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LNG *shipping*

REVIEW



- Market strength sustained
- GasLog newbuilding spree
- Fuel momentum increases
- Infrastructure on horizon
- Sloshing problem highlighted
- First DF cruise vessels

September 2013

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The RasGas operated and Teekay owned and managed Q-flex 'Al Khuwair' is one of 27 LNGCs under charter to the Qatari gas giant.

She is of 217,449 cu m capacity and was built to ABS class in 2008. 'Al khuwair' is fitted with a Technigaz Mk III membrane containment system.

Teekay owns, or manages, 32 gas carriers and is expanding its fleet with the addition of two former Awilco newbuildings and no doubt there will be others to come.

Ras Gas currently operates 12 Q-flex and one Q-max type, as well as smaller gas carriers.

No sign of a slowdown



With around 370 LNGCs in operation and another 125, or so on order, plus many projects, which could result in further new orders, the LNG shipping sector continues to march on at a significant pace.

Despite about 30 LNGCs being more than 30 years of age, the number of vessels scrapped thus far this year can be counted on the fingers of one hand. However, not all of these vessels are trading on a regular basis, as some are enduring periods of layup.

Although there are new containment systems on the market, the more traditional GTT and Moss types still prove to be the systems of choice, while the propulsion systems selected seems to be a strait choice between dual-fuel diesel-electric and tri-fuel type systems with the latter just beginning to edge it in the popularity stakes.

The favoured size today is around 170,000 – 180,000 cu m capacity, which gives the operator greater flexibility in trading patterns when compared with the larger Q-flex and Q-max types.

The increasing momentum in the move to power vessels with LNG is beginning to spawn a new generation of gas bunker tankers and barges. Several of the world's leading ports are working on infrastructure to offer

bunker facilities for vessels powered by LNG, some of which are backed by national and international funding.

Although in its infancy, this new market will come probably quicker than many people originally thought, especially if the LNG price remains competitive with other fuel types as at present.

New markets for LNG transportation worldwide are already beginning to spring up. For example, who would have thought that the US would become an exporter of natural gas and that Australia would be the world's largest gas exporter, although Russia will be a threat to that title going forward, if the rhetoric coming out of Russia is to be believed.

At present, seven out of 12 of the world's major projects are located around the Australian coast and the country will play host to the world's first FLNG - Shell's *Prelude* project, the hull of which is being built in South Korea.

BG said recently in a presentation that 'all eyes are on the US as the country is now awash with gas due to the shale

production gas boom.

'Several companies have signed deals to import US gas, including the UK's energy giant Centrica and Qatari interests. Centrica and others are also looking to purchase assets in the US and the country looks to be a net exporter of gas, rather than an importer,' the energy giant said.

LNG demand is expected to grow twice as fast as overall gas demand, with underlying supply needing to grow by nearly 9% to meet total demand, according to BG.

Shell has predicted that global demand for LNG will double between now (2013) and 2025.

US INFLUENCE

New markets are emerging and a shift from the US being a net importer to a net exporter allows gas to be diverted to Asia and Europe where demand is increasing. Most US LNG terminals have now been converted to export natural gas, rather than import the product as before, Shell said.

China is expected to double its gas demand

between now and 2025, while Thailand, Indonesia and Malaysia are also expected to step up consumption. The use of LNG for fuel is also expected to boost demand for natural gas.

Energy giant Total said in a report that global LNG output is expected to reach 360 mill tonnes and account for 13% of global gas supply by 2020. By comparison, in 2010, LNG amounted to 9% of global gas consumption with production of nearly 220 mill tonnes.

With demand rising at an average 3% a year for more than 30 years, natural gas has posted more dynamic gains than any other fossil fuel, Total said.

According to Total's estimates, demand for gas will rise at an annual rate of 2.5% between the years 2010 to 2030, outstripping demand growth for crude oil (1.1%) and coal (0.2%). At that pace, natural gas should rise to second place among fossil energies by 2030, capturing a greater share (24%) of the energy mix than coal for the first time.

According to a Drewry report earlier this year, LNG shipping enjoyed a dream run during 2011 and 2012, due largely to increasing tonne/mile demand and an almost stagnant fleet growth. Freight market prospects would be even brighter if fleet supply were to remain at current levels, but this will not be possible as 81 more vessels could join the fleet during 2013-15, while only 10 vessels could be considered as demolition candidates.

The fleet could grow to 430 vessels (accounting for projected demolitions) by the end of 2015, representing a rise of 20% from current levels, Drewry said.

Japan was the single largest factor driving the market in 2012 and this trend has continued this year, as re-starting all of the nuclear facilities will not happen overnight, if at all.

As for the prospects of vessels being fuelled by LNG, LR Fobas forecasted that 4.2% of newbuildings delivered between 2012 and 2025 will be fuelled by natural gas.

In its base case, LR expected 653 newbuildings to be LNG-fuelled, or 4.2% of global deliveries, from 2012-25. Under this scenario, LNG bunker demand could reach 24 mill tonnes by 2025, or 1.5% of global LNG production and 3.2% of global HFO bunker consumption.

LNGCs have been widely used since the late 1970s and even before to a lesser extent, but only in the 21st century have they become an integral part of the global energy market - more than 80% of the LNGCs currently in

use were built after 2000, despite extremely low scrappage rates, said Visiongrain in another report.

Among the core factors ensuring the independence and strength of this market going forward are the near 100% utilisation rates of the LNGC fleet, the growth of the LNG spot market, record LNG vessel charter rates and temporary expansions and fluctuations in the average nautical mileage of the fleet.

The market used to rely on the number of liquefaction terminals coming on stream but this dependency has reduced. However, there will be strong investment in terminals over the next 10 years and, when combined with the above factors, will drive heavy capital expenditure on LNGCs between 2013-2023.

ASIAN DEMAND

Growing Asian demand is expected to offer the largest market potential for LNG producers over the next couple of decades and it seems as though the US may be positioning itself to take full advantage of that demand growth, analysts said.

Ever since the shale revolution, which has flooded the US with an abundance of cheap natural gas, LNG project operators in Australia, East Africa, Canada, and Russia have been unable to rely on the US market, moving their focus almost entirely to Asia.

Future US exports, especially to Asia, should be boosted by the widening of the Panama Canal to allow the passage of LNGCs carrying US cargoes, cutting the trip length from 16,000 miles to just 9,000 miles.

It is estimated that once the Canal is open to larger vessels at the end of 2015, over 80% of the LNGCs will be able to use the waterway.

According to a report from Reuters, by widening the Panama Canal, the US can compete in terms of trip length and costs and also has an advantage over other exporters, due to the existing Gulf Coast infrastructure and expertise from the time when it was the world's largest LNG importer.

New facilities on the undeveloped coasts of Mozambique and Tanzania, the harsh Russian Arctic, and the remote wilderness of Australia and Canada, cannot compete on the same level, it was thought.

It is estimated that the US should win about a third of the 150 mill tonnes per year of extra LNG demand that is expected to appear from the Asian market, primarily due to the building of the two larger locks at each end of the canal.

Of course, this scenario very much depends on transit costs and the question of whether

the Panama Canal Authority will favour large containerhips over other types of vessels, having only one large lock at each end of the canal to schedule canal transits.

Another market, which will open up in the fullness of time is the Russian Arctic export potential. The first opportunity will come when the Yamal LNG project comes on stream in late 2015, or 2016.

There are increasing moves by the Russians to develop a fleet of ice class LNGCs, able to export gas to the US and Europe via the Atlantic, or using the Northern Sea Route (NSR) to Asia during its open season.

The great unknown with the NSR are the costs attached of chartering Russian nuclear icebreakers and obtaining the permits needed, plus the local pilots on a regular basis. At the moment the NSR is not competitive with Suez in terms of cost, but it is a much shorter route to and from northern Asian ports.

Another factor to be taken into account as *LNG Shipping Review* goes to press, is the political unrest in the Middle East and North Africa, which could affect Suez Canal transits and loadings out of Egypt and the Middle East Gulf.

Despite the euphoria surrounding those eager to ramp up their fleets, or get into the LNGC owning/operating business, there are a few failures to be considered. The FLEX LNG project being one.

South Korean shipbuilder Samsung announced on 2nd August this year that it had wrapped up arbitration for returning the LNGFPSO advance payments, in a dispute which had been ongoing since last May with FLEX LNG.

In 2008, FLEX LNG ordered four LNGFPSOs from Samsung, but soon cancelled the contract, due to internal financial difficulties, as well as failure to charter the ships.

Samsung received \$495 mill in advance, and FLEX LNG requested a refund of \$300 mill.

After negotiations, it was decided that Samsung should give back \$210 mill in lieu of the cancelled contracts. FLEX LNG then ordered two new 174,000 cu m LNGCs and used the returned payment of \$210 mill as an advance on the new orders.

The lack of finance coupled with the world's current economic situation has also put an end to several other potential deals, including Stena LNG's proposed IPO to raise cash for more LNGCs. The company decided to pull the float but will probably revisit this at a later date, once the financial climate is more conducive to potential investors. ■

Spot charter rates remain above six figures

Since spot charter rates for LNGCs took off last year, earnings have hovered around the six figure mark.

Thus far this year, rates have fluctuated, dipping below \$100,000 per day during the middle of the year before rising again to \$120,000 per day and ahead of the Winter demand at the beginning of September, they remain well above the \$100,000 per day level, explained Charlie Peile, head of LNG at Braemar Seascope.

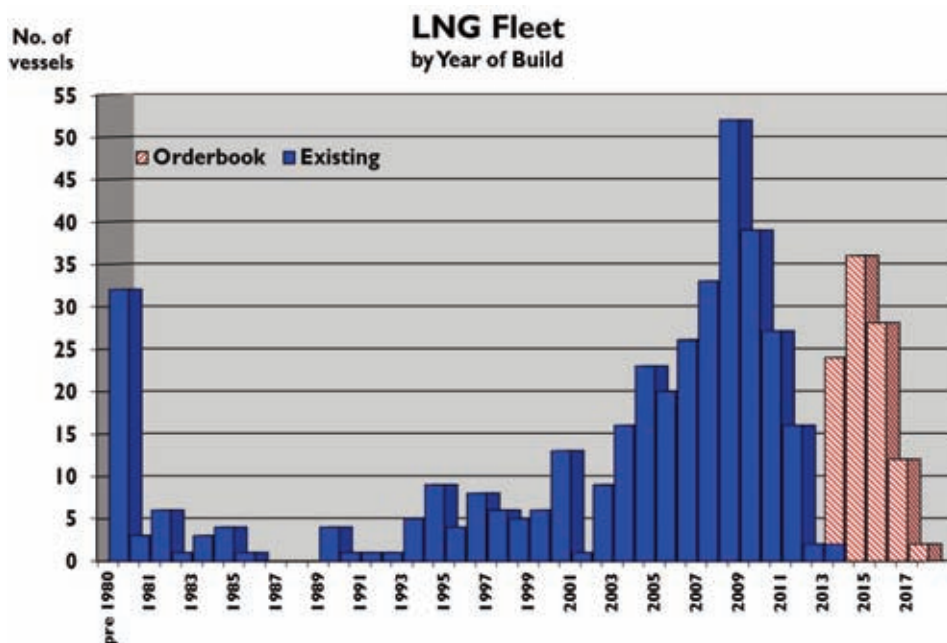
Despite, the earnings potential, in general the number of vessels in the spot charter market has not increased markedly through the year.

Most of the LNGC availability in the charter market over the last few years has been dominated by relets available for a specific limited period, supplemented by independent tonnage redelivering from period charters.

It is these vessels that have then been fixed on for a further six to 18 month charters, he explained.

As for any expansion of availability going forward, Peile said that out of the 121 or so newbuildings due to enter service in the next 12-20 months, there are about 30 that have so far not been committed to period charters.

They will not only increase the number of vessels, but change the mix of relet to independently owned vessels. In general, the more independent owners there are in a market, the more volatile it becomes, as independents are primarily concerned with maximising rates, while relets



Caption - Source: Gibson Shipbrokers as at April 2013.

concentrate on continuity.

ACTIVITY BOOST

This increase in the numbers of LNGCs available will be combined with the entry to the market of an increasing number of major traders. These two factors are expected to boost activity, especially as more product comes available.

The average length of a charter varies between independents and relets. Peile said that for relets, the average charter period was 45-60 days. These form the majority of the

fixtures. The relatively few independents on the market average six to 12 month periods.

Today about 30 LNGCs in any 90-day period come open for charter as relets, or independents. This amounts to about 10% of the existing total fleet.

He explained that the spot charter market is usually defined as those vessels that are fixed prompt for between one to three voyages - around 45-90 days.

No vessels have been contracted specifically for the spot market, as they were ordered on speculation in the expectation of being fixed prior to delivery from the shipyards for medium term business (three to five years). The risk of ordering LNGCs speculatively is that you do end up on the spot market, Peile said.

There are about 121 vessels on order today (early September). However, new orders for 2017 deliveries and beyond are being placed in increasing numbers against new projects, primarily for US exports commencing from 2016-2017 onwards, but also for others in East Africa and Russia.

Most of the LNGC availability in the charter market over the last few years has been dominated by relets available for a specific limited period, supplemented by independent tonnage redelivering from period charters.

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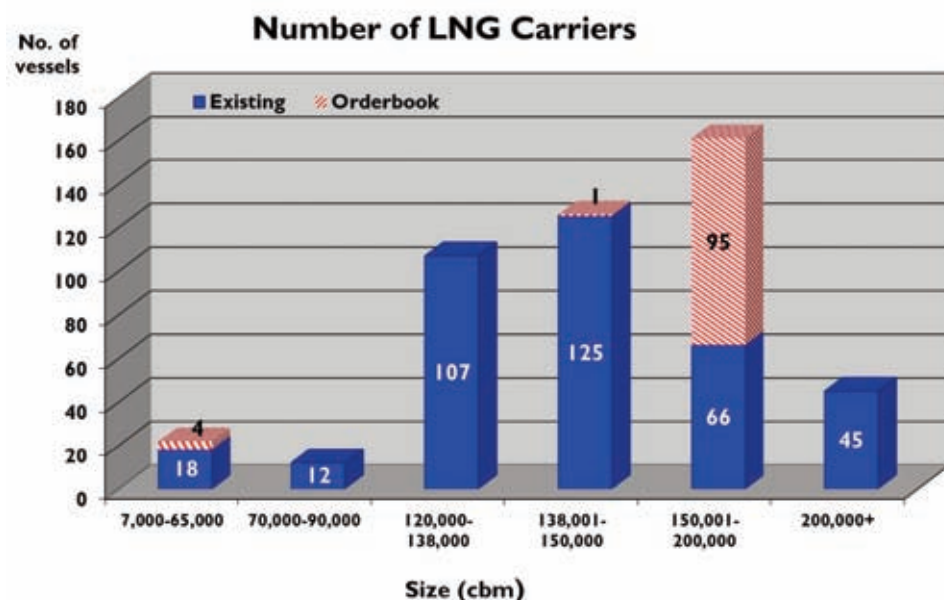
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Caption - Source: Gibson Shipbrokers as at April 2013.

Demand comes from the project's owner and a variety of shipowners offer their vessels for timecharter, he said.

The favoured LNGC size in capacity terms for the charter market is 160,000 – 175,000 cu m.

Peile explained that the differential between the youngest steam turbine vessels built 2000-2007, which are almost all 138,000-145,000 cu m capacity and the DFDE vessels built since with a size of 150,000 cu m plus, is not in operating costs but in better fuel

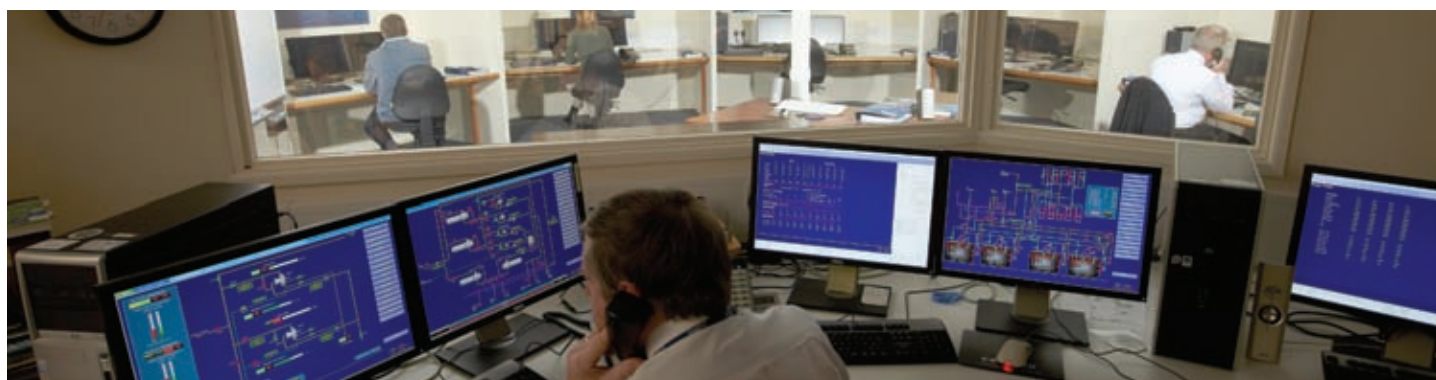
consumption, combined with a much greater carrying and thus earning capacity. Generally this equates to \$35,000-\$50,000 per day.

As for the fleet, there were around 375 LNGCs in operation of 7,000 cu m capacity and over as at April this year, according to figures produced by EA Gibson.

Somewhat surprisingly and proving the longevity of these vessels, there were around 32 operating built prior to 1980, although a couple have been recycled this year.

The new generation of dual-fuel diesel-electric (DFDE) and tri-fuel (TFDE) powered LNGCs are proving to be more popular than the older steam turbine-powered vessels, due to their greater flexibility in fuel choice on board, resulting in considerably lower fuel consumption and with it lower costs and lower emissions.

Membrane types are also favoured over the Moss design containment systems, as the latter are deemed to be more expensive to operate when transiting the Suez Canal, owing to higher canal dues. However, membrane containment systems are more susceptible to sloshing, especially when operating in the Atlantic.



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HÖEGH LNG

GasLog gears up for the future

One of the fastest growing owning companies in the LNG shipping sector is New York Stock Exchange quoted concern GasLog Ltd.

L *G Shipping Review* has put together a profile of this company's seemingly meteoric rise in the short space of 10 years, taken from various company presentations.

The company was incorporated in July 2003 under the chairmanship of Ceres Shipping's Peter G Livanos. He had founded GasLog LNG Services in 2001, which is now a subsidiary of GasLog Ltd.

GasLog LNG Services started its burgeoning relationship with BG Group's shipping arm- Methane Services - when it took on the management of two older LNGCs in 2002, which have since been sold.

Since then, the company has taken on the full technical management of 12 more of Methane Service's vessels and GasLog also has a 25% share in the 2007-built 145,000 cu m *Methane Nile Eagle*.

In May 2010, the company took delivery of its first wholly-owned vessel, the 155,000 cu m *GasLog Savannah* from Samsung Heavy Industries. This vessel was the first of 10 sisters, the last of which is due for delivery in 2016.

This year saw four of the 155,000 cu m sisters delivered. The *GasLog Shanghai* was the first of the quartet to enter service in January of this year, *GasLog Santiago* entered service in March, followed by the *GasLog Sydney* on 30th May and lastly, the *GasLog Skagen*, which was delivered on 25th July.

Another vessel under construction is also scheduled to be delivered this year, the company said in a presentation. The six delivered 155,000 cu m capacity vessels currently operating are on multi-year charters to Methane Services.

The *GasLog Sydney* is chartered out until 2019 with charterer's option to extend the terms of the charter at specified rates, while the *GasLog Skagen* is chartered out for three years followed by a subsequent five-year seasonal charter under which the vessel is committed to BG Group for seven consecutive months for a fixed monthly charter hire and is available to accept other charters for the remaining five

months. The *GasLog Santiago* is on a medium-term charter to Methane Services.

When delivered in March, *GasLog Santiago* was claimed to have set new standards for efficient performance and environmental protection.

She is classified to the ABS ENVIRO+ notation, signifying the highest level of environmental protection and energy conservation. Furthermore the vessel is equipped with a new type of cargo compressors that will reduce the release of greenhouse gasses and offer enhanced cargo and heel management, GasLog said.

Like all the vessels, she is operated by GasLog LNG Services in accordance with its marine health, safety, quality, environmental & energy management system, which in December 2012 was certified by ABS to be in compliance with ISO 50001

Each vessel owned by GasLog and the four 170,000 cu m LNGCs owned by Methane Services and technically managed by GasLog Services, are powered by tri-fuel diesel-electric (TFDE) propulsion units. The earlier Methane vessels are steam powered.

GasLog followed up the 155,000 cu m capacity series by ordering four 174,000 cu m LNGCs in two tranches from Samsung for delivery through 2016. The latest pair was ordered in August of this year for delivery in the third and fourth quarter of 2016, respectively when they will each commence a charter to Methane Services for a seven year period, plus extension options.

Due to the benefits gained from building a series of ships, the latter pairing will have a lower delivered cost than the two earlier LNGCs ordered in February, 2013 and are expected to generate a combined annual EBITDA of about \$46-\$47 mill over the first 12 months of operation.

The first pair is expected to be delivered in first quarter of 2016 and the second quarter of the year, respectively and upon delivery, will commence 10-year charters with the BG Group subsidiary. These two vessels are expected to have a combined fully delivered

cost of around \$410-\$420 mill and are expected to generate a combined annual EBITDA of about \$47-\$48 mill over the first 12 months of operation.

GasLog has also agreed up to six further options with Samsung - four priced and two unpriced - additional LNGCs of 174,000 cu m capacity each. The options expire during the fourth quarter of this year and the vessel deliveries run through 2017 should the options be declared, which seems highly likely in today's market.

Of all the newbuildings, two of the vessels still to be delivered will go on charter to Shell, another four will be chartered to BG, while the two remaining newbuildings were unfixed at the time of writing.

CHARTER OPTIONS

The strength of GasLog's existing fleet commitments and the addition of these new fixed rate term charters give the company additional flexibility to look at a range of charter periods for its two open vessels, scheduled for delivery at the end of 2014 and beginning of 2015.

In particular, this allows GasLog the flexibility to place these vessels into shorter-term charters if the company determines such charters would be beneficial to their overall profitability, it said.

Due to the support of Samsung Heavy Industries and the consequently attractive terms achieved and the recent successful launch of the Norwegian Bond (see below), GasLog said that it does not currently foresee the need to raise new equity within the next couple of years to fund the two latest orders.

GasLog revealed that its contracted charter revenues are estimated to increase from \$56.28 mill for the fiscal year 2012 to \$234.36 mill for the fiscal year 2016, based on contracts in effect as of 30th June, 2013 for the 10 ships in the owned fleet for which timecharters have been secured. This excludes the two newbuildings, but does include contracts for four newbuildings that are scheduled to be delivered on various dates in

2013, 2014 and 2016, but does not include extensions options.

Explaining its rapid expansion plans in a statement, GasLog said that the current supply and demand dynamics of the LNG industry are positive for LNG shipping. There continues to be progress on new LNG production projects and the new volumes and potentially greater voyage distances should create increased requirements for LNGCs.

