

LNG Journal supplement - the world's leading LNG publication

LNG *shipping*

REVIEW

- A cool pool
- FSRUs the quick fix
- Fuel slowly getting there
- Dual-fuel favoured
- Complete equipment package
- Containing the gas



2017

THE LOADING ARM MANUFACTURER

40 YEARS FIELD-PROVEN EXPERIENCE AND ONGOING PRODUCT DEVELOPMENT



✓ NEXT GENERATION SYMMETRIC DESIGN SUITS ANY APPLICATION

One or two liquid lines in one loading arm
Integrated or piggy-back vapor return lines
Specials: Ultra-long reach, Short tail

✓ ALL CRYOGENIC, PRESSURIZED AND HEATED FLUIDS AND GASSES

LNG – CNG – Oils – Chemicals – Food

✓ FLEXIBLE LNG BUNKERING SOLUTIONS

✓ 100% EN 1474-1:2009 CERTIFIED LNG MARINE LOADING ARMS



THE LNG journal

SHIPPING REVIEW 2017

An LNG Journal
publication

PUBLISHER

Stuart Fryer
Tel: +44 (0)20 7017 3400

EDITOR

Ian Cochran
Tel: +44 (0)7748 144265
cochran@tankeroperator.com

ADVERTISING SALES

David Jeffries
Only Media Ltd
T: +44 (0) 20 8674 9444
F: +44 (0) 20 8674 2743
djeffries@lngjournal.com

PRODUCTION

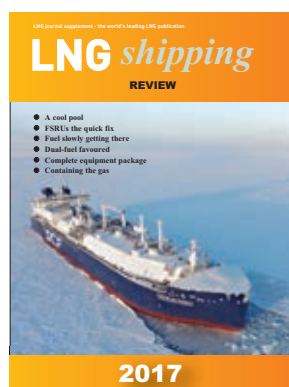
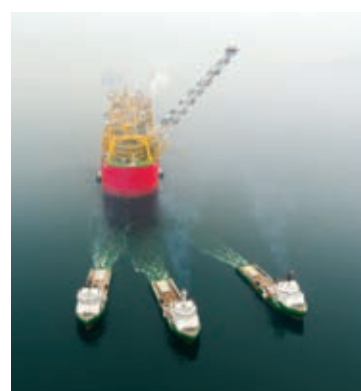
Vivian Chee
Tel: +44 (0)20 8995 5540
chee@btconnect.com

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

No part of this publication may be reproduced or stored in any form by any mechanical, electronic, photocopying, recording or other means without the prior written consent of the publisher. Whilst the information and articles are published in good faith and every effort is made to check accuracy, readers should verify facts and statements direct with official sources before acting on them as the publisher can accept no responsibility in this respect. Any opinions expressed in this magazine should not be construed as those of the publisher.

CONTENTS

Page 4	Markets: The bulls and the bears
Page 6	Profile: David Furnival talks SIGTTO and BSM
Page 8	Profile: Pool offers greater flexibility
Page 11	FLNGs: More projects on the horizon
Page 15	FSRUs: The jewel in the crown
Page 20	LNG AS A FUEL: Take up slowly increases Containership conversion
Page 27	SMALL SCALE: 'Coralus' takes her bow CRYO to feed northern Norway
Page 32	PROPULSION: Alliance favours dual-fuel
Page 34	LNG TECHNOLOGY: Wärtsilä offers complete package
Page 37	CONTAINMENT SYSTEMS: Number of systems increasing



Will the new Arc7s cut the ice?

The prototype 'Christophe de Margerie' has already transited the Northern Sea Route with a cargo loaded in Norway for discharge in South Korea and undertaken berthing trials at Sabetta.

Will gas become the panacea of future energy needs?

In what could be seen as good news for the LNG shipping sector, gas will become the largest single source of energy from 2034.

According to a DNV GL forecast, while renewable energy will grow its share of the energy mix, oil and gas will account for 44% of world energy supply in 2050, compared to 53% today.

DNV GL's 'Energy Transition Outlook' (ETO), a forecast that spans the global energy mix to 2050, predicts that global demand for energy will flatten in 2030, then steadily decline over the next two decades, thanks to step-changes in energy efficiency. The fossil fuel share of the world's primary energy mix will reduce from its current 81% to 52% in 2050.

Demand for oil will peak in 2022, driven by expectations for a surge in prominence of light electric vehicles, accounting for 50% of new car sales globally by 2035. However, the stage is set for gas to become the largest single source of energy towards 2050 and the last of the fossil fuels to experience peak demand, which DNV GL expects will occur in 2035.

Gas will continue to play a key role alongside renewables in helping to meet future, lower-carbon, energy requirements. Major oil companies aim to increase their share of gas reserves and DNV GL expects an accelerated shift by 2022, as they de-carbonise their business portfolios.

While demand for hydrocarbons will peak over the next two decades, significant investment will be needed to add new oil and gas production capacity and operate existing assets safely and sustainably. However, the results of DNV GL's model reinforce the need to maintain strict cost efficiency in order to achieve the margins necessary for future capital and operational expenditure.

This could be seen as positive for both the transport of LNG worldwide and the supply of LNG as bunker fuel. Since the 2016 *LNG*

Annual Shipping Review was published, the move to set up infrastructure for LNG bunkering has moved ahead.

People now seem to be taking it seriously, probably driven by the 1st January, 2020 sulfur cap, which is fast approaching. A recent report by IHS Markit suggests that scrubbers will be the preferred route to adhere to the new regulations. The report said that LNG as a fuel would mainly be used on newbuilds, meaning that engine retrofits will be few and far between.

We have seen an increase in ordering of vessels with LNG ready propulsion units, not least the recent order of 10 VLOCS for Polaris, so owners and operators are keeping their options open.

Most of the retrofits have involved smaller Baltic/North Sea and Norwegian coastal traders, the latter can tap into a government NOx funds as a sort of subsidy. It is also in these regions that much of the investment in bunkering infrastructure is appearing.

FSRUS IN VOGUE

Switching to larger units, FSRUs appear to be flavour of the month - see the feature on page 15 - as a quick fix for developing countries energy needs. LNGC design has remained much the same since our last report, but the average size has gone up a notch to around 175,000 cu m - 180,000 cu m capacity.

An LNGC of 180,000 cu m capacity is the maximum size that can transit the new Panama Canal locks, so this makes perfect sense.

Whether we see any more Q-Flexes or Q-Maxes built, apart from static offshore units, is debatable.

We are currently awaiting the deliveries of the next tranche of Yamal Arc7s, following the 'Christophe de Margerie', which has been put through her paces this year, including a well publicised trip through the Northern Sea Route, carrying a cargo from Norway to South Korea.

Of course, much of the LNG movement increase will be down to price against that of oil. Coal seems to have had its day even in China and India, while renewables are only forecast to take up a small percentage of the energy mix going forward.

Qatar and the US seem to be leading the way in LNG production and although Iran always makes noises, precious little seems to have happened to exploit the huge Middle East Gulf reserves.

The Asian majors - Japan, South Korea and China - still lead the way as far as imports are concerned to feed their utility needs. With the uptake in FSRUs in the next two to three years, several other countries will also become importers, most notably in the Indian sub-continent.

We keep hearing that next year, the LNGC market will turn and just maybe it will, if we can keep politics out of the equation. If the shipping business is allowed to run its empire without political distractions on a pure supply and demand basis, the better everybody involved will be. ■

Gas will continue to play a key role alongside renewables in helping to meet future, lower-carbon, energy requirements.

- DNV GL

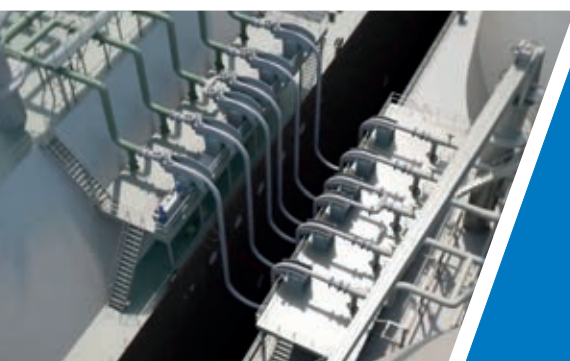
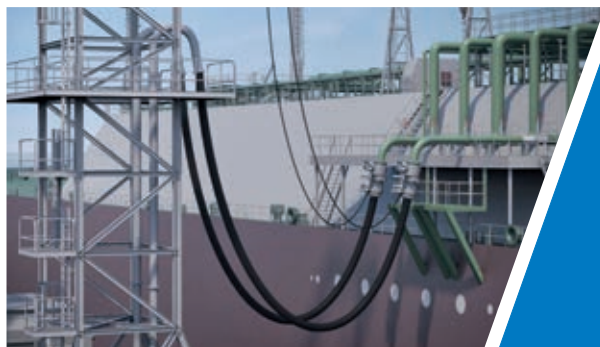
GAS TRANSFER SOLUTIONS



A SINGLE SOURCE FOR
THE ENTIRE **LNG**
AND **HPNG** TRANSFER CHAIN:
FROM LNGC TO FSRU AND
FROM FSRU TO JETTY



PIONEERING A STEP-CHANGE
IN THE **SAFETY** OF
LNG AND HPNG
TRANSFER
APPLICATIONS



MIB ITALIANA S.P.A.

Via Garibaldi, 6 - 35020 Casalserugo (PD) - Italy
Tel. +39 049 8741272 - e-mail: info@mibitaliana.it

MIB INTERNATIONAL Ltd

Sun Alliance House, Little Park Street Coventry, CV1 2JZ, ENGLAND
Tel. +44 (0) 24 76225202 - e-mail: sales@mibinternational.co.uk

www.mibitaliana.it

Owners bullish, analysts bearish

Analysing the second quarter results presentations from the major quoted LNGC owners, they were all bullish going forward, which is probably to be expected, as they attempt to keep their shareholders on side.

However, other reports were more bearish, saying that we were still some way off a balance in supply and demand.

With the opening of significant export facilities in the US and Australia, plus more to come, including Yamal LNG, this year, demand should more or less keep pace with supply, the owners claimed.

For example, Golar LNG said that the demand case for LNG continues to defy earlier expectations. During the first half of this year, Chinese imports increased by 38% on 2016. Due to a new Government coming into power, South Korea, the world's second largest LNG market, will increase its LNG imports, as it moves away from coal and nuclear.

In addition, India and frontier markets, such as Pakistan, are also proposing significant increases in LNG imports.

However, the second quarter shipping market showed no material improvement. The 2Q17 commenced with intense competition for fixtures in both basins, which continued to be reflected in poor rates and minimal compensation for positioning and ballast legs.

A tightening market was, however, highlighted toward the end of the quarter as reduced redeliveries in both the Atlantic and Middle East culminated in a one off six figure voyage rate being secured.

Subsequent to the end of 2Q17, chartering activity improved as some of the projects mentioned below commenced or ramped up production. Owner expectations firmed in response and this is contributing to a gradual recovery in shipping rates, the re-emergence of round trip economics and a widening rate spread for 2018 fixtures.

Whilst around 55 vessels are expected to be delivered this year, the tonnage required to meet incremental production is greater, Golar said. This gap between vessel deliveries and increasing LNG production is expected to widen in 2018.

Among the projects, due to come on stream

or ramp up production, the 15.6 mill tonnes per annum Gorgon project is producing at nameplate capacity. Cheniere's 4.5 mill tonnes per annum Train 3 continues to come on stream, whilst T4 recently commenced the commissioning of a further 4.5 mill tonnes.

Meanwhile, the start-up of Wheatstone's 4.5 mill tonnes per annum Train 1 is imminent with commissioning underway. A further 4.5 mill tonnes should follow in the next six to seven months from Train 2.

In addition, Novatek has started to commission the first of its three 5.5 mill tonnes per annum Yamal liquefaction trains and the 5 mill tonne Cove Point plant is on track to commence operations in 4Q17.

In 1Q18, Ichthys LNG is due to start production from the first of its two 4.5 mill tonnes per annum liquefaction trains and Shell's 3.5 mill tonne 'Prelude' FLNG facility has arrived offshore Australia. US exports are expected to grow significantly next year and 2019 with further capacity growth of close to 45 mill tonnes per annum.

INCREASED MARKET SHARE

To date, the Cool Pool (see page 8) has secured many more voyages, compared to the same period in 2016. As a more balanced market approaches and the number of prompt available vessels declines, its market share will increase, further strengthening rate expectations, Golar said.

Höegh LNG said that the total LNG trade reached 144 mill tonnes in 1H17, up by 17 mill tonnes (13%) from 1H16. The largest contributors to this increase in LNG consumption were China, Japan, South Korea, France and Turkey, driven by increased supplies and lower prices, as well as expanded regasification capacity. In 1H17, 36 countries imported LNG, more than twice as many as 10 years ago.

Around 13 mill tonnes of LNG production commenced in 1H17, and as much as 90 mill tonnes of incremental production is scheduled

to come on stream by 2020.

The largest exporter in 2016 was Qatar, with foreign sales of 79 mill tonnes of LNG. Qatar has also announced plans to further boost production from the North Field. This decision ends a self-imposed ban on additional gas production from the field, and Qatar could increase its LNG production to more than 100 mill tonnes annually.

With these volumes on top of gas liquefaction expansion elsewhere, the LNG market is likely to remain long and keep prices competitive, Höegh said.

The shift from a short to a long LNG market has resulted in a market structure where LNG buyers have acquired greater bargaining power. Consequently, contracts are tending to become shorter and smaller, requiring LNG producers to play a more active role in marketing their volumes.

