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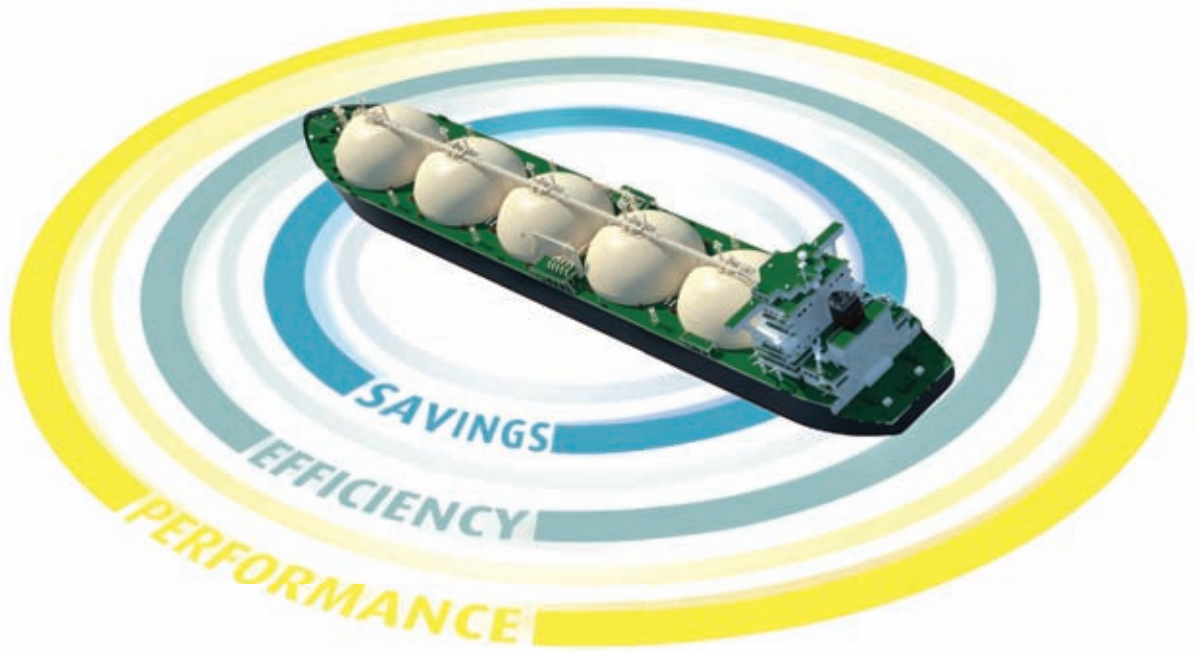
REVIEW



- 2016 - Seeing the sun rise
- FSRU interest increasing
- Gas turbines - an alternative?
- LNG fuel gains momentum
- Small scale LNG making waves

2016

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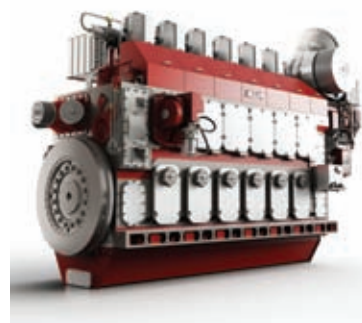
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**Listing of leading
owners, operators
and charterers**



Nakilat's Q-MAX 'Al Dafna' is currently managed by Shell. However, the Qatar-based company is now in the process of transferring large LNGCs into its own technical management department, which has been working alongside Shell for a number of years.

Opportunities increasing

Long term charter deals and interest in FSRUs have dominated proceedings thus far this year.

There have been several long term charters announced in 2016 and also extensions of charters that are already in place. However, the TCE rates have been disappointing.

For example, some speculative newbuilding orders have since found long term employment, as new export facilities come on stream or are due to start operations in the coming years, especially in the US.

Could the US or Australia overtake Qatar as the largest gas exporting nation? Time alone will tell. Russia's giant Yamal project is due to start production in early 2017 and some of the long term charters are attached to this vast project, although of course, the vessels need to be Ice Class and winterised.

Despite the hype a few years ago, the Northern Sea Route has not been a success thus far for transit passages but this could change once Yamal's loading facilities are used to their full potential. Much of the gas is expected to go to western destinations, including Europe, but no doubt Gazprom and its partners are looking to supply the Asia/Pacific region.

However, how much politics will play a part is anybody's guess at this stage, as this was written on the cusp of the US election and intense Syrian activity. Also gas prices might not be competitive with oil or coal as an energy source going forward, although the latter could be losing its popularity on environmental grounds.

Longer term, we will see new exporters line up, including Iran and east Africa and new importers on the Indian sub-Continent, Egypt (originally an exporter) and Israel among others.

The rush to build or convert LNGCs into FSRUs for use alongside import terminals has been noted. By using an FSRU, a country could have a gas importing facility ready for use in as little as 18 months from the time the go ahead is given.

Another advantage of using an FSRU was demonstrated in the UAE recently when two commercial gas-up operations were undertaken at Dubai Supply Authority's (DUSUP) Jebel Ali LNG import terminal.

This involved Exmar's FSRU 'Explorer', which gassed-up all five cargo tanks of two 173,000 cu m LNGCs taking around 15-20 hours for each operation.

DUSUP said that the ability to use the FSRU for these operations will allow LNGCs sailing from Middle East drydocking facilities to avoid having to sail long distances to perform this required step in the LNG cargo cycle, making Dubai a full-service LNG hub.

Gas-up is one of the mandatory operations an LNGC must carry out to enable the cargo tanks to be ready to receive LNG cargoes after leaving a drydock.

Following the completion of 'Explorer's' upgrading programme in early 2016, the FSRU can now provide gas-up, cool-down, and loading services to LNGCs. She was also upgraded to offload to small-scale LNG

vessels for future bunkering purposes and regional supply operations.

Looking at the orderbook, it is clear that the preferred size for an LNGC is between 170,000 cu m and 180,000 cu m. We have not seen any more Q-Flex or Q-Max type tonnage ordered or indeed any mentioned as potential orders.

OPERATIONAL FLEXIBILITY

This is probably due to the average size vessels having greater operational flexibility and the need to sometimes offload into smaller vessels, which will gain greater traction, as more small scale LNGCs and bunkering vessels enter service.

Propulsion has by and large settled on the TFDE and ME-GI type engines and French containment system supplier GTT reigns supreme over the systems available with the occasional MOSS-type system offered if ordering at a Japanese shipyard.

Some shipyards are offering their own design of containment system but probably due to cost, the more standard systems are prevailing. Each shipyard takes out a license from GTT or MOSS to construct their systems, which have stood the test of time.

As the shipyards specialising in the construction of LNGCs all appear to be in financial trouble, the cost of a standard gas carrier has fallen to just under \$200 mill. Whether it falls still further remains to be seen.

With all the talk of massive shipyard debt, especially in South Korea, seeing a shipbuilder go out of business is not good for the LNGC sector, as all the expertise built up over the years in building and designing gas carriers will be lost.

Whether it is a good thing to just pump money into the yards to save jobs is debatable, as this is a very short term fix, especially as in general, ship orders of all types are few and far between at present. The result could be a government staring into an empty building dock with thousands of employees doing nothing.

It is far better to consolidate shipyards into one or two large groups thus enabling synergies to be found to cut costs. ■



More LNGCs are being fixed on medium or long term charters as projects come on stream.

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Vessel supply and demand slowly increasing

With the gradual opening of exports terminals in the US, Australia and elsewhere, plus imports increasing in the Asia/Pacific rim, optimism for 2017 has increased among the major LNGC players.

A much greater increase in activity was reported in the second quarter of 2016. For example, Golar said that during the quarter, 22 spot voyages were concluded by the Cool Pool, compared to only eight in the first quarter of this year.

Much of this additional spot activity was initially supported by an ENARSA tender for 35 cargoes into Argentina early in 2Q16, followed by tenders for additional cargoes into Egypt. Despite this activity increase, timecharter rates hovered around the \$30,000 per day mark for TFD E tonnage and below \$20,000 per day for modern steam powered vessels.

In the 3Q16, chartering activity and LNGC spot charter rates climbed steeply. This firming was not down to seasonal fluctuations alone, Golar said.

A combination of increased production from new facilities, which came on stream in late 2015/early 2016, the withdrawal of spot traded ships in anticipation of the imminent start-up of their dedicated project volumes and more trading activity to service recently installed FSRU capacity, have all helped to start to absorb some of the excess spot tonnage.

The delayed Gorgon and Angola export projects that weighed heavily on the 1H16 shipping market are also now starting up and have now been joined by Sabine Pass Train 2.

In its mid-year report, Golar said that it believed sentiment was shifting and owners were cautiously confident in the market over the next 12-24 months. The volume of voyage charters concluded since 2Q, their headline rates and the re-emergence of full round trip economics, indicated that the anticipated 2H16 recovery in the shipping market was finally materialising as expected.

At the time of writing, round-trip voyages were being concluded at rates exceeding \$40,000 per day out of the Atlantic. Rates in the Pacific also strengthened but not to the

same extent with voyages typically being fixed in the mid-\$30,000 per day range.

INCREASED ENQUIRIES

Enquiries from traders and energy majors for 3-6-12 month charters accompanied by extension options have notably increased lately. Discipline among shipowners was also a welcome sight, as only four LNGCs were ordered during the first half of this year, subsequently joined by at least two more. Conventional carriers on order currently represent about 30% of the current fleet.

GasLog said that about 130 mill tonnes of new production, equivalent to 49% of current natural gas production, was expected to come on stream between mid-2016 and 2020.

However, in the conventional LNGC market, there were a number of newbuildings entering service this year with more to follow in 2017. But despite this influx of newbuildings, GasLog said that demand outlook for LNGCs with long-term charters remained positive.

Illustrating this point, on 11th July, 2016, GasLog announced a new seven-year timecharter contract with Total at a rate that was claimed to be consistent with the company's long-term charter rates, demonstrating the resilience of long-term rates against the volatility of the shorter-term market.

"We continue to see a number of tenders for multi-year charters for vessels, which will be used to transport volumes from new liquefaction facilities coming online over the coming years," the company said in a presentation.

In 2Q16, there were several announcements highlighting the ongoing demand for LNGCs. For example, in May, PETRONAS' FLNG facility was delivered for operation in Malaysia. The facility is the first of a number of FLNG projects that are scheduled to come online in the next few years.

In June, Kinder Morgan received US Federal Energy Regulatory Commission

(FERC) approval for its Elba Island project. The 2.5 mill tonnes per annum facility is expected to come on stream in 2018 and is supported by a 20-year contract with Shell for 100% of the liquefaction capacity.

Elba Island is one of several liquefaction projects that has yet to take a final investment decision (FID), but continued to make progress in the current commodity price environment. However, there have been other liquefaction projects, where timing of FID has been pushed back, such as Shell's Lake Charles project.

The expanded Panama Canal was also opened in June, 2016 and has seen a number of vessel transits since its completion. The opening of the new locks, which can accommodate larger vessels, such as LNGCs, should stimulate increased LNG trading activity between the Pacific and Atlantic basins, due to greater destination optionality.

On 25th July, 2016, the first LNGC transit was undertaken through the expanded canal. 'Maran Gas Apollonia', which is on charter to Shell, entered the locks on the Atlantic side carrying a cargo from the US Gulf Coast to Asia. Three more LNGC transits were booked for the following month.

INCREASING IMPORTS

On the demand side, there have been sizeable year-on-year increases in import volumes from many new and existing countries looking to take advantage of low cost LNG. For example, in the first six months of 2016, China and India imported 29% and 45% more LNG, respectively, versus the same period in 2015.

GasLog said that new importers, such as Jordan, Egypt, Pakistan, and Lithuania saw imports rise significantly in 2016 through the use of FSRUs, which are typically quicker to market and offer greater flexibility than land-based terminals. "We expect FSRUs to create additional demand in both new and existing markets for the new LNG coming online," the company said (see page seven).

Other positive pointers for LNGCs included the Gladstone LNG project, which started operations during 4Q15 and Australia Pacific LNG, which commenced operations shortly after. Indonesia's Senora-Donggi project and the second train of BG's Queensland Curtis project continued to increase its LNG production rates.

The 15.6 mill tonnes per annum Gorgon project has shipped its first cargo whilst Cheniere commenced operations and loaded its first cargo with Train 2 to follow shortly and in the long term, another two trains are due to come on stream.

It was also observed that ships dedicated to the Angola LNG project were now no longer competing for spot voyages. Start-up and ramp up of projects, as well as available cargoes from existing Pacific Basin projects, such as PNG and Bontang, has led to an increase in spot activity in the Pacific and was expected to have a material impact on the LNGC market during the second half of this year.

Activity was also driven by producers and FOB buyers looking for new homes for cargoes, as demand proved to be low at the originally intended destinations.

In the Atlantic, vessel availability was lower, as owners were reluctant to ballast ships to the area from east of Suez. These fixtures tended to come in waves with very quiet periods preceding sudden flurries of activity, sometimes leaving extremely limited prompt vessel availability for short periods during the first half of this year.

NEW CAPACITY

The new LNG production capacity due on stream will have commenced operations in a couple of years and will be equivalent to a 45% increase on the world's current natural gas production.

This will not only result in an increase in the utilisation of existing regasification capacity and shipping tonnage, but also create a need for additional regas capacity with the opening of new markets for LNG, the 'experts' predicted.

GasLog Partners concurred that the demand outlook for LNGCs with long-term charters remained positive.

"We continue to see a number of tenders for multi-year charters for vessels, which we expect will be used to transport volumes from new liquefaction facilities coming online over the coming years. We believe that these new LNG volumes will create demand for additional ships over and above those available in the market today," the company



Tsakos has announced a two-year charter for the LNGC 'Neo Energy'.

said in its third quarter presentation.

GasLog Partners said that there were several new announcements highlighting LNG supply and demand growth, as well as increased demand for LNGCs.

For example, Cheniere announced the substantial completion of Sabine Pass Train 2 with a production capacity of 4.5 mill tonnes per annum and commissioning cargoes from this facility are now being shipped. Angola LNG's 5.2 tonnes per annum facility and the Chevron-operated 15.6 tonnes per annum Gorgon project have restarted production.

In addition, the Canadian government has given conditional approval for Pacific Northwest LNG's 12 mill tonnes per annum project, while BP announced a FID for the Tangguh expansion project, which will add 3.8 tonnes per annum of capacity to the existing facility, bringing it up to 11.4 tonnes per annum.

However, during the third quarter of this year, Shell delayed FID for the 15 mill tonnes per annum Lake Charles LNG project and ExxonMobil announced it will no longer invest in the proposed 20 tonnes per annum Alaska LNG project.

On the demand side, Pakistan announced the purchase of its second FSRU. The country is expected to continue to increase its LNG imports to counter declining indigenous production. It was later announced that Pakistan LNG Ltd had launched a mid-and a long-term tender to purchase a total of 240

LNG shipments. Elsewhere, Bangladesh has announced agreements for the construction and operation of the country's first LNG import terminal, which will also be a floating facility.

Both projects continue a trend of new importing nations selecting FSRUs, which are typically quicker to market and more flexible than land-based terminals. "We expect FSRUs to facilitate the creation of additional demand in both new and existing markets," GasLog Partners said.

Year to date (November), LNG import volumes in China and India are up 27% and 34%, respectively, with both countries looking to take advantage of attractive LNG prices. In the third quarter, LNG prices in Northeast Asia and Northwest Europe rose by 16% and 15%, respectively, making the LNG price arbitrage for US exports more attractive.

In the shorter-term shipping market, spot rates increased from multi-year lows, due to new LNG supply coming online and the restarts of the Gorgon and Angola LNG projects, which removed vessel relets from the market.

From January to September, 2016, there were around 210 spot fixtures completed, compared to about 130 during the same period last year, an increase of around 60%.

"Whilst it is too early to predict a sustained recovery, we believe that fundamentals continue to point to a recovery in 2017 and beyond," GasLog Partners concluded. ■

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Interest in FSRUs growing at a faster pace

The first FSRU came on stream in 2005 and since then, the demand for regasification services has gradually increased.

Close to 25 FSRU projects are in operation with several others under construction or planned. FSRU technology is clearly the preferred LNG import solution if considering cost & timing advantages, Golar LNG said in a recent report.

The company's existing fleet consists of six operating FSRUs, all of which are owned by Golar Partners but are managed by Golar LNG Ltd.

By the end of the third quarter of this year, there were three charter free purpose built FSRUs available to meet near-term opportunities, one of which is being built for Golar.

In response to the weak freight market and solid economics in the FSRU market, Golar said it is currently finalising a new FSRU strategy involving the conversion of a number of its modern, fuel efficient TFDE LNGCs to FSRUs.

The target vessel conversions are similar in specification to the 'Golar Eskimo', currently operating as an FSRU in Jordan. This approach has the benefit of being able to deliver ahead of any FSRUs ordered new from a shipyard today and tailoring the unit's regas facilities to match a particular application, the company said.

The LNG market is oversupplied, a consequence of new LNG liquefaction projects having started operations and lower demand from some established markets. Current market fundamentals have been an important driver of demand for FSRUs in markets, which have previously been unwilling or unable to buy LNG.

Once FSRUs have unlocked access to LNG in new markets, the availability of

As a result in the rise in Global LNG demand, as well as the number of LNG exporters and importers, the demand for FSRUs is rising.

the commodity has enabled these markets to use the units at their peak capacity. Good examples of this are Egypt, Pakistan and Jordan.

By the third quarter of this year, only 10% of the 150 mill tonnes per annum of additional LNG liquefaction capacity coming on-stream between 2016 and 2020 was in operation. The LNG market should therefore see ample supplies as the remaining LNG liquefaction projects commence operations. This, coupled with the expectations of continued low LNG prices, is supportive for continued growth in the FSRU segment, Golar claimed.

'Golar Tundra' arrived off the coast of Ghana at the end of May and issued its notice of readiness the following month. However, her charterers, West Africa Gas Limited (WAGL) has experienced significant delays with respect to the part of the project for which it is responsible.

FLNG ON TRACK

The 'FLNG Hilli' conversion project remains on track to deliver within its stipulated window. In light of the suspension of Engie's proposed land-based LNG project and discussions with Golar's partners in Cameroon, local authorities and key stakeholders, Golar said that it is cautiously optimistic that increased utilisation of the FLNG can be achieved after production start-up.

During the first half of this year, Ophir and Golar continued to explore ways to develop the Fortuna reserves. Projected economics even at current gas forward prices are strong and the combined upstream and midstream investment required to complete the development should be manageable and financeable, the company said.

Golar said that a number of companies have expressed interest in operating FSRUs. Although they have been attracted by the strong underlying prospects, superior returns and increasing opportunities relative to conventional shipping, many of them lack the technical capability required to replicate Golar's own successful conversion model or do not have the risk appetite to speculatively order a newbuild.

A select few will, however, succeed and this has the potential to put pressure on margins where competitive tenders arise. It was also noted over time that a large proportion of FSRU projects are being used to directly support power projects. In many cases, these power projects enjoy returns well in excess of those achieved by the established FSRU infrastructure providers.

On 20th June, Golar entered into a 50/50 joint venture with Stonepeak. This venture, Golar Power, combined Stonepeak's independent power project experience with Golar's terminal and FSRU experience.

Golar Power was formed to offer integrated LNG based downstream solutions through the ownership and operation of FSRUs and associated terminal and power generation infrastructure.

On 6th July, Golar Power took over two newbuilding conversion candidates, the 2017 delivering FSRU newbuilding and Golar's right to participate in Brazil's Sergipe power project. Golar Power started to pursue both standalone FSRU opportunities and integrated

The LNG market is oversupplied, a consequence of new LNG liquefaction projects having started operations and lower demand from some established markets.



