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REVIEW



- More LNGCs and FLNGs needed
- Putin's Arctic dream a reality
- Nakilat expanding outreach
- Efficiency drives new LNGC design
- Engine OEMs look to cash in
- Bunkering at the crossroads

2018



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bunkering platform**



Nakilat has built up its service portfolio which now includes agency, in-house technical shipmanagement and the joint venture shipyard N-KOM.

With Qatar looking to considerably expand its LNG exports from Ras Laffan, there will be a need for more LNGCs.

Are we seeing a glimpse of the promised land?

The shipping industry is used to being told - wait until next year! In certain sectors, we have been waiting years only to be told that the promised light at the end of a long dark tunnel will be soon.

In the LNGC and the gas sector in general, it does look as though the promised land is getting closer, especially the market - at the risk of tempting fate.

For example, DNV GL recently conducted a survey among oil and gas sector leaders which, as a result, showed that nearly two-thirds (64%) expected to increase or sustain spending on gas projects this year, as the sector prepares for gas to overtake oil as the world's primary energy source in the mid-2030s.

Confidence in the case for gas is growing, according to the survey. The vast majority (86%) of the 813 senior industry professionals surveyed agreed that gas will play an increasingly important role in the global energy mix over the next decade, up from 77% last year.

The findings appear in 'Transition in Motion', a special report from DNV GL's research team on the outlook for the oil and gas industry this year. It reveals the primary driver for investment in natural gas and LNG projects is the global energy transition.

The pace of the oil and gas industry's intentions to lower carbon emissions differs by region, however. Just a third of survey respondents in North America (33%) said that their companies are actively preparing for the shift to a lower carbon energy mix this year, compared to more than half (51%) in Middle East and North Africa.

The stage is set for gas to become the

largest single source of energy. Demand for it will peak in the mid-2030s, well after the use of each of the other fossil fuels has gone into long-term decline, according to DNV GL's report.

"Society's transition to a less carbon-intensive energy mix is already a reality, and oil and gas will continue to be crucial components. Our research affirms that the industry is already taking positive steps to secure the important role we forecast gas to play in helping to meet future, lower-carbon energy requirements," said Liv Hovem, CEO, DNV GL- Oil & Gas.

"Significant investment will be needed in the gas industry over the coming decades to increase capacity, transform assets to source and transport a decarbonised mix of energies, and to safely build and maintain the infrastructure needed to connect emerging supply regions with evolving demand centres," she added.

POWER GENERATION KEY

Power generation is predicted to be the primary consumer of gas in most regions, though manufacturing could demand similar volumes in emerging markets.

DNV GL's 2017 Energy Transition Outlook suggested that North East Eurasia and the Middle East and North Africa will increase gas output towards 2040 at least, overtaking North America as the world's largest gas producer. Production is also forecast to double in China, the Indian sub-continent and Southeast Asia.

Among some of the other findings were that 72% believed, as traditional coal energy generation becomes obsolete over the coming decades, the long-term attractiveness of gas will significantly improve, while the number of respondents stating that traditional oil and gas prices will decouple in the long-term has increased from 45% in 2017 to 55% this year.

IN GOOD SHAPE

Also taking up a bullish stance, ahead of the recent World Gas Conference in Washington (DC), the US-based independent Center for Strategic and International Studies (CSIS) said that taking a macro view, gas is in good shape.

In 2017, demand grew by 3%, almost twice as fast as oil (1.7%) and three times faster than coal (1%). The 10-year growth rates are similar, with gas outperforming other hydrocarbons (data from the BP Statistical Review of World Energy).

The future is similarly seen as bright, CSIS said. In the International Energy Agency's (IEA) baseline scenario, gas grows at 1.6% a year through 2040, versus 1% for energy overall, and much faster than either coal (0.2%) or oil (0.4%).

Even in a scenario where the world meets its sustainable development goals, demand will merely plateau for gas rather than decline, as it must for oil and coal. By 2040, gas will even overtake oil in the IEA's "sustainable development" scenario. BP shows a similar picture in its "evolving transition" scenario — gas is just below oil in 2040.

Companies are investing billions to build pipelines, liquefaction facilities, regasification terminals, vessels, power plants, and distribution networks, while also pushing gas into new markets and sectors. This is a good era for gas.

Let us hope they are right!!

“ Society's transition to a less carbon-intensive energy mix is already a reality, and oil and gas will continue to be crucial components. ”

- Liv Hovem, CEO, DNV GL - Oil & Gas



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LNGC market update and outlook

This highlighted the growing commoditisation of the global LNG market and raised troubling questions about future supply, Poten & Partners said in a report issued earlier this year.

Average contracts lengths for deals signed in 2017 fell to the lowest ever recorded at 6.7 years, compared with 11.5 years reported for the previous year. With several supply options and future price uncertainty, buyers signed dozens of short and medium term contracts, rather than long term deals, which would have supported the construction of new capacity deemed to be needed by the mid-2020s.

The trend suited sellers who view shorter contracts as a way to handle the soft market and aggregators who have large amounts of LNG to sell during the coming years, as US projects come on stream.

However, with just two projects getting the green light over the past couple of years, fears were growing that the market could be under supplied in the medium term, Poten & Partners said.

Without long term contracts that would allow more projects to be financed, new capacity building could lag behind demand and the set the stage for future tighter markets and higher prices.

The number of short term contracts - from two to five years - more than doubled last year to 20 from the nine recorded in 2016, after being stable at around an average of five between 2013 and 2015.

Six to 10 year deals fell to just four last year from 10 in 2016, while the number of deals of over 10 years collapsed from 14 to

Last year was significant in that an accelerated trend towards shorter contracts and lesser volumes was noted.

six, following five years in which long term contracts proved the most popular.

Overall, contract sales fell to less than 22 mill tonnes per year, from more than 30 mill tonnes per year in 2016, Poten said.

Another feature of the declining contract length was the fall in average volume per contract across the board to an average of just 660,000 tonnes per year, down almost 27% of the 900,000 tonnes per year recorded in 2016.

This trend was most evident in contracts for six to 10 years, where the average volumes per contract fell 72% from 760,000 tonnes per year in 2016 to just 210,000 tonnes per year last year.

Of the 20 bilateral contracts signed for five years or less, 14 were oil-linked with most priced against Dated Brent. Three others were priced against European gas indices, two on a hybrid basis (Brent/Henry Hub) and one against the Asian JKM marker.

Prices for short term deals came down, as buyers took advantage of the abundantly supplied market and sellers competed to secure outlets for their supplies. Most contracts shorter than five years were priced as a percentage of Dated Brent, ranging from low 11% to mid 11%, down from mid 11% to above 13% seen in 2016.

Pricing was bit higher for medium terms

contracts as those recorded were concluded against oil benchmarks. Prices ranged from 11.5% to 12% of Brent or JCC for delivered supplies.

LONG TERM PREMIUMS

Long term deals also showed a slight premium to short term agreements. The highest prices were seen to be in the mid 12% of the Dated Brent range.

This move towards Brent and away from other benchmarks that had proved popular in recent years - European gas hubs, Henry Hub LNG indices, gas/oil hybrids - indicated that market participants had yet to gain confidence in alternative benchmarks.

There was a significant increase in liquidity in the Asian spot LNG swaps market, however, it was far less liquid than the Brent paper markets. Other spot benchmarks remained illiquid and didn't support any risk management tools.

As mentioned, just six long term contracts were signed last year and barring one exception, none were for supply from an project under development. The one exception was a 20-year deal for supply from the Calcasieu Pass liquefaction project in Louisiana, which still had not made a final investment decision (FID), despite an original start up date of 2021.

This lack of deals for projects under development highlighted concerns about the future supply of LNG, Poten & Partners said. With only one FID last year, the extensive investment in LNG capacity early this decade may now be followed by a dearth of commitments, as buyers - in the belief that they have many prices and that prices may fall further- prove reluctant to sign long term contracts that will enable project sponsors to finance new capacity.

This shortfall in investment activity could trigger future price volatility in much the same way that the commodity investment cycle in crude oil leads to market turbulence.

Many US-based projects were marketing new supplies. While a formula of 115% of the value of Henry Hub, plus a \$3-\$3.5/MMBtu liquefaction fee was attractive when the first tranche of US projects was marketed, many



TMS Cardiff Gas is a major player in the spot market

buyers were looking for better returns and sponsors were trying to respond.

For example, Tellurian Investments, the Driftwood LNG project sponsor, offered a range of alternatives intending to attract buyers. These have included fixed prices of \$7.5-\$8 per MMBtu delivered to Asia. The company has since devised a plan by which buyers pay \$1.5 bill up front in exchange for 1 mill tonnes per annum of LNG at an FOB cost estimated to be \$3 per MMBtu.

Other US projects were offering lower liquefaction costs and different approaches to secure their gas supplies in order to make their offering more competitive. As a result, liquefaction prices of \$2.25-\$2.5 looked to be on offer.

Winning over buyers reluctant to sign long term contracts will be critical if there is to be an adequate supply of reasonably priced LNG in the mid-2020s.

Most of last year's transactions reduced so called 'homeless' volumes. Poten explained that 'homeless' supplies were those that were expected to be produced but were not under contract to end users.

These include volumes under contract to aggregators or traders, which have not been sold on, contract volumes that were believed to be surplus to requirements of end users and tonnes that were held by producers.

Most of last year's deals involved supplies drawn from these sources. As many buyers opted to tap into these supplies, this LNG pool's drawing down should eventually encourage end users and/or aggregators, to look for new projects for their long term supply.

The question is whether project sponsors can convince enough buyers to return to long term contracts to ensure that additional liquefaction capacity is built in time to avoid potential supply constraints in the future, Poten & Partners concluded.

LNGC NUMBERS

As for the markets, there were 440 LNGCs in service last year of over 100,000 cu m capacity. Some 20 were delivered last year and another 20 deferred to this year, due to poor market conditions, Barry Rogliano Salles (BRS) said in its Annual Report.

Around 64 were due for delivery this year out of 105 LNGCs and nine FSRUs on the orderbook as at the end of last year. Of these around nine LNGCs and eight FSRUs were ordered in 2017. HHI secured three FSRUs and two LNGCs, DSME three LNGCs and one FSRU, Samsung two FSRUs for Hoegh



Golar was a founder member of the Cool Pool

LNG and Hudong-Zhonghua gained two FSRUs for Dynagas and four conventional LNGCs for MOL, earmarked for the Yamal project.

Last year also saw the first specialist LNG bunker vessels delivered. These were the 'Cardissa' for Shell (6,500 cu m), a vessel for Anthony Veder (5,800 cu m) and ENGIE/NYK's 5,000 cu m vessel. The increasing number of large containerships specified with LNG propulsion will lead to more specialised bunker vessels being ordered, some possibly up to 18,000 cu m in capacity, BRS said.

Another noticeable feature last year was that standard 174,000 cu m LNGCs were being specified with membrane containment systems, a boil-off rate of less than 0.08% and fitted with gas injection engines. The first X-DF engine was also delivered last year.

SPOT RATES

On the spot market, following more than two years of weak rates, earnings had almost doubled by the year end from the April, 2017 low.

Rates for 160,000 TFDE LNGCs fell to below \$30,000 per day in March and April, 2017, both East and West of Suez, due to the LNG price spread between the Atlantic and Pacific considerably decreasing, resulting in arbitrage opportunities almost disappearing.

Rates stayed below \$50,000 per day until October, due to reduced activity and a surplus of vessels. After October, an increase in the Japan Korea Market (JKM) benchmark triggered new arbitrage opportunities, thus demand increased pushing rates up for the rest of the year.

By December, 2017, virtually no vessels were available on the spot market in the

Atlantic, which had the result of driving rates up to their highest levels since early 2014.

Last year, the spot market was trader driven mainly by Vitol and Trafigura, which were responsible for around 30% of all the fixtures. Cheniere also proved a strong spot market player. Of the owners, the Cool Pool (Golar, GasLog and Dynagas) accounted for about 23% of the spot fixtures, followed by TMS Cardiff Gas.

For the timecharter market of between one and 12 months duration, the vast majority of vessels were taken for three to six months and around half were fixed for September to December delivery for seasonal cargoes. The ships were fixed as a hedge by charterers against rising spot rates and fears of a tonnage scarcity during the winter months.

Many vessels were taken out of the spot market to try to take advantage of firming timecharter rates, thus reducing the availability.

As for the prospects, BRS said that the nameplate capacity of new projects coming on stream should lead to the need for another 170 LNGCs, as against around 100 on the orderbook (see below).

Excess supply should gradually be reduced and a return to a supply/demand equilibrium should be seen around 2020. The Atlantic/Pacific price spread is expected to narrow again this Spring but trade route uncertainty, especially from the US export terminals, will have an impact on tonne/miles this year and consequently charter rates.

The long term looks bright, BRS said, but maybe there will be a bumpy ride this year (2018), due to the number of newbuilding deliveries expected. This year will also be crucial for the supply/demand balance.

What is actually happening? According to a

GasLog report released at the end of the second quarter of this year, the situation as at the end of June was that demand for natural gas and LNG remained robust, underpinned in the second quarter by significant increases in demand from major Asian consumers.

According to Poten, LNG imports into China, South Korea and India during the first half of 2018 increased 50%, 14% and 10%, respectively, year-on-year, marginally offset by a 3% reduction in Japan's LNG imports.

In particular, the growth in China's LNG demand was attributed to the secular driver of coal-to-gas switching, strong industrial demand and constrained domestic gas production. The backdrop for growth in global LNG demand remains favourable, with Wood Mackenzie estimating compound annual growth of 6% over the 2017-2023 period.

Wood Mackenzie also estimated that during 2Q18 global LNG supply increased by 8% year-over-year, but declined 3% from 1Q18.

This year-on-year increase was driven by the start-up of new liquefaction capacity in the US, Russia and Australia, while the sequential decline is attributed to normal seasonal weakness in the spring shoulder months, supply disruptions from PNG LNG, following the February earthquake, under performance from projects in Algeria and Trinidad and unplanned UAE facilities downtime.

These disruptions offset new liquefaction startups in the quarter, which included Cameroon Floating LNG, Cove Point and Wheatstone LNG Train 2.

In 2Q18, 75 cargoes were exported from the US, with around half delivered to Asia. Data from the period suggested that 1.91 vessels were required for each million tonnes of LNG exported from the US, compared to an average of 1.86 ships per million tonnes of LNG since the start-up of Sabine Pass.

Progress was also made during the quarter on projects that underpinned Wood Mackenzie's 2018 LNG supply growth forecast of 9%. Commissioning cargoes were discharged at the Ichthys and Prelude facilities, while Yamal Train 2 (Russia) and Elba Island (US) are also expected onstream before the year-end.

NEW SUPPLY EXPECTED

A further 41 mill tonnes per annum of new supply, or 13% growth, is expected in 2019, principally driven by US additions and the ramp-up of Ichthys and Prelude in Australia.

In May, Cheniere announced a final investment decision (FID) on Train 3 at the Corpus Christi liquefaction project, the first



Dynagas has recently withdrawn from the Cool Pool

approval of a new liquefaction project since June, 2017 and the first in the US since 2015.

According to Wood Mackenzie and other reports, in 2Q18, 15 mill tonnes per annum of long-term supply contracts were agreed or signed, bringing the total volume of long-term supply contracts concluded since the beginning of 2017 to 52 mill tonnes per annum.

Buyers included Asian and European utilities, as well as portfolio suppliers and traders. Several recent offtake contracts for projects yet to reach FID were agreed for a duration of 20 years or more, giving these projects greater visibility on cash flows, which may de-risk the financing required for FID.

LNG Canada, which is targeting 24 mill tonnes per year of capacity in a phased approach and in which Petronas took a 25% stake in May, may take FID later this year, while FID on the Golden Pass project (16 mill tonnes capacity) in the US may be taken in early 2019. Mozambique Area 1 LNG (13 mill tonnes per year capacity) and the Calcasieu Pass (10 mill tonnes per year capacity) project in the US also made progress in the second quarter towards potential FIDs next year.

During 2Q18, Panama became the 42nd country to import LNG after starting operations at its Costa Norte terminal. Plans also progressed to import LNG into eastern Australia's gas market to alleviate potential future shortages. In addition, Pakistan's Ambassador to the US outlined plans in early July to import more gas from the US, claiming that the country is on its way to becoming

“one of the world's largest gas importers”.

In May, Chinese gas distributor ENN was said to be seeking a commissioning cargo for the country's first privately owned LNG regasification terminal. The Zhoushan terminal has a planned capacity of 3 mill tonnes per annum and is expected to come onstream in the coming months.

Headline daily spot TFDE LNGC rates, reported by Clarksons, averaged \$54,000 in 2Q18, compared to \$34,000 in 2Q17. During 2Q18, rates exhibited counter-seasonal strength, rising to \$87,000 per day in late June from \$38,000 per day in late April.

This recent spot rate sharp increase was driven by increased vessel demand, as LNG suppliers sought to capitalise on the arbitrage between the Atlantic basin and Asian markets, which was widened by counter-seasonal strength in Asian LNG prices (as measured by the Platts JKM assessment).