As a consequence, potential buyers enjoy producer support for flexibility, both commercially and financially, since producers are also tending to play a more active role in the downstream part of the value chain. In order to boost LNG uptake, producers have embraced the FSRU concept to open up new markets – as exemplified by Nakilat's decision to team up with Höegh LNG.

The majority of new LNG importers are utilising FSRUs for regasification, and the FSRU solution has become the preferred alternative for new market entrants. FSRU tendering activity remains high, with unabated interest in most geographical markets (see page 15).

Awilco LNG said that there was a general consensus of opinion that the market will be 30 to 40 vessels short by the end of this decade amid a volume increase.

"Things are looking a lot better. There are more than 100 mill tonnes of LNG hitting the water over the next three years. There is a restrained order book and I think that is going to continue until charterers start biting the bullet and taking long-time charters," said Jon

Skule Storheill, Awilco LNG CEO, speaking on a panel at Capital Link's 10th Annual Shipping, Marine Services & Offshore Forum in London. "So, the oversupply of tonnage with which we struggled over the past few years looks to be diminishing, and this will likely lead to stronger rates."

The ordering activity is expected to remain low, at least for the next two years, despite newbuilding tonnage prices being at their lowest for eight years.

With respect to the trains that don't have committed vessels yet, Jonathan Cook, Flex LNG CEO, said that as it would be very difficult to get a 2019 delivery for a newbuilding at present, owners would have to tap into the existing order book.

"Quite a few charterers that are going to need vessels within the 2019 time frame, will have to draw from the existing orderbook of non-committed vessels or the existing fleet," he said. "From that perspective, there is definitely going to be a mix of vessel types that get chartered on a shorter term as a bridge to a newbuilding."

New LNG production coming online is bound to help alleviate the oversupply of tonnage in the LNG shipping market, however it still won't be enough to cater for all the newbuildings expected to hit the water during the next few months and as such, some of them are bound to be delayed, Awilco said in its quarterly report.

Awilco agreed that the long-term outlook for LNG shipping remains promising on the back of scheduled LNG production capacity coming on stream over the next couple of years.

RATES FIRMED

The falling gas price trend from 1Q17 levelled off and stabilised in 2Q17. Gas prices were more or less unchanged during the quarter. The soft LNG shipping rates showed a firming trend in 2Q17. The quarter started with day rates reported at \$30,000 and \$28,500 West and East of Suez, respectively, and ended up at \$40,000 and \$30,000, respectively.

Market activity was low for extended periods during 2Q17, but firmed on the back of additional enquires at the end of the quarter. In 3Q17, both activity and rates have continued to strengthen, leading to rates reported at \$43,000 and \$40,000 West and East of Suez, respectively, in addition to increasing ballast payments on full round voyage basis.

For example, in September, brokers reported that the Teekay-managed, Total operated 165,500 cu m 'Meridian Spirit' had been fixed to Indian energy concern GAIL for three years,



Qatar is expected to dominate LNG exports for years to come.

with an option for a further 12 months, at \$45,000 per day.

According to Awilco, during the second quarter of the year there were 48 cargoes exported from Sabine, compared to 43 in 1Q17 and 23 in 4Q16. Most of the cargoes went to South America, while South Korea, China, Japan and India imported spot cargoes, significantly supporting increased tonne/mile.

Awilco said that 13 vessels were delivered in the first six months of this year and a further 24 vessels are scheduled for delivery in the remainder of 2017, although some delays are likely to occur.

Newbuilding ordering was low in 2016, but has picked up moderately thus far in 2017, as eight newbuildings were ordered in 2017 up to the middle of the year.

BEARISH

However, Paris-based industry group Cedigaz presented a more bearish picture.

In a recently released forecast report, the analysts said that the global LNG market was not likely to rebalance before 2023 or even 2024, given that the expected rise in supply will outpace demand growth.

According to Cedigaz, total LNG production capacity is set to increase by 60% to 387 mill mill tonnes per year by 2021.

Forecasts vary on when the current assumed LNG supply glut is expected to end. For example, the International Energy Agency (IEA) said in June in its medium-term gas outlook that the global LNG glut would persist through the end of 2022.

Cedigaz said the significant increase in effective liquefaction capacity to 2020-21 would be led by strong growth in Australia and the US until 2019 and 2021, respectively.

After 2021, unless new projects are

launched, the researcher expected a gradual decline in production capacity, due to the ageing of some facilities (Southeast Asia) and growing constraints on resources (Trinidad and Tobago, UAE, Oman, Algeria, Indonesia and Malaysia).

Based on Cedigaz supply/demand estimates, new projects will need to come online post 2023/2024 to accommodate rising LNG demand, the report said.

Cedigaz expected that the strongest increases in LNG capacity from post-FID projects will come from the US, Canada, Mozambique and Qatar. Asian LNG imports are projected to more than double by 2035 to 368 mill tonnes per year, a 3.8% average annual rate.

The traditional markets (Japan, South Korea and Taiwan) will remain stable, while emerging markets (such as China, India, Malaysia, Pakistan, Singapore and Thailand) are expected to grow significantly from 41 mill tonnes per year in 2015 to 193 mill tonnes in 2035.

New Asian markets — Bangladesh, Indonesia, the Philippines and Vietnam — will also contribute to the increase in imports from the 2020s, reaching almost 40 mill tonnes per year, Cedigaz predicted. Asia will maintain its position as the leading LNG import region with a market share of around 70% to 2035.

At the time of writing, there were roughly 500 LNGCs in operation with around 100 LNGCs of over 100,000 cu m capacity on the orderbook, according to Fearnleys orderbook, supplied to sister publication - *LNG Shipping News*.

As mentioned ordering has been slow this year, except for interest in FSRUs, which is no bad thing going forward, as a small orderbook will help rebalance the market, as with any ship type, which relies on the charter market, either long term or spot. ■

A man on a mission

LNG Shipping Review spoke with David Furnival, SIGTTO President and COO of Bernhard Schulte Shipmanagement (BSM) about his dual role.

Starting with SIGTTO, he said that he was in his first year of a three-year tenure as President and the focus is to support the General Manager, Andrew Clifton, to deliver the objectives of the society's Strategic Plan and to lead the Board of Directors in the provision of effective governance.

He explained that BSM is also active at the working group level having contributing members on the General Purposes Committee, Chris Clucas – Corporate Expert Liquefied Gas and Human Element Committee – plus Giles Heimann – Corporate Director Fleet Personnel.

The main issues for SIGTTO going forward are safety and accident prevention, which remain at the forefront of the society's focus.

"The society has an effective system of sharing reports on incidents among members. SIGTTO is adopting modern risk assessment and mitigation techniques, such as the 'bow-tie' tool, to improve loss prevention performance. Human error in one form or other remains a causal factor in many accidents and SIGTTO's Human Element Committee has been established to better understand the underlying reasons and to develop more effective preventative measures.

"Effectively promulgating the safety message is of paramount importance and the society is committed to publish up-to-date, relevant reports and best practice guidance on liquefied gas shipping and terminal operations. The recent complete revision of our main publication – Liquefied Gas Handling Principles – is a good example how SIGTTO keeps its publications up-to-date and in line with current industry practices and concerns," he explained.

Turning to BSM, Furnival explained that the company was involved with all LNGCs, including spherical and membrane containment, plus steam, diesel-electric and gas-fired 2-stroke propulsion, as well as ships with full or partial LNG reliquefaction plants.

Answering the question as to why there is a need for a third party shipmanagement company in the LNGC sector, Furnival said that the LNG sector has traditionally been

dominated by a relatively small number of shipowners and operators and vessels were generally constructed for specific long-term charters.

"Because of the LNG industries' excellent safety record, standards and expectations are high and it is challenging for aspiring new entrants without the relevant experienced shore staff and crew. Suitably resourced and reputable third party shipmanagers, such as BSM, can provide an entry point for such shipowners who have no background or experience of gas shipping and for companies that wish to invest in this specialist sector but do not want to establish a ship operating company," he said.

TRAINING

BSM is well known for its training academies. The centres are equipped with LICOS cargo handling simulators for both LPG and LNG carriers. The LNG models also cover spherical and membrane containment systems, plus boil-off gas handling.

"In the past, we have had a training facility on board an operating LNG carrier to allow both academic and practical training to be conducted simultaneously, which is particularly effective. We are planning to replicate this facility when the Bernhard Schulte owned LNG carrier is delivered next year. A simulator model for our LNG Gas Supply Vessel and LNG as a fuel on non-LNG carriers is under development with our partners Babcock.

"All officers serving on LPG and LNG carriers must undertake flag state accredited basic or advanced training (depending on their rank) in liquefied gas tanker cargo operations in accordance with STCW. Having our own training facilities and faculty allows us to deliver the standard STCW model and to tailor individual courses to meet vessel specific aspects, which is a valuable capability given the introduction of a number of new technologies in the LNG sector. BSM is also able to provide LNG training berths that can facilitate adherence to the SIGTTO officer advanced competency and experience recommendations," he said.

As the world's LNG fleet has been steadily



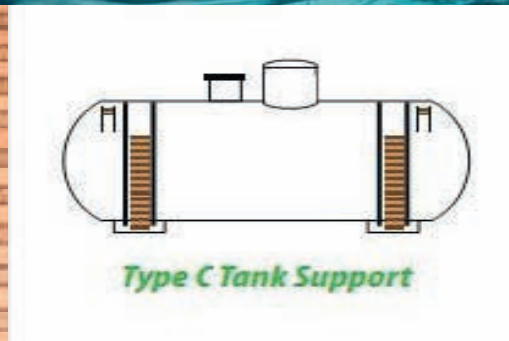
David Furnival.

expanding, there is no excess pool of experienced crew available to tap into. To meet the demand, it is necessary for owners and managers to develop an adequate talent pipeline. This is achieved principally through investment in additional training for officers experienced in other ship types, such as tankers and comprehensive cadet programmes.

BSM also offers design and newbuilding supervision under the banner of Schulte Marine Concept (SMC), which currently has six LNGCs under its wing with another two still under construction – a 174,000 cu m membrane type and a 7,500 cu m LNG Gas Supply Vessel.

The shipmanagement company has one technical and 23 crew managed LNGCs under contract, which will soon increase with the addition of another six technically managed LNGCs for which contracts have been signed. The number of crew managed LNGs is also expected to increase significantly over the next 12 months, Furnival concluded. ■

QUALITY & RELIABILITY
MADE IN GERMANY



DEHONIT® / PERMALI SUPPORTS

- Floating LNK storage tank
- **LNG fuel tank support**
- Prismatic LNG and LPG tanks
(up to 250.000 m³ and more)
- Bilobe, SPB, Prismatic,
Cylinder, LNG, LPG, Ethylene,
Chemical tanks

DEHONIT® / PERMALI MATERIAL IS APPROVED

- **GL** Germanischer Lloyd
- **BV** Bureau Veritas
- **DNV** Det Norske Veritas
- **LR** Lloyd's Register
- **GTT** Gaztransport, Technigaz
- **DIN ISO 9001 : 2008**
- **ABS** American Bureau
of Shipping

FEATURES OF DEHONIT® / PERMALI

- Low specific weight
- High compressive strength
- Water resistant
- Low thermal conductivity
- Low coefficient of friction
- Temperature stability
- Low coefficient of linear
expansion

Cool Pool keeps its LNGCs employed

Poten & Partners LNG specialist Arianne Perez has taken a look at progress made by the Cool Pool in keeping its ships employed.*

With 18 LNGs in its fleet, the Cool Pool continues to perform well in an oversupplied shipping market. All of its vessels have been snapped up for spot or short term employment.

When the pool was launched in October, 2015, it had a total of eight vessels and after operating for five months, it expanded to 13 vessels. With its current fleet ranging in size from 154,800 cu m to 162,000 cu m, the Cool Pool could add more ships from existing member owners Gaslog, Golar and Dynagas or from other owners, she was told.

“We continue to expect existing ship owners to add more vessels to the pool, although probably not as soon as this year because that will largely depend on the existing charterers, but in the next few years,” Cool Pool manager, Morten Nielsen, told Perez. “It is also hard to tell how many more ships because as of now it is pure speculation, as it will depend on so many things, such as the availability of ships and how relationships develop.”

With the recent addition of ships coming off charter –two each from Golar and Gaslog and one from Dynagas – the fleet now consists of three LNGCs from Dynagas, five from Gaslog and 10 from Golar. Sixteen of the 18 vessels are moving in the spot market while two others are employed under short-term timecharters.

For the Cool Pool vessels, a short term charter is generally six to 12 months employment, deployed globally.

Since the pool was launched, Nielsen said, the main strategy of the team – Nielsen and one representative each from Golar, Gaslog and Dynagas –is not to fixate on a certain strategy or operations pattern.

“We realised quite fast that the market changes all the time and we have to change with it. In the last couple of years, for example, traders have been very active. We don’t know if this will continue or [if it] will be the oil majors controlling the volumes,” he said.

The main commercial strategy of the Cool Pool is to be able to switch direction quickly in response to a market that is changing quickly. “The companies that have chartered Cool Pool ships have definitely seen the value of the pool’s flexibility,” Nielsen said. “We have done coas and introduced lots of things, such as alternative shipping procurement.”

Some shipowners outside the pool, for instance, would refuse to accept employment because the economics did not support the business. Having a pool of ships available as an option is completely new to LNG, Nielsen said. They do not need to rely on the spot market.

“And [the availability of pooling vessels as an option] is completely new to LNG,” Nielsen said. “No one relied on the spot market.”

MORE PARTICIPANTS

With the distinct possibility of other shipowners joining the pool, Nielsen said, there is constant debate about allowing more shipowners and more ships into the pool

because the industry is changing all the time.

