

# GAS CARRIER UPDATE

2017



Design for future markets

MRV compliance

Boosting LNG infrastructure

New tank dimensions

# CONTENT

Time for remodelling? .....	04	Preparing for MRV compliance .....	16
Designing for owners .....	06	Saving coastal ecosystems .....	18
Making headway into alternative fuels .....	09	Pushing the frontier .....	20
LNG industry update .....	12	Putting a stop to cyber exploits .....	22
Low-pollution energy for emerging markets .....	14	My DNVGL - a click away .....	24

Cover photo: Höegh LNG





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## DEAR READER,

Despite the depressed overall maritime market situation we have experienced over the last one or two years, the gas segment is beginning to move into a more promising direction.

LNG carrier earnings today are far from what they used to be, even though we have lately seen a small but measurable improvement. The energy demand is huge, new countries that used to be LNG exporters are now considering becoming importers. The LNG seaborne trade represents only eight per cent of the total gas trade and we see a slowdown in imports in traditional gas-importing countries (Japan, Korea). On the other hand, there will soon be new kids on the block, with countries such as Thailand, Vietnam, Myanmar, India (just to mention a few) considering bringing in FSRUs to support their energy demand. 30 per cent of the world's seaborne gas trade is now spot trade, which did not even exist just a few years ago. A substantial increase in gas production, combined with significant additions to both liquefaction and regasification capacity, have changed the market fundamentals. 53 large LNGCs will hit the water this year, followed by 41 in 2018.

It is the ambition of DNV GL to support the entire LNG industry as it strives to become more energy-efficient and environment-friendly while improving the cost effectiveness of its operations. Many improvements have been achieved without jeopardizing the already unprecedented safety record of the maritime gas industry.

Last year we developed new rules for LNG bunkering vessels and assisted yards and owners in developing new concept designs for the carriage of LNG and LPG. We launched new rules for REGAS and supported the efforts of owners to optimize their energy consumption through our new, ground-breaking tool COSSMOS.

With approximately 60 per cent of the world's FSRU fleet in operation, contracted and under construction classed DNV GL, and uniquely experienced in FRSU conversions, we have been a highly sought-after partner for new projects. We have also been instrumental in evaluating new concepts, such as new cargo containment systems, issuing Approvals in Principle (AiP) and General Approvals of Ship Application (GASA).

We hope you will enjoy reading our reports about promising new developments and opportunities in this issue. If you need more information, we are always there to assist you!

Happy reading!

## GAS CARRIER UPDATE

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# TIME FOR REMODELLING?

Amid a growing number of LNG importing nations the demand for natural gas is increasing, especially from Asia. With new players, a growing tanker fleet and changing patterns, the LNG trade is undergoing a remarkable transformation, becoming more international, flexible and dynamic.

While current LNG tanker earnings are not something to write home about, the ongoing transformation of this market is worth paying closer attention to. Until recently, the LNG seaborne trade represented only eight per cent of the total gas trade and was limited to a few large importers such as Japan and South Korea. Oil-linked gas prices prevailed and almost all contracts were signed as long-term charters with very few ships involved in spot activities. However, a substantial increase of gas production, combined with significant additions to both liquefaction and regasification capacity have changed the market fundamentals. Let's try to examine some of the most critical ones.

The seaborne trade, after years of stagnation, grew by seven per cent, adding 17 million tonnes of new cargo. The demand growth was driven predominantly by China and India, but also by newcomers such as Pakistan, Egypt and Jordan. These countries will continue to drive demand, however we also expect other countries such as Thailand, Vietnam and Singapore to play an increasing role as importers. As 85 per cent of newly constructed import terminals (or FSRU projects) are located in Asia, it is obvious that a substantial part of the new demand will be satisfied by sea transport. Clarksons Research expects a continued strong growth of seaborne trade, reaching eight per cent in 2018.

### Growth factors

Most of this growth is driven by Australian and US projects. Last year, newly opened terminals such as Australia-Pacific and Cheniere Sabine Pass (T1 and T2) in the US generated the majority of new cargoes. In 2017, we expect a modest 25.5 billion cubic metre (bcm) increase in liquefaction capacity, mainly coming from Australian Gorgon (T3), Wheatstone LNG (T1), and

Cheniere Sabine Pass (T3 and T4) in the US. A much stronger increase is expected in 2018 when 43.8 bcm of new capacity will come online, and in 2019 when another 47.8 bcm will be added. Next year most of the additions will come from Australia whereas 2019 growth will be dominated by US export facilities.

The US as a "new kid on the block" seems to be introducing new dynamics such as an increased tonne-mile demand, attractive price arbitrage and much more flexible contract terms.

US gas is still establishing its footprint and is testing all potential markets, such as Latin America and Europe as well as the Far East, which, due to the distance, generates the highest tonne-mile demand. Shipping one million tonnes of US gas to the Far East (per annum) requires around 1.7 ships, whereas the comparable trade originating in Australia generates a demand for 1.1 ships only. So, the tonne-mile effect generated by US exports is currently more rewarding than anywhere else.

### Market forces

Another interesting factor is the pricing and competitiveness of US gas. Most of the traditional Asian gas contracts are based upon oil-linked prices. In the US however, gas is priced according to the Henry Hub Gas Index and as such is not sensitive to changes in the oil industry. Needless to say, it is not only decoupled from oil but also cheap. In fact, with current freight rates of some 40,000 US dollars per day (USD/d), a price difference of six USD/mBTU FoB in the US versus eight USD/mBTU in Japan may create an arbitrage of some 0.5 USD/mBTU, which translates to one million USD per cargo. It is important to note that charter rates assumed for the calculation are very low, due to the current oversupply. Rising rates (something the market hopes for) would require a wider price differential to create arbitrage.



US contracts also bring a great deal of flexibility regarding terms and conditions. Contracts can be signed for any duration and quantity. There is also a lower penalty for not picking up the cargo (ToP), as in the US only the liquefaction fee is charged. In addition, no fixed delivery locations are required, which is of particular interest for traders who, in case of overcontracting, are able to resell their surplus of cargo somewhere else.

All of these new developments have changed the LNG trade substantially, making it more international and flexible. On the one hand, a growing number of importers are generating a steadily increasing demand while, on the other hand, forcing suppliers to demonstrate more flexibility. According to IEA, more and more contracts are being signed for shorter durations and smaller quantities, without fixed destinations, and decoupled from oil prices. For the shipping industry this translates to more spot trading and more diversified trade patterns. In general, more competitive US pricing should have a positive impact on the tonne-mile parameter, however on the flip side it also introduces a risk of redirecting some of the

cargoes to shorter routes; for example, Japanese traders might resell their US-purchased gas in Europe.

**Rate increases will take time**

It may still take a while for LNG carriers to experience higher earnings. The order book is still over 120 ships strong. Deliveries in 2017 will reach 53 vessels and in 2018 the fleet will grow by another 41 tankers - an estimated growth of 10 per cent and 7 per cent, respectively. In light of the plans for major export terminal expansions in 2018 and 2019 (unless delayed), freight rates are likely to remain low throughout 2017. Nevertheless, the current remodelling of the market creates new opportunities in the longer perspective. ■ JW



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Photos: DNV GL, fotmart - Fotolia



Rising demand, especially from Asia, is lending new impetus to the LNG transport market.



# DESIGNING FOR OWNERS

An out-of-the-box ship design optimized for the current and future market and regulatory environment is something that appeals to owners and charterers. DNV GL has sat down with industry partners to make it a reality.

Rapid advances in technology and emerging requirements in the LNG carrier market have prompted DNV GL to intensify its efforts towards developing new, ready-to-build ship designs that are custom-tailored to market needs in every conceivable aspect. There are currently two joint development projects (JDP) with industry partners underway, each addressing a specific market segment. Their common goal is to make it easier for owners to find the right ship design for their needs, providing them with fully developed designs they can take straight to the yard.

## Efficiency tops the wish list

Finding an efficient design for a new post-Panamax LNG carrier in the 200,000-cubic metre range was the objective of a JDP between Daewoo Shipbuilding & Marine Engineering (DSME) and DNV GL. The project began with a thorough market analysis to establish the key criteria for the development work. Based on this study the project defined its primary targets: carrying more cargo at lower cost while ensuring the highest levels of reliability, safety and eco-friendly operation.

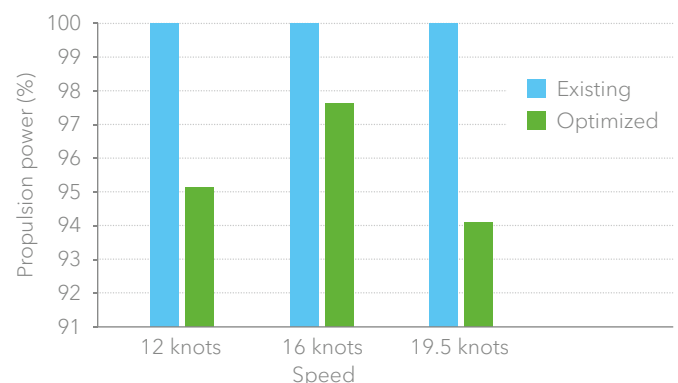
The project addressed all aspects of ship and cargo tank design, which included optimization of the hull form, propulsion system, auxiliary machinery and electrical systems while maximizing cargo capacity, all based on current and foreseeable regulations, market trends and operating patterns.

The dimensions of the new Panama Canal dictated the main particulars: a 300-metre length over all, 48.9-metre breadth, and 11.8-metre draught. Within these limits, the engineers sought to achieve the highest possible cargo carrying capacity, aiming to exceed 198,000 cubic metres.

Ensuring the reliability of the cargo containment system under increased stresses played a major role since nearly one third of all LNG trade occurs on the spot market, which results in a higher number of heating and cooling cycles compared with traditional fixed-charter trade. An additional important consideration was the trend towards lower, more energy-efficient transit speeds. The hull and propulsion system optimization work assumed three operating profiles of 19.5, 16 and 12 knots for a targeted trans-Pacific route. Calm water optimization resulted in gains of six, two and five per cent respectively over the reference design for the three operating profiles. The

## HULL AND PROPULSION SYSTEM OPTIMIZATION FOR THREE SPECIFIC OPERATING PROFILES

Compared with the reference ship, the optimized vessel design requires considerably less propulsion power as shown in this diagram.





