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THE LNG journal SHIPPING REVIEW 2019

An LNG Journal
publication

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Printed by: Rabarbar s.c.,
Polna 44,
41-710 Ruda Śląska,
Poland

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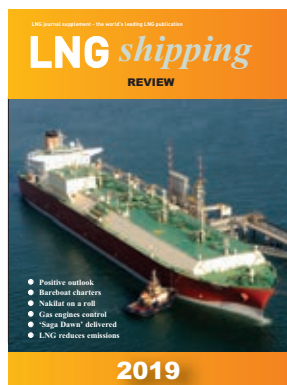
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FLNG prospects



Nakilat looks set to add several more LNGCs to its fleet in the near future and is touting both shipyards and owners for more tonnage.

'Mozah' was the first of the 260,000 cu m Q-Max series to be delivered and also gained the distinction of loading the 10,000th cargo at Ras Laffan in May, 2016. The cargo was discharged at Milford Haven in the UK.

Will we be overtaken by events?

It seems that good times have been reported as being around the corner for several years now and today appears to be no different.

The world's changing weather pattern has not helped bringing with it mild temperatures during the Northern Hemisphere winter, resulting in Asian imports dropping slightly.

Trade wars, geopolitical worries and other concerns have all led to caution before embarking on expensive projects, involving LNG. For example, should the Strait of Hormuz be closed for shipping, where will this leave Qatar?

Australia and the US would be the obvious beneficiaries of Qatari exports stopping altogether or slowing, as the former is much shorter in distance to the major Asian importers - China, Japan and South Korea.

US exporters are now benefiting from the expanded Panama Canal, again bringing them much closer to their Asian clients from the US terminals.

These moves will of course have a bearing on tonne/miles, reducing them considerably and even possibly reducing the need for as many LNGCs to serve these routes, unless there is a significant ramp up of imports.

It was noticeable that during the recent incidents involving tankers, which seemed to have involved Iran, Qatar was one of the first to send diplomats to Tehran in an effort to ease the situation.

And then we have the Trump affect. Nobody quite knows what this administration is going to do next. There was a rapid fall off seen in the volume of LNG going from the US to China to zero during the so called trade wars. Exports to China have recently started again albeit at a trickle.

Due to sanctions, pricing and other factors,

the Russians have been sending Yamal gas to European receiving terminals using Arc7s, most notably Zeebrugge, for transshipment. The Northern Sea Route (NSR) is being used more often to serve Asian terminals from Sabetta (Yamal) but it is restricted to Ice Class vessels even in the summer months and the costs of using this route can be prohibitive to all bar ships controlled by the Russians.

FIDS PENDING

There are a number of final investment decisions (FIDs) thought to be close to signing mainly in the US but also elsewhere. Several LNG producers have signed long term offtake deals with energy majors, trading houses and others, which has led in part to an increase in LNGC contracting, as the vessels recently ordered will not be delivered until the end of 2021 or 2022 when some of the forecast export capacity should come on stream.

The increase in the number of FSRUs seen during the past few years has tailed off to a certain extent mainly due to national import projects taking longer to get off the ground than previously thought. It is noticeable that little or no speculative FSRU newbuildings are being ordered today.

Apart from Shell's 'Prelude', a Golar conversion and two MISC units, the only interest in this sector has been in barge type units, such as Exmar's 'Tango' now operating in Bahia Blanca, Argentina. There are a few projects on the drawing board but the cost could be the deciding factor in whether they get the go ahead (see page 36).

There is interest in small scale LNGCs, some of which can double up as bunker

barges, which brings us neatly on to the the bunker market.

The take up of LNG as a fuel has not been as large as early forecasters suggested. However, we have seen an expansion of LNG bunker facilities mainly in Europe and the Baltic, plus Singapore and more are in the pipeline.

Several bunker barges are now available chartered for specific bunkering projects or owners/operators of LNG fuelled vessels, such as Shell with AIDA Cruises.

Despite being only a few months to go before IMO2020 kicks in, the jury still seems to be out debating the merits of LNG, HSFO with scrubbers or IFO. Other forms of fuel, such as batteries, methane, hydrogen, etc are still in their infancy and probably won't be used in main stream shipping to that extent.

As for technology, for standard LNGCs, membrane systems are the choice of South Korean and Chinese shipbuilders, while the MOSS type and its derivatives are still the choice of Japanese builders.

Boil-off gas is still one of the panacea's of efficiency, coupled with dual fuel main propulsion machinery. Here WinGD with its X-DF series engines appears to be in the lead for newbuilding contracts over MAN Energy's ME-GI and other propulsion units.

The average LNGC size now favoured by owners is 170,000 cu m to 180,000 cu m. These are able to pass through the expanded Panama Canal, although we have seen a Q-Flex transit through the new locks this year.

There is still some speculative ordering today, most notably by Greek interests, who are rising up the ownership ladder, probably due to the growth in medium term period charter business, as against the spot market.

Never has the shipping market in general and the LNG market in particular been more unpredictable.

This in itself makes analysis a test but roll on next year when we will mark ourselves out of 10 for this review. ■

“US exporters are now benefiting from the expanded Panama Canal, again bringing them much closer to their Asian clients from the US terminals.”

Geopolitical events apart - the outlook is set fair

However, at the time of writing, Qatar seemed nervous about the increasing tensions in the Middle East Gulf leading to the possibility of the Strait of Hormuz being closed cutting off the country's huge export trades.

Assuming everyone calms down and trade is not disrupted to any extent anywhere in the world, the signs all point to an increase in interest in investing in LNG as an environmentally friendly power and energy source.

For example, in July, Clarksons published its annual review - 'LNG Trades and Transport'.

In essence, it said that LNG trade was set to grow by 8% this year; Australia is forecast to become the largest LNG exporter in 2020 and LNGC fleet is projected to out number VLCCs by 2026.

Steve Gordon, Clarksons Research managing director, commented, "Global trade in LNG continues its strong growth phase, with an expected 8.4% growth in 2019 and 7.4% in 2020 (11.5% and 12.3% by tonne/miles).

"Recent export growth has been dominated

It would appear, that the LNG pundits are still somewhat bullish on the future of LNG transportation worldwide.

by Australia and the US, while China has driven import growth (60% of import growth in 2018). With 93 mill tonnes per annum of export capacity under construction, and a further 313 mill tonnes per annum of capacity at FEED, growth potential remains strong.

"This trade expansion, combined with high day rates for vessels trading on the short term market over the past 12 months, has supported newbuilding orders totalling \$17 bill since the start of 2018 and helped build a total newbuilding orderbook of 25% of the fleet (\$24.5 bill).

"Our longer term modelling now suggests that the LNG fleet will out number the VLCC fleet by 2026. We also see growing interest in small scale LNG, FSRU, FLNG and, increasingly, LNG as a marine fuel."

Other highlights included:

- Strong LNG growth phase continues, with

volumes projected to expand by 8.4% in 2019 and 7.4% in 2020 (11.5% and 12.3% by tonne/miles) and reach 370 mill tonnes through 2020.

- Global gas consumption grew by 4.7% year-on-year in 2018, with the role of LNG expanding to 11% of total demand and 35% of total trade (2000 = 6% and 26% by comparison).
- There was a continued diversification of LNG trades, with 317 bilateral trading routes in 2018 (2008 = 98).
- Recent export growth was dominated by Australia (2018: 44% of export growth) and the US (33%). Australia was predicted to overtake Qatar as the world's largest LNG exporter in 2020.
- Chinese imports increased by 38% in 2018 to reach 54 mill tonnes, accounting for 60% of global expansion. Clarksons soon to be released 'China LNG in 2030' suggests imports could reach 186 mill tonnes by the end of next decade.
- The researcher's projects database showed 93 mill tonnes per annum of export capacity under construction, and a further 313 mill tonnes at the FEED stage.
- LNG carrier fleet capacity grew by 11% during 2018 (As of June, 2019 the fleet totalled 570 vessels/85 mill cu m capacity) and Clarksons forecast growth of 5.6% and 6.9% in 2019/2020.
- A record 77 LNGCs (68 > 40,000 cu m) worth \$12.7 bill were ordered in 2018, almost 90% of which were contracted at South Korean yards.
- By June 2019, the LNGC orderbook had reached 141 ships of 21.1 mill cu m and \$24.5 bill, equivalent to 25% of fleet capacity, with 40% of the capacity ordered by Greek interests.
- Strong gains in charter rates across 2018 impacting the ~20% of the fleet on the spot market, with spot rates for a 160,000 cu m DFDE vessel averaging \$88,692 per day, up 93% year-on-year
- There was a slight softening in rates in the first half of this year, although supply/demand fundamentals in 2019-20 look supportive.
- FSRUs are playing a growing role,



Qatargas 'Al Dafna' recently became the first Q-MAX to call at Zeebrugge. She was carrying out a two port discharge and also called at Mifflord Haven.

accounting for 12% of current regasification capacity and 24% of export capacity under construction (see page 13). There was also some recent positive developments in the FLNG sector, with encouraging longer-term potential, as well as further expansion and potential in the small-scale LNG sector (see page 29).

LNG supply reached 320 mill tonnes last year, an increase of about 28 mill tonnes on 2017.

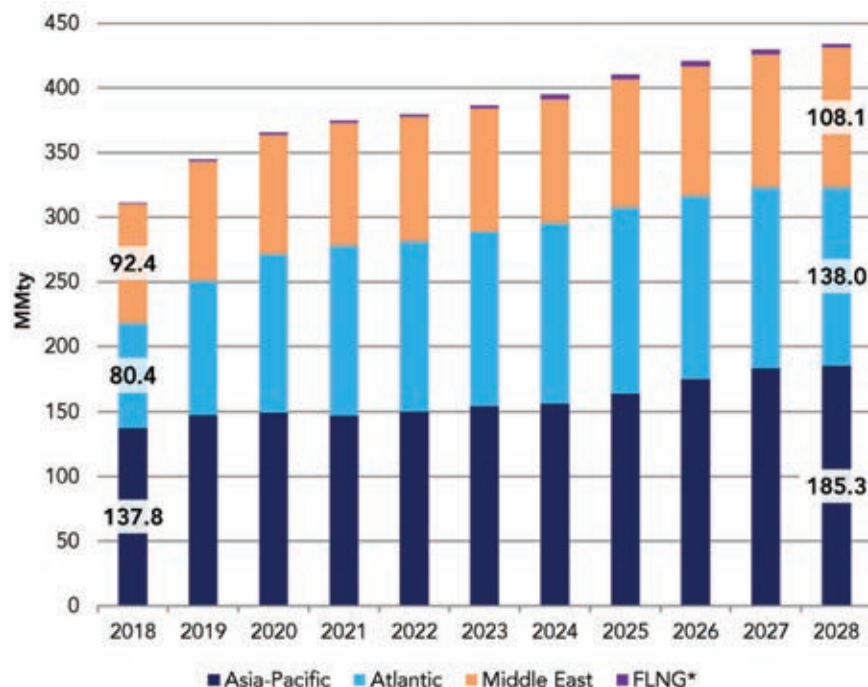
This rise was mainly driven by Australia - up 12 mill tonnes - and by the US, which showed an 8 mill tonne increase, according to Barry Rogliano Salles' (BRS) annual review.

Qatar was the largest producer at 77 mill tonnes, closely followed by Australia at 69 mill tonnes last year. As for the US, its production is expected to reach 45 mill tonnes this year from 21 mill tonnes in 2018, while Yamal LNG ramped up its capacity to 7-8 mill tonnes in 2018.

China again led the way in imports, taking 54.8 mill tonnes last year, up by 16 mill tonnes on the 2017 figure. This vast country is expected to import around 80 mill tonnes by 2030.

LONG TERM OPTIMISM

Long term, the analysts are reasonably bullish going forward as several final investment decisions (FIDS) are due to be taken this year, especially in the US. LNG demand is



*Excludes FLNG Unit 1 and 2 from Malaysia, Prelude FLNG and Coral FLNG

Source: Poten & Partners' Global LNG Outlook

Global Supply Growth

expected to grow by 4% per year through 2025, which should have a positive impact on newbuilding activity.

As for the charter market, rates fluctuated throughout the year, starting 2018 with numerous multi-month charters on the back of

high Asian prices. As a result, spot rates rose to around \$80,000 per day in January and most of February.

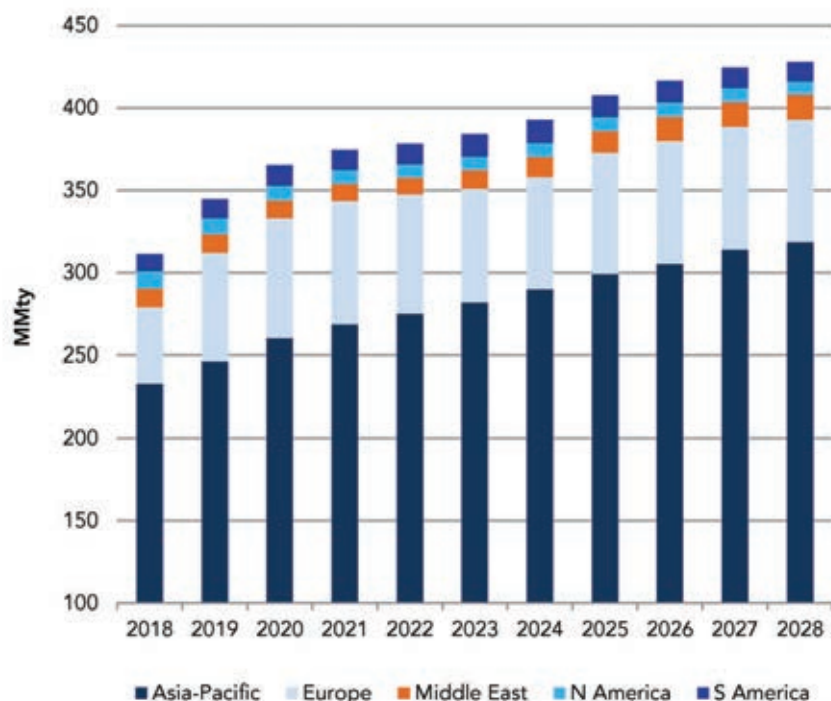
In March, arbitrage opportunities reduced between the two regions and ships were redelivered off charter. During the second quarter of the year, arbitrage was virtually non-existent and a number of LNGCs came open on the spot market and as a result, rates dropped to below \$30,000 per day for 160,000 cu m TDFE types.