In the second quarter of 2013, short term LNGC rates fell slightly before finishing the quarter higher than at the start. This end of quarter strength was attributed by observers to the start-up of the Angola LNG project taking vessels off the market, plus a mismatch between available LNGCs and cargo requirements.

The long-term fundamentals for LNG production continue to look strong, GasLog said. Further positive news has come out of the US, where Sabine Pass has taken final investment decision on trains 3 and 4, and Freeport LNG has become the second US project to receive approval from the US Department of Energy (DOE) to export to non-Free Trade Agreement (FTA) countries. It is widely expected that the DOE will approve additional projects' exports to non-FTA nations.

Further moves were made in the second quarter to develop large export facilities on the west coast of Canada. Prospects for LNG production in East Africa continue to improve with further progress offshore Tanzania and continuing investment momentum from Chinese and Indian buyers in gas reserves offshore Mozambique.

LIQUEFACTION PROJECTS

GasLog also said that the LNG market appears set for significant expansion in the coming years as a result of the large number of new liquefaction projects being developed.

For example, this year, projects in Angola and Australia are expected to start production and from next year onwards, significant additional capacity will come on line in Papua New Guinea and Australia. In addition significant plans for new exports from new and existing producing regions have been reported.

With an increase in liquefaction projects comes an increase in demand for transportation for the liquefied gas, hence the bullish statements. GasLog believed that these developments of new LNG supply projects and growing global demand for natural gas is likely to drive the need for more LNGCs.

Some of the older technology ships continue to experience idle time. However, on a historical basis LNG shipping rates remain firm and GasLog said that it expected this



Methane Services' 145,000 cu m Methane Lydon Volney is managed by GasLog LNG Services.

firmness to be reflected in the longer-term charter market.

LNG project developers are typically large multi-national oil and gas companies with exacting standards for safety and reliability. In addition, a preference for the latest technology in ship design and propulsion is expected. GasLog said that first class charterers will continue to engage experienced LNG shipowners to provide high quality LNGCs for multi-year charter requirements.

The company claimed that its strategy of using its established platform and customer relationships will give GasLog charter possibilities for the two uncommitted newbuildings, as well as the six vessel options it holds at Samsung.

In April 2012, GasLog floated in the US. A month earlier, the company set out the terms for its \$400 mill US IPO.

GasLog said that it planned to use the proceeds from the float to help fund the construction of the eight new LNGCs.

BOND ISSUE

On 27th June, 2013, GasLog Ltd issued a senior unsecured bond of NOK500 mill (\$83.2 mill) that will mature on 27th June, 2018. The bond bears interest at NIBOR plus margin.

In the same month, GasLog entered into three cross-currency swaps (CCSs) to exchange interest payments and principal on maturity and designated the CCSs as hedges of the variability of the US dollar functional currency equivalent cash flows on the bond.

The effect of these hedges is that on each interest payment date, GasLog will pay fixed interest in US dollars on a notional amount of \$83,206,215, the company explained.

As at the end of the second quarter of this year in its financial report, GasLog said that

it had cash and cash equivalents of \$211.75 mill of which \$187.86 mill was held in time deposits.

As of 30th June, 2013, GasLog reported an aggregate of \$657.27 mill of outstanding debt under four credit agreements, of which \$42.44 mill is repayable within one year. At that time, GasLog had \$82.45 mill outstanding under the bond agreement that is payable in June 2018.

There is also an undrawn revolving facility of \$50 mill available. In addition, there are three loan facilities with an aggregate undrawn amount of \$717.50 mill available that will be used to finance part of the contract prices of five newbuildings on their deliveries of which \$138.5 mill was drawn in July 2013 with the delivery of the *GasLog Skagen*.

At the end of 2Q13, the company's commitments for capital expenditures were related to the six LNGCs on order and the *GasLog Skagen*, which had a gross aggregate contract price with the shipyard of around \$1.38 bill. The total remaining balance of the contract prices of the above vessels was \$1.25 bill, which will be funded with available cash, cash from operations, existing debt and other financings.

GasLog's expected floating interest rate exposure was hedged at a weighted average interest rate of about 4.6% (including margin) as of 30th June, 2013.

HIGH PROFILE MANAGEMENT

In tandem with fleet growth, the senior management has seen a rapid expansion with some high profile names joining the company recently. These included Paul Wogan, who was promoted to CEO last February.

He joined GasLog in February 2012 as Chief Strategy Officer and took over the day to day running of the company from Peter G Livanos

who served as both Chairman and CEO since the company's IPO in April 2012. Livanos will continue in the role of Executive Chairman.

In addition, the board appointed Simon Crowe as CFO as of 1st April, 2013 and Graham Westgarth as executive vice president operations and strategy as of 14th January, 2013. On 14th June, Westgarth was promoted to COO.

As part of the changes in senior management, Philip Radziwill stepped back from his executive position in the company

but maintains his support of the management through his position on the GasLog board.

Both Livanos and Radziwill continue to play a key role in guiding the strategy of the company in the coming years, the company said.

Wogan has 26 years' experience in the shipping industry with many of those years spent leading large global shipping businesses. From 2004 to 2008 he was president of Teekay Tanker Services, which, with a fleet of 130 ships, was the largest commercial

business unit of Teekay Shipping.

Prior to that, he was CEO of Seachem Tankers, the world's third largest chemical tanker company. In 2000, he was instrumental in arranging and executing the merger of Seachem with Odfjell, forming the world's largest chemical tanker and logistics company.

Crowe joined GasLog from Subsea 7, an engineering, construction and services contractor to the offshore energy industry, where he served as CFO from 2009 until July 2012. Previously, he was with Transocean, the world's largest offshore drilling contractor, most recently as VP strategy and planning and prior to that as finance director for Transocean's Europe and Africa operations.

Westgarth joined GasLog from Teekay Shipping where he has been a member of the Teekay senior leadership team since February 1999. Most recently he was EVP of innovation, technology and projects, which included commercial and operational responsibility for a number of FSO's.

From 2001 to 2010 he served as president, Teekay Marine Services with responsibility for 5,000 sea and shore staff and the technical management of 200 vessels. During this period he also spent a year as CEO of Teekay Petrojarl following its acquisition. Prior to Teekay, he was at Mærsk Company Limited from 1987 to 1999, the last five years of which were as general manager of the Maersk UK flag fleet.

He is also the current Chairman of INTERTANKO.

As for GasLog's chairman Livanos, he is also chairman and sole shareholder of Ceres Shipping and several of its subsidiaries.

In 1989, Livanos formed Seachem Tankers., which in 2000 combined with Odfjell (later renamed Odfjell SE). He served on the Odfjell SE's board until 2008. He remains as the vice chairman of the board of directors of Belgian tanker owner Euronav, as well as chairing GasLog.

In June of this year, Dennis Houston joined the board. He was appointed member of the audit & risk committee, as well as a member of the compensation committee and HSSE committee.

Houston retired from ExxonMobil on 31st May, 2010, after over 35 years with Exxon and then ExxonMobil and currently has about 40 years of experience in the downstream sector of the oil and gas industry.

His positions on retirement were executive vice president refining & supply company, chairman and president of ExxonMobil Sales & Supply LLC and chairman of Standard Tankers Bahamas.

Fleet List

	Vessel Name	Propulsion	Capacity (cbm)	Delivered	Technical management	GasLog ownership
1	GasLog Savannah	TFDE	155,000	May 2010	Yes	100%
2	GasLog Singapore	TFDE	155,000	July 2010	Yes	100%
3	GasLog Shanghai	TFDE	155,000	Jan 2013	Yes	100%
4	GasLog Santiago	TFDE	155,000	March 2013	Yes	100%
5	GasLog Sydney	TFDE	155,000	May 2013	Yes	100%
6	GasLog Skagen	TFDE	155,000	July 2013	Yes	100%
7	GasLog Newbuilding - SHI #2041	TFDE	155,000	2013	Yes	100%
8	GasLog Newbuilding - SHI #2042	TFDE	155,000	2014	Yes	100%
9	GasLog Newbuilding - SHI #2043	TFDE	155,000	2014	Yes	100%
10	GasLog Newbuilding - SHI #2044	TFDE	155,000	2015	Yes	100%
11	GasLog Newbuilding - SHI #2072	TFDE	174,000	2016	Yes	100%
12	GasLog Newbuilding - SHI #2073	TFDE	174,000	2016	Yes	100%
13	GasLog Newbuilding - SHI #2102	TFDE	174,000	2016	Yes	100%
14	GasLog Newbuilding - SHI #2103	TFDE	174,000	2016	Yes	100%

Managed vessels

	Vessel Name	Propulsion	Capacity (cbm)	Delivered	Technical management	GasLog ownership
1	Methane Julia Louise	TFDE	170,000	2010	Yes	-
2	Methane Becki Anne	TFDE	170,000	2010	Yes	-
3	Methane Patricia Camila	TFDE	170,000	2010	Yes	-
4	Methane Mickie Harper	TFDE	170,000	2010	Yes	-
5	Methane Kari Elin	Steam	138,000	2004	Yes	-
6	Methane Rita Andrea	Steam	145,000	2006	Yes	-
7	Methane Jane Elizabeth	Steam	145,000	2006	Yes	-
8	Methane Lydon Volney	Steam	145,000	2006	Yes	-
9	Methane Shirley Elisabeth	Steam	145,000	2007	Yes	-
10	Methane Alison Victoria	Steam	145,000	2007	Yes	-
11	Methane Heather Sally	Steam	145,000	2007	Yes	-
12	Methane Nile Eagle	Steam	145,000	2007	Yes	25%

Source: GasLog.

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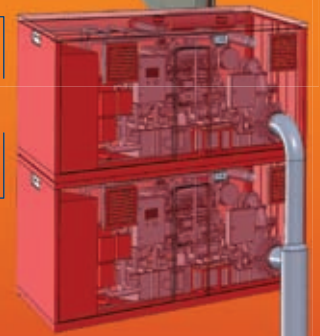
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German consultancy sees inquiry boom

Leading Hamburg-based consultancy Marine Service GmbH (MS) is seeing an increase in inquiries for its services on the back of the burgeoning interest in all things LNG.

Inquiries range from LNG bunkering, LNG fuelled engines to ship-to-shore interfaces, as well as vessel design, explained MS' sales director, Alexander Harsema-Mensonides.

One area that is very much on the radar is the offering of turnkey equipment solutions to shipowners using gas fuelled engines. This service can include all the equipment needed up to the engine's gas valve unit, thus not including the propulsion unit itself.

The equipment supply will normally be sub-contracted out and can be 'cherry picked' according to the owner's wishes when making up the whole package. This gives the owner the advantage of just speaking to one company rather than to various equipment suppliers when ordering gas bunker tanks, vaporisation units, etc.

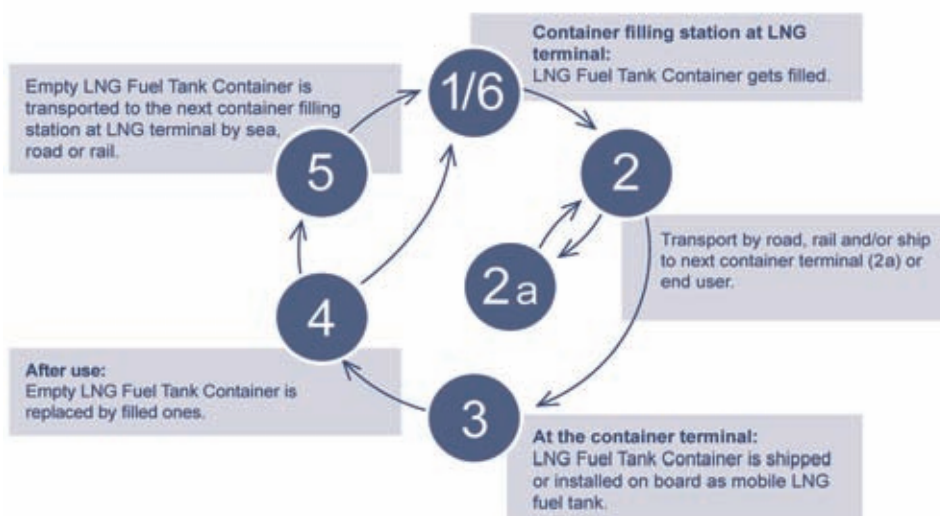
There is scope in taking the engineering, procurement and construction (EPC) route, especially when placing hardware on board ship, Harsema-Mensonides said. "Not many people can deliver the competency," he claimed.

Speaking of the various worldwide opportunities, he said that China was fairly well developed as far as LNG transportation was concerned. In the past, there was the potential for terminal development, but the vast country now has several terminals in operation, including the fitting of stainless steel tanks and in general China now offers good cryogenic services. As an example, several of China's inland waterways' vessels are already using gas fuelled engines, he said.

The US is a different story, as in this country the price differential between LNG as fuel and distillates is much larger than elsewhere, meaning that an owner/operator contemplating a conversion of an existing vessel to burn gas is only looking at a return on investment of two to three years.

In the US, gas is still cheap relative to other types of fuel, due to the abundance of shale gas. This gives much greater incentive for inland vessel operators to consider a conversion to gas.

As for US deepsea operations, there has been a resurgence of interest in Jones Act



The Marine Service LNG Fuel Tank Container	
Dimensions: L 12,192 x W 2,438 x H 2,591 m	Material: Inner tank: Steel 1.4301 Outer tank: Steel 1.4301 Frame: Carbon steel
Weights: Empty: 13,300 kg Max. load: 17,500 kg Eff. payload: 14,940 kg (33,2 m³ LNG @ 450 kg / m³) Eff. payload: 16,600 kg (33,2 m³ LNG @ 500 kg / m³) Max. weight: 30,800 kg	Developer: Marine Service GmbH Ziemann International GmbH

The Marine Service LNG Fuel Gas System.

vessels, especially tankers and these have a greater lifecycle than their counterparts in other areas of the world, again making a conversion to gas more viable.

Looking at Europe, the price differential between LNG and distillates is not so wide when compared with the US, meaning that gas conversion projects for inland vessels will be a bit slower to gain in popularity, due to both economics - a longer payback time - and the various regulatory bodies that need to be consulted, such as the Rhine Committee, etc. However, Harsema-Mensonides thought that European inland vessel conversions will definitely come, but at a slower pace than seen in the US.

In Europe, there is still an incentive to convert vessels to burn gas, but as mentioned,

the price differential is not as great as in the US, meaning a longer payback time for anybody considering a conversion.

TERMINAL LAYOUTS

Another area of interest for MS is looking at gas ship-to-ship transfers and ship-to-shore interfaces. Here the concern is the positioning of the manifolds, fendering and moorings, which might vary according to the size of the vessel and the layout of the terminal. MS holds a lot of data on marine terminals, he said. Part of the studies involved ensuring a smaller capacity gas carrier can access the facilities on a jetty designed to handle large LNGCs, in terms of the positioning of the mooring hooks and the fender patterns at the terminal.

This also applies to the question of what is

the optimum size of LNGCs today in terms of economies of scale. However, this often depends on the vessel's trading patterns and again the terminal's ability to handle vessels of any size up to Q-max. Today, the favoured vessel appears to be in the 170,000 – 180,000 cu m capacity size range, judging by the vessels recently ordered.

The new terminals coming on stream might not fit all size ranges and a terminal operator will be keen to know to what extent to upgrade an existing terminal, if at all.

As for the choice of containment systems, it is very much a matter of 'horses for courses'. A membrane system is often favoured over a Moss system, as the latter has to pay higher Suez Canal dues, but for North Atlantic trading, a Moss containment system is not so susceptible to sloshing.

Despite various new Japanese and South Korean containment systems being introduced down the years, the GTT system remains the containment system of choice among owners and operators. Much of the technology is still being developed in Europe, as Asian shipyards tend to focus on the business element, such as ensuring that vessel production is undertaken efficiently,

rather than seeking to develop new technology.

Turning to vessel bunkering, Harsema-Mensonides thought that an LNG bunkering station will be set up in Singapore in around two years' time. Gas stations will also be made available at most of the world's top bunker ports, such as at Fujairah and Rotterdam.

In Singapore, a gas receiving jetty is already in operation, as there is in Rotterdam. They will soon be able to load small bunker tankers, he said.

TANK CONTAINER

MS has developed what it claims is a quick and easy conversion solution that comes in the form of a Type C, IMDG tank container, which can be lifted or rolled on board ship. It is suitable for container feeders, ro-ro and con-ro vessels, ferries and cruise liners and can be fitted at the newbuild stage, or retrofitted.

The BV type approved box comes in the form of a standard FEU ISO container for universal storage and handling and has been designed to be stacked up to six layers high.

According to MS, by lifting the container on board ship, it eliminates the need for LNG handling during LNG bunkering, eliminating the risk of LNG spillage and fire hazard. It can

store LNG for 80 days unattended.

It is fitted with dry quick couplings for LNG liquid and vapour and is also fitted safety valve connections. It also has a dry break-away safety release on the LNG liquid and vapour connections.

MS will deliver the LNG fuel tank containers and the associated gas handling system, which will control the feed gas pressure and temperature for dual-fuel and gas engines.

This gas handling system is available as a containerised unit, or it can be skid mounted for installation in the vessel.

Harsema-Mensonides said that many people are looking at this bunkering system and that MS is working with several other class societies to approve the system. The container is insulated and double walled so that it doesn't get too cold to the human touch on the outside walls.

Summing up, he said that MS is seeing inquiries for the conversion of vessels to gas mode in Europe, the US and Canada. Newbuilding inquiries are emanating from the US and Canada. He said that the number of opportunities and projects in general were growing in Europe and the US. In Asia, inquiry mainly concerned power generation, he concluded. ■



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Gas as fuel - the momentum increases

With the rising interest in gas fuelled engines, not only installed on board LNGCs but also on other types of vessels, equipment manufacturers and suppliers have not been slow to act.

Although the new engines have been tested thoroughly, they have by and large not been running for many hours at sea. As with any new technology, there will probably be teething problems, but the potential is huge, as long as the price of LNG remains competitive with HFO and MDO.

Last year in *LNG Shipping Review*, we highlighted several new initiatives, from the major engines manufacturers and others.

In this feature, we continue that theme naming the key players in strict alphabetical order and in the later pages of this issue, we look at the bunkering options going forward, which will probably play a major factor in the next generation propulsion methodology chosen.

Power systems provider **ABB** has signed a long-term 'preventive service' agreement with China LNG Shipping International (CLSICO).

Under this agreement, ABB is now providing maintenance services for all of the company's equipment installed on board six LNGCs for the next five years. The contract commenced 1st January, 2013.

The new service agreement is claimed to help CLSICO with optimised vessel



A model of a CLSICO LNGC.

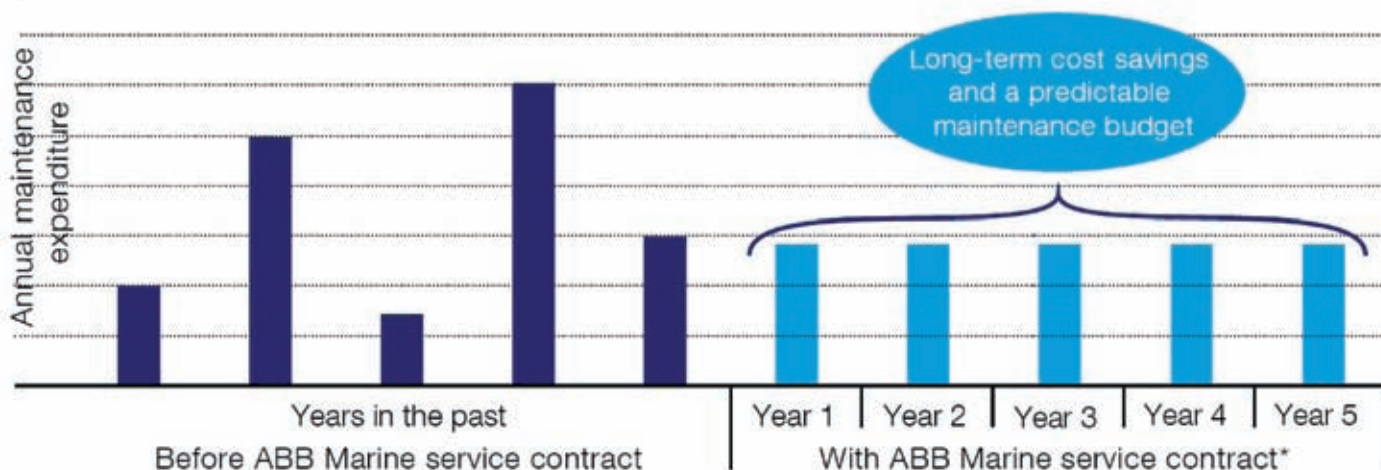
performance at a predicted minimum budget level. Under this agreement, ABB provides annual site survey and on-call services to the six vessels, as well as drydock services every 30 months.

The scope of the agreement covers preventive maintenance on board, the power generation plants and mechanical and electrical systems. All the systems covered by the contract will have increased reliability and extended life through the scheduled maintenance procedures and pre-planned service visits, ABB said. In turn, this enables CLSICO to ensure maximum performance

maintenance throughout its assets' lifecycle and to maximise trading days to the charters.

"ABB's modular service agreement concept allowed us to tailor make the service package that best suits CLSICO's fleet management model. With a thorough five years maintenance plan, CLSICO will be able to achieve ambitious cost saving targets", said Heikki Soljama, head of marine and cranes business at ABB, speaking earlier this year. "Additionally, the framework ensures effective communication and transparency between CLSICO management and ABB, which in turns strengthens the co-operation between

Moving from fluctuating expenditure to a fixed annual rate makes budgeting more predictable



Source: ABB.

both parties and streamlines key processes.”

“One of our key priorities is to maximise fleet availability, while keeping our costs as predictable as possible” said Sandy Farquhar, CLSICO fleet manager.

Established in Hong Kong in 2006, CLSICO provides LNG shipmanagement services. It was founded to manage the original five 147,000 cu m LNGCs built to supply the Guangdong and Fujian import terminals from the North West Shelf in Australia and Tangguh, Indonesia.

In 2012, another LNGC was added to the fleet in order to supply the Shanghai terminal from Bintulu, Malaysia, which increased CLSICO’s demand for higher equipment and vessel availability.

In total, the six LNGCs under CLSICO management transport more than 870,000 cu m of natural gas per trip serving the import terminals at Guangdong, Fujian and Shanghai.

ABB said that another crucial feature of the ‘preventive service’ agreement is the capability it gives shipowners to predict long-term maintenance costs and cash-flow. Once the maintenance expenditure is fixed to an annual rate, CLSICO will benefit from

having a more predictable maintenance budgeting process.

Included in the service agreements are discounted service rates for spare parts, training services and all on-call visits throughout the contract period.

MAJOR ORDERS

ABB has also secured total orders worth almost \$40 mill from three leading gas transportation concerns in the first quarter of 2013 to supply power and electric propulsion equipment for LNGCs to be built in South Korea.

The company will supply a propulsion plant to work in combination with a dual-fuel diesel engine to be installed on board a 155,000 cu m capacity LNGC ordered from Hyundai Heavy Industries (HHI) by a Southeast Asian shipowner.

The membrane-type vessel is expected to be delivered by HHI’s Ulsan yard in 2015. ABB’s scope of supply includes generators, switchboards, transformers, drives and propulsion motors.