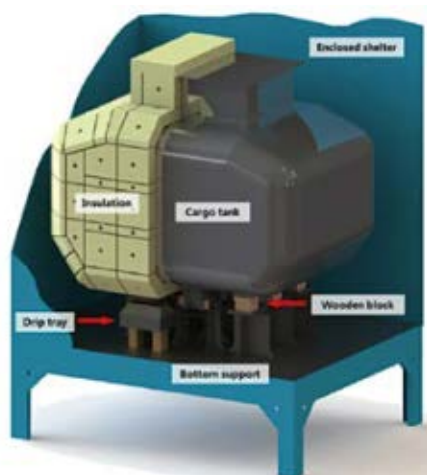
Through its JDPs, DNV GL provides owners and charterers with ready-to-build ship designs that are fit for tomorrow's market.

optimization calculations were performed using the DNV GL hydrodynamic analysis software Wasim as well as statistics and Reynolds-averaged Navier-Stokes (RANS) simulations for determining wave resistance.

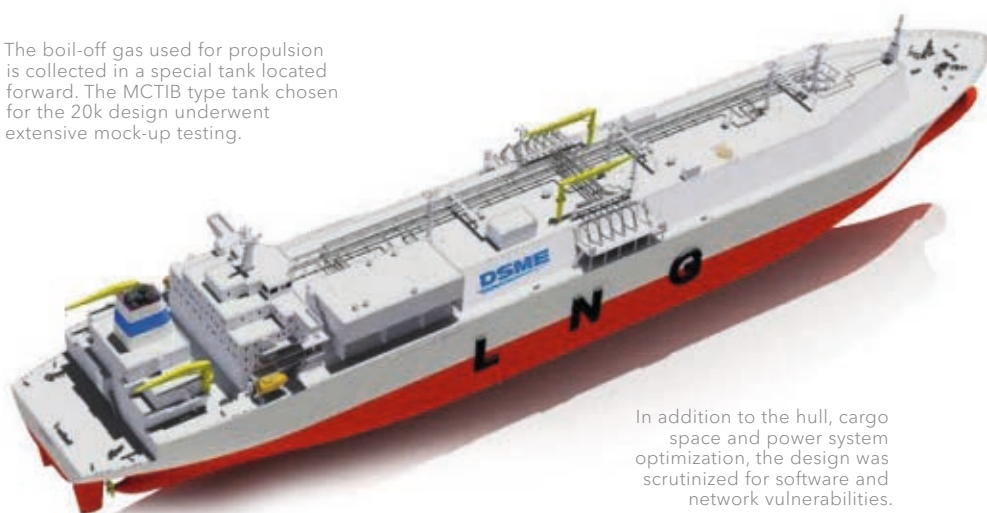
The designers based their work on the latest regulations and DNV GL rules and class notations, including BWM, the new IGC code, NO<sub>x</sub> Tier III and the latest applicable EEDI guidelines. The design proposes direct-coupled, two-stroke dual-fuel (DF) main engines and DF auxiliary engines, assuming LNG to be used as the primary fuel. A combined gas turbine, electric and steam (COGES) propulsion system was chosen for the optimized machinery.

For the portion of the boil-off gas used as LNG fuel, the developers opted in favour of a "High-Manganese Steel Cargo Tank Independent Type B" (MCTIB®), which underwent closed mock-up testing using liquid nitrogen (LN2). This solution was selected because it is competitive, features excellent tensile properties, high performance and product capacity at low cost, and allows flexible tank shapes while being slosh-free without imposing any filling limitations.

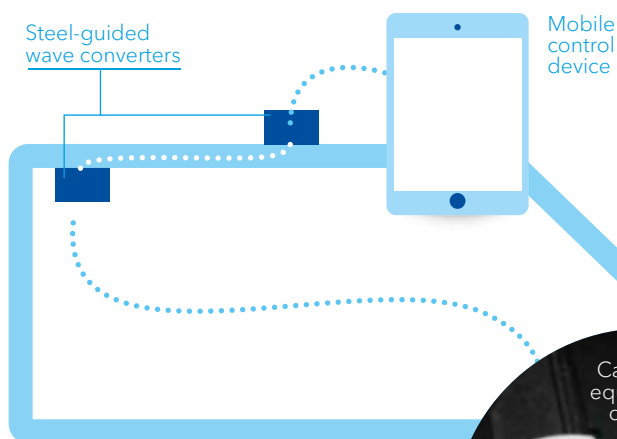
The proposed vessel will be equipped with a re-liquefaction plant for boil-off gas not used for the ship's own energy needs. In a sub-project, the JIP partners applied the DNV GL ISDS >



The boil-off gas used for propulsion is collected in a special tank located forward. The MCTIB type tank chosen for the 20k design underwent extensive mock-up testing.



In addition to the hull, cargo space and power system optimization, the design was scrutinized for software and network vulnerabilities.



Steel-guided wave converters installed outside and inside the tanks enable tank inspection using remote-controlled drones, without any personnel having to enter the tanks. This saves both time and money.

> (Integrated Software Dependent Systems) tool to address the quality, safety and security concerns associated with the software applications used to control the numerous systems on board LNG carriers. ISDS is a process standard which ensures adherence to the widely accepted international standards ISO/IEC 15288 and ISO/IEC 12207. Ensuring thorough verification of software by the supplier before it is shipped to the yard increases overall reliability and reduces commissioning delays; it may also reduce insurance and maintenance costs during operation.

Furthermore, the JDP incorporates DSME's SloT® (Ship Internet of Things) technology and their wireless computer network and integration system Smartship 4.0. The entire on-board computer environment underwent thorough scrutiny to ensure cybersecurity. Another neat feature is the installation of steel-guided wave converters on the inside and outside of tanks to allow remote inspection of tanks using drones.

### Attractive to owners and charterers

In another joint development project called "LNGreen II", the LNG containment system engineering company GTT, the ship-builder Hyundai Heavy Industries (HHI), the shipowner GasLog and DNV GL have combined forces to develop a state-of-the-art, ready-to-build design for a 180k LNG carrier. Expanding upon the same partners' earlier "LNGreen I" project, LNGreen II aims to explore ways to further enhance the ship design under a new set of market conditions, including the new Panama canal. It relies on proven technology and focuses on energy and operational efficiency while ensuring compliance with future regulations.

The main goal, however, is to give builders, owners and charterers a sound, attractive option. This puts limitations on potential features and technologies to use. Key aspects the project is looking at include the potential for optimizing the tank layout and decrease the boil-off rate through smart design, and ways to

optimize the machinery system, the re-liquefaction plant and the shaft generator in view of the trend towards lower transit speeds. All new developments will be compared with state-of-the-art vessels to make sure that all proposed improvements can realistically be achieved by owners and charterers. Compliance with the latest versions of the IGC Code and class rules is a matter of course.

To reduce both the boil-off rate and the construction costs, the LNGreen II design reduces the number of cargo tanks from the typical four to only three. The project partners are investigating the optimal tank arrangement to maximize cargo capacity while optimizing the scantlings and vessel stability as well as the cargo ventilation and auxiliary systems. The designers have decided to take advantage of the flexibility of membrane technology and its insulation properties and are considering various options to minimize sloshing.

### Advanced simulation tools

Other aspects being investigated include the trade-off between a twin and single skeg propulsion system, taking into account complex operational scenarios as well as market needs in terms of redundancy and manoeuvrability. Because of the complex nature of LNG carrier operation, the machinery and systems must be flexible and operate efficiently across the entire operational profile. Therefore the project is studying a variety of system configurations, including technologies such as re-liquefaction, waste heat recovery, variable frequency drives and batteries. The DNV GL simulation software COSSMOS enables the project engineers to assess the impact of each technology on vessel performance and its interaction with other components. The LNGreen II project is currently finalizing the individual studies and is expected to reach completion in late spring.

Explaining the rationale behind these joint development projects, Johan Petter Tuttoren, DNV GL Business Director Gas Carriers, comments: "All the experience and knowledge DNV GL has to offer will not be fully appreciated if we do not find suitable ways of sharing it with the industry. When we combine our knowledge with that of other industry partners we often see that 1+1 equals more than 2. It has been a privilege to work so closely with all the other esteemed companies in these projects, and I do believe we have managed to move the gas carrier business a little further in the 'safer, smarter and greener' direction." ■ AK



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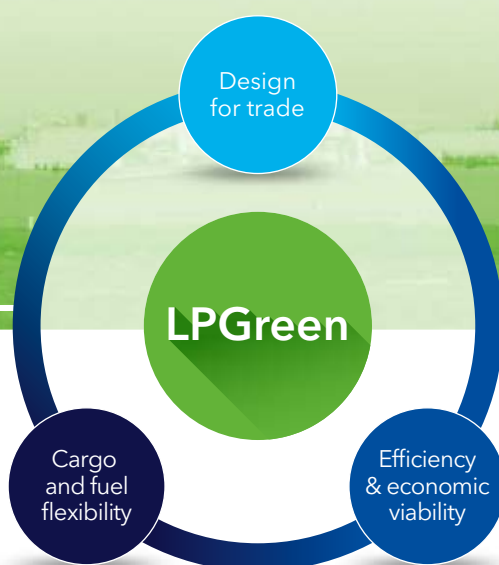


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# MAKING HEADWAY INTO ALTERNATIVE FUELS

LPGreen, a joint development project between four leaders in the maritime industry, is working on a concept design for an LPG carrier capable of operating on LPG fuel. A progress report.