However, Asian prices rebounded in May and remained firm until the end of June, while in the Atlantic, increasing spread between Northern European and Asian gas prices led to several reload cargoes being booked creating greater tonnage demand.

By the end of May, spot timecharter rates had hit \$50,000 per day in the Atlantic and \$40,000 per day East of Suez. By Mid-June there was a strong demand for tonnage with Atlantic rates rising to \$85,000 per day and Pacific levels hitting \$70,000 per day.

These higher rate levels led to charterers fixing multi-month period contracts to cover the winter period. For example, 12 month charters were being fixed at \$80,000 per day. By late June, period rates had fallen back to around \$70,000 and \$60,000 for Atlantic and Pacific business, respectively.

Spot charter rates increased again in September firming rapidly in October, as



Source: Poten & Partners' Global LNG Outlook

Global Demand Growth



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vessels left the spot market in favour of period charters to cover the Northern Hemisphere winter period. By early October, Pacific rate levels had reached \$100,000.

A milder than expected Asian winter and better planning by the shippers/receivers resulted in a less than anticipated demand and as a result over 20 loaded LNGCs were idle waiting to discharge their Asian cargoes. However, this had the effect of keeping them out of the spot market for a longer period.

The scarcity of ships sent rates soaring to \$185,000 per day by the end of October through November. In December, Asian prices were flat but European levels were rising but arbitrage opportunities did not materialise leaving charterers long on multi-month deals. As a result, spot rates started to soften, ending 2018 at around \$110,000 per day.

On the newbuilding front, there was a growing acceptance among owners and banks that shorter charters were being negotiated - around seven years with options. This marked a turning point in the thinking behind seaborne LNG transportation.

By the end of last year, there were 495 LNGCs of over 100,000 cu m in service, excluding FSRUs, FSUs and FLNGs.

Last year also saw a wave of new shipowners entering this market. For example, Capital Gas, Minerva Marine, Celsius Tankers and Navigare Capital, all ordered tonnage. As for the builders, Daewoo (DSME) offered standard LNGCs fitted with GTT's NO96 containment system and powered by MEGI type engines, while Hyundai and Samsung opted for Mark III containment systems with vessels driven by WinGD X-DF propulsion units.

In a recent presentation, Poten & Partners said that the contracts market was changing and a number were due to expire soon.

Next year, rapid growth on the supply side is forecast before flattening out by 2022. However, from 2024, due to the number of FIDs, which should have spawned exports facilities by then, the supply side will grow again.

On the demand side, the market will become more balanced by the end of 2021, remaining balanced through 2022-2023 until the new FIDs kick in around 2024.

Around 133 mill tonnes per year of gas exports have already been sanctioned with 33 mill tonnes per year the subject of FIDs this year and next, Poten said.

China's growth pattern is expected to remain strong but more pipeline gas is forecast and an increased use of renewables will give greater options in the energy mix. There are around 45 power projects known but some of these might be slow to get off the ground.

UNCERTAIN DEMAND

The demand picture was more uncertain. By the second quarter of this year, Europe was importing significant volumes of LNG and Southeast and South Asia were predicted to be big growth areas.

As mentioned, the contracts are becoming more complex with traders and aggregators becoming more involved. The world's stock markets could also be a cause for concern going forward but other opportunities could be created.

Some 190 mill tonnes per year of contracted gas is due to expire in 2030, which maybe replaced by shorter contracts. By 2028, up to 70% of LNG could be contracted on flexible terms. In 2017, the average contracts were concluded for less than seven years, however, the situation changed last year with the length increasing to around 13 years.

There is also a question mark over whether finance will be available

for deals other than long term contracts. Poten admitted that it was very hard to forecast whether this level will be sustained. New long term contracts were seen signed for 10-15 years and it was thought that banks could live with a 15-year contract. Delivery ex-ship is the preferred transport method with these contracts, although some Mozambique deals are being offered FOB (free on board).

Overall, the oversupply will not easily be resolved, as tweaks here and there will make little difference, Poten said.

Supply surplus was forecast to be 1.7 mill tonnes for the second and third quarters of this year. Prices are expected to remain low with Europe soaking up much of the surplus, as Asia experienced a mild winter.

For example, after importing a record level of LNG in December and January, China received only 4.1 mill tonnes in February - a drop of 31% on January's total. Reports have indicated that China's storage capacity is full, so imports are expected to decline for much of this year. However, Chinese demand is still forecast to increase by 21% during the period.

In 2Q19, the surplus was expected to peak in the shoulder months between March and

May and August and October with a slight drop during the summer months, due to demand increases for power, especially from the Middle East.

By 2021, the overall surplus is forecast to be substantially lower than in 2019 and 2020. By the winter of 2021, there could even be a slight deficit, depending on how base demand grows.

Poten said that it expected most of the overhang to be absorbed by Europe. If this region took the entire projected surplus, then overall LNG imports would increase by 38% during the season when demand is usually very low.

Traditionally, Asian demand has not been driven by lower prices. However, the rise of China as a major demand centre and the emergence of new importers in the region may throw up a few surprises, Poten said.

CHINA'S CHANGING PATTERNS

Looking at China in particular, last year, the country's LNG imports soared 40.4% year-on-year to a record 53.8 mill tonnes, according to figures from the Chinese General Administration of Customs.

China retained its position as the world's

second LNG largest importer after Japan, having overtaken South Korea the year before, according to a report from Italian broker and researcher, Banchero Costa.

This year, imports slowed slightly but growth remained impressive, with imports in the first five months of 2019 up 20.4% year-on-year to 23.9 mill tonnes.

The 2018 hike was driven by a major government push for households to shift from coal to gas for heating.

This year however, the focus of the domestic anti-pollution campaign has changed to clean coal rather than coal-to-gas switching, according to local analysts.

In addition, temperatures this winter have been higher than usual, and there have also been some backlogs at receiving terminals. Still, China is on track to overtake Japan this year as the world's top LNG importer, Banchero Costa said.

The market is very much dominated by Asia, which accounts for 75% of global LNG imports. For example, three countries - China, Japan and South Korea - account for 55% of global LNG imports.

In terms of supply, the big winner at the moment is Australia. In the first five months



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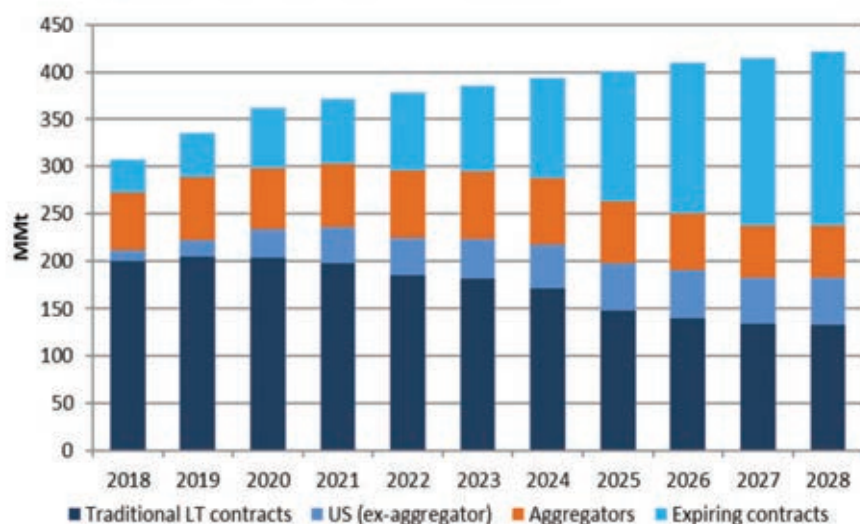
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Evolution of LNG market structure



Source: Poten & Partners' Global LNG Outlook

of this year, Australia accounted for 52% of China's total LNG imports.

This is a significant increase from the 45% share Australia had during the same period last year, thanks to a 37% jump in volumes between the two countries on a year-on-year basis.

Australia is benefiting from a number of new liquefaction projects that are being commissioned. With more projects coming onstream, such as Shell's 'Prelude', Australia is on track to soon overtake Qatar as the largest LNG exporter.

Qatar, on the other hand, saw its share of the Chinese market shrink to just 16% in the first five months of 2019, from 20% in the same period last year.

In terms of absolute volumes, there was a 5% decline year-on-year. The trade war clearly had an impact on US exports, as volumes of LNG from the US to China fell by 86% year-on-year, Banchero Costa said. To June this year, the US had just a 1% share of the Chinese LNG market.

Aside from Australia, another producer, which benefited from this trade realignment is Papua New Guinea, which almost doubled both its volumes and its market share in China from 3% to 6%.

Other countries increasing both volumes to China and their share of the Chinese market were Malaysia—from 10% to 12%—and Indonesia—from 5% to 6%, Banchero Costa concluded.

TRADE DEAL

However, increased US LNG exports to China will be one of the headlines when a final trade deal with China is reached, Tortoise Advisors

said in a July podcast.

Why? China needs to reduce carbon emissions and the best way to do that is to reduce its coal consumption that currently represents 58% of China's energy supply.

In addition, China has set a goal to increase its natural gas mix that currently represents 7% of energy supply to 10% of Chinese energy mix by 2020 and 15% by 2030.

What does mean in terms of new natural gas supply? Over the next 12 years, China potentially needs to source 60.2 bill cu ft per day of natural gas. To put this into perspective, today US natural gas shale fields produce a little over 65 bill cu ft per day.

The figures are so large because China's

population is over four times the size of the US yet China's natural gas consumption today is less than one-half of that of the US. So, where will China get its natural gas from? Domestic production within China from conventional sources will grow slightly.

A common question Tortoise is asked is what is the potential for shale gas in China? Shale gas production is focused on the Sichuan Basin located in southwest China. This basin is 89,000 sq miles, compared to the US Marcellus Basin that is 104,000 sq miles.

The early returns on shale gas drilling were not good and as a result, major energy companies, such as BP, Royal Dutch Shell, Exxon and ConocoPhillips have stopped exploring for shale gas in China, due to high costs and low returns.

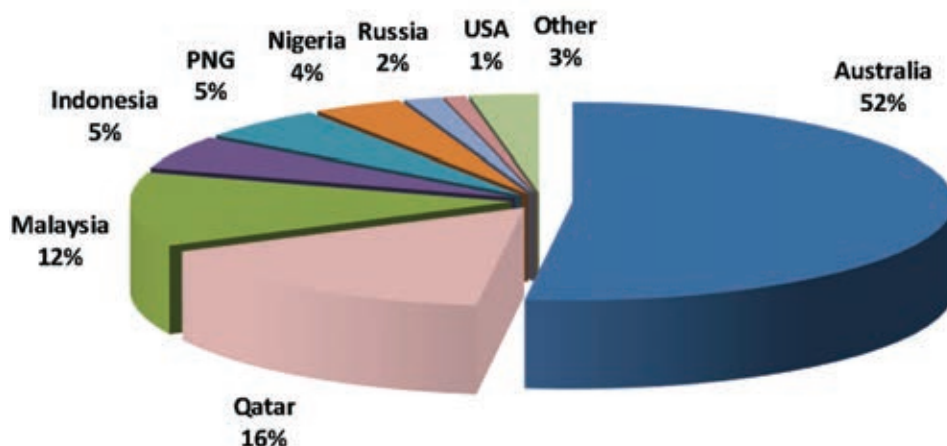
This is why we think US LNG exports of LNG to China will be a significant component of the trade deal, Tortoise said. It is not thought that China will be able to meet its natural gas demand with domestic sources alone. The analysts forecast that Chinese LNG demand will be four times the current levels by 2030.

China is preparing for more LNG imports as the Ministry of Transport plans to quadruple import capacity in the next two decades from 19 terminals receiving 8 bill cu ft per day to 34 terminals receiving up to 30 bill cu ft per day.

Meanwhile at the end of July, Fearnleys weekly average charter rates for 155,000-165,000 cu m TFDE LNGCs stood at \$54,000 East of Suez; \$57,000 West of Suez and \$84,000 per day for 12 month timecharters. ■

China - Sources of LNG Imports in Jan-May 2019

(source: customs data; in million tonnes)



Source: customs data / Banchero Costa

There is new energy in the heart of the Mediterranean

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More infrastructure needed

A recent report published by DNV GL has revealed that the vast majority (85%) of professionals working in the LNG sector believed that more investment was needed in LNG infrastructure to satisfy forecasts for growing global demand after 2025.

However, more than 69% said that uncertainty over prices was limiting spending on the mega-projects needed to feed the world's growing appetite for LNG.

DNV GL forecast that global LNG production will increase from 250 mill tonnes per year recorded in 2016 to around 630 mill tonnes per year by 2050.

According to DNV GL's report: 'The LNG era takes shape', oil-indexed LNG pricing is part of the issue.

Recent oil price swings have made LNG sellers reluctant to peg decades-long contracts to volatile crude markets, yet they still need long-term commitments to make infrastructure investments viable.

Half (49%) of the LNG professionals questioned by DNV GL expected contracted LNG prices to continue to be linked to the oil price, while a significant proportion (30%) disagreed.

Respondents expected the US (36%) and Australia (16%) to experience the greatest growth in LNG exports over the next three years.

Other nations, such as Canada, Russia, and Africa are also making moves for a slice of the cake. However, conventional gas from the

Middle East and North Africa, as well as North American unconventional gas, will account for 70% of LNG liquefaction capacity by mid-century, according to DNV GL's '2018 Energy Transition Outlook'.

As mentioned in other articles, China is expected to have the greatest growth in LNG imports over the next three years, according to the survey. This is largely driven by the country's 'blue sky' policies, aimed at reducing fossil fuel emissions and improving air quality. Other emerging economies, particularly in the Indian sub-continent and sub-Saharan Africa, will also drive demand towards 2050.