In a second contract, ABB will deliver a similar power and propulsion plant package to

a pair of 160,000 cu m capacity LNGCs ordered by US gas major player from Samsung Heavy Industries (SHI).

These two ships will be built at SHI’s Geoje Island facility for delivery between 2015 and 2016. This contract also calls for the delivery of the same package, plus additional switchboards for a 170,000 cu m LNGFSRU for a Norwegian/Southeast Asian shipowner. This vessel will also be built at SHI’s Geoje Island facility for delivery in 2015.

As per June 1st 2013, a total of 38 DFDE LNGCs were under construction, or commissioning with ABB power & propulsion system.

Soljama said: “Repeat orders for LNG carrier power and propulsion systems via HHI and SHI consolidates our strong relationship with two of the leading yards in the field. Our success in winning these contracts demonstrates that we are well on our way to achieving our targets in the fast-growing LNG industry and is in line with our position as a supplier of choice in this technically demanding segment.”

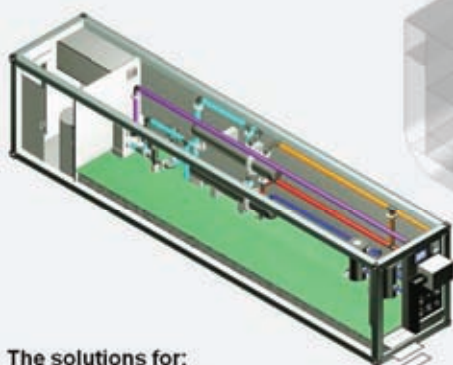
Alfa Laval’s recent acquisition of gas combustion technology from Snecma, part of

Marine Service GmbH



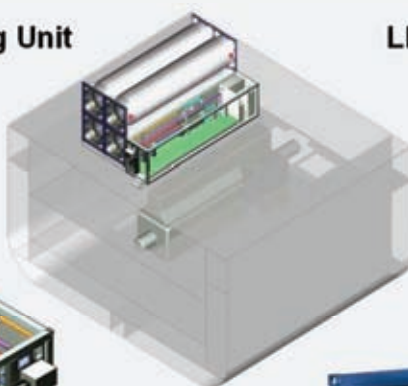
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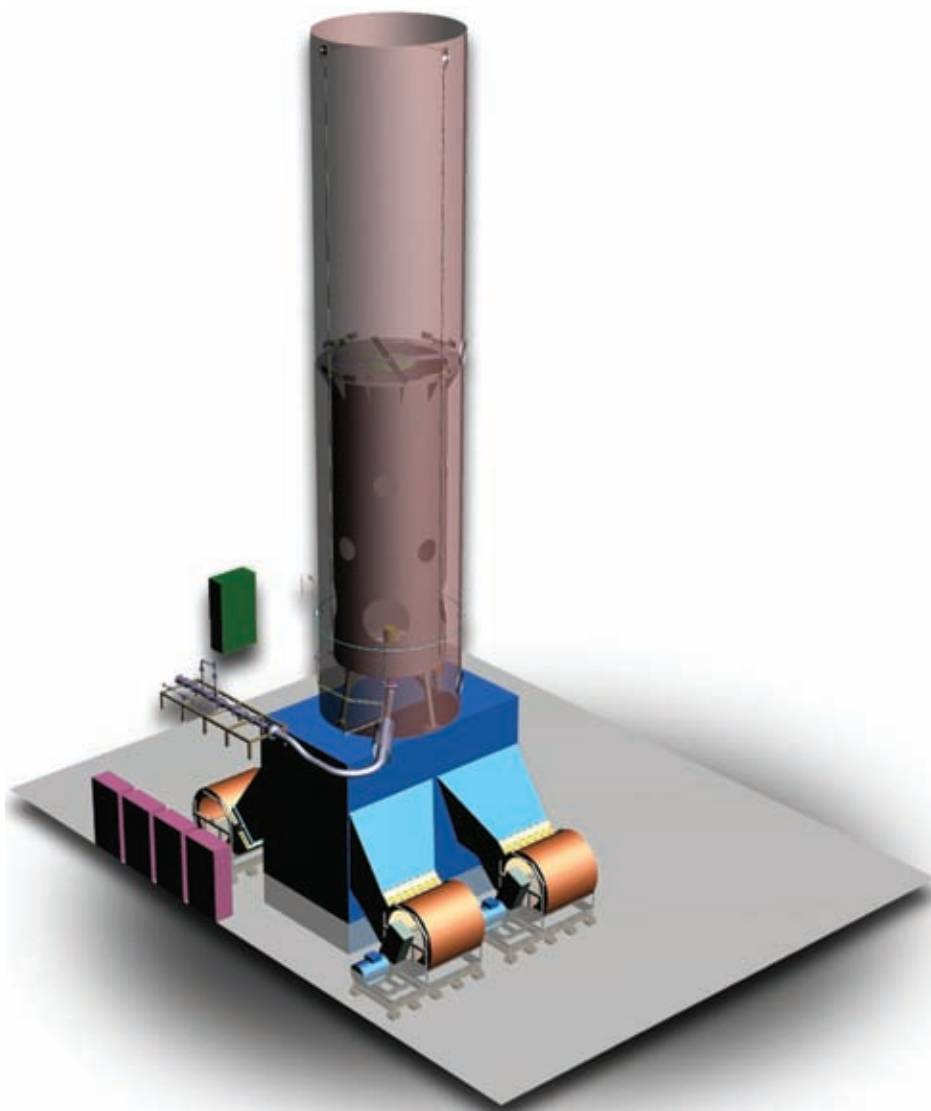
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Alfa Laval's compact gas combustion unit.

the Safran Group, provides LNGC owners using dual-fuel diesel electric (DFDE) engines, or low-speed diesel (LSD) engines with a compact gas combustion unit (GCU) that has lower installation costs and operating expenditure than comparable units, the company claimed. Moreover, the Alfa Laval GCU comes backed by the company's global sales and service network.

Although LNGCs have recently been lauded as the shipping industry's most profitable sector, LNG shipping companies continue to look for ways to lower costs as a measure to ensure long-term profitability. While steam propulsion has been the mainstay on LNGCs for decades, rising fuel costs, environmental regulations and the continuing shortage of qualified seagoing engineers are forcing LNG shipowners to re-evaluate critical systems on board, Alfa Laval said.

As more countries look to LNG for power generation and production needs, the shipping

companies involved must determine how best to build new LNGCs, or retrofit existing vessels, to ensure long-term profitability.

The selection of DFDE, or LSD engines as economical green alternatives to the traditional steam propulsion systems on board is one example of fuel-saving and environmental conservation efforts undertaken by LNGC owners.

By using these propulsion units, this provides additional means with which to regulate LNG cargo tank pressure. In some cases, this is accomplished by re-liquefaction but, in most cases, gas combustion units have been introduced to burn excess boil-off gas safely.

According to industry estimates, about 85% of all LNGCs fitted with either two- or four-stroke dual-fuel engines today have some type of combustion chamber to regulate the pressure in the cargo tanks by burning excess boil-off gas from the cargo tanks under safe

and controlled conditions.

"The Alfa Laval GCU is not, by any means, new technology," said René Fich Jespersen, Alfa Laval's general manager, new boiler & global sales support, marine & diesel division. "The big news here is that LNG shipowners can rely on Alfa Laval as a well-known partner who is focusing on providing what is essential for the marine industry to succeed in this competitive business environment and who has the infrastructure in place to ensure the delivery of the service and support required."

PRODUCT PORTFOLIO

By extending the company's portfolio of products and solutions for the marine industry with the Alfa Laval GCU, the company now offers a comprehensive LNGC product range, which includes Aalborg marine boiler systems with dual-fuel burners, waste heat recovery systems, inert gas generators and heat exchangers.

Why consider the Alfa Laval GCU over comparable gas combustion units? Jespersen said that the unit has the simplest design overall with fewer parts than comparable systems, straightforward operation, compact design, no pilot fuel and the smallest footprint in the business, all of which translates into cost-effective installation and operation.

"Only the burner, combustion chamber and monitoring sensors are in the stack of the Alfa Laval GCU," said Jespersen. "The design philosophy behind the Alfa Laval GCU essentially shares the same approach as that of our heat exchangers, separators and other equipment and solutions; in other words, we always put great effort into making designs simpler, more reliable, more economical and more efficient."

Available in four standard sizes, Alfa Laval GCU handles capacities of three, four, five, six and nine t/h methane using either single, or dual combustion chambers. In addition, the Alfa GCU is approved by major classification societies, including American Bureau of Shipping, Bureau Veritas, Det Norske Veritas and Lloyd's Register.

According to Jespersen, the Alfa Laval GCU provides the lowest possible operating expenditures for gas combustion technology. When asked how this is possible, he said that no oil is needed for ignition of the flame, the reduced parts count and smaller footprint and, no perforated dome, refractory lining, or expansion joints are required.

Fewer parts translate into reduced installation and maintenance costs. Unlike other gas combustion units, the Alfa Laval system has low-noise fans that serve a dual

purpose – both as combustion air fans, as well as dilution air fans for exhaust gas. This effectively does away with the need for separate combustion air fans and dilution air fans along with the associated ductwork, cabling and silencers.

Operating costs are reduced because the Alfa Laval GCU uses an electrical ignition device that enables fast start-up. This eliminates the requirement for a marine diesel oil (MDO) or distillate marine fuel (DMA) system with the requisite tank, pilot and oil lines. The self-purging burner is another example of smart design that reduces maintenance costs because it has no rotating parts. It also promotes safety due to its ability to handle combustion under conditions with high excess air and/or high inert gas content.

Without the additional fans and oil system required for other GCUs, the overall space requirement of the all-stainless-steel GCU combustion chamber is much smaller than that required for other GCUs.

Answering the question - why then aren't all LNG shipowners with DFDE, or LSD engines installing Alfa Laval GCUs on board? Jespersen said "We often see that new technology has a very slow adoption rate in our industry, which makes sense because

safety is the number one concern.

"However, new technology should not be confused with 'unsafe'. Using electronic ignitors on gas burners is often questioned, but Alfa Laval has been using these on our traditional gas burners for years – and these have a proven safety record. We see the same holding true for combustion and the GCU.

"Despite using a principle which differs from the traditional burners used on our boilers, for instance, the flame is maintained across variable loads. Shipowners sometimes forget that the objective of the combustion on a GCU differs from that of a boiler," he explained.

ELECTRICAL POWER

One of ABB's main rivals, GE has also gained success in the supply of power systems for LNGCs.

Earlier this year, the huge conglomerate's Power Conversion business unit announced the signing of \$80 mill worth of contracts to supply electrical power and propulsion systems for LNGCs, including FSRUs in just six months.

These contracts concern the supply of electric propulsion systems for 31 gas carriers, which include 26 LNGCs and five FSRUs.

The latest orders were announced last April and concerned the supply of electric power and propulsion systems for two LNGCs and one FSRU.

"We use high power pulse width modulation (PWM) technology to bring important added value to the end customer," said Jean-Philippe Chaignot, merchant marine business leader for GE's Power Conversion business in April. "Along with our induction motors, it is one of the most robust technologies available, and it substantially increases the overall availability of the system as a whole."

Among the recent contracts were –

- A GE propulsion system for shipbuilder Hyundai Heavy Industries to be fitted on board an FSRU ordered by Høegh LNG.
- A power and propulsion system for an LNGC being built for Tsakos Energy Navigation (TEN). GE will supply four generators, four propulsion transformers, two propulsion converters, two propulsion motors, four distribution transformers, main and cargo switchboards and remote control. GE also will provide project management, system and equipment engineering, commissioning and assistance for sea and gas trials.

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■ Daewoo Shipbuilding & Marine Engineering (DSME) chose GE's power and propulsion technology for two new LNGCs to be built for Maran Gas Maritime, the LNG shipping arm of the Angelicoussis Shipping Group.

This is the 11th Maran Gas LNGC that will be fitted with GE's power conversion system for its LNGC system. Again GE will supply a complete system, comprising four generators, two propulsion converters, two propulsion motors, four distribution transformers, main and cargo switchboards and remote control. GE also will provide project management, system and equipment engineering, commissioning and assistance for sea and gas trials.

Chaignot said that the electric drive concept has become the technology of choice for LNGCs, due to its overall performance. GE's combination of high power PWM technology based on insulated gate bipolar transistors (IGBTs) together with robustly simple induction motor technology offers important advantages to shipowners, it was claimed.

"The simplicity of induction-based propulsion motor technology makes it more reliable, helps lower routine or emergency maintenance costs and provide lower life-cycle costs of ownership," Chaignot said. "This is a proven technology that GE's Power Conversion business has advanced in the marine industry and which it is now applying extensively in sectors as diverse as naval, offshore, cruise ships and others, where multi-megawatt power with excellent performance in terms of power, propulsion efficiency is called for."

Induction motors for the marine industry were developed 15 years ago by GE's Power Conversion business for the US, UK and French navies. Today, GE claims to be the only company with marine applications that combine high-powered induction motors with PWM.

GE's Power Conversion unit was the first to equip a large LNGC with electric propulsion, *Gaz de France Energy*, in 2002.

It was later reported by the company that the first electrically propelled LNGCs to be built in China will incorporate power and

propulsion systems developed and built by GE's Power Conversion business.

Hudong-Zhonghua Shipbuilding Group, part of the China State Shipbuilding Corp, signed contracts with GE for the supply of power and propulsion systems for six 174,000 cu m LNG carriers to be built in Shanghai for Asian shipping companies, including China Shipping Group and Sinopec Kantons Holdings.

The gas carriers will transport LNG from Australia to China and will be delivered between April 2016 and November 2017.

The decision to use dual-fuel diesel-electric (DFDE) propulsion for the new LNGCs marks a turning point in propulsion systems for large gas carriers built in China, the company said as either steam turbines, or two-stroke engine technology had been the norm.

Electrical propulsion technology is claimed to be more efficient and offer lower fuel consumption and emissions. DFDE drive systems also are more compact than other types, enabling the gas carriers to ship more cargo.

At Hudong-Zhonghua Shipbuilding Group, Jin Yan Zi, vice president business and purchase said, "These important contracts for our next-generation LNGCs mark the beginning of a new relationship with GE's Power Conversion business. We look forward to a high level of co-operation that will benefit both parties."

GE will supply induction motors with PWM propulsion technology driven by electricity generated from dual-fuel engines that can run on natural gas, marine diesel gas, or heavy fuel oil. The combination of dual-fuel engines, which can use boil-off gas from the vessel's LNG tanks, and GE's electrical variable-speed drives, presents a proven solution that is now commonly used on LNGCs, the company claimed.

For each vessel, GE will supply two propulsion systems comprising of generators, main and cargo switchboards, transformers, MV7000 converters, motors and remote control. GE is responsible for design, engineering, commissioning, training and assistance for sea and gas trials.

As for the Maran Gas installations, the first electrical powered LNGC to be ordered by the company incorporating GE's induction-based electric propulsion motor technology entered service in July.

The *Woodside Rogers*, built by Daewoo completed sea trials in late April and was handed over to Maran Gas on 1st July. It is the first of seven LNGCs incorporating the GE power and propulsion technology that Maran Gas ordered from DSME for delivery between 2013 and 2015.

DSME and GE already had co-operated on electric propulsion systems for six vessels prior to the *Woodside Rogers*. For the this vessel, GE supplied a complete system comprising of four 9.85 MVA generators, main and cargo switchboards, four transformers, two converters, two 13.26 MW motors and remote control. GE also provided project management, system and equipment engineering, commissioning and assistance for sea and gas trials.

REDUNDANCY

The electric drive system for the *Woodside Rogers* is powered by TFDE engines that run on natural gas, marine diesel gas, or heavy fuel oil. The ship operator can choose the mode according to current prices of the different fuels, making the system very cost-effective. In addition, the layout of the TFDE engines provide a high level of redundancy, which improves the safety of the vessel, thus avoiding off-hire. Fuel consumption and emissions also are lower, it is claimed.

"As a result of this project, we have now developed and qualified a complete standardised product range for drives, generators and motors capable to handle a wider range of power requirements than ever," said Paul English, marine business leader for GE's Power Conversion business. "In the future, this will allow us to produce and deliver our product on even tighter schedules than before."

Andreas Spertos, technical director, Maran Gas, said, "We expect our shipbuilders to propose the most cost-effective and sustainable solutions for our requirements."

"The simplicity of induction-based propulsion motor technology makes it more reliable, helps lower routine or emergency maintenance costs and provide lower life-cycle costs of ownership,"

- Jean-Philippe Chaignot, merchant marine business leader, GE's Power Conversion

DSME made a strong case for using the GE technology based on their substantial experience over the years, in combination with the tri-fuel engine. This is our first time working with GE's electric propulsion system. We are very impressed by the level of their technical expertise and confident in the decision to use their electric propulsion systems."

ME-GI SUCCESS

Major diesel engine manufacturer, **MAN Diesel & Turbo**, has announced several orders of its new ME-GI type low speed engine recently.

One of the company's oldest licensees- Mitsui- held a demonstration of the company's ME-GI concept –a Mitsui MAN B&W 6S70ME-C-GI engine - on 17th April this year at its Tamano works. ME stands for M type electronically-controlled and GI for gas injection.

Dr Rene Umlauf, MAN CEO, described the ME- GI engine as representing a milestone in a shipping era where stricter emission regulations and rising fuel costs are calling for environmentally friendly and economic solutions.

"Dual fuel engines are tailored perfectly to these demands. When operated in gas mode, CO₂ and nitric oxide emissions are markedly reduced, while sulphur oxides, soot and particle emissions are virtually non-existent. Additionally, dual fuel engines give shipowners and operators tremendous flexibility and since the fuel can be changed based on its availability and price," he said at the test.

Umlauf said that gas, as a fuel, was on the rise and that hurdles such as infrastructure and refuelling were now being resolved. In this respect, he gave the recent example of Jurong Port in Singapore, one of the largest transshipment centres between Southeast Asia and Europe, where a new LNG terminal is now being established.

He concluded by referring back to Mitsui's building of the world's first commercial high-pressure gas injection 2-stroke engine, a 12K80MC-GI-S, delivered to a Chiba power station in 1994.

He said last April: "As we are now only beginning to receive orders for marine ME-GI engines, this early order bears witness to Mitsui's readiness and commitment to enter into new and daring projects."

At the same presentation, Thomas Knudsen, head of low speed business unit, said; "With this technology, Mitsui and MAN Diesel & Turbo will be able to supply the most environmentally friendly and most economical



MAN's ME-GI type engine.

power plants for not only LNGCs but also for VLCCs, containerships, ro-ros, bulkers and other ship types. These will all, in the near future, be able to harvest the benefit of utilising natural gas as a fuel."

He described the ME-GI technology as traditional 2-stroke engine technology that can be maintained and overhauled by chief engineers already capable of maintaining existing 2-stroke engines and he called the ME-GI engine "...a natural choice of technology for merchant ships where the goal is to provide shipowners and shipyards with environmentally friendly engines at a competitive price."

Unveiled at MAN's Copenhagen Diesel Research Centre in May 2011, the ME-GI engine represented the culmination of many years' work. Depending on relative price and availability, as well as environmental considerations, the ME-GI gives shipowners

and operators the option of using heavy fuel oil, or gas – predominantly natural gas, but also LPG and methane.

Mitsui is the second MAN 2-stroke licensee to demonstrate this type of engine concept following Hyundai in South Korea in November 2012. Shortly after this demonstration, US shipping concern TOTE ordered two 8L70ME-GI engines to power two 3,100 TEU newbuilding containerships with options for a further three.

That order was the first for a commercial vessel in the MAN's low-speed portfolio.

The following month, MAN Diesel & Turbo announced another order when Teekay LNG Partners placed a contract for two LNGCs, which will be powered by two 5G70ME-GI engines each. The contract included an option for three further LNGCs, which could bring the total number of engines ordered by Teekay up to six.

At the time of the Teekay order, Peter Evensen, Teekay CEO, said: “The newbuildings will be constructed with M-type, electronically controlled, gas injection (ME-GI) twin engines, which are expected to be significantly more fuel-efficient and have lower emission levels than other engines cost-efficiency, since the fuel can be changed based on its availability and price.

“MAN’s ME-GI engine is highly suited to the LNGC market and is recognised as the most fuel efficient gas burning engine on the market. We are confident that the quality and fuel efficiency of these engines will be very attractive to our customers,” he said.

To be built by Daewoo, the Teekay LNGC engines are based upon the new ultra-long-stroke G-type concept to deliver an even higher overall propulsion plant efficiency. The G-type engine has gained the fastest acceptance of any engine in MAN’s portfolio, the company claimed.

Teekay LNG has said that it intended to secure long term contracts for both of the 173,400 cu m capacity LNGCs prior to their delivery in the first half of 2016.

MAN B&W’s senior vice president sales and promotions, Ole Groene, said; “With the current flux in fuel prices and the new Environmental Control Areas (ECAs), we felt the timing of this release of a commercial, low speed, dual fuel engine was right.

“The TOTE order, the very first commercial order for the ME-GI engine, was proof of this and we view the continued momentum provided by the Teekay LNG order as confirmation that customers who understand the extremely positive commercial and environmental implications of the ME-GI are quickly embracing the concept,” he said.

The ME-GI uses high-pressure gas injection that allows it to maintain positive attributes of the low speed engine, which has been a popular choice among shipowners and indeed still is. It dispenses with the need for power de-rating and eliminates the significant problem of methane slip and the resulting CO₂ emissions.

TYPE APPROVAL

The MAN ME-GI dual-fuel, ultra long two-stroke gas injection engines received DNV type approval in 2010.

DNV’s experience from risk assessments of LNG-fuelled vessels showed that a gas-fuelled main engine has the same risk level as a diesel-fuelled main engine. One reason for the low risk is that the main engine undergoes rigorous type approval and testing regimes, as well as being subject to stringent rule and regulatory requirements.

The new electronically controlled, two-stroke ME-GI engines have undergone extensive testing. The engines will automatically switch between burning LNG and fuel oil when power is reduced to 15% load, making port-to-port operation on LNG possible.

“These engines place us at the forefront of technology in the marketplace,” said Tony Bingham, Teekay’s technical manager for LNG. “We benefit, our charterers benefit and so does the environment through lower SOx, NOx, CO₂ and particulate emissions.”

“We will install a revolutionary re-liquefaction plant which consumes less than 300 kw. This enables us to re-liquefy any excess boil off at speeds below 15 knots. Link this capability together with DSME’s patented sealed LNG containment system and we can ensure that no boil off is burnt in the gas combustion unit at any speed. This unique design ensures that the maximum cargo is delivered to the customer at the lowest unit freight cost in the industry,” he said.

DNV is providing full classification services for the Teekay newbuilding project. “As the class society that has approved most of the gas-fuelled vessels built to date, DNV has played a central role in the evolution of gas engine technology,” said Nick Roper, DNV’s district manager for the Pacific region.

The delivery time of Teekay’s LNGCs coincides with expected growth in the US LNG export market and a wave of increased demand for gas carriers. The new vessels will be among the largest LNG carriers able to transit the Panama Canal after its expansion, making them ideal for US LNG exports, the company claimed.

MAN has also won a contract to supply the prime movers for the six LR-classed Chinese LNGCs to be fitted with GE technology. The order for the 30 × MAN 51/60DF dual-fuel engines is a significant development for both Chinese shipyards, as well as the LNGC market, the company said.