As a result, the number of spot fixtures rose to 110 during 2Q18, an all-time high and an increase over the 70 and 78 fixtures in 1Q18 and 2Q17, respectively. Spot TFDE shipping rates have moderated since, with the mid-end July Clarksons assessment of \$75,000 per day, as softening Asia LNG prices narrowed the near-term arbitrage opportunity.

However, based on current JKM pricing, the arbitrage between the Atlantic and Pacific Basins is expected to remain open for the 2018/19 Northern Hemisphere winter, suggesting that the recent increase in LNG shipping rates could potentially be sustained throughout the remainder of 2018 and into early 2019.

According to reports, 26 firm orders for LNGCs had been placed by the end of the second quarter of this year and a few more have been reported since. The pace of firm newbuilding orders recently increased, due to shipowners locking into attractive yard pricing against a positive backdrop for LNGC demand.

However, even after taking into account the current orderbook, GasLog said it believed that the LNG shipping market could be short of vessels as soon as 2019 based on current supply and demand projections. The earliest a newbuilding can now be delivered is 2021, which points towards a tighter market in 2019 and 2020, again underpinning the firming outlook for shipping rates.

Based on GasLog's analysis and excluding the current orderbook, 28-56 additional vessels may be needed by 2022 to satisfy projected market growth, with this range increasing to 105-137 additional vessels by 2025. ■



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FLNG capex to grow substantially in five years

Global FLNG capex is forecast to total \$52.8 bill over the 2019-2024 period, Westwood Global Energy Group said in its a market forecast.

This capex is in line with the second wave of developments for the FLNG industry that comes in the wake of a 22-month hiatus in project sanctioning, as the market opens up to a greater number of participants, Westwood said.

The majority of this amount will be taken by liquefaction vessels, according to the forecast, standing at \$42 bill.

This investment is expected to result in the installation of 15 FLNGs adding 47.9 mill tonnes per annum to global export capacity by the end of 2024.

The rise in interest in FLNGs is driven by increased gas demand stemming from economic growth and fuel switching, combined with ongoing energy security concerns.

As had been said many times, the key

advantage in the use of floating units remains the short lead-time from sanction to operation and as a result, Westwood forecasts that FSRU tendering will remain strong over the next five years.

As LNG exports take a foothold in the US, investment in floating liquefaction facilities in North America will play a pivotal role in global FLNG expenditure over the period, accounting for 45% of expenditure.

In addition, the strong global fundamentals for regasification vessels have prompted some leasing contractors to sign letters of intent (LOI) for optional units to be delivered in the forecast period's latter years.

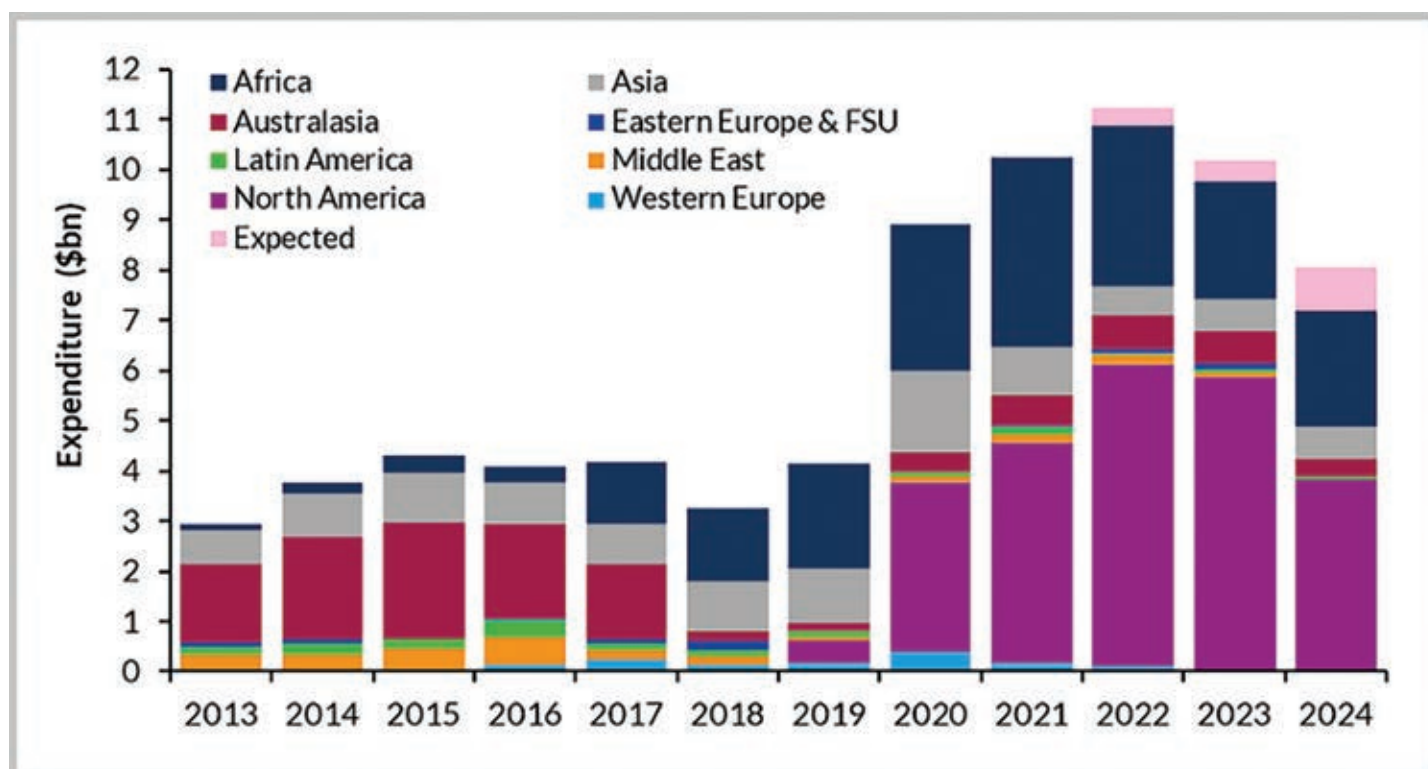
'As more FLNG units become operational, we are seeing project structures and financing more akin to the well-established FPSO sector. This includes a move to syndicated project financing (eg as arranged for ENI's Coral

“The rise in interest in FLNGs is driven by increased gas demand stemming from economic growth and fuel switching**”**

South Unit) and construction financing/sale and leaseback structures, such as the 'Hilli Episeyo', the report said.

In conclusion, some 18 countries are expected to have their first floating import vessels installed over the forecast period.

The analysis includes data from sanctioned and upcoming projects, as well as historic data from the previous five-year period 2013-2018.



Global Expenditure on FLNG Facilities by Region, 2013-2024. Source: Westwood Global Energy Group

Classing FLNG and FSRUs

Floating liquefied natural gas (FLNG) facilities, such as Shell's 'Prelude' and Petronas' 'Satu' coming online, as well as Chevron's onshore Gorgon project have greatly increased the availability of LNG.*

With so many large LNG projects coming on stream, the nature of gas as a primary fuel for not only the developed world, but also emerging markets, is changing. It is forecast that this expansion in the gas market will drive down technology costs and therefore, open up gas as a fuel to an even larger market.

In addition, the trading nature of gas has also started to change. While gas prices have historically tended to be more localised and more dependent on fixed long-term sales contracts than oil, we have seen a move to a more active spot market – often at considerable discounts to long-term contract pricing.

This has been enabled by the increase in transportability of LNG due to growth of the LNG carrier fleet and receiving facilities.

The current, and likely continuing, lower gas price environment has several main effects:

- A push for cheaper, simpler, field development solutions on the upstream (FLNG) side.
- An increase in demand for supply-side FSRU solutions which, of course, are on the upside of a lower gas price and provide a practical solution to the growing energy (particularly electricity) demands of developing nations – or anywhere where extended electricity grid networks are impractical.
- Renewed interest in gas compression projects.

These market developments are having inevitable knock-on effects for the types and designs of assets that are favoured for production or supply of gas from LNG – and consequently are exerting pressure on class societies to deliver rules and guidance for these new designs.

While there are similarities in the technical challenges (particularly for near-shore

operations) between FLNG and FSRU, we will consider them separately.

SMALLER, FASTER, CHEAPER

Instead of having a land-based LNG plant fuelled from a (consequently very large) floating platform (meaning that the gas reserves would need to be sufficiently large to justify the large field development capex) FLNGs are smaller, simpler assets which can be mobilised more quickly to smaller fields, allowing swift monetisation of projects on this smaller scale.

Options:

- Simpler liquefaction process allowing smaller footprint, but at reduced efficiency.
- More complex, miniaturised liquefaction plant offering smaller footprint but better efficiency.
- Number of (more traditional) gas floating production storage and offloading (FPSO) units providing gas conditioning linked with a centralised liquefaction facility – allowing individual units to be smaller and less complex, potentially reducing the need for more extensive subsea infrastructure.
- FLNG providing liquefaction (only) facilities for gas produced and conditioned elsewhere and accessed via land or subsea pipeline. Advantages over land-based solutions for remote areas or those with difficult political or social circumstances.
- Near shore export FLNGs ranging from simple LNG storage and offloading to full blown FLNG solutions.

All of these options are now being explored or actively developed in response to the demand of various local circumstances.

GAS COMPRESSION FPSOS

As a consequence of the driving down of cost, the industry continues to seek innovative solutions to monetising large and small offshore remote gas supplies, proposals being considered are for:

- Very large offshore floating gas compression projects, the upside being the ability to eliminate the need for on board storage with the complexity and associated cost. There is also sufficient experience and confidence in compressed natural gas (CNG) for combined storage and pipeline solutions.
- Long deep subsea compressed gas pipelines, the downside and opportunity of not providing on board storage.

FSRU – VERSATILITY AND DIVERSITY

In response to local circumstances, FSRU designs can come in a variety of shapes and sizes. It is the high versatility of this asset type which gives it its advantages, particularly over shore-based solutions. However, this also throws up obvious challenges to class societies in producing, revising and adapting their rules and guidance to meet the differing technical demands of such a diverse group.

- Gas ship with regasification facilities (which may work as a trading LNG carrier for periods of its life), conversion or newbuild.
- Storage barge with regasification facilities.
- Near-shore, at-shore or at-sea locations.
- Mooring systems, hull and mooring design for tidal conditions (potentially including grounding).

The much reduced operating costs (and potential for long term contracts) of an FSRU with respect to a trading LNGC can make conversion an attractive option for LNGC operators.

SUPPORTING THE MARKET

So where does class fit in this changing environment and how can it support innovative projects while not compromising on safety at any stage of the process?

Does the industry want class to come up with new prescriptive rules for these projects or should we utilise existing rules?

Before answering this, it is worth considering what is really being asked here and whoever you speak to you are likely to get a different answer.

Ask the operator what they want and the answer is likely to be a long term solution requiring minimal maintenance and lowest capex. An obvious answer, but to achieve this you invariably look at site specific solutions that hope to achieve hull scantlings based on the site specific corrosion and fatigue characteristics and process plant that fully integrates both process and marine requirements under one philosophy.

Ask those that need to prepare tenders and costings for such facilities and the answer will be that they want a set of prescriptive rules that can be applied anywhere and cover the marine requirements only without the need to be site specific.

The above holds true for all offshore projects but become more acute when considering the complexity of offshore gas projects, as we have to integrate gas containment into large floating structures for specific field requirements that also support very large process plants and that again are field specific.

So how should class address these requirements that do not provide a comfortable

fit with each other?

The view taken by LR is that new rules do not necessarily provide the most effective solution to highly focused projects, as they tend to deliver a more refined vision of prescription in an environment where the safest and most cost effective solutions can usually be found by allowing the developers a higher level of freedom when working on innovative concepts.

How can this be achieved? LR believed that the core elements of its Offshore Rules provide a suitable foundation for offshore projects with the flexibility to be able to be applied over many concepts. This is then supported by written guidance for specific project types, for example near-shore and at-shore projects which cover many of the LNG related export and import terminal concepts being developed.

Another advantage is that by allowing developers scope to explore concept types in more depth, class can also support the process plant development and integration. Again, this is not by prescription but through support and support in the suitability and performance of the supply chain underpinning this.

OPERATIONAL ASPECTS

The mantra of class is the 'safety of life,

property and the environment' and the skill set that has been developed to support this is evolving to leverage the new inspection and monitoring technologies that are coming on stream. With these new technologies, comes the opportunity to look for new ways to achieve the goals of class in a way that provides operators with more information and less invasive methods. The outcome of this is that safety can be enhanced while at the same time, the impact on facility operations can be minimised and integrated into existing integrity management activities.

Data driven inspection and survey is perhaps the next evolution of class in operation and supports both prescriptive regimes and Risk Based Inspection (RBI) philosophies. We can expect to see a revolution in how we operate assets over the next few years and much of this will be driven by the change in the way we use data. The offshore LNG industry has so far been at the forefront of this development and this will likely continue as these processes evolve. ■

**This piece was taken from an article written by Lloyd's Register's Richard Nott, Head of Offshore & Global Projects, and Mark Tipping, Manager Offshore Technology.*

The FSRU market: story of growth

Gas has established itself as a truly indispensable ally in the global endeavour to tackle emissions. In addition, there is a limited growth potential in the demand from conventional gas markets.*

This opportunity has fuelled the development of FSRUs to facilitate access to newer and emerging markets. Due to the flexibility of operations, increased natural gas production, time and cost savings during construction, the FSRU market is experiencing a period of rapid growth.

In recent years, as projects in the oil and gas sector are cancelled or put on hold, one niche segment is booming. The surge in interest from emerging markets for FSRUs is striking. FSRU projects offer the advantage of being economical and more efficient to execute than land-based facilities.

While long-term contracts with

traditionally saturated markets, such as Japan, are expiring, LNG sellers are attracting additional business from emerging markets that have a large customer base and substantial growth potential for energy.

With a much lower requirement for initial capital investment, FSRUs provide a feasible solution for any nation with a seaport to gain access to gas supply. They also have the ability to serve as a bridge solution to meet immediate needs until the onshore regasification facilities are commissioned.

With 26 FSRUs currently in operation, the newest project can be found in the Turkish LNG market. As an integral part of the new FSRU contract, ABS was selected to class an FSRU for BOTAS, Turkey's oil and gas pipeline operator.

Planned to be built at Hyundai Heavy Industries shipyard, this FSRU will be designed for 170,000 cu m storage capacity and with a regasification discharge capacity

of 1,000 mmscfd. This FSRU will be jetty moored off the coast of Turkey and operated by Mitsui OSK Lines (MOL).

It will be classed using the ABS 'Guide for Building and Classing LNG Regasification Vessels'.

This Guide is important for designers, builders, owners and operators of LNGCs/tank barges as it specifies the ABS requirements for obtaining the regasification classification notation.

It was developed to provide guidance for the design, construction, and survey of Liquefied Natural Gas (LNG) vessels using regasification systems.

Many experts consider that the option to commission an FSRU allows new markets the flexibility, supply security and price competitiveness to trade gas to fulfill their own demand. ■

**This article was taken from the GasTech Insight series.*

BUTTERFLY VALVES FOR **EXTREME** CONDITIONS

CRYOGENIC VALVES FOR
GAS CARRIERS



Bringing gas in from the cold

At present, a fleet of around 20 out of the world's 500 in service LNGCs is used to ship natural gas produced by the world's northernmost LNG projects.*

These loading terminals include Snøhvit (Melkøya or Hammerfest) in North Norway and the recently commissioned Yamal LNG, plus the under construction Arctic LNG in Russia's North.

Out of the 100 plus LNGCs on order, at least are 14 Arctic types (Arc7s).

There are five LNG-producing projects in the Arctic region but the Arc7s have only been chartered for projects that have already been commissioned or are about to begin operations, see chart below.

Equinor's Hammerfest liquefaction and export facility shipped its first LNG cargo to China on 16th April, 2014. About 144,000 cu m of LNG was sold to CNOOC and delivered

to the Zhuhai receiving terminal in Guangdong province. The LNG was sourced from Equinor's Snøhvit gas field and delivered by the 'Arctic Aurora'.

'Arctic Princess' delivered the first 145,000 cu m LNG cargo from Snøhvit to southern Europe in October, 2007, while the first cargo of LNG shipped from the Norwegian continental shelf to the US arrived in February, 2008 on the 'Arctic Discoverer'.

In 2012, Dynagas, which currently owns the world's largest fleet of Ice Class LNGCs, became the first company to sail an LNG carrier via the NSR when the Gazprom-chartered 'Ob River' delivered a cargo from Snøhvit to Kyushu Electric.

Tokyo Gas imported 60,750 tonnes of

Norwegian LNG for the first time in March, 2008 and another 61,910 tonnes in September, 2011

European countries received about 60% of Norway's LNG exports in 2014, most of which were exported to Spain, although 'Arctic Princess' discharged in Rotterdam.

The 'Arctic Princess' and 'Arctic Lady' were the pioneers at Hammerfest together with the 'Arctic Discoverer' and 'Arctic Aurora'.