SIGNIFICANT INVESTMENT

The level of supply and demand growth predicted by DNV GL will require significant investment; particularly facilities to re-gasify, store and distribute new liquefaction capacity.

The cost of financing new infrastructure will have the greatest impact on the global LNG market in 2019, according to a third of respondents (36%). Political risks (including trade agreements) was the leading market barrier (17%).

"The new era we see emerging for the

LNG sector will demand new thinking from our industry to ensure that a rapid evolution in demand and supply can be met. For example, our research shows signs of the sector opening up to new players, contracting models and pricing strategies.

"As reservations over capital spending and uncertainty over LNG pricing persist, the study reveals increasing interest in the sector finding more agile and flexible approaches to LNG production and trading," said Hans Kristian Danielsen, Senior Vice President and Marketing & Sales Director, DNV GL – Oil & Gas.

Agile approaches to LNG production are most likely to come in the form of smaller-scale FLNG projects. Smaller FLNG vessels and LNGC conversions are preferred by 59% of LNG professionals over the development of large-scale floating production units.

These are cheaper to build and operate, faster to deploy and more effective at exploiting smaller volumes of stranded gas for more markets.

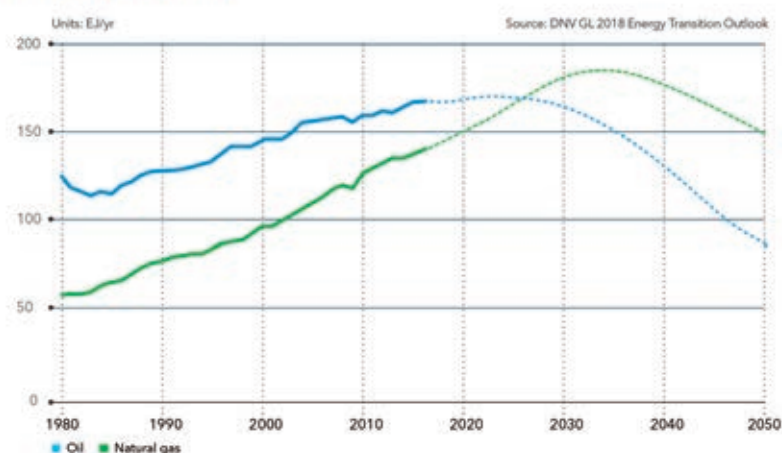
Contractor-led operating models are also becoming increasingly favourable for LNG production, according to the report's findings. In these instances, a contractor liquefies gas on behalf of an operator, who can reduce risk by purchasing a service instead of a costly asset.

More than half (55%) of senior oil and gas professionals globally believe it is likely that operators will outsource or lease critical field development assets, such as FLNGs, this year.

Agility will also be key to protecting LNG buyers against risk. Three quarters (72%) of LNG professionals believe that buyers need more flexible contracts, where LNG volumes can be reduced, tenures shortened, and delivery locations changed.

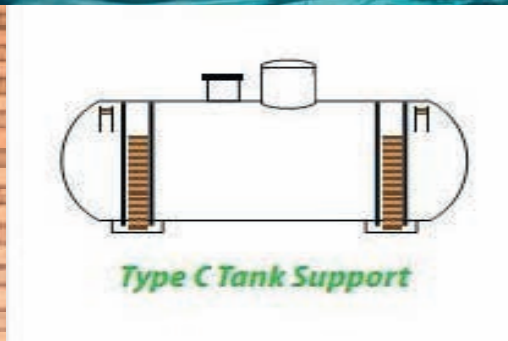
"New market actors could be key to bridging the divergent interests of LNG buyers wanting flexibility, and sellers, who demand long-term cash-flow certainty to support major investments. This was once the domain of oil majors, but commodity traders are now emerging as a significant new breed," Danielsen concluded. ■

Fossil energy use forecast



World gas demand has doubled since 1990. DNV GL's 2018 Energy Transition Outlook predicts that growth will continue for around 15 years, hitting a high in 2034 at a level 30% above that in 2017, before entering moderate decline as renewables account for an ever-increasing share of power generation.

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Despite a slowdown there are FSRU opportunities going forward

Although there has been a bit of a slowdown this year in FSRU uptake, mainly due to political and financial reasons, these units represent the most time and cost efficient way to import and tranship gas

As at 31st December last year, FSRUs were serving 22 import projects globally. In addition, over 10 more projects had signed up to an FSRU and were preparing to commence LNG imports over the next two years, according to research undertaken by Market Research Future ahead of IQPC's June Asia FSRU summit.

The global FSRU fleet consisted of 31 units as at the end of last year. Ten FSRUs, including one LNGC-to-FSRU conversion,

were under construction. Only one FSRU newbuilding was ordered in 2018, while one LNGC-to-FSRU conversion was sanctioned. Four of the FSRU newbuildings under construction appeared earlier this year to be uncommitted, although that has changed in recent weeks.

LNG imports via FSRUs fell by 6% in 2018 to 32.4 mill tonnes, as imports through recently installed FSRUs in Pakistan and Bangladesh were more than offset by declining FSRU-based imports in Egypt, the

UAE, Kuwait, Brazil and Argentina.

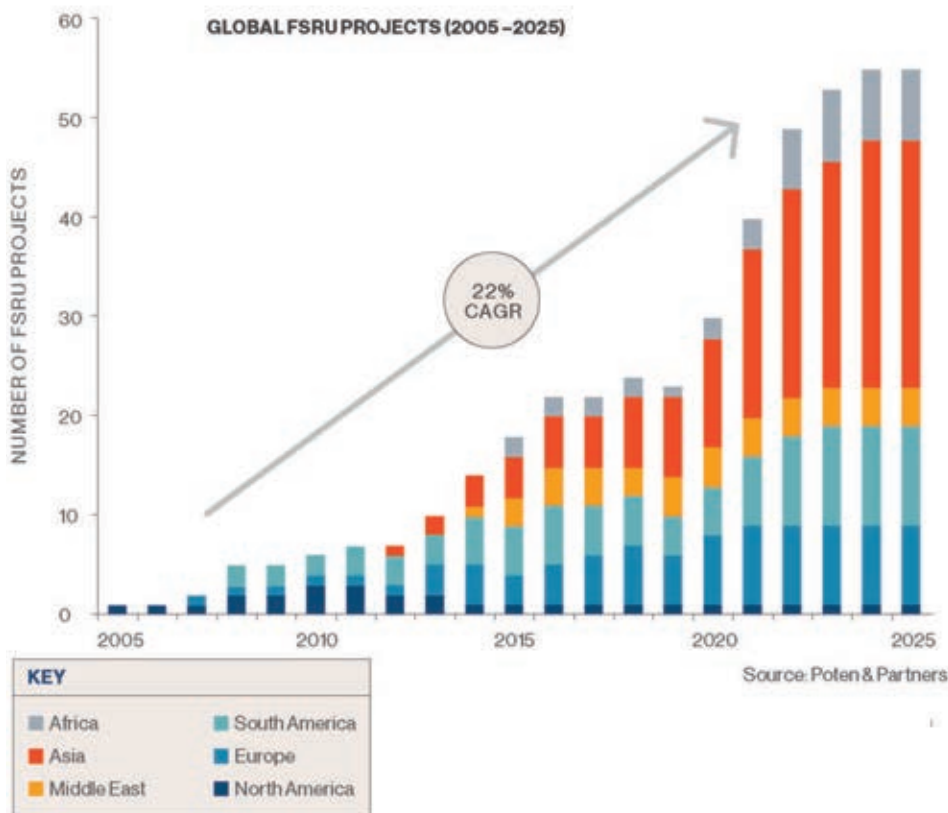
Three FSRUs previously operating in Brazil, Abu Dhabi and Egypt were released from their contracts last year. Six FSRU contracts were awarded in 2018, compared with only two short-term contracts in 2017.

In addition, a significant number of FSRU projects were still in the selection process adding to the market potential and employment opportunities for FSRUs.

In another IQPC report quoting Poten & Partners, there were 29 projects that had been



There are still opportunities on the horizon for more FSRUs. Photo credit- Excelerate Energy



Regional growth – FSRU projects in Asia, South America and Africa will drive future growth

developed across the world by the middle of this year.

Despite some being decommissioned, due to the changes in demand requirement, the prospects for FSRUs remained strong. “If you look at the drivers of FSRU demand going forward, our view is that the emerging markets will still drive the demand growth, especially in Asia, the Middle East, Africa and South America,” said Edi Saputra, LNG and Natural Gas Consultant at Poten & Partners.

Major markets, such as Australia were also becoming interested in FSRUs, but as Saputra explained, Australia falls into the category of an emerging player when it comes to LNG imports.

“When it comes to FSRU development, the key difference between the major markets and emerging markets is that emerging markets do not have enough existing infrastructure yet, hence FSRUs can be a quick and timely solution to meet their needs,” Saputra added.

There are different drivers for FSRU project across different regions. “If you look at the FSRU projects in Asia we’ve seen a lot of Asian countries face decline in their indigenous gas production. This decline in production is a very strong driver of an FSRU project, as they’ll need to import LNG to backfill that decline,” explained Saputra.

“We’ve seen this recently in Pakistan and Bangladesh. They are gas-based economies that rely a lot on their domestic gas production, which is falling rapidly.

“FSRUs provide a quick solution for them to import LNG to backfill the declining supply. These challenges are faced by other countries, as well in the Asia/Pacific and Middle East regions and will continue to drive the LNG demand going forward,” he said talking with IQPC.

LNG-TO-POWER

Aside from the declining supply of domestic gas production, the growing demand of power generation is also driving LNG demand. Many countries in South/Southeast Asia and South America are growing economies, which require a lot of energy sources to drive their economic growth. “This explains why we’ve seen that LNG-to-power is gaining traction,” said Saputra.

Examples of rising LNG-to-power projects were Brazil, Bangladesh, Myanmar, Indonesia, and Jamaica. This trend is beneficial for FSRU suppliers as it helps provide initial anchor demand for these projects, due to the emerging markets in these regions.

“The power contracts are based on long-term power purchase agreements, which run

for 20-25 years. The size of the power plants and the size of the LNG requirements are rather substantial. This provides a base demand for the FSRU project to be bankable as it’s able to secure the required throughput, otherwise the economic feasibility of the project cannot be guaranteed,” Saputra said.

In other regions, geopolitical factors are also driving demand in Europe, such as Russia’s move to place an FSRU in Kaliningrad. In Africa, the need to build more power infrastructure and to import LNG to provide fuel for power plant projects is also driving FSRU demand.

Newbuilding FSRUs dominate existing projects worldwide, due to the move toward improved operational performance, such as fuel options and boil-off rate. However, when it comes to shorter term requirement and shorter lead time, converted vessels could provide a quicker option.

Saputra noted another trend, “We’ve seen the trend where FSRU players, like Höegh and Golar, put in speculative orders for newbuilds. They book the FSRUs upfront so they can seize the opportunities in a timely manner. They anticipate the demand so they could have the vessel ready beforehand. When we look at the size of the newbuilds, the players tend to order a standard size (about 170,000 cu m) which makes it easier for them to meet the demand when it comes.”

On the political side, one of the challenges for FSRU projects is that the regulatory environment still needs time to be resolved. For countries like Vietnam or the Philippines, which plan to use FSRUs to import LNG for the first time, they still need to set up the right regulatory framework.

“In these countries, an LNG import project is considered public infrastructure procurement and therefore relies on the government’s direction. There are remaining challenges when it comes to setting up regulatory frameworks and the physical infrastructure there,” Saputra explained.

COMMERCIAL CHALLENGES

There are also related commercial challenges when it comes to switching to LNG. Domestic gas production tends to be less costly. “When countries bring in LNG via FSRU, the overall costs, in terms of delivered gas price to customers, tend to be higher than existing volumes, which creates price tensions,” he said.

In addition, securing demand will always remain important for FSRU projects. It’s a risk to bring in the FSRU if they cannot be sure

that there will be enough demand to underpin the project.

“Getting enough demand, securing enough throughput to meet what’s required to make the project bankable is always a key challenge to tackle,” he said.

Opportunities for future growth for FSRUs are encouraging. In Australia bringing in FSRUs is cheaper than building a long-distance pipeline. Energy security and geopolitical factors were also driving demand in the European market. Mature and emerging markets in Asia were also promising.

“The opportunities for future growth for Asia are such that falling domestic production will continue to drive demand, in addition to the increase energy demand due to economic development and also infrastructure constraints,” concluded Saputra.

Illustrating the move towards newbuildings, in July, Höegh LNG advised that an interim LNGC timecharter has been agreed with Cheniere Marketing International for its recently named ‘Höegh Galleon’.

This timecharter commences in September, 2019 after the delivery of the unit, Höegh LNG’s 10th from Samsung Heavy Industries.

The terms of the timecharter ensure ‘Höegh Galleon’s’ availability to serve the AIE project in Port Kembla, Australia, where Höegh LNG is the FSRU provider on a back-to-back basis. AIE recently announced a contract to supply gas to its foundation customer from 1st January, 2021.

Sveinung Støhle, Höegh LNG President and CEO, explained: “We are very pleased to further develop our relationship with Cheniere, the US’ largest LNG exporter. This charterparty will cover the period from delivery of ‘Höegh Galleon’ until its planned start-up in Port Kembla.

“Combined with a finalised AIE contract and the project’s FID, ‘Höegh Galleon’ will have long-term contract coverage in line with HLNG’s stated strategy. Finally, from commencement of the Cheniere contract in September, Höegh LNG’s fleet will be fully employed,” he said.

In late June, Höegh LNG announced that another Australian energy company, AGL, had selected ‘Höegh Esperanza’ as the FSRU for the Crib Point project in Victoria, Australia, as opposed to ‘Höegh Giant’ earmarked by the charterer in December, 2018.

‘Höegh Esperanza’ is fitted with both a closed loop and an open loop system and this was considered by AGL to be a better fit for the operational requirements arising from the Environment Effects Statement (EES)

currently been undertaken by the Victorian Government.