The successful outcome of an innovative project depends very much on the parties involved and in the case of the LPGGreen design concept, Kostas Vlachos, COO of Consolidated Marine Management (CMM), believes the mix is perfect. "The LPGGreen project could not have happened at a better time. With 2020 fast approaching, the shipping industry will have to make the right decisions in regard to the proper option and avoid spending a lot of money unnecessarily to meet the new regulations coming over the horizon. This concept of LPG carriers offering the efficient option of burning LPG is new. Nothing like it has been developed in the past," says Vlachos. He should know. Athens-based gas carrier owner and operator CMM, a company of Latsco Shipping, is one of the four industry leaders partnering to develop the LPGGreen concept design. By contributing the expertise of a ship operator, CMM is key to the project.

## Rapid progress

Apart from CMM, the partners to the LPGGreen concept design project include the shipyard Hyundai Heavy Industries (HHI), the cargo handling systems manufacturer Wärtsilä Oil & Gas (WAR), and DNV GL as the classification society.

Seeking to develop a safer and more energy-efficient, environmentally friendly and competitive vessel for the transport of LPG products, the project utilizes the latest advances in machinery technology, ship design and operational experience. Within the bounds of existing shipbuilding methods it pursues the clear target of arriving at an LPG carrier concept design that can be ordered and built immediately.

Vlachos, a former chairman of Intertanko's powerful Hellenic Mediterranean Panel, is a member of Intertanko's executive

Representatives of all key segments of the industry contribute their unique know-how to the development of a design for tomorrow's market demand.

council, its safety and technical committee (ISTEC) and its chemical committee.

He says the idea for the concept of using LPG as a fuel was first voiced several years ago. The project took shape in November 2015 when the partners formally agreed to cooperate, with the actual project work launched in May 2016.

The LPGGreen project pursues five main objectives: use LPG as a fuel; develop a highly fuel-efficient vessel; increase load rates to spend less time at terminals; and, most importantly, give utmost attention to both safety and an ergonomic arrangement of machinery to improve the safety of the ship personnel as well as ship operability.

Almost a year into the project, the partners agree the results to date have been good. The goal is ambitious, and with the highly valuable contributions of HHI and cargo handling system >



"The concept is a revolution compared to the classical designs. It secures a lot of energy savings and safety advantages."

Kostas Vlachos, COO, Consolidated Marine Management

### Machinery configurations

- Improved overall efficiency
- Both conventionally and LPG-fuelled energy recovery technologies
- IMO Tier III-compliant

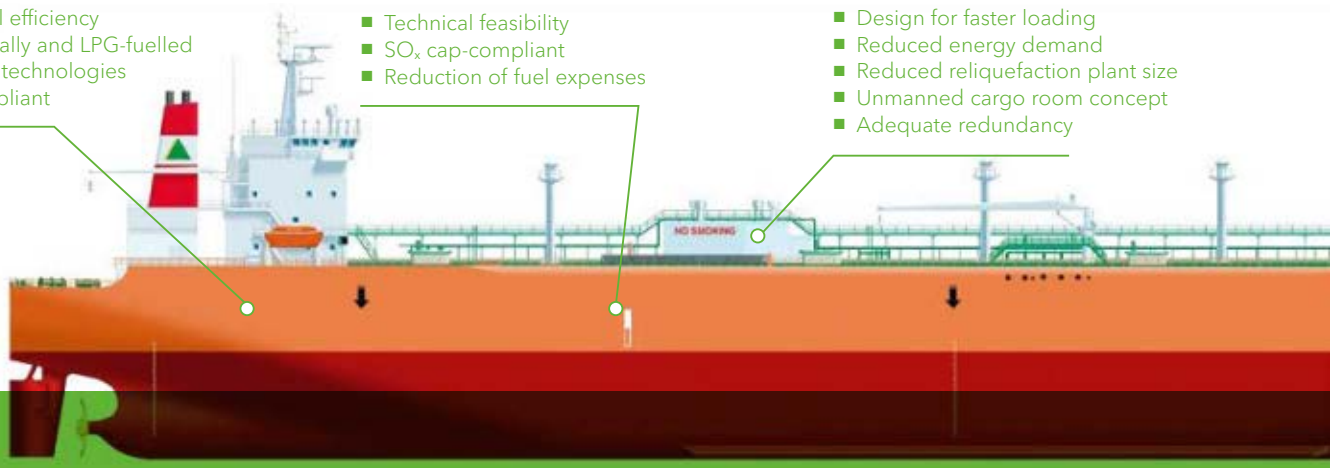
### LPG as fuel

- Technical feasibility
- SO<sub>x</sub> cap-compliant
- Reduction of fuel expenses

### Cargo handling

- Design for faster loading
- Reduced energy demand
- Reduced reliquefaction plant size
- Unmanned cargo room concept
- Adequate redundancy

The LPGreen concept design combines the best technologies available today.



> provider Wärtsilä Oil & Gas, the primary targets have been achieved: the new design will enable savings of five per cent to nine per cent in total consumption for all stages of operation (loading, discharging as well as sailing in laden condition and under ballast, including chilling and maintaining pressure), compared with the reference design, a conventional VLGC built by HHI.

CMM and HHI have been enjoying a strong working relationship since HHI began building gas carriers for the Greek operator at the South Korean yard in 2002. CMM embarked upon this project with a focus on finding a practical, energy-efficient design that is both competitive and safe, “with the safety aspect at the top of the list,” says Vlachos. “Any concept which is not safe is of no use to anyone,” he argues.

### Safety tops the list

George Dimopoulos, Principal Specialist for R&D and Advisory, DNV GL South East Europe & Middle East Region, who manages the LPGreen project, says CMM’s operational experience provided invaluable insight into the design aspects. “CMM collaborated very actively and closely with DNV GL on most of the safety aspects, a very important concern for the entire project,” he stresses. “About half of the project’s roughly 130 new ideas and vessel features involve safety criteria.”

Intensifying environmental pressure is driving energy efficiency improvements across the shipping industry. As the LPGreen concept matures, it will allow LPG-fuelled LPG carriers to become a reality, says Vlachos. The results obtained so far are encouraging: “We have a steady baseline,” he says, “since the vessel the project is based on is CMM’s own 54,400 dwt, 84,000 cbm VLGC *Hellas Gladiator* built in 2016. She is a modern and very efficient ship so all results of our project are true achievements.”

Summarizing the current project status, George Dimopoulos says the design concept is technically feasible, competitive and practicable. “Comparisons with the reference ship demonstrate that the concept improves overall efficiency by up to nine per cent, reduces energy demand for the cargo handling system by up to six per cent, potentially cuts loading times by up to 35 per

cent, and reduces fuel costs through the use of LPG fuel by up to 30 per cent,” he points out. “A slight increase in carrying capacity has also been demonstrated.”

Being able to draw on the extensive experience and competence of DNV GL in the LPG shipping sector as well as the classification society’s advanced analytical tools has enabled this consortium of international industry leaders to create an innovative ship concept with tangible improvements for the project partners.

The project has utilized the latest advances in machinery technology, ship design and operational experience within the bounds of existing shipbuilding methods. The contribution of the DNV GL computer modelling tool COSSMOS has been greatly appreciated: “COSSMOS allowed the project to take an analytical approach to data gathering and evaluation. Various options were compared, and the whole project proceeded in a highly professional, focused way towards the main goal: a design concept for a more energy-efficient VLGC operating on LPG,” says Vlachos.

He believes this is the first time the complete cargo, auxiliary and propulsion machinery was modelled, simulated and optimized for a full operating profile, and the COSSMOS application made this possible. “The role of this and other advanced technologies in identifying the best solutions for the industry is finding more wide-spread recognition,” he points out. “There is no doubt today’s computational methods speed up the development process considerably, enabling us to examine the numbers and reach conclusions faster.”

### Promoting the concept

Vlachos also notes that LPGreen is an international project in which Greek shipping has taken a leading role, working closely with other leaders across geographies and coordinated by the Piraeus office of DNV GL.

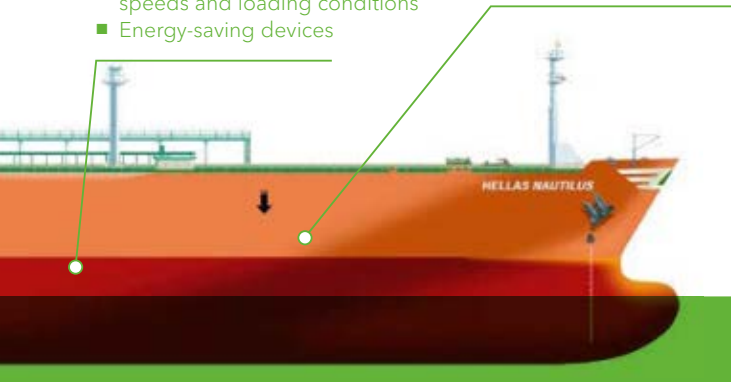
CMM’s COO says shipowners and their customers should be made aware of the concept as the industry is considering using LNG as a ship fuel. “But on an LPG carrier, that is not the best option,” he emphasizes. “I believe LPG ships burning LNG are not the right idea to pursue, since LPG is already available on board

**Hull and propeller**

- Optimized for both calm water and added resistance in waves
- Optimized for trade: multiple speeds and loading conditions
- Energy-saving devices

**Tank design**

- 99% filling limit: 1% additional cargo
- Higher design pressure



LPG carriers and adding a second gas fuel (LNG) will add to the overall complexity. Rather, the market should discuss the LPGreen concept, and by the market I mean all the players, from owners, charterers, clients, to shipbuilders, equipment makers and bodies such as Bimco, SIGTOO and Intertanko. They all should promote the idea of burning LPG rather than natural gas and formulate the proper clauses in charter parties for that purpose, because this involves a complex set of regulations. In fact, the concept is a legal matter that should be addressed as soon as possible. Until now nothing has been done on this front, and time is moving fast.”

This is a good time to promote a new design concept as ship newbuilding prices are reasonable, Vlachos points out. Until all parameters are clear and all questions answered, CMM will hold off on ordering a new ship, however. “We have always wanted to lead the way but have to wait and see what happens in the coming months, but I expect market pressure to speed up acceptance

of the LPGreen concept design,” he says. The far-reaching deviations from traditional designs will make the LPGreen concept attractive, he believes, not only in terms of the type of fuel burned by the main engine but also the changes affecting the cargo reliquefaction plant. Meanwhile, Wärtsilä is proposing a new configuration with only two redundant cargo compressors instead of the typical three.