Equinor's Hammerfest facility is currently Europe's biggest liquefaction plant and uses gas from the Snøhvit (Snow White) field in the Barents Sea. The Arctic gas is sent ashore through a 143 km long pipeline to Melkøya, near Hammerfest. The plant has the capacity to produce 4.3 mill tonnes per annum of LNG.

On 27th July, 2017 the first icebreaking Arc7 LNGC, 'Christophe de Margerie', began her voyage to Boryeong in South Korea. She loaded at the Hammerfest LNG terminal and sailed to South Korea via the NSR.

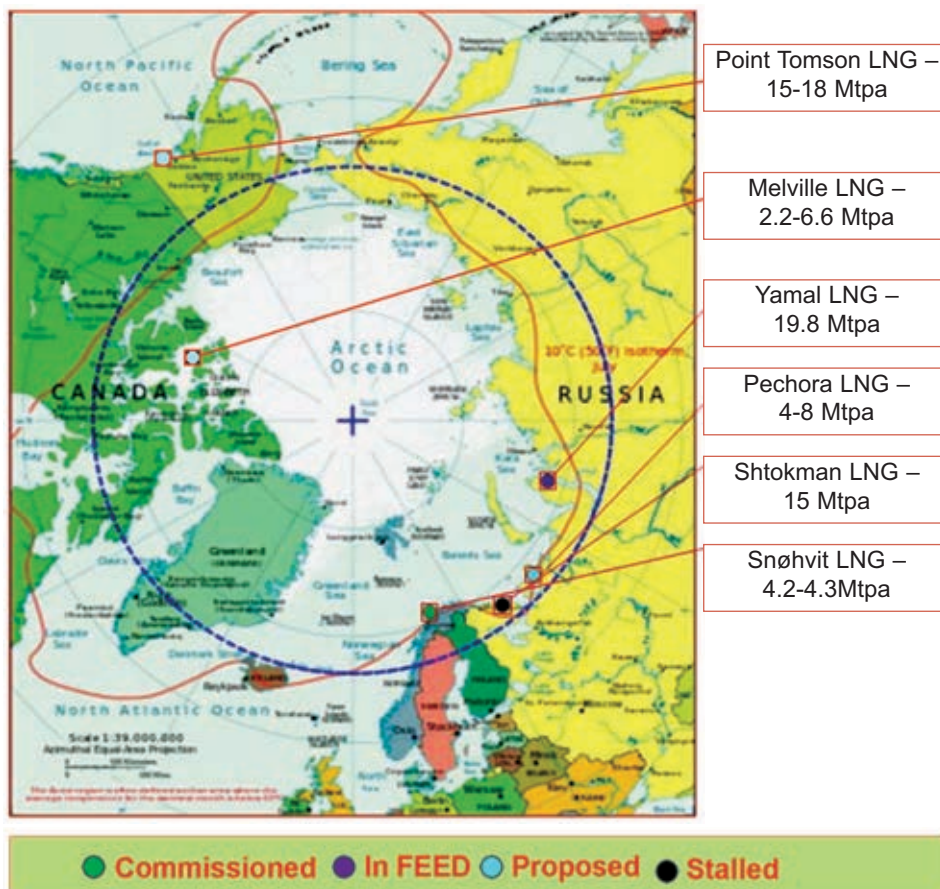
The French oil and gas major Total, which holds an 18.4% stake in the terminal, said at the time that the voyage marked the "first unescorted merchant vessel ever to take this route, which makes it possible to reach Asia via the Bering Strait in 15 days, versus 30 days via the Suez Canal."

The vessel was designed for Sovcomflot (SCF), specifically to serve Novatek's Yamal LNG project, and transport LNG all year round in the difficult ice conditions found in Ob Bay and the Kara Sea.

'Christophe de Margerie' is the prototype for a series of 15 LNGCs, which are being delivered for the Yamal project.

On 9th December, 2017, the first vessel loaded with Yamal LNG - also the 'Christophe de Margerie' - left Russia for Europe.

With a capacity of nearly 20 mill tonnes per year, the launch of the Yamal LNG plant has been an unmitigated success, especially given that it is the first Russian LNG project in which Russian shareholders have had a controlling interest from the outset.



LNG-Producing Projects in the North (as of mid-2018)



'Christophe de Margerie' seen at the new Baltic port of Bronka

The Yamal LNG is now the northernmost gas liquefaction project existing in Russia.

Yamal LNG is located at Sabetta to the northeast of the Yamal Peninsula. In addition to the LNG loading plant, this project includes production at the Yuzhno-Tambeyskoye (South Tambey) gas field, and the transport infrastructure, including Sabetta harbour and airport.

The three-train Yamal LNG plant, designed to produce about 16.5 mill tonnes per year, started liquefying natural gas from the South Tambey field earlier in December, 2013.

The export project's first liquefaction train will gradually ramp up to a capacity of 5.5 mill tonnes per annum. Phase II and III (each with the same capacities) will be commissioned in the third quarter of 2018 and the first quarter of 2019, respectively. The project's cost is estimated at nearly \$27 bill.

China is expected to take more than 4 mill tonnes per year when the plant hits full production capacity, CNPC said in a statement posted on its website.

Yamal LNG and Belgium's Fluxys LNG signed a 20-year contract for the transshipment of up to 8 mill tonnes per annum of LNG at Zeebrugge with Yamal Trade (a 100% subsidiary of Yamal LNG) to support year-round LNG deliveries from the Yamal Peninsula to Asian/Pacific markets.

During the summer navigation period, Arctic-class LNGCs will deliver gas directly to customers. In winter, they will berth at the Zeebrugge terminal where Fluxys will provide transshipment services onto conventional LNGCs for further delivery to customers in Asia, via the Suez Canal.

According to Yamal LNG's estimates, it will take half the time to ship LNG to Asian countries using the eastward route, compared to the sailing westbound. However, the benefit of the NSR will be fully realised only after Atomflot commissions three nuclear-powered 60 MW icebreakers ('Arktika', 'Sibir' and 'Ural') in 2019, 2020 and 2021, respectively.

Icebreaking gas carriers are needed as Yamal LNG is located above the Polar circle in the Ob River estuary, a wild, remote region that is frozen for seven-to-nine months of the year and where winter temperatures can drop to as low as -50 deg C.

Novatek, Russia's second biggest gas company after Gazprom, purchased a 51% stake in Yamal LNG in 2009. Two years later, Novatek increased its stake to 100% only to sell a 20% interest to Total soon after. In 2013, CNPC joined the project by acquiring 20%, and the Silk Road Fund (9.9%) in 2015.

In 2010, Novatek and Gazprom entered into an agency agreement by which Gazprom Export was to transport gas across the border for a commission fee, while Novatek would remain the project's operator.



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- LEONARDO DA VINCI



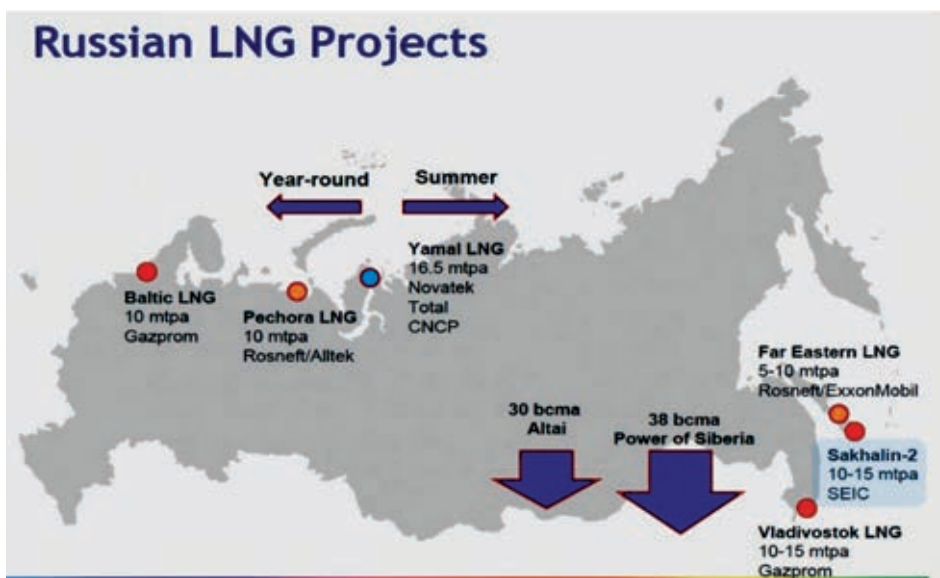
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Main Existing and Planned LNG-Liquefaction Projects in Russia (Commissioned as of 1/1/2018. Terminals are Highlighted in blue). Source: <https://eplaza.biz/is-the-yamal-lng-project-overhyped>

However, by the end of 2012, Gazprom Export had not signed a contract to supply gas from Yamal LNG. As a result, the project's shareholders were unable to use the contracts as collateral to obtain bank financing.

In 2013, LNG exports were partially liberalised. The right to supply LNG abroad was reserved for state companies operating on the shelf and companies whose licenses for field development as of 1st January, 2013, covered both LNG plant construction and transport of produced gas for liquefaction.

In addition to Gazprom, only Rosneft and Novatek met these criteria. As a result, in November, 2013, Yamal LNG signed a contract with Spanish utility Gas Natural Fenosa (GNF) (now Naturgy) to supply 2.5 mill tonnes of LNG annually for 25 years.

Agreements were also signed with Total (4 mill tonnes a year) and CNPC subsidiary PetroChina (3 mill tonnes), as well as with Novatek Gas & Power (2.9 mill tonnes) and Gazprom Marketing & Trading Singapore

(3 mill tonnes).

By March, 2016, 96% of the liquefied gas to be produced by the plant was contracted under long-term agreements.

In 2014, Novatek became subject to anti-Russia sanctions. Hence, the core project funders were Russian and Chinese state banks. In April, 2016, Yamal LNG signed a loan agreement with Sberbank and Gazprombank for €3.6 bill over a term of 15 years.

At the same time, an agreement was reached with the Export-Import Bank of China and China Development Bank for loans. As a result, in April, 2016, the banks became the key partners in the project by providing loans for €9.3 bill and RMB9.8 bill (around \$12 bill in total).

Each year, it was planned that nearly 16.5 mill tonnes of LNG would pass through Sabetta, with the gas produced sold to customers in Europe and Asia under 15- to 20-year contracts. At the start of 2018, the production capacity of the project was bumped

up to 19.8 mill tonnes per year. The project was on course to start fully exporting in 2022-2023.

With the launch of the Yamal LNG plant, Russian LNG exports have grown more than 100% in the first three months of 2018. Russia has increased the LNG exports by 2.1 times, to 9.8 mill cu m, while revenues surged to \$1.3 bill.

Interestingly, at present another huge LNG plant – Arctic LNG – is being built in Russia, Northeast of Yamal LNG, on the west coast of the Gydan Peninsula, in the shallow waters of the Gulf of Ob, the bay located near the coast of the Kara Sea between the peninsulas of Yamal and Gydan.

The plant's construction began this year. The plan is for three 5.5 mill tonnes per year stages to be built - Stage 1 to be completed in 2022, Stage 2 in 2023, and Stage 3 in 2025.

This project will be less capital intensive (only \$10 bill) than the Yamal LNG project – mainly due to the use of advanced German technology. Novatek, the project's leader, will use Linde's natural gas liquefaction technology, and has purchased the necessary license from Germany. In addition, the Russians are teaming up with the Italian company Saipem for the development of the gravity-based structure (GBS), which will be installed on the Ob Gulf seabed.

Each train will rest on three standalone, ice-resistant platforms to be stationed near the shore. The field itself is 40 km off the platforms. Before the produced gas passes to the liquefaction trains it must be processed by a gas treatment facility. Apart from treated gas, this stage will produce condensate. The end products – LNG and gas condensate – will be shipped directly from the platforms, as they will each be fitted with storage tanks.

Arctic LNG is to be ready for production by early 2023. It will be based on the three trains each with a production capacity of 6.1 mill tonnes per year.



Russian President Vladimir Putin celebrates the first cargo from Yamal in December, 2017

The project's front end engineering design (FEED) is reportedly due to be ready by late this year and a final investment decision (FID) will be taken before the end of 2019.

In May, 2018, Novatek and Total signed an agreement whereby the French company will participate in the Arctic LNG-2 project. The documents were signed after talks between Russian President Vladimir Putin and France's President Emmanuel Macron.

Novatek will sell a 10% share in the project to Total, Novatek CEO Leonid Mikhelson told reporters on the sidelines of the St Petersburg International Economic Forum (SPIEF) earlier this year. The Russian company plans to close the deal as early as the first quarter of 2019.

Recently, China's CNPC had expressed an interest in this project, as reported according to Li Yueqiang, CNPC's International Department Director-General. Chinese companies are discussing entering into a new project with Novatek for the liquefaction of natural gas, confirmed Russian Energy Minister Aleksandr Novak on the Russian TV on 12th June after the Russian-Chinese summit.

Also under construction are Baltic, Vladivostok and Pechora LNG terminals with

a combined expected capacity of 27.6-33.8 mill tonnes per annum, plus smaller-scale projects and others, which are not being built but are planned for on the drawing board for after 2021 possible starts.

Altogether, the known Russian LNG projects involving nearly 30 trains could produce up to 122 mill tonnes of LNG quite soon, the bulk of which is destined for exports.

The Kremlin banned foreign flagged Russian Arctic shipping on 1st February, 2018. Now the Ministry of Industry and Trade has put forward a new bill specifying that ships carrying fossil fuels through the NSR must be built in Russia. The new bill will ultimately come into force in early 2019.

Although the new restriction could potentially be very unfavourable for companies engaged in Arctic fossil mining and shipping, ministry officials said there would be exceptions allowing the use of foreign-built vessels in some cases.

In particular, Novatek will enjoy dispensations, as the gas producer is already allowed to use LNGCs sailing under foreign flags for the Yamal LNG project, while the lion's share of the vessels serving upcoming projects are likely to be built abroad, as the

company is building its fleet of Arc7s in South Korea.

In Canada, the construction of a one to two-train LNG plant with capacity of 2.2-6.6 mill tonnes per annum of LNG on Melville Island (the Canadian Arctic Archipelago) has been under study quite intensively since 2004. The plant should be fed by the Drake Point and Hecla fields holding 184-246 bill cu m of marketable gas.

According to the Canadian Energy Research Institute (CERI), investments in the project's LNG and transport facilities (a pipeline) were estimated at the start of 2005 at \$2.33 bill. Including expected costs for the five Arc7s and two standard LNGCs needed, this would require nearly \$1.46 bill in capital costs and almost \$239 mill in annual operating costs.

In the US, the economically feasible ways to ship natural gas by sea from northern Alaska and the Beaufort Sea - instead of using long gas trunk pipelines southward - have been explored for several years.

In particular, according to the most advanced project developed by ExxonMobil, a three-train liquefaction plant with capacity of 15-18 mill tonnes per annum will be located in the Nikiski area of the Kenai Peninsula (next

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to the existing Cook Inlet LNG facilities) and is to be supplied via a 800-mile 42-48 inch gas pipeline by the Prudhoe Bay field (with original gas reserves of 736 bill cu m) and the Point Thomson field (holding 227 bill cu m), both located in Alaska's North Slope area, on the coast of the Beaufort Sea.

The proposed design was based on 15–20 LNGCs and the total cost of the proposed gas pipeline, liquefaction plant and terminal was estimated at anything between \$45–65 bill.

Strictly speaking, the above does not fall in the category of Arctic projects, as it extends to the south of the Arctic's geographic border but its natural gas sources (Prudhoe Bay and Point Thomson fields) are located above the northern Polar Circle.

While INTERTANKO, which has included LNGCs in its portfolio since the end of 2015 and has a Gas Tankers Committee, said (at least, officially) nothing special about the shipments of natural gas. However, the IMO officially recognises that the sailing on LNGCs is more dangerous for seafarers than sailing on ordinary tankers and since 2017, has fought vigorously to ban heavy fuel oil (HFO) as a ship fuel in Arctic waters in favour of alternative fuels, such as distillate fuel and LNG.

As for the vessels, apart from SCF, Dynagas Holdings, the sponsor of Dynagas LNG Partners, said that it has entered into



'Arctic Princess' was one of the first to ship cargo out of Snohvit

long-term timecharter agreements for five Arc7s and four Arc4s for the Yamal LNG project. Dynagas is building five 172,000 cu m Arc7s at DSME.

In addition, four of Dynagas' existing Arc4s will enter the Yamal shipping fleet to support gas shipments committed to Asian buyers from 2019 onwards. They will be timechartered for 15 years each.

Both Rosneft and Sovcomflot (SCF) have also placed orders for several Ice Class vessels at the Zvezda (Star) shipyard on Russia's east coast. The yard is heavily supported by the Russian federal authorities and was built to be

able to construct large-scale tankers, including those with Ice Class.

Also, in October, 2017, Novatek filed preliminary applications and technical documentation through Sovcomflot for 15 Arctic-class LNGCs with Zvezda.