The EES is expected to be concluded no earlier than late first half of 2020. Final investment decision (FID) will be taken subject to and following the EES.

As ‘Höegh Esperanza’ is currently under contract with CNOOC until June 2021, taking into account the time needed for relocation, commissioning and start-up at Crib Point, this fits well with AGL’s planned commercial start-up in first half of 2022, Höegh LNG said.

The charter runs for 10 years and remains conditional on AGL Energy’s board taking a FID for the project.

‘Höegh Esperanza’ is expected to generate an annual EBITDA of \$31 mill, the company added.

As for Golar LNG, in its first quarter 2019 results presentation, the company confirmed it was to convert, sell and operate the ‘Golar Viking’ for the LNG Hrvatska project in Croatia for 10 years.

The conversion capex is to be funded by stage payments under the contract. Her conversion will start following the ending of an LNGC contract due in the first quarter of next year. The proceeds from the sale are expected to generate \$40 mill.

SERGIPE PROJECT

Another Golar FSRU, ‘Nanook’, received her first commissioning cargo from the FLNG ‘Hilli Episeyo’ on 27th February this year.

The FLNG and FSRU are currently on site at Sergipe, Brazil. The Sergipe power plant

will use up around 33% of ‘Nanook’s’ capacity.

As a result, Golar is developing a distribution hub in NNE Brazil to utilise the additional capacity. This will take the form of a small scale LNGC operation.

Other FSRU opportunities continue to progress albeit slowly, Golar said.

For example, towards the end of July, Argentinean energy company YPF announced that a preliminary agreement was reached with Excelerate Energy for the charter of an LNGC, which will export LNG produced from the ‘TANGO’ FLNG, located in Bahía Blanca.

Both parties will be executing the final agreement soon, with the objective of starting operations in the first week of September.

The natural gas, produced mainly from Vaca Muerta, will be processed by the ‘TANGO’ FLNG at Bahía Blanca, and from there, it will be transported by the 138,000 cu m LNGC ‘Excalibur’. The loading will be carried out over about 45 days.

YPF commissioned its first cargo in May, becoming the first Argentine company to export LNG.

Another ongoing project will see an FSRU stationed at Vassiliko Bay, Cyprus.

Three consortia have been shortlisted for this project.

Cyprus aims to have the FSRU in place and importing by 2021 and has a €101 mill grant from the European Union.

The government requested expressions of interest in June to supply the LNG, with a deadline of 6th September. ■



The Brazilian Sergipe project makes use of an FSRU and an FLNG

Demise charters and the creation of a paper reality

The case of the ‘Mount Apo’ and the ‘Hanjin Ras Laffan’ [2019] SGHC 57 brings to mind difficulties that may sometimes be encountered in proving the factual and legal status of a bareboat or demise charterer.

In this article, Dentons Rodyk explored proof of demise charter by the demise charterer, proof by a third party claimant when arresting a ship, and evidentiary differences in litigation and arbitration.

The case concerned a collision between the Capesize bulker ‘Mount Apo’ and LNGC ‘Hanjin Ras Laffan’.

The owners of the bulker, Cisslow Shipping (Cisslow) commenced an action in rem against the owner and/or demise charterer of the ‘Hanjin Ras Laffan’ in respect of the collision.

Parties claiming to be the owner and demise charterer of the LNGC, who were KSH International (KSH) and H-Line Shipping (H-Line), respectively commenced an action in rem against the owner and/or demise charterer of the ‘Mount Apo’ in respect of the same collision. Both actions were consolidated and the Singapore High Court was asked to apportion liability in respect of the collision.

A preliminary issue arose from the contention of Cisslow that H-Line had no title to sue because it was not the demise charterer of the gas carrier. Cisslow contended that if it bore any liability, it was only to KSH, the owners of the ‘Hanjin Ras Laffan’.

The evidence considered by the Singapore High Court included:

- The testimony of H-Line’s deputy manager Ms Joo, whose work concerned the management of vessels and, in particular respect of the ‘Hanjin Ras Laffan’, regulatory filings with South Korean government agencies, liaising with the Panama ship registry and liaising with insurers.
- The bareboat charter agreement between KSH and Hanjin Shipping.

- Amending and restating agreements between KSH and Hanjin Shipping on account of loan agreements between KSH and its lenders.
- A novation agreement novating the rights and obligations of Hanjin Shipping under the bareboat charter to H-Line.
- Continuous synopsis records issued by the Panama ship registry after the novation agreement recording that ‘Hanjin Ras Laffan’ was operated by H-Line under the terms of a registered bareboat charter.
- Invoices issued by a repair yard addressed to ‘Captain & Owners of Hanjin Ras Laffan, H-Line Shipping’.
- The LNGC’s passage plan bearing H-Line’s letterhead.
- The record of her passage planning, bearing H-Line’s letterhead.
- H-Line’s expenditure of monies to repair the ‘Hanjin Ras Laffan’ after the collision.
- A collision jurisdiction agreement containing a warranty that H-Line was the demise charterer of ‘Hanjin Ras Laffan’
- H-Line manning the crew of the ‘Hanjin Ras Laffan’ at the material time of the collision, consistent with actual possession of the vessel
- A charge registered at the UK companies registry against Hanjin Shipping dealing, among other things, with the earnings of Hanjin Shipping arising out of the use and operation of the LNGC, whose status remained listed as ‘outstanding’.

Significant in the Singapore High Court’s judgment was the judge’s treatment of Cisslow’s objection to the admissibility of the original bareboat charter between KSH and Hanjin Shipping, the subsequent amending

and restating agreements and the novation agreement.

The basis of the objection was in essence that, there was no one before the Court who could attest to the truth of the statements in the documents, because the deputy manager, Ms Joo joined H-Line after these documents were created. The documents were therefore ‘hearsay’.

CHARTER PROVEN

The judge’s approach was to observe that it was possible to prove a demise charter and, hence title to sue, even if documents recording a demise charter arrangement were not admitted in evidence. It was possible for a demise charter to be proved by the testimony of a person who was in a position to speak about the ownership and the demise charter of the vessel generally.

He reviewed Ms Joo’s duties as deputy manager and found that although she was not involved in the creation of the documents, she was familiar with the circumstances surrounding them and also had personal knowledge of running the LNGC according to the terms of the demise charter arrangements. The judge accepted Ms Joo’s evidence and found the demise charter proved.

Had the same question been one that had to be determined by an arbitral tribunal in Singapore, it is unlikely that any issue would have arisen over admissibility of the original bareboat charter between KSH and Hanjin Shipping, the subsequent amending and restating agreements and the novation agreement.

Singapore evidentiary rules on documentary hearsay are excluded from arbitration proceedings. Although the power conferred on arbitral tribunals includes the power to determine the admissibility, relevance, materiality and weight of any evidence, arbitral tribunals rarely hold that documents are inadmissible.

The usual course is for all of the evidence

“The basis of the objection was that there was no one before the Court who could attest to the truth of the statements ...”

to be considered. The tribunal would determine how reliable each piece of evidence is and what weight to give to it. The tribunal would then come to a decision on the whole of the evidence. Time and costs is rarely spent arguing admissibility of evidence.

This case serves as a reminder of the question whether Singapore's evidentiary rules on hearsay should be abolished on the ground that, in the modern age, they serve to distort a case that a party would otherwise be able to bring.

In a 2007 report, the Law Reform Committee of the Singapore Academy of Law recommended reform in the law by abolition of the hearsay rule in exchange for proper safeguards to ensure that there was a basic level of fairness between the parties.

One of the reasons given was that this would result in a more even-keeled trial process, especially in international disputes, and increase the attractiveness of Singapore as a forum for adjudication of international civil disputes.

SINGAPORE COURT

Some attention was paid to the recommendation, when the Singapore

International Commercial Court (SICC) was established in 2015. The SICC was given freedom not to apply Singapore evidentiary rules and/or to apply other rules of evidence (foreign, arbitration or otherwise) in cases and to the extent that SICC procedural rules allowed.

While this may be useful in most cases, including those involving carriage of goods by sea, actions in rem are still the specific province of the general Singapore High Court and parties will not be able to avail themselves to the freedoms in the SICC.

Also worth considering is the position of a claimant who wishes to arrest a ship on the basis that the party liable to the claimant is the demise charterer of that ship. Ordinarily, the bareboat charterparty or other documents containing or evidencing a demise charter would be private to the owner and the bareboat charterer and would not be available to the claimant.

The evidence of someone within the organisation of the party whom the claimant holds liable would ordinarily not be available, unless that person has since left the organisation. Neither would evidence of manning arrangements be ordinarily available.

The claimant would have to refer to circumstantial evidence, such as ship registry records of a bareboat charterparty, third party invoices referring to the party as a bareboat or demise charterer or the 'owner' of the vessel, and other extraneous documents to show that the party was the demise charterer of the ship.

The claimant may well have to conduct private or discreet enquiries into the vessel to obtain evidence of a demise charter arrangement. Although evidence adduced by a claimant in applications to arrest ships are not subject to the hearsay rule, a claimant must still prove the fact that the party liable is a demise charterer at the eventual substantive hearing.

If the substantive hearing takes place within arbitration proceedings, no evidentiary problem of the nature described above arises. If the substantive hearing takes place in the Singapore court, the claimant may well have a difficult time with proof.

Evidence and their ability to establish facts is crucial to the success of a claim or defence and should always be the subject of deep analysis before substantive engagement.

Sound advice on evidence could make all the difference. ■

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Nakilat continues to expand its LNG horizons

The world demands better commitment and greater responsibility towards sustainability and environmental protection globally.*

This has created a huge demand for cleaner energy, such as LNG, which has significantly lower nitrogen oxide and carbon emissions, as compared to coal and oil. Clean energy is vital for present and future developments, creating a sustainable future for the next generations.

In this prospering LNG market, the most critical link in the supply chain is the transportation – the vessel. Without gas tankers, LNG as a commodity cannot reach end users worldwide.

With one of the largest LNG shipping fleets in the world, Nakilat fulfills this global demand for clean energy by transporting LNG to over 90 terminals across 26 countries.

Since its establishment in 2004, the company has followed through its long-term business strategy to establish itself at the forefront of the energy transportation and maritime sector from thereon. The new liquefaction plants and an increase in global LNG demand will likely maintain the strong fundamentals of the LNG shipping market. Hence as the world's largest LNG shipping company which accounts for 11.5% LNG shipping capacity, Nakilat is well placed to take advantage of this.

Recognising Qatar's abundant natural gas

resources, Nakilat has capitalised on the opportunity to grow into a fully-fledged shipping company by adding shipmanagement capabilities. Carrying more than two-thirds of Qatar's LNG exports, Nakilat is determined to sustainably grow its fleet size and market share.

Nakilat has been diligently focused on expanding its international business portfolio in terms of strategically balanced growth and diversification. The strong fundamentals of the LNG market especially in recent years, create an attractive investment environment, enabling LNG shipping players to capture new business opportunities and profitable assets.

Strategic alliance with renowned partners has been fundamental to the company's success, and Nakilat always look for opportunities to grow its international presence and maximise returns for shareholders.

FLEET EXPANSION

Nakilat has enjoyed increased earnings given the full impact of its fleet expansion last year, with the inclusion of two additional LNGCs and an FSRU.

Earlier this year, Nakilat expanded its LNG fleet with four additional newbuild LNGCs, which will be fitted with the latest technology system, through the establishment of a new joint venture (JV) with Maran Ventures. The

new vessels will be commercially and technically managed by Nakilat with the delivery time between 2020 and 2021.

The expansion exercises effectively increase Nakilat's fleet size to 74 vessels, comprising of the world's largest LNG fleet of 69 LNGCs, as well as four large LPG carriers and one FSRU. Its in-house shipping management subsidiary, Nakilat Shipping Qatar Limited (NSQL), currently operates 18 vessels, comprising of 14 LNGCs and four LPG carriers.

Nakilat aspires not only to be the largest LNG shipowner but also recognised as a safe, reliable and efficient ship operator. Safety enhancement, vessel reliability and cost optimisation continue to be Nakilat's main drivers for operational excellence in managing its vessels.

SAFETY INITIATIVES

Nakilat enhanced its safety initiatives, leveraged operational opportunities and implemented efficiency measures to reduce costs that were beneficial to the company during this challenging period facing the shipping industry.

The company continuously seeks ways to enhance safety performance through setting stringent targets and higher standards than the benchmarked industry average. As such, the company takes pride in receiving honorary prestigious accolades for excellence in the areas of health and safety, sustainability development and business resilience. This is reflected through its second consecutive 'Five-Star' grading of the comprehensive Occupational Health and Safety Audit, as well as the 'Sword of Honour' award for reaching "the pinnacle of excellence" in managing the company's health, safety, and environmental risks by the British Safety Council (BSC).

All of Nakilat's LNGCs have received the 'Green Award' status and operate in accordance with best practices as defined within the programme. In addition, regular monitoring of ambient air quality and marine water and innovative measures to reduce electricity consumption have been introduced



Nakilat's reach

at its shipyard to improve efficiency.

Nakilat's main operational focus between late-2017 up to 2019 has been to safely and successfully complete all its vessels' second special survey drydockings, which is a requirement when vessels approach 10 years of age.

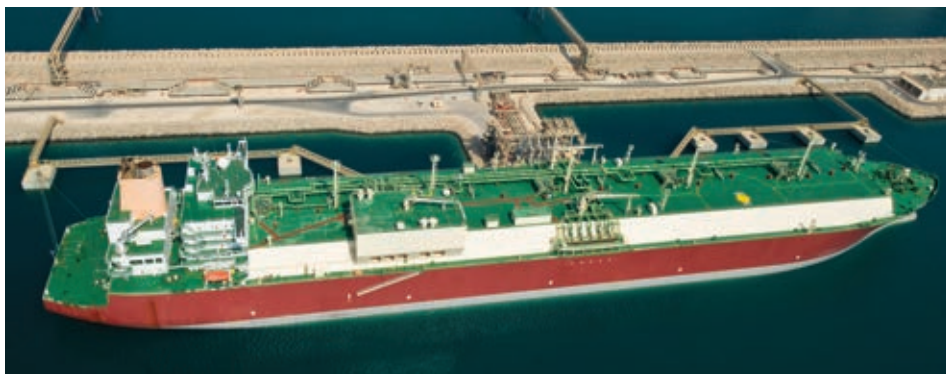
Delivering energy responsibly means being mindful of integrating environmental considerations across all operations. The landscape governing ocean transport is changing. With environmental agenda being a high priority in today's shipping industry, LNG as a fuel solution is growing momentum with shipowners across the world, Nakilat included.