Excelerate Energy is a major exponent of FSRUs.

LNG/FSRU supported power projects.

Since then, Golar Power has approved taking a Final Investment Decision (FID) on the Porto de Sergipe project.

This enables CELSE, the project company, to enter into a lump sum turnkey EPC agreement with General Electric to build, maintain and operate a 1.5 GW combined cycle power plant in Brazil.

In connection with the Sergipe FID, Golar Power is to charter the newbuilding FSRU 'Golar Nanook' for 25 years upon her delivery in November, 2017.

The annual EBITDA contribution for Golar Power is projected to be \$39 mill with further upside potential from the FSRU's capacity not used by the Sergipe power plant.

Golar Power has also increased its ownership in the Sergipe Project from 25% to 50%. The final price to be paid for the shares will depend on the performance of the project and the structure includes an option, which if exercised, limits the price to \$50 mill, the company said.

As Golar Power had previously committed to finance the selling shareholders' equity contribution in the project, the ownership uplift is expected to have a limited cash impact on the company during construction. The total equity funding from Golar Power remains unchanged at an expected \$165 mill.

Golar LNG Ltd owns 50% of Golar Power with the remaining 50% held by Stonepeak Infrastructure Partners. Golar Power will own 50% of the Sergipe project and 100% of the associated FSRU.

Golar Power CEO Eduardo Antonello, commented "We are very enthusiastic with the

FID of Porto de Sergipe and fully committed to deliver the plant and terminal in accordance with the original budget and schedule. The project shows very solid economics and provides a strong financial foundation for Golar Power.

"Through this project, Golar Power is developing a very robust and replicable structure to enable the most comprehensive, cost-efficient and flexible integrated gas-to-power solutions globally. We see a huge market to develop cheaper and cleaner energy solutions."

Located near Aracaju, the state capital of Sergipe, the 1,516 MW power station will be the largest thermal power station in South America.

In its third quarter results roundup, Golar said that it had sold a 50% interest in Golar Power to Stonepeak. Together with the addition of \$103 mill in new liquidity to the 3Q16 balance sheet, this transaction removed Golar's obligations to meet the remaining \$216.5 mill of instalment payments due to Samsung in respect of the 2017 delivering FSRU newbuild and substantially reduced the equity call on Golar should the Sergipe project proceed as planned.

In addition to paying Golar \$103 mill (net of a \$10 mill working capital contribution to Golar Power), Stonepeak has also subscribed to a further \$100 mill of preference shares in Golar Power. This, together with an additional \$75 mill funding commitment from Golar before 2H18 provides Golar Power with the capital it needs to sustain its asset base, pursue FSRU and other independent power projects, and, when combined with reasonable debt

assumptions, convert both of its LNGCs into FSRUs.

ONELNG FORMED

In the FLNG segment, Golar and Schlumberger agreed to co-operate on the global development of greenfield, brownfield and stranded gas reserves and as a result, on 25th July, the two parties established OneLNG, a joint venture 51% owned by Golar to develop low cost gas reserves to LNG.

The combination of Schlumberger's reservoir knowledge, well bore technologies and production management capabilities with Golar's low cost FLNG solution will offer gas resource owners a faster and lower cost development solution, the company claimed.

By presenting a united one-stop upstream and midstream solution, OneLNG reduces the number of competing interests in what can be a complicated set of negotiations and also increases the number of financing options available, Golar said adding that this would materially improve the likelihood of a project succeeding.

OneLNG was established with \$20 mill of working capital (\$10.2 mill funded by Golar) and a commitment to contribute a further \$250 mill each upon approval of the first project. A separate OneLNG organisation including a recruited CEO and CFO will be established in due course.

West Africa is one of main areas being looked at, as is Asia but although the cost of feed gas to North American export projects is significantly higher than West African gas, there are also a number of opportunities in this region that have the potential to be interesting

medium term prospects. These prospects would also represent an opportunity to diversify FLNG opportunities from both a gas source (onshore/offshore) and a geographic perspective, Golar said.

Another exponent of FSRU technology is Höegh LNG, having decided to concentrate purely on FSRUs

However, 'Höegh Grace' was employed as an LNGC under a short term contract with Trafigura until September, 2016 after which she proceeded to Cartagena, Colombia, to prepare for commissioning and start-up of the long term FSRU contract with SPEC.

The Colombian FSRU was on schedule to commence commercial operations in the fourth quarter of this year.

In Chile, the Penco LNG FSRU project, previously called Octopus, reached important milestones when all permits were issued by the regulatory authorities in July and August this year.

Höegh LNG said it was pursuing several FSRU projects with expected start-up dates, which match the delivery of the company's newbuilding FSRU No 7.

The company also revealed that it was involved in a tender process for an FSRU

project expected to be finalised shortly and was in bilateral discussions on a second and participating in a tender process on a third project. The projects could reach an investment decision in the near future.

In preparation for the next FSRU newbuilding order, Höegh LNG issued a tender in June and expects to receive bids on an early 2019 delivery from six international shipyards.

Assuming that a contract for FSRU No 7 is secured, the Group was due to evaluate and make a decision on the bids in the second half of this year. To capture additional business opportunities with a start-up at the end of 2017 and in 2018, Höegh LNG has ordered long lead time equipment and signed engineering agreements with Wärtsilä and Moss Maritime for an FSRU conversion project.

By starting preliminary engineering work before the summer 2016 and ordering equipment on the critical timeline in advance, the company hopes to reduce the conversion schedule by six months - from 18 to 12 months.

The conversion design is in line with several of the Group's short-listed projects, and since the equipment can also be used for Höegh's ongoing FSRU newbuilding

programme, the investment poses limited capital risk, the company claimed.

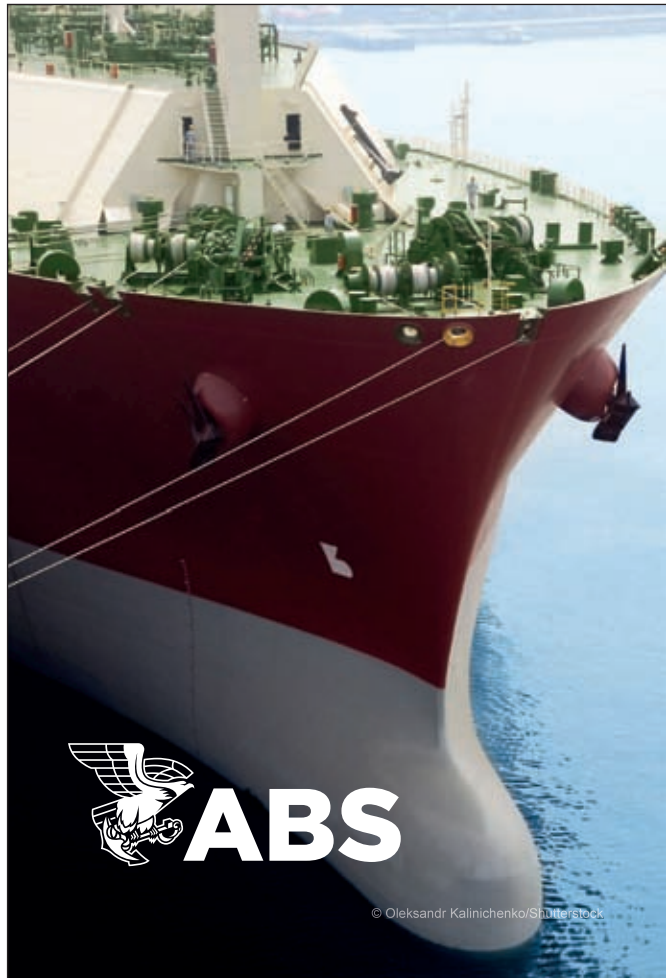
The Group said that it was determined to maintain its position in the growing FSRU segment with a target of owning 12 FSRUs by 2019.

Claiming to be the first to deliver an FSRU on site in 2005, together with partner EXMAR, Excelerate Energy is or has been involved with 11 regasification projects and currently has nine FSRUs, some of which are managed by EXMAR.

LNGC GAS-UP

On 31st August, Excelerate, in collaboration with Dubai Supply Authority (DUSUP), completed the first commercial gas-up operation at the Jebel Ali LNG Import Terminal via the FSRU 'Explorer'.

The FSRU gasged-up all five tanks of a 173,000 cu m LNGC, in 17 hours. DUSUP's ability to use an FSRU for these operations will allow LNGCs departing regional repair yards to avoid having to sail significant distances in ballast to perform this required step in the LNG cargo cycle. A second gas-up operation was completed a few days later on another vessel.



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Pakistan is expected to continue to increase its LNG imports to counter declining indigenous production

Excelerate said that this achievement not only demonstrates the enhanced capabilities of the newly upgraded 'Explorer', but also illustrates the versatility of FSRU terminals in their ability to provide more than just regasification services.

As part of 'Explorer's' recent upgrade, the vessel can now provide gas-up, cool-down, and loading services to LNGCs. The FSRU was also upgraded to include an LNG bunker port to service small-scale LNG vessels.

Gas-up is one of the mandatory operations an LNGC must perform to make the cargo tanks ready to receive gas cargoes after leaving drydock.

Excelerate is also involved with the Aguirre Offshore GasPort will be located around four miles off the southern coast of Puerto Rico. It will use one of Excelerate Energy's 150,900 cu m FSRUs.

The facility will operate year-round,

delivering natural gas to PREPA's Aguirre Power Plant as its primary fuel source, thereby eliminating the use of heavy fuel oil and diesel.

The company's largest FSRU, the 173,400 cu m 'Experience', is currently operating for Petrobras at Guanabara Bay, having arrived on site in 2014.

Another company becoming involved in FSRUs is BW Gas, part of the BW Group.

The company announced last August that it had signed a 15-year agreement with Pakistan GasPort Limited (PGPL) to provide LNG regasification services using a newbuilding FSRU for the second Pakistan LNG terminal.

BW's FSRU, Hull No. 2118, currently under construction at Samsung Heavy Industries will be used for this project. Due to be delivered in 4Q16, the vessel offers a low environmental footprint, high efficiency, storage capacity in excess of 170,000 cu m

and a peak regasification capacity of 750 mmscfd, the company said.

The project is scheduled to be commissioned by 30th June, 2017, at Port Qasim, Karachi.

The first Pakistani regasification project came on stream last year using an Excelerate/EXMAR FSRU.

BW's first FSRU, 'BW Singapore', is currently operating under a five-year contract providing LNG regasification and storage services at Ain Sokhna in Egypt.

Pakistan is expected to continue to increase its LNG imports to counter declining indigenous production and Bangladesh has announced agreements for the construction and operation of the country's first LNG import terminal, which will also be a floating facility.

Both projects continue the trend set by new importing nations in selecting FSRUs, which are typically quicker to market and more flexible than land-based terminals. "We expect FSRUs to facilitate the creation of additional demand in both new and existing markets," GasLog Partners said in its third quarter presentation.



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Trends in FSRU development

Since the inception of the floating regasification concept and the decade since their first operation in 2005, there has been tremendous growth to the current level of 24 vessels operating as fully-fledged Floating Storage and Regasification Units (FSRUs).*

Initially, such units were either newbuildings or vessel conversions, but all of them fit the mould of a conventional LNGC in terms of size and functionality, but with regasification systems fitted on board.

As the market has matured, more and different vessel concepts have made their way into the marketplace, focusing on different parts of the value chain.

An FSRU would typically have larger storage capacity than the discharging carrier and as the size of LNGCs has grown, older LNGC tonnage has been rendered too small for standalone FSRU conversion, paving the way for multiple units or even a barge alongside with an FSU or FSRU system.

Petronas pioneered this concept with the ABS-classed Melaka Terminal, where it employs its older 'Tenaga' class vessels alongside a jetty with a common regasification skid on the jetty. This approach allows for 250,000 cu m of LNG, which is ample for all but the Q-Max vessels while still providing buffer volume.

Another element that encourages the use of floating LNG storage units rather than complete FSRUs is seasonal demand. A simple solution for this is to place the regasification onshore or on the jetty and use an LNGC for storage - an approach taken by Teekay for its Bahrain LNG facility.

An additional factor is that in the conventional LNG size segment there are many ships available for FSRU or FSU conversion, which are still comparatively young. This 'middle-aged' tonnage is not as efficient as the modern vessels coming on



ABS has classed Petronas' Melaka Terminal, which employs an older MISC LNGC as a storage unit connected to a regasification unit on the jetty.

stream given the improvement that has taken place with propulsion and containment systems on newer ships.

The use of barge-based regasification units is a concept many players are investigating because of their potential multiple applications. A unit with some storage and regasification kit on board could effectively work together with an older and somewhat smaller FSU to provide the functionality of a large scale FSRU, also allowing the larger storage unit to trade as an LNGC if there is a low season with little or no gas demand.

SMALL AND MID-SCALE

A second and fast-growing segment of the market is for barges to serve as regasification units for the small and mid-scale segment. Units with a typical storage volume of 10,000 to 25,000 cu m are increasingly popular, can serve a smaller power station for an island nation or any other remote location and can be easily served by small scale LNGCs.

The current overcapacity in the market is leading owners to look toward new solutions

for how to best use their assets. This process typically also involves class, both as a discussion partner but most importantly, in ensuring that any new concepts are in line with applicable rules and regulations.

Finally, a concept that is gaining momentum is combining the FSRU with a floating power generation plant. Very often the LNG demand is driven by the need for clean power generation. So rather than having to build a power plant onshore, a floating LNG-fired power plant can provide a fully integrated solution, with clear advantages regarding project schedule and flexibility.

ABS anticipates a continued strong growth in the FSRU segment given both the current surplus of LNG and its very attractive pricing, as well as the pressure towards more sustainable power and transport solutions.

This growth will however, include a variety of concepts including regas barges, FSUs with barges or onshore regasification, large, purpose-built FSRU concepts, as well as the proven and tested LNGC with regasification facilities fitted on board.



*This article was written exclusively for *LNG Shipping Review* by Tor-Ivar Guttulsrød, Director FSRU & FLNG, Global Gas Solutions, ABS.

Guttulsrød is responsible for floating liquefaction and regasification activities within ABS' Global Gas Solutions, advancing the links between technology and class services with projects for shipowners, engineering houses, shipyards and energy companies.

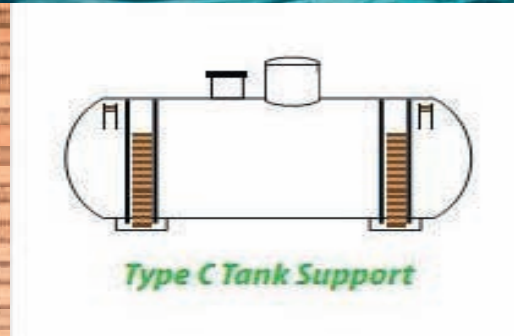
He brings extensive management and operational experience from business development and project and engineering positions in the energy and marine sectors. He started his career as a process engineer focused on LPG and LNG onshore facilities, and moved to offshore and marine working with FPSOs and floating LNG and LPG facilities.

Most recently, prior to joining ABS, Guttulsrød served as Vice President of LNG Sales for Wison Offshore and Marine. He also

held several technical and business development positions with Teekay and ABB. At ABB he worked through all phases of upstream and midstream projects from early conceptual studies through construction, commissioning and start up with a heavy emphasis on FPSOs.

While with Teekay, he started out working with FPSOs, FSOs and shuttle tankers and moved to the gas sector initially with FLNG and then LNG as a marine fuel, LNG bunkering and FSRUs.

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Gas turbines - reliable power in a small package

These reliable engines offer many advantages for commercial shipowners and that is why GE is teaming with some of the world's leading shipyards to bring its COmbined Gas turbine Electric and Steam (COGES) prime mover on board LNGCs and containerships.

Two key developments in the marine industry favour the use of gas turbines for ship power and propulsion: increasingly stringent emissions regulations and the advent of LNG as a viable marine fuel.

Gas turbines are no stranger to the seas and no new technology is required to construct GE's COGES system. Instead, GE is configuring existing products and integrating them into new applications.

Derived from GE's aircraft engines, the marine gas turbines incorporate the same quality requirements, corrosion resistant materials and reliability. The marine engines are fuel-flexible, capable of burning diverse fuels including natural gas, marine gas oil (MGO) and other bio-synthetic paraffinic kerosene blends.

The world's fastest commercial ship

GE's modified jet engines are compact, lightweight, produce low emissions and are easy to operate and maintain, the company claimed.

'Francisco' is an example of the dual fuel capabilities of GE gas turbines. The two LM2500 engines run on either MGO or LNG to propel this fast ferry at over 50 knots under normal operating conditions on each leg of its Buenos Aires to Montevideo route.

GE gas turbines also operate on cruise ships, eight of which feature COGES arrangements. Other marine applications include fast cargo ships, high-speed yachts, offshore platforms and FPSOs.

The fleet has accumulated more than 70 mill hours running on gas—more than 21 mill of which were on dual fuel engines. The same gas turbines are used by 34 navies worldwide for defence; now commercial marine

customers can experience the benefits of this propulsion system solution.

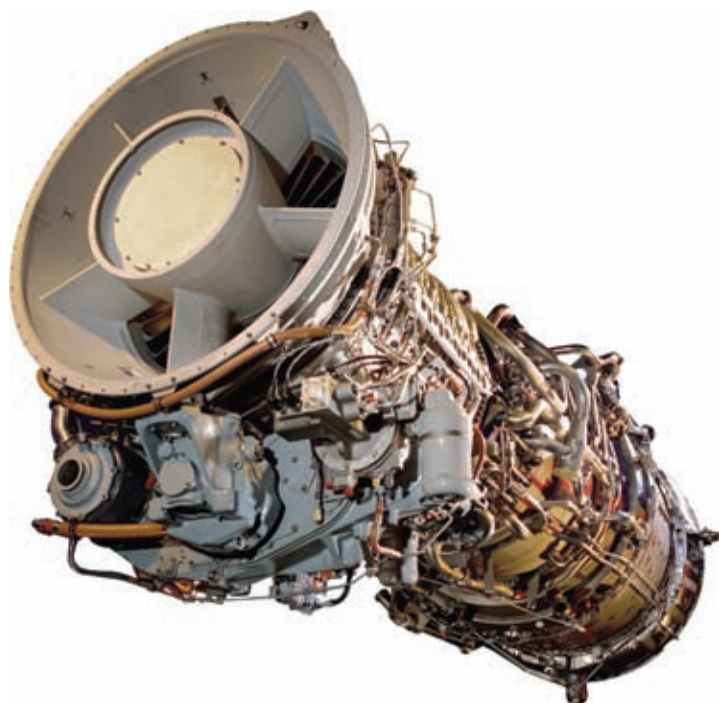
COGES BENEFITS

The COGES system employs a heat recovery steam generator that uses the high temperature of the LM2500 gas turbine exhaust to create steam, which is routed to a steam turbine generator set. Both generators put electricity into a common electrical bus capable of providing power for all ship needs, including propulsion.

GE's gas turbines can be equipped with a dry low emissions combustion system to reduce NOx to meet IMO Tier III/US Environmental Protection Agency (EPA) Tier IV requirements now, operating on gas or liquid fuel with no exhaust treatment and no methane slip.

The COGES system is not sensitive to fuel property changes during an LNGC transit unlike some diesel engines where de-rating may be necessary to avoid shortening the maintenance interval.

With little maintenance required while at sea, COGES makes possible the reduction of



GE's LM2500 gas turbine.