Thus far, the only builder of icebreaking LNGCs for Russia is DSME. This yard won the tender from Yamal LNG to build, equip, launch and deliver up to 16 Arc7s at a cost of \$320 mill each in July, 2013. Each vessel has an overall length of 299 m, a width of 50 m, a depth of 26.5 m, and a design draught of 11.7 m. The tank containment system on board the vessels incorporates GTT's NO96 GW membrane technology.

The NSR makes the transit distance from Russia's Arctic ports to Asia much shorter (see table).

Whereas a standard LNGC may cost around \$200 mill, Ice Class LNGCs will cost about 10% more. For example, 'Christophe de Margerie' cost around \$290 mill in 2016.

Also, LNGC icebreakers working in the harsh conditions of the High North are more expensive to operate. This applies, first of all, to shipping and chartering costs. As a result, bringing Russian LNG from the Arctic by sea is quite a costly adventure. Operating costs for a standard LNGC are usually assumed to be 75% of those for Arc7s. ■

Estimated Distances between LNG Ports, in nautical miles

Sea Route (LNG Ports)	Appx Distance, in nautical miles
Sabetta, Russia – Yokohama, Japan (via NSR)	6,800
Sabetta, Russia – Shanghai, China (via NSR)	7,790
Melkøya, Norway – Cartagena, Spain (via Strait of Gibraltar)	2,850
Melkøya, Norway – Montoir, France	1,850
Freeport, G.M., the USA – Yokohama, Japan (via Panama Canal)	9,210
Freeport, G.M., the USA – Yokohama, Japan (via Suez Canal)	14,520
Freeport, G.M., the USA – Shanghai, China	15,100
Freeport, G.M., the USA – Shanghai, China (via Panama Canal)	10,080
Freeport, G.M., the USA – Shanghai, China (via Suez Canal)	13,850
Nikiski, south of Alaska, the USA – Yokohama, Japan	3,400
Doha, Qatar – Yokohama, Japan	6,500
Bintulu, Malaysia – Yokohama, Japan	2,400
Brisbane, Australia – Yokohama, Japan	3,930
Barrow Island, Australia – Tokyo, Japan	3,730

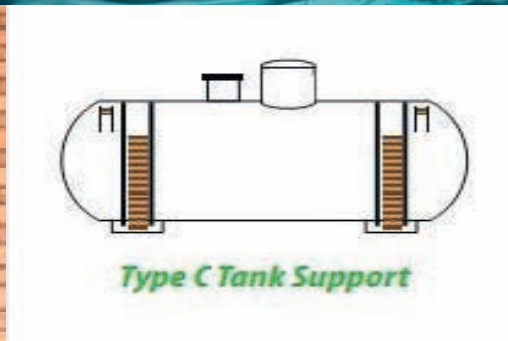
Source: the author's estimates based on <https://sea-distances.org>



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Trades - yesterday, today and tomorrow

World LNG trades started less than 60 years ago, when on 25th January, 1959, the first LNGC, the converted 'Methane Pioneer' (5,034 dwt) left the Calcasieu River on the Louisiana Gulf coast for Canvey Island, England.*

A few years later, in 1964, the newbuilding LNGCs, 'Methane Princess' and 'Methane Progress', left Algeria for Britain and France, joining the new French gas carrier 'Jules Verne', which was built to operate from Algeria to Le Havre.

The 'Methane' ships were fitted with Conch independent aluminium cargo tanks, had a capacity of 27,000 cu m and used LNG as fuel.

Fast forward to 2017, the global LNG trade, which consists of over 510 LNGCs with their maximum capacities of 266,000 cu m and costing up to \$320 mill each to build,

reached more than 290 mill tonnes, helped by 19 exporting countries and more than 40 LNG-importing nations.

In June of this year, Panama became the latest country to join ranks of LNG importers by receiving its first LNG cargo to commission the newly built \$1 bill Costa Norte facility and power plant at Colon, which is expected to be a hub for LNG trades across Central America.

No other global commodity market has showed such high annual growth rates (some 4% per year on average for the 2010-2017 period).

Russia began to export LNG at the end of

March, 2009. The first Russian LNG cargo was loaded from the Sakhalin II LNG plant into the LNGC 'Energy Frontier'. She left Prigorodnoye port on 29th March, 2009 for the Sodegaura terminal in Tokyo Bay, with a cargo of around 145,000 cu m of LNG intended for Tokyo Gas and Tokyo Electric.

The LNG was loaded via the 805 m long jetty at Prigorodnoye, which was built for the year-round export of LNG and crude oil.

On 9th December, 2017, the first LNGC loaded with natural gas from the Yamal LNG plant left Russia for Europe (see page 12).

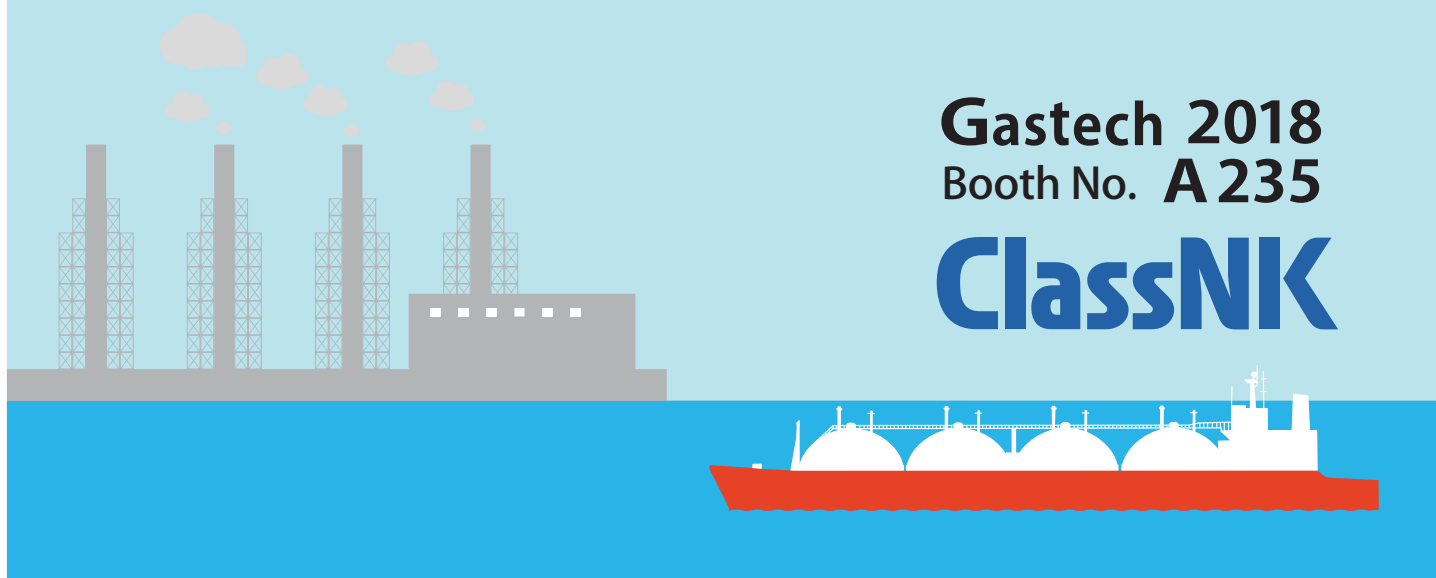
There are several other projects under development or planned in Russia.

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The World's share of Russia's LNG exports 2010-2017

Year	Russia's LNG Exports, in mt	World's Total LNG Exports, in mt	Russia's Share, in %
2010	1.9	222.2	0.9
2011	2.3	241.5	1.0
2012	1.4	237.7	0.6
2013	1.5	236.8	0.6
2014	3.4	239.2	1.4
2015	3.6	245.2	1.5
2016	3.7	263.6	1.4
2017	3.3	289.8	1.1

Source: the author's estimates based on Gazprom, IGU, GIIGNL and BP data

Unsurprisingly, all Western analysts predicted a substantial growth both in LNG export capacities and exports of LNG in/from Russia in the years to come.

Today, Gazprom (or Russia) supplies LNG to more than 10 countries – Japan, South Korea, China, India, Taiwan, the UK, the US,

Kuwait, the UAE, Mexico, Thailand, plus others.

This export of gas by ship is very unusual move by Gazprom, which has two deep-rooted and well known gas 'traditions' - 'land and pipes'. Nevertheless, at the beginning of 2018, Gazexport's head, Aleksandr Medvedev, was

reported as saying that by 2025, Gazprom would provide around 6% the world's LNG exports.

Quite a difficult but realistic prediction, bearing in mind the plans to aggressively develop the country's LNG business, despite the fact that Gazprom's all-time high share of global LNG trade was only 1.5%.

Royal Dutch Shell, the world's largest LNG trader, predicts an emergence of a growing gap between global demand for LNG and its probable supply, starting sometime in the first half of 2020s.

More than \$200 bill of investment in LNG supply is needed by 2030 to meet the expected boom in demand, according to the major oil and gas group. Unlike pipeline gas trades, clearly divided into regional markets - North America, South America, Eurasia, Australia, Middle East and SEA - LNG global market is well interconnected by sea shipments (and especially by the LNG spot trade, which is growing rapidly).

Spot and short-term imports (ie, volumes delivered under contracts with a duration of four years or less) increased by 2.1 mill tonnes and amounted to 77.6 mill tonnes in 2017, compared to 75.5 mill tonnes in 2016. The

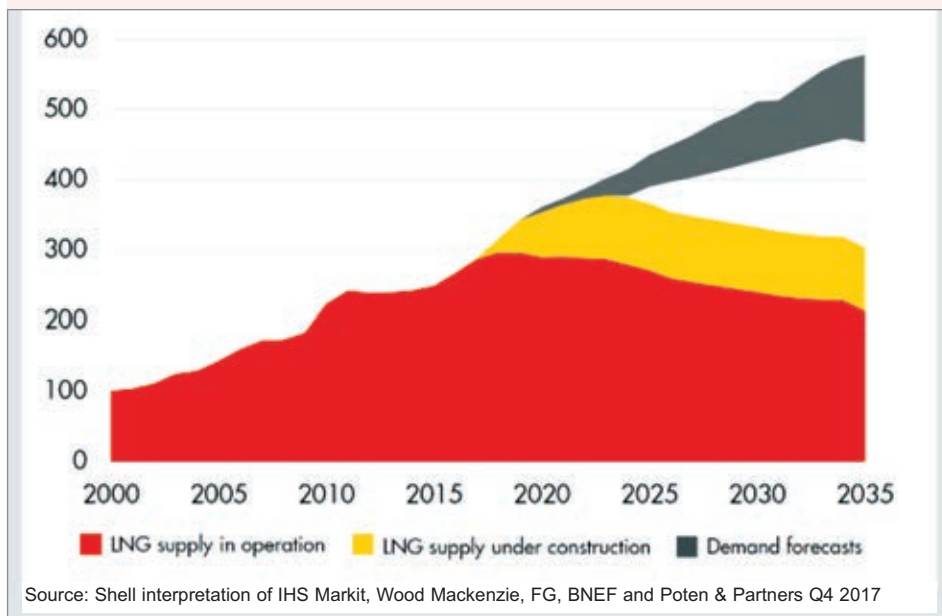
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Emerging LNG supply/demand gap, 2000-2035, in mtpa



Source: Shell LNG Outlook 2018. – Lnd.: Royal Dutch Shell, 2018, p.24

share of spot and short-term total LNG imports reached almost 25%.

On the supply side, the rise of spot and short-term volumes was essentially underpinned by the development of US exports, which accounted for 10.4% of LNG volumes delivered under contracts of four years or less in 2017.

Conversely, Qatar saw its share of this market decrease from 27.3% in 2016 to 19.7% a year later.

As for imports, China and South Korea showed the largest appetite for spot and short-term imports, recording increases of 3 mill tonnes and 4.1 mill tonnes, respectively. Japan experienced the largest decline in spot and short-term trade (-2.8 mill tonnes), despite total imported volumes being stable, followed by Jordan (-1.9 mill tonnes) and the UAE (-1.7 mill tonnes).

‘Pure spot’ LNG imports - defined as LNG deliveries, which occurred less than three months from the transaction date - reached about 20% of total volumes delivered in 2017, representing about 59 mill tonnes.

Spot imports were facilitated by LNG contracts with destination flexibility, by increased contracting for portfolio trade and by the growing volumes handled by traders.

Asia received about 60% of spot LNG (35.4 mill tonnes), followed by Europe (9 mill tonnes), the Americas (8.6 mill tonnes) and the Middle East (5.5 mill tonnes). The largest growth in spot imports were to China and

South Korea, who imported 21% and 22%, respectively, of their LNG supplies on a spot basis last year.

The world’s largest LNG-exporting country is currently Qatar (56.9 mill tonnes in 2017; eight active LNG export terminals), while the biggest LNG importer – Japan (83.5 mill tonnes in 2017), has at present 34 LNG receiving terminals. Japan is by far the world’s

top buyer of LNG.

LNG receiving (import) terminals greatly facilitate the cohesion of the global LNG market, as they are built not only to serve a liquefaction plant in a long-term agreement but can be easily re-equipped to receive practically any spot LNG cargo.

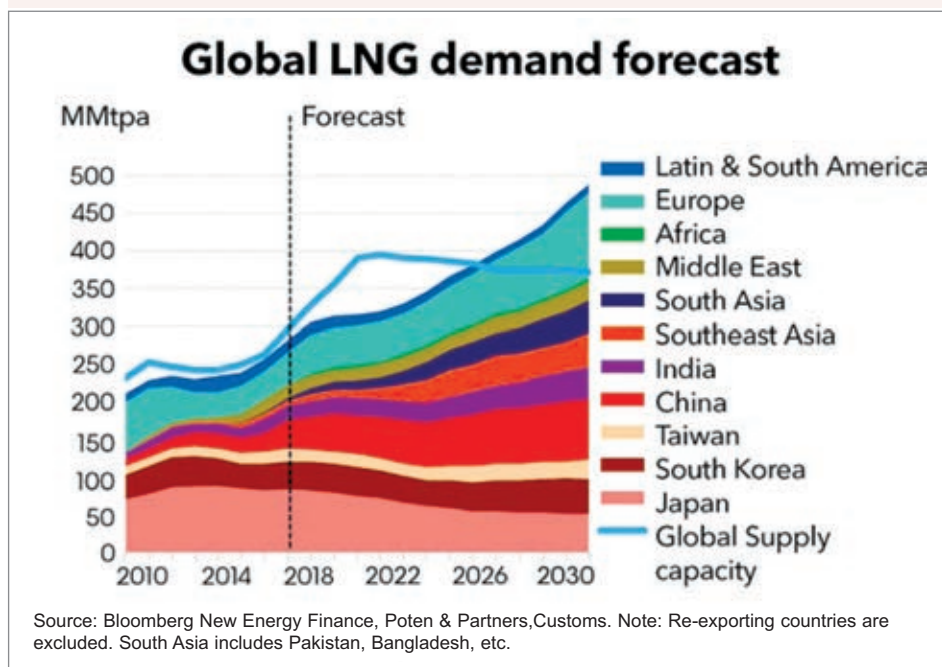
Shell, Cheniere, Kogas, Mitsui, Mitsubishi, Qatar Petroleum, Sonatrach, Petronas and Trafigura are the main players of the present-day LNG market, accounting for more than 93% of sales (2017). In particular, Shell produced 33.2 mill tonnes of LNG in 2017, Qatar Petroleum exported via its huge LNG companies since joined- QatarGas and RasGas - 103.4 bill cu m in the same year, while Trafigura, the world’s leading independent trader in this fast-growing energy market, delivered over 8.1 mill tonnes of LNG in 2017.

As for forecasts, I chose one prepared by Bloomberg in the spring of 2018. The New York-based agency predicted that global demand for LNG (and its world trade) should grow from 290 mill tonnes in 2017 up to some 480 mill tonnes per annum in 2030.

According to London-based McKinsey’s Energy Insights, the global deficit should develop from 2023 and may grow up to 150 mill tonnes per annum by 2030. ■

**This article was also written by Eugene Khartukov.*

Global Demand for LNG in 2010-2030, in mtpa



Source: <https://twitter.com/bloombergnef/status/986645643048472576>

Nakilat - expanding outreach to global markets

Established in 2004, Qatari-owned shipping and maritime services company Nakilat remains the essential transportation link in the State of Qatar's LNG supply chain.

In March this year, Nakilat expanded its joint venture partnership with Greek shipping company Maran Ventures to include two additional LNGCs.

This new agreement increased the number of vessels jointly-owned by Nakilat and Maran Gas from 13 to 15 vessels. Strategic alliances with renowned partners have been fundamental to Nakilat's success, and the company said that it was always looking for opportunities to grow its international presence.

Capitalising on the growing global energy demands, Nakilat also pursued the FSRU niche market by signing an agreement with Excelerate Energy-USA in June, 2018 to establish a joint venture company, which acquired a 55% stake in an FSRU - the first such vessel to join Nakilat fleet. This marked the beginning of the company's penetration into the FSRU market, aimed at further developing its LNG profile.