Driven by its sustainability focus in the aspect of environmental management, it is worth noting that Nakilat pursued a pilot project for the world's first M-type electronically controlled - gas injection (ME-GI) systems on board the LNGC Q-Max 'Rasheeda'. The 266,000 cu m vessel was built in 2010 and is one of the 45 Q-Max and Q-Flex types owned by Nakilat. Nakilat's excellent safety track record and the availability of LNG supply on board greatly facilitated the incorporation of such a system on the vessel.

FUEL EFFICIENCY

The ME-GI system offers a robust environmentally resilient combustion solution with among the highest fuel efficiency available in the market. Aimed to give full control on choice of fuel type, the Q-Max 'Rasheeda' became a pivotal case study for ships of its scale.

Thus far, the GI engine has been providing an optimal fuel flexibility, greater control for operational efficiencies for Nakilat, and comes with enormous environmental advantages. To date, 'Rasheeda' has showcased promising results with significant running hours on gas



Typical Nakilat LNGC

since the project's roll-out. Besides other substantial commercial benefits, the company has also observed around 95% reduction of sulphur oxides (SOX) when burning gas. There is no doubt that learnings from this pilot project will pave way for greater enhancement for greener shipping system designs.

Nakilat believes that its success has been and shall continue to be internally generated through a high calibre workforce that forms its most valuable asset. Aligned with its long-term growth strategic objective, Nakilat will be expanding its in-house crew administration to have greater autonomy in its operations and closer management of its seafarers. This will, in turn support the company's efforts in strengthening in-house capabilities, technical knowhow, development of a sustainable workforce as well as optimising operational costs.

The company is consolidating its capabilities by means of modernising systems, enhancing human capital capacity, developing competencies, and acquiring technical knowhow not only in preparation for the next phase of LNGC expansion but also FSRUs.

The next round of vessel management transitions from Shell International Trading and Shipping Company (STASCO) to NSQL is scheduled to commence in 2020. Nakilat

also intends to take full shipmanagement responsibility of the FSRU 'Exquisite' from the current operator in the same year. This will require NSQL to complement its skill base with additional knowledge and competencies to strengthen the company's positioning in this fast-developing, niche segment of the LNG industry.

With an integrated maritime portfolio comprising shiprepair and conversion, towage, agency and logistics, Nakilat is strategically equipped to capture business across the LNG value chain. The company's shipyard, the Erhama Bin Jaber Al Jalahma Shipyard, has already completed over 1,000 shiprepairs, offshore maintenance, shipbuilding and fabrication projects, with LNGC repairs making up roughly 20% of this figure.

Nakilat strives to meet the growing energy transportation needs in a responsible manner, by balancing the economic, environmental and social needs aspects of sustainability, steered by excellence in safety and health, solid governance and ethical business practices.

The driving forces behind Nakilat's continued success have always been its skilled professionals, coupled with a keen focus on high standards safety management, operational efficiency, sound business diversification strategies and alliances with established industry partners. Nakilat continues to focus on long-term growth and development strategies.

Qatar's plans to increase LNG exports to 110 mill tonnes per annum over the next few years will provide an excellent, large-scale opportunity for further growth in Nakilat's fleet.

The company is continuously looking to expand its international portfolio on the basis of long-term contracts, as well as exploring multiple market sectors such as LNGCs, FSRUs, LPG carriers and also small-scale LNG to cements its position as a global leader in energy transportation.



Dawn of a new era

**This article was written exclusively for LNG Shipping Review by Nakilat.*

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Sensing a new approach to gas engine control and monitoring

Patrice Flot, CMR Group CTO, examines the development of new natural gas sensors in the wake of the increasing specification of engine technology.

Diesel engines have long been appreciated for their efficiency and capability to burn cheap residual fuels. However, the market for this technology is beginning to change, as the marine sector considers alternative solutions in the face of global environmental issues and the drive to reduce carbon emissions.

Previously restricted to LNG carrying ships until just a few years ago, we are now seeing gas engines increasingly being specified for a wide variety of vessels, including passenger ships (under full agreement and control of the class societies), as the technology continues to develop, and owners and operators recognise the fleet optimisation advantages offered.

Whilst the growth of gas engine usage and the interconnection of the gas networks, together with a greater requirement for reliability and availability and lower maintenance, are creating new challenges, are all important considerations in the continued development of engines, the issue of gas quality variation - how gas quality varies between sources, countries, regulations and even time - is also a critical consideration, presenting a challenge that new sensor technology can help to overcome.

EU attempts to harmonise gas quality regulations, which in turn, eases gas trading across borders, are convincing gas distributors to push for a broadening of gas quality limits to enlarge the portfolio of possible sources. Simultaneously, OEM engine builders and other gas-fuel users, are pressing for restrictive limits that are better suited for their power plants and ancillary equipment.

Natural gas is a generic designation for various qualities of gas based on the main gas component methane (CH₄). As such, it covers many different qualities linked to the gas

composition, including the source of raw gas and refinery processes. The gas can be manufactured from synthesis technologies, natural processes, or 'renewable power-to-gas' technologies.

Gas networks are interconnected and strategically linked to multiple sources. Because of this, the quality of gas can change at a given location and these changes could be rapid when switching from one source to another. In addition, rapid changes of gas quality can occur in other situations faced by end users, such as onsite switching from a gas tank to the gas network, or vice-versa.

Also, when gas is only available in LNG tanks, switching from an empty tank to a full tank can result in significant changes in gas quality - an empty tank will deliver the heaviest molecules contained in natural gas, and a full one may deliver the lightest molecules.

In marine applications, propulsion gas engines are often fed by boil-off from LNG tanks. When engine power exceeds the capacity of the boil-off flow, the additional gas flow is fed to the engine from the bottom of the tank. Boil-off is made from the lightest molecules of the natural gas, especially when the tank is nearly full. In contrast, gas delivered from the bottom of the tank comprises the heaviest natural gas molecules. Consequently, the resulting mixture quality varies with the load of the engine.

During heavy seas, load fluctuation on the propeller will typically generate rapid changes in gas quality at the engine inlet. Engine builders are acutely aware of these situations, which deeply affect the combustion inside the gas engines. Most of these gas engines are running in accordance with the Otto principle - ie, a 4-stroke engine cycle - which is sensitive to the methane index.

Gas with a high methane index (80 - 90)



Patrice Flot

will provide smooth combustion starting from the spark ignition device, whereas gas with a low methane index (55 - 65) enhances the risk of knocking by auto-ignition at several places inside the combustion chamber.

To counteract this, vibration sensors and combustion pressure sensors are used by engine builders to monitor high levels of knocking and reduce it to low levels by adapting the tuning of the engine. As are often the case, such alterations do not always occur quickly enough to accommodate sudden gas quality changes, causing an engine emergency stop. Additional margin is usually obtained through conservative engine tuning. This includes reduced spark ignition timing before top dead centre, which is detrimental to the efficiency of the engine.

Another major difficulty for engine builders is the rate of change of gas quality over short periods of time. Because this is not

addressed by regulations, engine builders must cope with potential sudden changes in gas quality that are not always managed by current combustion control loop technologies. These control loops are based downward on combustion parameters measurement, not upfront on gas quality measurement.

SIGNIFICANT DEVELOPMENTS

To overcome the knocking issues linked to the Otto principle and rapid gas quality changes, we have seen significant strides in the development of new technology - the Near InfraRed Intelligent Sensor natural gas sensor (NIRIS NG) for instance – which has been designed to analyse the natural gas composition at the inlet of the gas engine. (Surprisingly, there hasn't been a sensor commercially available in the industrial market to allow upfront gas quality measurement that eases the engine combustion control loop).

Compared to other gas quality analysers, CMR's new generation of gas pipe plugged sensors use low cost optical components and proprietary signal treatment software contained within robust housing to resist vibration and heat. Light is emitted by the sensor and travels through the gas inside the supply pipe on the engine before being

analysed by a detector. The output signal from the detector is a simple spectrum that is then processed by a calculation matrix to provide gas composition, and related parameters.

This matrix is specific to each sensor and is inbuilt during manufacturing at the calibration stage thanks to a data base of gas mixtures. Calculation is carried out through multi-variable methods like the principal component regression (PCR) and partial least square regression (PLS).

Measurement data is then provided through CAN protocol to the engine. The methane number input at the ECU (engine control unit) can be used by the engine builder to continuously optimise the spark ignition timing and other engine actuators.

Using the new CMR NIRIS NG sensor reduces consumption levels of natural gas-powered engines through the real time measurement of fuel quality. Directly connected to the gas feeder pipeline, the sensor is built around smart infrared hardware and data treatment software and features a CAN bus communications facility, which enables it to be upgradeable without dismantling the sensor for improved performance and retro applications.

Natural gas consumption levels can be further reduced by engine tuning closer to

knocking limits, due to effective fuel management strategies using sensor data. Other benefits include lower fuel analysis costs, correct engine performance and the overall alleviation of time consuming and costly damage to components due to inferior or low-grade gas fuels.

New opportunities are opening-up to gas engine manufacturers on the back of new technology. Linked to electrical actuators, the new generation of sensors permit instantaneous adjustment of the engine during a change of gas supply from one source to another of different quality, or when heavy seas place variable load on the propulsion system, requiring variable forced boil-off to be added to natural boil-off, resulting in a highly variable methane number at engine entrance.

Moreover, with the capabilities offered by a fast response time sensor, gas authorities and suppliers can harmonise gas quality better, finding new and easier ways for agreement and greater opportunities for global gas trading.

CMR Group designs, manufactures and commissions automation, control system and turnkey project solutions for global industrial and renewable energy sectors, alongside specialist instrumentation for high power diesel or gas engines. ■

WinGD enjoys strong first quarter

A newbuilding order spree of LNGCs has helped WinGD maintain its leading position in the market.

WinGD has reported a very solid order intake for the first quarter of this year for its low-pressure, dual-fuel 2-stroke X-DF engines.

The maritime industry's response to the call for tighter environmental regulations combined with the 2020 sulfur cap is steadily driving the industry towards dual fuel solutions, the company said.

A few recent high profile orders confirmed that confidence in LNG as a marine fuel is growing and now includes a broader range of vessel types apart from LNGCs, such as chemical & crude oil tankers, asphalt carriers and container feederships.

For example, WinGD's X-orderbook now stands at over 200, some 32 being

won in the first quarter of this year.

"This doesn't mean that there isn't still a considerable amount of debate about what the future fuels will be, but it does give owners peace of mind that their vessels will be compliant, safe and reliable for many years to come.

"LNG is the bridge, which will get us closer to a carbon neutral future. Every day that passes more and more of the engines ordered for propelling deepsea vessels are choosing LNG as fuel. The reasons are compelling: lower emissions, less CO2 and offered at a very attractive price, compared to 0.5% sulfur fuels," claimed Rolf Stiefel, WinGD's vice president sales.

The combination of strong running experience results and the growing infrastructure to support LNG as fuel has helped position the X-DF as the dominant engine in dual-fuel orders, the company said. ■



Rolf Stiefel

‘Saga Dawn’ enters service

LNT Marine recently completed gas trials of its patented LNT A-BOX containment system on board ‘Saga Dawn’, a mid-size LNGC, which was due for delivery from China Merchants Heavy Industry (Jiangsu) shipyard last month.

Saga LNG Shipping and China Merchants Industry Holdings (CMIH) signed a contract for the 45,000 cu m capacity LNGC in late 2015, with the yard subsequently entering into a license agreement with Singapore’s LNT Marine for the LNT A-BOX containment system.

Kjetil Sjølie Strand, LNT Marine CEO, said: “The success of the gas trials – the culmination of nearly 10 years’ research and development – verifies that the LNT A-BOX concept is a viable solution for flexible LNG carriers. We are delighted that the gas trials have been a success and now look forward to seeing ‘Saga Dawn’ entering commercial service.”

The ABS-classed ‘Saga Dawn’ is based on LNT Marine’s LNT45 containment system design, whereas the basic ship design was developed in co-operation with Sweden’s FKAB. She was claimed to be the first vessel to enter service with a completely new LNG containment system for decades.

Stein Foss, LNT Marine COO, said: “LNG carriers are among the most sophisticated and expensive merchant ships to build, with construction traditionally limited to a few shipyards around the world. However, the cost

and complexity of traditional LNG containment systems does not make smaller LNG projects commercially feasible. LNT A-BOX does. It offers a simple, flexible and efficient cargo containment system enabling more shipyards to build LNG vessels at more attractive prices.”

The containment system is based on proven technologies, but in a new patent-protected configuration. The design is based on an independent tank type ‘A’ as the primary barrier and a full secondary barrier. Design and construction of type ‘A’ tanks is based on classical ship structural principles and is reasonably easy to build.

In addition, the tank is flexible in shape and geometry, catering for excellent volume utilisation, while internal structure mitigates sloshing and eliminates any loading limitations, the company claimed..

The tank itself is not insulated but installed in an insulated cargo space. This means that the insulation is attached to the interior surface of the hold, while a liquid tight barrier is fitted on the inner surface of the insulation acting as the secondary barrier. In between the tank and the secondary barrier is a cold inter-barrier space, which offers direct access for visual inspections and maintenance of both barriers,

as well as the tank supports.

Since the insulation is not exposed to any static or dynamic loads from the cargo, the insulation material is optimised for thermal performance, which means that the LNT A-BOX system can offer competitive boil-off rates (BOR).