Until very recently it did not make sense to add more vessels and more shipowners when the market was not very active. New additions

Cool Pool LNGCs

Name	Built	Cu m capacity
Clean Horizon	2015	162,000
Clean Planet	2014	162,000
Clean Vision	2016	162,000
Gaslog Chelsea	2010	155,000
Gaslog Salem	2015	155,000
Gaslog Saratoga	2014	155,000
Gaslog Savannah	2010	155,000
Gaslog Singapore	2010	154,800
Golar Bear	2014	160,000
Golar Celsius	2013	160,000
Golar Crystal	2014	160,000
Golar Frost	2014	160,000
Golar Glacier	2015	162,000
Golar Ice	2015	160,000
Golar Kelvin	2014	162,000
Golar Penguin	2014	160,000
Golar Seal	2013	160,000
Golar Snow	2015	160,000

Source: Poten & Partners, Cool Pool

“ One of the main factors contributing to the success of the Cool Pool is the great flexibility it offers to meet a charterer’s needs and the fact that it can adapt quickly to changes in spot or short term trends. ”

- Morten Nielsen, Manager, Cool Pool

to the pool could have taken business from vessels and shipowners already in the pool. But in the current market it makes more sense to add more ships or shipowners because activity has been picking up, particularly in the spot market, Nielsen said.

"We have to explain why the pool is a good idea," he said. Because the industry is evolving quickly, the market is now much different from what it was six months ago, so it is very important for players to adapt quickly. A lot of players are left behind because they do not adopt new strategies.

One of the main factors contributing to the success of the Cool Pool is the great flexibility it offers to meet a charterer's needs and the fact that it can adapt quickly to changes in spot or short term trends.

"With a number of similarly sized vessels, the pool has more wiggle room to satisfy a charterer's needs. And I think we have to continue [offering that flexibility] because I haven't found a single person who could tell me how the industry is going to look exactly in the next few months," Nielsen said.

As soon as the shipowners realise that the spot market is here to stay, they will put more

effort into understanding that the market and the pool makes sense, he said. Some new owners who came into the market when freight rates were around \$150,000 per day and timecharters spanned up to 10 years, need to wake up to new realities.

Freight rates are not going to reach six digits in the foreseeable future unless there is a major unpredicted event, and contract durations have shortened significantly. "One of the challenges right now is making some shipowners realise they need the spot market," Nielsen said. "Most of the third-party owners are waiting for a miracle. They don't realise they need to work in the spot market and for them to realise this has been a slow process."

Poten said that it expected total spot fixtures to surpass 300 this year and Nielsen agreed that the data is pointing that way, as new projects are coming online. In Australia Gorgon LNG is starting up and Australia Pacific LNG is producing above nameplate capacity. The US is starting to be active and extra cargoes are coming from both West Africa and Algeria. Cargoes continue to come from Bontang and Bintulu in Indonesia and from Papua New Guinea.

In July alone, there were over 40 fixtures reported, with around a third coming from the Cool Pool fleet. With the increased activity this year, freight rates have moved up but not significantly. "Cargo prices have been low so charterers have done their best to avoid fixing ships," he said. "But if we continue to see the same flow of cargoes from the projects, I can't see the charterers winning this battle because they ... really have to lift the cargoes."

Nielsen agreed with the general view that the market will improve vastly towards end of 2018. However, he warned that it only takes one very low-priced deal to upset any potential recovery.

Perez said that Poten was seeing an early indication of a tightening market, although the orderbook remained a hurdle with around 20 vessels due for delivery this year.

Meanwhile, four liquefaction trains with combined nameplate capacity of almost 15 mill tonnes per year are expected to start up this year and that is seen as a benefit for the spot shipping market. ■

**This article was reproduced courtesy of Poten & Partners.*

THE MARSHALL ISLANDS REGISTRY



committed to the quality of the world fleet

We are committed to upholding the values of safety, security, and environmental protection. This is evidenced through the quality of our fleet and outstanding port State control record as the only major international flag to remain on the United States Coast Guard's Qualship 21 roster for 13 consecutive years. We achieve this goal through 24/7 service provided from 27 offices, staffed with experienced personnel, located in major shipping and financial centers around the world.



International Registries, Inc.

in affiliation with the Marshall Islands Maritime & Corporate Administrators

info@register-iri.com | blog.register-iri.com | www.register-iri.com

BUTTERFLY VALVES FOR **EXTREME** CONDITIONS

CRYOGENIC VALVES FOR
GAS CARRIERS

FLNG concept moves on slowly

Are FLNGs and FSRUs ships or floating offshore structures?

A moot point. However, we have included both of these structures in this review, as they are designed to transfer gas to and from conventional LNGCs and some of them are conversions from gas carrier hulls.

For example, FLNGs are mainly designed to process, liquefy and export natural gas and are located on gas fields, unlike FSRUs, which are used as regasification floating import terminals, receiving gas from LNGCs.

According to Melanie Lovatt, finance advisor, Poten & Partners, writing in GasTech Insights, if all things go to plan for the sponsors of the Fortuna project in Equatorial Guinea, three FLNG projects will complete their fundraising this year.

If successful, Fortuna will join Eni-led Coral South in Mozambique and Exmar's Caribbean FLNG.

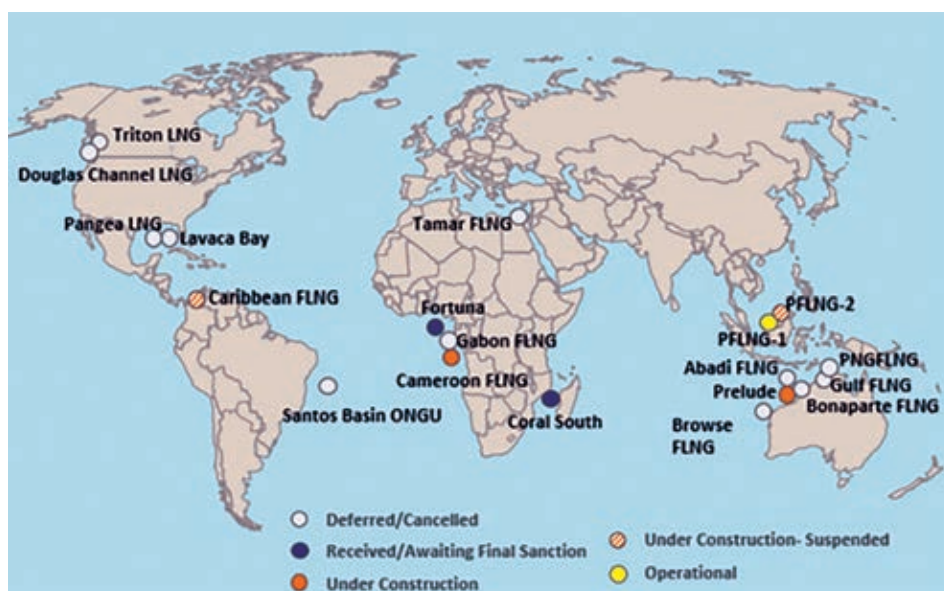
Looking at the funding for the three projects and the three other FLNG projects that completed their funding earlier, shows that diversity is already emerging in this nascent sector. For example,

1) Malaysia's Petronas: Shipped the first cargo from 1.2 mill tonnes per year 'PFLNG Satu' in April 2017 and financed this unit from its own resources.

2) Shell: Took the same route by using its balance sheet to finance the giant 'Prelude FLNG', at the time claimed to be the largest floating offshore structure ever built at 600,000 tonnes with its tanks full. The FLNG arrived at its offshore location in northwest Australia in July, 2017.

3) Golar LNG: Attracted \$960 mill worth of funding in July, 2015 for its 126,200 cu m 'Hilli Episeyo' from Chinese company CSSC (Hong Kong) Shipping Co Ltd, which provided the funds in a sale and leaseback structure.

The cost of converting the 'Hilli', a 42-year-old LNGC into an FLNG at Singapore's Keppel yard, was estimated at \$1.2 bill. The 'Hilli Episeyo' is scheduled to leave the yard for its near shore location in Cameroon at the end of the third quarter of this year.



A map of the identified FLNG projects. Source: Poten & Partners.

4) Fortuna: Financing for the 'Gandria' – another converted Golar LNGC – will also be provided via a sale and leaseback deal from Chinese lenders. The overall cost of the project is about \$2.1 bill, with about \$1.2 bill to be debt financed.

The cost of the vessel is estimated at \$1.5 bill with the upstream part of the project accounting for the remaining cost. The 'Gandria' is costing more than the 'Hilli Episeyo', due to the equipment needed to contend with the harsher conditions found in a more open marine environment.

LNG shipping companies have stepped up their use of Chinese funding provided in the form of sale and leaseback structures, for LNGCs, FSRUs and FLNGs.

5) Exmar: For its newly delivered 500,000 tonnes per year 'Caribbean FLNG' unit, costing \$300 mill, the Belgian company took a more classic route, securing funds from banks and an export credit agency (ECA), receiving \$200 mill from Bank of China, China's ECA, Sinosure and Deutsche Bank.

6) Coral South: The 3.4 mill tonnes per year project, which is costing around \$8 bill, also took a financing route that is common for large-scale projects. It used a project finance

structure and received debt funding totalling around \$4.7 bill from international banks and ECAs.

Project finance structures are commonly used in liquefaction projects, which cost billions of dollars, although Coral South is the first FLNG project to use this structure.

The financing methods used for future FLNG projects are likely to be determined by the size of the project and the type of sponsor. Gas majors are predicted to turn to either classic project finance, such as Eni, or use their balance sheets, like Petronas and Shell. This will depend on:

- The strength of a company's balance sheet and whether it has partners.
- The location of the project.
- Company preference.

Projects using a vessel leased from a shipping company could continue to see these units financed via sale and leaseback structures from Chinese providers, which can often provide higher leverage than commercial banks and ECAs. The financing could be applied to the vessel only, as with the 'Hilli', or the vessel and other parts of the project, as with the 'Gandria', where part of the upstream is being financed.



The giant 'Prelude' FLNG leaves South Korea under tow for Australia.

However, it might take a while to see if these tried and tested patterns emerge, or if new funding methods are embraced. Like land-based projects, many FLNG projects have seen their final investment decisions delayed as a result of the difficult market conditions, Lovatt said.

Also highlighted in the GasTech Insight series of articles, Lincoln Clark, Engineering and Operations Manager, LNG Limited, spoke of the advantages of using FLNGs for near shore gas projects.

Remote full-offshore FPSO type LNG liquefaction applications can economically afford to place a low emphasis on the efficiency of the liquefaction technology, compared to other features and factors.

Nitrogen expansion technology or basic single mixed refrigerant (SMR) processes are well suited for these remote floating LNG projects, since the facilities are relatively simple to operate and have a reasonably small footprint, while access to large reserves of offshore stranded gas renders the inherent inefficiencies and high emissions of these processes less consequential, he said.

A new category of proposed liquefaction

facilities has emerged, the near shore FLNG concept. In this case, where a project is located closer to shore and sources third party feed gas from a pipeline system, a more efficient liquefaction technology provides economic merits, since every molecule of gas must be paid for.

Generally, capital and operating economics favour onshore LNG when this option is feasible. In those situations, where onshore options are stymied, the advantages of adopting an alternative mid-scale near shore FLNG solution can include:

- **Realise smaller parcels of gas** - Isolated and relatively small fields may be otherwise uneconomic.
- **Minimise onshore challenges** - Onshore plant locations may face lengthy legal and permitting time and community objections.
- **Reduce environmental footprint** - Near shore LNG concepts may not require long pipelines, dredging for jetties or extensive onshore roads and construction.
- **Re-deployment opportunity** - Onshore LNG plants represent a huge point investment, while near shore facilities can be relocated.

- **Deliver projects faster & cheaper** - Traditional onshore LNG facilities can face extensive infrastructure development in some locations.
- **Potential to use seawater cooling** - Depending on the location, seawater cooling may be viable option to air cooling.
- **Project construction control** - The logistics of getting a skilled workforce to an onshore LNG construction site and keeping them there can be hugely challenging. Near shore facilities can be built in established yards with established labour forces
- **Regulatory** - Specific to the US but possibly applicable in other locations, near shore projects will be administered under Maritime Administration (MARAD) rather than FERC, providing the opportunity for reduced permitting timelines.

In some cases, the choice may be between a near shore floating system or no project at all. With the market changing, companies are innovating in response to these new demands. The fundamental attributes of efficiency, emissions, reliability, flexibility, safety, simplicity and cost must get attention when

developing a near shore LNG project.

When purchasing third party gas, efficiency stands out as a necessity and also represents an excursion from other traditional full offshore remote FLNG solutions. Proponent economics will be best optimised when efficiency is provided with a high degree of consideration in near shore liquefaction technology selection, he concluded.

'PRELUDE' ON SITE

One of the most ambitious and expensive projects was the 'Prelude' FLNG. This giant structure was towed recently from the Samsung Heavy Industries Geoje shipyard in South Korea to its location off Western Australia. The FLNG was constructed by a consortium involving Technip and Samsung at the yard.

'Prelude' is a 488 m long floating structure, which will be of 600,000 tonnes when all the tanks are full. It will extract and liquefy gas at sea, before exporting the LNG worldwide. The structure is now located about 475 km north-north east of Broome in Western Australia.

Shell Australia Chairman Zoe Yujnovich said the arrival of the 'Prelude FLNG' facility signalled a new era for the Australian LNG export industry, with the first floating liquefaction facility deployed in local waters.

"Prelude's arrival is a clear demonstration of Shell's long standing commitment to investment and development in Australia – delivering significant economic benefits to the nation," she said at the time of the vessel's arrival.