Today, Nakilat operates one of the world's largest LNG fleets, comprising 65 LNGCs. The company also jointly owns four large LPG carriers and one FSRU. To date, Nakilat Shipping Qatar Limited manages and operates 18 vessels in-house, comprising of 14 LNGCs

(six Q-Max, eight Q-Flex) and four LPG carriers out of its overall 70 vessel fleet.

The 45 Q-Max and Q-Flex vessels are the world's largest LNGCs, each exceeding 200,000 cu m capacity. Nakilat's combined LNG fleet carrying capacity has grown to over 9 mill cu m, accounting for 12% of the world's total carrying capacity. Transporting more than 60% of Qatar's LNG exports globally, Nakilat's shipping network extends to more than 90 terminals across 26 countries worldwide.

UPHOLDING SUPERIOR QUALITY

Located within the Erhama Bin Jaber Al Jalahma Shipyard complex in Ras Laffan Qatar, joint venture Nakilat-Keppel Offshore & Marine Ltd (N-KOM) has successfully undertaken more than 800 marine and offshore projects to date.

Leveraging on the extensive experience and technical knowhow of its parent companies, N-KOM is widely known as experts in handling gas carriers and a variety of other vessels. Offering comprehensive range of repair, conversion, maintenance and fabrication services to marine, offshore and onshore industry, N-KOM continues to win

new and repeat clients with its track record of safe, quality and timely deliveries, the company claimed.

This year, N-KOM has seen an increase in the number of LNGCs repaired at the facility as compared to 2017, with close to 20 gas carriers repaired in the first six months of 2018. With world-class facilities to accommodate all types of vessel repairs, including cryogenic cleanrooms and specialist sub-contractors based on-site, N-KOM has serviced vessels from leading shipowners and managers such as Shell, MOL, Maran Gas, NYK, K-Line, Teekay and The Shipping Corporation of India.

Most of these vessels underwent routine drydocking and repairs, such as cargo tank inspections, overhauling of main engine cylinders, LNG cargo and spray pumps, general steel repairs, hull treatment and painting, as well as load tests for the lifeboats and other related inspections. The shipyard's popularity with LNGCs and managers was proven, as the yard was fully booked for repairs in advance for July and August.

The shipyard boasts state-of-the-art facilities with three Q-Max sized docks (two



N-KOM handles a variety of LNGCs, including Moss and membrane types



Maran Gas' 'Maran Gas Coronis' seen in dock

graving docks and one floating dock), 15 cranes of varying capacities along the docks and quays (30t, 50t, 100t), and a berthing capacity of 3,150 m, which makes it well-equipped to handle the complexities associated with repairs of such sophisticated vessels.

In addition, the presence of prominent maritime service providers, such as Gaztransport & Technigaz (GTT), Goltens, Wärtsilä, Wilhelmshaven Ships Service, Turbo Technik and Cargotec operating within the shipyard greatly enhances the overall repair process, offering convenience to shipowners and managers using the shipyard. In addition to its team of GTT qualified membrane welders, the shipyard also works together with various other membrane repair specialist contractors.

The growth in the LNG spot market has resulted in a significant increase of inquiries for repairs from LNG vessels that are not traditionally trading in the Middle East Gulf area. Earlier this year, N-KOM received an award for the 'Best Behavioural Safety Initiative' during a safety workshop organised by Shell International Trading and Shipping Company (STASCO) for its contractors.

The yard was lauded for deploying effective strategies and achieving successful measurable results with specific focus on safety and quality. This recognition bears testament to the high safety standards throughout its operations and N-KOM's successful approach towards improving behavioural safety among its employees and contractors, it said.

N-KOM continues to see interest for ballast water treatment system (BWTS) installations,

given the yard already has experience handling these systems for several vessels in the past. Understandably for large LNGCs, the choice of BWTS is relatively limited to those that are able to meet the ballast volume, vessel flow requirement and the need to complete necessary ballast treatment operations in line with their cargo handling timescales.

Thus far, the yard has carried out installation of three different BWTS – Samsung, OceanSaver and Alfa Laval.

LNGCs have sufficient space and power for the installation of a BWTS. The engineering of the retrofit process should be carefully planned ahead and rehearsed before drydocking. Amongst the challenges are how to optimise both installation processes and costs of man hours and materials.

From interactions with ship operators, N-

KOM has observed a delay in the selection of a BWTS albeit with reasonable justification. The technology maturity, equipment approvals and regulations are the main three parameters that pose serious challenges to the operators. As such, adequate planning and preparations are highly required when the inevitable time comes.

Whilst there may be different approaches among the ship operators in dealing with air emissions requirements that are coming into force, a number of them with modern yet high fuel consuming vessels are exploring scrubbers as a solution. N-KOM has already been booked for scrubber retrofits for a series of VLCCs from a major tanker operator based in Greece. The yard said it expected that the remainder of 2018 and the whole 2019 will be a year with strong interest for scrubbers retrofits.

EXCITING JOURNEY AHEAD

Nakilat is also dedicated to developing and strengthening in-house capabilities to build technical knowhow in preparation for any future possibilities. The State of Qatar's future plan to increase LNG exports to 100 mill tonnes per annum creates an excellent, large-scale opportunity for growth in Nakilat's fleet size.

In view of what is perceived to be an exciting journey ahead, Nakilat is always looking for potential opportunities in diversifying its business, expanding global reach, as well as exploring the downstream LNG value chain. LNG regasification, power generation and small-scale LNG are among the areas Nakilat will continue to explore for possible opportunities to expand its business portfolio. ■



N-KOM boasts three large docks, capable of handling Q-Maxes



MEG4: The industry is changing. ARE YOU?

Samson can help.

SamsonRope.com/Icaria



Global versatility and enhanced efficiencies for MISC's new LNGCs

Not only are environmental concerns and regulations beginning to bite, but there is also a growing need to load from floating facilities and discharge at multiple terminals worldwide. Sustainability and flexibility is key to a successful LNG operation and these are the dual design considerations underpinning MISC's newest fleet of 'Seri C' class LNGCs.

With a fleet of 29 vessels, a track record of more than three decades for quality and on-time delivery, and a long and established relationship with the world's third largest LNG producer - PETRONAS- MISC now delivers around 8% of the global LNG requirement.

Harnessing this experience has allowed MISC to pursue its agenda of furthering sustainable shipping through the introduction

The landscape governing the ocean transport of LNG cargoes is changing.

of these five new vessels in the 'Seri C' class.

South Korean shipbuilder, Hyundai Heavy industries (HHI) was entrusted to design, build and deliver all five vessels and the yard collaborated with MISC's in-house project management team throughout the construction process. All five vessels recorded zero lost time Injury (LTIs) and zero total recordable case frequency (TRCF) from keel-laying to launch.

Delivered between 2016-2018, these 150,200 cu m capacity vessels were designed for worldwide trading and are able to call at various major LNG receiving terminals and liquefaction terminals worldwide. The 'Seri C' vessels also have a loading capability at FLNG facilities, due to the robust and superior cargo containment system that ensures a higher degree of operational flexibility.

SUPERIOR CONTAINMENT SYSTEM

The 'Seri C' vessels are fitted with the MOSS-type containment system, which allows the cargo tanks to absorb a greater degree of sloshing at any level of filling without endangering the tanks, notwithstanding rough weather when loading offshore.

This robust and superior cargo containment system allows for a higher degree of flexibility to accommodate cargo-loading operation at

FLNG facilities. Until this point, MISC had been operating exclusively with membrane vessels and as a result, the introduction of MOSS-type vessels adds further flexibility to MISC's global operations, the company claimed.

The lead vessel in the class, 'Seri Camellia', was the first to experience LNG offtake from PETRONAS' first FLNG facility (also known as 'PFLNG 1') in the Kanowit gas field offshore Sarawak, Malaysia, making MISC the first shipowner in the world to have operational experience with an FLNG.

ENVIRONMENTAL ENHANCEMENTS

Flexibility and sustainability were the main drivers in choosing the main propulsion system. Ultra steam turbine (UST) technology was selected to give a 13% efficiency gain over conventional steam plants.

Most new LNGCs are fitted with dual fuel diesel engines or the new low speed diesel engine; but following a thorough review of the new vessels' operating patterns, MISC was confident that the UST option would be more economical and sustainable on a total cost of ownership basis for the life of the PETRONAS contract.

The vessels can also operate entirely on LNG for full compliance with existing Sulfur Emissions Control Area (SECA) regulations and impending global sulfur requirement in 2020 giving the vessels full global trading options.

With a keen eye on environmental performance, the 'Seri C' vessels have been

Principal Particulars - 'Seri C' LNGCs

LOA	290m
Length BP	277m
Breadth, moulded	48.9m
Depth moulded	23.35m
Design draught	11.5m
DWT	72,880 tonnes
Displacement	108,818 tonnes
GT	133,948 tonnes
Cruising range	16,000nm (34+5 days)
Speed (NCR with 15% SM)	abt 19.44 knots
Containment system	Spherical independent type "B" Moss tanks
No of cargo tanks	Four
Tank capacity (100%)	150,200cbm
Boil off rate	<0.1% per day
Main engine output	21,519kW



'Seri Camar'

fitted with a range of eco-innovations to enhance energy efficiency and reduce emissions. Installation of energy saving devices, such as the Mewis pre-swirl duct and Propeller Boss Cap Fin (PBCF) contributes to an average energy saving of about 4% at design draft. The fitting of an X-Twisted rudder also improves cavitation and enhances manoeuvring performance, which also contributes towards improving energy efficiency. The use of low-friction anti-fouling paint reduces speed losses during operation and ensures compliance with the IMO Anti-Fouling System Convention.

The new fleet has also been installed with a selective catalytic reduction (SCR) system allowing the vessels' diesel generators to comply with the latest IMO Tier III requirement, as well as an Ozone ballast water treatment system to avoid the spreading of potential destructive organisms to the marine environment.

INTEGRATED HULL STRUCTURE

The 'Seri C' vessels feature an integrated hull structure (IHS) with the four spherical tanks shielded by a continuous cover. This cover design improves the overall structural strength of the hull and is optimised both for aerodynamics and hydrodynamics.

IHS delivers a steel reduction of about 5%, which reduces the weight of the vessels when compared with conventional MOSS-type LNGCs. Optimisation of the hull form was rigorously tested during the design phase to minimise hull resistance, increase propulsion efficiency, reduce power requirement, and improve energy efficiency.

The combination of the advanced hull form, UST propulsion and various energy saving devices means that the new vessels have achieved and attained Energy Efficiency Design Index (EEDI) of about 7 [g-CO₂/tonne NM]. Each of the LNGCs comply with and will carry ECO Notation awarded by class in recognition of their environmental credentials.

Zahid Osman, Vice President of MISC's

LNG Business Unit, said "MISC's 'Seri C' vessels demonstrates to the industry-at-large that there is always room for innovation, ambition and progression within the shipping and energy industries. These vessels set a new standard for our fleet and serve as the catalyst to MISC's journey in sustainable transportation

of LNG, as well as our commitment towards upholding environmental stewardship, aligned with our Group's mission to care for the environment and operate responsibly."

Interestingly, the 'Seri Camellia', was reportedly due to arrive at the US Cove Point export plant to load a cargo on 2nd August. ■

Green Technology Features of the

Seri C Class LNG Vessels

The new generation of MOSS-Type Seri C Class Liquefied Natural Gas (LNG) vessels offers a superior and robust cargo containment, ensuring a high degree of operational flexibility to operate in harsh meteorological conditions.

Features

- Compatible with Petronas FLNG
- No cargo filling limit
- Energy efficient
- Environmental friendly
- Low boil-off rate



Extended/ Low Load Gas Mode

100% gas-mode combustion during manoeuvring and ship idle operation which will provide a more environment friendly operation



Green Passport

Voluntary adoption of Green Passport to provide safe working conditions for the ship crew and to protect the marine environment.

All material and system shall not contain asbestos, Halon, PCB, HCFC, CFC and toxic materials



Environmentally Acceptable Lubricants (EAL)

Utilisation of high performance synthetic EAL to provide optimal protection and reduce risk of environmental pollution

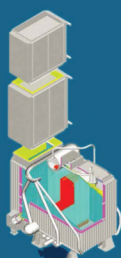


Seri Camellia, first of MISC's Seri C Class vessel was recognised as one of the "Great Ships of 2016" and shortlisted at the top 4 for the "Nor-Shipping Energy Efficiency Award 2017"



Hull Form Optimisation

Optimisation of the hull form to minimise hull resistance, increase propulsion efficiency, reduce power requirement and reduce CO₂ emissions



Ultra Steam Turbine

13% higher efficiency compared to conventional steam turbine plant

Nitrogen-Oxide (NOx) Emissions

Complies with IMO Tier III with the installation of Selective Catalytic Reduction (SCR) System

Sulphur-Oxide (SOx) Emissions

Complies with Sulphur Emission Control Area requirement by burning LSFMO, LSHFO with no more than 0.1% Sulphur content



Pre-Swirl Duct & Propeller Boss Cap Fins

Energy-saving of about 4% at design draft

X-Twisted Rudder

Improved cavitation and maneuvering performance



Low Friction Anti-Fouling Paint

Reduces speed losses during operation, Tributyltin-free (TBT) and complies with IMO's Anti-fouling System Convention



Ballast Water Treatment System

Ballast water is treated using ozone technology on every voyage to avoid spreading potential destructive organisms to marine environment

'Seri C' class LNGCs

Name	DOB
Seri Camellia	2016
Seri Cenderawasih	2017
Seri Cempaka	2017
Seri Camar	2018
Seri Cemara	2018

The 'Seri C' Class LNG Fleet

For more information, please contact: info@misc.com.my or visit our website: <http://www.misc.com.my>

misc moving energy

Engine manufacturers keep up with the gas revolution

Only five years after the launch of the X-DF engine, WinGD has secured the 100th order for this engine type.

This technology has demonstrated, on tests and engines currently in operation, that it offers stable combustion, inherently low NOx and greenhouse gas emissions and high overall system efficiencies, as well as reliable and safe gas operation, the company claimed.

GasLog Ltd, one of the early supporters of X-DF technology, has eight LNGCs, each fitted with twin 5X72DF main engines with

three new builds recently entering operations. For the latest order of additional tonnage at Samsung Heavy Industries, the same engines were selected.

“When we select an engine for GasLog, the most important considerations are the engines’ contributions to the safety, competitiveness, sustainability and reliability of the vessel for our customers. When we selected the X-DF it was crucial for us to find a dual fuel engine which could offer all those features for today’s and the future environment. WinGD’s X-DF engines were the choice for our new vessels and we continue to be confident in their low pressure dual fuel technology,” said Richard Sadler, Gaslog Ltd COO.

“If ever there was confirmation that the shipping industry is embracing LNG as the first choice for IMO compliant engines, the 100th ordered WinGD X-DF, dual-fuel engine is proof. With over 12,000 running hours logged on the first WinGD DF engine in operation (Terntank’s ‘Ternsund’) and over 100,000 running hours accumulated for the full X-DF engine fleet with 13 vessels at sea, the performance, benefits and reliability of WinGD’s low-pressure technology is proven,” claimed Rolf Stiefel,

WinGD’s Vice President of Sales and Marketing.

“Achieving the 100th X-DF engine milestone in July, 2018, after only five years, validates that customers such as shipyards, vessel owners and operators have recognised its unique benefits. Beside its leading position in the LNGC market today, X-DF is gaining ground for future tankers and containerships to ensure that newbuilds are built to meet 2020 regulations in the most economical way.

“The 2017 decision by CMA CGM, to power their nine ‘mega’ containerships to be built by CSSC shipyards in China with delivery in early 2020, with our 12-cylinder X92DF engines, is a strong statement that greener shipping can be achieved best by applying X-DF main propulsion engines,” Stiefel added.

X-DF BENEFITS

WinGD’s low pressure X-DF engines work on the lean-burn Otto cycle when operated in gas mode – ie, ignition of a compressed lean air/gas mixture by injection of a very small amount of liquid pilot fuel.

X-DF engines undercut the IMO Tier III NOx limit in gas mode in ECAs by a considerable margins without any additional exhaust gas abatement measures, such as EGR or SCR.

With liquid fuel consumption for pilot ignition below 1% of total heat release and with practically no sulfur content in LNG, WinGD’s X-DF technology offers a reliable solution to answer the call for the 0.5% global cap on sulfur in marine fuels on 1st January, 2020.

In addition, particulate matter emissions is reduced to almost zero, and the CO2 emissions, inherent to burning natural gas, are further reduced. The total hydrocarbon content of X-DF is considerably lower, compared to 4-



WinGD 6X72DF_DU

stroke low-pressure DF engines, which employ the same technology and are used as auxiliaries.

LNGPAC MILESTONE

Wärtsilä's Fuel Gas Supply Systems has also passed a significant milestone with the 100th order being booked for its LNGPac units.

These will be installed on two new shuttle tankers being built for Singapore-based AET Tankers. Each vessel will feature Wärtsilä 34DF dual-fuel auxiliary engines running primarily on LNG fuel and fitted with LNGPac units.