Further efforts are needed to make charterers aware of the innovative features of the LPGreen design regarding bunker capacity as well as loading and discharging procedures, Vlachos adds. “Charterers in particular have to be brought up to speed about the development since increased capacity and reduced time spent in terminals is of great interest to them, along with the significant reduction in fuel consumption during all stages of operation. Besides, it is simply necessary to have the charterers on board.”

The LPGreen concept offers great benefits to VLGC owners and operators. “Now it is up to us to convince the Asian market to follow. The concept is a revolution compared to the classical designs. It secures a lot of energy savings and safety advantages. It opens the road into the future, and that is what we at CMM have chosen as our mission.”

The decisive factor that has made this truly innovative and practicable concept possible is close collaboration of representatives of all key industry segments – builders, vendors and class. “All the partners in this project have given their best, offering their knowledge and experience from their respective sectors,” Vlachos emphasizes. ■ GD



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Using the DNV GL software COSSMOS, the project partners were able to take an analytical approach to gathering data, evaluating various design options and comparing variants.

The Negishi LNG bunkering hub in the port of Yokohama is an ideal refuelling location for vessels departing on the trans-Pacific route.

# LNG INDUSTRY UPDATE

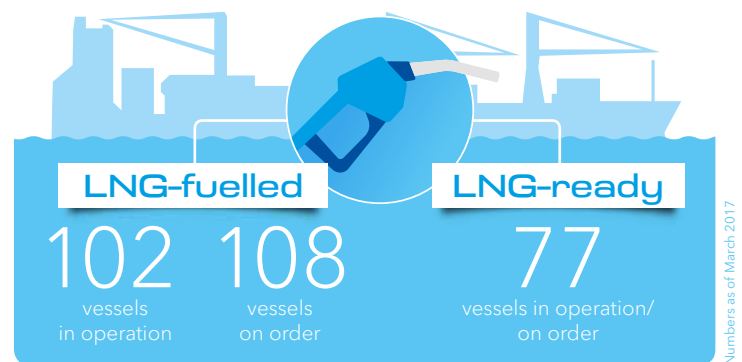
Exciting new projects in the cruise industry and many other segments during the past nine months are giving the LNG industry a boost. And with the global 0.5 per cent sulphur cap coming into force in 2020, these developments are an indication of what is to come.

The global count for LNG-fuelled ships as per March 2017 shows 102 ships in operation and 108 on order. In addition, 77 LNG-ready ships already in operation or on order are designed for efficient conversion from conventional fuel to LNG. While in previous years the LNG industry was mainly concentrated in Norway, the order book is currently dominated by vessels intended for operation in the North European and North American trade. Furthermore, even without the necessary LNG bunkering infrastructure in place, we see LNG fuel making its way into global ship trades. Seven of the vessels currently in operation operate globally, and 19 of the newbuilding orders are also destined for global trade. The LNG bunkering infrastructure will expand as these vessels venture into new territories. These examples show that LNG fuel has moved out of a niche and is now a viable option for all newbuilds and trades.

## LNG uptake

When we look at the uptake in various ship segments, car and passenger ferries are still far in the lead. One reason is that their LNG consumption and frequency of refuelling often enables LNG distribution and bunkering by truck. As long as LNG bunkering infrastructure remains scarce, this flexible and low-CAPEX solution will play an important role. Distribution by truck could even be a cost-efficient solution in the long-term as long as the required amount of bunker is needed in certain areas only.

Offshore vessels come in second. However, with the downturn of the offshore market, growth is expected to remain low for now. Overall we expect the strongest growth in the tanker, car/passenger, cruise and container segments. There is also some interest in LNG fuel coming from the gas carrier segment (excluding LNG carriers), with 13 ships in operation and five more on order. They are mainly operating in Europe and between Europe and the US.



The global LNG-powered and LNG-ready fleet is growing steadily.

## Outlook for 2020

We anticipate a worldwide fleet of 400 to 600 LNG-powered vessels to be in operation by 2020. It will be interesting to see how the recent decision of the IMO to implement the global 0.5 per cent sulphur cap from 2020 will affect the LNG segment. We expect the price of 0.5 per cent sulphur fuel to be somewhere between heavy fuel oil (HFO) and marine gas oil (MGO). This will be an additional incentive for shipowners contemplating a switch to LNG to achieve compliance with the sulphur cap. Generally the interest in LNG as a ship fuel and the number of newbuilds using LNG for propulsion are likely to increase. The impact will be felt most in the deep-sea ship segments. The application to the IMO for a NO<sub>x</sub> emission control area (ECA) in the Baltic and North Sea (keel laying date 1.1.2021) received somewhat less attention after MEPC 70, but this will be one additional regulation in favour of LNG over the alternatives in this region.

## LNG bunkering infrastructure

Our view is that LNG availability for ships is better than what the industry generally perceives and statistics from our LNG



The interactive world map of the LNGi portal allows users to select specific details to view, from project status to bunkering infrastructure data.

### DNV GL LNGi PORTAL

With LNG gaining ground rapidly, it is a challenge to keep track of all the latest developments. This led DNV GL to develop LNGi, the LNG intelligence portal, which allows subscribers to assess the availability of LNG fuel for specific trade routes and newbuilding projects. It also provides information about current market developments as well as status updates on other alternative fuels and emission reduction technologies across all vessel segments.

LNGi allows us to pool our efforts with those of the industry to generate high-quality data and increase transparency in a market that is set to receive multi-billion-US-dollar-investments in the coming years. In this way we can innovate together, and with much greater speed and impact than we could hope to achieve working alone.

Potential subscribers may visit the LNGi website [dnvgl.com/lngi](http://dnvgl.com/lngi) for further information, to fill in the contact form or to simply contact their local office.



intelligence portal (LNGi) show that LNG bunkering infrastructure is developing rapidly. There are 58 LNG supply locations in operation for ships worldwide, not counting LNG bunkering vessels and LNG trucks which can go anywhere (subject to permits). Investment decisions have been confirmed for an additional 36 projects, and 36 project proposals are registered as currently being discussed.

As for LNG-fuelled ships, we clearly see that the majority of LNG bunkering projects under development are in Europe, mostly concentrated around the ECAs. We also see quite a few projects developing in Asia. In North America, the pace of development has been somewhat slower than expected. The slowing effect of lacking infrastructure developments, amongst other factors, should not be underestimated.

We are still in the early days of LNG as a ship fuel, so flexible infrastructure assets make sense. Orders for LNG bunkering vessels are clearly picking up as ship-to-ship distribution and bunkering is emerging as an important step towards cost-efficient LNG refuelling. Four LNG bunkering vessels are currently on order for Shell, Skangas, BominLinde/Klaipėdos Nafta and TOTE/JAX LNG, respectively. In February the first LNG bunkering vessel ordered by Engie/NYK/Mitsubishi was delivered. It will be based at the Fluxys terminal in Zeebrugge, Belgium. Furthermore, DNV GL awarded Vard Engineering Brevik AS with an Approval in Principle (AiP) for their new 6,500-cubic-metre bunker vessel design at the end of September 2016. There are six loading facilities for LNG bunkering ships globally, another nine projects have been approved, and five more are under discussion.

### New developments in Asia

Looking to Asia, some of the most promising LNG bunkering projects are underway in Japan. A recent feasibility study looked at the development of an LNG bunkering hub at the port of Yokohama, the first/last Asian bunkering port for the trans-Pacific route. The study, which was supported by various government agencies as well as Yokohama Kawasaki International Port Co. Ltd. and NYK Line, resulted in a three-phase approach: Phase I began the process by providing truck-to-ship bunkering; Phase II will introduce

ship-to-ship bunkering from the existing LNG terminal which already has suitable infrastructure, and Phase III will establish a local LNG supply chain with two bunkering ships in Yokohama once demand rises to an appropriate level.

Other LNG initiatives are joining the trend. An international focus group including the Japanese Ministry of Land, Infrastructure, Transport and Tourism as well as the Norwegian Maritime Authority, South Korea's Ulsan Port Authority and the ports of Singapore, Rotterdam, Antwerp, Zeebrugge and Jacksonville has formed to cooperate on LNG bunkering. It is encouraging to see the industry making strides towards adopting LNG. ■ MCW

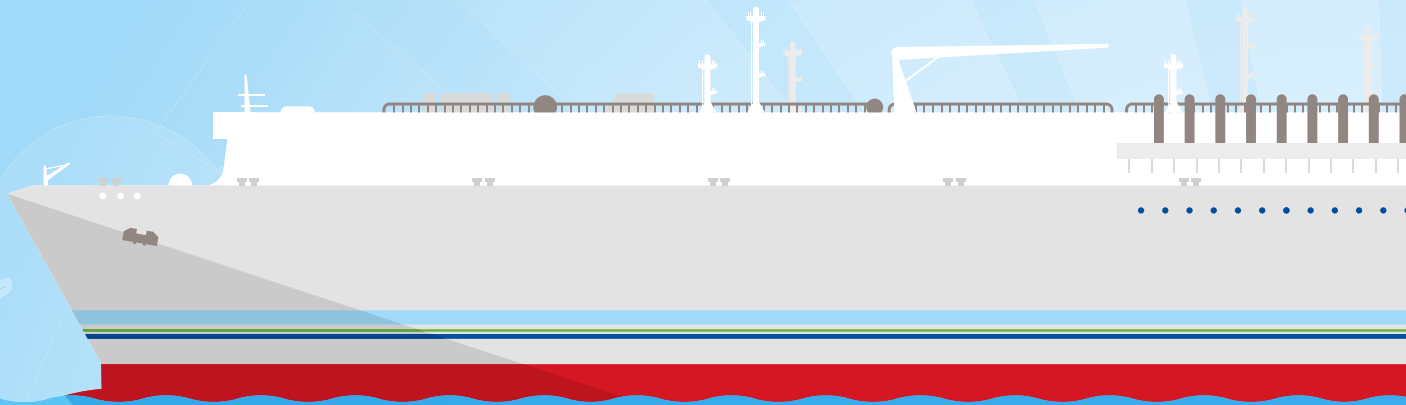


#### DNV GL Expert

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# LOW-POLLUTION ENERGY FOR EMERGING MARKETS

As floating natural gas sources, FSRUs bring energy and quality of life to places lacking conventional supply infrastructure. Far superior to land-based alternatives in terms of cost, environmental impact, and construction time, FSRU newbuilding projects are booming.