DSIC COGES-based LNGC specification

Length	abt 292 m
Breadth	46.40 m
Draught	11.50 m
Service Speed	19.5 kn

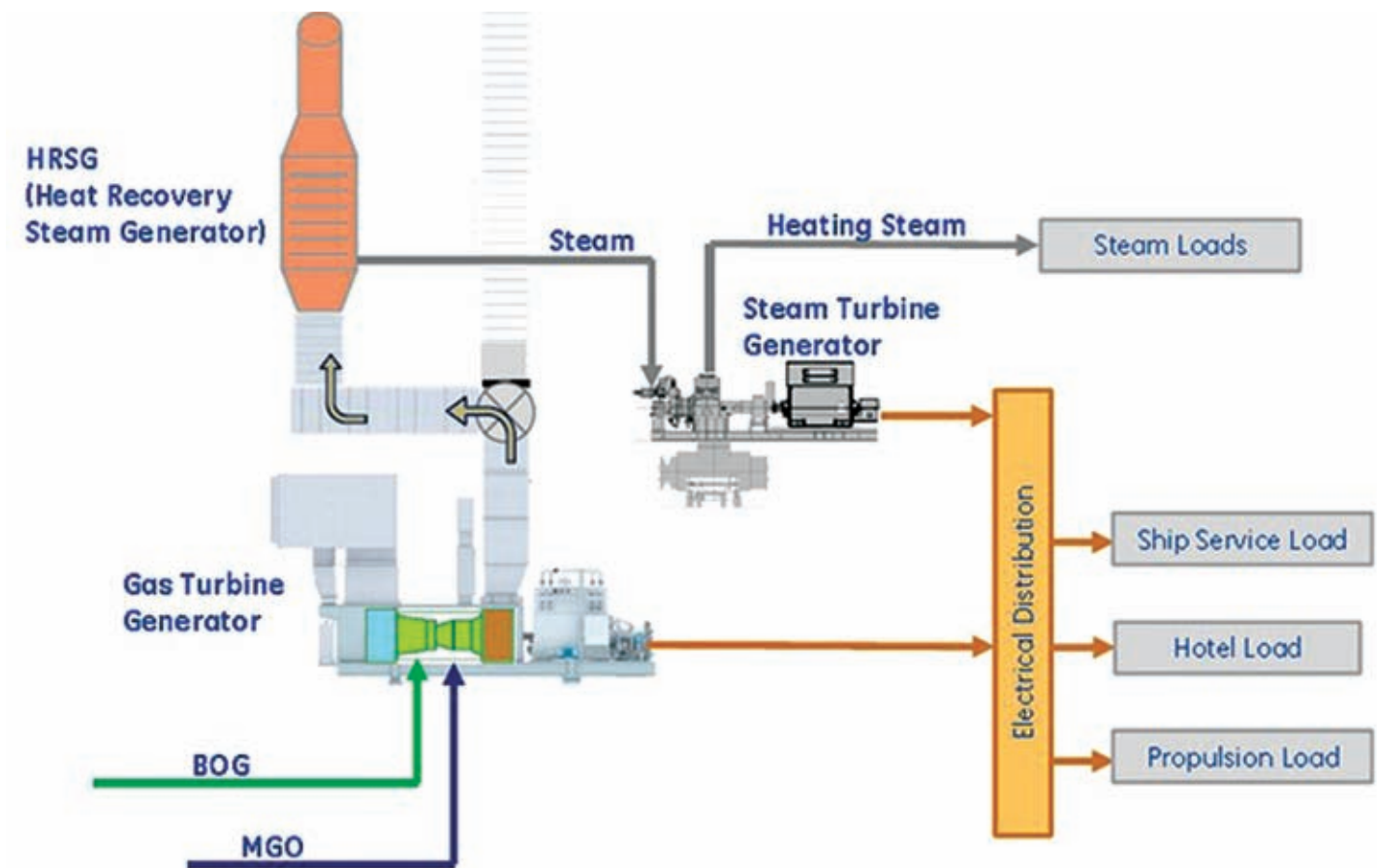
Cargo tank

Containment system	GTT No. 96-GW
Capacity (100%)	abt 179,400 cu m

Main propulsion system*

Gas turbine generator	21,500 kW
Steam turbine generator	8,500 kW
Auxiliary diesel generator	3,000 kW

* Rating at 25 deg C ambient temperature; for reference only



Schematic of an LNGC gas turbine layout.

four engineering crew members versus diesel-powered ships. For normal scheduled maintenance, the entire turbine can be removed and replaced within 24 hours. The combination of outstanding reliability and gas turbine swapping greatly reduces downtime and minimises interruption to ship operations, GE said..

COMMERCIAL SHIP

The LNGC and/or containership designs, outlined below, were developed jointly with GE, have received Approval in Principle (AiP) from either Lloyd's Register or ABS, and use GE's dual fuel LM2500 gas turbine.

The designs will save on capital and operating expenses, and the reduction in weight compared to diesel engines is expected to be around 80% lower with gas turbines. This allows for design flexibility to increase ship efficiency or to carry additional cargo.

- Dalian Shipyard Industry Co (DSIC) offers a gas fuelled 20,000 TEU containership design using a COGES system.
- Hudong-Zhonghua Shipbuilding has a 178,000 cu m LNGC design that will provide an additional 4,000 cu m of LNG cargo space versus a traditional 174,000 cu m LNGC powered by dual fuel engines.

- Hyundai Heavy Industries has a 174,000 cu m LNGC that will use boil off gas or MGO for the COGES system, offering savings calculated at about \$20 mill over the life of the ship.

GE is one of several companies united in accelerating the use of LNG as a marine fuel through participation in the SEA\LNG cross-industry initiative.

Launched recently in London, the objective of this coalition is to work closely with key players across the value chain, including shipping companies, classification societies, ports, major LNG suppliers, downstream companies, infrastructure providers and original equipment manufacturers to ensure an understanding of the environmental and performance benefits of LNG as a marine transport fuel.

SEA\LNG aims to address market barriers and help transform the use of LNG as a marine fuel into a global reality.

The increased use of LNG is good news for GE customers—on land and at sea—because more than 95% of GE-fielded industrial aeroderivative gas turbines burn methane today. These are the same gas turbines used in marine applications of which around one third are dual fuel-capable, burning both gas and

distillate fuels.

GE said that it is continuing to work to fully commercialise COGES-powered LNGCs and containerships. GE also is exploring other LNG-fueled commercial marine opportunities for its compact and lightweight gas turbines that produce low emissions, offer superior reliability, fuel flexibility and ease of maintenance.

Early last year, GE Marine and DSIC received an updated LR AiP for their jointly developed gas turbine-powered LNGC design.

The updated AiP reflects the continued refinement of the LNGC design to take better advantage of the unique capabilities the gas turbine based COGES power and propulsion system provides, GE Marine said at the time.

"With the AiP in hand, customers can feel confident in procuring a COGES-powered LNG carrier," said Brien Bolsinger, vice president, marine operations, GE Marine at the time. "Operational benefits of gas turbines to naval architects, owners and operators, include high power in a compact package and design flexibility. The gas turbine is so lightweight - fully 80% lighter and 30% smaller than comparable slow-speed diesel applications - that it can be located anywhere on the ship."

The LNGC design allows for more cargo - some 5,000 cu m of additional space in the same size hull - along with low emissions and the flexibility to operate on LNG or liquid fuel. The LNGC will be built around a GE gas turbine-based COGES system that will feature one 25 MW gas turbine, one steam turbine generator set and a heat recovery system, including a gas combustion unit.

In addition, the design allows for flexible configuration of prime movers and a total installed power of more than 50 MW, if required. The GE gas turbines can be equipped with a GE dry low emissions (DLE) or single annular combustion system -- both capable of meeting Tier III IMO/Tier IV US EPA requirements with no exhaust treatment and no methane slip.

LR spearheaded and completed a preliminary hazard identification (HAZID) and hazard and operability (HAZOP) study and a

This study delved into the carrier's power station configuration, hazardous areas, structural integrity, safe separation, pipe routing and ventilation [which] will help mature the design and minimise risk for the COGES LNG carrier system.

COGES operation modes evaluation.

According to LR's global special projects manager, Thanos Koliopulos, "This study delved into the carrier's power station configuration, hazardous areas, structural integrity, safe separation, pipe routing and ventilation. The studies will help mature the design and minimise risk for the COGES LNG carrier system. Meanwhile, we evaluated

technical risks including the gas combustion unit and compressors with the equipment makers to ensure safety and operability."

All of the company's marine gas turbines are built at GE Marine's Cincinnati aircraft engine factory. These engines are very compact and light weight, thus it is not a problem to ship them anywhere in the world by sea, land or even air transportation, GE said. ■

Parker Bestobell to supply valves to the rest of Yamal fleet

Parker Bestobell Marine, supplier of cryogenic valves and part of the Parker Group, has secured a nine vessel order.

Worth \$5 mill, this is the single biggest order that the company has won to date, it said.

The contract is with Daewoo Shipbuilding & Marine Engineering (DSME) in South Korea to supply cryogenic globe valves. The vessels form part of a series of 15 LNGCs being built for the Yamal gas project in the Arctic.

The company had already secured the orders for the other six vessels.

This order marks a milestone in the company's history as it has seen a tenfold increase in sales over the past five years in the marine sector and its market share has risen from less than 10% to over 30% during the same period.

Duncan Gaskin, Parker Bestobell Marine's Market Development Manager, said: "The fact that our valves have been specified for such a large and prestigious project is testament to the quality of manufacture and design, as well as the long term, reliable performance in the field. As these valves will have to operate in extreme environments, we have to take some innovative steps to modify the design of the valves to suit the conditions.

"I would like to thank DSME who put their faith in Parker Bestobell Marine when they first specified our valves for vessels on the Yamal project three years ago and this new contract now means we will enjoy a five year ongoing relationship with the company," he said.

As has been well documented, the ships are designed specifically for the Russian LNG Yamal project. The 15 Arc7 Ice Class gas

carriers will operate in Arctic conditions, with temperatures as low as -54 deg C.

They will be required to independently navigate ice more than 2 m thick in a region that is ice-bound for up to nine months of the year. At Yamal, more than 200 wells will be drilled to extract LNG in the largest and most complex project of its type. The annual capacity is expected to be 5.5 mill tonnes. Each of the 15 icebreaking LNGCs has a capacity of 170,000 cu m.

Parker Bestobell Marine supplies cryogenic globe and check valves for many applications, including cargo handling, re-gasification, re-liquefaction, compression, storage, transfer and for fuel gas systems.

The Sheffield, UK-based company has supplied valves to over 250 ships over a 16 year period. ■



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Caterpillar wins dual-fuel engines contract

The company's MaK 16 M 46 DF dual fuel engines, along with a full LNG supply and handling systems, are to be installed on four new ships, under construction at Meyer Werft's Papenburg and Turku shipyards (two apiece).

Caterpillar Marine said that it now offers all round LNG propulsion solutions – from shore-side bunkering to on board storage; from bunker tanks via LNG handling and treatment to the dual-fuel engines, including automation systems; and ultimately the dual fuel main engines MaK 16 M 46 DF, in close co-operation with LNG and cryogenic specialist Marine Service GmbH.

"From a single source, we provide the complete system for ship operators who wish to capitalise on the benefits of LNG as a

Caterpillar Marine has been chosen to fit dual-fuel engines on board a new generation of cruise ships.

marine fuel," said Ulf Hannemann, Caterpillar Marine cruise and ferry segment manager. "We have successfully completed a number of diesel to dual-fuel conversions in the commercial shipping sector and our pipeline of newbuild installations continues to grow."

"However, it is in the cruise sector that we see the greatest opportunities," Hannemann continued. "Clean fuel for cruise vessels is essential in both operational and business strategy terms."

Further, the company is pioneering new techniques to make gas-only operation more attractive. For the first time, research and development at Caterpillar's Rostock facility has demonstrated the efficient operation of LNG main engines at loads of less than 20%.

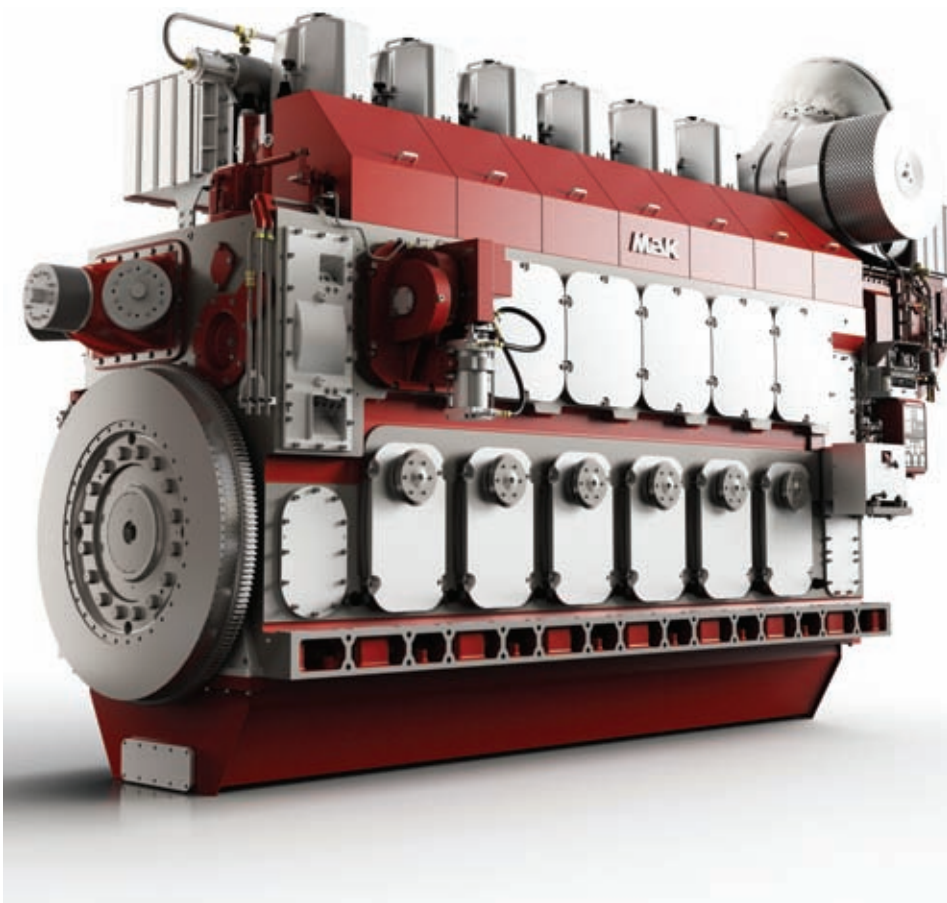
Caterpillar demonstrated the capabilities of the MaK M 46 DF engine and started the engine by using LNG from the very beginning, thus avoiding diesel engine specific emissions – another first for the company. "This development is a key consideration for cruise operators who wish to use LNG, rather than risk smoke from the funnel or soot on deck, whilst starting main engines and manoeuvring in port waters," noted Dr Frank Starke, Caterpillar Motoren managing director.

TECHNICAL INNOVATIONS

The Caterpillar engines are claimed to offer a whole range of technical innovations, including fast load response, better fuel consumption and long intervals between overhauls. They will use the latest generation of the proprietary Cat Engine Control Units (ECU), which in conjunction with in-house software, enabling customer operation profile-specific optimisation.

Caterpillar is also providing its Asset Intelligence (AI) technology and service, which leverages remote monitoring, automated data analytics and expert advisory services to ensure the highest uptime and lowest operating cost.

Caterpillar's sales and service partner Zeppelin Power Systems, based in Hamburg, is managing the project, including supply, commissioning and service. "As a trusted Caterpillar sales and service partner for over 60 years with extensive experience in power solutions, we offer our customers individual and highly efficient solutions for marine applications," said Volker Possoegel, Zeppelin Power Systems CEO. "With our excellent sales and service organisation, we are looking forward to providing the new flagships with comprehensive engineering and service competence to ensure the highest uptime." ■



Caterpillar's MaK 16 M 46 DF engines have been chosen to power dual fuel cruise ship newbuildings.

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Measuring real-time boil-off

With sensor information on board LNG vessels and enrichment using the laws of physics and mathematics, Eniram has developed the technology to precisely ascertain the real time rate of boil-off on an LNGC.

By using this technology, the actual boil-off rate can be calculated at any instant and in any situation that the vessel finds itself.

According to Capt Melvin Mathews, Eniram maritime director, the LNG rate of boil-off is not an unknown entity as such, as it can be calculated in test conditions in a laboratory. This has however, not yet been attempted on board in a scientific manner due to its sheer complexity.

The instantaneous rate of boil-off when it is in a tank on a ship in routine operation, facing the fluctuations in ambient temperature, dynamic conditions at sea, with rolling, pitching and sloshing is a different matter altogether.

When added with the complexity of cargo operations en route, such as working of re-

liquefaction plants with continuous outflow of natural gas vapour and inflow of liquid natural gas into tanks, running of gas combustion units, boil-off processing for use in engines or boilers, etc, computing the boil-off in real-time becomes even more complex.

For a cargo that is carried at temperatures below -260 deg F, the implications of being able to calculate boil-off in real-time are enormous. To begin with, monitoring the performance of the insulation system becomes possible. Measuring the impact of repairs to LNG tanks and insulation is key to knowing if the repair was effective or further repairs are to be undertaken.

Selecting the right insulation for a newbuild LNGC means reducing the effective boil-off and far better performance when it comes to boil-off management and reduction in cargo out turn shortages at the discharge

ports during the operational life of the vessel.

When this information can be mathematically modelled, it gives the capability of predictive simulation of boil-off in any expected sea state or weather condition. This will allow the crew and the operator a better estimation of voyage boil-off losses in advance.

Similarly, knowing in advance that a vessel is going to encounter conditions where there is going to be spike in the boil-off rate, allows the crew to take proactive action to reduce tank pressures well in time. Early insights and visibility allow better decision making on whether to run the re-liquefaction plants or use the boil-off LNG as a fuel.

The system is installed on over 10% of the worldwide LNG fleet. The unique technology to monitor boil-off is well-researched area by Eniram, Capt Matthews claimed. ■

Measuring LNG fuel quality

Barriers remain to the widespread adoption of LNG as a fuel.

One challenge is the varying compositions of gas fuel globally, which can lead to engine damage and failure.

DNV GL claimed to have addressed this by developing an online PKI Methane Number calculator to match fuel quality with an engine's requirements. It can also support the development of an international standard.

The calculator can be applied to a wide range of engine types and used across the entire supply chain by engine manufacturers, ship and truck owners, traders, as well as LNG international policy makers.

Engine knock is characterised by auto-ignition of the unburned fuel mixture, known as the end gas, ahead of the propagating flame in the engine cylinder.

DNV GL has developed a verified algorithm to quantify the effect of LNG quality on engine knock, and thus to help LNG users ensure safe and efficient engine operations. The algorithm has been shown to give a significantly more accurate reflection of the impact of variations in fuel quality on engine knock than traditional tools.

An added advantage is that the algorithm can

be readily incorporated into an engine-control system to maximise knock-free performance when supplied with a wide range of fuel.

DNV GL's senior vice president, Oil & Gas, Liv Hovem, said: "As LNG is produced at different locations around the world, using an assortment of production technologies, its composition can vary considerably. Determining its fitness-for-purpose can be difficult and the consequences of mismatching fuel quality to a specific ship engine can cause potentially dangerous effects, such as significant loss of performance, engine shutdown and even damage. Knowledge of the knock characteristics of LNG fuels is therefore crucial for suppliers and traders to provide reliable and efficient products and to break down the perceived barriers of adopting LNG."

