, LNG trucks, or other method

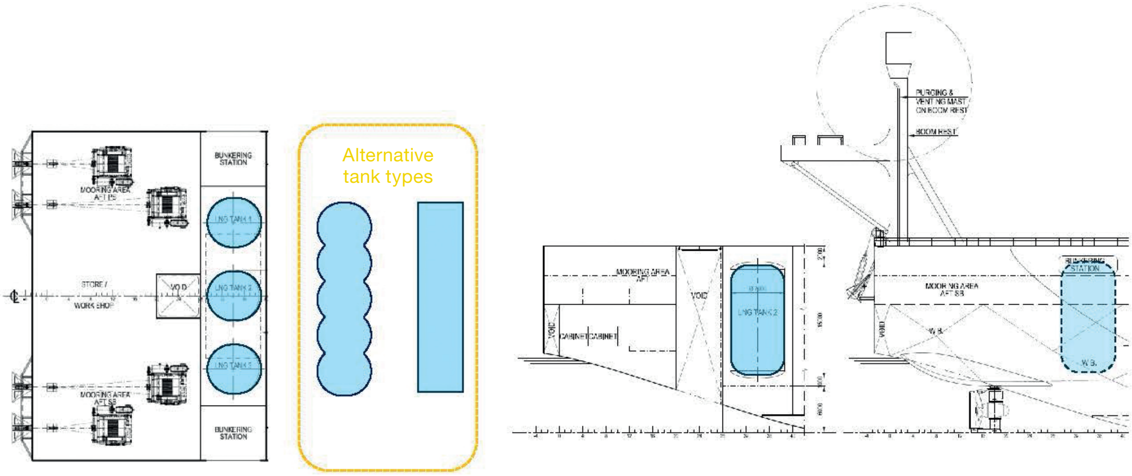
Truck to ship bunkering is an established method, but for the units under consideration the capacity and flow rates are considered impractical. The feasibility of the remaining options will depend on the proximity of LNG import/export terminals and the presence of existing plans for development of the local small scale LNG infrastructure. For both a vessel and a jack-up, the combination of supply volume, typical delivery location and supply interval is assumed to be feasible for a bunker vessel. A local onshore buffer might be required to achieve these boundary conditions, which is a decision that requires special attention at the conceptual stage and close alignment between designer, owner and LNG supplier.



## Concept characteristics and economics

Unlike for shipping, design performance for offshore units is rarely expressed in just volumetric or mass payload. It is a complex system of modular functionalities, mission specific equipment and supporting systems. The addition of LNG in cargo vessel types will usually result in loss of payload, or an increase in the unit's main dimensions, i.e. footprint.

However, for offshore vessels the total footprint might be governed by boundary conditions other than mass or volume payload; meaning that an increase in the total footprint due to LNG is not necessarily the case. Both concepts under consideration in GustoMSC's research are representative for the step-up in size of offshore wind farm developments, and offer the benefits of the design philosophy described; optimisation of tank size and



dual fuel engine count.

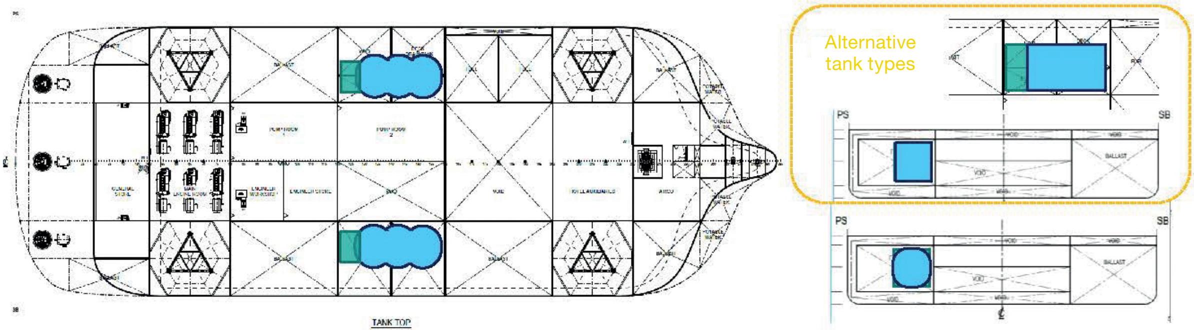
**ENSIS wind turbine foundation installation vessel**