## HÖEGH LNG orders new FSRUs with DNV GL class

Höegh LNG just ordered one new floating storage and regasification unit (FSRU) from Samsung Heavy Industries (SHI) and Hyundai Heavy Industries respectively plus an option for three more from SHI. All

vessels will be DNV GL-classed. With this newbuilding programme, Höegh aspires to become the leading global provider of FSRUs for LNG. With a storage capacity of 170,000 m<sup>3</sup> each, the newly

ordered FSRUs will have full trading capabilities. The first vessel will be delivered by SHI in May 2019, with the optional ones expected to follow at six-month intervals. They will serve in Ghana and Pakistan.



Commissioned in 2014, Höegh Gallant is currently moored in Ain Sokhna, Egypt, providing LNG for power generation.

## DNV GL at the forefront of FSRU development

### 1962

- DNV GL has played a key role in defining the LNG carrier industry
- **First classification society to publish rules for gas carriers in 1962**



### 2008

- **Development of Classification Note for FSRUs**





**15 ORDERS**

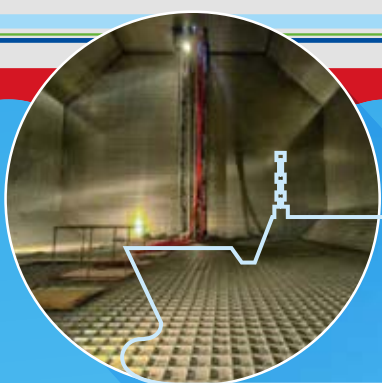
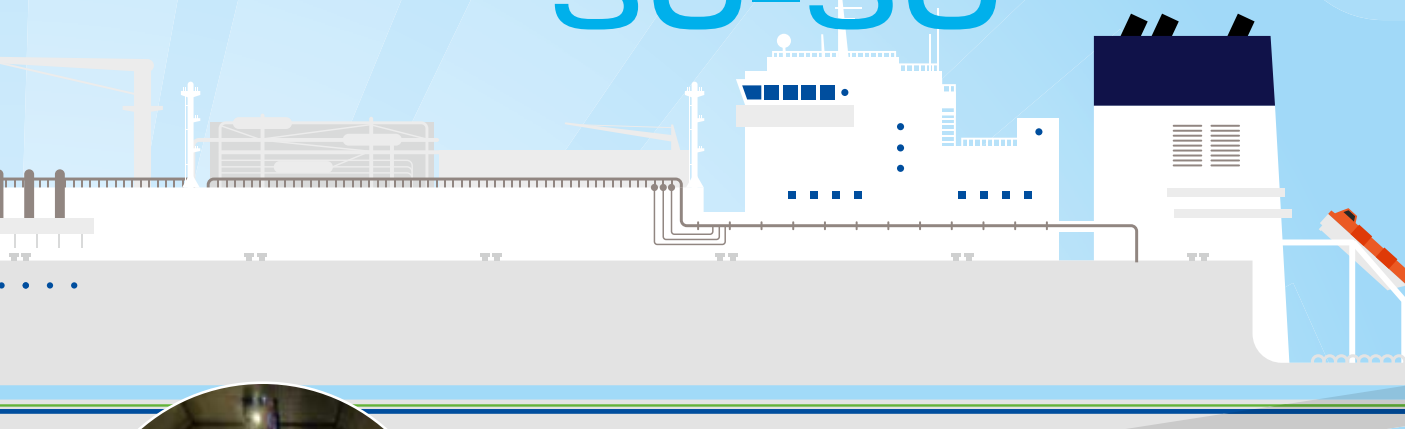
The global order book of approx. 15 FSRUs underscores the general trend towards this flexible, readily available energy source.

**KEY COMPANIES** in FSRU business

There are four contestants for market leadership. New players are expected to enter the market soon.

<b>EXMAR/EXCELERATE</b>	<b>10</b> in operation	<b>1</b> on order
<b>HÖEGH LNG</b>	<b>6</b> in operation	<b>5</b> on order
<b>GOLAR LNG</b>	<b>7</b> in operation	<b>2</b> on order
<b>BW GAS</b>	<b>1</b> in operation	<b>2</b> on order

**POTENTIAL OVER NEXT FIVE YEARS**  
**30-50**



**STORAGE** capacity of FSRU tanks

Converted Moss FSRUs approximately **125,000 m<sup>3</sup>**      FSRU newbuilds approximately **170,000 m<sup>3</sup>**

**2009**

- **First conversion to FSRU:** DNV-classed *Golar Spirit*
- **First FSRU newbuild:** DNV-classed FSRU *Neptune* (below)

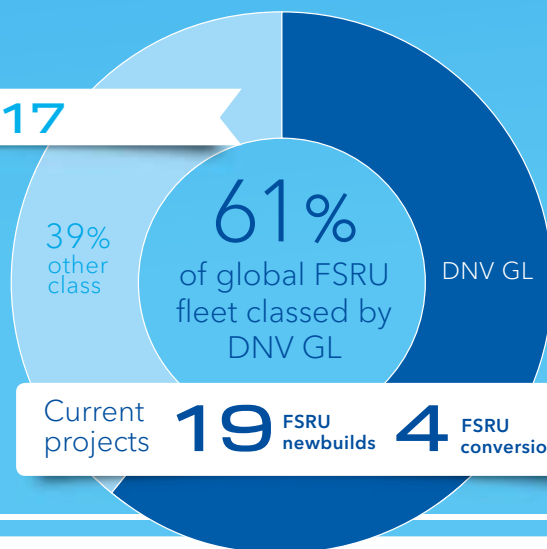


**2015**

- Latest revision of REGAS rules



**2017**



Current projects **19** FSRU newbuilds **4** FSRU conversions

Photos/Illustrations: CC0 1.0, icons by Freepik from www.flaticon.com, Höegh LNG (2)

# PREPARING FOR MRV COMPLIANCE

The European Union's Monitoring, Reporting and Verification (MRV) regulation requires, as a first step towards compliance, monitoring plans for every ship to be submitted to independent verifiers by 31 August 2017 at the latest. This overview helps owners and operators get ready.



## YOUR FOCUS/ CHALLENGES

**Study the EU MRV regulation** – familiarize yourself with the “M” (monitoring) and “R” (reporting) in particular. Identify challenges such as how to monitor cargo for particular vessels etc.

Assess your **reporting system** and decide whether it satisfies the MRV regulation. In case the system needs an extension or

replacement, allocate resources to decide on the right system, its distribution and implementation on board your vessels.

Gain confidence in data reported by your crew by assessing the related data quality. This enables you to take corrective measures before reporting commences in 2018.

## DNV GL SUPPORT

DNV GL has published an MRV guidance paper and offers webinars, regional meetings and seminars throughout 2017.

Should you have specific questions or need clarification on the regulation, please see the FAQs at [www.dnvgl.com/mrv](http://www.dnvgl.com/mrv) or contact your local DNV GL office directly.

**DNV GL's MRV Readiness Check app** provides a first assessment of whether you are EU MRV-ready or not. It guides you through a condensed checklist covering all aspects of the regulation, giving you a clear picture of your present preparation status and leaving you with a to-do list to plan your next steps. The app is available to our customers through *My DNV GL* free of charge.

Should more detailed support be required, DNV GL offers a tailored **MRV Ready service** through our Advisory department.

**Navigator Insight** is the DNV GL solution for ship-to-shore reporting. It comes with an on-board reporting tool for manual input of all the parameters required by the MRV regulation and can be extended to cover all aspects of daily ship operations. More than 450 plausibility checks enhance data quality before the data is sent ashore. More information can be found at [www.dnvgl.com/navigator-insight](http://www.dnvgl.com/navigator-insight).

### MY DNV GL APP: MRVMP

#### The app

- The application will help users generate an MRV monitoring plan and hand it in for approval



#### Features

- Provides an easy-to-use, step-by-step template that helps with pre-filled technical information of the particular vessel to generate the MRV monitoring plan
- Smooth 1-click transition from plan to approval with discounted pricing for verification

#### Benefits

- Informs about the upcoming MRV regulation
- Saves time and effort on both the customer and DNV GL side
- All relevant vessel data is stored and accessible via *My DNV GL*
- Avoids the need for iterative clarifications



The upcoming EU MRV regulation requires careful attention. As a very first step, companies should assess whether tools already in place today will suffice for the MRV regulation and its reporting needs or whether they need to be extended or maybe even replaced by a new solution. Important questions to ask include:

- Is my system capturing all the required data? Is it also capable of differentiating between EU ports and non-EU ports, while reflecting on the different fuels and emissions at berth as well as many additional details such as anchoring time? Does it allow for repair calls in ports not subject to reporting requirements and so forth?

- Will I be able to efficiently extract and aggregate all the required data as necessary for the emissions report and corresponding verification?
- Is the system sufficiently implemented within the company to ensure a certain data quality which matters for MRV reporting, as data will be made publically available?

Once assessed and decided, companies will need to establish management procedures to ensure successful implementation of their monitoring systems and their proper usage on board. On the way towards compliance, we propose the following actions:

Summer  
2017

Companies have until 31 August 2017 to create and submit a ship-specific **monitoring plan** to the contracted verifiers indicating the method chosen to monitor and report emissions and other relevant information for each vessel over 5,000 GT that calls at EU ports.

Preparing the monitoring plan can be a time-consuming task. Its content is specified in detail by the EU MRV regulation. Requirements include ship-specific data, such as emission sources, as well as information about the development and implementation of additional management procedures.