The configuration for the new order covers five 8L51/60DF engines. They are all IMO Tier II-compliant in diesel mode and will have lower exhaust-gas emissions in gas mode than IMO Tier III stipulates – fuel-sharing mode will be applied to each unit, MAN said.

The customer is a consortium, formed by Sinopec Kantons, MOL and Shanghai-based CSLNG, a daughter company of China Shipping.

As stated by GE, the vessels will be constructed at Hudong-Zhonghua Shipyard located in Shanghai at the Jiangnan Changxing Production Line No.1, now the responsibility of Hudong, following parent group China State

Shipbuilding Corporation’s (CSSC) re-organisation of production facilities.

When delivered, the ships will load LNG in Gladstone, Australia for a number of Chinese import terminals –Qingdao, Beihai, Tianjin, Lianyungang and Wenzhou. Steel cutting on the first gas carrier is set for January 2014.

The sixth vessel is scheduled for delivery in the fourth quarter, 2017. MAN said that the engines will be designed and built at its Augsburg works in southern Germany.

Fuel sharing mode (FSM) describes the operation of a dual-fuel engine with a mixture of fuel gas (NG, NBOG) and fuel oil (MGO, MDO, or HFO) at a certain ratio. All cylinders operate at the same fuel-sharing ratio simultaneously.

MAN’s Erwin Boijmans, sales manager – marine medium speed business unit, based in Augsburg said: “This order is yet another success for the 51/60DF’s fuel-sharing capability, a special feature and one of the reasons we have especially focused on LNG carrier applications with the 51/60DF unit. This Chinese order comes on the back of another milestone LNGC order with the same configuration we recently landed in Japan and augurs well for the future.”

Adopting FSM brings several advantages, including:

- Full load with low quality of fuel gas (LHV, MN).
- Full load with low quantity of fuel gas.
- Full load with high ambient air temperature.
- Retrofit ‘DF-light’ (gas mode without pilot fuel system).

SMALLER VESSEL DESIGNS

The Norwegian arm of the power provider **Rolls-Royce** has introduced several designs of LNG powered vessels, many of which are at the smaller end of the size range, intended to trade around Norway, the Baltic and northern Europe.

An example of RR’s design concepts was an announcement at this year’s Nor-Shipping that Norwegian-based Jahre Marine had signed a newbuilding contract with Chinese yard Avic Dingheng to build what was described as the first seagoing LNGC to be built for both bunkering and small-scale distribution.

The 6,200 cu m capacity vessel was designed by Rolls-Royce Marine and will be fitted with an RR complete equipment package, including the prime mover. It will utilise LNG as fuel, with gas fed to the engine taken from an aft cargo tank.

It will be fitted with what is claimed to be a



Bergen Viking - soon to be powered by LNG as fuel.

novel design of cargo tank, developed by Norwegian company Torgy LNG, using non-pressurised IMO A technology.

Jahre Marine is a partnership between Jahre Holding and Donsøtank. The latter will be responsible for newbuilding follow up and technical management after the vessel's delivery.

The concept has received the promise of funding from Innovation Norway and the Norwegian NOx fund, which covers the gas propulsion system and the infrastructure.

RR has also won a contract to convert the chemical and product tanker *Bergen Viking* to run on natural gas, replacing its diesel engines. The Norwegian shipowner Bergen Tankers said that it had chosen gas engines and accompanying systems from RR for this upgrade.

Neil Gilliver, RR's president merchant, said; "LNG is growing in popularity as a marine fuel, due to its environmental characteristics and lower cost than diesel. The new engines for *Bergen Viking* will have reduced fuel consumption by about 25%. At the same time, emissions of NOx are cut by about 85%, CO₂ by 25%, SOx by 100% and particles are reduced to approximately zero."

The conversion to LNG is planned to be undertaken during the summer of 2014.

Bergen Viking is a 95 m long chemical and product tanker operating along the Norwegian coastline. Delivered in 2007, the vessel is

part of a total fleet of six vessels owned by Bergen Tankers.

Kjell Olav Haugland, managing director of Bergen Tankers, said: "For a relatively small shipowner, this change represents a significant investment. However with some financial support from the Norwegian Government's NOx funding programme, we are confident that the solution offered by Rolls-Royce will prove to be cost efficient for us."

The vessel will go on charter to Statoil supplying refined products along the Norwegian coast. VP Statoil shipping and operations, Ann-Elisabeth Serck-Hanssen said: "Statoil has a long co-operation with Bergen Tankers and we are pleased that we can take this step together towards a more environmentally friendly shipping operation. The vessel has a high safety standard enabling secure operations in a vulnerable area along our Norwegian coastline."

COMPLETE PACKAGE

Another company well known for developing and supplying power systems is **Wärtsilä**.

The company has developed into a complete solutions and service provider for the marine industry by acquiring several companies down the years from being well known for the design and development of main engines and auxiliaries.

Wärtsilä has not been slow to embrace the LNG as fuel opportunities and recently won a

contract to supply a comprehensive package to be fitted on board a series of hybrid gas carriers being built for Danish operator Evergas, formerly known as Eitzen Gas.

The advanced technology solution to be provided by Wärtsilä will make the vessels the most modern and environmentally sustainable LNGCs ever built, the company claimed.

Up to eight and possibly 10 vessels of around 12,000 cu m to 17,000 cu m multi-purpose capacity gas carriers are being built at the Sinopacific Offshore & Engineering (SOE) shipyard in China. In addition to LNG, the ships will be able to carry and reliquefy ethane and LPG. Once delivered they are earmarked to serve the Rafnes gas plant and receiving terminals on the West Coast of Norway.

The LNG will be carried in tanks on the vessels' deck, which can be used to store fuel and/or cargo. Wärtsilä will supply the cargo handling package, as well as the dual-fuel engines and propulsion equipment.

"The customer's essential requirements for these vessels are to achieve the operational and fuel efficiencies needed to optimise their operating costs, while at the same time complying with the upcoming Tier III environmental regulations," said Aaron Bresnahan, vice president sales, Wärtsilä Ship Power. "The advanced technology solution to be provided by Wärtsilä, whereby the cargo handling system, the gas supply system and the propulsion machinery are fully integrated

with each other, will make the vessels the most modern and environmentally sustainable LNGCs ever built."

Martin Ackermann, CEO of Evergas said, "We have enjoyed a lengthy and trusted relationship with Wärtsilä. This, together with Wärtsilä's relentless efforts in understanding and adapting to our demands, has enabled us to successfully achieve a total integrated solution. I am convinced that our DRAGON 27500 series will be a benchmark in the LNGC markets."

For example, efficiency and fuel savings will be gained through the Wärtsilä Energopac rudder, which because it streamlines the water flow from the propeller, lowers resistance and increases propulsion power, the company said.

The vessels will operate primarily using LNG as a source of power, using Wärtsilä dual-fuel engine technology. This will enable the vessels to comply with current and anticipated environmental legislation, including the IMO's Tier III regulations.

The Wärtsilä technology, however, also provides operational flexibility and redundancy, since it allows the possibility to utilise various conventional fuels in addition to LNG. The integrated LNG fuel system also enables the vessels to operate on natural gas independently of the cargo carried.

INTEGRATED SYSTEM

This integrated systems contract enables a range of individual Wärtsilä solutions to be combined into a fully optimised package. Engineering and delivery of the complete cargo plant in combination with the gas fuel supply system and propulsion plant is enabling Wärtsilä to optimise the complete vessels

energy consumption, the company claimed.

This is demonstrated, for example, where the LNG supply system is integrated with the cargo handling system so that it can be used to cool the cargo. In so doing, less energy and power is needed to keep the cargo temperature suitably low, thus providing a more efficient and environmentally sound overall system.

In conversation with Wärtsilä's Peter Jantzen, head of life cycle solutions development and Jaakko Eskola, president, Ship Power & executive vice president Wärtsilä Corp, the company is now able to offer larger packages, including ship design, since purchasing companies such as Hamworthy, which gave Wärtsilä a much larger scope.*

Indeed, Hamworthy has given the company a new dimension, they said, being able to offer a complete technical solution in a one-stop shop operation, as illustrated by the Evergas package, which also included the vessels' design.

They thought that in 10-15 years time, most newbuildings will be fitted with dual fuel engines. At present, many operators are concerned about infrastructure problems in converting vessels to LNG powered, such as bunkering stations.

Operators would also prefer the option of switching to other fuels for perceived safety reasons. However, they said that the use of diesel oil had been virtually ruled out when trading in an ECA.

The US is set to become a major supplier of gas, due to the discovery of huge shale gas reserves, which could change the way the world sees the use of LNG, Jantzen explained. The price level of fuel in the US will become

highly competitive, offering substantial savings for those operators opting for a dual fuel solution.

However, the US is expected to first become self-sufficient in fuel supply, before looking to export gas for dual fuel use.

Norway, where the Evergas vessels will operate, is already way ahead of any other country in terms of infrastructure for gas supplies to its ferry and offshore supply vessel fuel markets.

Wärtsilä is able to offer a modular approach to conversions of existing vessels. The age of the vessel will be a critical factor in any future conversion projects, Jensen said.

For larger LNGCs, the tri-fuel option included in the current South Korean shipyard designs and dual fuel packages on 2-stroke engines are the favoured propulsion system going forward. Jantzen claimed that the yards were developing the right product and that Wärtsilä was way ahead of the competition in dual fuel technology.

However, he warned that there were no quick fixes as an LNGC and its propulsion system is a long term project. "Operators need to see the future clearly and not go into a project half-baked," he warned.

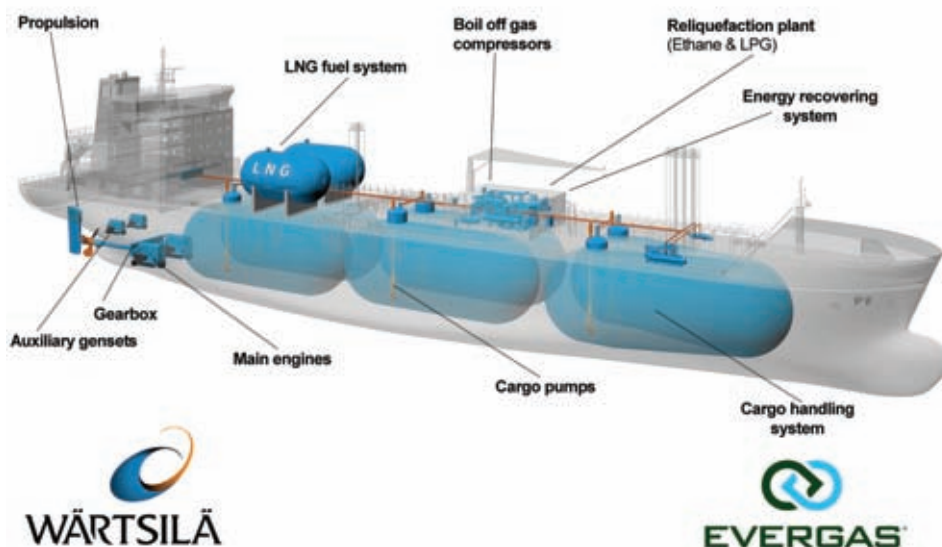
EXTRA CAPEX NEEDED

For example, there would be around 5-10% extra capital expenditure needed per vessel to fit the new technology, but in the long term, the total economics look good. "Banks need to get on board," he said. A commercial timeline for the vessel needs to be calculated and a proper business model presented to the banks on a case by case basis.

He summed up the future use of gas as a fuel by saying that the first message he wanted to put across was that the dual fuel technology will be well proven in the next 10-15 years. Development is happening today, he said and he urged operators to see the long term economic advantages of such a system, rather than regarding the use of this technology as a "quick fix."

Towards the end of last year, Wärtsilä, said that the company had sold more than 2,000 gas fuelled engines, which in total had accumulated more than 7 mill operational running hours in both land-based and marine applications.

Wärtsilä began development work with dual-fuel gas engines in 1987, the first concept being the gas-diesel (GD) engine with high-pressure gas injection. This was followed by the second generation of gas engines in the early 1990s, when the company introduced spark-ignited (SG) pure gas engines utilising



Wärtsilä is supplying a total package for the Evergas vessels.

low pressure gas.

However, the real breakthrough came when the dual-fuel (DF) engine was introduced by Wärtsilä in 1995. This third generation gas engine development resulted in the ability to combine fuel flexibility and efficiency with environmental performance, the company said.

In late 2010, Wärtsilä initiated a major project to adapt its low pressure gas engine technology for use in its low-speed engine portfolio. Subsequently, a new test engine, the 'RTX-5', based on a commercially available 6-cylinder RT-flex50 engine, was installed in the Trieste engine laboratory in Italy in March 2011.

The resulting tests with the low pressure 2-stroke dual-fuel engine have successfully demonstrated that, for the first time ever, low-speed engine performance can fully comply with the IMO Tier III nitrogen oxide (NOx) limits when operating on gas, Wärtsilä said.

Wärtsilä's low pressure 2-stroke gas engine was released this year and will be available for commercial use in 2014. It will be incorporated into the full portfolio of engine types during 2015/2016.

Since the first Wärtsilä 50DF engines were fitted on board LNGCs over 10 years ago, about 65% of all new LNGCs have been fitted with Wärtsilä dual-fuel engines.

Wärtsilä has already supplied 50DF engines to more than 100 LNGCs. Gas and dual-fuel engines are becoming the propulsion choice throughout all segments of the shipping industry. This is particularly the case where ships, such as tugs, ferries and cruise liners, are frequently operating in ECAs.

Also, offshore oil and gas industry vessels such as FPSOs and PSVs, which have a need for flexibility, fuel efficiency and compliance with stricter environmental legislation, are increasingly being fitted with Wärtsilä dual-fuel engines, the company said.

With the acquisition of Hamworthy, Wärtsilä's can now offer small scale LNG liquefaction, regasification and LNG fuel systems. Combined with Wärtsilä's gas and dual-fuel engine technologies, this expanded scope of supply further promotes the benefits of LNG use and creates added operational flexibility, the company claimed.

SERVICE CONTRACT

In March of this year, Wärtsilä, signed a five-year maintenance agreement with Finnish shipowner, Viking Line to maintain and service the Lloyd's Register classed *Viking Grace*, the largest passenger ferry thus far to operate on LNG fuel.

This agreement covers the four Wärtsilä



Wärtsilä 20DF engine.

50DF dual-fuel main engines, as well as the Wärtsilä LNGPac gas system's safety valves.

Under the terms of the contract, Wärtsilä provides a broad range of services, including engine maintenance planning, maintenance work, condition monitoring, spare parts supply, technical support and workshop services.

The overall target is to extend the ferry's intervals between maintenance, to optimise the logistics for spare part deliveries and to ensure optimal operating efficiency and fuel consumption, thereby lowering operating costs.

Viking Grace operates a regular schedule in the Baltic sailing between Turku in Finland and Stockholm, Sweden. By operating on LNG fuelled Wärtsilä DF engines, the vessel can sail without restrictions in SECAs and forthcoming Nitrogen Emissions Control Areas (NECAs).

In August, Wärtsilä said that it had won a contract to supply the main propulsion generating sets for a new, environmentally sound, double-ended ferry. The vessel, which is the first gas fuelled ferry for a domestic route in Denmark, will operate between Jutland and the island of Samsø and will carry passengers, cars and trucks.

The vessel, designed by the Danish OSK-ShipTech, will be built for the Danish municipality Samsø Kommune by Remontowa Shipbuilding in Gdansk, Poland. Wärtsilä signed the contract in June.

The ferry will be powered by four Wärtsilä 20DF dual-fuel engines running on LNG and will have extremely low emission levels.

The new ferry project is considered as being

a state-of-the-art project by setting an environmental benchmark for inland ferries, and is being closely followed by other municipalities and governmental bodies in Denmark and abroad.

Samsø Kommune actively promotes environmental sustainability through its 'Green Island' image featuring renewable energy, low pollution and recycling activities. The vessel is scheduled to be operational in autumn 2014.

The new ferry will be one of the smallest ships to be powered by Wärtsilä 20DF engines. It is also the first Danish ferry to be operated on LNG fuel and the design of the 100 m long double-ended ship is tailored to its operating profile and route. Bunkering of the LNG is planned to take place in the Hou harbour in Jutland.

"The overriding priorities for the owners were to achieve the highest possible level of operational reliability to support the local business but with focus on environmental sustainability, which, among others, means to ensure excellent overall efficiency in energy consumption.

"By selecting Wärtsilä technology these aims will be met, and we are delighted to be a partner in this trend setting project," said Aaron Bresnahan, vice president sales, Wärtsilä Ship Power. ■

**This piece first appeared in Tanker Operator Magazine, by whose kind permission LNG Shipping Review has reproduced certain parts of the article.*

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AIDA opts for dual fuel operations for newbuildings

Two cruise vessels building at the Nagasaki shipyard of Mitsubishi Heavy Industries (MHI) are claimed to be the world's first cruise vessels to be fitted with dual fuel engines.

The keel laying of the first cruise vessel took place on 30th June this year while the 124,500 gt ships will be delivered in 2015 and 2016 to AIDA Cruises of Rostock.

Each vessel will be fitted with a MaK DF engine, plus three MaK 12M43C marine gensets. They will be the first cruise vessels to have dual fuel engines installed, enabling them to operate on liquefied gas, depending on its availability at the port of call.

TGE Marine Gas Engineering is to supply the complete LNG fuel systems for each vessel.

"With these ships, AIDA will set new industry standards for the future both with regard to their new and innovative product features as well as in terms of protecting the environment," Michael Ungerer, president of AIDA Cruises, said recently.

The MaK M46DF dual-fuel marine engines are being built by Caterpillar Marine Power Systems in Kiel and Warnemünde. This engine has been designed for both electric

drive and mechanical propulsion systems and is able to alternate from gas to diesel mode during operation. This will allow the vessel to operate in all geographical areas, regardless of fuel and emission restrictions.

The first DF engine was transported to MHI on 5th June for immediate installation on the vessel. "We're pleased to deliver our first dual fuel marine product to AIDA Cruise lines, a longtime collaborator and partner" said Detlef Kirste, Caterpillar Marine Power Systems senior product definition engineer. "The M46DF will provide AIDA with superior performance and operational flexibility without sacrificing power, or reliability."

OPERATIONAL FLEXIBILITY

Able to alternate from gas to diesel mode during operation, the M46DF allows the vessel to operate in all geographical areas, whether the fuel available is gas, marine diesel oil (MDO), or heavy fuel oil (HFO). In gas mode, the M46DF features low fuel consumption and will comply with IMO III,

as well as EPA Tier 4 regulations. The engine has been designed to allow retrofitting of current M43C engines.

With a bore of 460 mm and stroke of 610, the engine was designed for electric drive propulsion systems, as well as mechanical propulsion systems. Although designed for unlimited operation on LNG, marine diesel oil and heavy fuel oil, the M46DF will reach maximum efficiency in gas mode, the company claimed.

These marine engines were developed by Caterpillar Motoren in Kiel, Germany, (Kiel Engine Center, KEC) and manufactured at the Rostock subsidiary.

The MaK M46DF dual-fuel marine engine, available in vee and in-line formation, marks Caterpillar's entry into the gas segment of the commercial marine industry. Each engine delivers a power rating of 900 kW per cylinder at 500 and 514 rev/min in diesel and gas modes, respectively.

On average, an AIDA cruise ship currently consumes only three litres of fuel per passenger per 100 kilometers. The new AIDA vessels will consume even less, the company claimed.

In 2011, the Rostock-based cruise company awarded the contract for the construction of the two next generation AIDA ships to



Becker Marine Systems' LNG hybrid barge.

Principal Particulars LNG Hybrid Barge

Length, oa	abt 76.7 m
Breath, oa	abt 12.2 m
Breadth, moulded	11.4 m
Depth	4 m
Draught	1.5 m
Air draught	6.5 m
Class	BV
Power (maximum)	7.5 MW (five gensets) 10.5 MW (seven gensets)

Mitsubishi Heavy Industries following a worldwide call for tenders.

With a GRT of 124,500 tons, the new sister ships, which will be 300 m long and have a beam of 37.60 m, will each carry around 3,300 passengers and will be delivered in March 2015 and March 2016, respectively.

To bunker such vessels in Hamburg – a major cruise turnaround port - Becker Marine Systems has developed the LNG hybrid barge.

Designed in close co-operation with SCHRAMM Group, Inigo Schluter, EON Hanse Wärme, AIDA Cruises, Bureau Veritas, plus Gasnor, the barge is claimed to be an environmentally-friendly and low emission solution for supplying power to cruise ships in port.

Currently while in port, cruise ships generate the energy required for on board operations by using the ships' on board diesel engines. The use of these engines results in a high level of pollution in the form of soot particles.

The new concept is said to be able to

solve this problem by producing energy on the floating LNG hybrid barge from liquefied natural gas (LNG) by means of several generators, which are coupled to gas motors.

The power generated can be fed into the supply grid of the cruise ship, as needed. The LNG is delivered in modular form, as this is less expensive than bunkering.

An LNG bunkering station to ensure supply at all times, is being built in Brunsbüttel by SCHRAMM Group, which will also be the operator of the barge in Hamburg.

The use of the barge will significantly reduce particle emissions during port calls. In contrast to the diesel engines currently in use, SO_x will no longer be produced during port layovers. In addition, the emission of NO_x will be lowered by up to 80% and the output of carbon dioxide by an additional 30%.

Another benefit is the year-round utilisation of the system. The Hamburg energy provider, EON Hanse Wärme, is planning to feed the energy produced in the cruise off-season into

the municipal grid, thus supplying electricity and heat to around 11,000 households (based on four-person households).

In the Autumn of this year, the *AIDAsol* will be the first cruise ship in the world to be supplied with electricity by Becker Marine Systems' barge at Hamburg's Hafen City cruise terminal.

On board the barge, five gas generators can feed up to 7.5 MW into the supply grid of the cruise ship as needed. The liquefied natural gas is delivered in modular form and no bunkering procedure is needed.

An important advantage of the barge is that it requires significantly less investment and construction work in ports compared to a high voltage shore connection (HVSC) solution.

This results in less planning and project administration for the city, or port authority (only planning and costs for the berth infrastructure). Due to the 12 months of (summer and winter) operation, the barge also has a positive return of investment, Becker claimed.

NLI unveils large volume LNG bunker barge concept

Offshore oil and gas engineering specialist NLI Solutions (NLI) has developed a concept for a LNG bunker barge based on the NLI LNG tank design.

This concept has been taken a step further in a design study together with Rolls-Royce's marine division and Wilhelmshaven Technical Solutions (WTS).

As can be seen in the pages of LNG Shipping Review, interest in LNG as a marine fuel is rapidly increasing, but one limiting factor is practical availability of LNG bunker facilities.

LNG bunker barges are often described as the 'missing link' in the LNG supply chain. Today, only one example exists, capable of carrying 187 cu m of LNG, even though oceangoing ships need to bunker several thousand cu m of gas.

The so called HighTechBarge (HTB) will be equipped with podded propulsion similar to those used in offshore support vessels, as well as electronic systems for early threat detection.

The NLI LNG tank is an atmospheric, prismatic steel tank, type 'B', with a capacity of 4,000 cu m of LNG. It will be fitted with a new insulation system with very low levels of boil-off gas.