"DNV GL's PKI Methane Number Calculator applies a generic method to quantify the knock resistance of LNG. The methodology behind the knock characterisation calculator has been developed with an eye towards serving as the basis for a robust standard," said Johan Knijp, head of gas quality and energy transition, DNV GL – Oil & Gas. "The user-friendly tool is based on the physical and chemical processes that govern knock and the

methodology behind the tool can be applied to a wide variety of new and current marine and land-based engine types.

"Together with an international industrial consortium, the calculator is currently being extended to cover this full range of engines. Market analyses using the tool to characterise the range of fuel qualities can be used by the entire supply chain, by engine manufacturers, ship and truck owners, by traders and by international policy makers on LNG," he said.

The knock resistance of LNG is characterised by a methane number, similar to the octane number used in gasoline engines. Users of the tool simply enter LNG composition information, such as nitrogen, methane, ethane, propane, and n-butane, and the tool calculates a PKI methane number, which can be matched with the engine specification.

DNV GL has also launched a joint industry project (JIP) to develop tools to support customers in investment decisions on the design of small-scale LNG distribution infrastructure. The project will perform economic and supply chain optimisation analyses to improve knowledge on LNG transportation, storage, quality, and safety. ■



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Turning up the gas

Although the advancement of gas as a fuel pace would seem to some to be a bit on the slow side, initiatives are now taking shape and the numbers of dual-fuel powered vessels being ordered are increasing.

For example, just before the IMO's MEPC 70 meeting in October, the cross-industry coalition SEA\LNG highlighted the ability of the LNG sector to meet the future emissions requirements of the global shipping industry.

Then following the IMO's announcement, SEA\LNG said that it applauded the IMO's decision to confirm the global 0.5% low sulphur cap as coming into force in 2020. Certainty of the regulatory regime going forward is important for the maritime industry, the organisation said.

Peter Keller, SEA\LNG chairman, speaking for the organisation, said: "In light of MEPC 70's approval of the global sulphur cap in 2020, there is now new impetus to resolve the structural and commercial obstacles hindering the widespread adoption of LNG as marine fuel.

"We anticipate increased and significant investments across the shipping value chain as a result of this decision and the certainty it provides. LNG is an economic, clean and safe marine fuel with increasing global availability, offering shipowners a real opportunity to improve the environmental performance of the industry," he said.

The decision taken at MEPC 70 will now have to be implemented by the member states. For those with concerns about the availability

Since last year's Annual LNG Shipping Review, the fears of a perceived lack of LNG fuel infrastructure have eased somewhat.

of low sulphur fuel, the SEA\LNG coalition has already stated that the LNG sector is well prepared and able to meet the future emissions requirements of the global shipping industry.

The recently formed coalition issued a position statement before MEPC 70, which outlined the benefits of LNG as a marine fuel and offered its support for the implementation of MARPOL Annex VI for the prevention of air pollution by ships.

Keller said: "The industry is making big steps in creating the infrastructure to enable quick, safe and cost effective LNG bunkering in key global ports; diminishing the price premium for LNG-fuelled vessels; as well as working with regulators to establish consistent international and national regulations, which we believe will enhance investment in this sector."

In its paper, the organisation said that compared to existing heavy marine fuel oils, LNG can, depending on the technology used, emit 90% less nitrous oxides (NOx) and 20-25% less carbon dioxide (CO2).

SEA\LNG also said that it believed that LNG will be the fuel of choice for vessels operating in global trade lanes, as well as in ECA zones, where the fuel is already gaining a foothold.

Coalition members are positioned to help facilitate the adoption of LNG as a marine fuel, the paper explained. Its members come from across the LNG marine value chain, including LNG suppliers, shipping lines, classification societies, OEMs and port authorities.

Thus far, members include ABS, Carnival Corp, DNV GL, Eagle LNG Partners, ENGIE, GE, GTT, Keppel Offshore & Marine, Lloyd's Register, Mitsubishi Corp, NYK Line, Port of Rotterdam, Qatargas, Shell, TOTE and Wärtsilä.

According to SEA\LNG, there are already 86 LNG-fuelled ships in operation worldwide (excluding LNGCs) and a further 95 on order.

The LNG transportation industry was claimed to have an excellent safety record where gas is commonly used as fuel. Over the past 50 years, global LNG shipments have covered more than 100 mill miles without any major safety incidents in port or at sea.

Globally there are 20 exporters of LNG and some 35 importers in almost all regions of the world, which is growing significantly.

The SEA\LNG coalition was established by Xyntéo, an advisory body, which works with global companies to identify and implement collaborative initiatives to enable businesses to grow in a new way, fit for the resource, climate and demographic realities of the 21st century.

EAGLE LNG

An example of a coalition member involved in bunkering is Eagle LNG Partners, which became a member last July.

Industry leaders come together

In October, SEA\LNG announced its board of directors, which followed the appointment of Peter Keller, Executive Vice President of TOTE, as chair of the coalition.

The board is responsible for the strategic development and oversight of SEA\LNG's vision, mission, objectives and activities, directed towards the accelerated use of LNG as a marine fuel. It will play a critical role in representing the membership in key decision making, as well as promoting SEA\LNG initiatives, the organisation said.

The board consists of:

- Peter Keller, Chairman, SEA\LNG and Executive Vice President, TOTE.
 - Michael Chia, Managing Director (Technology), Keppel Offshore & Marine.
 - Tjerk Johan de Vries, Executive Vice President and Regional Director, DNV GL.
 - Timo Koponen, Vice President, Flow and Gas Solutions, Wärtsilä.
 - Tetsuya Mizuno, Deputy General Manager, Energy Business Division, Mitsubishi Corp International (Europe).
 - Svein Steimler, Executive Vice President and Chief Operating Officer, NYK Group Europe.
 - Tom Strang, Senior Vice President, Carnival Corp.
 - Yvonne van der Laan, Director of Process Industry and Bulk Goods, Port of Rotterdam.
 - Laurant Wetemans, General Manager, Downstream LNG, Shell.
- Encouraging a co-ordinated value chain approach, Keller, said: "To fully realise the potential of LNG as a marine fuel, it is vital that we work together, across the LNG value chain. No one organisation can advance this agenda alone. Our newly constituted board of directors reflects the diversity of our membership and the scale of the opportunity that lies ahead of us." ■

This US-based company is developing liquefaction and bunkering projects on the US Atlantic, Gulf and Pacific coasts, together with inland waterways. It is currently building and/or going through the permit stage of two new LNG production facilities in Florida.

The facility in Jacksonville, for which Eagle LNG was due to submit formal filing to the US Federal Energy Regulatory Commission (FERC) in the fourth quarter of this year, will liquefy, store, and supply LNG for export to countries currently using heavy fuel oil or diesel for power generation, as well as for use as a marine fuel.

A liquefaction plant in Maxville and a marine terminal near Jacksonville, both under construction, are due to be operational in early 2017. These facilities will supply LNG to Crowley Puerto Rico Services for the company's LNG-fuelled Commitment Class conros.

The two conros are currently under construction at VT Halter Marine's Pascagoula shipyard for delivery next year. They will operate on the US Jones Act trade between the US and Puerto Rico.

BUNKER VESSELS

LNG bunkering vessels are beginning to appear on strategic routes on which the use of LNG has been earmarked or is already available. For example, Bomin Linde LNG has secured what is claimed to be the largest LNG bunker supply vessel of its kind to date with a capacity of 7,500 cu m. A timecharter contract was signed with shipowner Bernhard Schulte on 30th September, 2016.

The vessel is to be chartered by a joint venture, established in November, 2015, in which Bomin Linde LNG holds 90%. The remaining 10% is held by Klaipėdos Nafta, the owner and operator of the Klaipėda LNG import terminal.

Commissioning of the vessel is scheduled for late 2018 and Bomin Linde LNG will use the bunkering vessel to supply LNG-powered ships and small-scale LNG terminals along the Baltic Sea coast. For Klaipėdos Nafta, this vessel will secure a flexible LNG transport service to its onshore LNG reloading station, which consists of an FSRU, on charter from Hoegh LNG.

Mahinde Abeynaike, Bomin Linde LNG CEO, explained at the time of the announcement: "The share of LNG as a marine fuel will grow significantly in the Baltic Sea over the next few years. We intend to be at the front, leading the development. Signing this contract is an important milestone for Bomin Linde LNG and a big step forward for the maritime LNG market in the Baltic Sea region.

"For the first time, shipowners and operators will have access to a complete LNG supply chain in the Baltic Sea region. The new vessel will secure LNG supply at an attractive price level, which is crucial for shipowners and charterers of LNG-powered vessels.



Bomin Linde is to operate the world's largest LNG bunker tanker to date.



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“Our parent company - The Linde Group - already operates the LNG terminal in Nynashamn and the smaller LNG bunker supply vessel ‘Seagas’ in Stockholm. Complemented by LNG trucking operations, Bomin Linde LNG, with the new large supply vessel can rely on a unique LNG supply network,” he said.

Due to its propulsion and steering system, including azimuth thrusters and pump jets, the vessel will be highly manoeuvrable. Offshore bunkering will also be possible using dynamic positioning 2 (DP2) technology. Frequency-driven pumps with high flow rates will allow for fast LNG transfer to vessels resulting in short-term layovers at port, the company said.

At the same time as signing the charter contract, The Linde Group acquired the shares of Bomin Linde LNG held by previous co-owner Marquard & Bahls.

An example of a vessel in service, for the first time since her conversion to a triple fuel system, the product tanker ‘Fure West’ was bunkered with LNG by Skangas.

The bunkering operation took place at the Skangas LNG terminal at Risavika, near Stavanger.

‘Fure West’ is the first vessel within the Gothia Tanker Alliance to be fitted with a dual fuel engine. The Alliance has also recently



Another two orders have been added to the four originally announced for the Gothia Tanker Alliance.

ordered six low emission newbuildings fuelled by LNG.

Skangas said that it has in-depth experience in providing efficient and safe LNG bunkering services and has two jetties equipped with dedicated loading arms for bunkering at Risavika.

“We are very proud to offer a flexible, easily accessible LNG bunkering service directly at our LNG Terminal in Risavika,” said Tor Morten Osmundsen, CEO of Skangas when announcing the bunkering operation. “We operate an LNG infrastructure ready to provide LNG bunkering services along the coast of the Nordic countries, as well as ship-to-ship deliveries. Availability of LNG bunkering services is not an issue any longer.”

By next summer, Skangas will be operating the 5,800 cu m capacity ‘Coralus’ designed for ship-to-ship bunkering in icy conditions.

“We are very satisfied that we have now completed the conversion to LNG propulsion on the product tanker ‘Fure West’, and are able to offer first class shipping services to the market using the clean fuel LNG,” said Lars Höglund, CEO and owner of Furetank. “We are convinced that our strategy to invest in an environmentally-friendly propulsion solution, for both the conversion of the ‘Fure West’ and the six newbuilds in the Gothia Tanker Alliance, is the right decision for the future.”

Wärtsilä was awarded the contract to equip the six newbuilding tankers.

The ships are to be built at the Avic Dingheng shipyard in China, on behalf of three Swedish owners - Furetank (three), Älvtank (two) and Thun Tankers (one). The latter is a wholly-owned subsidiary of Thunbolaget.

They will be commercially managed by Furetank Chartering within the Gothia Tanker Alliance. Four contracts were signed in 2Q16 and another two in 3Q16.

The six will fulfil the IMO’s Tier III requirements and will be fuelled primarily by LNG.

Wärtsilä will supply a 9-cylinder Wärtsilä 34DF dual-fuel main engine, two Wärtsilä Auxpac 20 auxiliary engines, the gas valve unit, a controllable pitch propeller (CPP) compliant with Ice Class 1A, a high performance nozzle, a Wärtsilä Energopac rudder system, a Wärtsilä selective catalytic reduction (SCR) system for the auxiliary engines, 12 Wärtsilä deepwell cargo pumps, and two Wärtsilä deepwell ballast pumps with a frequency control system for each vessel.

Wärtsilä will also supply the vessels with a gearbox and shaft alternator having ‘take-me-home’ functionality. This provides propulsion power to the auxiliary engine should the main engine be out of operation for any reason, thus allowing the vessel to return safely to port.

LNG is not the solution - Ian Adams

An alternative viewpoint of LNG as a fuel has been put forward by Ian Adams, the former CEO of IBIA.

He said that LNG is not a panacea to reducing greenhouse gas emissions and its increasing use as a marine fuel could be worse for the environment than burning heavy fuel oil.

In stark contrast to media reports claiming that the use of LNG as a marine fuel can reduce the industry’s CO2 emissions by 75%, Adams, who is often called upon as an expert witness in bunker dispute cases, said: “Whilst it is well documented that LNG is an excellent solution for reducing SOx and NOx emissions, I am dismayed to see it being promoted as a solution for reducing GHGs.”

Adams, who now heads the Association of Bulk Terminal Operators, said: “The energy content of LNG is slightly more than half that of fuel oil, so to extract the

same energy output when consuming LNG rather than fuel oil, it is necessary to consume almost twice the volume of LNG.

“Whilst the chemical make up of LNG will admittedly result in a slightly lower CO2 emission, it is certainly not a large magnitude; but there is another important consideration: LNG is principally methane. With methane recognised as a GHG and widely considered to be 25 times more harmful than CO2, it would only require a 4% slip through the supply chain to equal the CO2 emissions from the industry’s current consumption of heavy fuel oil.

“If we, rather generously, accept that burning LNG will reduce CO2 emissions by 20% over the current level it would require less than 1% slip for there to be no gain from a GHG perspective. Taken over the entire supply chain, 1% is not an unrealistic slip. Unfortunately, the LNG myth has progressed unchecked with very few challenging those lobbying for a wider take up of LNG.” ■

Delivery of the Wärtsilä equipment is scheduled to commence in spring 2017.

In order to achieve optimal propulsion efficiency for these vessels, Wärtsilä used its OPTI Design methodology. This uses extremely accurate information via computational fluid dynamics (CFD) analysis to calculate the performance of the propeller, nozzle and rudder, including their interaction with the vessel's hull, thereby enabling a design that gives a perfect match between the various propulsion elements.

"Wärtsilä is the only company in the world capable of providing such a comprehensive scope of marine solutions from its own portfolio. Being a total solutions provider brings significant added value to our customers since delivery and scheduling risks are reduced, and the various systems can be integrated to achieve optimal performance and lower operating costs," said Aaron Bresnahan, Vice President, Sales, Wärtsilä Marine Solutions last September.

"These environmentally friendly tankers will run mainly on LNG fuel. No other company can match Wärtsilä's experience and reference list in LNG solutions, and we are very confident that the Wärtsilä technology

and broad range of solutions are the right choice," said Furetank's Höglund.

The vessels will be built to a design, developed by Swedish ship designer FKAB together with Furetank.

In addition, Furetank has signed a Letter of Intent (LoI) with Bomin Linde LNG to initiate long-term co-operation regarding the supply of LNG in the Baltic Sea region.

In 2015, Furetank retrofitted the 'Fure West', pioneering the use of LNG as marine fuel in Europe.

According to the LoI, Bomin Linde LNG will supply the Furetank vessels with LNG, including the newbuildings, in a ship-to-ship transfer operation using a new LNG bunker supply vessel both in ports and potentially offshore, using DP2 equipment.

The commissioning of this Klaipeda-based supply vessel, the largest of its kind to date, is also scheduled for late 2018 (see above).

The group will also explore the possibility of establishing designated lightering areas in the Baltic.

STANDARDS LACKING

In another move, a group of ports, including Antwerp and Zeebrugge, Belgium; Rotterdam,

The Netherlands; and Singapore, have joined together to develop a set of harmonised LNG bunkering standards.

The ports have formed a body - Network of Ports and Maritime Administrations - which also includes Jacksonville, US and Norway.

In addition, a Memorandum of Understanding (MoU) was signed between Japan's Ministry of Land, Infrastructure, Transport and Tourism and Ulsan Port Authority, South Korea to be included in the Network of Ports and Maritime Administrations.

The new standards will ensure streamlining of the LNG bunkering operations process and will also assist ports intending to be LNG bunker-ready, the organisation said.

Maritime and Port Authority of Singapore (MPA) CEO Andrew Tan said that as the world's largest bunkering hub, MPA was pleased to co-operate and work with ports in Europe and the US, and moving ahead, Asian ports, to encourage the use of cleaner marine fuels, such as LNG.

This harmonised bunkering standards development is one of the key components in enabling LNG bunkering operations to be conducted safely. The members will continue to work with and through this focus group to

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facilitate LNG as an alternative marine fuel for the future.

The Network of Ports and Maritime Administrations will follow International Association of Ports and Harbours (IAPH), International Organisation for Standardisation (ISO) and Society for Gas as a Marine Fuel (SGMF) guideline documents to develop the new LNG bunkering standards.

HYBRID BARGE

Becker Marine Systems, which conceded that it was struggling to gain acceptance for its hybrid LNG barge system from the Hamburg authorities, last year signed a MOU with KOTUG to introduce a hybrid LNG barge system at Rotterdam from June of next year.

The LNG hybrid barge concept is a floating energy plant, designed to provide environmentally friendly power for ships in ports. The barge will deliver clean energy to moored cruise ships as an alternative for producing electricity in the traditional way by either using generators or main engines. During the winter season, the barge will be able to deliver heat to factories or to the central city heating system in addition to electricity.

The concept was developed by LNG Hybrid, a division of Becker Marine Systems. Dirk Lehmann, Becker Marine Systems managing director, said: "The LNG Hybrid Barge is the first flexible solution supplying clean LNG energy to cruise ships during summer season and providing the flexibility of generating electric energy and heat into a public grid system or industrial users during winter season. We see this advanced flexible solution as an opportunity for Rotterdam and other international ports."

Primarily, the barge will support cruise ships berthed in Rotterdam, traditionally key clients of KOTUG. KOTUG will tow the barge and will provide its commercial, technical and operational management.

This new concept and unique co-operation has drawn significant attention from key players in the LNG market, such as Cruiseport Rotterdam, Dutch National LNG Platform and Shell.

Arjan Stavast, Shell's downstream LNG business development manager for Europe, said "We see the LNG Hybrid Barge as a unique solution for the maritime industry. We will follow these developments closely, as we do believe that the delivery of electricity through LNG is possible for (cruise) ships, factories and cities, while not having to invest heavily in additional electricity infrastructure."

At the recent SMM exhibition in Hamburg,

Lehmann said that the barge had also attracted interest from the ports of Rostock/Warnemünde, Palma (Majorca), Barcelona and Civitavecchia.

CLASS SOCIETIES

The major class societies have not been slow to react to the growing LNG as a fuel momentum and indeed, have been involved with concepts for several years.

For example, RINA has formed what it calls a 'Gas Centre of Excellence' in response to an EU plan launched a year or so ago.

The EU plan was aimed at developing framework conditions for the use of LNG on ships in the Mediterranean, Atlantic and Black Sea areas. This plan will increase the potential of 'Motorways of the Sea' by lowering transport costs and reducing CO₂, NO_x and SO_x emissions, in conjunction with using LNG as an alternative to more traditional marine bunker fuel.

RINA's gas expertise, which covers test, inspection and certification (TIC) and consulting engineering services, including CSM, which focuses on special steel alloys, will be 'virtually' centred in Italy, Greece and Northern Europe.

By using virtual reality, RINA will be able to deliver services globally, thereby helping the industry address the particular needs of using gas as a green fuel source, the class society said.

This has already led to the classing of four LNG fuelled cruise vessels.

Within the development, there are two EU projects (GAINN4CORE and GAINN4MOS), which aim to support the use of LNG as fuel.

RINA Services will provide classification and inspection of vessels and offshore and onshore terminals, while CSM will provide advice on materials and D'Appolonia will provide engineering consultancy around the design, construction and management of LNG terminals.