**DNV GL's MRV monitoring plan app** supports you in preparing your monitoring plans for your entire fleet – semi-automatically and efficiently. The app pre-populates technical input fields in advance where data is already available from external data sources such as vessel particulars. It supports the definition of management procedures by offering predefined text blocks. Upon completion it compiles all information gathered in the correct format. The app is available to our customers through *My DNV GL* free of charge.

#### DNV GL's monitoring plan verification

We will verify whether your company has compliant monitoring plans and is ready to submit plausible emissions reports. DNV GL will design the verification process as digital as possible to reduce the additional work for you.

Beginning  
2018

The first **reporting** period commences at the start of 2018. Based on your individual monitoring plans, your vessels will collect all the necessary data and transfer them ashore.

We suggest you initiate the processing of data in 2017 so there is still time to take corrective action in case any system or process shortcomings are discovered.

**Navigator Insight** is our suggested tool for ship-to-shore data collection and reporting.

Beginning  
2019

Prepare the emissions report and submit it to the contracted verifier. DNV GL has incorporated the guideline on verification for its verification activities.

#### DNV GL's emissions report verification

Verification of your emissions report(s) starts in January 2019. DNV GL will design the verification process as digital as possible to reduce the additional work for you. We will check your emissions report against your voyage log abstract and the external data we require.



Please refer to [www.dnvgl.com/mrv](http://www.dnvgl.com/mrv) for a comprehensive overview of all topics regarding the EU MRV regulation.



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# SAVING COASTAL ECOSYSTEMS

With the Ballast Water Management Convention coming into force in September, shipowners and operators have little time left to ensure compliance. DNV GL provides comprehensive support.

It has taken the International Convention for the Control and Management of Ships' Ballast Water and Sediments (in short, Ballast Water Management or BWM Convention) nearly 20 years to reach this point, but following the accession of Finland last autumn, the percentage of global shipping tonnage covered by ratifying nations finally crossed the required 35 per cent threshold. The BWM convention, a crucial measure to protect marine ecosystems against invasive aquatic species, will take effect on 8 September 2017.

With only a few months to go, shipowners must take action as soon as possible to implement the convention. All affected vessels – which includes most ships travelling international waters and using ballast water – will be required to carry on board an approved Ballast Water Management Plan (BWMP) as well as the International BWM Certificate ensuring compliance with the so-called D-1 standard, the first portion of the convention. If the flag state of a vessel has not ratified the BWM Convention as yet, a Statement of Compliance (SoC) should be issued and carried on board to avoid challenges of documenting compliance in foreign ports. Furthermore, all ballast water operations must be documented in a BWM record book. Since approval activities are expected to intensify as the deadline draws nearer, it is advisable to submit the BWMP for approval as soon as possible. Shipowners and operators should begin the process by identifying the affected vessels still lacking this documentation. Where required, they should order and perform the initial survey in due time before 8 September.

Most initial surveys can be performed in conjunction with other surveys.

The D-1 standard relates to the first, transitional implementation phase of the convention, during which all ships not equipped with compliant ballast water treatment systems are required to exchange their ballast water in mid-ocean, at specified distances from the nearest shore, using one of several approved methods.

## BW treatment systems

The next step for owners and operators will be to review the International Oil Pollution Prevention (IOPP) certificate renewal date for each particular vessel. The first IOPP renewal date after 8 September 2017 is the deadline for installation of a ballast water treatment system, the second phase of the convention, which stipulates the actual treatment of ballast



## MY DNV GL APP: BWMP

### The app

- The application will help users to generate a Ballast Water Management Plan and hand it in for approval

The customer portal *My DNV GL* provides access to the web application.

### Features

- Easy-to-use step-by-step template that helps with pre-filled technical information of the particular vessel to generate the Ballast Water Management Plan
- Smooth 1-click transition of plan to approval with discounted pricing

### Benefits

- Saves time and effort on customer and DNV GL side
- All relevant vessel data is stored and accessible via *My DNV GL*
- Avoids the need for iterative clarifications

water according to the so-called D-2 standard. The effectiveness of the treatment system is assessed by the maximum permissible number of viable organisms remaining in the treated ballast water: ten viable organisms larger than 50 µm per cubic metre, and ten viable organisms 10 to 50 µm in size per millilitre. The BWM

Convention also specifies certain indicator microbes as well as broad safety requirements.

The spread of invasive species through ballast water is causing enormous damage to biodiversity.

All relevant ships should be in compliance with the D-2 standard by the end of 2022.

Ships in service still lacking a type-approved ballast water treatment system (BWTS) must be retrofitted by the IOPP renewal date as indicated. There are various treatment technologies available, all of which have their pros and cons. The choice should depend on the characteristics of the given fleet, and the documents relating to the retrofit should be forwarded to class for plan approval as early as possible. According to the D-2 standard, ships must carry on board the type approval certificate for the BW treatment system as issued by the responsible administration, approved technical documentation and an operation manual as well as the International BWM certificate issued after the initial survey to confirm compliance with the D-2 standard.

Newbuilds with keels laid down after 8 September 2017 will be required to be delivered with a BW treatment system installed. Newbuilding projects begun before that date should be retrofitted accordingly.

### USCG performance requirements

After much anticipation the announcement at the end of 2016 that the first ballast water treatment systems had been approved by the U.S. Coast Guard (USCG). Alfa Laval, Optimarin and OceanSaver became the first suppliers in the world to be awarded USCG-type approval and DNV GL is proud that it had worked with all three of these successful applicants.



Ballast water management is among the top environmental issues addressed by new regulations.

The USCG officially appointed DNV GL as an Independent Laboratory (IL) to perform type approval testing of ballast water treatment systems in 2013. "DNV GL and its associated sub-laboratories DHI-Denmark, NIVA, Golden Bear Facility and DHI-Singapore have been deep into the details of USCG testing for three years and have gained substantial experience in what is practical and possible to achieve compliance with the regulation." DNV GL has a team of about 15 engineers, biologists and scientists, working full-time with BWTS," says Martin Olofsson, Senior Principal Engineer, Environmental Protection DNV GL - Maritime Approval of Ship Systems and Components.

As an interim solution the USCG Alternate Management System (AMS) is temporarily accepting type approvals to IMO standards for a period of five years, after the installation on a particular vessel. Affected owners should visit the USCG environmental web pages from time to time for updated information before making a final decision regarding the type of BW treatment system to install.

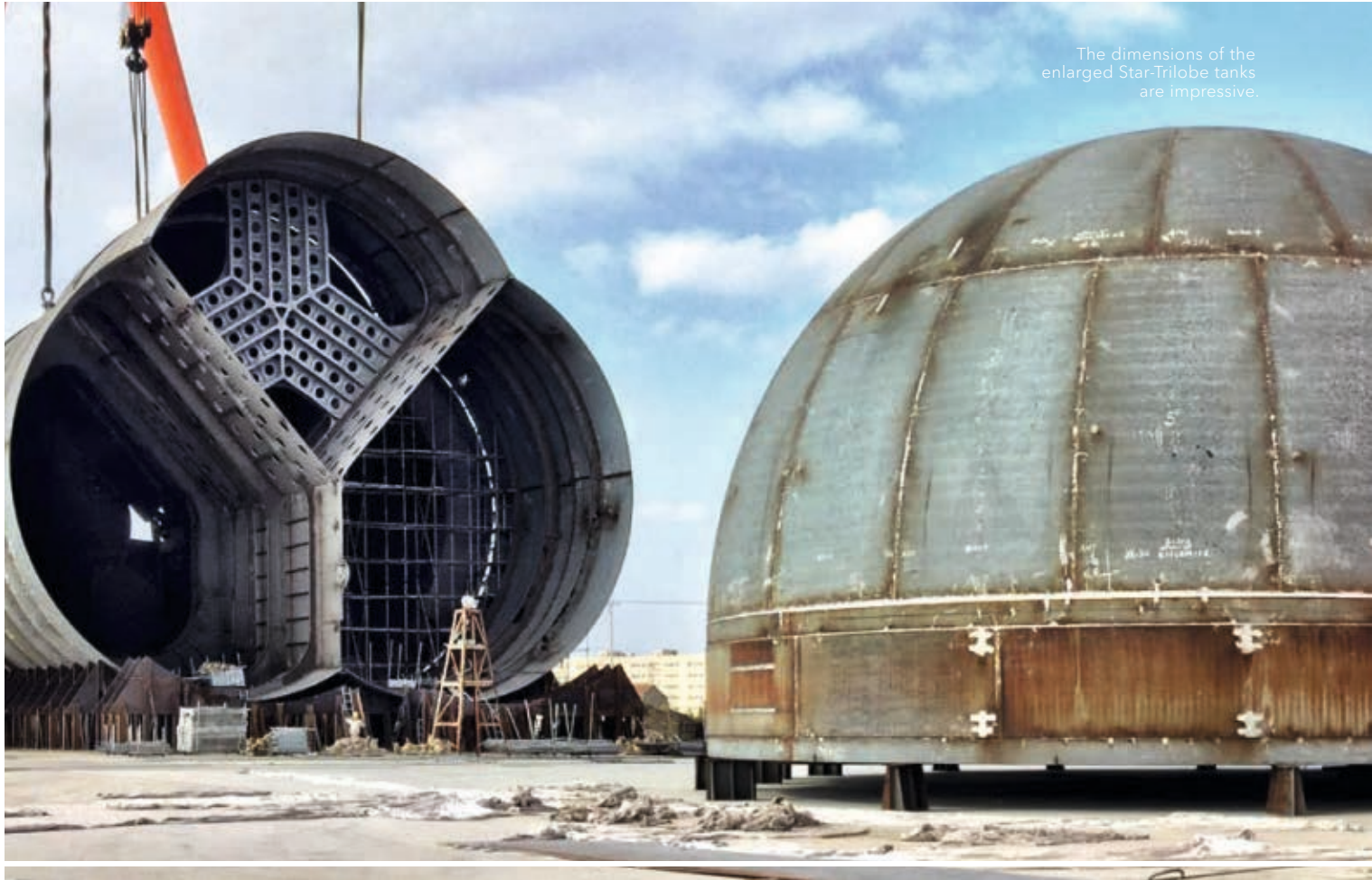
DNV GL has been involved in ballast water treatment technology, testing and type approvals as well as the development of the BWM Convention itself for many years. As a Recognized Organization for most flag states, DNV GL can approve BWM plans, perform surveys, and issue international BWM certificates. DNV GL has published a Retrofitting Guide and a Regulatory News issue that give a concise overview of BWM requirements, and a Web-based application on *My DNV GL* helps owners accelerate the BWMP approval process. DNV GL stands ready to give comprehensive advice and support for all questions on the subject, including the best timing of surveys in view of the time frame for retrofits. ■ AK

More information on ballast water management is available at [dnvgl.com/bwm](http://dnvgl.com/bwm)



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The dimensions of the enlarged Star-Trilobe tanks are impressive.