On board power and propulsion will be fed by an environmentally-friendly gas engine. The HTB has a large pressure tank on the aft deck for boil-off gas handling and gas delivery to the engine.

Since re-condensation equipment is very expensive, takes a lot of space and has very low efficiency for small installations such as this, excess boil-off gas can be delivered to a shoreside gas grid when the barge is not on bunkering operations. The barge can also deliver electric power to a shoreside grid system.

Planning for the study has been carried out between:

- NVC – responsible for design, Bergen gas engine, pod drives and bridge systems.
- TI Marine Contracting (part of WTS) – responsible for insulation systems.
- NLI – responsible for tank, LNG/gas systems, bunkering systems.
- DNV – evaluation of the barge concept with respect to limitations and possibilities within the existing codes and regulations.



NLI Solutions' LNG bunker barge design.



A drawing of an LNG powered Wadden Sea ferry.

Becker Marine Systems was also involved with the development of an emission-free ferry with very low draught for shallow European coastal waters.

This came about after the company took a look at the fragile Wadden Sea national park – a UNESCO Natural Heritage site, near Hamburg.

The sisterships *Fering* and *Öömrang* developed by Becker Marine Systems and its partners will be the first vessels with an LNG hybrid propulsion concept in the world.

This concept consists a combination of the latest lithium batteries in combination with

environmentally friendly LNG generators.

Each LNG generator produces a maximum power of 285 kW at 1,800 rev/min and will supply the battery pack during the daily operation.

Two highly efficient electric drive motors, each with a maximum power output about 630 kW, will allow the ferry to travel at up to 11 kn. During night crossings, the large battery capacity of the ships is also charged by means of environmentally wind energy. Again the LNG is delivered in modular form. No bunkering procedure is needed.

Due to the trade in CO₂ emission

certificates, it is possible for the first time to introduce a ‘green’ ferry operation, ie emission certificates from energy savings of other Becker Marine Systems products, for example the Becker Mewis Duct, can be offset against each other.

So the new Wadden Sea ferries no longer contribute to the pollution of the environmentally sensitive coastal waters with SO_x and exhaust gas particles. CO₂ emissions are reduced by 20% and the output of NO_x by as much as 80% - in comparison to the use of conventional marine diesel with a sulphur content of 0.1%.

With a length of 74.2 m, a width of 15.8 m, a draught of 1.5 m and ice class, the ferry concept will fit perfectly for the shallow water conditions in the Wadden Sea and the operating route between Dagebüll – Wyk auf Föhr – Wittdün/Amrum.

A maximum of 480 passengers and 52 cars, or 10 trucks can be transported. Both ships will be built at European shipyards and equipped with the latest LNG hybrid and Becker technology to ensure the highest environmental protection of the Wadden Sea.

This modular LNG hybrid concept is transferable to other ferry routes worldwide. ■

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LNG bunkering infrastructure set for rapid increase

In less than 18 months all vessels operating in Sulphur Emission Control Areas (SECAs) must comply with the 0.1% sulphur limit; an obvious catalyst for the transition from strategic debate to a more pragmatic solutions-based approach.

In terms of development over the coming years, there is now little doubt that the LNG bunkering infrastructure will advance quickly enough, with Lloyd's Register FOBAS estimating that 653 vessels, or 4.2% of global deliveries, could be fuelled by LNG between 2012 and 2025. Growing to scale will most likely be an evolution rather than revolution, but it will come.

Perhaps the key barrier to a more rapid conversion from traditional HFO and MDO to LNG is not just the sheer scale of bunkering delivery infrastructure required to fuel the international shipping fleet (and the financing that would have to come with it), but the multi-faceted nature of the infrastructure required.

From a bunker supplier's perspective, LNG symbolises both headache and paracetamol. Despite the obvious cost associated with building the necessary production, liquefaction, storage and delivery supply chain, LNG can, in principle, provide early adopters with a significant market advantage.

Indeed, a group of suppliers with third party finance could deliver infrastructure in key ports and potentially link with some US ports, where increased transatlantic demand, aided by very low LNG prices in the US, would seem to be the likeliest first phase of development for larger vessels.

Thus far, the main infrastructural development has been in Norway, where incentives to local owners and operators have seen a number of smaller LNG bunkering facilities spring up.

However, much of the delivery has been made through bunker trucks or terminals situated in a harbour where a vessel can receive fuel directly – therefore negating the wider investment required for larger scale and larger vessels. There are also developments, with impetus for smaller bunkering vessels intensifying, especially in the North Sea and Baltic Sea.

The sentiment behind the development of LNG as a bunker fuel has made a notable shift in recent months.*

In time, these vessels will increase in size to meet growing demand. For example, two to three years ago it was not uncommon for suppliers to talk about bunker barge capacity in the range of 1,000-4,000 cu m, but the size of those bunkering vessels is now increasing incrementally. As fuel-guzzling larger vessel owners and operators start to crunch data on how much time they will spend in ECAs, the interest from inter-continental shipping grows; the more time spent in ECAs and the larger to power requirement, the shorter the payback on LNG engine conversion, or newbuild investment will be.

Testament to this, bunker suppliers are showing serious interest in the design of bunkering vessels and barges and enquiries from shipyards across the globe demonstrate that the transition from conceptual study to viable project has started.

EXPERTISE ENHANCED

Wärtsilä's existing LNG design expertise was bolstered by its acquisition of Hamworthy in early 2012, and combined with more than 45 years experience of LNG cargo handling systems, enables an invaluable 360 deg perspective. Importantly, this provides the platform for managing the interface between parties; for example balancing the design needs of the bunkering vessel owner/operator with those of the export terminal.

In addition to Norway, ports such as Rotterdam and Antwerp are also pushing to create some terminals, or bunkering availability by means of barges, or small LNG bunkering supply vessels, with plans for a small scale bunkering harbour accelerating.

While capital investment remains a barrier given the billions of dollars required to build and convert the current bunkering supply

chain, it is unlikely to remain so for long as investors begin to tap into projections for the growth in the LNG bunkering market over the coming decades.

Given its variance from conventional bunkering, its multi-faceted nature and its complexity, training and education of barge, terminal and other asset operators will be another crucial element determining the rapidity of growth and success of LNG as a bunker fuel.

In principle, there is a clear separation of responsibilities. When a vessel comes alongside a bunkering station, the responsibility of the bunker supplier is typically up to bunkering flange, transferring to the vessel from bunkering flange up to the tank. Yet that may have to change.

With the development of regulation and guidance such as the ISO TC 67 WG10 PT1 LNG bunkering guidelines and the International Code for Gas Fuelled Vessels (IGF Code), a key objective is structuring procedures for LNG bunkering operators. It is evident that when it comes to bunkering, there will have to be a clearly defined split of responsibilities.

Before operatives are trained, however, the foundation for education on all aspects of LNG bunkering must start with regulators and policy makers defining clear codes and legislation - an area where Wärtsilä, with all its experience in the global chain of LNG from reliquefaction plants, LNGPac storage and process systems to dual-fuel engines, is keen to contribute.

As a result of progress made to date, nearly all major shipping companies across every major vessel segment are evaluating LNG as a marine fuel. As sentiment towards LNG bunkering continues to shift in favour of the emerging benefits for the shipping industry, it is important that progress is made to ensure that storage and bunkering infrastructure can complement the technological advances made in engine capability. ■

** This article was written by Yves Bui, business unit fuel gas handling director, Wärtsilä.*

Bunkers- future demand prospects & port design options

A detailed report on LNG as a fuel was recently published by a leading consultancy.*

Given that there is much speculation on the subject, Ocean Shipping Consultants has produced – *LNG as a Bunker Fuel: Future Demand Prospects & Port Design Options*.

This report examines the economics of LNG as a fuel for several vessel types, including containerships, bulkers, ro-paxes and platform supply vessels.

As well as investigating the economics of gas as a fuel, the costings and options that are currently available to those ports wishing to install LNG bunkering infrastructure are also discussed.

In addition to the well documented question of reducing emissions, there are new regulations regarding ships' energy efficiency for owners/operators and charters to consider, in which LNG can play a significant role.

However, major developments of the LNG bunkering infrastructure needs to take place before it can be viewed as a viable alternative to conventional fuels, the report said.

There is a continuing rise in the number of ports that are reporting to be investigating

LNG as a bunker fuel. The main focus has been on the Northern European ports, spurred on by the 2015 deadline for the Sulphur Emission Control Area (SECA).

However, there are other ports that are

implementing bunkering facilities, such as Singapore, with additional ports in Europe, North America and Asia.

Over the past decade, the number of vessels that have either been designed to use LNG as a bunker fuel, or have been converted to burn it has slowly increased.

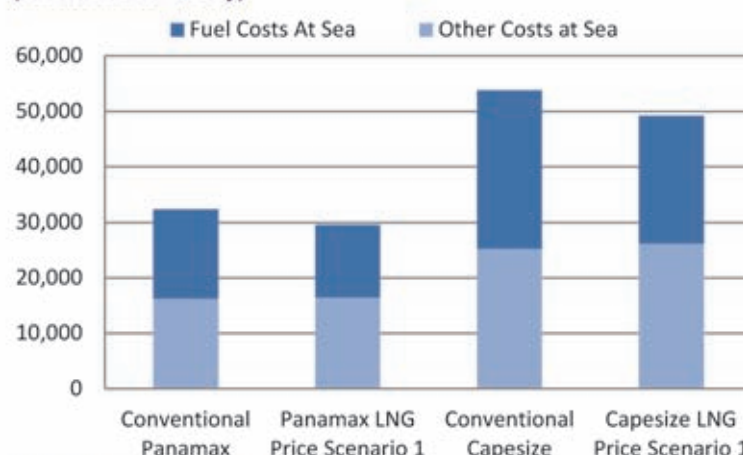
Currently there are about 40 trading vessels using gas as a fuel. The current orderbook contains around another 30 vessels. This number is forecast to increase in the future while the LNG bunker concept could spread to large commercial vessels.

An example of the investigation into the economics of operating a drybulk vessel on LNG, compared to HFO, identifies that for a Panamax the overall reduction approximates \$2,750 per day at sea (for price scenario 1 – where LNG is priced at 80% of HFO).

For Capesize vessels, the overall reduction is \$4,500 per day at sea for price scenario 1, compared to conventional HFO, as detailed in Figure 1.

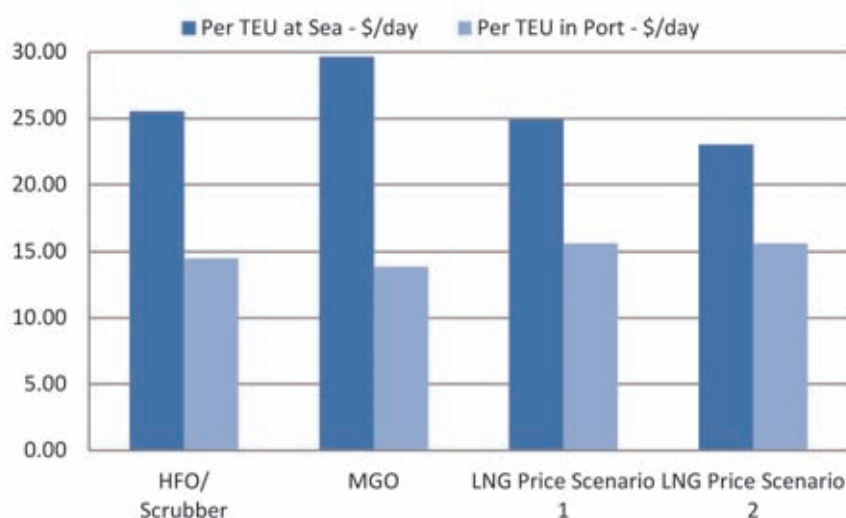
A further example compares the associated fuel costs of a feeder container vessel of about 1,000 TEU trading in an emission control area (ECA).

Figure 1
Conventional versus LNG Bulk Carrier Costs at Sea
(Costs at Sea - \$/day)



Source: Ocean Shipping Consultants.

Figure 2
Trading Costs for 1,000 TEU Feeder Vessel – by Fuel Type
(Costs per TEU\$/day)



Source: Ocean Shipping Consultants.

The potential costs savings of using LNG as a bunker fuel over other fuel solutions is highlighted in Figure 2 on the previous page.

The main points of the feeder container vessel example are:

- MGO is calculated to be the most expensive option at \$29.6 per TEU per day at sea and \$13.9 per TEU per day in port.
- This is followed by the scrubber solution at \$25.5 per TEU per day at sea and \$14.5 per TEU per day in port.
- Then the LNG Price Scenario 1 (80% of HFO on a comparative basis) at \$24.4 per TEU per day at sea and \$15.6 per TEU per day in port.
- The LNG Price Scenario 2 (60% of HFO on a comparative basis) is the lowest cost option with costs of \$23 per TEU per day at sea and \$15.6 per TEU per day in port.

Similar calculations are also presented for the other vessel types.

Ocean Shipping Consultants also worked with the in-house engineers of port consultancy Royal Haskoning on the type and cost of typical LNG infrastructure that would need to be installed in a port to facilitate bunkering.

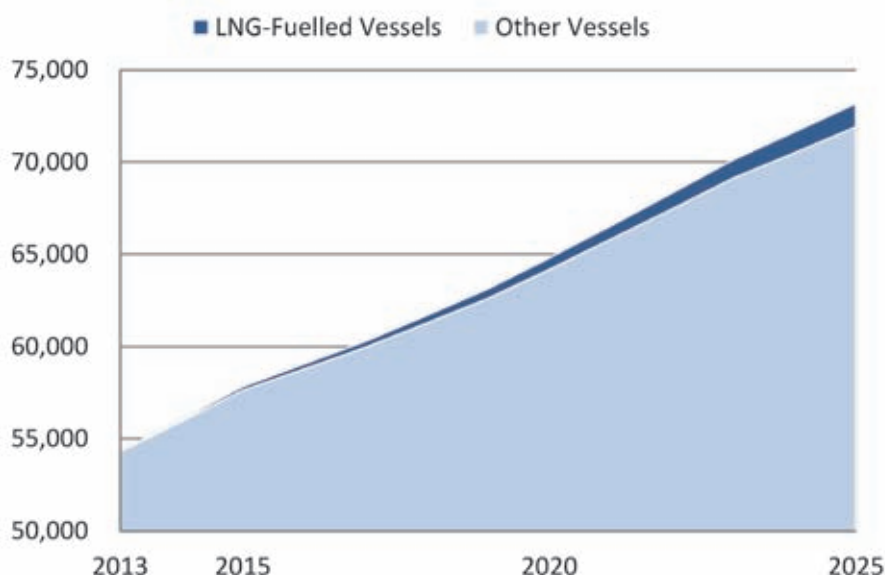
While currently there is no set pattern for LNG bunker infrastructure, the engineers were able to provide approximate costs for such equipment and structures.

These are highlighted in the following:

Small/Medium-scale bunkering facility -

- Operating pressure 5-6 bar.
- Double steel cylindrical tanks.
- Capacity 500 cu m.
- Approximate cost \$1-1.5 mill.
- Construction programme - 6-12 months.

Figure 3
Forecast Total LNG-Fuelled Fleet Development to 2025
(No. of vessels)



Source: Ocean Shipping Consultants.

LNG Quay/Jetties -

- New or retrofitted quays and jetties.
- Offshore, or in port facilities.
- Single point mooring.
- Jetty and quay wall cost will vary significantly depending on length, ground conditions, bathymetry and vessel size.

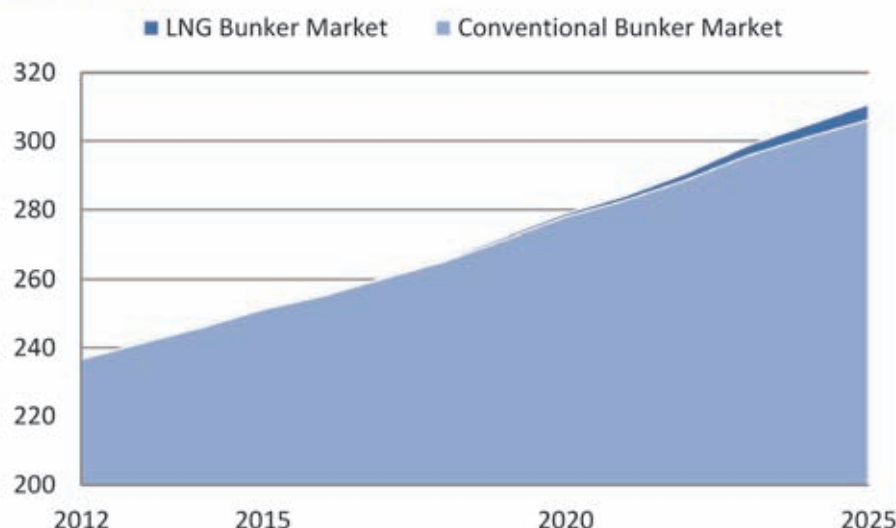
A typical medium/large-scale jetty is likely to cost:

- Approach trestle - \$3,000 - 5,000 sq m.
- Mooring dolphins - \$400k - 600k per dolphin.

- Berthing dolphins - \$600k - 700k per dolphin.
- Loading platform - \$3,000 - 5,000 sq m.
- Construction programme - two to three years.
- Typical quay wall, including cope beam, fendering and mooring bollards - approximate cost \$30k - 50k per metre.
- Construction programme - one to two years.

In addition, large-scale bunkering facilities, LNG pipes and LNG loading arms are also considered with regards to costings and construction periods.

Figure 4
Forecast Bunker Market Developments to 2025
(Million tonnes)



Source: Ocean Shipping Consultants.

FUTURE BUNKER MARKETS

As mentioned, the current LNG-fuelled fleet is about 40 vessels, accounting for less than 0.1% of the overall main operating vessel fleet of over 54,000 seagoing vessels. It is expected that the up-take of LNG-fuelled vessels will increase to around 1,250 vessels by 2025, as highlighted in Figure 3.

Forecast LNG bunker market growth will be related to the number and size of vessels that will utilise it. Initial estimates suggest that LNG bunker fuels will increase to 4.6 mill tonnes by 2025, the report said.

**LNG as a Bunker Fuel: Future Demand Prospects & Port Design Options is Available. Price: £1,200, or €1,450, or \$1,900 (all including courier delivery) – for printed, or electronic versions.*

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The sloshing problem still exists

To assess gas carrier and containership behaviour patterns, Germanischer Lloyd (GL) introduced GL SeaScout, a hydrodynamic integrated software navigational decision support solution. Marketed mainly to the LNGC sector, the software introduced last year is based on computational fluid dynamics (CFD), which is used to assess how vessels behave at sea in certain conditions.

It can inform the vessel's officers on how the vessel is responding to currents, or upcoming conditions to help navigators determine the optimum speed and course to minimise, or avoid weather damage to a vessel's structure and/or cargo.

In heavy seas, vessels can roll at up to 30 deg and with vessels getting larger and faster coupled with less experienced crews, there is a need to try to forecast a vessel's behaviour and not leave it up to a navigator to assess when he, or she, is stationed some 50 m above the waterline, especially at night, GL said.

Dr Torsten Bussow, GL's vice president

Persistent sloshing in a part loaded LNG carrier's tank can cause extensive damage to the tank walls if not checked.*

maritime software said that vessels and their cargoes are subject to heaving, pitching, slamming, wave loads on deck and in certain cases, the parametric roll, which has adversely affected containerships' deck cargoes.

Down the years, the class society said that it had gained considerable experience in vessels' seakeeping qualities but there was no onshore component, such as a fleet management guide on what to do in certain sea conditions. "If you swing 10 deg to port, how will it affect the vessel's rolling motion?" he asked. "How well can you judge the seakeeping behaviour of your vessel?"

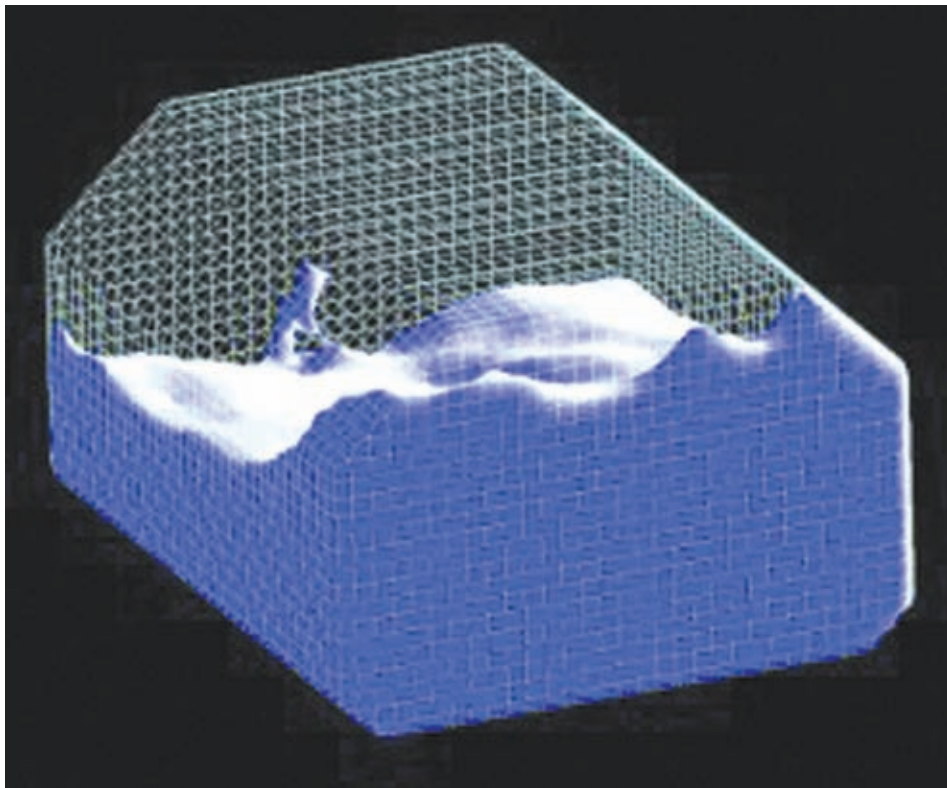
GL SeaScout models the vessel's underwater line to determine the seakeeping behaviour by putting the vessel through a

virtual tank trial simulation using CFD. The simulation can give an operator a 180 deg view of the vessel's behaviour and in addition, an infinite number of parameters can be introduced into the simulation, which can also be analysed.

Bussow explained that the act of sloshing will create a large force against a tank wall, which could lead to the destruction of the tank, or severe damage, leading to large repairs lasting up to three weeks and expensive offhire time. The damage caused by sloshing could also result in the gas carrier losing cooling capacity, as the generators would not be able to keep up the required cooling rate.

Sloshing is impossible to predict but once started, it is often audible to the crew. However, by using a simulation derived from CFD, it is possible to predict the likelihood of sloshing in certain sea conditions.

On a laden LNGC, the cargo in the tank will gradually reduce during the voyage due to boil-off gas, leaving a void space thus enabling the cargo to move with the vessel's



Schematic of a sloshing action inside a membrane tank containment system.

Using GL SeaScout to predict sloshing occurrence

Waves

- Measured (eg via X-band wave radar)
- Forecasted (eg weather routing data)
- Observations.