“The potential for LNT A-BOX to revolutionise existing and emerging LNG shipping markets is a very exciting prospect,” said Strand, adding that the technology completely “supports the growth of the expanding LNG sector going forward.”

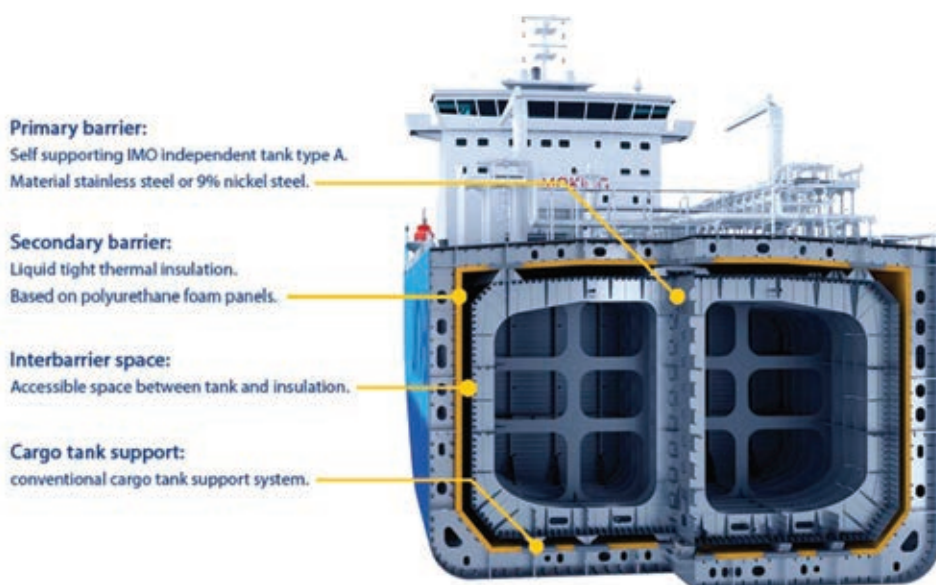
While the concept has initially been focused on the small-to-mid-size LNGC segment, Strand said the technology can be scaled up or down. “We are currently involved

‘Saga Dawn’ Principal Particulars

Loa	195.3 m
Lbp	184.8 m
Beam	30 m
Depth, moulded	20 m
Design draught	9 m
Scantling draught	10.3 m
Deadweight, scantling	29,500
GRT	30,000
Service speed	16.5 kn
Range	13,000 nm
1 x DF engine	11,700 kW
Aux engines	2,500 kW

LNT A-BOX Containment System

Cargo tanks	3 (IMO type ‘A’)
Total capacity	45,000 cu m
MARVS	0.4 barg
Design density	0.6t/cu m
BOR	0.15%/day
Min temp	- 163 deg C



Schematic of the containment system



'Saga Dawn' seen on gas trials

in a number of projects to develop new LNGC designs based on the LNT A-BOX concept, including an 80,000 cu m LNG carrier, shallow draught vessels and small and mid-size FSRUs."

A self-supporting prismatic tank is a proven and reliable technology, as it has been successfully used for more than 50 years in the seaborne transportation of liquefied gas. Internal structures and bulkheads inside the tanks curb movements of the liquid, eliminating sloshing problems regardless of the liquid levels in the tanks.

Furthermore, the solid tank framework structure prevents vacuum problems in the tanks, simplifying pressure control and cargo handling work. IMO independent tank type 'A' is based on classical ship structural design and construction procedures in accordance with recognised standards.

The thermal insulation with the secondary barrier is moved to the inner hull

to facilitate visual access of the secondary barrier system, including support structures and tank shell. The hold space is protected from sloshing loads, allowing arrangement of a flexible cold insulation system with outstanding thermal properties.

Avoidance of sloshing loads allows simplified corner panel geometries, enabling more volume efficient and slender hull forms for improved transportation efficiency. The thickness of the insulation system can easily be adjusted to achieve the required BOR.

LNT Marine has also developed a semi-

pressurised LNG fuel tank - LNT Fuel-BOX. This is based on the principles of the LNT A-BOX but optimised for fuel tank application. The design, which has already received Approval in Principle (AiP) from ABS, is particularly appealing to containerships and other volume sensitive vessels with large LNG fuel tanks, the company said.

In addition, the company is currently involved with the LNG fuel tank insulation for Carnival's new series of LNG-powered cruise vessels under construction at Meyer Werft; Hurtigruten's LNG conversion project; and cargo tank insulation for Avenir's 7,500 cu m LNG bunkering vessels under construction at Keppel Nantong.

LNT Marine developed the 'Saga Dawn's' concept design and specifications for the complete vessel, and all design and engineering for the containment system, including, cargo tanks, cargo tank support system, insulation & secondary barrier system, and safety & auxiliary systems.

The company also supplied the materials for the insulation & secondary barrier system, as well as a project management and supervision team for the construction and installation of the containment system. ■

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DAMEN

First of Damen's new bunker vessels to enter service next year

In 2017, Damen unveiled LNG bunker vessel designs (LGCs) ranging from 500 to 7,500 cu m in capacity at a time when it was very much a 'chicken and egg' situation.

However, the tightening of exhaust emission regulations, both in 2020 and beyond issued by the IMO, has stimulated action.

Oil and gas majors have sat up and taken notice, particularly as there is EU funding available for European operations.

Fast forward to May this year when the keel was laid at Damen Yichang Shipyard in China for an LNG bunker vessel for the new energy brand Elenger, formerly known as Eesti Gaas.

With a 6,000 cu m capacity, the new vessel will facilitate the adoption of LNG by providing an efficient ship-to-ship distribution service for all kinds of LNG vessels operating in the Baltic region with an emphasis on ro-ro traffic.

Following sea trials in the spring of 2020, the 100 m long ship will arrive in Estonia next September and will start serving LNG clients in the autumn, carrying out bunker activities at designated locations both in and outside ports.

For example, Elenger currently uses road tankers to refuel Tallink's LNG-powered ropax 'Megastar', which operates between Tallinn and Helsinki. The new LGC 6000 LNG will be able to refuel the ferry in a single, efficient and much faster procedure while she is alongside her regular berth, loading and

unloading passengers and vehicles. Ports will also be spared the additional traffic generated by moving LNG by road, Damen said.

Damen now offers a range of LGCs that are claimed to be ideal for bunkering operations. The vessels range in capacity from 1,500 to 10,000 cu m and all feature highly efficient hull forms, comfortable, modern accommodation and wheelhouses with excellent all-round visibility for both sailing and manoeuvring in harbour.

The cargo tanks and their systems can be supplied by leading manufacturers and the designs are able use vapourised LNG on board for propulsive and auxiliary power. This provides an economic alternative to conventional fuels and reduces the need for liquefaction, Damen said.

The LGC 6000 LNG type, now under construction, is designed to meet the requirements of Ice Class 1A certification, allowing her to operate all year in the Gulf of Finland and the northern Baltic. She will also achieve a green ship notation.

A dual-fuel propulsion system will be used for the management of the boil-off gas (BOG) in combination with a gas burner. She will be fitted with two Type 'C' tanks.

Elenger will operate the vessel under a long-term charter from its parent company Infortar. Since 2016, Eesti Gaas, as the

company was formerly known, has expanded its LNG transport and bunkering capacity by entering into long-term LNG supply contracts with shipping companies and industrial consumers.

MORE VESSELS NEEDED

Over time, as the adoption of LNG as a marine fuel gains momentum, it is anticipated that additional LGC 6000 LNGs will be needed, Damen said.

This project is co-funded by the EU through the CEF Transport programme.

Peter Anssems, Damen Sales Manager, told LNG SR that thus far this is only one of the designs on offer to have been ordered.

He confirmed that the company was marketing the 10,000; 8,500; 7,500; 6,500; 4,000; 3,000 and 1,500 cu m capacity units worldwide.

Anssems also explained that the designs can operate as bunker vessels, as well as LNG feeder vessels. He expressed optimism that more orders would come saying, "More vessels using LNG as fuel are being ordered, as well cruise vessels and bulkers, so ports need to have LNG bunker facilities."

As for the tank containment technology, he said that the systems are designed in close co-operation with the owner, Damen and a specialist company.



Artist impression of Damen LNG vessel LGC6000



The LGC6000 portrayed alongside Tallink's 'Megastar'

LNG fuel supporters gain traction

An independent study report published recently claimed that greenhouse gas (GHG) reductions of up to 21% are achievable today from LNG as a marine fuel.

In the study, LNG usage was compared with current oil-based marine fuels over the entire life-cycle from well-to-wake (WtW).

It also confirmed that emissions of other local pollutants, such as sulfur oxides (SO_x), nitrogen oxides (NO_x) and particulate matter (PM), are close to zero when using LNG, compared with current conventional oil-based marine fuels.

Commissioned by SEA\LNG and Society for Gas as a Marine Fuel (SGMF), the study was conducted by data and consultancy provider thinkstep according to ISO standards. It was reviewed by a panel of independent academic experts, who claimed it was the definitive study into GHG emissions from current marine engines.

Commenting on the report, SEA\LNG Chairman, Peter Keller, said: “The ‘Life Cycle GHG Emission Study’ is a long-awaited piece of the ‘LNG as a marine fuel’ puzzle. It not only confirms what we already knew in terms of LNG’s immediate impact on air quality, human health and its cleanliness, but also clearly highlights the genuine, substantiated GHG benefits of using today’s marine engines capable of burning natural gas.

“Moving from current heavy fuel oil (HFO) to LNG does reduce GHG emissions. LNG does contribute to the International Maritime Organisation (IMO) GHG reduction targets. And it is clear that LNG is the most environmentally-friendly marine fuel that is readily available and safe, both today and in the foreseeable future,” he claimed.

REDUCTION BENEFITS

On an engine technology basis, the absolute WtW emissions reduction benefits for LNG-fuelled engines, compared with HFO fuelled ships are between 14% to 21% for 2-stroke slow speed engines and between 7% to 15% for 4-stroke medium speed engines.

Around 72% of the marine fuel consumed

today is used on 2-stroke engines with the remainder used on 4-stroke medium speed engines.

Study partner Chad Verret, SGMF Board Chairman, added: “LNG is safe to use, fully compliant and readily available as a marine transport fuel.

“Standards, guidelines and operational protocols are all in place to ensure that the safe way is the only way when using gas as a marine fuel. LNG meets and exceeds all current and 2020 marine fuel compliance requirements for content and emissions, local and GHG. With the world LNG bunker vessel fleet doubling in the next 18 months and those vessels being deployed at major bunkering hubs, LNG as a ship fuel is rapidly becoming readily available,” he stressed.

Ongoing optimisation in supply chain and engine technology developments will further enhance the benefits of LNG as a marine fuel.

In addition, bioLNG and synthetic LNG - both fully interchangeable with LNG derived from fossil feedstock - offer the potential for significant additional GHG emissions reductions.

For example, a blend of 20% bioLNG as a drop-in fuel can reduce GHG emissions by a further 13% when compared to 100% fossil fuel LNG.

Dr Oliver Schuller, Team Lead Energy & Mobility at thinkstep, explained: “The main goal of this study was to provide an accurate report of the life-cycle GHG emissions from LNG as a marine fuel compared with conventional marine fuels.

“This is a comprehensive report using the latest primary data to assess all major types of marine engines and global sources of supply with quality data provided by OEMs, including Caterpillar MaK, Caterpillar Solar Turbines, GE, MAN Energy Solutions, Rolls Royce (MTU), Wärtsilä, and Winterthur Gas & Diesel (WinGD), as well as from ExxonMobil, Shell, and Total from the supply side.

“The report is quality assured in assessing the supply and use of LNG as a marine fuel according to ISO standards. And objective having been peer-reviewed by leading academics from key institutions in France, Germany, Japan and the US,” he concluded.

LARGE VESSEL BOOM

Meanwhile, at June’s Nor-Shipping event, DNV GL’s Martin Wold, head of the Alternative Fuels Insight (AFI) platform, presented the latest AFI figures.

Looking at the data, Wold said that exponential growth in installed LNG tank capacity pointed to a potential boom in LNG for larger vessels over the coming years.

Wold suggested that the rapid growth in installed LNG tank capacity could mark the start of a new era in ship fuel. “There are now 163 LNG-fueled ships in operation and a further 155 ships on order,” he said in Oslo. “Order intake for LNG-fueled vessels has remained steady for several years now at around 40 ships per year. However, in 2019 we have already passed 40 new orders in the first five months, which could be a sign that the pace for LNG fuel investments is picking up.

“Perhaps more interestingly, the AFI platform shows that installed LNG tank volume will more than triple from around 100,000 cu m today (June) to the end of 2020. This represents large tanks in large vessels, propelled by the introduction of LNG fuel in the cruise, container and tanker segments.

“The 2020 ‘sulfur cap’ seems to have accelerated LNG adoption, especially for larger ships, which could be good news for the industry, increasing fuel availability and improving asset utilisation,” he said.

Since the launch of the AFI platform in 2018, interest has been steadily growing with over 2,000 users signed up to the platform, Wold said. New features and focus areas have been added, such as a global overview of cold ironing infrastructure.

The number of vessels with scrubbers stood at 3,553, said Wold, but this could be higher as some manufacturers did not report orders on a regular basis. “The boom of 2018 seems to have leveled off somewhat, but new orders keep coming in. There are more than 2,000 installations reported to be completed in 2019, which would mean by the start date of the ‘sulfur cap’ almost 3,000 scrubber vessels will be in operation,” he said. “However, due to the complexity of scrubber retrofits, we expect that not all of these vessels will be on the water by 2020.”

The AFI platform covers LNG, LPG and methanol, as well as emission reducing technologies, such as scrubbers and batteries. With interactive maps and data visuals, it is claimed to be easy for users to see where infrastructure already exists or will shortly be developed, alongside the growing alternative fueled fleet.

Advanced tools let users dig deeper into the data to analyse trends and screen the feasibility of their alternative fuel projects based on CAPEX, OPEX, and fuel prices. Much of the content is free to access.