## PUSHING THE FRONTIER

A new, highly efficient, eco-friendly 38,000 cubic metre liquefied ethylene gas carrier was delivered last November: *GasChem Beluga* is equipped with innovative "Star-Trilobe" cargo tanks boosting cargo capacity by nearly 30 per cent. An even larger design will soon follow.

Norwegian owner Ocean Yield ASA took delivery of the 36k ECO STAR-type vessel, the largest LEG carrier with Type-C tanks built to date, from Sinopacific Offshore and Engineering shipyard, China, on 11 November 2016. GasChem Services, a member of the Hartmann Group based in Leer, Germany, has been entrusted with *GasChem Beluga's* commercial management, and Hartmann Gas Carriers is in charge of technical and nautical operations. The ship operates under a long-term charter for SABIC Petrochemicals B.V. and will be joined by her sister vessel *GasChem Orca* this summer.

The ECO STAR design was developed under the leadership of Hartmann Reederei working closely with several long-term partners: HB Hunte Engineering of Oldenburg, Germany, designed the ship itself; the unique Star-Trilobe tank, which combines three cylinders into a single unit, is a brainchild of Star-Gas Tank Design (SGTD); and the gas plant and equipment were designed by AC Inox GmbH, Alsdorf, Germany. "When we came up with this idea



*GasChem Beluga* is the largest LEG carrier with Type-C tanks built to date.

we immediately contacted class," says Hartmann's Fleet Manager Ulrich Adami, considered to be the "father" of these next-generation vessels. "We wanted DNV GL to be involved from the start."

Jan-Lars Kruse, Managing Director Finances of Hartmann Shipping Services, is pleased with the rapid progress of the project: "The first vessel of this new design hit the water with only a month's delay," he says. "This is a remarkable achievement in these challenging times and we are very grateful to all our partners involved in this project. Everybody helped push this project into the right direction. We could not have done it alone."

The hull design of the vessels is unique and highly efficient: with the superstructure at the bow and the engine near the stern, weight distribution is excellent and the ballast water requirement minimal. In combination with the new "Svelte" bow design developed by Hartmann, the hull increases efficiency and reduces fuel consumption. The innovative MAN dual-fuel main engine is the first-ever ethane or LNG-powered two-stroke engine with negligible methane slip thanks to the diesel combustion principle. This low-emission technology will enable the ECO STAR-type vessels to meet future emission control requirements.

### Aiming higher

It was not until 2012 that the market began demanding LECs carrying more than 25,000 cubic metres. Until then the common assumption was that Type-C tanks larger than 40,000 cubic metres were not feasible, and that future ethane carriers capable of transporting in excess of 80,000 cubic metres would use either prismatic Type-B tanks or several membrane systems. But a comparative study by DNV GL of typical 83k VLGC hull scantlings, which would also apply to 85k very large ethane carriers (VLECs), concluded otherwise.

Hartmann and Star-Gas Tank Design took up the challenge and adapted their Star-Trilobe concept for the next generation of 85,000 cubic metre VLECs. The dimensions of the enlarged tanks are impressive: at a length of 40.4 metres and a lobe diameter of 21.6 metres, each tank rises to a height of 27 metres, weighs in at 1,900 tonnes and has a volume of 23,100 cubic metres.

The tank design has been verified by DNV GL. The refined design analysis went beyond the normal scope of Type-C tanks, which covers aspects such as plastic deformation and buckling. "We also performed fatigue and crack propagation analyses and supported the designers in specific areas such as the twin saddle, swash bulkhead and triple Y-joint design tasks, enabling significant improvements to the 36k Trilobe design," explains Matthias Malinowski, Ship Type Expert at DNV GL. The fatigue strength and fracture mechanics verification performed by DNV GL was extended from a 20-year to a 30-year tank lifetime.

Further enhancements were achieved by including V-shaped longitudinal bulkheads (LBHD) and inter-lobe venting. All these features add up to a highly advantageous weight and capacity rating, with space utilization approximating that of a standard VLGC design with Type-A prismatic tanks. The tanks are proportionally lighter than bilobe tanks while offering around 20 per cent more capacity, and 50 per cent more than cylindrical forms on ships featuring the same hull scantlings. The stresses acting

### INNOVATIVE SEMI-REFRIGERATED SOLUTION FOR VLEC

#### Dimensions and main data

- Length over all: 231.60 m
- Length between perpendiculars: 225.50 m
- Breadth max.: 36.60 m
- Depth: 22.00 m
- Depth to trunk deck: 30.95 m
- Deadweight max. abt.: 50,000 tonnes
- Design draught: 12.00 m
- Speed loaded abt.: 16 kn
- GT abt.: 58,100
- NT abt.: 17,500
- Accommodation: 23

#### Cargo storage capacity

- Total abt.: 83,220 m<sup>3</sup> of liquefied gas up to -104 °C

#### Cargo tank characteristics

- Number of tanks: 4
- Tank 1: independent C-type, cylindrical, insulated
- Tank 2-4: independent C-type, Star-Trilobe, insulated
- Construction material: 5% Ni
- Max. tank pressure: IMO 4.5 bar (g)

#### Classification

- GL 100A5 Liquefied Gas Carrier, -104°C; 0.602 t/m<sup>3</sup>, 4.5 bar g; type 2-G; NAV, IW; BWM (D2); INERT; NLS; ERS GL MC AUT GF; CM-PS; EP-D



The next big thing: 85k VLECs featuring space-saving Trilobe tanks.

upon the support elements are lower than those from 36k tanks. In 2015 JHW Engineering & Contracting, a joint venture of the Luxemburg-based Jaccar Holdings, Hartmann and the Chinese engineering company WOE headquartered in Shanghai, ordered five 85k VLECs from Dalian Shipbuilding Industry Offshore Co. (DSIC), China, which is also installing the Trilobe tanks. The ships will be managed by United Ethane Carriers (UEC), a joint venture of Jaccar and the Hartmann Group established specifically for developing the ethane business. UEC secured a 10+5-year charter contract with Oriental Energy for the five vessels. The first ship is scheduled for delivery in early 2018.

"In view of the considerable amount of new design work involved in these new gas carriers it is extremely important to work very closely with class," says Michael Ippich, Managing Director Operations of Hartmann Shipping Services. "We essentially developed a prototype, and the gas carrier expertise of DNV GL was instrumental in bringing it to maturity." ■ AK



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# PUTTING A STOP TO CYBER EXPLOITS

Marine Cybernetics, a DNV GL service line, works to identify maritime and offshore cyber-security vulnerabilities. The experts give an in-depth look into one of their most recent cases.

“This was a vulnerability that could have allowed a hacker to remotely shut down the drilling control system, a blowout preventer, power management systems, or an emergency shutdown system,” says Mate J. Csorba, Principal Specialist Cybersecurity, Marine Cybernetics (MC). In January 2016, Csorba’s MC team and partners at the Norwegian University of Science and Technology (NTNU) contacted Siemens about a denial of service (DoS) vulnerability in a series of their programmable logic controllers (PLCs). Designed for discrete and continuous control in industrial environments worldwide, these PLCs are among the most widely deployed Siemens controllers. Many critical applications are built on top of this family of PLCs.

“We engaged with ProductCERT, the central Siemens team for responding to potential security incidents and vulnerabilities,” continues Csorba. “Through a coordinated disclosure procedure, we sent an encrypted proof of concept showing how the vulnerability could be exploited.” The resulting dialogue between Marine Cybernetics services and Siemens produced a firmware update that addressed the issue.

“This most recent finding has been the result of our collaboration with the Department of Telematics at NTNU. The investigation relied on state-of-the-art security testing methodologies, in particular fuzzy testing and negative testing

of industrial communications,” Csorba adds. “The proof of concept developed by MC only required TCP/IP packets to be sent to the PLC. By doing this we could disable a PLC in such a way that only a cold restart would bring it back to normal operation.”

### High-severity vulnerability

The issue detected received a base rating of 7.5 out of 10 based on the industry standard for assessing the severity of computer system security vulnerabilities (CVSS) - which meant it was a high-severity vulnerability. Most control systems are designed assuming a secure PLC operating environment.

But in practice, industrial systems are often connected to other networks, allowing remote access through the Internet. “This vulnerability could have been exploited by an attacker gaining access to the control system network. This is why the verification and testing of deployed barriers, such as network segregation, and secure remote connectivity is so essential to ensuring system security,” says Csorba. While the vulnerability identified by Marine Cybernetics services and NTNU was, on this occasion, in a Siemens PLC, serious vulnerabilities have also been reported in similar products from other vendors. “The ProductCERT team from Siemens was excellent. They handled the finding and disclosure

The inventiveness and viciousness of hackers should not be underestimated.

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process professionally and swiftly. The major control system vendors take such findings very seriously and are continually working to maintain and improve their development cycles.”

But at the same time, he states, owners in the maritime and offshore industries should seriously contemplate third-party verification of their assets’ cybersecurity. “The current practices to mitigate cybersecurity risks, especially in the industrial environments where these controllers are used, are not always best suited for addressing such issues,” Csorba explains.