Ms Yujnovich said Shell had awarded a majority of 'Prelude' contracts to Australian concerns, including local engineering company Monadelphous, which was chosen to provide maintenance and modification services valued at \$200 mill.

"Prelude' is an Australian project and Shell has recognised how important it is to build strong partnerships with Australian industry," she said. "To develop and maintain a safe, high performance culture on the facility, Shell has partnered with South Metropolitan TAFE in Western Australia to develop specific training for 'Prelude' technicians.

"One hundred and fifty technicians have been trained across a broad range of critical skills, including helicopter landing and refuelling skills, rigging, scaffolding and first aid. West Australian based company CIVMEC, a construction and engineering services provider, constructed the four massive anchor piles for 'Prelude's' subsea flow lines from their facility in Henderson," she added.

The project will employ 260 local workers on board the facility during operations and create over a 1,500 jobs during the hook-up and commissioning phase. Shell said that it expected to see cash flow from the project next year.

In its second quarter presentation, Golar said that OneLNG's Fortuna joint venture, involving the conversion of the 'Gandria' has executed an Umbrella Agreement with the Republic of Equatorial Guinea to establish the fiscal and legal framework for the Fortuna FLNG project. The project's final investment decision (FID) is now expected during the second half of this year.

FLNG BUSINESS MODEL

Golar said that the rate of offshore natural gas discoveries has soared in recent years. There are estimated to be at least 300,000 bill cu ft of natural gas lying in offshore fields – of which 40% is estimated to be stranded. 'Stranded gas' means gas that would not be viable to extract using established methods.

Locating the liquefaction process offshore on a vessel can dramatically reduce the cost per MMBTU of liquefying gas.

Energy at work



FORTIS BC™



Image courtesy of Seaspan Ferries Corporation

Clean, competitively priced LNG

FortisBC's high-capacity LNG facilities are strategically located near ports, water channels and the Pacific Ocean. We can help you get on board with our competitive LNG pricing, incentive programs and our truck-to-ship onboard LNG bunkering system—the first of its kind in the world.

That's energy at work.

fortisbc.com/LNGshipping

Converting a vessel in a specialised shipyard, where the skills and resources are already at hand and do not need to be brought in, is much quicker and cheaper than building a facility in remote parts of the world that lack the essential infrastructure necessary to get started.

With an FLNG model, Golar said that a mega-gas field is no longer a prerequisite to monetisation. By using this model, it is now easier to sell small parcels of gas without flooding the market, as it is no longer necessary to find a large number of buyers at once.

Golar's FLNG solution is based on the conversion of a Moss type LNGC fitted with Black & Veatch (B&V) liquefaction technology and connected to a client-specified mooring system. The patented B&V PRICO process uses a single mixed refrigerant technology that is simple, reliable and efficient.

B&V has developed more than 30 operating LNG production facilities globally and most of them use this process. This process also has a small enough footprint that

it can be mounted on a vessel. The first marine-mounted PRICO process was successfully commissioned in 2016.

In addition, Golar LNG Limited and Golar Partners have entered into a purchase option agreement for the latter to acquire up to a 25% interest in FLNG 'Hilli Episeyo'.

LNG bunkers were ordered for a mid-September delivery to 'Hilli Episeyo' in Singapore ahead of her departure for Cameroon in late September/early October, Golar said.

Subsequently, the Fortuna joint venture awarded LNG offtake to the Gunvor Group.

All parties agreed the principal commercial terms subject to finalising a Sale and Purchase Agreement (SPA) for the offtake ahead of Fortuna FLNG's FID.

Gunvor is committed to take the full contract capacity of the 'Gandria' FLNG 'of 2.2 mill tonnes per annum, which will be purchased on a Brent-linked, Free on Board (FOB) basis for a 10 year term.

The contract structure allows flexibility for up to 1.1 mill tonnes per year of the Fortuna capacity to be marketed on an alternate basis.

Consequently, the agreement gives the Fortuna partners, alongside the State of Equatorial Guinea, the potential to sell volumes to higher priced gas markets in Africa and beyond, whilst retaining a share in the profits of onward marketing.

With the identification of a preferred LNG buyer now achieved, the last significant milestone prior to the FID of the Fortuna FLNG project is the completion of the project funding, with FID remaining on track for this year, Golar said.

Meanwhile, EXMAR took delivery of the 16,100 cu m FLNG 'Caribbean FLNG' (CFLNG) on 27th July, 2017.

The financing of the unit was concluded with Bank of China, Deutsche Bank and Sinosure for a \$200 mill facility.

The CFLNG is currently laid up at the Wison shipyard at Nantong in China, where it was built, following the collapse of an earlier charter.

EXMAR said recently it was still in dialogue with several interested parties for its charter but no revenue was expected before the second half of 2018. ■



HIPAC^{CC-V}



LNG Pipe Supports: Clever Thinking leads to Innovative Line-Stop Design

- Support Installation Independent from Existing Steel Structure
- Superior Clash Free Clamping Design
- Standard Product Range Facilitates Engineering Process
- High Performance to Weight Ratio for Steel Cradles
- Clamping Forces Engineered for Lifetime
- Surpasses the Requirements of the Latest Industry Standards
- Extensive In-House Product Testing Facilities

YOUR BENEFITS:
Outstanding Product Quality
Savings in Site Installation
Reduced Total Cost of Ownership

Having **50 years of experience**, well established as the world market leader in pipe supports, LISEGA provides a full range of standardized as well as custom designed high quality products whilst **keeping delivery promises**.

References available on request.

To complete the product package, the LISEGA Group provides **world-wide after sales service** including training for installation contractors, technical assistance and site supervision.

Interested in project cost savings and want to know more about our innovative technology?

Please contact: cryo-sales@lisega.com

LISEGA
 performance with system

LISEGA SE - Germany
 Hochkamp 5 - 27404 Zeven - Postfach 1357 - 27393 Zeven
 Tel.: +49 (0) 42 81-713-0 - Fax: +49 (0) 42 81-713-214
 E-Mail: cryo-sales@lisega.com - www.lisega.de

FSRUs gain in popularity due to their quick fix ability

The idea of using an FSRU as an import terminal has gained considerable momentum in the past year or so.

They would seem to be a favourite of the less developed countries, as FSRUs are perceived to be a cheaper and quicker option to building onshore receiving terminals.

They are also proving to be the preferred import method for new gas market entrants, as the majority of new LNG importers are either using or thinking of using FSRUs for regasification, Höegh LNG said recently in a presentation.

Although many are newbuilds, some are conversions from conventional LNGCs and can be built or converted for a specific function in 18 months to three years.

FSRU tendering activity remains high, with unabated interest in most geographical markets.

This high level of FSRU activity generates interest among potential new entrants, and competition is therefore likely to increase.

Recent news that Mitsui OSK Lines (MOL) had signed an agreement with an Indian group for the long-term operation of an FSRU, plus an FSU, and a recent visit to Höegh LNG's offices in Oslo, prompted *LNG Shipping Review* to look at the state of play in this particular niche segment of the market.

As for MOL, the Japanese conglomerate recently joined Swan LNG Private Limited to invest in an FSRU and an FSU, which will

serve as the main facilities for an LNG receiving terminal to be developed by Swan Energy at Jafrabad, Gujarat State, India.

The FSRU has been ordered at Hyundai Heavy Industries and will be owned by Swan Energy, through a subsidiary. MOL has an option to participate in a joint ownership project, which is exercisable any time before the delivery of the FSRU, scheduled for 2019.

In addition, MOL will invest in Swan LNG and act as the technical partner in many of the project's operations.

The terminal's facilities will include a 180,000 cu m FSRU, a 135,000-145,000 cu m FSU, a breakwater, jetty mooring and onshore facilities. The terminal will have an LNG receiving capacity of 5 mill tonnes per year and is due to start operations in early 2020.

MOL said that in general, FSRUs were becoming more popular, due to their flexibility and mobility in the LNG supply chain and as a result, the company said it planned to promote FSRU opportunities worldwide.

The company is already one of world's largest LNGC operators and is the only Japanese FSRU owner and operator, thus far, with the 'Punta de Sayago' in Uruguay, which is based on a Q-Max hull.

Black & Veatch was awarded the EPC contract for this terminal.

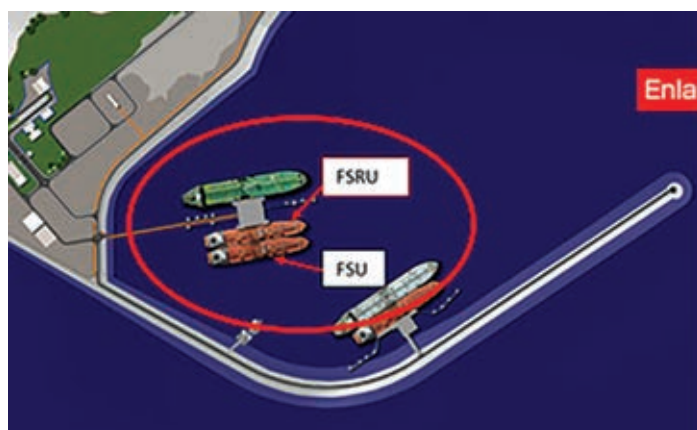
There have been several reports produced on FSRUs and one of the latest, published by The Oxford Institute for Energy Studies and authored by Brian Songhurst, claimed there were 26 in operation as of the beginning of July this year, of which three were being used as standard LNGCs.

There are another 10 on order with a further 10 known to be on option. A recent IGU report suggested that there could be close to 50 in operation by 2025. There were also thought to be around 67 projects under discussion that could involve the use of FSRUs.

LOW COST OPTION

They provide a low cost option, compared to a fixed onshore import terminal, fast track and flexible by way of being able to be moved to another location, once the operation has finished.

FSRUs are normally leased and are mainly used as flexible pipelines to supply gas quickly, cheaply and on a short term lease contract basis to developing markets. This was recently demonstrated in Egypt where gas delivery was executed in just five months from issue of the tender documents, compared with an onshore terminal, which is a sunk cost and typically takes four to five years to construct, the Oxford report said.



MOL is to invest in an FSRU and FSU project in India.



Many of the current and planned FSRUs are involved with the rapidly increasing gas-to-power market, where there is no access to existing gas infrastructure.

This confidence is demonstrated by the owners ordering new vessels at a cost of up to \$250 mill each on a speculative basis, the report said. The average size of a unit today is around 173,000 cu m storage capacity, able to produce around 6 mill tonnes of LNG per year.

The speed of setting up a terminal using an FSRU is illustrated by the time it takes to build a unit from scratch - normally around 27-36 months - while a \$80 mill- \$100 mill LNGC conversion will only usually take about

18 months to complete.

In addition to FSRUs, there are currently four LNG FSUs in operation, plus one newbuilding.

The largest FSRU owner in terms of the number of vessels in operation is Excelerate Energy with around nine FSRUs, three of which are currently trading as normal LNGCs. In addition, Excelerate has another eight 173,400 cu m units on order at Daewoo Shipbuilding (DSME), which can be purpose-built for a particular project.

Four of the FSRUs in operation are jointly owned by EXMAR and are long term chartered to Excelerate. These units are

operated and maintained by EXMAR Ship Management.

Golar has seven FSRUs and another of 170,000 cu m, due for delivery from Samsung in December this year.

Also on seven is Höegh LNG. This Oslo-based company also has three on order, plus several other options, making it the largest in terms of units operating as pure FSRUs. The company said that by 2019, it wants to own 12, either operational or under construction.

The company also said that in order to boost LNG uptake, producers have embraced the FSRU concept to open up new markets, illustrated by Nakilat's decision to team up with Höegh LNG to pursue FSRU opportunities.

Current Terminals

Terminal	Location	Current Vessel	Storage m3	Nominal mmscfd	Nominal mtpa	Start-up
Bahia Blanca	Argentina	Excelsior	138,000	500	4.1	2008
Pecem	Brazil	Golar Spirit	129,000	240	2.0	2008
Guanabara Bay	Brazil	Experience (prior 2014 other vessels)	173,400	700	5.8	2009
Buenos Aires	Argentina	Exemplar	149,700	500	4.1	2011
Jakarta Bay	Indonesia	Nusantara Regas Satu	125,000	485	4.0	2012
Heidera	Israel	Excellence	138,000	500	4.1	2013
Tianjin	China	Neo Energy (Replaced Suez Cape Ann)	149,700	500	4.1	2013
Bahia, Salvador	Brazil	Golar Winter	138,000	500	4.1	2014
Mina Al Ahmadi Port	Kuwait	Golar Igloo	170,000	500	4.1	2014
Klaipeda	Lithuania	Independence	170,000	384	3.2	2014
Lampung, Sumatra	Indonesia	PGN Lampung	170,000	360	3.0	2014
Offshore Livorno	Italy	FSRU Toscana (Golar Frost)	137,500	530	4.4	2014
Jebel Ali	Dubai	Explorer (Replaced Golar Freeze)	151,000	500	4.1	2015
Port Qasim 1	Pakistan	Exquisite	151,000	500	4.1	2015
Ain Sokhna 1	Egypt	Gallant	170,000	500	4.1	2015
Aqaba	Jordan	Golar Eskimo	160,000	500	4.1	2015
Ain Sokhna 2	Egypt	BW Singapore	170,000	500	4.1	2016
Ruwais	Abu Dhabi	Excelerate	138,000	500	4.1	2016
Aliaga, Izmir	Turkey	FSRU Neptune (GdF Suez Neptune)	145,000	500	4.1	2016
Cartagena	Colombia	Grace	170,000	500	4.1	2017
Aguirre	Puerto Rico	Expedient (Proposed)	138,000	500	4.1	2018
Punta de Sayago	Uruguay	GNL Del Plata	263,000	500	4.1	2018
Tema	Ghana	Golar Tundra (Pending Final Contract)	170,000	350	2.9	2018

Source: The Oxford Institute for Energy Studies, Brian Songhurst.