Looking at the forthcoming IMO2020 regulation, the pathways to compliance are relatively clear.

These are being addressed in essentially three ways -the use of low sulfur fuel; continue using the same fuel oil as before, but with scrubbers fitted to clean the exhaust, while the third choice, and one that is being adopted more and more when building new ships, is to have the engines run on LNG.

CREATING INFRASTRUCTURE

In a comment piece, Wärtsilä experts pointed to global trends as an indication of how transformative gas can be in the near future.

As LNG burns emphatically cleaner than distillate fuels, territories like the US, China and Europe are rapidly switching to gas as a fuel for heavy vehicles, thus creating the infrastructure.

This movement further elevates LNG as a viable bunkering fuel for seagoing vessels. Market watchers foresee an imminent inflection point where demand for LNG will significantly increase.

Dual-fuel engines capable of running on

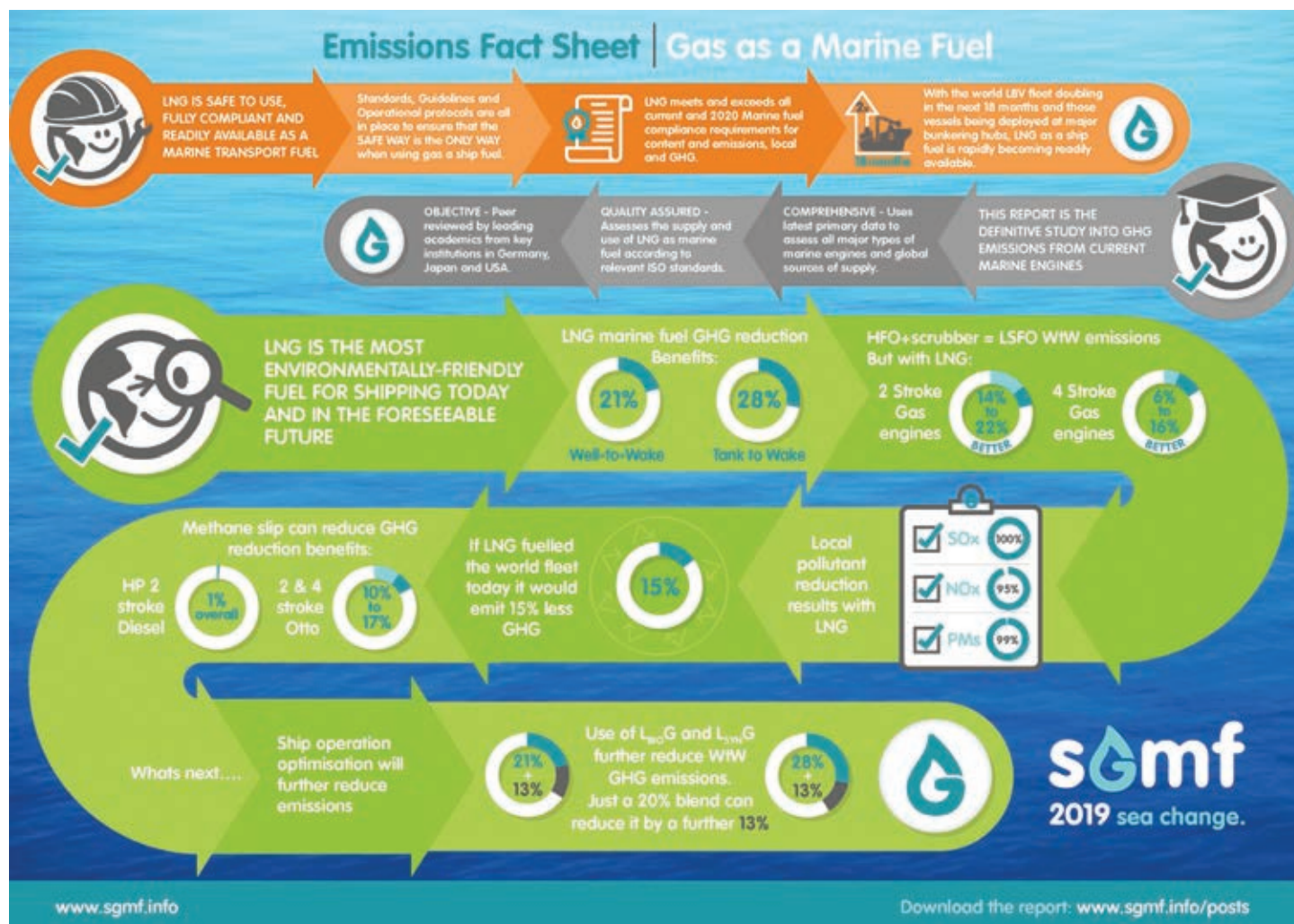
both regular fuel and LNG were introduced to the maritime sector some 30 years ago by Wärtsilä, so this is a well-established and proven technology. LNG contains virtually no sulfur, thus making 2020 compliance easier.

After passing the first milestone - sulfur compliance - the going gets far tougher. None of the solutions for compliance with the sulfur regulations alone can get the CO2 levels down to where the IMO has stipulated, but a combination of different solutions can certainly make significant headway.

This means that alternative clean-burning solutions too have to be found to power ships.

There are, of course, existing ways of propelling a ship with zero or almost zero emissions. However, Wärtsilä believed that the internal combustion engine will continue to play a critical role at a time when the industry is faced with difficult questions on how to move forward.

Therefore, the engineering group said that it recommended shipping companies should look to using future-fuels compatible with existing combustion engine technology, but without the harmful emissions.



In the run-up to the IMO 2030 milestone, the most economically viable and reliable solution for ships being built from now on comprises a combustion engine running on LNG that is supported by the use of connectivity, real-time communication and data analytics in operation and energy management.

Wärtsilä, and other major industry providers, is investing heavily in research on possible alternative fuels. These include bio-LNG and synthetic LNG, ammonia and hydrogen fuel cells.

However, there are considerable obstacles to overcome before their widespread use can be adopted. Let's not forget that the introduction of a new fuel – LNG - required a long period of testing and development of technologies covering the whole supply chain, which finally resulted in the adoption of the IGF code in 2015.

Apart from the potential suitability of these alternative fuels for meeting the legislation, other questions to which answers are needed, include the likely costs involved, the existence

or not of an adequate supply chain and future proof infrastructure and will there be enough to meet demand.

Here, the flexibility of multi-fuel combustion engine technology comes to the fore. As experience has shown, such engines can switch seamlessly between different fuels so if one is not available, others can be used.

DIGITAL SEASCAPE

Wärtsilä's Smart Marine vision is an initiative that takes a big picture approach to reaching the IMO's targets and to improve sustainability in general, the company explained.

In a Smart Marine ecosystem, vessels will be technologically smart, using cloud-based software and digital technology to substantially increase efficiencies that will optimise the use of energy, so that fuel consumption is minimised.

These ships will sail between smart ports that manage traffic flows extremely efficiently so that waste, such as ships waiting to dock in congested harbours, is eliminated. The vision

also foresees new business models emerging whereby greater co-operation between shippers will ensure that ships sail with full cargo loads, thus enabling more cargo to flow using the optimal number of vessels.

Essentially, it seems that the big change will be in the fuel mix used by the engines. The fuel-flexible combustion engine, therefore, presents itself as a future-proof technology, which will enable the industry to meet future targets as and when alternative and renewable fuels become available.

The world of shipping is being re-shaped and investments in sustainable production of bio and synthetic fuels are needed today if they are to become broadly available post 2030. Leveraging radical and transformative innovation is no doubt the way to tackle emissions.

Today, LNG presents one of the best and most economical pathways to decarbonisation, owing to its cleaner burn, compatible pricing and established supply infrastructure - the same infrastructure that can be used for future fuels.

Therefore, the combustion engine remains key to shipping because the reciprocating engine enables fuel flexibility leaving the doors wide open for the future renewable liquid and gaseous fuels, as and when they become compliant, market-ready and available, Wärtsilä concluded. ■

“...investments in sustainable production of bio and synthetic fuels are needed today if they are to become broadly available post 2030.”

Savings claimed with Alfa Laval's heat exchanger

Alfa Laval's DuroShell plate-and-shell heat exchanger is optimised for use as an LNG vaporizer, providing higher thermal efficiency than conventional plate-and-shell designs, as well as fatigue resistance.

Thanks to new research into glycol freezing, it can now be used in even more compact and cost-effective installations, the company claimed.

“The continued rise in the number of vessels sailing with LNG is one of the most significant trends in today's marine industry,” said Jonny Hult, Alfa Laval's Head of Marine Heat Transfer Equipment. “With more and more ships relying on LNG as fuel, we are seeing greater demand for vaporizer technology that can dependably resist freezing and the fatigue caused by pressure and temperature. DuroShell is exceptional in this regard.”

DuroShell has been optimised for use as a vaporizer in fuel gas applications. With its 100% stainless steel design, it can handle LNG entry temperatures that approach -170 deg C or lower.

EXTENSIVE TESTING

Alfa Laval has also performed extensive laboratory freeze testing, gaining knowledge that will lead to lower capital and operational costs, the company said.

“Extreme low temperatures are not an issue for DuroShell, but a glycol mix with a freezing point of around -50 deg C has the potential to freeze when it meets plate surfaces as cold as -90 deg C,” Hult explained. “Solving this problem with a higher glycol flow is a very expensive solution for our customers, so Alfa Laval has worked with SINTEF Energy Research to find the correlation of flows on both sides and thereby avoid freezing of fluid

on the hot side.”

Hult concluded that this will allow shipbuilders to use a more compact plate-and-shell design with smaller pumps and pipes, which, in turn, will mean CAPEX and OPEX savings for the shipowner.

DuroShell's ability to withstand the large temperature differences in fuel gas supply systems stems partly from its special CutWing plates, which feature the patented Alfa Laval RollerCoaster plate pattern. This design provides high turbulence that improves heat transfer efficiency and thus significantly reduces the risk of freezing and fouling.

Another unique DuroShell feature is the patented PowerPack distribution tubes, which run through the plate pack and secure an optimised flow distribution onto the heat transfer surface. This design further enhances the strength of the plate pack for added fatigue resistance in demanding LNG duties. ■

LNG OneWorld.com



LNG bunkering facilities top 100

This is due to the increasing number of vessels of all types, which have been ordered, delivered or planned with LNG as a primary or secondary fuel.

Even charterers/operators are getting in on the act by stipulating low sulfur/low emissions fuel for their chartered ships, illustrated by a recent tender issued by BHP for LNG powered large bulk carriers.

Clarksons said last month that interest in alternative fuels has begun to gain traction. LNG fuel capable adoption stands at around 3% of the world fleet and about 16% of the world orderbook by tonnage.

The broker estimated that 3% to 4% of world tonnage will be LNG fuel capable through 2020, albeit the majority will still be in LNGC transport sector.

LNG infrastructure is also ramping up, with number of ports globally with LNG bunkering facilities having increased from around 20 to about 100 in past five years.

Expanding emission regulations and a growing demand for cleaner marine fuel are expected to bring the LNG bunkering market size to over \$12 bill by 2024, Global Market Insights said in a report.

US LNG bunkering is predicted to exceed 3,000 kilotons by 2024 owing to the advent of

LNG bunkering has taken a giant step forward worldwide in the past year or so.

shale gas, which can be used for marine fuel.

The report added that abundant availability of LNG along with measures to reduce carbon footprints would stimulate Qatar's LNG bunkering market. The country is expected to become the prime source for flexible LNG supply with the capacity of 77.8 mill tonnes per annum.

This has led to an upsurge in small vessels being designed and ordered capable of shipping LNG, either for small scale operations or for bunkering, or both.

LNG SR has outlined a few of these smaller vessels together with their operations.

In 2017, Damen unveiled LNG bunker vessel designs ranging from 500 to 10,000 cu m in capacity at a time when it was very much a fluid situation (see page 23).

Oil and gas majors have sat up and taken notice, particularly as there is EU funding available for European operations.

Recently, Heerema's latest semi-submersible crane vessel (SSCV) 'Sleipnir' began her maiden voyage from her Singapore

builder to Spain.

'Sleipnir' is the world's largest and the first crane vessel with dual-fuel engines running on MGO and LNG.

LNG bunkering took place 12 miles off the coast of Indonesia by 'Coral Fraseri', which is commercially managed by Anthony Veder. It was the first LNG bunkering in this area of the world.

Heerema chose Dutch company Titan LNG to help, which chartered the 'Coral Fraseri'.

Jan Valkier, Anthony Veder CEO, said: "Shortly after adding 'Coral Fraseri' to our fleet we have already mobilised her in the small scale LNG market, which underlines our strong position and commitment in supplying the maritime industry worldwide sustainable solutions for LNG as marine fuel."

"We are extremely proud to have successfully completed the largest LNG bunkering in the world," said Niels den Nijs, Titan LNG CEO, "It was a herculean task, supplying this eight legged extremely potent crane vessel, the 'Sleipnir'. I'd like to thank our partners Anthony Veder, SLNG and Pavilion Gas for their support in this Dutch Singaporean co-production. And look forward to supplying Heerema with more LNG in the future to fulfill our mission of helping to lower harmful emissions from the marine sector."

'Sleipnir' is now on voyage to Spain, via South Africa. In Spain, Titan LNG and 'Coral Fraseri', which will transit via the Suez Canal, will again supply the crane vessel.

In addition, Titan LNG's bunker barge 'FlexFueller001' performed the first official bunkering in Rotterdam on 14th June this year.

The fuel was delivered to the short sea liner shipping company, Norlines.

Titan LNG thus became the first accredited LNG bunker supplier capable of delivering LNG by inland waterway barge. The LNG bunker permit for Rotterdam and the overall LNG bunkering accreditation were granted in May by an IAPH audit team.

'FlexFueller001' is the first of a series. Titan LNG will deploy the 'FlexFueller002', currently under construction, in Antwerp by mid-2020. The third barge will be announced in the coming months.