Ship

- Hydrodynamic properties
- Tank geometries
- Loading condition (displacement, tank fill levels).

Ship Dynamics

- Large motions
- Frequencies of motions, fluids in tank
- Risk assessment.

The sloshing likelihood is calculated for all vessel speeds and headings plus safe and hazardous speed and course combinations are identified.

“The less you put on board a vessel, the less maintenance is needed on board,”

- Dr Torsten Bussow, vice president, Germanischer Lloyd

motion at sea. Impact pressures are very high but of a short duration and mainly affect the tank corners.

FUEL TANK PROBLEM

In addition, the rising interest in LNG as a fuel could lead to vessels' gas fuel tanks being subject to sloshing, as the fuel tanks are only partly filled with LNG and will empty further while the vessel is on passage.

GL has held discussions with all the major LNG containment system manufacturers and designers about CFD method of assessing seakeeping behaviour. “The less you put on board a vessel, the less maintenance is needed on board,” Bussow explained. He also said that CFD computations match up well with validated experimental measured data.

The vessel's motions should be

continuously monitored, especially at night when the sea conditions are not so apparent to a navigator, as a course change can be quickly planned if sloshing looks likely. Using a weather routing system will only tell the crew about possible forthcoming weather conditions, whereas GL SeaScout will warn of the consequences of wave lengths, frequencies and heights under certain sea conditions at certain vessel speeds. The system's central display unit is colour-coded for ease of identifying risks.

However, the software can be integrated with weather routing software systems, such as those available from Applied Weather Technology (AWT), as weather routing technology has a part to play, Bussow said.

For example, GL SeaScout will support route planning by assessing the vessel's

behaviour and safety based on weather forecasting for the entire voyage. X-band wave radar information and other navigational systems on board can be integrated into the system for greater accuracy and information gathering.

Bussow said that there has been a lot of interest shown in GL SeaScout, especially from Greek owners, who have been active in the LNGC newbuilding market recently. He said that he had seen GL's IT business grow substantially in the past three years, or so mainly driven by two tendencies.

The first tendency was that quality shipping companies were still willing to invest in new technology to stay ahead of the competition and second, there were many software systems made available during the boom times, but since then there has been significant consolidation in the shipping IT sector, which will likely continue, Bussow said.

“Small companies cannot invest in the future,” he explained. ■

**This article was first published in GL's in-house magazine- Nonstop.*



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Amarcon and GTT sign co-operation agreement

Amarcon, a member of the ABB group, has signed a co-operation agreement with Gaztransport & Technigaz (GTT).

This agreement calls for the marketing and further development of a forecasting and advice software system for sloshing prevention on board LNGCs.

In the coming years, a significant growth in the long distance transport of LNG is expected. Consequently, a considerable number of newbuild LNGCs will come into the market.

In response to this demand, last year Amarcon and GTT had already announced a joint effort to develop sloshing prevention software for LNG Carriers.

The sloshing prevention tool is an advanced module within Amarcon's OCTOPUS advisory suite that will forecast and advise the crew with optimum route to achieve time savings while preventing sloshing risk.

Sloshing prevention will greatly boost the LNGCs safety conditions and optimise the operational availability of the ships, the companies said.

"We are looking forward on working together with GTT in order to serve LNGCs with a state of the art on board sloshing advice, which will help crews to choose the

route, speed and course with least risk for sloshing, so time savings can be achieved and damage to the LNG membrane tanks can be prevented.

"Also in the offshore LNG sector, we see large potential and need for this kind monitoring and advisory systems, as a part of an asset management programme," Leon Adegeest, Amarcon's general manager said.

GTT is a French engineering company formed in 1994 specialising in the design and the licensing the construction of cryogenic LNG storage tanks for the shipbuilding industry.

Amarcon, a fully owned subsidiary of ABB, provides monitoring and forecasting software solutions for performance and availability optimisation of seagoing vessels, including vessel motion prediction solutions.

ABB acquired Amarcon in August 2012 as an important step to expand its marine software offering.

MONITORING SYSTEMS

In addition, Light Structures and containment system designer GTT have joined forces to

deliver sloshing monitoring systems to the growing LNGC fleet.

Fibre-optic monitoring technology producer Light Structures recently released its new sloshing monitoring system. Since then, the company has announced that it had entered into a marketing agreement with GTT, the French technology and engineering company.

GTT is the market leader of LNG membrane containment systems.

In the coming years, Light Structures and GTT said that they will work together to develop and market tools and services for LNGC operators with vessels fitted with membrane containment systems, to enhance the safety of operations by monitoring cargo sloshing in the tanks.

The new system will be based on Light Structures's fibre-optic monitoring solution and a prediction module to be developed by the partners.

Inge Paulsen, Light Structures' managing director claimed that this will be a breakthrough for their monitoring technology and that it will most likely become a standard equipment on new LNGCs. ■



The cavernous area of a membrane tank system is the ideal location for sloshing.



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No let up in expansion plans



There are several changes and additions to this year's listing, as this industry sector has become one of the success stories of the past few years.

Providing the price of gas stays competitive to other fuels available worldwide and the world's energy companies embrace gas as a source of fuel, the spate of newbuildings will continue.

We are also seeing natural gas start to gain in popularity as a fuel of choice for vessels on the back of the stringent forthcoming emissions controls. This will lead to an increase in the number of smaller bunker and local distribution LNGCs, either newbuilds, or conversions.

ALMI GAS

There is still no news concerning the proposed order for two 159,800 cu m LNGCs at Daewoo.

No hull numbers have been allocated to the vessels, which are believed to have been delayed due to a lack of finance.

Almi Gas was set up by Almi Tankers specifically to operate gas carriers.

ALPHA TANKERS & FREIGHTERS

There is also no confirmation of the two orders reported in 2012 edition of *LNG Shipping Review*, although hull and IMO numbers are being shown against both vessels in brokers' newbuilding lists.

However, they was thought to be a strait swops for Capesize vessels, which had previously been contracted by the Agelef (Angelicoussis) managed company at STX Jinhae.

AUSTRALIAN LNG SHIP OPERATING CO (ALSOC)

ALSOC operates the four Australian flag purpose-built LNGCs, delivered between 1989 and 1994 for the Northwest Shelf project.

They continue to operate between Dampier

and Japanese receiving terminals.

Six of the vessels were docked at Sembawang Marine for major lifecycle upgrades a few years ago.

AWILCO

During the first half of 2011, Norwegian investment vehicle Awilco acquired three elderly former Japanese LNGCs and established Awilco LNG SA.

Since then, the company has ordered two 156,000 cu m LNGCs at Daewoo for delivery this year. However, the first vessel, due to be delivered in the third quarter of 2013, was sold to Teekay LNG Partners.

Upon her delivery, Teekay LNG said that it will purchase the vessel and bareboat charter her back to Awilco at a fixed rate for a firm period of five years, plus a one-year extension option.

The purchase price for the LNGC is \$205

mill, less a \$50 mill upfront pre-payment of charter hire by Awilco, which is in addition to the daily bareboat charter rate.

Awilco has fixed-price purchase obligations at the end of both the firm charter period and option period.

As part of this transaction, Awilco agreed to an option to sell to and bareboat charter back from Teekay LNG the second LNGC newbuilding currently under construction at DSME, under similar terms. She is due for delivery in the fourth quarter of this year.

Awilco is currently listed on the Oslo Stock Exchange with the parent company owning about 34% of the LNG subsidiary.

BERNHARD SCHULTE SHIPMANAGEMENT (BSM)

Bernhard Schulte Shipmanagement (BSM) Group, was recently awarded the technical management of the three Thenamaris LNGCs ordered at Samsung.

BSM has developed extensive training courses to operate LNGCs direct for the newbuilding yards and into service.

BSM currently crew manages four Q-flex LNGCs each powered by heavy fuel oil burning two-stroke diesel engines with a cargo boil-off reliquefaction plant fitted on each vessel. BSM has another 21 LNGCs under crew management contracts.

BSM is involved in conducting the plan approvals and newbuilding supervision for the delayed FLEX LNG FPSOs under contract at Samsung.

In addition, BSM's commercial director Chris Clucas doubles up as chairman of SIGTTO's general purposes committee and BSM COO David Furnival is Vice President of the SIGTTO Board.

BG GROUP (METHANE SERVICES)

The BG Group, formerly known as British Gas, controls one of the world's largest fleets of gas carriers, operated under the banner of Methane Services.

The group uses the LNGCs to secure and control a competitive, flexible, safe and reliable LNG shipping portfolio with sufficient capacity to meet its gas transportation requirements, it said.

Under direct ownership are two 138,000 cu m, seven 145,000 cu m and four 170,000 cu m LNGCs. They are all technically managed by GasLog Services (which see).

BG also uses the charter market to secure vessels against cargoes and to maintain a balanced shipping operation, the company said. In total, the group can be responsible for around 25 LNGCs at any one time.

Recently, BG's joint venture with China National Offshore Oil Co (CNOOC) ordered two LNGCs in China adding to the two ships already committed under the LNG agreements signed in March 2010.

In addition, Methane Services will also charter several of GasLog's newbuildings, which also see.

BP SHIPPING

BP Shipping continues to operate seven LNGCs in two classes.

The first three- the 138,000 cu m *Trader* class – were delivered in 2002-2003, while the second series – *Emerald* class – were delivered in 2007-2008.

The so called larger Gem class are powered by dual-fuel diesel-electric (DFDE) propulsion units, which are claimed to be more efficient than the steam turbines fitted on board the *Trader* class.

In addition, BP Shipping technically manages the *Northwest Shearwater*, which operates for the Northwest Shelf group between Dampier and Japan.

BRUNEI GAS

Brunei Gas Carriers Sendirian Berhad (BGC) was established in 1998 and is a joint venture company with Shell Gas and Diamond Gas Carriers.

BGC owns two 147,000 cu m LNGCs and provides management services to Brunei Shell Tankers (BST).

Hyundai has confirmed that it had won an order for two 155,000 cu m LNGCs worth around \$210 mill each from Brunei Gas for delivery in 2014 and 2015, respectively.

BGC said in December last year that finance was in place for another two newbuildings.

BW GAS

A company within the BW Group, BW Gas owns 14 LNGCs, the last of which was delivered in 2009.

However, in September 2011, the company ordered two 155,000 cu m LNGCs at Hyundai in a \$400 mill deal. At the same time, an option for a further two was agreed.

The two membrane-type LNGCs are due for delivery in the second half of 2014 and the first half of 2015, respectively. The vessels will be powered by dual-fuel engines.

At the beginning of this year, BW signed a contract with Samsung Heavy Industries (SHI) to build the company's first LNG floating storage and regasification unit (FSRU).

When completed, the FRSU will have storage capacity of 170,000 cu m. Delivery is scheduled in early 2015.

BW Gas also manages eight 146,000-149,000 cu m LNGCs for Nigeria LNG, in which the company has a 50% stake.

In addition, two more LNGCs are managed for GDF SUEZ in addition to the *Berge Arzew*, which is operating for Sonatrach.

Last year, Marubeni said it would invest almost \$710 mill in BW Gas and in particular



The BW Gas managed 138,059 cu m *BW Suez Boston* was built in 2003 and fitted with a GT No 96 containment system. She is 51% owned by BW Gas and 49% by Distrigas.



BW Gas also manages the 148,565 cu m LNG Kano. She was built in 2007 and also fitted with a GT No 96 containment system.

in the eight LNGCs in the Nigeria LNG joint venture. This was the Japanese conglomerate's first foray into the LNGC market.

BW Gas is also involved in a Norwegian project- Energy Management in Practice – in which the company is researching alternative fuels, such as the use of LNG and LPG on board ship.

CARDIFF MARINE

George Economou's shipmanagement vehicle Cardiff Marine has joined the growing ranks of Greek owners investing in gas tankers.

Cardiff Marine ordered four 159,800 cu m LNGCs from Daewoo for delivery this year and next.

Another two options are believed to be held at the yard for Cardiff Marine.

CHEMIKALIEN SEETRANSPORT

This Hamburg-based shipmanagement concern still has the two elderly cross-Mediterranean LNGCs under management.

Both were delivered in 1975 and are the 35,500 cu m *Annabella* and the 31,600 cu m *Isabella*.

The *Annabella* also operates as a cadet training vessel.

CHEVRON SHIPPING COMPANY

Chevron owns a one-sixth interest in each of seven LNG carriers that transport cargoes for

the North West Shelf Venture in Australia.

In 2012, Chevron said that it had ordered eight new vessels from Samsung to modernize the fleet and increase the oil major's LNG coverage.

At least four 160,000 cu m LNGCs are known to have been ordered while the remaining four could be options.

Chevron Shipping operates the 2004-built *Northwest Swan* for the Northwest Shelf consortium.

Last year, Chevron also took on the shipmanagement and operations of three LNGCs owned by Sonangol, Angola's national oil company.

The four firm newbuildings at Samsung are also being built for the Sonangol project.

CHINA LNG SHIPPING (INTERNATIONAL)

Established in 2006 in Hong Kong, China LNG Shipping (International) (CLSICO) was set up to manage the original five 147,000 cu m LNGCs supplying the Guangdong and Fujian import terminals from the North West Shelf in Australia and Tangguh, Indonesia.

In 2012 another LNGC was added to the fleet in order to supply the Shanghai terminal from Bintulu, Malaysia, which increased CLSICO's demand for vessel availability.

In order to safely and reliably manage the growing fleet, CLSICO has signed a preventive service contract in co-operation with ABB. The agreement commenced 1st January, 2013.

Thus this Hong Kong-based shipmanagement company now has five LNGCs under management with another newbuilding to come.

Three of the 147,000 cu m LNGCs are still thought to be operating between Dampier and Guangdong, while the other two are believed to be operating between Bintulu and Shanghai.

The newbuilding was also thought ordered to operate from Petronas' loading terminal at Bintulu for discharge at Shanghai under a charter to CNOOC.

All of the vessels built and ordered were constructed at the Hudong-Zhonghua shipyard to a French design.

More newbuildings could follow, as China ramps up the number of its receiving terminals.

CHINA SHIPPING DEVELOPMENT

China Shipping Development (CSD) and Mitsui OSK Lines (MOL) have ordered six LNGCs for \$1.51 bill.

The joint venture, involving Sinotrans and China Shipping, China Energy Shipping Investment (CESI) and MOL, contracted six 174,000 cu m LNGCs at Hudong-Zhonghua Shipyard for delivery between April 2016 and November 2017.

CESI will take a 80% stake in the vessels, while MOL will take 20%. CESI is 51% owned by China Shipping LNG and 49% by Sinotrans.

The vessels will be paid for in a series of five installments with an initial payment of \$252 mill.

Funding for the newbuildings will come 20% from shareholders who will fund \$302 mill. The remaining 80%, or \$1.2 bill, will be funded by loans from a syndicate banks, the company said in a statement.

The newbuildings are destined for long term charter to Sinotrans for the company's Australia Pacific LNG project.

CHINA NATIONAL OFFSHORE OIL CO (CNOOC)

A major player in China's oil and gas sector, the BG Group and CNOOC have agreed to invest in a further two newbuilding LNGCs in China.

These are in addition to the two ordered in March 2010.

CYGNUS LNG SHIPPING

Cygnus was established by NYK and Tokyo Electric Power (TEPCO), plus the Mitsubishi Corp, to import gas for TEPCO.

TEPCO put up 70% of the capital while Mitsubishi and NYK provided 15% each.

On the back of this investment, a 147,000 cu m Moss type LNGC was ordered from Mitsubishi and named *Cygnus Passage*.

She was delivered to NYK in 2009 and now serves the Russian Far East loading terminal at Prigorodnoye (Sakhalin II) and Tepco's Japanese receiving terminals.

DISTRIGAS/ENI

Now owned by the ENI Group, this Belgian-based concern has been importing LNG from Algeria since 1982 and from Qatar since 2007, primarily using the Zeebrugge receiving terminal.

In May 2009, Italian energy company ENI bought a majority stake in Distrigas.

Distrigas owns the 1978-built *Methania*, for some time following her delivery, the largest LNGC in the world at 131,235 cu m capacity.

In addition, the company has a 49% stake in the *BW Suez Boston* with BW Gas.

In March 2007, Distrigas signed a 20-year contract with RasGas to import LNG from

Qatar and regularly uses the spot market to access vessels for cargoes.

Methania is currently managed by Exmar and has endured several periods of layup in the past few years and at the time of writing was lying in Brest.

DYNAGAS

Formed by George Prokopiou's Dynacom group, this company manages three 149,700 cu m LNGCs

They were built at Hyundai and delivered in 2007-2008. Dynagas then added the 1977-built *Transgas* to its fleet, the former *Edouard LD*.

The two newer vessels – *Clean Force* and *Clean Power* – are classed with Lloyd's Register with a notation – 1A for Hull and Propulsion system, which allows the vessels to sail in first year ice of up to 80 cm thick.

Subsequently, Dynagas ordered seven TFDE- powered 155,000 cu m LNGCs from Hyundai with deliveries slated through 2015.

The first vessel delivered was the *Ob River*, which last year became the first gas carrier to transit the Northern Sea Route (NSR).

Both *Ob River* and the second vessel delivered – *Yenisei River* – have been taken on long term charter by UK listed Gazprom Marketing & Trading (GM&T).

They are 1A ice class and 'winterised' for navigating in ice conditions, including in the NSR during its open navigation season.



Dynagas' second ice class 149,700 cu m, Technigaz Mk III type LNGC was delivered in 2008.

EMPRESA NAVIERA ELCANO

The Spanish operator manages two LNGCs – a 138,000 cu m vessel delivered in 2003 and a 173,600 cu m vessel delivered from STX in 2010 to lift gas from the Peru LNG project for charterer Repsol.

Similar to several other LNGCs involved with Spanish energy concerns, the vessels are operated by Stream- a company set up by Repsol and Gas Natural.

EXCELERATE ENERGY

The US-based concern operates nine LNGCs in close co-operation with Exmar.

The fleet includes one traditional LNGC and eight floating storage regasification units (FSRUs/LNGRVs).

Excelerate has another 173,400 cu m LNGRV on order at Daewoo for delivery next year. She is earmarked for Petrobras' Guanabara Bay receiving terminal project.

She will be capable of operating as both a floating storage and regasification unit (FSRU) and a fully tradable LNGC.

The fate of another eight sister LNGRVs held as options at Daewoo since last year has not been decided thus far. According to the company, the specifications could change depending on market conditions.

The company claims to have several projects on the drawing board, both FSRUs and LNGFPSOs and said that any new orders placed would support these projects.



Exmar/Excelerate's 150,981 cu m LNGRV Explorer seen alongside Kuwait's Mena al Ahmadi gas receiving terminal. She is fitted with a GT No 96 containment system and was delivered in 2008.

Since the company started operations a few years ago, about seven LNG import facilities have been developed and an eighth is underway in Puerto Rico - the Aguirre Offshore GasPort - a proposed LNG import facility located about four miles offshore the southern coast of Puerto Rico, near Salinas.

Excelerate was the first to execute an LNG ship-to-ship transfer operation. All of the vessels are capable of being discharged at a traditional terminals and/or Excelerate's own facilities, including buoy-based STL type mooring systems in offshore locations.

Excelerate's flexible and less capital intensive floating LNG import solutions are based on its dockside (GasPort) and offshore (Gateway(TM)) Energy Bridge shipboard regasification technology.

Last year, the US Department of Energy granted Excelerate a long-term, multi-contract authorisation to export LNG to free trade agreement (FTA) nations from its Lavaca Bay LNG project, currently under development.

Located on the Texas Gulf Coast, Lavaca Bay LNG will be the first floating liquefaction export facility in the US and will use Excelerate's floating liquefaction storage offloading vessel (FLSO) technology.

EXMAR

Antwerp-based LNG and LPG carrier manager became involved in the transport of natural gas in 1992, when as part of the CMB Group, the company bought the 1978-built 131,000 cu m *Methania*, which was on long term charter to Distrigas to import gas through the Zeebrugge receiving terminal.

The vessel was subsequently sold to Distrigas/ENI with Exmar retaining the technical management.

Subsidiary Exmar Shipmanagement- formerly known as Tecto- manages 13 LNGCs, eight of which are LNGRVs. Other shipmanagement contracts held by the company are for two Distrigas/ENI-operated LNGCs.

Exmar originally developed and pioneered the LNGRV concept for El Paso, before the US concern exited the LNG sector. Following this, the company embarked on its newbuilding spree when two LNGCs were delivered from Daewoo in 2002-2003, respectively.

Following the collapse of Enron and the withdrawal of El Paso from the market, Exmar joined forces with George Kaiser who formed Excelerate Energy (which see) from the ashes of El Paso's LNG portfolio.

Excelerate period timechartered the LNGRV *Excelsior* in 2005 and purchased a second LNGRV through Kaiser's family foundation. Exmar and Excelerate then ordered a third LNGRV of 138,000 cu m capacity.

Subsequently, five more larger units were ordered from Daewoo of 151,000 cu m capacity each. The last in this series - *Exemplar* - was delivered in 2010.

In November 2010, it was announced that Teekay had purchased a 50% stake in Exmar's LNGRV *Excelsior* and the conventional LNGC *Excalibur*. Exmar retained the technical and commercial operations of the two vessels.

Today, Exmar is an owner of a diverse fleet of gas carriers, including LNGCs, LPG/Ethylene and petrochemical gas carriers.

Adding to its portfolio, during the middle of this year, the company announced that it had signed a Letter of Intent (LOI) and Term Sheet with LNG Partners, LLC and LNG BargeCo BVBA to provide an FLSU to serve the BC LNG project to be located on the west bank of the Douglas Channel near Kitimat, British Columbia, Canada.

EXMAR will design, contract, and deliver the floating barge equipped with an air-cooled PRICO liquefaction plant in the first quarter of 2016.

This will be the world's second floating LNG production barge, following Exmar's

and Pacific Rubiales Energy (PRE) first unit to be located offshore Colombia, which will be operational in the first quarter of 2015.

EXMAR will charter the second FLSU, designed to remain operational on location without drydocking, to the BC LNG Project for 20 years with options to extend for two periods of five years each.

The two companies have invested in a joint venture company appropriately named Marching Prospect Limited. The new company will acquire interests in the BC LNG Project upstream of the FLSU.

GASLOG

This Ceres (Livanos)- controlled concern has built up a considerable portfolio of gas carriers in a short space of time.

As of August this year, the company owns six 155,000 cu m LNGCs with another eight on order at Samsung, for delivery this year through 2016.

These are managed under a subsidiary company - GasLog LNG Services - which also manages 12 LNGCs for Methane Services.

GasLog's first two wholly-owned vessels were purchased from Chevron before they entered service in 2010.

Of the newbuildings, most will be operated by Methane Services, but two have been chartered to Shell and another two will operate in the charter market.

All of the fleet are powered by TFDE propulsion technology.

*It was recently announced that GasLog had purchased the 2010-built 153,000 cu m STX *Frontier* for \$160 mill.

GAZOCEAN

This French shipmanagement concern - a joint venture between GDF SUEZ and NYK - manages three LNGCs operated by GDF SUEZ (which see) and the 150,000 cu m *Grace Cosmos* owned by NYK.

GAZPROM MARKETING & TRADING (GM&T)

The London-listed subsidiary of the Russian energy giant has taken at least two of Dynagas' 155,000 cu m LNGCs on long term charter.