NEW ENTRANTS

A majority of the new LNG importers are using FSRUs for regasification purposes and therefore, competition is likely to increase, Höegh LNG said, as FSRUs have become the preferred alternative for new market entrants.

The company further said that it will continue its policy of expanding its newbuilding portfolio on the basis of further contract awards and to maintain its strategy of having one uncommitted FSRU under construction to meet a tight timeline for future projects, thus saving costs.

With a solid operational and financial platform in place and backed by a positive market environment, Höegh LNG said that it was continuing to pursue additional business opportunities.

The company also confirmed that it was focusing on preparing for the three long-term FSRU contracts awarded to Höegh LNG in Ghana, Pakistan and Chile, and for optimising interim employment periods.

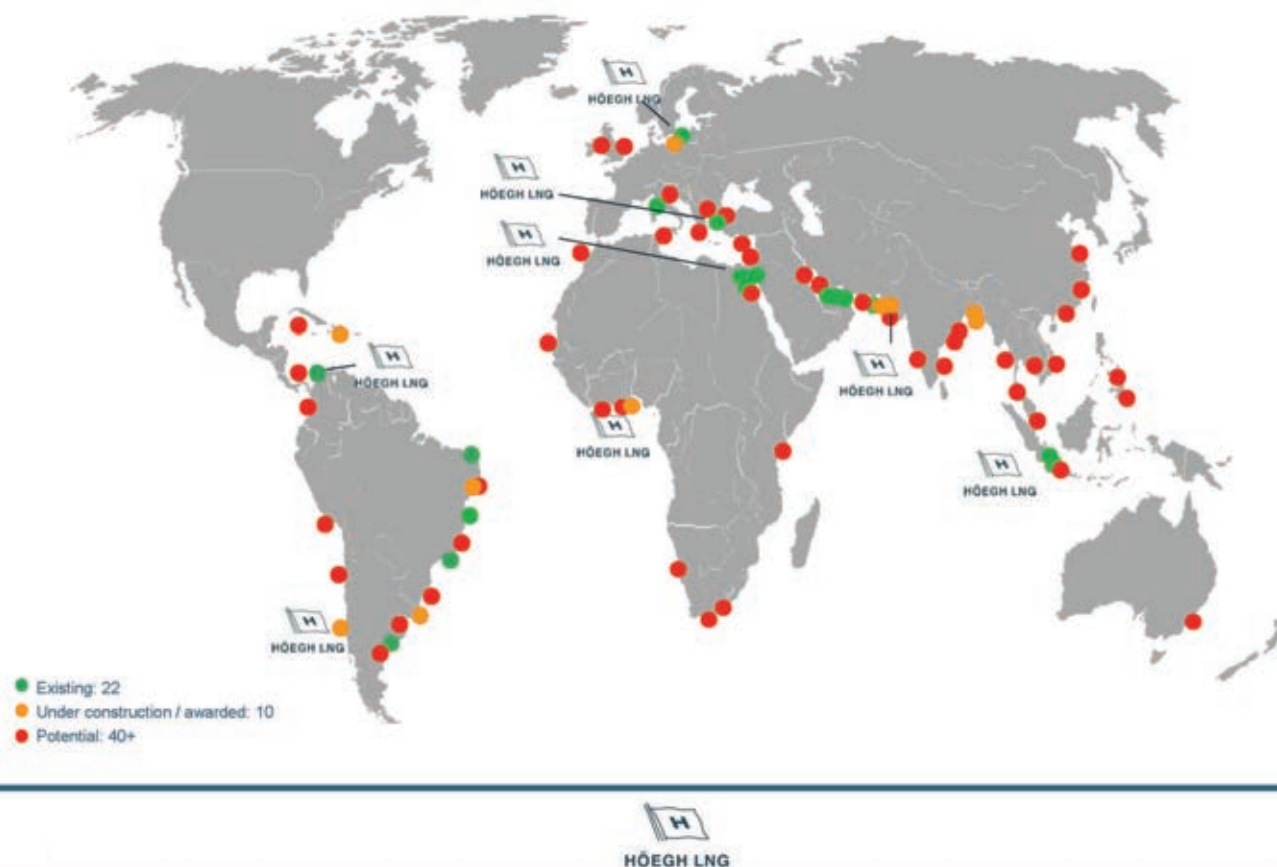
Subsequent to the publication of this report, Höegh had agreed to increase its equity stake in the companies owning the 'Neptune' and 'GdF Suez Cape Ann', the majority of which is held by MOL. However, *LNG Shipping Review* has since learnt that this move has been postponed. This would have increased Höegh's interest in the joint ventures to 73.5%.

Another major LNGC player, GasLog is also making progress with an FSRU strategy and is actively involved in a number of projects, the company said.

In particular, the FEED study for the Alexandroupolis project in Greece, should be completed in the third quarter of this year.

As a shareholder in operator Gastrade, GasLog said it was advancing discussions with potential offtakers, with both the Greek and Bulgarian national energy companies expected

Pipeline of around 40 projects around the globe



Around 40 projects worldwide. Source: Höegh LNG.

to play a major role. Gastrade is expected to take a FID in early 2018.

In December, 2016, GasLog entered into a sale and purchase agreement (SPA) to acquire a 20% shareholding in Gastrade, a private limited company licensed to develop an independent natural gas system offshore Alexandroupolis in Northern Greece using an FSRU along with other fixed infrastructure.

This acquisition closed on 9th February, 2017, the company said.

Keppel Shipyard Limited began ordering long lead items required for the conversion of a GasLog or GasLog Partners LNGC to an FSRU a few months ago.

GAS-TO-POWER

Gas-to-power generation is another area that an FSRU can be used, either an existing unit, or a purpose-built barge.

Illustrating this potential, in August, Summit Power International, a Singapore

incorporated power producer, announced plans to collaborate in the development of a \$1 billion gas-to-power generation project, which will include an offshore liquefied natural gas import terminal, in Bangladesh.

IFC, a member of the World Bank Group, was engaged as the lead arranger for financing to develop the Meghnaghat II natural gas based combined cycle power plant. Upon completion, Summit will have a total installed generating capacity of over 3,000 MW.

SHI showcases glycol regas system

Samsung Heavy Industries (SHI) has unveiled an in-house LNG regasification system for FSRUs.

SHI showcased the system, called S-Regas(GI), to 40 representatives from 19 shipowner companies, including FSRU owners, such as Golar LNG, Höegh LNG and GasLog.

The new system utilises glycol to regasify LNG into gas and is SHI's latest

regasification equipment, following the direct sea water regasification system launched earlier.

SHI said that S-Regas(GI) reduces the chance of corrosion from the traditional method of heating LNG directly with seawater and saves energy by 5%.

In-house regasification system enable not only cost savings but also improvement in schedule and quality management, SHI claimed.

An SHI representative said "In-house development of the LNG regasification system improves LNG-FSRU's safety and performance.

"SHI will continue to lead market by developing the next generation technologies in the whole LNG value chain. With proven track record and experience we will meet customer's needs such as saving operating costs of LNG-FSRU and solid performance," he added. ■

To enable clean, sustainable power, Summit said it will charter an FSRU from Excelerate Energy for LNG storage and regasification services.

To progress the project, GE, through GE Capital's Energy Financial Services and Summit have entered into a Memorandum of Understanding (MOU) for GE to potentially provide \$50 mill of equity to Summit, to be used for the development of power projects in Bangladesh.

In addition, GE Gas Power Systems will have right to supply equipment for the power projects based on gas turbine technology developed in the next 36 months by Summit.

To make gas available for these projects, Summit LNG Terminal Company (SLTC) will sign an FSRU timecharter agreement for 15 years with Excelerate Energy for the provision of one of Excelerate's existing FSRUs.

At the signing ceremony, Karlman Tham, Excelerate general manager, said: "We are pleased to be partnering with Summit on this very important project. We are confident our experience and expertise in FSRUs will ensure an efficient and reliable project for Bangladesh for the years to come."

As for BW Gas, following the signing of a 15-year agreement with Pakistan GasPort Limited (PGPL) to provide LNG regasification services using a newbuild FSRU for a second Pakistan LNG terminal, BW held a ship naming ceremony last January at Samsung for its second FSRU, the 'BW Integrity'.

EGYPTIAN CONTRACT

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

Last year, BW Gas converted an LNGC order into a third FSRU at DSME, which is



STS transfer Neptune Turkey.

scheduled for delivery in November, 2019.

The largest FSRU project in terms of ship size is Fox Petroleum's contract with Hyundai Heavy Industries for the construction of a 330,000 cu m unit to serve the \$1.05 bill Karnataka LNG development located at Karwar in southwest India.

A Memorandum of Understanding (MoU) was signed with the Karnataka State Government in April, 2016 for the project and the vessel was ordered earlier this year.

The \$560 mill contract will see Hyundai build Asia's largest FSRU, with an annual processing capacity of 28.3 mill cu m. It is expected to be completed by late-2018, after which it will moored in 40 m of water.

Among the other owners involved in FSRU projects are Maran Gas Maritime, Bumi Armada and Teekay LNG.

Maran Gas reportedly firmed up an 173,400 cu m FSRU at DSME earlier this year

for 2020 delivery. At the time, it was thought that the vessel was ordered without a contract.

Bumi Armada was responsible for an LNGC conversion project, which is now moored at Marsaxlokk, Malta, operating as an FSU for a nearby power plant.

As for Teekay LNG, in late 2015, this Teekay Corp daughter company entered into a joint venture partnership with The National Oil & Gas Authority (NOGA) of Bahrain, Gulf Investment Corporation (GIC) and Samsung Construction and Trading (SCT) to form a company called Bahrain LNG (BLNG).

The new venture has been contracted to deliver an LNG import terminal in Bahrain to NOGA, with a commercial start date in 2019 for 20 years.

The terminal layout comprises of an offshore dual jetty and regasification module, which is protected by a 600 m long breakwater, a subsea pipeline to shore and onshore infrastructure to allow the gas to be delivered to the onshore delivery point.

Teekay LNG will provide the FSU 'Bahrain Spirit' for the project, thus securing one of the company's DSME newbuildings on a long-term charter, the company said.

Most of the potential projects for FSRUs come in two capacity tranches - smaller units of between 1.7 mill - 2.5 mill tonnes per annum units and larger vessels of 4 mill to 6 mill tonnes per annum capacity.

The Oxford Institute report said there could be another 25 FSRUs delivered in the next eight years - some three per year. Illustrating their popularity was the number of speculative newbuilding deals, either firm or Letters of Intent, for around \$250 mill per unit. ■



'Neptune' is located at Aliaga, near Izmir.



شركة ناقلات كيبييل للأعمال البحرية المحدودة
Nakilat - Keppel Offshore & Marine Ltd

PREFERRED DELIVERING SHIPYARD SOLUTIONS

Nakilat-Keppel Offshore & Marine (N-KOM) is a joint-venture between Nakilat and Keppel Offshore & Marine. To date the Qatar-based facility has completed more than 600 marine and offshore projects for various major shipping and oil and gas companies. Located within the world-class Erhama bin Jaber Al Jalahma Shipyard in Ras Laffan Industrial City, N-KOM has proven its expertise and infrastructure to undertake a wide range of marine and offshore services for all types of marine vessels and offshore structures.



SERVICES:

- ◆ Ship repair & conversion
- ◆ Construction and repair of offshore structures
- ◆ Gas & green shipping solutions
- ◆ Mobile repair squad

FACILITIES:

Drydock 1 ◆

360m x 66m x 11m (350,000dwt)

Drydock 2 ◆

400m x 80m x 12m (450,000dwt)

Floating Dock (Q-Max size) ◆

405m x 66m, Lifting Capacity: 120,000T

Berthage ◆

8 quays and piers of 3,000m & 1 loading quay of 150m

Cranes (15 nos.) ◆

8 x 30T, 3 x 50T, 4 x 100T

Mobile Hoists ◆

300T & 1,100T



www.nkom.com.qa



commercial@nkom.com.qa

LNG fuel project take up slowly increases

As 2020 approaches, the shipping industry is beginning to realise that the time is running out to do something about the IMO's 0.5% sulfur cap.

Running on LNG is one of the three main options, the others being the fitting of scrubbers or opt to operate on distillates. Earlier forecasts of a massive swing towards LNG as a fuel has not materialised as quickly as was first thought.

However, there has been a gradual movement towards catering for LNG by the bunker sector, owners and operators and the ports. This is mainly occurring for short sea operations with deepsea operators keeping their options open by ordering vessels fitted with propulsion machinery that can easily be switched to burn on LNG, or choosing dual-fuel engines.

The class societies and the IMO have issued guidelines for vessels running on LNG, as the industry moves tentatively in that direction.

Since the IMO announced a global sulfur emission limit of 0.5%, shipowners have been faced with making tough decisions ahead of the impending deadline.

Amongst the limited options is to invest in tonnage capable of burning LNG as a marine fuel. The decision has been widely embraced by vessels currently operating in ECAs, however, the global merchant fleet has so far not been so enthusiastic in choosing a path, Gibson Shipbrokers said in a report.

Excluding LNGCs, the global merchant fleet of dual-fuel vessels (capable of burning LNG bunkers) has grown considerably since 2014. Although a fairly insignificant portion of the global fleet, the current orderbook for dual-fuel vessels also shows some considerable growth.