First introduced in 2009, this system has played an important role in establishing the viability of LNG as a marine fuel. It comprises a bunkering station, an LNG fuel tank and related process equipment, as well as the control and monitoring system. LNGPac fuel can be offered as a standalone product, or as part of a complete propulsion system.

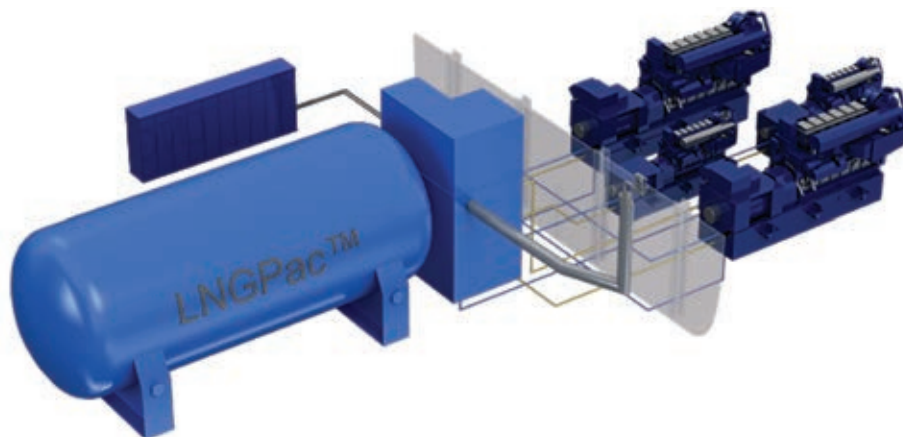
"A major reason for the global acceptance of LNG fuel for shipping is that Wärtsilä realised at an early stage that more than just a dual-fuel engine and a stand-alone LNG system was needed. LNG fuelled ships require a complete fuel handling system, and the innovative LNGPac system very successfully meets this requirement," said Mathias Jansson, General Manager, Fuel Gas Supply Systems, Wärtsilä Marine Solutions.

The first LNGPac was fitted on board the chemical tanker 'Bit Viking' owned by Swedish operator Tarbit. This vessel was converted for LNG fuel operation in 2011, and its success paved the way for the rapid acceptance of the Wärtsilä solution, the company claimed. Today LNGPacs are installed on some 12 or more different types of vessel, including passenger ferries, tugs, dredgers and offshore vessels.

Since the introduction of the LNGPac, Wärtsilä has continued to develop the system. For example, the company has pioneered the usage of the cold energy stored in LNG by using it to cool the on board HVAC and galley system.

Another achievement was the development of a compact LNGPac with an integrated gas valve unit (GVU) and airlock. The inline tank connection space for single shell tanks was developed, as was a dedicated LNG fuel pump based on the deepwell pump technology.

The system can be customised to the needs of each project on a case by case basis. Dedicated engineering is conducted from the beginning of the project to match the specific operational requirements, safety and class



Wärtsilä's LNGPac design has passed a major milestone

society requirements.

Wärtsilä also offers optimised maintenance agreements, including condition-based monitoring (CBM), for the LNGPac system.

ME-GI ENGINES

Meanwhile, MAN Energy Solutions (MES) has more than 200 ME-GI (gas injection) engines on order. This 2-stroke propulsion engine has been fitted on board LNGCs, container vessels, car carriers and bulk carriers.

With the ME-GI engine, 2-stroke development has taken a step further by combining the unique properties of multi-fuel combustion and the reliability of MES' ME-engine. The diesel principle provides the ME-GI engine with high operational stability and efficiency, including during load changes and fuel change-over, while defining properties, such as a stable change-over from fuel to gas with no fuel-penalties, are maintained.

MES announced an order to install the propulsion systems for two 2,525-teu US Jones Act containership newbuildings, which will join the fleet of Pasha Hawaii. Each ship will be fitted with a 7S80ME-GI Mk 9.5 main engine, three MAN 6L35/44DF GenSets and an MAN Alpha FPP propeller system. The vessels will be constructed at Keppel AmFELS in Brownsville, Texas to Keppel's proprietary design.

Bjarne Foldager, MES Vice President, Sales & Promotion, 2-Stroke Business, said: "With some 200 engines on order or already in service, the ME-GI's popularity continues to grow. This is yet another order within the container segment and cements the ME-GI concept. More so, the project at hand shows how our customers pick up on offers of complete propulsion systems beyond just the main engine. This confirms our strategic path to develop into a system provider."

Doosan Engine will build the main engines in South Korea. They will meet Tier III emission standards by use of an exhaust gas recirculation system. Similarly, MES Augsburg will build the auxiliary engines, which will also meet Tier III with the aid of a selective catalytic reduction system.

Engine delivery is scheduled for 2019 with the two vessels due to be delivered in Q1 and Q3 of 2020, respectively.

Honolulu-based Pasha Hawaii, said that the new vessels will have a sailing speed of 23 knots and that the ships' hulls have been fully optimised using computational fluid dynamics (CFD) to be among the most hydrodynamically efficient in the world.

The new vessels will operate fully on LNG from day one, dramatically reducing environmental impact and increasing fuel efficiency. Energy savings will also be achieved with a state-of-the-art engine, an optimised hull form, and an underwater propulsion system with a high-efficiency rudder and propeller.

Earlier this year, the 'Ilshin Green Iris' was delivered. She is the world's first LNG-fuelled bulk carrier and was built at Hyundai Mipo Dockyard (HMD) for Ilshin Logistics and was the result of a project, announced in July, 2016, to develop the first in a new generation of environmentally-friendly LNG-fuelled bulk carriers.

Foldager said: "We are very pleased to be part of this exciting project and to see our dual-fuel ME-GI engine win favour in yet another market segment. We look forward to following its progress."

'Ilshin Green Iris' is fitted with a Type 'C' LNG fuel tank with a capacity of 500 cu m and comprised of a material – high-manganese austenitic steel – newly developed by POSCO specifically designed for cryogenic LNG and liquefied gas-storage applications. ■

Providing and analysing data from LNGC operations

Before joining the Wärtsilä Group, maritime efficiency software developer Eniram had met with some success in the LNGC owner and operator sector.

LNG Shipping Review spoke with Dimitris Argyros, Eniram's Senior Portfolio Manager, who explained that the company offers services to both LNGC owners and technical managers, plus charterers/operators.

The services typically start from a comprehensive data integration with LNGC-specific equipment and systems, ie cargo systems, propulsion, machinery and navigation.

Once the relevant data stream is established, the services will then vary depending on the customers' needs and focus. For example, if the focus is on shipboard

decision-support systems leading to tangible savings, Eniram can offer services, such as trim optimisation, speed optimisation or engine selection/load optimisation for dual/tri-fuel diesel-electric propulsion.

In terms of onshore analytics, services allowing the monitoring of the technical efficiency/performance of the vessel/fleet (hull/propulsion, power generation and machinery) and cargo containment system are offered.

In addition, voyage performance against KPIs (Eniram or customer-defined) can be monitored and benchmarked against the customers' fleet and industry (where supported by the relevant data).

Finally, and recognising that there are different LNGC customer needs, Eniram can (and has) developed tailored analytics services, such as regular reports, office dashboards, utilising the collected data or modelling, where necessary, and parameters, such as the boil-off rate.

For boil-off gas (BOG) calculations, Eniram can monitor the entire BOG lifecycle on LNGCs, from generation during cargo operations/voyage to usage in generator engines, steam turbines or propulsion engines and management in gas combustion units, steam dumps or reliquefaction.

BOG reduction can be achieved via a combination of more advanced cargo containment systems or reliquefaction/cargo

conditioning systems (technical solutions) and more efficient cargo management during voyages (pressure and speed management).

Monitoring the BOG reduction at a high level KPI (eg, BOG/BOR per voyage or over a longer period) is generally straightforward to undertake. Analysing and allocating accurately the reduction requires isolation of the influencing factors (technical/operational/environmental) and this requires some more advanced modelling, which is available from Eniram.

Argyros explained that gas management used in references referred to the optimisation of BOG generated during the laden voyage. This involves understanding the factors affecting the generation of BOG (cargo and tank conditions, environmental factors, vessel motions) and how the generated BOG is utilised (speed and voyage optimisation, gas combustion unit, reliquefaction, etc).

Ultimately, optimum gas management means the combination of a) controlling/reducing the boil-off gas generation and b) maximising the use of generated boil-off gas for propulsion/power generation.

As there are several types of propulsion systems used in today's LNGCs, Eniram's installation base includes all types, namely dual/tri-fuel diesel-electric (DFDE/TFDE), steam turbine and slow-speed diesel mechanical propulsion.

"This allows us to benchmark the performance among vessels of the same type but also against each other via a suitable KPI.

"For example, especially for DFDE/TFDE, our parent company, Wärtsilä, is the market leader providing us with additional expertise and benchmarking data. Our techniques can remove external factors (weather/operational), enabling a true comparison/benchmarking at normalised conditions," he explained.



Dimitris Argyros, Senior Portfolio Manager, Eniram

“

Our domain expertise is different but our services are complementary,...Data acquisition is often the common foundation to our services

”

- Dimitris Argyros, Senior Portfolio Manager, Eniram

LNGCs are among the most sophisticated and CAPEX-intensive vessel types and their technical management and operation requires a high degree of domain expertise. Eniram's LNGC customers tend to concentrate in areas beyond the 'traditional' aspects of hull condition/fouling and fuel consumption/charterparty monitoring, which are typically the focus of other segments.

MISSION CRITICAL

There is also a lot more 'mission-critical' equipment and cargo systems on board, which require a deeper level of monitoring and data integration/analysis.

Tracking the vessel's position, status and real-time mobile notifications provided by Eniram can support other processes, such as cargo transactions during a voyage, which is

often a commercial matter. The inputs to cargo transactions extend beyond the data collected on board the vessel, as there are additional elements/data, which Eniram, or indeed any other provider, wouldn't have access to.

Since joining Wärtsilä, Eniram is now working closely with colleagues in the relevant Wärtsilä Group units to offer comprehensive solutions to both existing and new customers.

"Our domain expertise is different but our services are complementary, for example, voyage monitoring and optimisation versus machinery and equipment condition monitoring and optimisation. Data acquisition is often the common foundation to our services," Argyros explained.

Eniram has been leading the market when it comes to performance optimisation and monitoring for LNGCs with particular

innovation in the area of boil-off.

This success is reflected in the fact a significant proportion of the leading LNG vessel owners and charterers use the Eniram system for both management insight and operational optimisation, he said.

As an example, last February, Wärtsilä announced that it had expanded its co-operation with Athens-based shipmanagement company, TMS Cardiff Gas.

Under a maintenance agreement, Wärtsilä now helps to ensure the maintenance predictability for four TFDE LNGCs in the fleet.

Wärtsilä's dynamic maintenance planning, in combination with Eniram's vessel digital performance management system, provides TMS Cardiff Gas with a comprehensive view of each vessel's performance, efficiency, and improvement possibilities.

Wärtsilä provides all necessary spare parts for the maintenance of the vessels, as well as field service resources for scheduled maintenance that was planned based on the actual running hours of the engines.

TMS Cardiff Gas has recently expanded its LNGC portfolio by ordering up to 10 gas carriers. ■



Dedicated
to the
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TWO TUGS FULL CONTROL



By Rotortug.

Babcock LGE introduces LNGC reliquefaction system

Babcock LGE has developed an eco LNG reliquefaction system, which makes use of single mixed refrigerant technology as a smart alternative to existing systems, the company claimed.

The key drivers behind the development of the patented ecoSMRT were based around designing a more efficient and cost-effective solution for LNG reliquefaction compared to competing systems.

These efficiencies included; - :

- Lower initial purchase costs.
- Lower overall installed cost.
- Lower operational costs.
- Simplified operation with reduced maintenance.

Improvements in main engine fuel efficiency, coupled with lower voyage speeds, has resulted in LNG reliquefaction systems being increasingly used to tackle excess boil off gas (BOG) on LNGCs.

ecoSMRT's development was achieved by using proven technologies applied in a novel manner resulting significant improvements over existing systems, Babcock LGE said. The use of standard proven technologies provides the reassurance owners need when making final investment decisions (FIDS).

In August 2015, partnering with Hyundai Heavy Industries (HHI), Babcock designed and developed a reliquefaction system that was claimed to be capable of reliquifying 100% of excess BOG.

The concept design was completed in 2016 and patent applications filed in June and August of that year.

Approval in Principle (AiP) by Lloyds Register (LR) was achieved in April, 2017. The fully-matured design recorded its first sales in February, 2018 with the announcement that four LNGCs would be built at HHI, South Korea, each fitted with the system.

ecoSMRT can be supplied in a range of plant capacities from 1.3 to 3.1 tonnes per

hour using a single mixed refrigerant (SMR) compressor to suit XDF or ME-GI type main engines. Larger capacities can be catered by using two SMR compressors.

The key feature of the ecoSMRT plant is the incorporation of a SMR pre-cooling within a multi-channel aluminium brazed plate fin heat exchanger (BAHX) using a single closed loop cycle (patent pending). Competing designs utilise external pre-cooling, which require an additional refrigeration plant - typically a propane or chilled brine cycle.

Another important feature is how ecoSMRT handles refrigerant oil carry-over. The design eliminates the potential for oil carry-over within the SMR cycle from entering the cryogenic sections of the BAHX (patent pending).

The LNG BOG is delivered to the ecoSMRT plant from the LNGC's existing fuel gas compressor. The pressurised BOG passes through the BAHX, in which the cold temperature required to reliquify the BOG, is provided by the system. The BOG condensate is then ready to be returned to the cargo tanks.

Reliquefaction capacity is automatically controlled within a range of 10% to 100% to match the BOG system requirements.

BENEFITS

ecoSMRT offers a range of benefits to the shipyard and owner, the company said. Delivered as a fully-fabricated module, the system is ready for installation in the deckhouse. The modular design footprint is up



Babcock LGE's ecoSMRT

to 40% smaller than current designs. These two benefits significantly reduce the installation work required by the shipyard.

Incorporating the pre-cooling within the SMR cycle removes a secondary refrigerant plant typically comprising a screw compressor plant, complete with an oil management system, and up to five heat exchangers and other pressure vessels. This simplification gives 'ease of operation' to the owner and up to 50% reduction in maintenance requirements.

The optimised ecoSMRT range provides increased efficiencies of up to 30% on a like-for-like basis, when compared to current systems. The coefficient of performance (COP) rising to up to 40%, gives the owner immediate opex benefit of increased reliquefaction plant capacity, combined with reduced power consumption, leading to a reduction in fuel consumption for electric power generation.

Recently Babcock announced that it had won contracts to install six new ecoSMRT

contracts with Hyundai Heavy Industries (HHI).

ecoSMRT's order book totals 11 contracts placed over the last six months which is worth in excess of £40 mill.

Benefiting from its reduced environmental footprint and low cost of ownership, ecoSMRT's improved efficiency provides

customers energy savings for both newbuilds and retrofit programmes across the optimised cargo handling market.

Neale Campbell, Babcock LGE's Managing Director, said: "ecoSMRT is an innovative solution; we are well placed to support our customers as technology and environmental factors drive efficiencies and

improvements across the market. Our recent success highlights that ecoSMRT is trusted to deliver energy and cost savings for our customers."

Babcock delivers a range of solutions designed to support the growing liquefied gas market, including ecoSMRT and the patented Vent Gas Cooler (VGC). ■

Gas Supply Vessel (GSV)

Babcock and Bernhard Schulte (in a joint venture Babcock Schulte Energy (BSE)) recognised that the demand for LNG bunkering vessels was set to expand rapidly following IMO regulations reducing global sulfur emissions.

In this emerging market there was a perceived lack of high specification, future-proof solutions.

With this in mind, and working alongside suppliers, port authorities, charterers and shipowners with LNG fuelled fleets, BSE combined its expertise in shipowning/management and 50 years' experience in the liquefied gas market to design a vessel, which met the requirements for all parties, whilst complying with environmental legislation and at the same time, remaining cost-effective.

The BSE Gas Supply Vessel (GSV)/LNG Bunker Vessel (LNGBV) was designed to provide LNG to a wide variety of ships operating on LNG as a marine fuel. All aspects of the vessel were designed to provide maximum operational efficiency.

The first contract for a GSV was signed in December, 2016, with the keel laid in March, 2018 against a delivery date of September this year. Babcock supplied the FGSV0, which provides a zero emissions compressed natural

gas (CNG) fuelling solution for GSVs, for which patents were filed in July, 2015.

The patent-pending FGSV0 system ensures zero emissions to atmosphere during normal operations, the company claimed. Boil-off gas (BOG) generated during operations (both during transits and cargo transfers) is compressed and stored as CNG on board the GSV.

The CNG is used to generate electricity to power the vessel. For redundancy, an LNG vaporiser supplies gas fuel directly from the cargo tanks.

LNG GSV FEATURES

Forward accommodation enables good bridge visibility and an excellent manoeuvring capability to provide 'port' operational confidence and allow for tug waivers and pilot exemptions.