Operating LNG ships and terminals demands significant training, so the RINA Academy, as part of the 'Gas Centre of Excellence', has developed both basic and advanced LNG fuel courses, in line with STCW requirements.

Elsewhere, DNV GL has written a report for the EU^[1] providing recommendations on how to address barriers to wider adoption.

By November, 2016 all member states were meant to have submitted national policy frameworks for the implementation of the EU alternative fuels directive.

According to DNV GL, two key barriers to the take-up of LNG as ship fuel are the gaps in the legislative or regulatory framework, and

the lack of harmonised standards.

The class society has undertaken an analysis and evaluation identifying the remaining gaps for completing an EU-wide framework for marine LNG distribution, bunkering and use. The report is part of the 'Study on the completion of an EU framework on LNG-fuelled ships and its relevant fuel provision infrastructure' commissioned by the European Commission, Directorate-General for Mobility and Transport (DG MOVE).

This report builds on a study commissioned by EMSA^[2]. It provides an overview of currently applicable standards, rules and regulations governing the maritime LNG supply chain, a gap analysis identifying the gaps in the current regulatory framework in order to make LNG bunkering and LNG fuelled vessels feasible in the EU, a set of recommendations addressing the gaps identified, and an impact assessment of the prioritised recommendations and actions.

"DNV GL's assessment of the existing rules, standards and guidelines shows that from a legal point of view, there are no remaining major show stoppers for the use of LNG as fuel - both for seagoing vessels and inland waterway vessels - nor for the deployment of LNG bunker facilities," explained Martin Layfield, global segment leader of the Gas Value Chain, DNV GL - Oil & Gas, recently.

"In November, members states will have to submit their national policy frameworks using the report's recommendations. DNV GL has advised the EU to implement a low/ moderate harmonisation scenario as the most workable policy option, which will enable members states to transpose the directive on alternative fuels with a 'light touch'. This will reduce effort in implementation, delays and administrative burden while still enabling standardisation," he explained.

"The next three decades will see substantial increase in energy demand. At the same time, a big part of the world expects the energy to be greener, more reliable and more affordable. This is what we refer to as the energy 'trilemma'. Natural gas has a key role to play in the future energy mix and Europe will continue to be a significant import hub for LNG," said Liv Hovem, regional manager, Continental Europe, North and East Africa for DNV GL - Oil & Gas.

"DNV GL is already driving harmonisation through a recommended practice for LNG bunkering and is well placed to support member states, as well as port authorities and the wider industry with guidance on adopting the guidance into their own legislation, in much

the same way as we are doing with the industry on the EU Offshore Directive,” she said.

DNV GL recently published ‘Recommended Practice for Development and Operation of LNG Bunkering Facilities’, which was claimed to be the first industry guidance on securing a high level of safety, integrity and reliability in the design and operations of LNG bunkering facilities.

The class society also contributed to the EU report on ‘Creating Awareness on LNG Risks and Opportunities’, with PwC as the main contributor.

In addition, DNV GL has awarded Vard Engineering Brevik with an Approval in Principle (AiP) for a new 6,500 cu m bunker vessel design.

This design was evaluated for compliance with the DNV GL Gas Bunker rules, the applicable Gas Carrier rules as well as the IGC Code's 2016 edition.

The AiP is a continuation of the GASA (General Approval of Ship Application) of Vard and Brevik Technology's new IMO Type-B LNG cargo containment system, which was granted by DNV GL at the end of 2015.

The bunker vessel will be given the following class notation - 1A tanker for liquefied gas (-163°C, 500 kg/m³, 0.7 bar) Gas Bunker.

Lloyd's Register (LR) has also given Approval in Principle (AiP) for a design from

Hyundai Mipo Dockyard (HMD) for a 6,600 cu m capacity LNG bunker vessel.

The design will be capable of supplying both small scale requirements and the current maximum expected requirements for large ships trading worldwide.

Compliant with the requirements of the revised IGC Code, the design incorporates two cylindrical type ‘C’ tanks, reliquefaction plant, a new loading arm and high manoeuvrability for safe operations. The design is available in both single and twin screw configurations with different propeller options.

According to HMD, three prototypes of 6,600 cu m (single or twin screw) and 15,000 cu m class dual-fuelled LNG bunkering vessels have been designed. They are targeted to operate from Zeebrugge's small LNG terminal to develop a market for the LNG bunkering business in northern Europe.

The 6,600 cu m bunkering vessel design has two cylindrical tanks and a non-bulbous bow shape, while the 15,000 cu m design has three bi-lobe tanks and a bulbous bow.

Leo Karistios, gas technology manager, LR, commented at the design's launch earlier this year: “This HMD design is another significant step in the requirements for safe, efficient gas bunkering worldwide. We are at the start of the LNG bunkering era. The industry is developing technical solutions to support commercial and regulatory

requirements. No one knows at what speed the commercial take-up of gas-fuelled shipping will now proceed, but concrete technical progress is being made.”

Tokyo-based class society ClassNK has also issued an AiP for a 7,500 cu m LNG bunker-supply vessel designed by Hanjin Heavy Industries & Construction (HHIC).

This design is the result of joint research carried out by HHIC and ClassNK to improve the efficiency of LNG bunkering vessels.

ClassNK said that the choice of LNG as a ship's fuel has become increasingly prevalent in the industry, and is expected to become one of a primary source of fuel in the near future. However, LNG-fuelled vessels are currently largely dependent on existing infrastructure comprised mainly of fixed bunker locations, potentially limiting their operations.

Recognising the greater flexibility that LNG bunker vessels could provide through ship-to-ship bunkering, HHIC and ClassNK worked together to improve the viability of this technology.

The design employs Type ‘C’ bi-lobe tanks. The AiP was granted after confirming the design complies with ClassNK's Rules and Guidance for the Survey and Construction of Steel Ships.

This AiP allows the design to be considered for further individual projects, where tests on the hull structure scantling and direct stress analyses will be carried out to ensure the structural integrity of each specific design is in line with class rules and the IGC Code.

Takashi Nishibashi, ClassNK's South Korean country manager, said: “We hope this AiP will help pave the way for a new generation of highly efficient LNG bunkering vessels.”

Cha-Soo Lee, HHIC technical director, added: “When we are commissioned to develop an LNG bunkering vessel concept by clients, we faced a much wider array of challenges, such as compact ship's dimensions, robust hull structure, more cargo capacity, simple operation and lower ship's price, etc. We are happy to find the best compromise between economic and technical issues through this joint research with ClassNK.” ■

[1]DNV GL was the primary advisor to the report (90%) with PwC as sub-contractor (10%).

[2]The EMSA report, published in February, 2013, described the existing rule framework related to LNG bunkering provided a gap analysis of missing rules for bunkering LNG and related aspects were identified. DNV GL's objective was to analyse, further evaluate and propose solutions to the identified gaps and barriers based the findings of the EMSA study and the evolutions since.

LNG fuel survey reveals optimism

Ahead of the fifth LNG Bunkering Summit to be held in Amsterdam early next year, a survey conducted by IQPC's oil & gas bunkering network, showed an encouraging picture.

When asked whether the use of LNG as a fuel would be widespread in vessels in 2017, 79% said yes. For short sea shipping the percentage was 87, while for deepsea vessels some 64% agreed.

Around 83% said that the current low oil price would be a hindrance to the advancement of LNG as a fuel in 2017, while the most important reason for its adoption was regulatory compliance at 42%, followed by profitability with 25%.

Some 52% thought that Europe would drive the market for LNG as a fuel forward in 2017, followed by Asia with 24% and the US at only 6%, while 18% said that there would be no significant progress made.

Partnerships were said to be the biggest

reason for helping to accelerate growth next year with 30%, followed by lower costs at 26%, technical innovation at 16%, funding at 13%, higher oil prices at 11%, while only 4% saw environmental regulations as having an affect.

The greatest hurdle for its adoption in 2017 was seen as infrastructure at 56%, however, this figure was down from the 73% who thought that this would be the biggest problem this year.

Initial costs were cited by 23% of the respondents for next year, but conversions fell to 9%, compared with 34% in 2015 and 22% this year. LNG fuel pricing also dropped from 26% in 2015 to just 6% for 2017 and funding fell from 25% in 2016 to only 3% in 2017.

The best ships suited for the use of LNG as a fuel were ro-ros at 27%, containerships at 25%, tankers at 19% and cruise ships at 12% - the latter was down from 21% in 2016. ■

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Small scale LNG – is the potential still there?

Five years ago small-scale LNG (ssLNG) was considered new and exotic, with only a few early-established players having practical market experience.*

Driven by stricter emission regulations in the shipping sector and falling gas demand, the market showed potential for an attractive business case.

The key challenge was to overcome the 'chicken and egg' issue, which was omnipresent in any discussion about the potential of ssLNG given the need for up-front investment in costly infrastructure.

Today, over a year after the Sulphur Emissions Control Area (SECA) regulations came into force, we are seeing value chains established in some areas, but without the expected pickup in demand. The commodities slump has raised additional concerns for the sellers' business cases, while potential buyers are wondering whether the entire ssLNG

endeavour is worth the hassle.

Despite the increased uncertainty, Pöyry maintains that ssLNG presents interesting opportunities for diverse energy players. With the right business model it is possible to assemble an attractive business case.

There have been many positive developments in ssLNG in recent years, especially on the supply side:

First, the availability of ssLNG has increased significantly. The development of infrastructure for ssLNG supply at the large scale import terminals means that the product is now available in most Northwest European markets. Second, the fall in demand (and willingness to pay) in traditional gas markets has encouraged large scale gas sellers to look for new growth opportunities.

For example, Shell is developing bunkering services in the ARA region as well as in Northern Germany. The gas majors' deeper pockets and a recognition of first mover advantage means that the "chicken-and-egg" has become less of an obstacle.

It takes longer than expected, but demand is growing in the marine and road transport sectors. In the marine sector, the current marine bunker fuel consumption (mainly high sulphur fuel oil) in the European SECA is 20 mill tonnes per year.

Combined with emission regulations, this makes an attractive target for anyone aiming to sell ssLNG. Although the global LNG bunkering market has been slow, Singapore recently announced ambitious plans to position itself as a major LNG bunkering hub and the

LNG accessibility and SSLNG infrastructure

- High accessibility to LNG
 - Medium accessibility to LNG
 - No accessibility to LNG
- Large scale terminals**
- Existing/under construction
 - Planned
- With Smaller scale LNG services:**
Y=existing / P=planned / N=no
- Smaller scale LNG terminals**
- Existing or under construction
 - Planned
- ★ Liquefaction



Source: Pöyry

situation looks promising in China after it announced low sulphur requirements in 11 major ports effective from 2017 and in an extended area from 2019.

As for road transport, LNG is well suited for long distance heavy duty trucks (HDT). This is a large scale market - Pöyry has estimated that the diesel oil consumed by heavy duty trucks in Germany alone is equivalent to more than 90 mill tonnes of LNG.

The main drivers of growth will be strong tax advantages, compared to traditional fuels, combined with infrastructure investment subsidies. Transportation companies such as Tesco, DHL, and UPS are now operating a significant number of LNG-fuelled trucks and fuel distribution companies are opening filling stations.

PRICING

The pricing of ssLNG relative to the alternative fuels is a large unknown. Whilst Gas and LNG prices have fallen to new lows, the future price level is what really matters. Forward prices of oil products are in a strong contango, with the market expecting a

recovery in the mid to long term.

Although the price of wholesale LNG is relatively easy to ascertain, the premium that end users can expect to pay is difficult to estimate, creating a significant risk for potential LNG consumers.

Retail LNG and oil product prices are very close together at the moment, however, they are expected to diverge with more investments, competition and market maturity in LNG, bringing greater demand from the transport sectors in particular.

One of the key challenges is the need for co-ordinated investments and risk allocation throughout the value chain. Generally, market participants prefer to only be exposed to the risks they are familiar with, meaning that unless you rely on players with integrated business models, an appropriate model of risk sharing between stakeholders is crucial for growth.

Currently there are diametrically opposed expectations between the producer and the consumer that could hinder market development;

- Infrastructure developers prefer long term contracts.

- LNG sellers prefer long-term agreements, but are becoming used to a shorter term trading and selling.
- Shipowners considering LNG engines want the ability to purchase in any port at a transparent and predictable price without a long term commitment.
- Truck fleet operators require a reliable network of filling stations.

So is the potential still there? The small scale LNG market is still immature with large differences by region. Added to this, the potential complexity of the value chain and lack of transparency in price levels poses risk, and means that different entities will need to come together and deliver mutually beneficial business models.

However, an increasing number of players are taking an interest and new projects are being developed both on the supply and consumer side. Alongside this, the regulatory incentives aimed at reducing local emissions of SOx and NOx from transport continue to favour LNG, and unit costs are coming down. ■

**This article was written by Andrew Morris, director at Pöyry Management Consulting.*

FSRU compressor system upgrade

Atlas Copco and Neuman & Esser recently joined forces to create the first dual piston/centrifugal compressor application for boil-off gas (BOG) and DFDE fuel for an FSRU upgrade project.

At the end of 2015, Excelerate Energy upgraded the FSRU 'Explorer' for new deployment at the Dubai Supply Authority's Jebel Ali LNG import terminal.

Despite the project having to solve challenges, such as reconfiguration of multiple vessel systems, Excelerate Energy increased the FSRUs regasification capacity output by about 40%.

As an extension to this project, Excelerate asked Atlas Copco for an efficient method to boost the FSRU's BOG handling capacity and to deliver fuel to the vessel's DFDEs, as no system for this type of solution existed. Working in an 18-month window, Atlas Copco developed a solution to incorporate new centrifugal compressors used in series with reciprocating compressors supplied by Neuman & Esser.

As a result, the capacity was increased

from 690 MMscf/d to a world-first 1 Bcf/d, with a base load capacity of 800 MMscf/d. The compressor solution, designed by Atlas Copco, raised BOG handling capacity to match this increase, while delivering the fuel gas to power the ship.

During retrofits, equipment such as HP vaporisers, HP pumps and BOG compressors must be replaced or redesigned to accommodate new outputs. Replacing cryogenic reciprocating compressors could result in longer lead times and project delays.

The combined solution exploits the advantages of both types of compressor technologies: reciprocating compressors are used to create high pressure, while the centrifugal compressors handle larger volumes and cryogenic temperatures.

By accommodating the two compressor types – with the reciprocating compressors 'piggy backed' on to the centrifugals as an alternative means of gas management – the 'Explorer' meets higher BOG handling requirements and delivers fuel gas to its DFDEs and reliquefaction system as needed.

The solution also saves energy and reduces maintenance costs – most notably because the reciprocating compressors can be turned off for part of the year when the output is not needed.

"While the 'Explorer' was the first FSRU to employ this type of dual compression operation, this solution is used at larger LNG receiving terminals where centrifugal compressors handle base load BOG and reciprocating compressor deliver high pressure for fluctuating BOG levels," said Todd Gibbs, Atlas Copco Gas and Process LNG Offshore product manager. "Centrifugals can also be combined with reciprocating compressors for other gas applications."

"By upgrading an existing FSRU we eliminated the long lead time required for a new vessel, improved the overall efficiency of the system, and were able to provide our customer with a world class FSRU with extraordinary capabilities and flexibility specifically designed to meet their challenging needs," said Edward Scott, Excelerate Energy COO. ■

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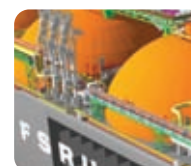
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Photo credit: Bonny Gas Transport / Wärtsilä

Projects are beginning to come together with several at the FID stage. This could be good news for the future of LNGCs and FSRUs.

Next year and 2018 are seen as watershed years for the future of the LNG vessel market by many players, due to the amount of loading terminals due to come on stream or increase their capacity.

However, according to the newbuilding orderbook supplied by Fearnleys and reproduced in our sister publication 'LNG Shipping News', there are still nearly 120 LNGCs earmarked to join the fleet by about 2020 and more orders are likely.

This year alone, at the beginning of November, there were another 15 LNGCs due for delivery. For 2017, the figure is 41 and for 2018, some 44 are due to enter service. This number drops to 15 for 2019 and there are a couple already scheduled for 2020 and beyond.

Of course, most of this tonnage is already committed to long term business for forthcoming export/import projects, due to come open for business in the next few years, including the giant Yamal project. Even some

of the speculative orders for 2018-2019 deliveries have found charterers willing to lock vessels into long term deals at what are perceived a reasonable rates.

The cost of a standard 170,000 cu m newbuilding has fallen on average to just under \$200 mill per vessel, as shipyards fight for what little business comes their way. Most yards are in serious financial trouble and consolidation is on the cards.

Demolition deals reported for older tonnage were very few and far between this year, as owners and operators sought to convert their older tonnage into FSRUs and even FLNG terminals. As reported in this annual review, interest in FSRUs has blossomed this year, as they are seen as a quick fix for near term projects.

ALPHA TANKERS & FREIGHTERS

The one remaining order listed in our 2015 entry for Alpha Tankers was delivered during September of last year.

The 160,000 cu m 'Energy Atlantic'

is fitted with a GTT NO96 LO 3 type containment system and is being managed by Bernhard Schulte Shipmanagement (BSM).

There are currently no other orders being shown for this company.

AUSTRALIAN LNG SHIP OPERATING CO (ALSOC)

ALSOC still operates four of the original seven LNGCs built for the Northwest Shelf project.

They entered service between 1989 and 1994.

The vessels have undergone life extension dockings at Sembawang in the past few years.

AWILCO LNG

Following the sale of three elderly gas carriers, Awilco is now left with two TFDE 156,000 cu m LNGCs- 'WilForce' and 'WilPride'.

The first gas carrier to be sold was the 'WilPower', which left the fleet last year. She



Awilco's 'WilPride'.

was followed by the 1984 and 1983 built 125,000 cu m LNGCs 'WilGas' and 'WilEnergy'.

The former Japanese operated vessels are currently in cold lay-up. The delivery of the vessels to their new owners said to be Far East interests took place in August 2016.

Broking sources said that the sale price was somewhat below \$20 mill each.

BERNHARD SCHULTE SHIPMANAGEMENT (BSM)

BSM currently manages over 80 gas carriers of all types of which 30% are LNGCs.

The third party shipmanagement concern looks after conventional steam powered and Q-Flex types, among others.

Included in the vessels managed is Alpha Gas' 160,000 cu m 'Energy Atlantic', for which BSM provides technical and crew management.

In addition, crewing services are provided for three Thenamaris 160,000 cu m TFDE LNGCs, four Q-Flexes, plus another 16 LNGCs.

BSM provides specialist LNG training courses to facilitate crew with LPG experience migrating to LNGCs.

Corporate expert - LNG, Chris Clucas is currently chairman of SIGTTO general purposes committee, while COO David Furnival will be elected as President at the upcoming SIGTTO AGM in Japan this month.

Clucas was also elected the inaugural chairman of The Society of Gas as a Marine Fuel (SGMF).

BG GROUP (SEE SHELL)

BONNY GAS TRANSPORT (BGT)

BGT is the shipping arm of Nigeria LNG Ltd (NLNG) and was formed in 1989.

The last of BGT's six DFDE 170,000 cu m LNGC newbuildings was delivered in June. Five of the six were delivered between November, 2015 and March of this year.

Four were built by Samsung and the other two by Hyundai.

Nearly 600 Nigerians were trained in the art of shipbuilding in both Nigeria and the two South Korean shipyards. The project also paved the way for the building of a large repair complex in Nigeria supported by both shipbuilders.

A report earlier this year said that NLNG had shipped more than 3,500 gas cargoes in its 15 years of operation

NLNG accounts for 7% of the global LNG market and is the fourth largest LNG plant in the world, the report claimed.