Large crane vessel 'Sleipnir' being bunkered by 'Coral Fraseri'



Shell is bunkering AIDA's LNG powered cruise ships in the Canary Islands and at Barcelona

Samskip, operator of the LNG powered Norlines' vessels 'Kvitnos' and 'Kvitbjørn', has a weekly service into Rotterdam in which the ships will be fueled by LNG.

SINGAPORE TRANSFER

As for Pavilion Gas, earlier this year the company performed the first commercial ship-to-ship LNG bunkering at Singapore.

The operation comprised of a re-load of 2,000 cu m of LNG onto a small-scale gas carrier at the newly-modified secondary jetty of the Singapore LNG (SLNG) terminal, followed by a ship-to-ship transfer to a heavy-lift vessel (see above).

Pavilion Gas, is a Singapore licensed LNG bunker supplier. Parent, Pavilion Energy demonstrated its truck-to-ship bunkering capabilities in 2017, and further expanded its bunker logistics with the charter of its first LNG bunker vessel newbuild in February, this year.

The 12,000 cu m GTT Mark III Flex membrane LNG bunker vessel is set for delivery by 2021, and is the largest newbuilding for use in Singapore to date.

Moving to the Baltic, Finnish energy company Gasum has reported that its 5,800 cu.m LNG bunkering vessel, 'Coralius' recently carried out its first ship-to-ship bunkering at Rotterdam.

The LNG was supplied to the product tanker 'Bit Viking'.

'Coralius's' main operational area is in the North Sea and the Skagerrak area.

In another first, an inland-waterway LNG bunker vessel has performed her first bunkering operations, delivering gas to the

'Containerships Polar' and 'Containerships Nord' in Rotterdam.

The 'LNG London', which is owned by LNG Shipping – a co-operation between Victrol and Sogestran - is on long-term charter to Shell.

She will primarily be used by Shell for LNG bunkering in the ports of Amsterdam, Rotterdam and Antwerp.

'LNG London' loads LNG at the Gate terminal in Rotterdam. An innovative transfer system enables delivery of LNG to seagoing vessels, inland barges and terminals onshore, while a restricted air draft allows the barge to sail via inland waterways to Antwerp and Amsterdam, if required.

Remaining in the Baltic, on 21st April, 2019, the world's first containership retrofitted with an LNG engine, 'Wes Amelie', received LNG through a ship-to-ship operation from the

LNG bunker supply vessel 'Kairos', operated by Nauticor.

The operation took place in an anchorage near Visby, Sweden.

This was a landmark for several reasons. 'Wes Amelie' received LNG for the first time from a bunker supply vessel and the Baltic Seal saw the first ship-to-ship LNG bunker operation for that type of vessel.

'Wes Amelie', owned by Wessels Reederei based in Haren/Ems, was the first container feeder to run on LNG, when the vessel was retrofitted in 2017. Operating between Rotterdam and the Baltic, the vessel is operated by Unifeeder, which provides the largest feeder and shortsea network in Europe.

A few days later, Nauticor and Klaipėdos Nafta (KN) announced the transfer of KN's 10% stake in 'Kairos' charter contract to Nauticor. Thereby, Nauticor is now the sole charterer of the bunker vessel.

'Kairos' started operations in the fourth quarter of last year. She was originally chartered by Blue LNG on behalf of owner Babcock Schulte Energy.

Blue LNG was a joint venture between Nauticor (90%) and Klaipėdos Nafta (10%).

Within the first months of operation, customers from the container, tanker and ferry segments were supplied with LNG via ship-to-ship bunkering by the vessel.

TRANSHIPMENT

'Kairos' is also used for the transshipment of LNG from the Klaipėda import terminal to the LNG reloading station situated next to the entrance to the port.

Mahinde Abeynaike, CEO of Nauticor, explained: "By having 100% control over 'Kairos', we can deploy the vessel at the LNG bunkering hotspots without having the



Nauticor's 'Kairos' seen alongside 'Visborg' at Visby

obligation to deviate to Klaipeda on a regular basis. Hence we will be able to fully focus on our customers' scheduling requirements. We are looking forward to working closely with KN also in the future to further strengthen the Baltic Sea LNG small scale supply infrastructure."

A month earlier, 'Kairos' conducted the first LNG bunker supply operation for the recently delivered ropax 'Visborg' at Visby's ferry terminal.

This was as the result of the signing of a contract for the supply of LNG, which was signed by Nauticor and Destination Gotland, the owner and operator of the ferry, in December, 2017. The ropax connects the Swedish mainland with the island of Gotland.

Meanwhile, China's first seagoing LNG bunker vessel will operate with an integrated package of environmentally sustainable solutions from Wärtsilä.

The ship is being built by the Dalian Shipbuilding Industry Corp (DSIC) for an affiliate of the ENN Energy holdings, one of the largest users of LNG in China.

It has been designed by China Ship Design & Research Centre (CSDRC).

Wärtsilä will provide the vessel's cargo handling system, the Wärtsilä 34DF dual-fuel main engine, the gearbox, controlled pitch propeller (CPP), shaft generator, two Wärtsilä 20DF dual-fuel auxiliary engines, and the ship's sewage treatment plant.

The integrated gas, propulsion, and waste treatment systems are designed to deliver high efficiency with stable and clean operations. The equipment is scheduled for delivery in early 2020.

The 8,500 cu m capacity vessel is the first newbuilding LNG bunkering vessel for ENN Energy Holdings and is part of the Group's

ambition to play an active role in the international marine LNG fuel supplier market.

With this bunker vessel, ENN will be capable of supplying fuel to the world's biggest LNG fuelled vessels. She is expected to begin operations in 2020 and will be based at the newly opened ENN Zhoushan LNG receiving & bunkering terminal in China's eastern Zhejiang province.

In addition to providing bunkering supply operations, it will also carry out gas testing services for LNGCs and other LNG fueled vessels.

GREEK INTEREST

In the Mediterranean, Greece-based probunkers has invited stakeholders' proposals for the design of LNG bunkering vessels (LNGBVs).

As part of its new project, probunkers plans to design, build and operate a fleet of modern, eco-friendly LNG supply vessels.

Earlier this year, the company said that it was interested in building seven ships, which will operate in various ports worldwide.

probunkers has asked companies to submit initial concept design proposals, along with outline specification and general arrangement for LNGBVs.

probunkers Holding was established in 2017 in Cyprus, with its headquarters in



Gasum's 'Coralius' seen bunkering the 'Bit Viking' in the Caland Canal, Europoort

Athens. The company will have shareholding control over a another group of companies operating in the shipping and energy sectors.

The shipping division will design, build, own and operate a fleet of LNG supply vessels, while the commercial division will operate in seven different locations worldwide, through local offices.

Elsewhere, class society DNV GL has presented ShipInox with an Approval in Principle (AiP) for a new small-scale LNG carrier/bunker vessel design.

This is the first class-approved design based on an offshore supply vessel (OSV). With a length of 92 m, the ship will have a carrying capacity of 6,000 cu m.

DNV GL's most recent forecast predicts that by 2050 over 20% of total shipping energy will be provided by LNG.

"The enthusiastic support we have received throughout the challenging development of this design makes us feel very humble," said Rune Østbøe, ShipInox CEO, speaking last April. "Not only DNV GL and the Norwegian Maritime Authority (NMA), but a diverse range of companies spanning Innovation Norway, to the LNG-specialists at Torgy, and Fearnleys have all enabled us to deliver on this design. We are now in a position where we can help to accelerate entries into small-scale LNG with this fast-to-market and low-cost LNGC."

"This AiP is the result of an excellent co-operative process that included a feasibility workshop with the designers, the Norwegian Maritime Authorities, an OSV owner, and DNV GL experts," said Johan Petter Tuttoren, Business Director for Gas Carriers, DNV GL – Maritime. "We have been able to ensure that this novel design is in full compliance with the 2016 IGC Code and with the relevant class rules."



'Kairos' bunkering the 'Wes Amalie'

Tapping into small and medium scale markets with FSRUs

Demand for small scale units must balance business case against local regulations and longer-term energy market risks, said ABS's Tor-Ivar Guttlesrod in a recent article.*

Numerous projects are being developed across the world and prospects for FSRUs remain strong, particularly in Asia, the Middle East, Africa and South America. As a result, the business case for the supply of LNG on a small scale is attracting more attention.

Similar to full scale FSRUs, small scale projects continue to be challenging in a number of ways. While a full scale project will require a proven business case, small scale counterparts also need to balance risks around national legislation, baseload cargo volumes and whether the supply economics provide the necessary return on a smaller scale. A small scale opportunity might be an extension of a larger scale project.

In the full scale FSRU market, an emerging trend is towards ownership of the assets rather than chartering in the units required, sometimes for economic reasons and sometimes for political ones. Project owners might charter tonnage while units are under construction but the longer term strategy is to maximise return on investment by owning the FSRU as well as associated storage vessels.

This follows the FPSO model, which includes a combination of owned and leased units. In both sectors, it may make sense to buy the asset for long term operation rather than charter it, and there are typically different preferences between different operators and owners when it comes to owning or chartering.

Among notable small scale projects, the Bali LNG terminal comprising a floating regasification barge and a 26,000 cu m FSU was an early mover and has been operational since 2016. Exmar had ordered speculatively rather than against specific projects but still secured long term charters while the company waits for FIDs or local regulations to permit the use of floating power supply

in national waters.

In addition, vessels are under construction in China for potential end-users in South America and an energy major is understood to be tendering for small scale regas units for the same location.

Meanwhile, a tender for small scale energy provision in Indonesia, including regas units and storage barges, has been offered on more than one occasion but so far has failed to materialise.

Indonesia has around 7,000 islands that have a need for electricity and for these locations LNG is in many ways the logical answer, being cheaper and cleaner than coal-fired alternatives, as well as offering greater versatility as it can also be used as a local transport fuel.

UNIT COST

The question of the unit cost for which the supplier can deliver LNG is not straightforward. Whether selling gas on a MMBtu or per tonne basis, the infrastructure and transport costs are not linear and therefore can be a challenge to achieve the necessary delivered price.

Operators must also navigate local conditions since power markets can be subject to regulation, users sensitive to price fluctuations and national laws may impact the ability to operate some types of vessels offshore.

Markets such as Asia, as well as the Southern Hemisphere or the Caribbean are still suitable for small scale LNG but the relationship has to be based on long term government commitment and access to finance.

The challenge for designers and builders is to develop small scale LNG projects that answer all these questions simultaneously. Rather than rely on economies of scale, they

must find ways to build units with the simplicity required to lower the overall delivery cost.

In technical terms, there is not a huge difference between classing a full scale FSRU and a small scale unit, though smaller units can be more complex in execution.

For small scale units, designers will need to think more closely about hazards since there is much less space that can be used for escape routes or blast walls, so comprehensive safety studies are essential.

Only certain yards are able to build units of the required level of complexity. These tend to be in South Korea or China, where ABS has multi-decade experience in classing some of the world's most advanced LNGCs.

Of current full scale FSRU projects, ABS is classing a 170,000 cu m unit currently under construction for Turkish operator Botas at South Korea's Hyundai Heavy Industries and Dynagas' FSRU under construction at Hudong in China.

In general terms, though it appears that the trend towards speculative ordering is slowing, orders are not coming to an end but are being modified.

With the era of the very big floating E&P gas projects coming to an end, there is some doubt as to LNG's role in the larger story of de-carbonisation. Most governments have identified LNG as part of the solution but others see it more as a transition fuel, at least until renewables are established at affordable prices.

This uncertainty means that short term spikes in demand should still be expected, though perhaps the first generational model of take or pay over 20 years is behind us. ■

**This article was taken from Gastech Insights, provided by ABS.*

Second wave of FLNGs on the way

Over the next five years, CAPEX on FLNG units is expected to total \$42 bill – a 172% increase compared to the expenditure of \$15.5 bill seen from 2013-2018.

With four FLNG projects currently in commercial operations and the technology finally moving towards commercial viability, the market is now ready for the second wave of FLNG projects, as global LNG demand is set

to create deficit by 2020.

The four operational FLNGs, include Shell's giant 'Prelude', Golar's FLNG 'Hilli Episeyo' conversion and MISC's units off Malaysian waters.

Another barge-based FLNG, Exmar's 'Tango', recently started operations at Bahia

Blanca, Argentina. Others are planned for small scale operations.

Ahead of November's Singapore 2019 FLNG World Congress, organiser IQPC has put together an infographic showing the major projects in operation and planned, which is reproduced below. ■





Operating Documentation for LNG-Fuelled Vessels

Worldwide standard for:

- LNG Bunkering
- LNG Fuelled Vessel
- Gas Supply Vessels
(LNG Bunker Barges/Vessels)
- FSRU
- LNGC
- FLNG



Project Technical Documentation and Training:

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- Operating Procedures
- Engineering Consultancy
- Technical Translation
- Cargo Operation Manuals
- Engine Room Operations
- Bridge & Deck Operations
- Ship to Ship Transfer

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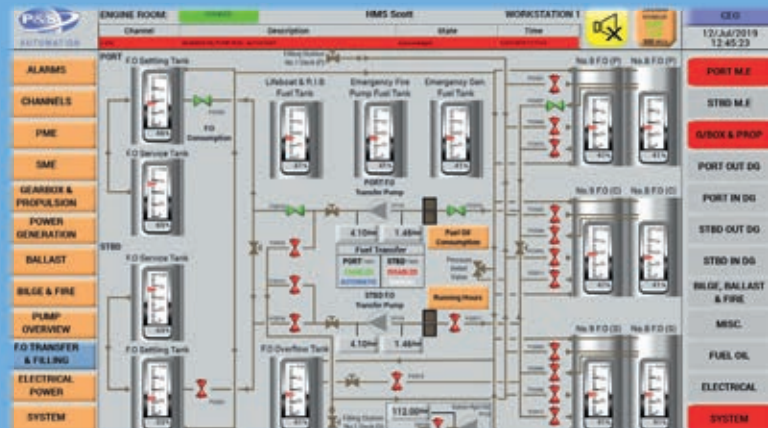


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