### Customized tools and methods

This is just one example of how DNV GL works to identify and prevent cybersecurity vulnerabilities that can impact critical maritime and offshore control systems. As part of DNV GL - Maritime, Csorba works in one of the test labs in Trondheim, Norway, where the focus is on addressing cybersecurity in on-board control and various auxiliary systems.

The DNV GL - Maritime labs can host replicas of a variety of control systems, including power management systems,



Photos: Carabay-Fotolia, DNV GL

Modern ship systems are vulnerable to cyberattacks and computer viruses.

“Maintaining the integrity and resilience of cyber-physical systems, including critical control systems, requires a holistic approach to safety and security.”

**Mate J. Csorba**, Principal Specialist Cybersecurity, Marine Cybernetics services

blowout preventers, drilling control systems, steering and propulsion systems. Cybersecurity threats are entering the maritime domain, but the testing of systems for cyber vulnerabilities is still relatively new to the maritime and offshore industries. Proprietary and closed-source solutions require novel and often customized tools and methods to address these concerns.

“Cybersecurity regulations and guidelines are for the most part still under development,” says Csorba. “But maintaining the integrity and resilience of cyber-physical systems, including critical control systems, requires a holistic approach to safety and security. This is an area where we foresee increased demand over the next few years the industry becomes more aware of the potential vulnerabilities in these complex, software-dependent systems.” ■ SA



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**MY  
DNV GL**

**A CLICK AWAY**

DNV GL has developed a series of new web applications to provide easy access to various DNV GL services and information about a wide range of topics.

*My DNV GL*, the customer portal of DNV GL, provides a single point of entry into all relevant applications as well as exclusive information resources. A new, intuitive interface and customized accounts enable users to easily access the services they need to advance their business – whether they are shipowners, managers, yards, designers, manufacturers or flag states.

**App features**

*My DNV GL* is a key element in our effort to redefine the way we interact with customers in the digital domain. DNV GL - Maritime is continuously working to increase the number of services offered on *My DNV GL*. Our goal for 2017 is to launch at least 10 new services. Releases during the first quarter of 2017 include a Port State Control Inspection Planning tool (PSC Planner), a Ballast Water Management Plan Generator and an MRV Plan Generator.

“We are very pleased to see that the number of users has increased to 7,500. We have received plenty of positive feedback. Customers are eager to have access to a digital interface,” says Kay Dausendschön, Programme Manager for *My DNV GL*. ■ KD



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# PSC

## In brief

The Port State Control (PSC) app allows users to determine the likelihood that their vessel will be inspected at a specific port and helps them be prepared optimally for the next Port State Control inspection.

## Features

The PSC app predicts the likelihood of inspection under the three major

MOUs based on specific criteria and historical data. It provides comprehensive statistics of past deficiencies and detentions, filtered by vessel category (e.g. type, size, age) and port to help determine high-risk items. The PSC pages include bespoke checklists for customer vessels so the crew can make sure the ship is well prepared for the next inspection.

## Benefits

- Provides an instant overview of the inspection risk for the customer's entire fleet
- Saves time in preparing for inspections
- Helps customers to focus their checks on truly important items when entering port



# FLEET STATUS (FLEET IN SERVICE)

## In brief

Fleet Status is a convenient online service allowing customers to get a status overview of their entire fleet. It shows a list of all vessels in the selected fleet, from which the user can compile a personal collection of vessels called "My fleet" that can be displayed in a graphical overview. Status information includes ship position, certification details, audit and survey data, class status and much more.

## Features

- Switch between "My fleet" and "My company's fleet"
- See days to overdue or soon overdue for certificates by class (first number) and others (second number) for each vessel
- View the detailed status of a vessel by clicking on the name

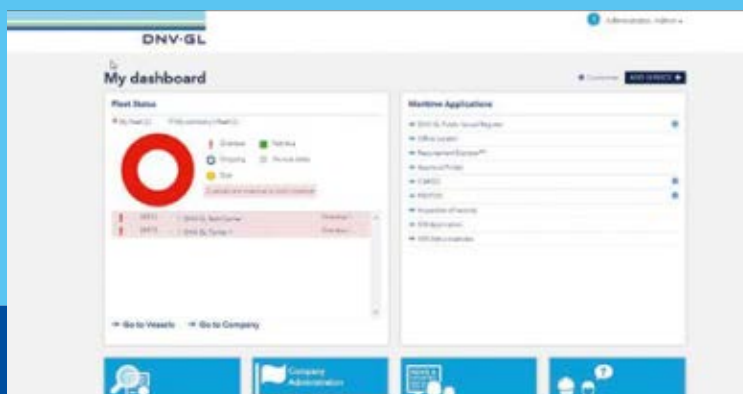
- View vessel position on a map
- Ordering surveys and audits
- Overview of certificates and reports
- Download survey preparation notes
- Manage ISM audits and non-conformities
- Full control of user and vessel access
- DATE (Direct Access to Technical

Experts) cases including vessel history communication

- Automatic alerts and class status reports

## Benefits

- Saves time and effort on customer and DNV GL side
- Fleet overview accessible from anywhere at any time
- All relevant vessel data is stored and accessible via My DNV GL



Photos: DNV GL

# LNGi

**In brief**

The application hosts LNGi, the DNV GL business intelligence portal for the LNG industry, to support and accelerate the adoption of LNG as a ship fuel.

**Features**

In addition to detailed statistics on LNG-fuelled ships, shipowners, charterers, LNG suppliers, and equipment manufacturers have access to an interactive LNG bunkering map which delivers and continuously updates information on the entire, worldwide LNG ship fuel value chain.

**Benefits**

LNGi combines market intelligence provided by LNG suppliers, infrastructure owners and DNV GL to create a comprehensive information platform for the industry. LNGi allows members to:

- Assess the availability and attractiveness of LNG fuel for specific routes and newbuilds
- Save time and the cost of mapping LNG availability themselves

- Understand current market developments and evaluate the uptake of LNG fuel and competing technologies in their segment
- Get up-to-date, accurate information regarding potential LNG suppliers for specific projects
- Use an efficient source of information for business development and planning



# MRV READINESS

**In brief**

The MRV Readiness application enables a fast gap analysis between a customer's monitoring and reporting system and the requirements according to the new EU regulation on monitoring, reporting, and verification (MRV).

**Features**

According to the new EU MRV regulation, all vessels calling at EU ports must monitor and report their CO<sub>2</sub> emissions as of 2018. The MRV Readiness app provides a comprehensive checklist of all data that must be monitored on EU-related voyages and reported to the European Commission. A full explanation is given for each data category, allowing owners and operators to learn more about MRV

in general and check for compliance with MRV. Furthermore, the MRV process and its timeline are represented graphically. Users can check for updates on MRV in the app's news section. The app also includes a frequently-asked-questions section and provides direct access to experts if required.

**Benefits**

The MRV Readiness app supports environmental compliance officers and fleet performance departments in identifying gaps between their current monitoring and reporting systems and the requirements of the MRV regulation.

# CYBERSECURITY SELF-ASSESSMENT

**In brief**

The application helps users assess relevant questions regarding cybersecurity in a maritime environment (shipping companies, vessels). The quick check covers the following questions:

- Does a company/vessel have a cybersecurity vulnerability that could be exploited?
- How well is a company/vessel protected against a cyberattack?
- What could be the consequences of a cyberattack be for the vessel/business?

and improve resilience against cyberattacks.

Using a questionnaire, users can assess the cybersecurity risk for each process or system. This includes potential loss of data and software availability, among other items. The application also gives a general overview of cybersecurity.

**Features**

The application offers a straightforward way for customers to assess their cybersecurity measures. It provides an overview of high-risk items and the general risk status of maritime assets. It also creates awareness and provides general recommendations on how to eliminate vulnerabilities

**Benefits**

The app updates customers regularly on the latest developments and discoveries in the field of cybersecurity and provides a means to assess the status of a company or vessel, identify common vulnerabilities, and plan the next steps to fend off cyberattacks.



# DATE

**In brief**

The DATE application offers direct access to our most competent and up-to-date experts on every maritime topic. All owners and operators of DNV GL-classed vessels are automatically entitled to use DATE.

alterations. An update that will be implemented soon will also include answers to frequently asked questions to provide customers with an additional source of information.

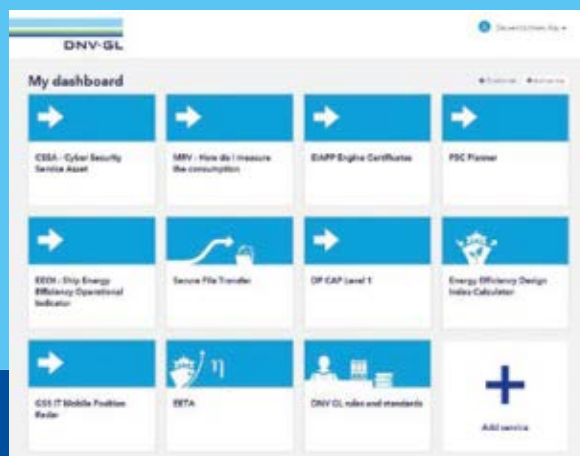
**Benefits**

All relevant vessel data is stored and accessible via My DNV GL. Using the web application avoids the need for iterative clarifications, which means bet-

ter answers are provided faster. Queries are automatically passed on to the most competent and up-to-date subject matter expert. In urgent cases responses take only a few hours.

**Features**

More than 400 experts covering all technical disciplines at five centres around the world stand ready to answer questions, independent of the time zone. Some of the subjects they offer support for include certificate issues, postponements, survey requirements, evaluation of repair proposals, class and statutory rule interpretation, and minor



Photos: DNV GL

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### About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. Operating in more than 100 countries, our professionals are dedicated to helping our customers in the maritime, oil & gas, energy and other industries to make the world safer, smarter and greener.

DNV GL is the world's leading classification society and a recognized advisor for the maritime industry. We enhance safety, quality, energy efficiency and environmental performance of the global shipping industry - across all vessel types and offshore structures. We invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.

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