BP SHIPPING

There was no news regarding BP's rumoured newbuilding orders, however, the oil major has chartered in LNGCs on period business.

Teekay LNG Partners confirmed that it had entered into a 13-year timecharter contract with BP Shipping for one LNGC newbuilding, plus an option for another under similar terms.

The vessels were chartered to ship gas from the Freeport LNG project located on Quintana Island near Freeport, Texas, scheduled for start-up in 2018.

BP had agreed to purchase 4.4 mill tonnes

of gas per year from the Freeport project under a 20-year contract.

As a result, Teekay ordered two 174,000 cu m LNGCs from Hyundai Samho, scheduled for delivery in the first quarter of 2019, plus an option for a third.

In addition, Greek shipowner Chandris, a newcomer to the LNG market, is also believed to have been awarded a timecharter contract for one newbuilding LNGC with an option for a second.

Chandris had earlier ordered a 174,000 cu m membrane-type newbuilding at Daewoo, which is scheduled for 2018 delivery in partnership with 'K'Line.

BP manages three 138,000 cu m steam turbine LNGCs, four 155,000 cu m DFDE LNGCs and the 1991-built LNGC 'Northwest Shearwater' for the North West Shelf consortium.

When approached BP refused to comment.

BRUNEI GAS CARRIERS (BGC)

Incorporated by the Brunei Government in 1998, BGC is a joint venture between Shell Gas and Diamond Gas Carriers.

BGC currently owns four A-class vessels ranging from 137,000 cu m to 154,000 cu m in capacity and provides management services to Brunei Shell Tankers two elderly B-class LNGCs of around 77,000 cu m each.

The vessels are technically managed by STASCO.

The last vessel, the 154,800 cu m 'Amani' was delivered in December, 2014.

BW LNG

BW has been involved in LNG shipping since the early 1970s and in the early 2000s, the company expanded its LNG activities to take advantage of growth in LNG transportation, securing a number of longer term charters.

The most recent growth has been through the deliveries of two LNGCs and the company's first FSRU last year.

BW's current fleet comprises 21 vessels, including five newbuildings. Out of the total, 18 are LNGCs and the remaining three are FSRUs. BW also owns a stake in two LNGC newbuildings at Hudong Shipyard, China.

The first of the current LNGCs was delivered in 2003.

BW LNG has partnered with major energy companies, such as Engie, Marubeni and Pavilion Energy.

In August, BW announced that it had signed a 15-year agreement with Pakistan GasPort Limited (PGPL) to provide LNG regasification services using a newbuilding



BW LNG's 'BW Panda' seen fitting out.

FSRU for the second Pakistan LNG terminal.

BW's Hull No. 2118, currently at Samsung Heavy Industries, will be used for this project. To be delivered in fourth quarter of this year, the vessel is claimed to offer a low environmental footprint, high efficiency, a storage capacity in excess of 170,000 cu m and a peak regasification capacity of 750 mmcsfd.

The FSRU is due to be commissioned by 30th June, 2017, at Port Qasim, Karachi.

BW's first FSRU, the 170,000 cu m storage capacity 'BW Singapore', is currently operating under in a five-year contract providing LNG regasification and storage services at Ain Sokhna, Egypt.

CHEVRON SHIPPING

Chevron owns one-sixth interest in each of the seven North West Shelf LNGCs.

It also manages the 'Northwest Swan' on behalf of the consortium.

The company also manages at least two other LNGCs and has another two set for delivery this year - 'Asia integrity' and 'Asia Vision'.

It is believed that the newbuildings are earmarked to ship gas from Chevron's Gorgon and Wheatstone projects.

In March, Chevron made its first shipment of LNG from the Gorgon Project, using the

LNGC 'Asia Excellence', which left Barrow Island off the northwest coast of Western Australia.

The cargo was delivered to one of Chevron's foundation buyers, Chubu Electric Power, for delivery in Japan.

Chevron Shipping is in the final stages of its largest shipbuilding and fleet modernisation programme in recent history, which includes the addition of six new LNGCs, its parent said.

COSCO SHIPPING ENERGY TRANSPORTATION

Newly formed tanker giant COSCO Shipping Energy Transportation will have at least nine LNGCs in its portfolio, according to Chinese sources.

The asset value of COSCO Shipping Energy Transportation accounts for 11% of COSCO Shipping's total assets and its oil and gas tanker fleet amounts to 20% of the group's entire shipping capacity.

COSCO Shipping chairman Xu Lirong reportedly said that the establishment of the new company is a practical way to achieve business scale and synergies particularly in the sectors of energy shipping and logistics, in order to better compete with other established global rivals.

"This move is also part of ongoing

restructuring of State-owned enterprises," Xu said.

Local reports said that COSCO Shipping Energy Transportation was born out of China Shipping Development (CSD) and others, itself a player in the tanker and gas carrier markets.

At the time of writing, it was not clear how China LNG Shipping (Holding) (CLNG), which was jointly established by China Merchants Group and COSCO in 2004 and was the first China-based LNG shipping company, will fit into the new structure.

CLNG had established several business sectors, including investing in LNG shipping related businesses; LNG shipping arrangements for gas projects; investment in LNGCs; consultation services in LNG shipping, financing and technology, as well as shipbuilding supervision.

A specialised shipmanagement company - China LNG Shipping International (CLSICO) - was formed to undertake LNGC crew training, manning, technical maintenance and ship operations.

CLNG and CNOOC hold 60% and 40% of CLSICO shares, respectively.

CLSICO was financed and managed by CLNG and BP. The latter sold its shares to CNOOC on 1st August, 2013 having passed

on its ship operation and management expertise.

At least six 174,000 cu m newbuilding LNGCs are believed to be under construction at Hudong-Zhonghua for China Shipping for possible China National Offshore Oil Co's (CNOOC) operation.

CYGNUS LNG SHIPPING

Nippon Yusen Kaisha (NYK), Tokyo Electric Power (TEPCO) and Mitsubishi Corp formed Bahamas-registered Cygnus LNG Shipping in 2006.

TEPCO provided 70% of the capital, while the other two partners contributed the remaining 30% on a 50:50 basis.

A 147,000 cu m Moss type LNGC was built and the 'Cygnus Passage' was delivered from Mitsubishi Heavy Industries in 2009.

She transports LNG from Sakhalin II to TEPCO's receiving terminals in Japan.

DYNAGAS

This group is split between Dynagas Holding and Dynagas Partners. The Partnership was formed to operate the LNGCs on long term leases.

At present, the two companies account for 10 LNGCs, of which six are owned by the Partnership.

Earlier this year, new long-term charters were agreed for the 'Lena River' and the 'Yenisei River' with Yamal Trade Pte.

The charters have an initial term of 15 years, and one year delivery windows starting 1st January, 2019 and 30th June, 2019, respectively, with options to extend for three consecutive periods of five years each.

In March 2016, Dynagas entered into a timecharter contract with Gazprom Marketing and Trading Singapore for the 'Ob River', for a firm charter period of 10 years.

This charter will be in direct continuation of the current agreement with Gazprom, which was also extended to the second quarter of 2018.

EMPRESA NAVIERA ELCANO

The Spanish shipping company manages two LNGCs - a 2003-built 138,000 cu m LNGC and a 173,600 cu m vessel, delivered by STX in 2010.

Elcano has since ordered two 178,000 cu m LNGCs from Imabari. The 'Casillo de Merida' is due to be delivered in May, 2017 and her sister 'Castillo de Caldelas' a month later.

They will be fitted with GTT's Mk III Flex containment system and powered by MAN ME-GI propulsion units.

EXCELERATE ENERGY

The company was formed in 2003 to operate LNGCs and FSRUs.

Excelerate currently owns and operates one conventional gas carrier and nine FSRUs, it confirmed.

The FSRUs operate with gas projects worldwide, including Argentina, Brazil, UAE and has several other projects under negotiation

One of the latest projects concerns the signing of a Terminal Use Agreement (TUA) and the Implementation Agreement (IA) with the Bangladesh Government for the construction and operation of Bangladesh's first LNG import terminal – Moheshkhali Floating LNG.

Located offshore near Moheshkhali Island in the Bay of Bengal, the terminal will provide the infrastructure required to access natural gas from global markets. The terminal is expected to be in operation in 2018.

The project is a result of the collaboration between Excelerate, Petrobangla, and IFC, a member of World Bank.

Moheshkhali Floating LNG will be the world's first fully integrated turnkey floating LNG terminal whereby all services will be provided under a single contract by a single provider – Excelerate Energy - the company claimed.

Excelerate will fully develop, design, construct, install, finance, and operate the terminal. and will operate the terminal and will operate it for 15 years, after which the company will transfer ownership to Petrobangla.

The terminal will include the provision of an FSRU, the installation of a subsea buoy system anchored offshore, and the employment of port service vessels during operation.

The FSRU will have 138,000 cu m of LNG storage capacity and a base regasification capacity of 500 mill standard cu ft per day.

Excelerate completed its 1,000th commercial ship-to-ship (STS) transfer of LNG on 31st August, 2016, in Escobar, Argentina at GNL Escobar LNG import terminal.

Using Excelerate Energy's FSRU 'Expedient' and a conventional LNGC, 83,767 cu m of LNG were transferred using the double-banked LNG transfer system. To date, Excelerate has transferred over 113 mill cu m of LNG using its STS protocol.

Excelerate developed Argentina's YPF's first LNG import terminal Bahía Blanca Gasport in 2008. Located in Bahía Blanca, Argentina, it was South America's first LNG

import terminal and helped open new markets for LNG in the region.

In 2011, Argentina again contracted Excelerate to supply a second FSRU terminal project - GNL Escobar.

Excelerate Energy, in collaboration with Dubai Supply Authority (DUSUP), recently completed the first commercial gas-up operation at DUSUP's Jebel Ali LNG import terminal via Excelerate's FSRU 'Explorer'.

The FSRU gasged-up all five tanks of a 173,000 cu m LNGC, in a 17-hour period. DUSUP's ability to use the FSRU for these operations will allow LNGCs departing drydocks in the area avoid having to sail for long distances to perform this required step in the LNG cargo cycle, making Dubai a full-service LNG hub.

A second similar gas-up operation was completed a few days later on another vessel.

This achievement not only demonstrates the enhanced capabilities of the newly upgraded 'Explorer', but it also illustrates the versatility of FSRU terminals in their ability to provide more than just regasification services, Excelerate explained.

As part of 'Explorer's' recent upgrade, the vessel can now provide gas-up, cool-down, and loading services to LNGCs. The FSRU was also upgraded to include an LNG bunker port to service small-scale LNG offtakers.

Gas-up is one of the mandatory operations an LNG carrier must perform to make the cargo tanks ready to receive LNG cargoes after leaving the drydock.

DUSUP completed the construction of the LNG import terminal at Jebel Ali in 2010. To meet the increasing demand for natural gas in the Emirate, DUSUP entered into a long-term timecharter with Excelerate in 2014 for a larger and more efficient FSRU to replace its existing regasification vessel.

The 'Explorer' has 151,000 cu m of LNG storage capacity and is permanently moored alongside the jetty at Jebel Ali and can accommodate deliveries from LNGCs of up to 263,000 cu m.

EXMAR

The Belgian-based company claims to be well placed to take advantage of the upswing in demand for FSRUs.

This is due to operating these sophisticated units and immediate availability of the company's barge-based FSRU in 2017, the company said.

EXMAR has been focusing on the development of dedicated LNG infrastructure solutions with its jointly-owned fleet of

FSRUs and one LNGC, some of which are under long-term charter contracts with Excelerate Energy.

At present, the company owns four FSRUs and two 138,000 cu m LNGCs in joint ventures and has another six FSRUs and at least two more LNGCs under management.

The commissioning process of EXMAR's 0.5 tonnes per annum Caribbean FLNG started on 14th June. Performance testing was due to be undertaken before delivery during the third quarter of this year.

It remains available on the market and EXMAR claimed to be pursuing a number of promising employment prospects. In addition, a number of new parties have approached EXMAR citing an interest in the possible acquisition of the barge.

EXMAR's 26,320 cu m barge-based FSRU is also currently under construction at the Wison yard in Nantong, China and has attracted interest from the market as a fast-track solution to their energy needs, as it allows customers to start importing natural gas in less than one year from now, whereas a traditional onshore terminal would take four to five years to develop, the company claimed.

With over a decade's operational experience since pioneering the world's first regasification at sea in 2005, EXMAR realised that most FSRU projects require long term deployment at a fixed location, making a barge-based solution economically more attractive than a traditional ship-based FSRU solution, the company said. The barge will be delivered next year.

Final investment decision (FID) has not yet been declared for the SWAN LNG project in India. Discussions are still ongoing for the leasing of a FSRU.

Elsewhere, discussions are currently taking place between EXMAR and Vopak to explore the possibility of the acquisition of EXMAR's current floating regasification business by Vopak.

Four jointly-owned FSRUs remain on long-term charter to Excelerate Energy for a combined term of more than 60 years. This significantly reduces EXMAR's exposure to the markets, it said. EXMAR Ship Management (ESM) remains under contract to operate and crew these vessels and has just completed a major upgrade programme on the FSRUs that are jointly owned and/or managed.

At the DUSUP facility at Jebel Ali, UAE, the regasification vessel 'Explorer' achieved the world's highest send out rate, reaching above 1,000 mill standard cu ft of gas per day

and loading at 10,000 cu m per hour through ship-to-ship transfers.

'Excel' completed her charter at the end of April and is now on the market and available for deployment, either as a standalone carrier or in combination with floating regasification/liquefaction solutions as a high-spec FSU. The LNGC 'Excalibur' remains under long-term charter to Excelerate Energy until March, 2022.

By the end of August 2016, the milestone of 1,000 LNG ship-to-ship transfers was accomplished on ESM LNGCs.

In the first half of this year, ESM launched an education department - EXMAR Academy. This ISO - and government-approved initiative has been established to meet the STCW training needs of its seafarers, as well as offering internal and external trainees MCRM training, training facilities, and specialised training for liquefied gas carriers.

FLEX LNG

FLEX LNG is constructing two Neo-Panamax LNGCs with a capacity of 174,000 cu m at Samsung Heavy Industries for delivery in the first half of 2018.

The company said that it continued to contract services from Frontline Management, which includes technical management, newbuilding supervision and administrative services.

The specifications of the newbuildings were changed last year from LNGFPSOs to pure LNGCs. They will be powered by ME-GI propulsion units, instead of the original DFDE engines.

FLEX LNG said that it was hopeful that by the time the vessels were delivered, several more LNG export trains will have come on stream.

GASLOG

GasLog has recently chartered its last open vessel on order (Hull 2801) to Total Gas & Power Chartering for seven years, commencing in 2018, at what it claimed were attractive rates.

'GasLog Glasgow' was delivered on 30th June, 2016 and commenced her 10-year charter to a subsidiary of BG Group, now owned by Shell. This vessel was one of eight newbuildings with multi-year contracts being delivered between 2016 and 2019, of which about five are still under construction.

Two vessels due to be delivered this year are timechartered to MSL, a subsidiary of BG Group in turn now owned by Shell, for seven years.

Another two vessels expected to be delivered in 2018 and 2019 will also enter into 9.5 year timecharters with MSL upon their delivery.

Following the Total fixture, GasLog now has 13 LNGCs under long-term charters that are eligible to be dropped down into GasLog Partners through the omnibus agreement.

In all, GasLog, including GasLog Partners, has the 13 vessels in operation, plus another five managed at the time of writing.

The company also executed debt refinancing of \$1.05 bill with a number of international banks, extending the maturity of six existing credit facilities to 2021 and issued NOK750 mill (equivalent to \$90.2 mill) of new senior unsecured bonds maturing in May, 2021 in the Norwegian bond market refinancing NOK588 mill of existing bonds maturing in June, 2018.

In addition, GasLog launched a public offering of 2,750,000 common units raising gross proceeds of \$53.6 mill.

Just recently, GasLog ordered another LNGC on the back of a seven-year charter to Centrica and dropped the 'GasLog Seattle' into GasLog Partners through the omnibus agreement giving the Partnership nine vessels.

GAZOCEAN

The Marseille-based company is a subsidiary of GDF SUEZ and NYK groups and operates five LNGC both on regular and tramp trading.

Three of these vessels are fitted with DFDE propulsion systems.

Since the expansion of the fleet and the merger of Gaz de France with Suez, GAZOCEAN, has strengthened its position in the carriage of LNG in French and international markets.

GAZPROM MARKETING & TRADING

The London-based commercial arm of the Russian energy Giant currently operates six Ice Class LNGCs.

Four are long term chartered from Dynagas, while the other two are managed by Sovcomflot.

A twin engined 174,000 cu m Ice Class TDFE FSRU is due to be delivered next year, according to the company.

GOLAR LNG

During the last quarter of 2015, Gazprom, Perenco and SNH signed a firm eight-year S&P contract for LNG from the converted GoFLNG 'Hilli' and the project reached



Golar is one LNGC operator to take advantage of Gibraltar's STS slot. Photo credit - Gibraltar Port Authority.

a Final Investment Decision (FID).

This, the world's first FLNG project based on the conversion of an LNGC, was one of only a handful of global oil and gas investment decisions to receive the go-ahead in 2015.

During the same quarter Golar also took delivery of the FSRU 'Golar Tundra' and executed a firm five-year employment contract with West Africa Gas Limited.

Early the following year, the company entered into a MoU with Schlumberger to co-operate globally on the development of green field, brown field and stranded gas reserves using GoFLNG vessels. Shortly thereafter Golar agreed to sell the FSRU 'Golar Tundra' to Golar LNG Partners for \$330 mill.

All of Golar's seven delivered FSRUs now sit within the Partnership. In March, 2016 the 'Golar Arctic' commenced a two-year storage contract with New Fortress Energy off the coast of Jamaica.

In June, Golar and Stonepeak Infrastructure Partners launched Golar Power, a 50/50 Joint Venture to offer integrated LNG based downstream solutions through the ownership and operation of FSRUs and associated terminal and power generation infrastructure.

In December, 2016 Golar Power reached a

FID on its first integrated LNG to power project in Sergipe, Brazil which will employ the November, 2017 delivering FSRU newbuild, 'Golar Nanook'.

Shortly after forming Golar Power, Golar and Schlumberger agreed to form OneLNG, a Joint Venture 51% owned by Golar and 49% by Schlumberger. OneLNG is now actively pursuing a handful of promising potential FLNG projects and is confident that it will have secured contracts for five units by 2020, Golar said.

This month, Ophir Holdings & Ventures, a wholly owned subsidiary of Ophir Energy, and OneLNGSM announced that they have signed a binding shareholders' agreement to establish a joint operating company (JOC) to develop the Fortuna project, in Block R, offshore Equatorial Guinea using Golar's FLNG technology.

OneLNG and Ophir will have 66.2% and 33.8% ownership of the JOC respectively. It will facilitate the financing, construction, development and operation of the integrated Fortuna project and, from Final Investment Decision (FID), will own Ophir's share of the Block R licence and the 'Gandria' FLNG vessel.

The LNGC 'Gandria' was chosen to service this project, and, subject to FID, will be

converted into an FLNG by Keppel Shipyard, Singapore.

FID is now expected to take place in 1H17 with first gas anticipated in 1H20. Initial offtake is expected to be 2.2-2.5 mill tonnes per annum for between 15- 20 years, which will monetise around 2.6 trill cu ft of the discovered resource.

The forecast total capital expenditure for the integrated project is around \$2 bill to reach first gas. About \$1.2 bill is expected to be debt financed, with full drawdown by the start of commercial operations.

As of today, the GoFLNG 'Hilli' conversion project remains on schedule and within budget. The vessel left drydock for the last time with her sponsons attached on both sides earlier in the year. Installation of pre-assembled topside plant and equipment is now well underway, as are site works for the gas processing equipment in Cameroon.