With twin azimuth thrusters, aft and bow thrusters, the GSV is highly manoeuvrable and can rotate through 360 deg in its own length in about two minutes. In addition to a DP2 capability, the GSV uses proprietary RangeGuard, a target-less proximity system, to accurately position the GSV alongside by parallel vectoring, thereby avoiding hard contact with the receiving ship.

Its design is longitudinally balanced requiring a minimal volume of permanent

fresh water ballast for trim purposes and therefore a ballast water treatment system is not required. The design uses a power station concept delivering immediate propulsion during LNG transfer operations which, together with quick release hooks, allows unrestricted ESD separation.

The bridge incorporates the control systems for the engine room and the cargo system and with 360 deg visibility supports single man operation. In addition, CCTV cameras are strategically located to assist manoeuvring in restricted areas.

It also contains GSV simulator software, which is a unique proprietary software, developed in-house by Babcock. This allows for verification of proposed design criteria against given vessel voyage profiles. The output from the voyage-profiling software allows for rapid assessment of design suitability and indicates opportunities for refinement.

Recognising the growing nature of the business, the accommodation includes extra cabins for training purposes.

Overall benefits include

- Reduced cargo loss – BOG returned to tanks.
- Flexible operations (GSV simulator allows operation to be tailored to specific voyages meaning optimisation of fuel usage and reduced cargo loss).
- Zero operational methane emissions.
- Sophisticated cargo off-loading system.
- Optional metering, loading/offloading sampling and composition analysis.
- Optional reliquefaction systems.
- Equipped for worldwide operation, no restricted areas of operation and fully compliant with SOLAS and the new edition of the IGC Code, in terms of both stability and safety.
- Fully complies with Nox Tier III requirement of MARPOL Annex VI Regulation 13 during operation in Environmental Control Areas (ECAs) - Zero-emissions to atmosphere when loading. ■



Babcock Schulte Energy - GSV

Persisto - unique materials for reciprocating compressors

A variety of high-quality plastic compounds is now available for use as sealing and rider rings in reciprocating compressors.*

But in many cases, these materials have not been developed specifically for use in a reciprocating compressor.

The requirements that an optimal dry-running material for reciprocating compressor sealing elements should meet can be described as follows:

- Favourable tribological properties ensuring minimal friction and low wear.
- High degree of chemical resistance for use with as many different gases as possible.
- Good mechanical properties to withstand maximum load parameters.
- Good shape adaptability for optimal sealing performance.
- Minimum abrasiveness to avoid counter body wear.

To date, this general requirement profile is not fully satisfied by any dry-running materials. In particular, there is no dry-running material available that exhibits the same good wear properties in every gas and gas mixture environment.



Persisto® 850 (red), shown in a heterogeneous combination of rings within a Redura® Rod Sealing System

In an effort to improve service life, the dry-running materials often contain a significant proportion of abrasive fillers, including glass fibres or ceramic with the correspondingly negative consequences for soft counter body materials, such as grey cast iron.

Many high-temperature polymers with good mechanical properties display a high elastic modulus. This leads to rigid sealing rings or sealing ring segments which, in turn, display very poor adaptability. The latter has a particularly negative impact on oil-free compression of light gases at high pressures.

The patented Persisto family stands for materials which have been specially developed for use as sealing elements in reciprocating compressors. For example, Burckhardt Compression uses five reciprocating compressors to test the materials for each particular application.

The Persisto materials currently available already cover a wide variety of gases in oil-lubricated as well as in dry-running environments. Persisto® 850 and Persisto® 851, the youngest members of the family, were specifically developed for use in dry-running reciprocating compressors for the compression of hydrogen and tested on a hydrogen test compressor, whereby the highly-optimised alloy comprising polytetrafluorethylene and polyphenylene sulfide is of particular significance.

This alloy offers particularly favourable properties for the requisite sealing functions and, in particular, permits a higher load and a reduced creep compared to conventional filled PTFE materials. At the same time, sealing and rider rings made of Persisto® 850 and Persisto® 851 display good flexibility and correspondingly good adaptability.

If the wear compensation of sealing elements is based on shifts in ring components, rather than their elastic/plastic deformation^[1], even

high differences in pressure can be realised with Persisto® 850 without failure by fracture.

Discharge pressures of more than 300 barg can be sealed in oil-free compression of hydrogen. In addition, the permissible pressure load for dry-running packings with a pressure difference of more than 200 barg is remarkable.

Persisto® 851 is used in the pressure range of up to 50 barg. The wear coefficients of both Persisto materials are significantly lower than those of conventional polymer blends or carbon and fibre filled PTFE grades.

Persisto® 850 can be used in a wide range of gases and gas mixtures but is not recommended for compressing oxygen-containing gases. Apart from hydrogen, this new development is predestined for applications with various hydrocarbons (including boil-off gas), carbon monoxide, carbon dioxide or ammonia. Thanks to its special composition, the atmospheric dew point of the gases can be significantly below -70 deg C (bone-dry).

COMPLEX SEALING

With its Persisto® 850 materials, Burckhardt Compression offers new solutions for complex sealing applications in reciprocating compressors. These optimised, custom-made compounds are distinguished by superior sealing properties without requiring the use of expensive counter body materials or coatings.

Only by the exclusively produced the proprietary Persisto materials, the patented Redura sealing systems achieve their maximum performance for an efficient, reliable and long-lasting operation in reciprocating compressors. ■

**This article was supplied by Burckhardt Compression.*

[1] Performance improvement of dry-running sealing systems by optimization of wear compensation 9th Conference of the EFRC, September 11th / 12th, 2014, Vienna.

LNG as a fuel - it's decision time!

With 1st January 2020 not that far away, it is decision time for those not having made up their minds about how to comply with the forthcoming low sulfur fuel cap.

There have been many papers, conferences, opinions expressed, etc on the subject of using LNG, some of which are mentioned below.

Infrastructure is the usual excuse given by people not opting for LNG but that is being slowly addressed. As shipowners on regular runs opt for gas, so the infrastructure plans have quickly followed - CMA CGM's giant containerships are a case in point (see below).

Many class societies have issued guidelines on fuelling vessels with gas and in April, class society DNV GL issued a White Paper examining the alternatives and the technologies to go with them.

'Alternative fuels and technologies for greener shipping' examines the price, availability, regulatory challenges and environmental benefits of alternative fuels and technologies, including LNG, LPG, hydrogen, fuel cells, and hybrid and battery technologies.

It also compares their use to that of

conventional fuel with scrubbers and new low sulfur alternatives.

"The incoming IMO sulfur cap on emissions from shipping could have a significant effect on the maritime industry, and it has the potential to be a game changer for alternative fuels," said Trond Hodne, Senior Vice President, Sales & Marketing Director at DNV GL – Maritime. "Our new white paper is designed to set out the options for interested stakeholders and to offer a balanced assessment of the potential of these fuels and technologies going forward. We hope that by doing so we can add to the growing body of knowledge and enable investment decisions to be made with greater certainty and confidence."

The technologies and fuels considered in the white paper are many of the most commonly used in the shipping industry today - LNG, LPG, methanol, biofuel, hydrogen, battery systems, fuel cell systems, and wind-assisted propulsion.

The white paper identifies and examines the factors that will affect the uptake and acceptance of alternative fuels and technologies in shipping, including - environmental compatibility, availability, fuel costs and the international rules within the IGF Code.

Over the short term, the white paper foresees that the vast majority of conventionally fuelled vessels already in service will either switch to low sulfur conventional fuels, or implement a scrubber system while continuing to use heavy fuel oil (HFO).

For newbuilding vessels, the sulfur cap could be a major driver for alternative fuels, and DNV GL's Gerd Würsig, Business Director Alternative fuelled ships at DNV GL – Maritime, believed that LNG is the prime contender among them: "LNG has already overcome the barriers related to international legislation and is available in sufficient quantities today to meet the requirements of the shipping industry for many years. It also fits within the trend of demands to lower emissions of CO₂, NO_x and particulate matter. At the end of the day however, the best concept for a given application needs to be determined by the shipowner on a case-by-case basis," he said.

Elsewhere, after 18 months of research and development, the Society for Gas as a Marine Fuel (SGMF) released two new publications that will further enhance the excellent safety record regarding the use of LNG as a marine fuel.

SHIP OPERATIONS

One of the new publications looked at undertaking typical ship operations in port whilst transferring fuel at the same time (SIMOPS). Given that it is imperative that safety is not compromised when using LNG, it is also important that other operations can be undertaken thus allowing efficient and in some cases, improved efficiencies in port.

This publication looks at the issues



In May, Hamburg-based Nauticor and Madrid-based Gas Natural Fenosa (Naturgy) co-operated to bunker the recently built chemical tanker 'Fure Vinga' in Cartagena, Spain.

involved and describes clearly the process of how the risks can be managed.

The other publication details an investigation into how to effectively determine the location and size of so-called controlled zones around the bunkering equipment itself.

For both, the Society has also published industry guidelines. For safety distances, it has further developed 'Bunkering Area Safety information LNG', or BASiL modelling tool. The intention is for the industry to have access to a definitive benchmarking tool for evaluating safety distances with regard to gas-fuelled bunkering.

In this way operators and port authorities can now evaluate operations using a common methodology that is cutting edge. Results are then available that can be used in a comparative manner.

It is hoped that this will facilitate common operations and practice for operators that are always safe, SGMF said.

The society is a non-government organisation, which exists to promote safety and industry best practice in the use of gas as a marine fuel. It is committed to ensuring the global shipping industry can make confident decisions about the safe transfer, storage and operation of ships with LNG.

A transition away from traditional heavy fuel oils to LNG will virtually eliminate particulate and sulfur emissions, vastly reduce nitrous oxides, and most importantly reduce carbon dioxide emissions by around 17%.

Also championing the use of LNG as a fuel is SEA\LNG, the multi-sector industry coalition.

It recently reiterated how continuing investment in LNG as a marine fuel is to meeting both air quality and greenhouse gas (GHG) emissions targets. In an effort to ensure that industry and governments make a pragmatic and balanced analysis of the future of maritime fuels, SEA\LNG issued the following statement:

'Assessing the case for LNG must include the full benefits from both an air quality and GHG perspective. Assessing it purely from a GHG point of view is not responsible – we must consider the significant public health benefits LNG can and is delivering now through significant local emissions reductions in markets where it is being utilised.

'The maritime industry has been working for decades to help ease the air quality issues around the globe. This serious health hazard still persists and must continue to be addressed. LNG is ready now as an unrivalled solution to these critical air quality issues. LNG far outperforms conventional marine fuels in terms of dramatically reducing local emissions to improve air quality and human health. LNG emits zero sulphur oxides (SOx) and virtually zero particulate matter (PM). Compared to existing heavy marine fuel oils, LNG emits 90% less nitrogen oxides (NOx) emissions.

'As regards GHG in the maritime sector,

realistic reductions of up to 20% are achievable now with LNG. As technology continues to develop, these reductions will increase. Furthermore, LNG, in combination with efficiency measures being developed for new ships in response to the IMO's Energy Efficiency Design Index (EEDI), will provide a way of meeting the IMO's de-carbonisation target of a 40% decrease by 2030 for international shipping.

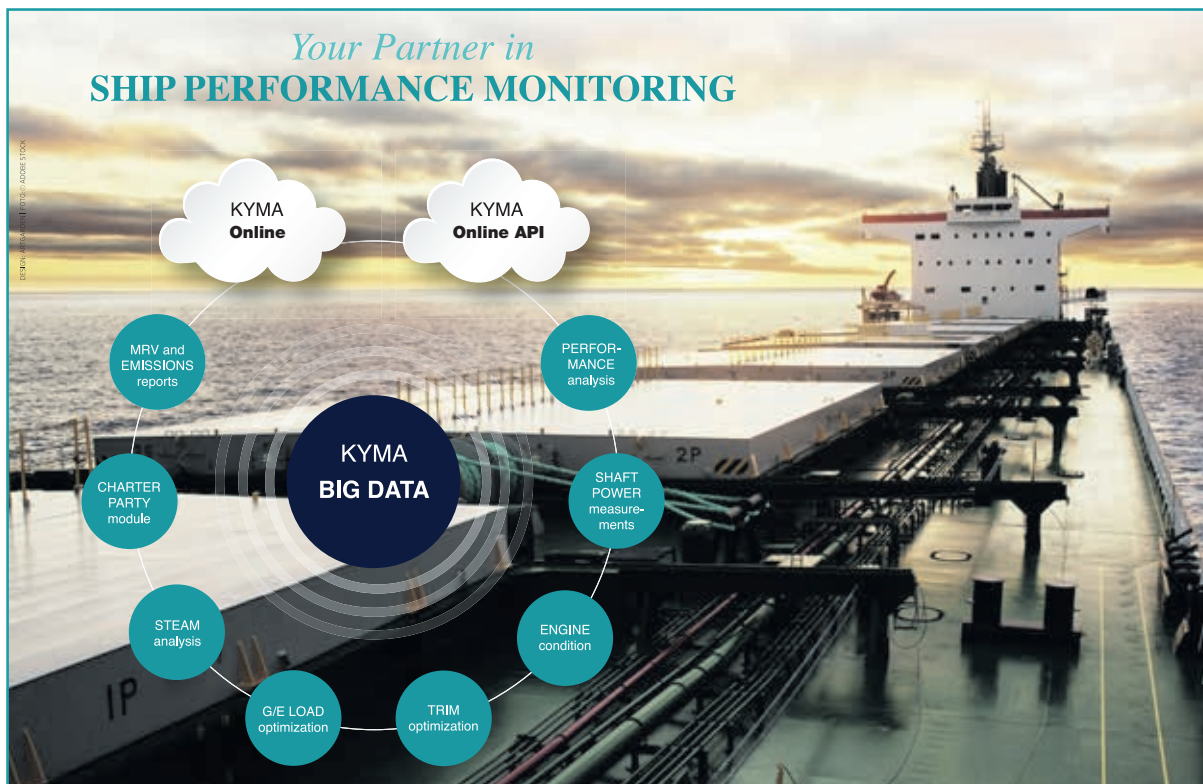
'Current technologies are well ahead of where we were just a short time ago and there are clear technology pathways, which will allow further emissions savings to be realised, for example advancements in dual fuel technology and propulsion, enhanced control systems, and future use of gas turbine technologies.

'Today, LNG is the only scalable and economic alternative fuel available for the vast majority of deepsea ocean shipping. Alternative fuels, such as hydrogen and ammonia are not economic, not available at scale, and unproven for shipping operations. They are called future fuels for a reason!

'Electrification, batteries and hybrid solutions on the other hand may be viable for certain specific short sea, harbour or ferry type operations but this represents an almost infinitesimal portion of the world's vessel fuel consumption.

'These future fuels will require huge investments by industry and governments over decades to realise their potential. SEA\LNG encourages and supports industry and

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The diagram illustrates the KYMA BIG DATA ecosystem. At the center is a dark blue circle labeled 'KYMA BIG DATA'. Surrounding it are several teal circles connected by a circular path, representing different data modules: 'MRV and EMISSIONS reports', 'CHARTER PARTY module', 'STEAM analysis', 'G/E LOAD optimization', 'TRIM optimization', 'ENGINE condition', 'SHAFT POWER measurements', and 'PERFORMANCE analysis'. Above the central circle are two white cloud shapes labeled 'KYMA Online' and 'KYMA Online API'.



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One of many bunker barge designs appearing on the drawing board

government initiatives which would assist with the development of future technologies.

'LNG offers a commercially viable long-term bridging solution to a zero-emissions shipping industry. BioLNG (from biogas sources, such as landfills and waste generators which is renewable and CO₂ neutral) can and is already being used as a 'drop-in' fuel, significantly reducing GHG emissions. While longer-term, 'power-to-gas' is a key technology with the potential to produce large volumes of renewable LNG.

'LNG-fuelled vessels and bunkering infrastructure can easily blend in bioLNG or zero- emission fuels. Today's investments will not become stranded and offer further potential to progress towards a zero- emission solution for shipping.

'It should also be noted that the infrastructure for LNG supply is already there; the focus is on investments in the 'last mile' – getting the LNG from the bulk LNG terminals to the ship.

'LNG is the only creditable alternative to meet national and international regulatory targets. It solves the sulfur and particulate matter emissions issues and dramatically reduces nitrous oxides. LNG also enables the shipping industry to take a major step forward to reduce GHG emissions. It is readily available at scale now and offers a proven, affordable, and competitive solution for the maritime sector while retaining tremendous flexibility for the future.

'SEA\LNG, in conjunction with SGMF, is continuing to develop studies and tools for the industry to better understand the true benefits of LNG from both an air quality and GHG

mitigation perspective. The coalition continues to encourage meaningful debate using current and academically supported data and analysis.'

BUNKERING VESSELS INCREASE

The number of LNG bunkering vessels grew from one at the beginning of 2017 to six in early 2018. This number is expected at least to double by 2020. Furthermore, in the next five years, 30 LNG bunker vessels could be operating worldwide.

"The bulk LNG infrastructure is largely built, what remains is the last mile, in which the industry is showing a growing appetite to invest," Peter Keller, SEA\LNG Chairman and executive vice president of TOTE, said.