Some significant orders have included Sovcomflot's four Ice Class Aframaxes and AET's order of four Aframaxes in addition to two Aframaxes and three MRs capable of switching to LNG bunkers currently trading.

The majority of LNG bunker ready ports are located in the Baltic and North Sea, where Norway has the largest with six, mostly catering to ferries and cruise ships. However, new bunkering facilities or upgrades are

planned in the Netherlands, France, Belgium and Spain.

Repsol in co-operation with Enagás, has completed what is considered to be Europe's first pipe-to-ship LNG bunkering at the Cartagena regasification terminal. Furthermore, Fujairah, the second-largest bunkering port globally, has begun strengthening infrastructure whilst introducing LNG ship-to-ship transfers, Gibson said.

The US has grasped available technology and aims to take advantage of an abundance of cheap gas to push forward plans for LNG bunkering.

Further afield in Asia, momentum is gathering to remove obstacles standing in the way of a widespread implementation of LNG as a marine fuel. The Japanese port of Yokohama can provide truck-to-ship bunkering, and is planning to introduce ship-to-ship bunkering by 2020, positioning Yokohama as a regional LNG bunkering hub.

South Korea now provides LNG bunkering services from Incheon with an additional facility planned at Busan. China will also be increasing LNG services for inland waterways and at Zhoushan.

Not surprisingly, given its position as the world's largest bunkering port, Singapore has also made big strides. The Maritime and Port Authority of Singapore (MPA) has awarded two separate LNG bunkering licenses and expects to begin supplying LNG bunkers this year. Singapore has also joined forces with other global ports to progress and harmonise LNG bunkering standards and operations.

Oil majors, including Shell, BP, Chevron and Total have invested heavily in downstream LNG distribution and infrastructure. Shell in particular is taking an active role as evidenced by the agreement to supply bunkers to Sovcomflot's newbuilding Aframaxes for the North Sea and Baltic.

Advantages in LNG over conventional marine fuels are the improved emissions performance when compared with scrubbers or burning low sulfur fuels. LNG has zero

sulfur content and relatively low levels of NOx emissions.

This has led some to declare LNG as 'future proof' against any future reductions in sulfur emission levels. However, downsides are the unknown cost of LNG bunkers and additional construction and containment costs on board, as well as ashore. Another significant drawback is that LNG will require around twice the storage space of marine fuel on a vessel, thus reducing cargo intake.

There are several pros and cons with LNG bunkering but expect it to become a more viable alternative in the coming years. With the dual-fuel capable fleet forecast to grow and major strides being made by ports to harmonise operations and improve global standards, perhaps we will see an increasing number of owners turn to LNG as a viable marine fuel in the future, Gibson said.

FINANCE PROGRAMME

In Germany, the Federal Ministry of Transport and Digital Infrastructure has announced a new financing programme for LNG-fuelled ships in an effort to support the use of natural gas as marine fuel.

Enak Ferlemann, Parliamentary State Secretary at the Ministry said that Germany is one of the world's largest shipping nations and the goal is to keep the top position. Therefore, the country supports the introduction of innovative technologies. With the new programme, the Ministry is trying to speed up the use of alternative fuels in shipping, pursuing the goal of fewer emissions, especially in the context of the upcoming environmental regulations.

Shipowners with a vessel in operation or planning to build a new vessel, as well as bodies governed by public law, are eligible to apply.

The funding encompasses equipping newbuildings with LNG propulsion systems and upgrading existing ships to be fitted with dual-fuel machinery.

The German Shipowners' Association (VDR) welcomed the government's initiative and said that the programme will help



The 'Wes Amelie' conversion was undertaken with the help of German Government finance.

shipping companies bear the costs of LNG-powered vessels, given that retrofitting or building vessels with LNG propulsion machinery is more expensive.

The new financing scheme was announced following the launch of the world's first containership converted to LNG, 'Wes Amelie'. The 1,000 TEU feeder is German-owned and underwent an LNG engine conversion at Bremerhaven. The conversion was supported by the Ministry.

One of the main obstacles to the accelerated uptake of LNG is the uncertainty regarding future market volumes for LNG.

DNV GL attempted to address this issue in a recent study on the future LNG market in the Iberian Peninsula, as part of driving the development of an EU-wide network of LNG refuelling points.

DNV GL conducted the market study on behalf of the six-year CORE LNGas Hive project, which aims to provide an investment plan for LNG fuelling in Spain and Portugal. The €33 mill project is co-ordinated by Enagas and co-funded by the European Commission.

DNV GL study forecast the potential future demand for LNG as a fuel and the future infrastructure needed for the areas

around Spain and Portugal, covering the Mediterranean, Atlantic and Gibraltar Strait regions.

The results of DNV GL's analyses have since contributed to the CORE LNGas Hive project's recommendations for the development of an LNG supply chain infrastructure, involving over 40 ports in the area.

Fernando Impuesto, CORE LNGas hive project co-ordinator from Enagas, said: "The consortium partners selected DNV GL to execute the demand studies of the project based on the fact that DNV GL has been at the forefront of the development of LNG as a ship fuel.

"DNV GL's network and market knowledge have added to a successful outcome. Through this market study, we now have a strong decision basis to prepare the supply side on the Iberian Peninsula in meeting future demand for LNG bunkering at competitive conditions," he said.

Despite LNG fuelled shipping being high on the agenda in the maritime industry, the market drivers have changed. From previously being encouraged by the lower price of LNG compensating for the added cost for installing

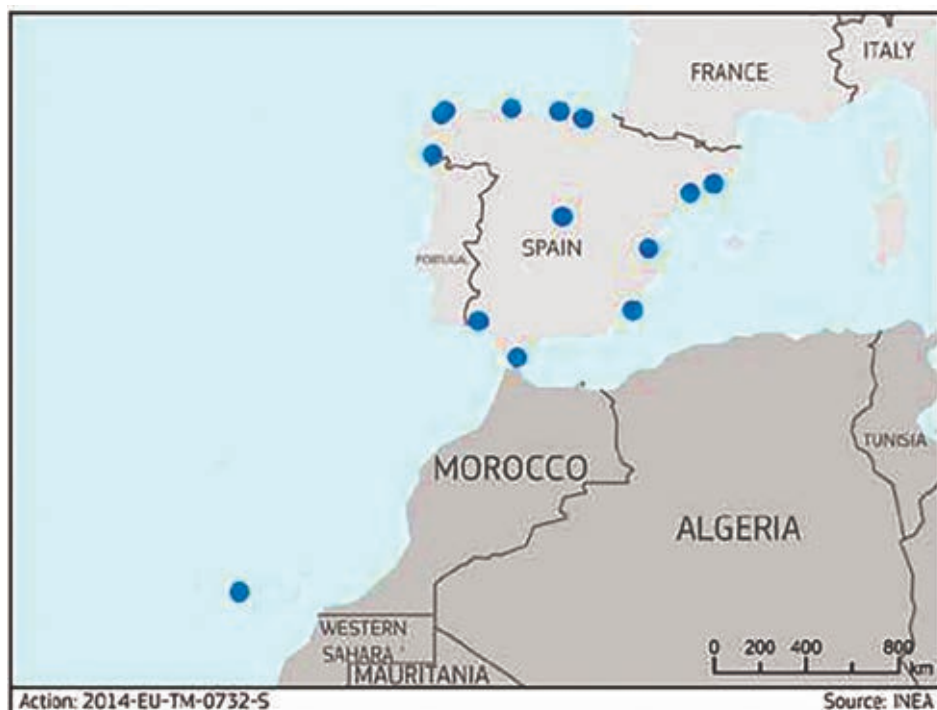
new equipment, results from interviews conducted by DNV GL indicated a shift towards compliance with emissions regulations to be the main motivator.

The study has revealed a huge potential for LNG as a marine fuel that will use the current spare capacity of the existing LNG import terminals around the Iberian peninsula. The consolidated quantitative results show that by 2030 up to 2 mill cu m per year of LNG will be used as bunker fuel by ships - with Algeciras, Las Palmas and Barcelona the most important bunkering ports - and by 2050 around 8 mill cu m per year of LNG will be needed.

On the logistical side, the market study further concluded that existing LNG terminals will need to develop breakbulk capacity to allow for loading LNG onto small LNGCs and gas bunkering vessels.

In most ports, development of local intermediate storage capacity needs to be synchronised with increasing LNG demand by larger vessels. Besides bunker stations and local storage facilities, small-scale LNGCs used for delivering LNG cargoes to other ports will play an important role in the years ahead.

However, in order to realise the predicted



DNV GL has undertaken a study on the potential for LNG bunkering at Iberian ports.

LNG supply chain in 2030, about €1 bill of capital expenditures (CAPEX) investment will be needed, going up to around €3.7 bill in 2050, the study showed.

Liv Hovem, DNV GL's recently appointed CEO of the Oil & Gas division, said: "DNV GL's market study has clearly shown the major potential LNG has as a fuel in the region. We hope that the conclusions from our study will help shipowners, natural gas suppliers, bunker companies, port authorities and LNG terminal operators gain the confidence they need to move forward with

LNG as a fuel for a more sustainable shipping industry."

The six-year CORE LNGas hive project is co-funded by the European Commission and is scheduled for completion by December, 2020.

The project will provide recommendations to the National Policy Framework (NPF) as to the demand for LNG as a maritime fuel in Spain and Portugal on the deployment of alternative fuels infrastructure.

It also aims to provide an investment plan for scaling associated project results.

COLLABORATIVE PROJECTS

To push the idea of using LNG as a fuel, several co-operative agreements have been signed at a high level, including country level.

For example, to promote LNG bunkering in Asia, the Maritime and Port Authority of Singapore (MPA) and the Ports and Harbours Bureau of the Ministry of Land, Infrastructure, Transport, and Tourism of Japan (MLIT) will lead a working group put together to conduct a feasibility study on LNG bunkering for car carriers plying between Japan and Singapore.

This working group will include Japan's big three shipowners – Kawasaki Kisen Kaisha (K Line), Nippon Yusen Kaisha (NYK) and Mitsui OSK Lines (MOL).

The study will focus on the technical details, such as fuel tank capacities and refuelling requirements to assess the feasibility of running LNG-fuelled car carriers between Japan and Singapore.

The joint feasibility study was announced

at the inaugural Singapore and Japan Port Seminar 2017 held in Singapore at the end of August. The study will be one of the activities jointly undertaken by MPA and MLIT under the Memorandum of Co-operation (MOC) signed between MPA and MLIT in April, 2017. The MOC is aimed at co-operation between the two entities in areas, such as port planning, port management and technological development in the port sector.

Both countries said that they are ready to provide LNG bunkering operations using trucks and are now looking into the next phase of LNG bunkering for deepsea vessels.

MPA and MLIT also signed a multilateral Memorandum of Understanding, concluded in Singapore in October, 2016, to widen the network of LNG bunker-ready ports in Europe, US and Asia.

The two countries enjoy a strong working relationship at international and regional forums, such as the IMO and the Co-operative Mechanism on Safety of Navigation and Environmental Protection in the Straits of Malacca and Singapore.

In addition, to strengthen the network of LNG bunker-ready ports and to bolster efforts towards enabling the uptake of LNG as marine fuel, in July the Port of Ningbo-Zhoushan, Port of Marseille/Fos, and Port of Vancouver joined the Port of Singapore and seven other organisations to participate in an international LNG bunkering port focus group.

The inclusion of Ningbo-Zhoushan brings the network up to 11 ports and maritime administrations across Asia, Europe and North America.

This focus group was first formed in 2014 by the MPA, Antwerp Port Authority, Port of Rotterdam and Port of Zeebrugge. In 2016, Asian representation in the LNG bunkering focus group increased with the joining of MLIT and Ulsan Port Authority, South Korea.

Through the signing of a MoU in Singapore on 5th October, 2016, all of the focus group members committed to work together to deepen co-operation and information sharing in relation to LNG bunkering, to develop a network of LNG bunker-ready ports across the East and West and Transpacific trade.

The first meeting was held in April, 2017 in Yokohama, Japan, where the focus group agreed to focus on collaborative efforts to enabling the uptake of LNG as bunkers globally.

Inaugurated by MPA in 2015, the Port Authorities Round Table (PAR) is described as a key platform for port authority heads to come together to discuss key issues of mutual



DNV GL's Liv Hovem led the study.

interests, exchange best practices and promote closer collaboration.

The 3rd PAR was organised by the Ningbo Municipal Port Administration Bureau in July, 2017. The first and second PARs were organised by Singapore and Rotterdam in 2015 and 2016, respectively.

PAR2017@Ningbo saw 14 organisations participating in the event, including Port and Urban Projects Bureau, Kobe City Government, Port and Harbour Bureau, City of Yokohama, Port of Le Havre and Port of Dalian Authority who participated for the first time.

The focus group, which initially comprised the MPA, Port of Rotterdam, Antwerp Port Authority and Port of Zeebrugge, first came together in 2014 to discuss harmonising LNG bunkering standards and procedures for international shipping.

In early 2016, the Norwegian Maritime Authority and Jacksonville Chamber (representing Port of Jacksonville) joined the group.

A set of harmonised LNG bunkering standards developed by the six members was launched in October, 2016 to provide a guide to ports which were seeking to be LNG bunker-ready.

There were several reports of LNG projects, concepts and actual orders reported recently, including South Korea's launching of a pilot scheme to build the world's largest LNG powered vessel.

The South Korean Ministry of Marine and Fisheries said it will join forces with local shipyards, builders and state institutes to develop 180,000 dwt LNG-propelled vessels.

A Government task force was launched last January incorporating local companies to develop this emerging marine transport sector to comply with the IMO's 2020 sulfur cap on bunkers.