Despite a setback earlier in the year, the Fortuna FLNG project being developed by Ophir and Golar has made good progress. This is a low cost high quality gas reserve that has attracted strong interest from high quality off-takers and is ideally suited to Golar's technical offering. Both parties are confident that the project will reach a final investment decision in the near future.



'Höegh Grace' operated as an LNGC before taking up station in Colombia as an FSRU.

As significant new volumes of LNG are scheduled to deliver over the coming four years, we can expect to see a gradual tightening in the shipping market from its current weak state, Golar said.

Based on the current conventional carrier orderbook, anticipated tonne/miles and scheduled start-up dates for this new production, we can expect to see a return to shipping equilibrium toward the end of 2017 and into 2018.

Golar has 10 LNGCs exposed to this market and will look to place these into long-term contracts suitable for drop-down to the Partnership, as and when opportunities present themselves.

Significant new LNG production is also resulting in depressed LNG prices. This has made LNG even more cost competitive relative to oil and other liquids and increasingly competitive with coal.

In turn, this is stimulating significant interest from new markets that require a quick and cheap means of switching. Demand for FSRUs has therefore increased, however, the current supply of available unfixed FSRUs looks insufficient to meet this demand.

Golar Power will therefore look to initiate the conversion of its two LNGCs to ensure that it is well placed to capture some of this new demand, the company concluded.

H-LINE SHIPPING

Private equity concern Hahn & Co completed the purchase of the majority stake in Hanjin

Shipping's bulk business during the middle of 2014.

At the time Hanjin contributed 36 vessels, including seven LNGCs, of which three are shared. These are operated by H-Line LNG department and includes the world's first membrane LNGC 'Hanjin Pyeongtak'.

The LNGCs ship gas from Indonesia, Oman and Qatar under a 20 - 25 year long-term transportation contract with KOGAS.

HOEGH LNG

With a strategic focus on long-term contracts Höegh LNG's portfolio currently has an average remaining contract length of 13 years.

The company is currently preparing for the start-up of the Colombian FSRU project, which is on schedule to commence commercial operations at the beginning of the fourth quarter of this year.

The project will strengthen the group's operating results and create opportunities for an accretive drop-down to Höegh LNG Partners (HMLP), assuming the MLP market is available.

'Höegh Grace' has been employed as an LNGC under a contract with Trafigura for the second quarter of this year. The intermediate employment lasted until September, 2016 after which she was due to proceed to Cartagena, Colombia, to prepare for commissioning and start-up of the long term FSRU contract with SPEC - the group's sixth FSRU project to date.

The Trafigura charter covers positioning costs to Cartagena, resulting in a lower capex

and consequently in a lower delivered cost for the FSRU. A local office has been established in Cartagena

According to the contract with SPEC, Höegh LNG will be paid 50% of the charter hire from June, 2016 until the regas trial starts in the fourth quarter. This charter hire will be recognised over the first 10 years of the contract.

The Penco LNG FSRU project in Chile, previously named Octopus, reached important milestones when all permits were issued by the regulatory authorities in July and August this year.

In addition, Höegh LNG is pursuing several FSRU projects with expected start-up dates, which match the delivery of FSRU No 7. The group is currently in a tender process for an FSRU project expected to be finalised shortly, according to the client's schedule. Höegh LNG is also in bilateral discussions on a second and participating in a tender process on a third project, which are both due to make an investment decision in the near future.

In preparations for the next FSRU newbuilding order, Höegh LNG issued a tender in June and expects to receive bids on an early 2019 delivery from six shipyards. Assuming that a contract for FSRU No 7 is secured, the group will evaluate and make a decision on the bids in the second half of this year.

To capture additional business opportunities with a start-up at the end of 2017 and in 2018, Höegh LNG has ordered long lead time equipment and signed

engineering agreements with Wärtsilä and Moss Maritime for its FSRU conversion project.

By starting preliminary engineering work before the summer and ordering equipment on the critical timeline in advance, Höegh LNG will reduce the conversion schedule by six months- from 18 - 12 months. The conversion design is in line with several of the group's short-listed projects, and since the equipment can also be used for its ongoing FSRU newbuilding programme, the investment poses limited capital risk to Höegh LNG, the group claimed.

The two Arctic LNGCs were operated in accordance with their long-term contracts, while Höegh LNG ceased to operate the LNGC 'Matthew' in July, 2016, when Engie sold the vessel to a third party.

Favourable market fundamentals, Höegh LNG's expertise and its financial position provide the basis for maintaining its ambition of managing 12 FSRUs by 2019, the company said.

HUMPUSS INTERMODA TRANSPORTASI

The LNG shipping interests managed by Humpuss Transportasi Kimia (HTK) serves Pertamina using the LNGC 'Ekaputra 1'.

PT HTK also operated three LNGCs belonging to third party in 2015, one being the 'Surya Satsuma', which is wholly owned by HTK.

'Ekaputra 1's' gas shipment contract with Pertamina is scheduled to last until 2020.

HYPROC SHIPPING SERVICES

The shipmanagement arm of the Algerian gas major Sonatrach, Hyproc has two LNGCs under construction at Hyundai for delivery in December of this year and February, 2017.

It is believed that once delivered, the 170,000 cu m DFDE 'Tessala' and 'Ougarta' will replace some of the elderly LNGCs currently under management.

Indeed, the 1976-built 'Mostefa Ben Boulaid' has been reported as sold for recycling. Another two were built in the late 1970s and two in the 1980s.

Japan's Itochu Corp presided over the latest newbuildings contract signing and has supported their construction phase.

Itochu jointly owns three LNGCs with Hyproc, MOL and Sonatrach.

HYUNDAI LNG SHIPPING

Hyundai Merchant Marine (HMM) sold its LNG transport business for around \$1.03 bill

in 2014 to help solve HMM's financial crisis.

IMM Investment Corp was chosen as the preferred bidder.

HMM operated 10 LNGCs, which were long-term charter contract to South Korean state-run KOGAS until 2028.

According to Equasis, four LNGCs have been managed by Hyundai LNG Shipping since 2014 and are now believed to be operated by Korea Line remaining on long term charters to KOGAS.

IINO KAIUN KAISHA

The Iino Kaiun Group has long participated in Japan-bound, as well as trilateral LNG transportation projects.

In 2005, Iino started to manage its first LNGC - 'SK Sunrise' - which was long term chartered to KOGAS.

In 2008, Iino began joint LNGC operations with the Kansai Electric Power Company (KEPCO).

The company said that the growth of the large gas carrier division will continue to be a priority to support the advance of the Iino Kaiun Group's business.

KAWASAKI KISEN KAISHA

At the end of 2015 fiscal year, K Line had interests in 41 LNGCs, down from 43 a year earlier.

K Line's five year LNG sector plan has been revised downwards with 57 units planned instead of the original 61.

Three contracts were signed for newbuilding LNGCs primarily to tap into the US shale gas export market.

Among the newbuildings are a 180,000 cu m Moss type LNGC under construction at Kawasaki for the Ictys project. She was due to be delivered at the time this publication went to press.

Another newbuilding was also due for imminent delivery. This is a 155,300 cu m LNGC building at Mitsubishi for the Inpex project. Inpex will be operated by Oceanic Breeze LNG Transport, a joint venture company set up by K Line and Inpex Shipping.

The vessel is earmarked to load cargo at Ictys LNG project in Western Australia for discharge at Inpex's Naoetsu LNG receiving terminal at Niigata.

In August next year, the 164,700 cu m 'Bishu Maru' is due for delivery from Kawasaki for long term charter to Chubu Electric Power. She is being built to serve the Freeport LNG project in Texas.

She will be named after Japan's first large

LNGC, which was delivered to K Line in 1983.

A sister vessel is also on order at Kawasaki for April 2018 delivery and finally, a 178,000 cu m LNGC was ordered at Imabari for the Trinity joint venture project. She is due to be delivered in January, 2020.

KNUTSEN GAS SHIPPING

Knutsen recently took delivery of the first of two newbuilding 176,300 cu m LNGCs from Hyundai - 'La Mancha Knutsen'.

Her sistership - 'Rioja Knutsen' - is due for delivery as this issue goes to press.

Today, all 10 of the large LNGCs owned by the company are chartered out on 20 year contracts or longer. For example, both of the newbuildings have been chartered to Gas Natural for 20 years.

The fleet also includes the revolutionary 1,100 cu m 'Pioneer Knutsen', which delivers LNG along Norway's west coast.

KOREA GAS CORP

KOGAS normally charters around 25-30 LNGCs at any one time to feed the energy company's three South Korean receiving terminals.

The company still claims to be the world's largest importer of LNG.

Among the newbuildings reported with KOGAS charters are two 174,000 LNGCs at Daewoo for Hyundai LNG Shipping. They are due for delivery in January and March 2017, respectively.

In addition, Korea Line was thought to have a similar size vessels on order at Daewoo for delivery in April, 2017, while SK Shipping was said to have two 174,000 cu m LNGCs on order at Samsung.

The SK shipping vessels will be fitted with the newly developed KC-1 containment system together with KOGAS's onshore membrane tank.

It was thought the vessels will serve Cheniere's Sabine Pass loading facility.

KOREA LINE

According to the company's website, Korea Line (KL) operates eight LNGCs all of which are on long term charter to KOGAS.

These include four Hyundai LNGCs.

In addition, KL has at least one 174,000 cu m newbuilding - 'SM Eagle' - due for delivery in April, 2017 from Daewoo and Hyundai LNG is shown to have one similar newbuilding for KOGAS charter.

These vessels will form part of a tender charter project awarded by KOGAS in 2014 for six newbuilding LNGCs.

LNG SHIPPING SPA

The Milan-based subsidiary of ENI owns two LNGCs built in the 1990s.

They are managed by Exmar.

The company is also involved in offshore LNG terminal projects.

MARAN GAS MARITIME

MGM is the gas shipping subsidiary of the Angelicoussis Shipping Group.

It was formed in 2003 and took delivery of its first LNGC in 2005.

Since then MGM has amassed 21 LNGCs with another 11 on order of around 174,000 cu m each.

The vessels on order or under construction are due for delivery this year (three), 2017 (two), 2018 (one) while the remaining five are all due in 2019.

Two were ordered in June of this year from Daewoo, which is MGM's preferred builder.

MGM chartered its first four vessels to RasGas, which led to the setting up of Maran Nakilat joint venture, which now involves at least 13 vessels, of which two joined last year.

Other major charterers of MGM tonnage include Shell (BG) and Woodside.

Angelicoussis has a modern training centre, based near its Athens office, which caters for the whole group fleet. For LNGC training, the centre is equipped with a liquid cargo handling simulator and operates gas carrier training under SIGTTO and DNV GL guidelines.

MISC BERHAD

MISC is one of the world's largest single owner-operators of LNG vessels and for over



MISC's newly delivered 'Seri Camellia' - the first of five Moss types.

three decades, has safely delivered more than 400 mill tonnes of LNG globally.

In 2015, MISC delivered 20.74 mill tonnes of LNG, carving 8.3% of the total world LNG trade.

MISC took delivery of its newbuilding LNGC - 'Seri Camellia' on 30th September, 2016.

The 150,200 cu m vessel is the first in a series of five MOSS-Type LNGCs ordered from Hyundai Heavy Industries by MISC. Upon their delivery, these new LNGCs will be chartered to PETRONAS.

Her delivery brings the current number in MISC's LNG fleet to 26 vessels, plus two FSUs.

'Seri Camellia' forms part of a new generation of the 'Seri C' class LNG fleet,

comprising MOSS-Type vessels that provide a more robust and superior cargo containment system whilst ensuring a higher degree of operational flexibility for MISC to operate in harsh weather conditions, the company said.

The new generation of LNGCs incorporate modern technologies in various forms, including the Integrated Hull Structure (IHS) with four spherical tanks shielded by a continuous cover, which improves the overall structural strength of the hull.

In addition, green technology features adopted for these new vessels include energy efficiency, emissions reductions, biodiversity management and end-of-life disposal.

Also included is a selective catalytic reduction (SCR) system for the diesel generators to comply with the latest IMO Tier III requirement and the Ozone ballast water treatment system. The LNGCs are powered by Ultra Stream Turbine (UST) plants, and installed with pre-swirl duct and propeller boss cap fins (PBCF) for improved fuel efficiency.

'Seri Camellia' sailed on her maiden voyage from South Korea to Bintulu, Malaysia on 1st October, 2016.

MITSUI OSK

As of the end of its fiscal year at 31st March, 2016, MOL operated or part operated 69 LNGCs and said it was aiming to operate 81 by the end of Fiscal 2017.

These figures included ethane carriers.

In its 2016 report, MOL claimed to have around 30 outstanding orders for LNG and ethane carriers, all being built to long-term contracts.

Revenue and income will likely continue to increase in fiscal 2016, as 14 new projects,



MGM's 'Maran Gas Apollonia' became the first large LNGC to transit the new Panama Canal locks.

including six for ethane carriers, are scheduled to be launched.

Personnel hiring and training were also on course, as the company sought to secure enough seafarers to match the vessels scheduled for delivery, MOL said.

Expanding overseas will be central to MOL's fiscal 2016 strategy. Specifically, the group is actively targeting China, India and Southeast Asian countries, where there is growth potential for energy, as their populations expand, and is also targeting Europe, which is promoting measures to lower its dependence on Russian energy.

MOL's business model includes joint ventures and vessel sharing with companies in Japan and overseas.

Since the Offshore and LNG Project Division was established in June, 2014, MOL is currently engaged in six FPSO projects and one FSRU project; three facilities are already in operation with the other four are under construction. MOL said that it aims to expand the offshore business and will continue to steadily grow it over a long-term span of five to 10 years.

Analysing sister publication 'LNG Shipping News' newbuilding list supplied by Fearnleys, it becomes clear how many newbuildings MOL is involved with one way or another.

For example, this year the company is due

to take delivery of a 153,000 cu m vessel for Osaka Gas and a 173,000 cu m LNGC for Petronet in a consortium.

Next year, a 177,000 cu m vessel is due to be delivered for Kansai Electric and two 165,000 cu m LNGCs for Tokyo Gas, plus three for the Yamal project in co-ordination with China Shipping Development Corp and another sister in 2018.

Turning to 2018, MOL is due to take delivery of three 177,000 cu m vessels for Mitsui & Co, plus two 155,000 cu m LNGCs for the same account.

In addition, another 165,000 cu m LNGC is due for delivery for Tokyo Gas and a 179,900 cu m vessel for the Juniper project (E.On). A 180,000 cu m unit is scheduled to be delivered for Osaka Gas and two 177,000 cu m vessels for Chubu Electric.

Finally, in 2019, another 177,000 cu m LNGC is due to join Mitsui & Co's account.

This makes 20 firm vessel orders at the time of writing.

NAKILAT

Nakilat Shipping Qatar (NSQL) a wholly owned shipmanagement subsidiary of Nakilat, signed an agreement with Shell International Trading and Shipping (Shell) to begin the planned phased transition of the management of the LNG fleet from Shell to NSQL.

Shell has provided a range of shipping

services to Nakilat's LNG fleet since it was established in 2006. These included the shipmanagement of 14 Q-Max and 11 Q-Flex LNGCs and the sharing of Shell's Shipping & Maritime expertise.

The vessels will be transitioned in three phases starting this year and will be managed by NSQL. NSQL has to date, assumed shipmanagement for two Q-Max vessels from Shell,

Last year Nakilat expanded its joint venture with Greek shipping company Maran Ventures to include two new LNGCs.

Maran Nakilat was established in 2005 with four jointly-owned vessels and since then, the agreement has been expanded on three occasions. The latest agreement increased the number of vessels jointly-owned by Nakilat and Maran Gas to 13.

At the time, the two vessels, delivered in the third and fourth quarters of 2015, as well as another unit in early 2016, brought the total number of LNGCs and LPG carriers partially or wholly owned by Nakilat to 67.

The vessels are of TFDE propulsion with capacities of between 161,870 cu m and 174,000 cu m, respectively.

The LNGCs are long term chartered to either Qatargas or RasGas with the wholly-owned vessels managed by STASCO (see above) and the joint venture LNGCs by Maran Gas, MOL, NYK, K Line, Teekay, Pronav and SCI.



The Q-Max 'Mekaines' has become the second vessel to be taken back by Nakilat from STASCO management.

Nakilat also operates the shiprepair and shipbuilding facility at the Erhama Bin Jaber Al Jalahma Shipyard, along with a shipping agency in Qatar. Its shiprepair base, Nakilat-Keppel Offshore & Marine (N-KOM) and located adjacent to the Ras Laffan loading terminals, specialises in LNGC repairs, having completed more than 120 repair task on gas carriers to date, including the first ME-GI conversion for a Q-Max LNGC last year.

NATIONAL GAS SHIPPING CO

NGSCO was formed in December, 1993 to transport gas for Abu Dhabi Gas Liquefaction Co (ADGAS).

The company still operates the original eight 137,000 cu m LNGCs, which were claimed to be the world's largest when delivered between 1994 and 1997.

Built to a Moss Rosenberg design, four were built in Japan, while the second quartet came from Finland. Initially, they were technically managed by third parties but since 2007, they have been managed by NGSCO.

In 2009, all the supporting services were merged with ADNATCO to form one management operation.

NIPPON YUSEN KAISHA

At the end of March this year, NYK controlled 68 LNGCs, according to its annual fiscal report.

Aiming to establish a structure less susceptible to market fluctuations, NYK said that it acquired long-term contracts mainly for shale gas and oil projects during the 2015 fiscal year.

Following on from the timecharter contract concluded with Mitsui & Co in fiscal 2014, NYK concluded timecharter contracts for two vessels with Mitsubishi Corp in fiscal 2015 for the Cameron LNG project.

In addition, the Japanese giant concluded timecharter contracts for two vessels with Chubu Electric Power for the Freeport LNG project in Texas.

Although the recent fall in oil prices is leading to the postponement of LNG projects, all of the contracts cited above are long-term contracts that are less susceptible to market fluctuations, the company explained in its annual report.

For fiscal 2016, NYK said that its strategy is to develop businesses steadily in light of near-term market conditions.

The medium-term management plan calls on the company to expand the LNGC fleet to more than 100 vessels by fiscal 2018. However, given the many project

postponements and recent market conditions, it is expected that this figure will drop to about 90 vessels by then.

In October, 2016, the company was due to take delivery of an LNG bunkering vessel, which will initially be deployed in Europe. In future, however, NYK plans to develop LNG bunker operations in other areas, the company said.

Again consulting Fearnleys orderbook, it shows a 173,000 cu m vessel due for delivery for Petronet, ordered by a consortium involving NYK.

A 165,000 cu m LNGC is due to be delivered in July next year for Tokyo Gas and a 153,000 cu m vessel for TEPCO in October next year.

In 2018, two 165,000 cu m LNGCs are on order for Mitsubishi and two 180,000 cu m LNGCs for Chubu Electric, plus a 177,000 cu m vessel for Mitsui & Co.

NOVATEK

In June it was announced that OAO Yamal LNG had withdrawn the first tranche of financing to the amount of €45 mill provided by the China Development Bank and the Export-Import Bank of China under loan agreements signed on 29th April, 2016.

The financing from the Chinese banks was part of the project finance package totalling the equivalent of \$18.4 bill, of which more than \$4.6 bill had already been withdrawn.

Novatek owns 50.1% of Yamal LNG with China National Petroleum Corp owning 20%, Total (20%) and Silk Road Fund with 9.9%.

First LNG production is scheduled for next year and once completed, the liquefaction plant will produce 16.5 mill tonnes of LNG per annum.