The first vessel delivered - *Ob River*-transited the Northern Sea Route (NSR) last year. The second vessel - *Yenesei River* - was recently delivered by Hyundai.

They are both 1A ice class and winterised to allow navigation in ice conditions, including in the NSR during open navigation.

Russian Maritime Register of Shipping (RS)



The first of SCF's 170,000 cu m ice class LNGCs could herald the start of a large series of vessels for Gazprom charter.

said that it had completed an 'Approval in Principal' of technical documentation for an LNGC that is claimed will form the basis of the gas carrier fleet to meet the future needs of the Gazprom Group.

The approved vessel (project name – 'Gaz-Ice') in some respects exceeds the characteristics of four LNGCs of Sovcomflot's *Velikiy Novgorod* series currently under construction in South Korea for GM&T and Shell under the supervision of RS and Lloyd's Register, the class society claimed.

As required by GM&T, two alternative designs were developed and approved, with a DFDE and with 2-stroke low-speed engines equipped with a gas injection system (ME-GI) which, according to calculations, allows the reduction of fuel consumption by more than twofold, compared with LNGCs fitted with steam power plants, RS said.

GDF SUEZ

This concern was born out of the merger of Gaz de France and GDF SUEZ in 2007.

GDF SUEZ owns, or part owns, three St Nazaire-built LNGCs – *GDF SUEZ Global Energy*, *Gaselys* and *Provelys*.

Gaselys is part owned by NYK, which has a 60% share in the vessel.

All of the vessels are technically managed by Gazocean (which see).

GDF Suez has also won a contract to build an LNG regasification plant in Montevideo, Uruguay for the state-owned concern Ancap.

The plant will have a processing capacity of up to 10 mill cu m of LNG per day.

Ancap is said to be negotiating with

shipping companies to supply LNG to the plant.

An LNGRV will be chartered-in but a new vessel will be used for the project's second phase. It should be operational by the first quarter of 2015.

Uruguay plans to export part of the LNG to neighbouring Argentina, which has had to buy more natural gas from abroad to make up for dwindling resources at home.

GOLAR LNG

In 2010, Golar joined forces with Wilhelmsen to form Golar Wilhelmsen Management

(GWM), which today manages Golar's LNGC and FSRU fleet.

Golar has four converted gas carriers into FSRUs on at least 10-year charters – two with Petrobras, one with Dubai Supply Authority and more recently, a third with Nusantara Regas in Western Java.

Another FSRU conversion was sold to Italian interests in 2010 and is operating off Tuscany.

Golar claimed to have been short listed for other FSRU projects, as several were under negotiation and during the past couple of years, the company has reactivated the elderly



The 2009-built 145,130 cu m *GDF Suez Neptune* is jointly owned by MOL and Hoegh LNG. She is fitted with a Technigaz Mk III containment system.



Golar is still interested in FSRU conversion projects, such as the vessel seen the right.

LNGCs *Gandria* and *Hilli*, following the reactivation of the *Gimi*.

Last year, the company announced it had ordered another two LNGCs at Samsung for about \$200 mill each, bringing the newbuilding total up to 13 vessels.

The latest pair are due for delivery next year and in 2015, respectively and the company has an option to convert both into FSRUs before their delivery, as necessary. Another two options are believed attached to the last two orders.

All of the newbuildings will be fitted with TFDE propulsion units with the lowest boil-off rate claimed of around 0.1%, while they will have a service speed of 19 knots.

Golar LNG Ltd (GLNG) has agreed to sell the company that owns and operates the LNGC *Golar Maria*, together with her timecharter, to Golar LNG Partners LP (GMLP) for \$215 mill.

Golar LNG Ltd, which transports, liquefies and trades LNG, said that it expected to reinvest a significant part of the net proceeds in its newbuilding programme and other capital projects.

Golar Maria was delivered to its current charterer, LNG Shipping SpA, a subsidiary of Eni, last November under a charter with an initial term expiring in December 2017.

The partnership estimates that the acquisition will generate annual revenues of

between \$28 mill and \$29 mill during the term of its charter to LNG Shipping.

In July of this year, Golar LNG Ltd has executed a \$1.125 bill financing agreement to fund the first eight of its planned 13 newbuilding LNGCs and FSRUs.

HANJIN SHIPPING

Hanjin manages four LNGCs, all of which are operating for Kogas under long term charters.

They are operating from Indonesian, Omani and Qatari loading terminals to Kogas' receiving terminals in South Korea.

The company took delivery of South Korea's first membrane type LNGC – *Hanjin Pyeong Taek* – in 1995. She is of 130,600 cu m capacity.

HOEGH LNG

Höegh LNG is a fully integrated provider of floating LNG infrastructure services, offering regasification, transportation and production services under long-term contracts.

The company is publicly listed on the Oslo Stock Exchange and operates a fleet of six LNGCs and two floating storage and regasification units (FSRUs).

In 2011 and 2012, Höegh LNG ordered four 170,000 cu m FSRUs, two of which have secured firm long term charter contracts.

The first contract was signed with Perusahaan Gas Negara (PGN) in January

2012, and the FSRU will serve as a new LNG import terminal offshore Lampung, South Sumatra, Indonesia.

It will be moored offshore and connected to the existing gas grid, via subsea pipelines. The agreement is for a firm 20-year charter with two five-year extension periods.

In the first quarter of 2012, Höegh LNG also signed a 10-year timecharter agreement with state-owned AB Klaipėdos Nafta for an FSRU to be moored in Klaipėda, Lithuania to provide natural gas to the country.

This operation is due to commence in the second half of 2014.

In the third quarter of 2012, Höegh LNG was selected the preferred bidder for an FSRU project in Chile. The final negotiations with Colbún and AES Gener, for the FSRU, is currently ongoing. The contract term is 10 years, with an extension option of five years.

As part of the company's strategy to have at least one FSRU available at all times to meet customers' early start-up requirements, the fourth FSRU on order is still uncommitted and is currently being offered up to serve a number of projects worldwide.

In addition to offering transportation and regasification services, the company is also active in the market for floating production and storage units (FLNG). In July 2013, Höegh was awarded a pre-FEED study for a jetty-moored 2 mill tonnes per annum FLNG barge solution for a North American LNG export project.

The study will be executed in 2nd half of 2013 with the potential to conduct a full FEED in 2014.

HUMPUSS INTERMODA TRANSPORTASI (HITS)

HITS lays claim to being the only Indonesian company to manage and operate LNGCs, despite the country's huge gas interests.

It manages four vessels one of which is the wholly-owned 136,400 cu m *Ekaputra*.

The other three are the managed 127,385 cu m *Dwiputra*, plus the smaller 19,475 cu m *Surya Ki* and the 23,096 cu m *Surya Satsuma*.

All of the vessels are operated by Indonesian energy concern Pertamina.

HITS also has six Japanese-controlled LNGCs on crewing contracts.

HYPROC SHIPPING SERVICES

Hyproc is the shipmanagement arm of Algerian energy company Sonatrach.

This concern has eight LNGCs on its books, including two 75,500 cu m MedMax types.

All the vessels are operated by Sonatrach.

HYUNDAI MERCHANT MARINE (HMM)

HMM operates about 10 LNGCs, of which seven are wholly owned.

They all operate for Kogas serving South Korea's LNG receiving terminals.

HMM's first LNGC – *Hyundai Utopia* – delivered in 1993 had the distinction of being South Korea's first gas carrier newbuilding.

Lloyd's Register Marine Consulting has been appointed as the independent service provider for a longevity study on the *Hyundai Utopia* by Hyundai Ocean Service (HDOS).

The president of HDOS, Taek-Gyu Lee said: "We know that charterers of LNG ships are quite understandably concerned whether older ships can be relied on to remain in service before signing up for new long-term charters of the type common in the LNG business."

"We, HDOS, know that Lloyd's Register's experience with ships in service is indeed recognised by many LNG shipowners, even those who may not have classed their ships with LR initially.

"There is a high risk that without appropriate experience, expertise and a documented database the longevity study may invite serious trials and errors, resulting in double effort and possible unexpected excessive refurbishment cost and time due to the project complexity," he said.

SY Lee, LR's chief representative in South Korea, said "The four LNG vessels in the current HDOS fleet remain in class with LR since delivery from the shipyard. This contract will help HDOS to gain confidence and reputation with charterers by publicising that their vessel has gone through a longevity study."

IINO KAIUN KAISHA

Iino has interests in at least 26 LNGCs in various consortia and wholly owns the 138,300 cu m *SK Sunrise*, operated by SK Shipping on charter to Kogas.

In 2008, Iino began a joint LNG transportation operation with Kansai Electric Power (KEPCO), thus increasing its LNGC interests.

KAWASAKI KISEN KAISHA (K LINE)

K Line claims to be the first Japanese company to take delivery of a gas carrier when in 1983, the 125,000 cu m *Bishu Maru* was delivered.

Since then, K Line has participated in Indonesian and Qatari projects, including shipments from MEG to South Korea and

India, plus Norway to Spain/US and Qatar to Europe.

The company is also involved in compressed natural gas projects (CNG) and as its gas interests expanded, K Line opened offices in Houston and London.

Through various consortia, K Line has interests in around 46 LNGCs, including three vessels delivered in 2009 – two from Samsung and one from Imabari.

One of the latest projects involves an agreement to build a 164,700 cu m Moss-type LNGC at Kawasaki under a long term charter to Chubu Electric.

The vessel is due for delivery at the end of 2015.

KHI's newly-developed hull form design will be adopted for the vessel, which gives a capacity increase of 18,000 cu m, compared to the conventional 147,000 cu m Moss types.

As a result, the vessel will be compatible with major LNG terminals worldwide and will also be the largest Moss type LNGC that can transit the soon to be enlarged Panama Canal.

In addition, Japan's Inpex recently signed shipbuilding and shipping contracts for two LNGCs, which will deliver cargoes to its new Naoetsu import terminal, as well as to Taiwan's CPC from the Ichthys project in northern Australia.

As part of the deals, Inpex will operate the first LNGC through Ocean Breeze LNG Transport, a 30:70 joint venture between Inpex Shipping, a wholly-owned subsidiary of the largest Japanese upstream company and K Line.

The 155,300 cu m LNGC will be built by Mitsubishi Heavy Industries and is due to be delivered by the end of 2016, when the Ichthys project is scheduled to come on stream.

KNUTSEN OAS SHIPPING

At the end of 2010, about 10 years after Knutsen entered the gas market by signing its first contract with Repsol, the LNGC *Ribera del Duero Knutsen* was delivered from Daewoo.



Kawasaki has ordered a Moss type 164,700 cu m LNG from KHI. This vessel will be built to a new hull design aimed at greater cargo carrying capacity.



The 173,400 cu m Sevilla Knutsen is currently operating for Stream. She was built in 2010 and is fitted with a GT No 96 containment system.

This marked the end of the company's current LNGC newbuilding programme.

She is classed by DNV to the notation ICE 1A and also has a 'winterisation' notation.

Knutsen manages eight large modern LNGCs operating worldwide and one small LNGC – *Pioneer Knutsen* – which operates along the West Coast of Norway delivering gas fuel to the LNG powered ferries operating across the fjords.

The company also has CNG and floating LNG storage designs on the drawing board.

KOREA GAS CORP (KOGAS)

Around 25 LNGCs are operated by Kogas, South Korea's state-owned gas concern.

However, there are no more newbuildings to come at this point in time.

KOREA LINE (KLC)

Cash strapped KLC has managed LNGCs for Kogas operation since 1990.

The company is thought to own four LNGCs and has a part share in another four. Two of the wholly-owned vessels were delivered in 2000 and the second pair in 2008.

Similar to other Asian owners, KLC also manages four smaller coastal gas tankers in joint ventures.

LNG SHIPPING SPA

Formed in 2001, this shipmanagement company is 100% owned by Italian oil major ENI.

The company manages four LNGCs, two

of which are elderly.

It is also involved in the Italian coastal offshore LNG terminal projects, one of which is planned for La Spezia.

MARAN GAS MARITIME

Part of the Angelicoussis shipping empire, Maran Gas currently manages six LNGCs - five 145,000 cu m steam-powered LNGCs built between July 2005 and July 2007, plus one 159,800 cu m TFDE delivered on 1st July, 2013.

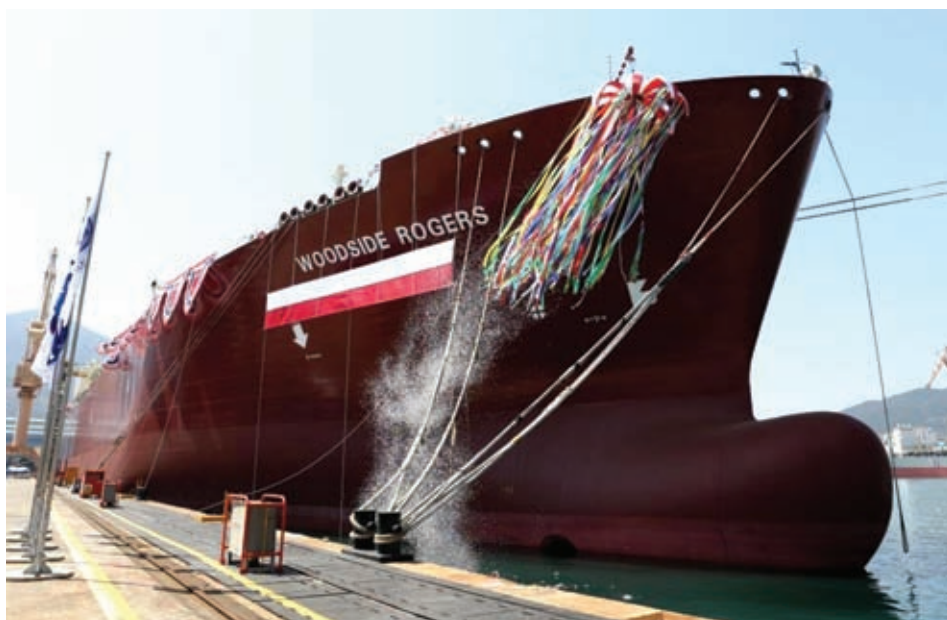
All of the vessels were built by Daewoo.

Four of the five 145,000 cu m vessels are operating under 20-year charters with RasGas with extension options.

Since 2011, Maran Gas has ordered seven 159,800 cu m (one of which has already been delivered, as noted above) and two 173,400 cu m LNGCs at Daewoo, while at Hyundai Samho, Maran has ordered four 161,900 cu m and six 174,000 cu m LNGCs.

All of the newbuildings will be fitted with TFDE propulsion units.

Of these new vessel orders, Maran has succeeded in chartering 14 vessels to BG and



The recently delivered 155,900 cu m Woodside Rogers is the first of two Maran Gas newbuildings to be chartered to Woodside.



MISC's 152,944 cu m *Seri Bakti* is fitted with a GT No 96 containment system and was delivered in 2007.

two vessels to Woodside. Three of the newly ordered vessels remain open at the time of writing, the company said.

MISC BERHAD

This Petronas subsidiary owns 27 LNGCs, taking delivery of the last vessel- *Seri Balqis* - in 2009.

The vessels are trading worldwide, as well as transporting gas for another Petronas subsidiary- Malaysian LNG. MISC claimed that some of the vessels are capable of two port discharge operations by lifting part cargoes.

MISC also claimed to have made a breakthrough in the Asia/Pacific markets by forming a strategic alliance with Petromin to ship LNG from Papua New Guinea and increasing the number of Japanese clients to 16.

In addition, a couple of years ago, ABS granted approval for MISC's FSRU design solution.

The last two LNGCs delivered – *Seri Balhaf* and *Seri Balqis* – were fitted with dual-fuel, diesel-electric propulsion units and were built on the back of 20 year charters to lift cargoes for Yemen LNG.

Two other MISC LNGCs were converted by Malaysian Marine and Heavy Engineering (MMHE) and Keppel Shipyard into FSUs to be moored at Malaysia's first regasification terminal which was due to start operations at the end of last year.

The *Tenaga Satu* and *Tenaga Empat* were timechartered to Petronas Gas, which intends to deploy the vessels at the Sungai Udang terminal in Melacca. Each vessel will be able to store 130,000 cu m of LNG, transferred

from other LNGCs.

Both of these vessels were previously laid up having come off charters in 2010.

MISC is also involved in the front-end engineering and design (FEED) study for a Petronas floating LNG project.

MITSUI OSK (MOL)

MOL claims to manage, or operate, around 25% of the worlds LNGCs through various consortia.

The Japanese conglomerate has interests in over 70 LNGCs and there are still more to come. In 2008, MOL claimed to be involved in around 35 worldwide gas projects and this number has increased.

In January 2011, MOL and its partner ExxonMobil announced an order for four 177,000 cu m LNGCs at Hudong-Zonghua for delivery 2015-2016.

They will be used to ship LNG from the Papua New Guinea and Gorgon Jansz LNG projects and will be jointly owned by MOL and China Shipping Co.

In June 2012, MOL announced the signing of a long term contract for two new LNGCs to operate for Kansai Electric Power. At the same time, the company signed a contract to build a 164,700 cu m LNGC at Kawasaki Heavy Industries and a 155,300 cu m LNGC at Mitsubishi Heavy Industries.

The first vessel will be a Moss type 164,700



MOL has ordered a 155,300 cu m 'Sayaendo' type LNGC developed by Mitsubishi. This design features a continuous cover over its Moss type tanks.

LNG OWNERS, OPERATORS AND CHARTERERS

cu m LNGC, based on a new design from Kawasaki. It is envisaged that upon its delivery it will be able to pass through the expanded Panama Canal, while retaining a hull size to enable the vessel to call at most of major terminals worldwide.

The second vessel is a 155,300 cu m 'Sayaendo' type gas carrier developed by Mitsubishi, which features a continuous cover over its four Moss-type spherical tanks. This peapod-shaped cover is integrated with the vessel's hull, thus achieving weight reduction while maintaining overall hull integrity. MOL said that this design will increase fuel efficiency.

They are due to be delivered in 2016 and 2017, respectively. MOL will manage and operate the vessels on behalf of Kansai.

In addition, MOL has two more 155,000 cu m LNGCs under construction at Mitsubishi in a joint venture with Osaka Gas. They are due for delivery in 2014 and 2015, respectively.

MOL has also entered into an agreement with China Shipping Development (CSD) to order six LNGCs for \$1.51 bill.

This takes the form of a joint venture involving Sinotrans and China Shipping, China Energy Shipping Investment (CESI) and MOL. The six 174,000 cu m LNGCs have been ordered at Hudong-Zhonghua Shipyard for delivery between April 2016 and November 2017.

CESI will take an 80% stake in the vessels while MOL will take 20%. CESI is 51% owned by China Shipping LNG and 49% by Sinotrans.

The LNG newbuildings will be long term chartered to Sinotrans for its Australia Pacific LNG project.

NATIONAL GAS SHIPPING CO (NGSCO)

NGSCO was formed in 1993 to transport LNG on behalf of Abu Dhabi Gas Liquefaction Co (ADGAS).

The company currently operates eight LNGCs, each with a capacity of 137,000 cu m.

It took delivery of its first vessel – *Al Khazmah* – in July 1994, followed by another seven, the last of which was delivered in 1997.

The first four were built in Japan, while the other four were built in Finland. Both types were based on the Moss Rosenberg design and when delivered, were the largest gas carriers in the world.

Since the end of 2007, the company has managed the vessels in-house, rather than use third party management concerns as in the past.

In addition to its LNG interests, NGSCO has a contract of affreightment (coa) to lift LPG from Das Island.

In 2009, the company's supporting services were merged with ADNATCO to create a pool of versatile and experienced personnel in

preparation for possible expansion, the company said.

NIGERIA'S LIQUEFIED NATURAL GAS COMPANY (NLNG)

South Korea's Samsung and Hyundai are both believed to be involved in deals to provide six LNGCs to Nigeria's Liquefied Natural Gas Company (NLNG).

Samsung confirmed through a stock exchange announcement in March of this year that it had won an order to build four LNGCs for NLNG.

Hyundai confirmed that it was in talks with NLNG to provide two additional LNGCs.

Both Hyundai and Samsung said that the deal is conditional on NLNG securing finance.

BNP Paribas and Nigeria's GT Bank were said to be brokering a \$1.6 bill loan to help fund acquisition of the vessels and that the loan documents will be signed shortly.

NLNG, which is majority owned jointly by Nigeria's state oil company NNPC and Royal Dutch Shell, said last year it would seek international loans to expand the operations of its shipping subsidiary Bonny Gas Transport, which currently operates 24 LNGCs.

NIPPON YUSEN KAISHA (NYK)

NYK has been involved in LNG shipping since 1983 and has a fleet of 68 LNGCs of



The J5 Nakilat owned, NYK LNG Ship Management managed 216,200 cu m Q-flex *Al Sahla* was delivered in 2008 and has a Technigaz Mk III containment system fitted.

which it manages 38 through various subsidiary shipmanagement companies.

In March 2011, the company ordered a 145,400 cu m LNGC at Mitsubishi on the back of a long term charter to LNG Marine Transport.

Upon her delivery next year, she will transport gas for TEPCO, which has signed a 15-year agreement with LNG Marine Transport.

In October 2010, a 145,330 cu m LNGC - *Taitar No 4* - was delivered. She was built for joint owners NYK, CPC and Mitsui & Co and was the last of four sisterships.

They were all built to ship about 3 mill tonnes of gas per annum from Qatar to Taiwan under 23-24 year contracts.

Another LNGC was delivered by Kawasaki to fulfill a Tokyo Gas charter in 2011. The same year saw four 160,400 cu m LNGCs delivered from Samsung to a joint venture involving Teekay and trading house Mitsui & Co on the back of a charter to Angola LNG to lift cargoes to the US under a 20-year charter.

NYK also manages a cadet ship with another planned.

In February of this year, NYK Energy Transport (Atlantic), a London based subsidiary of Japanese NYK and GDF SUEZ timechartered the 149,700 cu m *Grace Barleria* for four years.

The LNGC has been operated by NYK since her delivery in 2007.

NYK and GDF SUEZ said that they regularly co-operate in shipping activities - for example, the co-ownership of the LNGC *Gaselys* (60% NYK, 40% GDF SUEZ), co-ownership of the shipmanagement company Gazocean (80% GDF SUEZ, 20% NYK), and the chartering of the *Grace Cosmos* and the *Grace Acacia*, sisterships of the *Grace Barleria*.

NYK Energy Transport (Atlantic) is responsible for NYK's LNG and other energy related shipping activities for utilities, national and international energy companies and traders west of Suez.

NOVATEK

Although thought to be several years away, this company still plans to order up to 10 LNGCs for its Arctic project.

The vessels are believed to have capacities of between 183,000 cu m and 208,000 cu m and will be used to ship gas from the giant Yamal project. They are intended for operation all year round in harsh ice conditions to export the gas to western markets, as well as to Asia using the NSR.

It is believed that no contracts have been signed thus far.

The project will serve the nearby South Tambej Field and it will be operated by Yamal LNG - a joint venture between Novatek and Total.

The giant Shtokman development in the Barents Sea might eventually need up to 20 LNGCs to export gas, but this project seems to be slipping back and now must be in some doubt.

Later it was announced that Daewoo had won a tender to build ice class gas tankers for the Yamal LNG project.