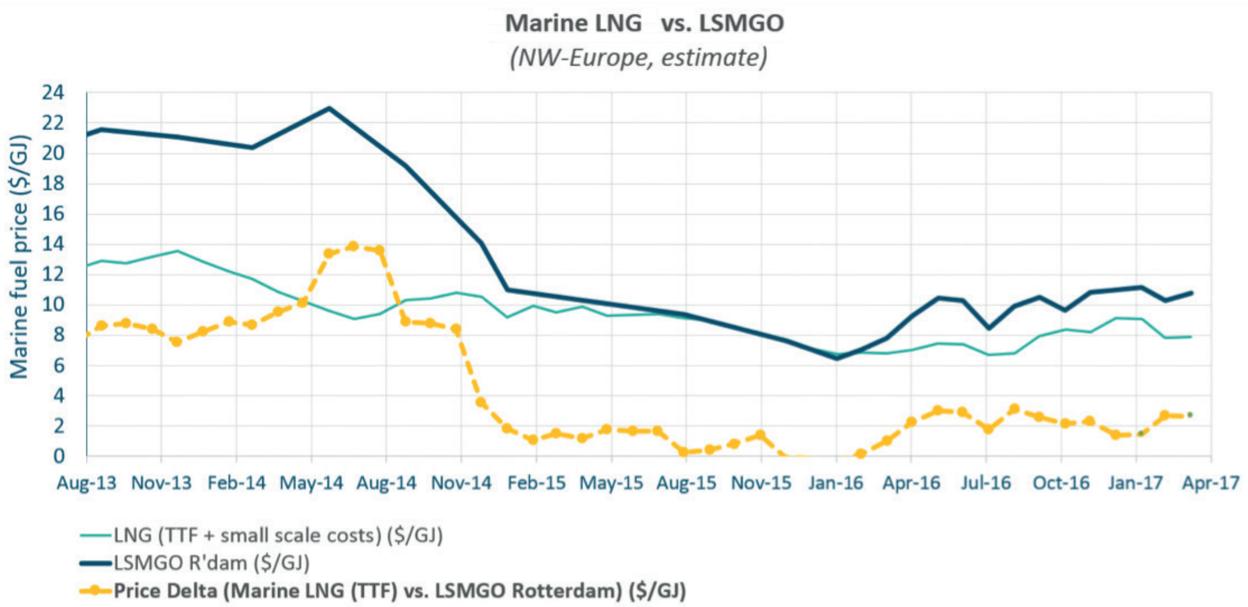
The LNG capacity for this concept is sized to single roundtrip autonomy (approx. 10-13 days, one of the longer roundtrips envisioned), with a single roundtrip consisting of the vessel loading wind turbine foundations to capacity at the shore base and installing these offshore. For a fuel price advantage of 2-4 $/GJ (GJ=GigaJoule. fuel prices normalised to energy content) the payback time for the added LNG investment is around 5-10 years.

**NG-14000X wind turbine installation jack-up**

The LNG capacity for this concept is sized for a 20 to 23 day single roundtrip autonomy, with a single roundtrip consisting of the vessel loading wind turbine components to capacity, at the shore base and installing these offshore. For a fuel price advantage of 4 $/GJ the payback time for the added LNG investment is approx. 8 years.

To relate the fuel price advantage reference points to commodity and LSMGO (Low Sulphur Marine Gas Oil) prices, the following graph compares marine LNG price estimates with LSMGO in Rotterdam.




The marine LNG price trend presented was established using a price estimation method that takes a local Natural Gas index price (TTF) and corrects it for additional small scale LNG costs.

### Final remarks

LNG presents several significant advantages as a marine fuel, with several new build references having already found their way into offshore wind and civil construction. However, Identifying operational, technical and commercial feasibility at an early stage can be a challenging task, requiring specialised knowledge combined with a holistic approach.

Multiple parties need to be aligned: vendors, classification, LNG suppliers, etc. An independent designer with the right knowledge could fulfil the role of early stage facilitator, as well as provide full project cycle engineering services.

When it comes to clean and more efficient solutions, the offshore wind industry has already picked up the gauntlet. LNG could play a significant part in meeting that challenge.

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References

1. LNG fuelled mobile offshore units, GustoMSC, February 2017 www.gustomsc.com/downloads?name=Paper+-+LNG+fueled+mobile+offshore+units