The first of the 16 Arc7 LNGCs is also due for delivery early next year and will load at Sabetta, a new port under construction on the Yamal Peninsular. Thus far, Sovcomflot, Teekay, MOL and China Shipping LNG have ordered specialist Ice Class double-acting ABB Azipod powered LNGCs in different consortia.

GTT has developed a specially adapted No 96 membrane cargo containment system to be fitted on at least nine of the LNGCs.

Early last year, Yamal LNG said that Yamal Trade and Gazprom Marketing & Trading, Singapore had signed long term supply and purchase agreements for 2.9 mill tonnes of LNG per year from Yamal.

The 20-year agreement called for the supply of gas to the Asia/Pacific region, primarily to India.

OMAN SHIP MANAGEMENT

Oman Ship Management - the shipmanagement arm of Oman Shipping (OSC) - now looks after six LNGCs, following the delivery of the 162,000 cu m 'Adam LNG' in 2014.

Technical management is undertaken by MOL, which also acts as a company consultant.

The latest vessel has accommodation for up to six cadets, plus an instructor.

OVERSEAS SHIPHOLDING GROUP

The company has a 49.9% interest in a joint venture with Nakilat, which owns four 216,000 cu m LNGCs.

These gas carriers are chartered out to Qatargas under 25-year timecharters that expire between 2032 and 2033. Each agreement provides the charterer with options to (i) extend the respective charter for up to 10 additional years at amounts set out in the c/p and (ii) purchase the vessel during the charter term at amounts agreed in the charters, which decline over the period of the charter.

In accordance with the terms of the charter, the daily rate of hire during the charter term is the sum of the capital expenditure element of hire plus the operating expenditure element of hire.

The operating expenditure element is subject to escalation, as provided in the c/p.

The long-term bank financing obtained by the LNG joint venture is secured by the vessels and bears interest at LIBOR plus a margin of 67.5 or 90 basis points. The loans are repayable in equal quarterly instalments with a final balloon payment of \$85 mill per LNGC, due on the 15th anniversary of the vessel delivery, which occurred between 2007 and 2008.

PAN OCEAN

Restructured Pan Ocean aims to build on its LNG interests by investing in LNG bunkering and small scale LNG, as well as expanding its current fleet of just one vessel.

The company, formerly STS Pan Ocean, became involved with LNG transportation in 2005 when it was selected as a contractor for a KOGAS project to ship gas from Yemen to South Korea.

To service this project, Pan Ocean took delivery of the 153,000 cu m 'LNG Kolt' in December, 2008.

Another LNGC, the 2010-built 'STX Frontier' was operated between 2010-2013 until it was sold to GasLog for about \$160 mill.

PETRONAS

As a result of the Canadian Government giving a conditional approval for the proposed Pacific NorthWest LNG project, PETRONAS and its partners will study the conditions imposed by the authorities and conduct a total review of the proposed project prior to deciding on the next steps forward, the Malaysian energy giant said in a statement.

Elsewhere, PETRONAS and JX Nippon Oil & Energy (JX NOE) have signed an agreement for the sale and purchase of equity in PETRONAS LNG 9 (PL9SB), a wholly-owned subsidiary of PETRONAS.

Under the agreement, JX NOE will purchase a 10% stake in PL9SB, which owns the ninth LNG liquefaction train within the PETRONAS LNG Complex in Bintulu, Sarawak, Malaysia. The train, with a production capacity of 3.6 mill tonnes per annum, is expected to commence commercial operations in the first quarter of next year.

With the addition of the new liquefaction plant owned by PL9SB, the PETRONAS LNG complex will have the capacity to produce around 30 mill tonnes per annum.

A marketing support agreement was also signed between PETRONAS LNG and JX NOE.

Earlier this year, PETRONAS' first floating liquefied natural gas (LNG) facility, 'PFLNG SATU' was towed to the Kanowit gas field, offshore Sarawak. She is currently being installed, hooked-up and commissioned.

Designed for water depths of between 70 - 200 m and a processing capacity of 1.2 mill tonnes per annum with 145 crew on board, the vessel will support PETRONAS' global LNG portfolio, the company said.

On April 30th this year, PETRONAS Floating LNG2 (PFLNG2) was officially launched at Samsung Heavy Industries (SHI) shipyard in Geoje Island, South Korea.

The 393 m long hull was floated out from the building dock to the outfitting berth signifying the near completion of the hull construction, which commenced in June, 2015.

Both 'PFLNG Satu' and 'PFLNG2' pave the way to unlocking gas reserves from remote, marginal and stranded gas fields, which would otherwise be uneconomical to develop, the company said.

Once completed, 'PFLNG2' will enable the liquefaction, production and offloading processing of natural gas in the Rotan field, 240 kilometers offshore Sabah.

It has been designed for a water depth of between 500 - 1,500 m and a processing capacity of 1.5 mill tonnes per annum.

PETRONAS charters in its LNGC needs from part owned subsidiary MISC.

PETRONET

This joint venture company was formed by the Indian Government to import LNG and build and operate the LNG receiving terminals in the country.

Four of the top Indian public sector companies in the hydrocarbon sector - Oil and Natural Gas Corp (ONGC), Indian Oil Corp (IOCL), Bharat Petroleum Corp (BPCL) and GAIL (India) have invested in Petronet LNG.

Each has a 12.5% equity share, leading to a total of 50%. GDF Suez also has a 10% stake in Petronet, while the public own the remaining 40%.

Petronet commissioned the country's first LNG receiving and regasification terminal at Dahej, Gujarat, and another terminal at Kochi, Kerala.

While Dahej has a nominal capacity of 10 mill tonnes per annum, Kochi has a capacity of 5 mill tonnes per annum. The company is about to build a third terminal at Gangavaram, Andhra Pradesh.

Petronet has negotiated 7.5 mill tonnes per annum of LNG with RasGas on a long term basis. Three LNGCs, 'Disha', 'Raahi' and 'Aseem' have been timechartered by the company from a consortium led by Mitsui OSK Lines to ship LNG to Dahej.

The Shipping Corporation of India (SCI) is currently operating and maintaining the first two LNGCs. The third vessel 'Aseem' started to supply an additional volume of RasGas LNG in first week of January, 2010.

To bridge the natural gas demand/supply gap in India, Petronet also imports LNG from various sources on a long term and short/spot term basis.

The company has also signed an LNG SPA with ExxonMobil for the supply of about 1.44 mill tonnes of LNG per annum from the Gorgon LNG project, Australia on a long term basis for the Kochi LNG terminal.

As for the third terminal, Petronet has signed a firm and binding term sheet for developing a land-based LNG terminal at Gangavaram Port, Andhra Pradesh with a initial capacity of 5 mill tonnes per annum with Gangavaram Port Limited (GPL) on east coast of India.

Pre-feasibility studies such DFR, FEED and various other pre-project work have been completed and all necessary approvals received for the Gangavaram project to go ahead.

PRONAV SHIP MANAGEMENT

Pronav manages nine LNGCs from its Hamburg office.

These include four Q-Flexes and five conventional LNGCs, three of which were built in 1978-1979.

They are all operated by an MOL-led consortium.

RASGAS

In June, RasGas announced that Ras Laffan Liquefied Natural Gas Company (3) (RL 3) had signed a new LNG Sales and Purchase Agreement (SPA) with French energy company, EDF.

Under the terms of the SPA, starting next year, RL 3 will deliver up to 2 mill tonnes per annum over the medium term of Qatari LNG to EDF's new terminal at Dunkerque, France.

This new agreement complements three existing long term LNG SPAs between RasGas ventures and EDF Group subsidiaries, for delivery of up to 4.6 mill tonnes per annum to Edison in Italy and up to about 3.5 mill tonnes per annum to EDF Trading in Belgium.

In August, RasGas shipped its first LNG cargo to the FSRU 'Toscana', located off Italy. The spot cargo was delivered on 23rd August, 2016 to a new RasGas customer, DufEnergy Trading, which is an international, multi-energy trading company based in Lugano, Switzerland.

FSRU 'Toscana' is one of Italy's main regasification projects, and is located 22 km off the Italian coast between Livorno and Pisa. The terminal is permanently anchored to the seabed through a mooring system, with a single point of rotation at the bow.

To ensure secure and reliable delivery of LNG to RasGas' global customer base, the company acquired an LNGC fleet under long term charters. The fleet currently consists of 27 vessels - 14 conventional LNGCs with a cargo-carrying capacity of 138,000 - 151,700 cu m, and 13 Q-class vessels with a cargo capacity ranging from 210,000 - 266,000 cu m.

RasGas' fleet was built up through a series of timecharter agreements with separate shipping companies and consortia, including Milaha, Maran Gas Maritime, the J3 consortium of Mitsui OSK, NYK and K-Line and the J5 consortium consisting of Nakilat and Teekay Nakilat Corp.

The first ship, 'Fuwairit', entered service in February, 2004 and recently celebrated her 100th cargo loaded at Ras Laffan.

Between May and September 2008, RasGas took delivery of 12 Q-Flex vessels. The milestone agreement with J5 Nakilat and

Teekay Nakilat was, at the time of signing, one of the largest-ever commercial shipping contracts.

In October 2009, RasGas took delivery of its first 266,000 cu m Q-Max, 'Al Dafna', which completed the fleet of ships ordered as part of RasGas' shipbuilding programme.

SHELL SHIPPING

On 15th February 2016, Shell completed the purchase of the BG Group.

On the shipping side, this gives Shell access to Methane Services, which is the shipping subsidiary of the BG Group.

At the time of writing, Methane Services is still a going concern but headquartered in Shell's building in London. Methane Services has been gradually selling off the majority of the fleet to GasLog on a lease back basis.

As for Shell, the company is still very active in LNGCs either managing or chartering the vessels. At one stage before the BG merger, Shell boasted interests in around 25% of the world's LNGCs, amounting to more than 50 vessels in various joint ventures, etc.

However, this figure is believed to have diminished.

STASCO, as the shipping arm is known, currently manages around 25 Nakilat controlled Q-Flexes and Q-Maxes, although it has handed back at least two to the Qataris to manage. The company has also taken two of Sovcomflot's

Ice Class LNGCs on long term charters.

In 2013, Shell acquired Repsol's LNG interests, including Stream - the Spanish company's commercial shipping arm.

Shell has also jumped firmly on the LNG bunkering bandwagon by ordering a specialised gas bunkering vessel for operations around northern Europe. The barge will initially load at the GATE terminal near Rotterdam.

Recently, the Government of Gibraltar and Shell signed an agreement for the supply of LNG for use in power generation on the Rock, which will include the construction of a small regasification unit that will receive, store and re-gasify the LNG arriving by ship for use in Gibraltar's adjacent gas-fired power plant, which is already under construction.

The regasification unit will be operated by Gasnor, another 100% Shell-owned subsidiary Gasnor, which has over 10 years of operational experience in LNG for marine and small-scale LNG in Northwestern Europe.

The project will also include a berth for a small LNGC that will supply the gas at night, minimising disruption to the neighbouring port, airport and housing estates. There is also potential for LNG bunkering operations in the future, following the appropriate environmental assessments and safeguards.

Following the recent approval of an Environmental Impact Assessment report,

construction of the regasification unit is planned to start towards the end of this year with commissioning and first delivery of LNG expected to take place ahead of the start-up of the power plant, expected during the second half of 2017.

SK SHIPPING

Having secured its first LNGC - 'YK Sovereign' - in 1994, SK Shipping now operates a fleet of 12 ships, which makes it the largest LNG shipping company in South Korea.

SK Shipping also claimed to be the first in the world to gain experience at operating four types of cargo containment systems including Moss, membrane (Mark III, NO96-GT) and KC-1 (Korean LNG cargo hold).

Following its start in 1994, in 1996, 1997 and 2001, SK Shipping concluded long-term transportation contracts for five LNGCs with KOGAS.

In 2013, the company won a long-term shale gas transportation contract from Total for which it ordered two additional 180,000 cu m LNGCs. In 2014, SK Shipping won a long-term transportation contract from KOGAS for which it ordered two KC-1 (LNG carrier cargo hold) LNGCs.

Thus SK Shipping became the first in the world to gain KC-1 cargo hold operational experience.



Mozah was the first LNGC to leave STASCO's management for Nakilat.

The two KOGAS vessels are due to be delivered in September next year, while the Total LNGCs are due in October, 2017 and January 2018, respectively.

Fearnleys orderbook is also showing another two 180,000 cu m gas carriers on order for deliveries in February and May, 2019.

IM SKAUGEN

IMS manages six LNG/LPG/Ethylene carriers (Multigas (MG) operating under the Norgas Carriers banner. In addition, Norgas operates another nine LPG/petrochemical carriers.

In the first half of this year, Norgas continued to perform several LNG voyages in Asia using one Multigas vessel.

LNG was shipped from a large export terminal in Asia and delivered to a smaller re-distribution hub. The main use for the LNG from this trade is for a fast growing transport market either in the form of LNG or CNG (compressed natural gas)

These voyages re-confirms the US dollar premium that the MG vessels can earn when shipping LNG, due to a more complex operation, compared to the LPG/petrochemical market.

Norgas is set to continue to perform further LNG spot voyages with this client in the second half of this year and IMS said that it saw a growing spot market in Asia.

The current order book for similar sized vessels for small scale LNG and liquefied gas transportation is low. For smaller LNG vessels, there are only five smaller sized LNGCs, including three, which are earmarked for specialised marine bunkering operations and another vessel is tied up in a long term charter contract.

In addition, the remainder of the current sailing fleet of small-scale LNG vessels is currently operating with longer charter agreements.

IMS said it was currently developing four specific LNG projects to supply power plants with LNG and on the back of these projects he fleet of LNG capable vessels could be deployed in 2016/2017.

The company's focus is on projects or countries with a required early start-up, and all of the projects could enable the company to use the unique small scale LNG competence and know how developed over the past 10 years.

IMS has provided offers and participated in tenders. The potential longer-term LNG contracts being pursued, will allow the company to unlock the inherent value of the



SCF's 'Christophe de Margerie' has become the first Yamalmax to sail for the Arctic.

LNG R&D, know how and expertise built up over time and the value of the LNG capable vessels owned and/or controlled.

As a result, improve the cash flow, which will enable a refinancing of the debt maturities in 2017.

SONANGOL

Subsidiary Sonangol Shipping Holding operates three 173,000 cu m LNGCs delivered in 2007 and 2008.

The Angolan state-owned energy company has a 22.8% stake in Angola LNG (ALNG) along with Chevron (36.4%), BP (13.6%), ENI (13.6%) and Total also with 13.6%.

Exports were handled at Soyo Terminal until an incident in October, 2014 shut the facility.

On 6th June this year, ALNG confirmed that production has resumed at Soyo, northern Angola and the first LNG cargo had loaded. It was sold by an international tender.

Production was continuing and ALNG said that it expected to load further LNG and LPG cargoes as part of the plant commissioning and testing process. Full hand over and commercial operation of the plant from ALNG's contractor Bechtel will take place in due course after a planned shut down, the company said in June.

SOVCOMFLOT

In January 2016, the world's first Arctic LNGC was launched. She has since been named 'Christophe de Margerie'.

She is due for delivery on 31st January, 2017 and will have a cargo capacity of 172,600 cu m.

Built to Ice Class Arc7, she will be double acting, propelled by ABB Azipods, developing 45 MW and be able to cut through ice 2.1 m thick.

Other vessels in the series were ordered by different companies, such as Dynagas and Teekay.

In addition, SCF owns four conventional LNGCs, plus another four AtlanticMax gas carriers, including two long term chartered to Shell. The other two AtlanticMaxes are on charter to Gazprom.

Of the conventional gas carriers, two were built for a consortium involving SCF, NYK and Samudera to serve the Tangguh gas project in Indonesia. The other two operate loading gas from Sakhalin II (Prigorodnoye).

STENA BULK

Stena Bulk LNG owns and operates three LNGCs- 'Stena Blue Sky' (147,000 cu m, built in 2006), 'Stena Clear Sky' (174,000, built in 2011) and 'Stena Crystal Sky' (174,000 cu m, built in 2011).

They were built at DSME to Ice Class 1C.

Currently the vessels are trading on the short term market for charterers, such as North West Shelf and Cheniere.

TEEKAY LNG

Teekay LNG Partners has agreed a 15-year timecharter contract with Yamal LNG, sponsored by Novatek, Total, China National Petroleum Corp and Silk Road Fund, to provide conventional LNGC transportation services.

The fixed-rate timecharter contract will be serviced by one of Teekay LNG's previously unchartered 174,000 cu m MEGI LNG newbuildings scheduled for delivery in early-2019.

This has reduced the number of uncommitted newbuildings to just one. The Partnership will now provide Yamal with both icebreaker and conventional LNGCs.

In addition, Teekay LNG announced that

on 1st August, the ME-GI LNGC 'Oak Spirit' had joined her sister vessel - 'Creole Spirit' - on a five year charter to Cheniere Energy.

At present, Teekay LNG owns or partly owns 31 LNGCs, plus LPG carriers and conventional tankers, plus another 19 LNGC newbuildings, including six Arc7s for Yamal.

The company said in its second quarter 2016 results that securing long-term financing for the growth projects that deliver through 2020 has been a major focus area. Good progress was made this quarter in securing the required debt financing and, since May 2016, the division has secured lender credit approvals on over \$900 mill of new debt financings, including three MEGI LNGC newbuildings, the first two Yamal LNG Arc7 newbuildings and the majority of the remaining LPG carrier newbuildings.

TSAKOS ENERGY NAVIGATION

TEN recently took delivery of its second LNGC, the 174,000 cu m TFDE 'Maria Energy' from Hyundai Heavy Industries.

Upon her delivery, 'Maria Energy' immediately entered into a minimum 18 months and maximum three years charter, which could generate gross revenues in excess of \$70 mill if all optional periods are exercised.

With the commencement of this fixture, TEN's two LNGCs, 'Neo Energy' and 'Maria Energy,' are now under medium-term charters, the company said.

Following the ending of a long term charter of the 2007-built 'Neo Energy', the vessel has now started another medium term



Teekay's 'Creole Spirit' was delivered this year into a five year charter with Cheniere Energy.

charter to a major Far Eastern gas concern.

The charter, which commenced in October upon completion of the vessel's drydocking, has a two year minimum duration, which could be extended to 2.5 years, if the charterer exercises a renewal option at a higher rate.

For the much of the charter, the vessel will serve as an FSU.

ANTHONY VEDER

Following the announcement of the 5,800 cu m LNG bunker feeder 'Coralius' ordered last year, Anthony Veder has unveiled a 7,500 cu m LNG bunker & feeder vessel concept.

This vessel design allows operators to competitively serve both their terminal and bunker customers at the same time, the company claimed.

Anthony Veder also has a small FS(R)U concept for gas to power solutions enabling the company to offer the whole logistic chain.

'Coralius' was ordered by a joint venture - Sirius Veder Gas- at Royal Bodewes in The Netherlands for delivery 2017.

Anthony Veder also has a 18,000 cu m LNGC on order with the notation Ice Class 1A Super, which allows her to trade to the Northern part of Finland during winter. This vessel 'Coral EnergyIce' will be delivered in the second half of 2017.

The company currently operates two LNG/LPG/LEG hybrids - the 2014-built 'Coral Anthelia' and 2009-built 'Coral Methane' The latter is chartered to Gasnor, now a Shell subsidiary and was the world's first small scale LNG/LPG/LEG carrier.

In addition, Anthony Veder has the 2012-built 16,000 cu m LNGC 'Coral Energy', which was developed with and chartered to Skangas. Again this was the world's first direct drive dual-fuel Ice Class 1A LNGC when delivered.



TEN's newly delivered 'Maria Energy' has entered into a medium term charter.

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