Yamal LNG said that it had signed an agreement with Daewoo for the option to build, launch, equip, complete and deliver up to 16 gas carriers and will establish the preliminary prices of the vessels and the timing of their launch and delivery.

The agreement also allows transfer of rights to finance the vessels' construction to third parties - shipping companies chosen by Yamal LNG.

Novatek previously owned 80% in the project, but recently sold 20% to China's CNPC. Total holds 20% in Yamal LNG.

Bringing the project closer to fruition, this year Sovcomflot, Novatek and Vnesheconombank signed a memorandum on co-operation to build of two LNGCs for the Yamal LNG project.

According to this agreement, Vnesheconombank is to look into the possibility of financing the construction of two 'pilot' LNGCs. Sovcomflot has confirmed its interest in operating the new vessels as a bareboat charterer and technical manager.

The design of the 170,000 cu m capacity gas carriers has been specially developed for the LNG Yamal project. They will have a high ice class (Arc7) and will be fitted with a diesel-electric propulsion system, which includes three Azipods, each with an output of 15 MW.

Final delivery of the new vessels is scheduled to take place in 2016.

OMAN SHIP MANAGEMENT

A subsidiary of state-owned Oman Shipping Co, this commercial management concern formed in 2003, operates six LNGCs- the latest of which was delivered in 2008.

All of the vessels are managed by MOL, which acts as a consultant to the company.

Hyundai is building another LNGC of 162,000 cu m capacity, which will be delivered in 2014.

This vessel will have accommodation for up to six cadets, plus an instructor.

OVERSEAS SHIPHOLDING GROUP (OSG)

OSG is currently under Chapter 11 protection but still commercially and technically manages four Q-Flex LNGCs jointly owned by Nakilat.

These come under OSG's products business division.

The 216,000 cu m capacity vessels were delivered in 2007-2008 and are on 25 year charters to QatarGas.

PETRONET LNG (PLL)

Petronet is a consortium of India's leading gas energy players, including GAIL, ONGC, IOCL and BPCL.

GDF SUEZ is a strategic partner while RasGas has signed an agreement to supply the gas.

Two LNG receiving plants are in operation at Dahej in Gujarat State and at Kochi in Kerala State.

In May last year, Petronet and Gangavaram Port signed an agreement to develop a land-based LNG terminal at Gangavaram Port, Andhra Pradesh State, which will have a capacity of 5 mill tonnes per annum and is scheduled to come on stream in 2016.

Two Indian LNGCs have served Dahej since 2004. They came under the technical management of SCI in 2008 and transport RasGas cargoes to India, in a contract due to last until 2028.

Petronet's Dahej terminal caters for 10 mill tonnes of LNG per year. Its capacity will be expanded to 15 mill tonnes next year.

A third LNGC was delivered at the end of 2009 on the back of an extended contract from RasGas to operate between Ras Laffan and India.

Petronet has also signed an agreement with GDF SUEZ for the supply of LNG.

It was recently announced that Petronet is to take 26% stake in a shipping company planned to ship gas to a new terminal at Kochi in Kerala. An LNGC will be chartered for 20 years.

Petronet also needs a vessel to ship 1.44 mill tonnes per annum of LNG it has contracted from Gorgon, Australia. Supplies from Australia will begin sometime in 2016.

PRIMORSK SHIPPING CO (PRISCO)

Prisco is involved in a consortium, which operates the LR Ice Class 1C 145,200 cu m *Grand Mereya*.

The other consortium members are MOL and K Line.

LNG OWNERS, OPERATORS AND CHARTERERS

The vessel is managed by MOL, but operated by Prisco to load gas at the Sakhalin II terminal of Prigorodnoye under a long term contract to Sakhalin Energy.

PRONAV SHIP MANAGEMENT

Pronav manages nine LNGCs from its Hamburg and Stamford (Conn) offices.

These include four Q-Flex types in Hamburg and five standard LNGCs from the US.

The five standard gas carriers are elderly having been built in the US in the late 1970s and early 1980s.

They are all operated by an MOL-led consortium.

QATAR GAS TRANSPORT (NAKILAT)

Maran Nakilat, a joint venture (JV) between Nakilat and Maran Ventures, recently secured Islamic refinancing worth \$662.4 mill.

As a result of the refinancing, Maran Nakilat will be able to expand its fleet from four vessels to six LNGCs, with the delivery of two new gas carriers scheduled for early 2014.

At the same time, Nakilat has increased its ownership of Maran Nakilat.

The vessels being added to the fleet are currently under construction in South Korea.

Nakilat managing director Muhammad Ghannam, said of the finance deal: "Nakilat's financial strength allows us to expand our business and to further cement Nakilat's leadership position in the global LNG transportation industry. With the refinancing of Maran Nakilat, we are proud to increase Nakilat's total fleet from 54 LNGCs to 56."

Maran Nakilat was established in 2005. Its original fleet of four LNGCs is on charter to RasGas.

Nakilat also manages and operates four LPG carriers and through two joint ventures, N-KOM and NDSQ, Nakilat operates the shiprepair and construction facilities at Qatar's Erhama Bin Jaber Al Jalahma Shipyard in Ras Laffan.

Along with another 31 gas carriers owned by various consortia, Nakilat operates a fleet of 56 vessels.

These include 11 LNGCs of between 145,000 cu m and 154,000 cu m, 31 Q-Flex and 14 Q-max types.

The consortia partners have stakes ranging from 20% to 60%. These include Teekay, OSG, MOL, NYK, K Line, Pronav, Maran Gas and Petronet.

Shell Shipping (STASCO) was appointed technical manager of 25 LNGCs for periods of between eight to 10 years, following the delivery of the last Q-Max - *Rasheeda* - in August 2010.

Following the ending of the management period, Nakilat intends to take over the vessels' technical management.

RASGAS

RasGas' fleet includes 27 LNGCs, which include 14 conventional gas carriers of between 138,000 cu m and 151,700 cu m capacity, plus 13 larger vessels of up to 206,000 cu m.

This fleet was built up through timecharter agreements with various owning companies and consortia. The major players include Qatar Shipping, Maran Gas, the Japanese consortium of MOL, NYK, K Line, the J5 Nakilat and Teekay Nakilat Corp.

Between May and September, 2008, RasGas took delivery of 12 Q-Flex types, while in October 2009, the company took delivery of its first Q-Max - *Al Dafna* - which completed RasGas' newbuilding programme.

SHELL SHIPPING (STASCO)

Shell was involved with the world's first two purpose-built LNGCs in the 1960s.

They were constructed to serve the Canvey Island, UK receiving terminal from a loading terminal at Arzew in Algeria.

Since then, the oil major's shipping arm and its partners have been involved with around 25% of the world's gas carriers and operations.

Today, Shell has a stake in about 50 LNGCs.

In 2007, Shell was awarded the technical management of 25 Nakilat-operated Q-Flex and Q-Max LNGCs and in addition manages eight 'B' class, six 'G' class, 12 for Nigeria LNG (Bonny Gas Transport) and five for the Northwest Shelf project.

NLNG (which see) is close to ordering around five LNGCs from South Korean yards.

Shell is also involved in a project to build a series of LNGFPSOs to a standard design at Samsung over 15 years and in 2010 awarded the same builder a \$4-\$5 bill contract to build a 220,000 cu m gas FPSO - *Prelude*.

Her keel was laid in May of this year and she will be delivered in 2017 and she was jointly designed by Samsung and Technip.

Once completed, *Prelude* will be moored and hooked up to the undersea infrastructure, around 475 km northeast of Broome, Western Australia.

Last year, the company signed an agreement



The Shell managed and operated Q-Max *Mozah* has a capacity of 266,000 cu m, was delivered to Nakilat in 2008 and is fitted with a Technigaz Mk III containment system.



The veteran 122,255 cu m *LNG Lagos* was built in 1976 and is managed by Shell for the Nigeria LNG operation. She is fitted with a GT No 85 containment system.

to charter two of Sovcomflot's four ice class LNGCs under construction at STX Offshore & Shipbuilding in co-operation with JSC United Shipbuilding.

The first vessel is due to enter service in late 2014 with the second following in 2015.

SK SHIPPING

In April of this year, Marubeni Corp, in collaboration with SK Shipping, concluded long-term charter contracts for LNGCs for a UK subsidiary of Total.

With a loading capacity of 180,000 cu m, the ships will be the largest LNG carriers which will be able to transit the Panama Canal after the planned expansion in 2015.

Marubeni and SK Shipping, by jointly establishing shipowning companies, have signed shipbuilding contracts with Samsung, charter contracts with Total and loan agreements with several financial institutions.

The LNGCs are scheduled for delivery by January 2017 and October 2017, respectively and will be chartered to Total for 30 years maximum under the ownership and management by the joint venture companies.

Each of the two ships will transport LNG from separate projects - the Australian Ichthys LNG project and the Sabine Pass liquefaction project at which, the US' shale-gas will be converted to LNG.

With this agreement, SK Shipping has

become the first shipping company in the world with a long-term shale gas transportation agreement, as well as the first South Korean shipping company to have won a tendered long-term overseas LNG transportation carrier contract, the company claimed.

Beginning with *YK Sovereign* in 1994, currently, SK Shipping operates six LNGCs and expects to have a total of eight by 2017.

IM SKAUGEN (IMSK)

IMSK was one of the first companies to develop smaller LNG capable gas carriers for regional distribution of LNG.

In its current fleet of 18 gas carriers, six are capable of shipping LNG, in addition to the conventional petrochemical gases and LPG.

Four are of 10,000 cu m capacity, while the other two are slightly larger at 12,000 cu m capacity.

The first – *Norgas Innovation* – was delivered in 2010, while the sixth – *Bahrain Vision* – was delivered in 2011.

Called the 'Multigas' class, they were built at Chinese yards under management of Skaugen Marine Construction.

SONANGOL

The Angolan state-owned oil concern operates three 173,000 cu m LNGCs delivered in 2007-2008 from Daewoo.

Sonangol has a 22.8% stake in Angola LNG along with Chevron (36.4%), BP (13.6%), ENI (13.6%) and Total (13.6%).

In July, Angola LNG delivered its first cargo to Brazil.

The 160,000 cu m cargo - which left Soyo on board the *Sonangol Sambizanga* in June - was discharged at Petrobras' regasification terminal in Guanabara Bay, Rio de Janeiro.

At full production, it is expected that over 70 cargoes per year will leave the Angola LNG plant, supplying 5.2 mill tonnes per year of LNG, plus propane, butane and condensate.

A large number of master LNG sale and purchase agreements have been executed with energy companies worldwide. Further agreements are currently being negotiated, the company said.

Angola LNG will use seven LNGCs and will operate three loading jetties (LNG, liquids and compressed butane).

SOVCOMFLOT (SCF)

The Russian shipping giant has six LNGCs on its books, two of which are elderly and four are modern.

To gain the experience needed to operate gas carriers, SCF purchased the 1969-built *SCF Arctic* and *SCF Polar*, which are on charter to Gas Natural (Stream).

In 2007-2008, SCF took delivery of the newbuildings *Grand Aniva* and *Grand Elena*.



IMSK's last 12,000 cu m Multigas type *Bahrain Vision* was delivered in 2011 (see page 49).

They were built by a joint venture involving SCF and NYK to ship gas from the Sakhalin II project.

A further two 145,700 cu m LNGCs were delivered in 2008 for the Tangguh project in a joint venture with Samudera and NYK.

In addition, SCF ordered four 170,000 cu m ice class LNGCs from STX Offshore & Shipbuilding. They are being built in co-operation with Russian builder JSC United Shipbuilding and will be delivered from 2013 through 2015.

Two of the new vessels will be operated by Gazprom, while Shell has taken the other two on long term charters. The first of the Shell vessels is due for delivery in late 2014 and the second in early 2015.

On 20th February this year, the keel was laid for the second Gazprom-chartered LNGC – *Pskov* – at STX Offshore & Shipbuilding. A month before, the first gas carrier in this series (*Velikiy Novgorod*) was launched. She is due for delivery in December, 2013.

The two AtlanticMax Ice2 (1C) LNGCs have a cargo capacity of around 170,000 cu m and are equipped for operating in low temperature conditions. SCF claimed that their unique design allows the vessels to transport gas all year round from almost any existing LNG terminal in the world, including Russia's first LNG project – Sakhalin-II.

Since then, SCF has signed an agreement with United Shipbuilding Corp (USC) for the reservation of construction slots to build further gas carriers of the *Velikiy Novgorod* series.

Along with reservation of construction slots,

SCF concluded a memorandum of understanding with Gazprom Marketing and Trading (GM&T), which calls for the building of up to 13 LNGCs from the enhanced 'Gaz Ice' series under future GM&T charters.

Also recently, SCF, Novatek and Vnesheconombank signed a memorandum on co-operation to build two LNGCs for the Yamal LNG project.

According to the agreement, Vnesheconombank is to look into the possibility of financing the construction of two 'pilot' liquefied natural gas carriers for the Yamal LNG project. SCF confirmed its

interest in operating the new vessels as a bareboat charterer and technical manager.

This agreement also provides for the participation of Russian shipbuilders in the project, including the transfer of LNGC construction technology to Russia, as well as the organisation of training for Russian technicians at overseas shipyards and subsequent technical support in establishing gas carrier production in Russia.

The design of the 170,000 cu m capacity LNGCs has been specially developed for the LNG Yamal project. They will be built to a high ice class (Arc7) and they will be fitted



SCF's 145,000 cu m *Grand Aniva* was delivered in 2008 and as can be seen is fitted with a Moss system.

with a diesel-electric propulsion system driving three Azipods, each with an output of 15 MW.

Final delivery of the new vessels is due to take place in 2016.

All of the SCF vessels are managed by subsidiary Unicom out of Limassol, Cyprus.

STENA LNG

In 2011, Stena Bulk purchased three Ice Class LNGCs from Taiwan-based shipping company Today Makes Tomorrow (TMT) for a total of about \$700 mill.

A year later, Stena LNG had been formed to operate the vessels and to be fully responsible for the management and development of all Stena's LNG and gas related activities, which the company had big plans for.

However, a proposed IPO to raise cash on the Oslo market was put on hold due to the financial situation.

At the time, the company held talks with Daewoo and Samsung about newbuildings, but nothing has been firmed up thus far, as the company opted to put the IPO on hold.

The company still has newbuilding plans against charter contracts and is short listed on several long term projects, it said.

The three LNGCs purchased from TMT were the 145,000 cu m *Stena Blue Sky* and two recently delivered 173,400 cu m vessels – *Stena Clear Sky* and *Stena Crystal Sky*.

Stena uses Glasgow-based affiliate Northern Marine Management to technically manage all three vessels.

STX PAN OCEAN

STX operates two LNGCs – the 2008-built 153,600 cu m *STX Kolt* and the 2010-built *STX Frontier*.

They were built on the back of long term charters to Kogas to lift Yemeni cargoes under a 20-year contract.

At the beginning of September this year, it was announced that STX had sold the *STX Frontier* to GasLog for about \$160 mill.

STREAM

This commercial operation was formed by Gas Natural Fenosa and Repsol in 2005.

Stream currently operates around 16 LNGCs among the latest of which were two from Knutsen and one from Elcano. They were delivered to ship gas from the Peru LNG project.

The company has also signed an agreement to build and operate and liquefaction plant for the Nigerian Government. In addition, Stream holds an 80% stake in a regasification plant at Damietta and a 7.3% stake in a similar plant at Qalhart, Oman.

Through stakeholder Repsol, Stream supplies gas to the Canaport LNG import and regasification terminal at St John (NB).

TEEKAY LNG PARTNERS

Teekay entered the gas shipping market in 2004 and a year later formed Teekay LNG Partners, leading to an IPO in 2005.

The quoted subsidiary now claims to be the

world's second largest independent LNGC owner and operator. As well as gas carriers, the Partnership owns LPG carriers and tankers, primarily operated under fixed-rate long term charter contracts with major energy and utility concerns.

It has interests in 32 LNGCs, including one regasification unit; 27 LPG carriers and 11 tankers. The Partnership's stake in these vessels ranges from 33% to 100%.

The company maintains a 33% stake taken in four Angolan LNGCs from Teekay Corp in August 2011 and January 2012, as well as a non-controlling 40% equity interest in the RasGas III project, which includes four LNGCs.

The number of LNGCs controlled, or part controlled by the Partnership was boosted last year with the purchase of 52% of six Maersk LNGCs in partnership with Marubeni.

Teekay said last year that it had confirmed a three year time charter for the LNGC *Magellan Spirit*, starting from September this year, at an increased rate of about 20% over the vessel's current charter. The Partnership has also signed a joint agreement to develop CNG technology using the Coselle containment system.

Recently, Teekay LNG confirmed the purchase of one 155,900 cu m LNGC newbuilding from Awilco. The vessel is currently under construction at Daewoo and is due for delivery later this year. She will be bareboat chartered back to Awilco at a fixed rate for five years, plus a one-year extension option.



Sovcomflot's first of four 170,200 cu m newbuilding *Velikiy Novgorod* at STX Offshore is due to be delivered in December of this year.

Teekay LNG has agreed a price of \$205 mill less a \$50 mill upfront pre-payment of charter hire by Awilco, which is in addition to the daily bareboat charter rate. Awilco also has fixed-price purchase obligations at the end of both the firm charter period and option period.

As part of this transaction, Awilco has the option to sell and bareboat charter back from Teekay LNG the second newbuilding under similar terms. The second LNGC newbuilding is expected to be delivered in the fourth quarter of 2013.

In July of this year, Teekay LNG entered into two, five-year time charter contracts with Cheniere Marketing to provide two 173,400 cu m LNGCs, ordered in December, 2012. The newbuildings are currently under construction by Daewoo and are scheduled to be delivered in the first half of 2016. They will be powered by twin M-type, electronically controlled, gas injection (ME-GI) engines.

Later that month, Teekay LNG announced that it had exercised two of its three existing options with Daewoo for the construction of two more ME-GI powered sister 173,400 cu m LNGCs for delivery in 2016.

The partnership said that it intended to secure long-term contract employment for both vessels prior to their delivery in 2016. At the same time, the partnership secured further options from DSME, which will enable the company to order up to five additional LNGCs.

THENAMARIS

Another major Greek shipping company to commit to the gas market, Thenamaris, ordered three 160,000 cu m LNGCs from Samsung for delivery 2013-2014.

In October last year, Bernhard Schulte Shipmanagement was awarded the technical

and crew management contract for the three vessels. They will be handled from the BSM office in Athens, Greece.

The vessels will be commercially operated by a new company – Thenamaris LNG. It is envisaged that the management will revert to Thenamaris LNG, after a period of operation.

TIANJIN MARINE

Tianjin Marine Shipping Co, a subsidiary of Hainan Airlines Group (HNA Group), has unveiled plans to build four LNGCs, as part of an expansion programme, which also includes VLCCs.

Shanghai-listed Tianjin Marine plans to raise up to RMB 12 bill (\$1.96 bill) through a private share offering to help fund the purchase of the new ships and to replenish working capital. Out of the RMB 12 bill, the four LNGCs will account for RMB 4.8 bill.

TOKYO GAS

This Japanese energy concern has been involved in gas carriers shipments since 1969, mainly serving terminals and power plants in the Tokyo Bay area.

The company has chartered a 177,000 cu m LNGC, which was due to be delivered to NYK last year from Kawasaki.

TSAKOS ENERGY TRANSPORT (TEN)

TEN currently manages the 150,000 cu m *Neo Energy*, which it had built to gain experience with this type of vessel.

Last year, the vessel was chartered at a rate, which was claimed to be four times as much as the rate it was earning in the second quarter of 2011.

TEN then placed an order for a tri-fuel 162,000 cu m newbuilding in 2012 with an

option for a second vessel.

The new vessel is due to be delivered in the first quarter of 2015.

ANTHONY VEDER

The Rotterdam-based small gas carrier manager owns two hybrid gas carriers in addition to LPG/ethylene carriers.

The 7,500 cu m *Coral Methane* was delivered in 2009 from Remontowa and is currently operating for Gasnor on a long term charter shipping gas from Spanish receiving terminals to Norwegian interests.

In January 2011, Veder ordered a larger version from Meyer Werft. The 15,600 cu m *Coral Energy* was delivered earlier this year and is powered by a dual fuel engine and has entered a long term charter with Skangass.

Meyer Werft's sister company Neptun Werft of Rostock was involved with her building and fitting out. Meyer Werft has built many LPG carriers in past and said that it sees a future in small scale LNGCs.

LNG operator Skangass has also announced that it is to charter the 2013-built hybrid LNG/LPG/Ethylene carrier *Coral Anthelia*, to operate alongside *Coral Energy*. She has a capacity of 6,500 cu m.

Coral Anthelia is scheduled to enter service by the end of 2014 with a timecharter agreement for a medium period, with extension options. The vessel will carry gas from Risavika to the Skangass terminal in Fredrikstad.

The ship will also offer ship-to-ship bunkering, thereby increasing the number of bunkering options offered by Skangass.

Coral Energy will be used to ship LNG to the new Skangass terminal in Lysekil to be opened before summer 2014, plus other operations. ■

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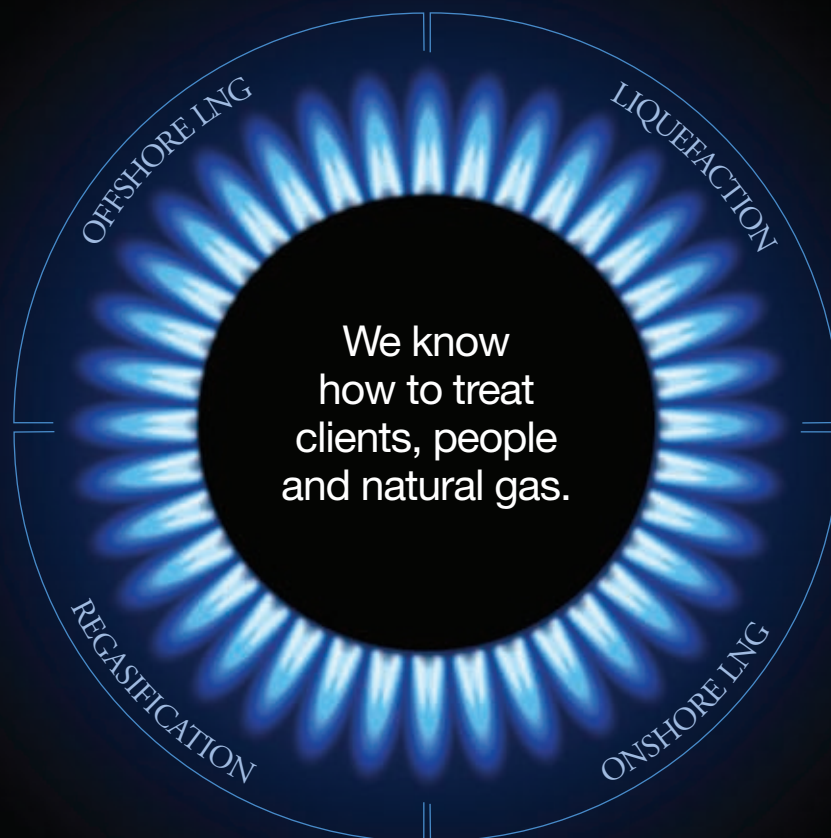
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