"To effectively incentivise the developments needed to realise a competitive global LNG value chain for cleaner maritime shipping by 2020, we need to make the credible, fact-based case for LNG as a marine fuel to the shipping industry – which includes investors, bankers, shipping lines, bunkering

companies, ports, and other enabling stakeholders such as shippers, governments, regulators, and local communities.

"Second, we need to develop content and data that decision makers can use as they evaluate future fuel alternatives and make decisions. The industry continues to require credible, fact-based material, backed-up by academic research as necessary, on the emissions, investment and infrastructure case for LNG," Keller added.

The association said that it believed that once a fact base is available in a clear and credible manner for the global shipping industry, LNG will move from the 'chicken and egg' to the implementation phase.

More companies have joined the coalition this year.

These include Exeno Yamamizu Corp (Yamamizu) & Fearnleys AS who became the first shipbroking companies to join.

The coalition's membership stands at around 35 organisations with the addition of the two shipbroking firms.

Japanese-based shipbroking company, Exeno Yamamizu has a long history in shipping, including drybulk chartering of all ship sizes and all cargo types. Since April, 2017, its energy department has been responsible for managing LNG-related chartering services for several clients, such as utilities, gas companies, trading houses, shipowners and operators, among others.

In addition, the energy department is responsible for monitoring the growing demand of LNG as a marine fuel, and for facilitating business development in this emerging market by co-ordinating information about LNG bunker supply vessels, barges, and loading facilities in Japan and abroad.

Hisaaki Masuda, president, Exeno Yamamizu, said: "Exeno Yamamizu Corp has a great wealth and breadth of expertise in relation to LNG, as well as the wider marine



HMD ballast free bunkering vessel design

industry. We look forward to working collaboratively with our fellow SEA\LNG members to support the growth and development of LNG as a marine fuel as the preferred fuel choice of the future.”

Fearnleys’ involvement in LNG began in the late 1960s. Today, the company has a team of 15 personnel focussed exclusively on LNG, with offices in Japan, South Korea, China, Singapore, Oslo, Houston, and London.

Kristian Sorensen, CEO – global head of shipbroking at Fearnleys, said: “We are very pleased to join the SEA\LNG coalition and to collaborate with its membership to meet the challenges of the future marine fuel environment. We look forward to lending our knowledge and expertise as we continue to work together to achieve the common goal of making LNG the fuel of choice for the shipping industry.”

MAN JOINS

Earlier SEA\LNG had welcomed MAN Energy Solutions (MES) to its membership coalition.

As a major provider of large-bore diesel and gas engines and turbo-machinery, MES’ technical expertise will augment those of

existing SEA\LNG member OEMs - Wärtsilä and GTT.

MES’ increased focus in the field of converting existing vessels to operate using LNG fuel is illustrated by its pivotal role in the world’s first conversion of a containership’s propulsion system from heavy fuel oil (HFO) to LNG.

The dual-fuel conversion saw the 1,036 TEU feeder containership ‘Wes Amelie’ retrofitted in August, 2017 to a multi-fuel, 4-stroke unit that enables dual-fuel operation.

In October 2017, MES pledged a €2 mill discount to convert 10 HFO engines into gas engines, as part of its drive to find clean solutions for seaborne trade and transportation.

Dr Uwe Lauber, CEO, MES, said: “SEA\LNG’s vision is well aligned with MES’ strategy. In 2016, after COP 21, we launched the initiative ‘Maritime Energy Transition’ that encapsulates MES’ call to action to reduce emissions and establish natural gas as the preferred fuel of choice in global shipping. SEA\LNG aims to address and overcome current challenges impacting the global uptake of LNG, and MES is delighted to join forces with other industry leaders to support this work.”

More recently, SEA\LNG registered its

strong support for the CMA CGM, Dunkerque LNG, MOL (Mitsui OSK Lines) and Total Green Loop project.

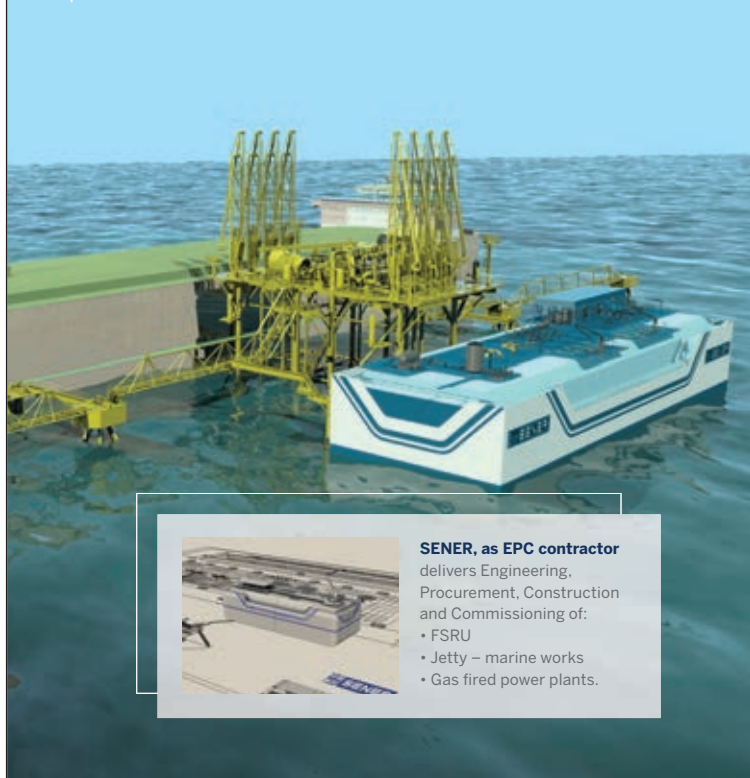
The investments in new innovative technologies by CMA CGM, Total and their partners Dunkerque LNG and MOL, will significantly advance the development of LNG as a marine fuel and enable the industry to maximise the environmental benefits it can bring, the coalition said.

The large-scale LNG bunkering infrastructure developed for the Green Loop project will not only serve CMA CGM’s shipping business but will also underpin further investments by shipping operators in Europe and internationally.

SEA\LNG said it offered support for the ground breaking, innovative efforts of CMA-CGM, TOTAL and their project partners applying for funding under the current (2017) European CEF-T Blending Call and the realisation of the project as a European lighthouse project.

“We believe this initiative will become a catalyst for further investments in this environmentally friendly marine fuel to the benefit of European and global communities,” the coalition said. ■

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Breaking the status quo in LNG transfer

Things have continued to heat up illustrated by the announcement from the South Korean government that it is to establish advanced LNG bunkering facilities at two of its main ports - Busan and Ulsan.*

South Korea's commitment to investing in LNG projects reflects a global shift towards natural gas as a marine fuel. Indeed, it's expected that by 2020, nine of the world's top 10 oil bunkering ports will offer LNG bunkering.

By 2025, every continent except Antarctica is predicted to have at least one large LNG bunkering hub. Any doubts regarding LNG as a potential mainstream shipping fuel now seem to be firmly quashed.

Precipitating the global expansion of LNG bunkering services is the growing orderbook of LNG-fuelled vessels. With shipping's

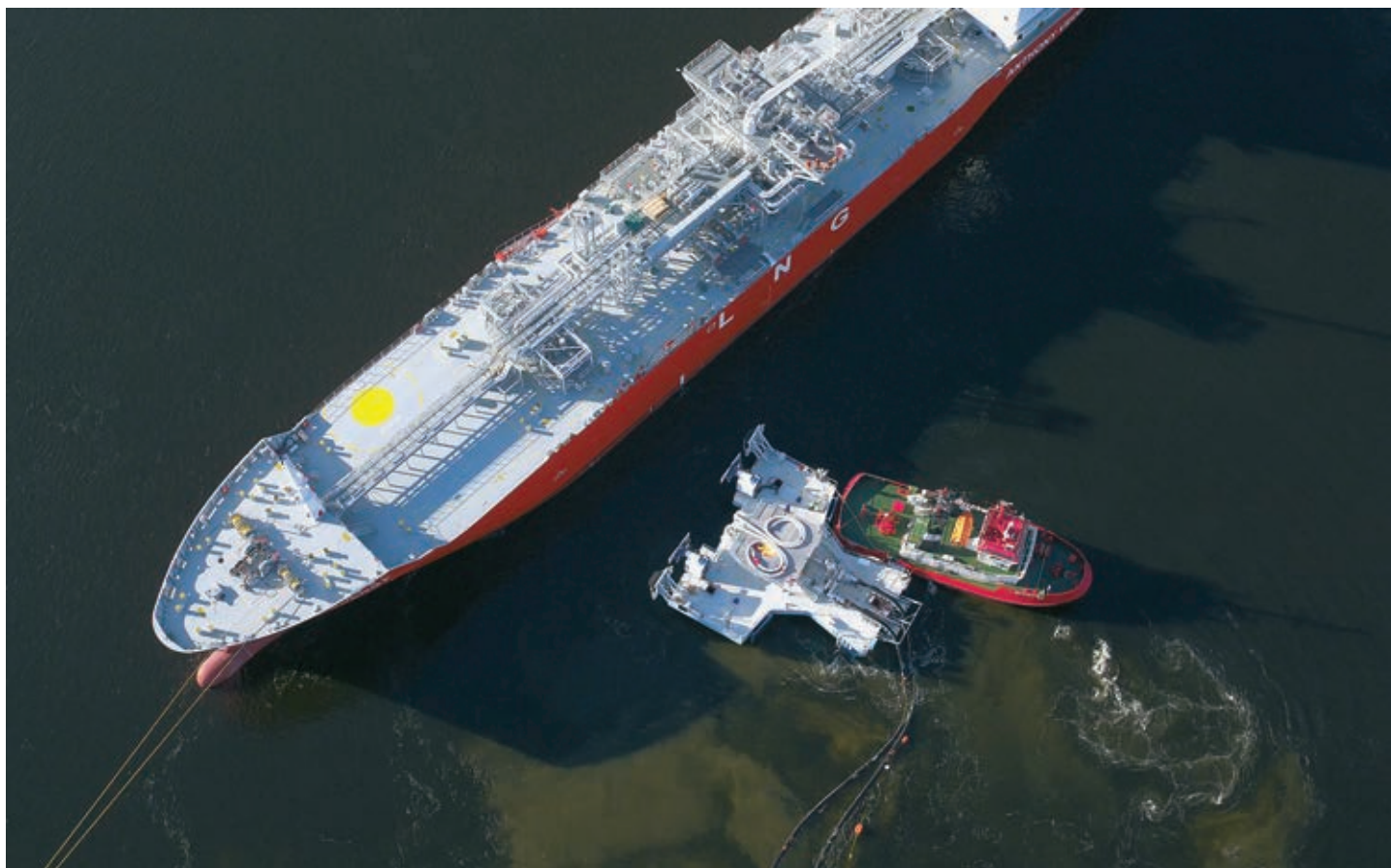
environmental credentials under increased scrutiny, shipowners continue to bet big on natural gas.

At the front of the pack is CMA CGM: last year the French shipping giant ordered nine ultra-large LNG-fuelled containerships, setting in motion a wave of new orders across the industry. As of January, 2018, there were 125 vessels on order – a number that will more than double the number currently in operation.

While the hunger for LNG is present, and gas itself is readily available, the cost and time involved in developing new infrastructure risks is reducing the feasibility of bunkering projects.

Some industry professionals now fear that current bunkering projects will not be capable of meeting growing demands, creating an infrastructure backlog that could have lasting effects across the industry, as it tries to adapt to meet the requirements of increasingly stringent regulations.

Another problem the sector faces is that existing infrastructure at the current hubs may not be suited to the range of vessel sizes represented in today's fleet. The diversifying LNG-fuelled fleet requires infrastructure that is more flexible, cost-effective at a smaller scale, and adapted to the needs of a range of locations.



The Universal Transfer System seen being pushed towards a small scale LNGC

“

Currently, most bunkering activity is centred around existing gas hubs. However, over on the small Norwegian peninsula of Herøya, a new type of LNG transfer is afoot, which could be the answer to the industry is looking for.

”

What the industry now needs is a solution that is both quick to install and flexible enough to be deployed anywhere in the world, even in the remotest and most environmentally challenging of locales.

Currently, most bunkering activity is centred around existing gas hubs. However, over on the small Norwegian peninsula of Herøya, a new type of LNG transfer is afoot, which could be the answer to the industry is looking for.

Last October, Trelleborg's oil and marine operation joined forces with Connect LNG and Natural Gas Fenosa to launch the world's first Universal Transfer System (UTS) – a floating platform designed to manoeuvre offshore to meet a vessel, rather than requiring it to moor at shore.

The lighter, more flexible infrastructure

uses Trelleborg's Cryoline floating hose technology.

The Cryoline LNG hose features a unique hose-in-hose design: the inner cryogenic hose, which consists of multiple polymeric film and woven fabric layers encapsulated between two stainless steel wire helices, provides resistance to internal pressure, while the outer hose provides protection from the environment. Fibre optic technology is incorporated into the hose to ensure real-time monitoring of the LNG transfer.

‘PLUG AND PLAY’

The UTS is a ‘plug and play’ solution, requiring no modifications for LNGCs. By allowing a greater level of flexibility, it addresses an infrastructure challenge that is becoming increasingly vital to the

evolution of the LNG market.

This solves the problem by bringing the infrastructure to the carrier, reducing the need for extra construction, while also enabling transfer in areas that would be otherwise unsuitable – for instance, too shallow for carriers, or too deep to construct a jetty.

It also allows transfer infrastructure to be relocated when out of use, or for maintenance, or brought into port to avoid damage from adverse weather, freeing up space and time in busy ports.

A short installation time adds to the success of the UTS. The initial project took only six months to set up, which is up to six times faster than a jetty, and up to 80% cheaper, compared to traditional fixed infrastructure.

The UTS shows that LNG infrastructure doesn't need to be bound by the same thinking that underpins transfer solutions for oil or coal. By thinking laterally, the industry has proven that it has the tools and the expertise to break the dam holding back the growth of LNG bunkering and allow it to reach its full potential. ■

**This article was written by Vincent Lagarrigue, Director, Trelleborg Oil and Marine.*

The whole LNG Market at your fingertips

- Increased market visibility through a quick “lowdown of the market” on Monday morning and detailed “bird’s eye” view of the past month
- Break-down and illustration of complex LNG trade relations backed by real data to increase feel for the market
- Access to pre-digested primary market data
- Consistent & systematic market perspectives
- Market and fleet overview in one convenient package

LNG Unlimited



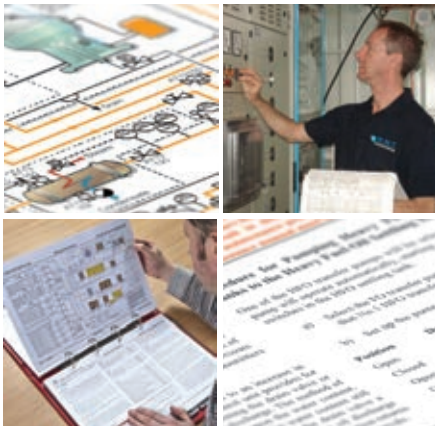
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Most of the world's LNG fleet rely on WMT Manuals

Image courtesy of LNG STS Solutions

Worldwide standard for:

- LNGC
- FSRU
- FLNG
- Bunkering



Project Technical Documentation and Training:

- Technical Documentation
- Operating Procedures
- Engineering Consultancy
- 3D Animations & Simulations
- Planned Maintenance
- Training, Familiarisation & Competency
- Cargo Operation Manuals
- Engine Room Operations
- Bridge & Deck Operations
- SOLAS & Fire Safety Manuals
- Ship to Ship Transfer
- Technical Translation

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Vacuum Insulated Pipelines for LNG bunkering

World's first LNG-Powered Hopper Dredger

Name: Minerva
Customer: DEME
Builder: Royal IHC
Subcontractor: Demaco Holland



Superior Insulation - Smallest Footprint - Durable - Double containment

Superior Insulation:

The Demaco Vacuum Insulated Pipeline (VIP) has the optimal design, blocking all three ways of heat transfer: Conduction, Convection and Radiation. This results in a 10 to 15 times better insulation value than any type of conventional insulation (e.g. Glassfoam, PIR etc.). Subsequently protecting the ship from the cryogenic temperatures of the LNG and ensuring the lowest Boil Off Gas (BOG).

Smallest Footprint:

Comparing VIP to any other type of conventional insulation, it has the smallest footprint and is in this regard the frontrunner. The Demaco VIP merely has a 2" wider jacket pipe than the process pipe and therefore, uses around 50% less space as the conventional insulated pipes. In fact it has approximately the same diameter as a ventilated pipeline.

Durable:

In the harsh maritime environment the VIP is like a duck to water. There is no risk of water inclusions deteriorating the insulation or Corrosion Under Insulation. The outstanding stainless steel construction will outlive the ship.

Double containment:

The Vacuum insulated pipeline is a pipe-in-pipe system providing double containment. This double containment ensures a safe transfer of the LNG on the vessel.

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