South Korean shipyards have the expertise in building LNGCs, LNG-fuelled ships and bunkering vessels but are still in the early stages when it comes to LNG-powered ships and bunkering infrastructure. Only one LNG-propelled vessel is currently operating in South Korea.

Recently, POSCO, South Korea's largest steel maker, as well as the state-run Korea Gas Corporation (KOGAS), the Korea Development Bank and marine research institutes, signed an agreement with the oceans and commerce ministry to launch the pilot programme.

CRUISE SHIPS

Cruise ships and ferries also lend themselves to LNG propulsion with several projects on the drawing board or already in operation.

For example, Carnival Corp has marked the official beginning of construction for the first of its seven fully powered LNG cruise ships with a keel-laying ceremony at Seatrade Europe in Hamburg.

These new ships will be the first in the cruise industry that can use LNG to generate 100% of their power both in port and at sea. The seven ships, with delivery dates between 2018 and 2022, will be built by German and Finnish shipbuilders, Meyer Werft and Meyer Turku.

Following the introduction of 'AIDAnova' in 2018, Carnival Corp's Costa Cruises brand will take delivery of the industry's next LNG powered cruise ship in 2019. LNG-powered ships for Carnival Cruise Line and P&O Cruises (UK) will follow in 2020. Costa Cruises and AIDA Cruises will each receive an additional LNG-powered ship in 2021, followed by another LNG-powered ship for Carnival Cruise Line in 2022.

In October, 2016, Carnival Corp signed a framework agreement with Shell Western LNG (Shell) to be its supplier of marine LNG to power the first two of its new LNG ships for AIDA Cruises and Costa Cruises, which will visit European ports.

As part of the agreement, the ships will use Shell's infrastructure in cruise ports to refuel with LNG throughout their itineraries.

In 2015, as a pilot project, 'AIDAsol' from Carnival's AIDA Cruises

The advertisement features a large, stylized white 'A' logo against a background of a sunset over water. Below the logo, the text 'SIMPLICITY IS THE ULTIMATE SOPHISTICATION' and '- LEONARDO DA VINCI' is displayed. The lower half of the ad shows a blue background with white line drawings of ships and a central graphic of a ship's hull cross-section showing internal components. The text 'LEAN BRINGS YOU' is followed by a list of benefits: '+ SAFETY & RELIABILITY', '+ VERY LONG LIFETIME', '+ COST EFFICIENCY', '+ STEALTH & HSE', '+ MORE CARGO CAPACITY', and '+ LESS EMISSION AND FUEL'. The website 'WWW.STADT.NO' is at the bottom.

STADT
LEAN PROPULSION

SIMPLICITY IS THE ULTIMATE SOPHISTICATION
- LEONARDO DA VINCI

LEAN BRINGS YOU

- + SAFETY & RELIABILITY
- + VERY LONG LIFETIME
- + COST EFFICIENCY
- + STEALTH & HSE
- + MORE CARGO CAPACITY
- + LESS EMISSION AND FUEL

WWW.STADT.NO

brand was the first cruise ship in the world to be supplied with power by an LNG Hybrid barge and, last year, the newly delivered 'AIDAprima' became the first cruise ship to regularly use LNG with a dual-fuel powered engine while in port. Her sister ship, 'AIDAprila', delivered this April, was fitted with the same technology.

Other vessels have also been ordered recently with dual-fuel propulsion units fitted.

For example, US-based Keppel AmFELS, a wholly owned subsidiary of Keppel Offshore & Marine (Keppel O&M), has won a contract worth more than \$400 mill from Honolulu-based Pasha Hawaii for the construction of two LNG fuelled containerships.

The dual fuel LNG vessels will be built to Keppel's proprietary design with delivery of the first vessel expected in 1Q20, and the second vessel in 3Q20.

Customised to Pasha Hawaii's requirements, the new, 774-ft Jones Act vessels will be able to carry 2,525 TEU. The ships' hulls have been fully optimised using computational fluid dynamics (CFD).

The containerships will be able to run completely on LNG, dramatically reducing their environmental impact and increasing fuel

efficiency. Energy savings will also be achieved with a state-of-the-art engine, an optimised hull form, plus an underwater propulsion system with a high-efficiency rudder and propeller.

Located in Brownsville, Texas, Keppel AmFELS possesses comprehensive facilities, a highly-capable workforce, and a strong track record in the construction, refurbishment, conversion, life extension and repair of a variety of projects, the company claimed.

The average age of the US-built Jones Act fleet is more than 30 years, beyond the typical operating life of most ocean-going vessels. The new vessels will also be needed to meet the latest safety and environmental standards.

The first two Handysize bulkers to be powered by LNG are nearing completion at Jinling Shipyard in China.

They were ordered by ESL Shipping, a member of the Aspo Group and named 'Viikki' and 'Haaga'. The LNG-fuelled vessels will be of 160 m in length and of 26,000 dwt. They are due to start operating in the Baltic during the first half of 2018.

This construction project is part of the Bothnia Bulk project, partly funded by the EU. Its objective is to modernise the route between

Luleå, Oxelösund and Raahé. These vessels were designed in Finland, and European equipment suppliers will account for roughly 60% of the total value of the vessel investments.

To fuel the vessels, ESL has signed a contract with Skangas.

These new, Ice Class 1A ships will be the first LNG-fuelled large bulk carriers in the world, representing the latest in technology. As part of the agreement, Skangas will also deliver liquefied biogas (LBG) to ESL. LBG and LNG are interchangeable as fuel and thus the same LNG supply chain is used.

UK BUNKERING

Flogas has partnered with Associated British Ports (ABP) to bunker a ship with LNG for the first time in the UK.

This project, which mirrors similar successful schemes in other European countries, saw the 110 m cement carrier - 'Ireland', operated by Norwegian shipping firm KGJ Cement - refuelled with LNG at Immingham on 16th August.

Lee Gannon, managing director at Flogas, explained: "At Flogas, we pride ourselves on leading the way when it comes to developing

Choose industry-leading solutions for your LNG carrier fleet

Steam★
DFDE★
XDF★
ME-GI★
Regasification★
Reliquefaction★

innovation • technology • integrity





ABP's port manager for Immingham and Grimsby oversaw the bunkering operation.

the LNG industry in the UK, and exploring new opportunities for end users to benefit from this highly versatile fuel. There is great potential for LNG in the maritime industry as a more environmentally-friendly alternative to traditional oil-based bunker fuels, but until now this potential has remained untapped here in the UK."

Both Flogas and ABP said that they saw a potential to replace thousands of tonnes of heavy fuel oil each year with cleaner, cost-effective LNG.

Mark Frith, port manager for ABP Immingham and Grimsby, added: "We are proud to be a key part of this flagship operation, which has really put the UK on the map as the latest European hub for more climate-friendly bunkering. Demand is already beginning to shift away from oil across the international fleet, and we very much see natural gas taking its place as the marine fuel of choice. We look forward to welcoming increasing numbers of ships to Immingham as a result of our new and unique offering in partnership with Flogas."

The new road tanker-to-ship service provides the flexibility needed to meet current demand, but as the LNG marine market grows, Flogas will invest in storage and bunkering facilities at ABP ports when required, the company said.

GOTHENBURG CONTRACT

In Gothenburg, MAN Cryo, MAN Diesel & Turbo's marine-LNG fuel-gas-system manufacturer, has signed a contract with Swedish infrastructure company, Swedegas, to deliver an LNG bunkering facility within

the Port of Gothenburg.

This new facility will enable vessels to bunker LNG from trucks or containers, while simultaneously loading/unloading cargo at two jetties at Gothenburg's Energy Port, dispensing with the need to make a separate refuelling call. The solution will be open for multiple suppliers.

The purpose-built facility will comprise of a discharge station for LNG trailers or containers, feeding pumps, vacuum-insulated piping and bunkering equipment to facilitate efficient operations. The installation will also satisfy the stricter sulphur directive for shipping and has been designated by the EU as one of the most prioritised infrastructure projects in Europe.

MAN Cryo will oversee the project under the terms of an EPC contract and it will be managed from MAN Diesel & Turbo's local Gothenburg office.

The facility is scheduled to open during 2018 and will be operated and managed by Swedegas in close co-operation with the Port of Gothenburg.

Returning to the US, JAX LNG has received US Coast Guard acceptance for an LNG waterfront facility and bunkering operations.

JAX LNG received a Letter of Acceptance (LOA) from the USCG for the operation of its waterfront LNG facility and the approval to conduct ship-to-ship LNG bunkering operations with TOTE Maritime's 'Marlin' class ships and the LNG barge, 'Clean Jacksonville'.

This ship-to-ship LNG bunkering operation is expected to commence early in 2018.

In August, 2015, JAX LNG and its partner TOTE Maritime received their first LOA from the USCG establishing a first landside LNG bunkering facility in the Port of Jacksonville.

Since then, JAX LNG has safely delivered LNG to TOTE Maritime's LNG fuelled containerships. In addition, Pivotal LNG has demonstrated the ability to safely conduct LNG bunkering operations while TOTE Maritime simultaneously loads and off-loads cargo at the port.

JAX LNG is a joint venture between Pivotal LNG and Northstar Midstream. Expected to be operational by end of 2017, JAX LNG's waterfront LNG facility will be outfitted with a marine berth and truck loading capability. ■



Gothenburg has long been interested in supplying LNG.

'Wes Amalie' conversion project

As mentioned in the main article, the containership 'Wes Amalie' has become what is claimed to be the first LNG propulsion conversion project to be bunkered.

Since May, this year, the Wessels Reederei owned 1,036 TEU containership has been undergoing engine conversion to burn LNG at the German Dry Docks in Bremerhaven. She was redelivered on 23rd August.

Hamburg-based Nauticor was contracted to conduct the vessel's initial LNG bunkering at Bremerhaven's Kühlhauskai. Four trucks of LNG were brought to the German port and the gas transferred to the vessel. "Due to the smooth co-operation between the ship's crew, the Bremenports team, and our experienced specialists, the initial bunkering was a complete success," claimed Sonja Neßhöver, Director of Nauticor's LNG department.

Similar to her 15 sisterships, 'Wes Amalie' is operating on the intensive feeder routes between the North Sea and the Baltic Sea. By using LNG, the vessel will contribute to the reduction of emissions in this environmentally-sensitive region.

The conversion was supported by the Federal Ministry of Transport and Digital Infrastructure (see main article) and this will likely be extended to other ships in the fleet.

Upon completion of the initial bunkering, Christian Hoepfner, of Wessels Reederei, said, "We are glad that the first transfer of LNG in

Bremerhaven has been completely smoothly. Our thanks go to the Harbor Security Office Bremerhaven, the Port Authorities of the Hanseatic City of Bremen, and the LNG supplier Nauticor, who have supported us actively in this project."

Mahinde Abeynaike, Nauticor managing director, added, "With the conversion of 'Wes Amalie', Wessels Reederei has become a pioneer in establishing LNG as fuel for containerships. We are happy to support that effort and are looking forward to future co-operation, taking into consideration that our second LNG bunker vessel will start operations in Northwest Europe next year with a focus on customers in North Sea & Baltic Sea."

Nauticor GmbH & Co KG is part of the Linde Group, a gas and engineering company. Nauticor has a broad range of competencies in cryogenic technology, logistics, and bunkering to develop LNG supply solutions for maritime customers in Northwest Europe.

The company said that its strategy is to cover the entire LNG value chain from the terminal to the end customer, including sourcing, transport, storage and bunkering at strategically important ports.

MDT ENGINE

Subsequently, at the Hamburg offices of MAN Diesel & Turbo (MDT), MDT CEO Dr Uwe Lauber presented Gerd Wessels, managing owner of Wessels Reederei with a certificate marking the formal conclusion of the 'Wes

Amelie' LNG conversion project.

Wessels said: "This pioneering project marks a milestone in the European container feeder market and MAN has impressively proven that existing engines can be converted to LNG operation with a tremendous effect on exhaust emissions and the environment."

The project involved the retrofitting of the feeder containership's MAN 8L48/60B main engine to a multi-fuel, 4-stroke MAN 51/60DF unit that enables dual-fuel operation – claimed to be the first conversion of its type.

Stefan Eefting – head of MAN PrimeServ based in Augsburg who also attended the ceremony, said: "We are very happy to have successfully completed this project with the great co-operation of our partner, Wessels Reederei. In doing so, we trust that the dramatic reduction in emissions will mark the beginning of a trend towards the adoption of LNG as an environmentally friendly fuel within the maritime sector."

"By providing customers with the technology to retrofit their existing fleet, we are driving what we call the maritime energy transition", added Dr Lauber. "There are roughly 40,000 cargo vessels in operation worldwide. If we are serious about decarbonisation and want the shipping industry to be climate neutral by 2050, we need to take action today."

The dual-fuel conversion has enabled the 'Wes Amalie' to significantly reduce its SOx emissions by about 99%, NOx by approximately 90%, and CO2 by up to 20%. The vessel now meets both the IMO's Tier II and Tier III emission requirements.

Work was carried out at Bremerhaven in co-operation with gas-specialist, TGE Marine Engineering, who provided tank and LNG components. Bureau Veritas classed the conversion.

Wessels and MDT originally signed the retrofit contract at the Europort exhibition in November, 2015. The 'Wes Amalie' was built in 2011 and has already re-entered service on its normal route between the North and Baltic Seas.

When selecting a suitable vessel for conversion, special attention was paid to the scalability of the engineering services, as well as the development costs, which will significantly reduce the costs for follow-up projects.

This ship was regarded as a multiplier effect, with several other 'conversion-capable' vessels trading around Europe. ■



The 'Wes Amalie' conversion was achieved with the help of the German Government.

‘Coralius’ enters service

Europe’s first newly built LNG bunker vessel - ‘Coralius’ - completed her first ship-to- ship LNG transfer on 19th September, when she bunkered the ‘Fure West’ in the northern Kattegat.

Earlier, the Skangas chartered, Sirius Rederi and Anthony Veder-controlled vessel had delivered her first LNG cargo to Øra, near Fredrikstad in Norway on 14th September. She loaded the LNG at Skangas’ terminal at Risavika, near Stavanger.

She was built by Royal Bodewes and delivered on 2nd September. The 5,800 cu m vessel was designed in close co-operation between the owners and Skangas.

‘Coralius’ is owned by the joint venture Sirius Veder Gas AB and is operated by Sirius Rederi. She is 99.6 m long was built to a Finnish/Swedish Ice Class 1A notation.

The STS operation was undertaken about 15 miles north of Læsø in calm weather.

‘Coralius’ came alongside fitted with fenders, after which all the check lists and procedures were completed and bunkering could commence.

For Sirius Rederi, this was the 1,318th bunker operation to date successfully carried out by the company.

“The bunkering of ‘Fure West’ confirmed that ‘Coralius’ delivers in accordance with what she is built for,” said Kimmo Rahkamo,

Skangas CEO. “This is a key milestone in our history of developing the LNG availability. We are happy working together with our customer Furetank for this first of several upcoming ship-to-ship bunkerings.”

The receiving vessel, ‘Fure West’, is an oil and chemical tanker with a length of 144 m. She operates mainly in the Baltic and Kattegat area. In 2015, Furetank Rederi retrofitted the tanker pioneering the use of LNG as marine fuel in Europe.

Skangas said that it expected LNG demand for ships to increase significantly in the next few years, as responsible shipping companies sought cleaner fuel alternatives.

‘Coralius’ was christened on 22nd May. The vessel was commissioned by Anthony Veder and Sirius Rederi in 2015. This new vessel will offer LNG bunkering services for Skangas, a subsidiary of Gasum, mainly operating in the North Sea, the Skagerrak area and the Baltic Sea.

The vessel is equipped with state-of the-art LNG transfer equipment and the flat working deck is especially designed for safe side-by-side operations. Special winches were also fitted to enable safe and swift mooring operations.

“Bunkering LNG ship-to-ship increases the accessibility of this marine fuel for our



‘Coralius’ at Øra.

customers,” Rahkamo said. “It is a very valuable add-on to our existing bunkering methods of truck and terminals along the coast.”

Principal Particulars - ‘Coralius’

Class notation - +HULL +MACH, Liquefied gas carrier, Ship type 2G (-165 deg C, 500 kg/cbm, 4,5 barg), +AUT-UMS, Ice Class 1A, MON-SHAFT, +SYS-NEQ1, COMF-VIB 2, COMF-NOISE 2, CLEANSHIP

Length, overall	99.60 m
Length, bp	90.44 m
Beam	17.95 m
Draft	5.8 m
LNG capacity	5,800 cu m
Service speed	13.5 kn
Summer deadweight	3,163 t
Gross tonnage	6,015
Net tonnage	1,805



‘Coralius’ (right) seen alongside the ‘Fure West’.



The cryogenic hose connection can clearly be seen.

Jan Valkier, Anthony Veder CEO, said: “We have a long track record in small to mid-size LNG shipping. Last year we conducted the first safe bunkering operation in the Gothenburg area for Skangas with ‘Coral Energy’, another of our LNG carriers. The ‘Coralus’ is our first LNG bunker vessel developed in co-operation with Sirius Shipping and we are very proud to serve the

market in a safe and efficient way with the delivery of this dedicated LNG bunker vessel.”

Jonas Backman, Sirius Rederi CEO, said: “I am very happy to see the development of this vessel become reality following our close co-operation with Skangas and Anthony Veder. This ship considerably strengthens our position in the local market and we are excited

to bring our knowledge to this project.”

‘Coralus’ was built according to the guidelines set by the Society for Gas and Marine Fuel (SGMF) whose aim is to harmonise safe and responsible operations of gas-fuelled ships.

Alewijnse Marine delivered the electrical fit-out on board ‘Coralus’. The hull of the vessel was built in Poland before being transferred first to Papenburg, Germany and then to Eemshaven in the Netherlands for fitting out and sea trials.

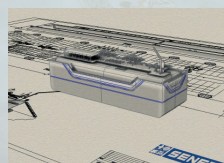
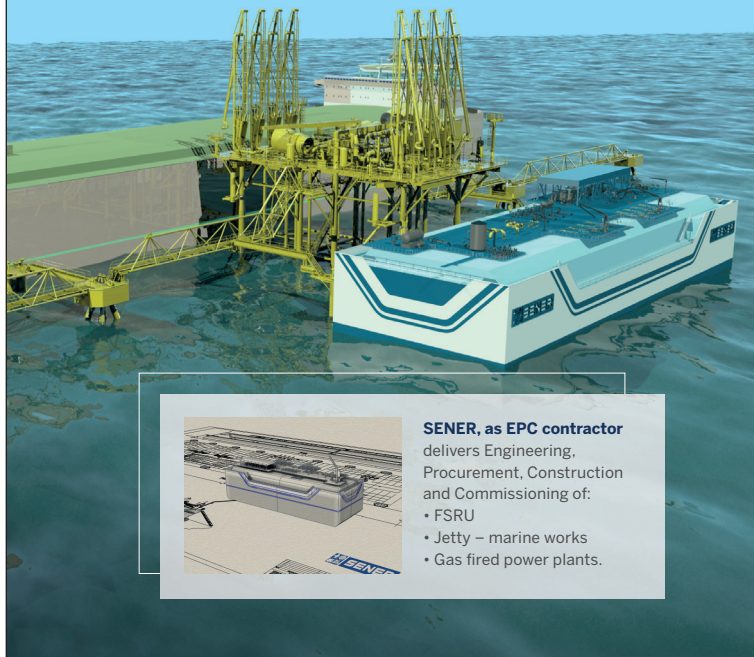
‘Coralus’ was the first purpose-built LNG bunker and feeder vessel built in Europe. She is specially designed to transport LNG to areas where supply via pipeline is currently not an option.

The vessel is part of the EU projects Plug & Play with LNG, a regional EFRO-project, which concentrates on technical LNG related system developments and Pilot LNG, which is tasked with promoting a pan-Europe LNG bunkering network.

Alewijnse was contracted by Royal Bodewes for the engineering and installation of the main electrical systems on board and started work in November, 2016.

The systems fitted included the alarm

www.poweroilandgas.sener.com
gas.solutions@sener.es



SENER, as EPC contractor
delivers Engineering,
Procurement, Construction
and Commissioning of:

- FSRU
- Jetty – marine works
- Gas fired power plants.

Leading innovation in LNG

SENER Floating Storage Regasification Units (FSRUs) are oriented to small-mid scale capacities.

- LNG storage capacity between 5,000 and 90,000 m³.
- Send-out capacity between 0.1 and 3 BCMa (10 to 300 MSCF/day).
- Feeding natural gas to power plants (up to 550 MWe) as well.

SENER provides bespoke design and is aimed at the best technical performances at lowering costs, unlike most EPC contractors, SENER uses its own technology and engineering.

Pre-agreements with major equipment towards an adjusted budget.



The way to see the future

ALGERIA • ARGENTINA • BRAZIL • CHILE • CHINA • COLOMBIA • INDIA • MEXICO • MOROCCO • POLAND • PORTUGAL • SOUTH KOREA • SOUTH AFRICA • SPAIN • UNITED ARAB EMIRATES • UNITED KINGDOM • UNITED STATES

monitoring and control system (AMCS), the power management system (PMS), the main switchboard board (MSB), the emergency switchboard (ESB) and the closed-circuit TV installation (CCTV).

Also included were the distribution panels, indoor and outdoor lighting, navigation lights, engine room signal columns, transformers, frequency drives, harmonic filter units, all cabling, fire detection and gas alarm system, domestic equipment, window wipers, sensors, UPS and batteries, shaft generator and the stern and bow thruster motors, plus other ancillary systems.

The ship's emergency shut down (ESD), a security system especially made for the LNG room, was claimed to be unique, having been designed to automatically shut down various critical systems when gas is detected. Furthermore, the vessel has a dual fuel engine and hot water boiler technology, lean gas auxiliary engines, a fuel performance system and advanced thrusters for precise manoeuvring in restricted harbours.

The vessel's LNG small-scale transfer system was supplied by Sweden's MannTek. The system, which has been proved to be lighter, easier to handle and safer for operators

than any other system available, successfully completed an FAT (factory acceptance test) before being fitted on the 'Coralius'.

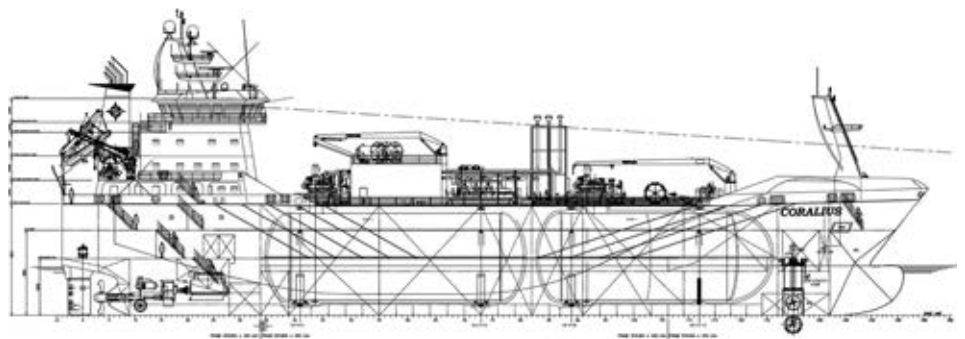
The system, which consists of MannTek's DCC (dry cryogenic couplings), CBC (cryogenic break-away couplings), LNG hoses, an ESD (emergency shut down, which provides an ESD signal to ship or shore ESD system) and HPN2 (high pressure nitrogen system), is lighter, by up to 50%, than any other LNG transfer system available today, the company claimed. It is currently available in 4 in, 6 in and 8 in variants.

This weight-saving is vital to owners and operators of the system, as it makes it easier

and safer for operators who have to manually lift the connections. MannTek's CEO Markus Bäckström said: "The lighter design makes for a more manoeuvrable design, which in turn makes the role of the system's operators easier, and more importantly, safer."

To protect the system's operators, the MannTek team has ensured that the system achieves a number of international standards and meets the requirements of a range of regulatory bodies, including SIGTTO, SGMF, ISO, EN, class approval with DNV GL, BV and LR. The Transfer system can also be provided with a SIL 2 classification.

Markus said: "We have taken the issues



GA of 'Coralius'.

REPAIR & CONVERSION



BACK ON COURSE AGAIN

WE BELIEVE ALL SHIPS HAVE MORE THAN ONE LIFE.

We have decades of experience, highly skilled project teams and extensive expertise in newbuilding and engineering. With our craftsmanship and facilities we can design, engineer and execute all kinds of repair and conversion jobs to meet your needs.

WWW.DAMENSHIPREPAIR.COM

DAMEN

raised by our customers and engineered a solution that makes the system simpler and lighter to use thereby reducing risk to operators and the equipment.”

For the systems’ users both purchase and maintenance costs will be reduced compared to other systems available, the company said.

MannTek has been manufacturing LNG transfer systems for about three years and claimed to have substantial experience in an industry, which is relatively young.

“The company’s DCCs have connected and transferred LNG 20,000 times, we believe we have the most experience in cryogenic transfer in the industry,” Markus said. “This includes the first ferry for LNG ‘Viking Grace’ and the first containership for Tote Maritime.”

On this project, MannTek worked closely with the owners and charterer on the installation of the system. Markus said: “During the project, we have made design suggestions that we felt would improve the way the system is fitted to the vessel. We were involved from a very early stage in design, as bunking activities on a vessel need to be able to take place at four different locations.”

‘Coralus’ is fitted with a Wärtsilä W6L34DF B, 3,000 kW main engine fitted to a Wärtsilä controllable pitch propeller (CPP). Her two LNG auxiliary engines were supplied by Mitsubishi, type GS6R2-MPTK of 394 kW each.

In addition, she is fitted with a Mitsubishi MGO auxiliary engine of the same type,

developing 500 KW, plus a retractable bow thruster -ZF Azimuth 600 kW and a Verhaar Omega 400 kW tunnel stern thruster.

As for the cargo, she is fitted with two TGE Marine independent tanks, separated by a bulkhead, thus acting like four tanks. The four cargo pumps were supplied by Svanehöj of a deepwell type with a capacity of 250 cu m per hour each, giving a load and discharge rates of 1,000 cu m per hour.

Two manifolds are available, one located at the centre and the other on the foredeck. Loading, discharging and ballast operations are controlled from Cargo Control Station located on bridge. Two Triplex 360 deg hose handling cranes have also been fitted on board. ■

CRYO Shipping to start LNG shipments in Northern Norway

Bergen based shipping company, CRYO Shipping, is to establish seaborne LNG transportation services in northern Norway.

The company claims that it is the first to offer competitive and sustainable LNG infrastructure solutions in the northernmost counties in Norway.

Distribution of LNG in Nordland, Troms and Finnmark, is carried out solely by land transport, ie the delivery of small unit volumes by road tanker and tank container.

This entails expensive logistics with heavy loads on roads, environment and increased risks of road traffic safety.

CRYO Shipping will offer short-sea shipping services for LNG transport in Northern Norway allowing new and existing LNG consumers in the region to have access

to supply by ship in a cost-effective and socio-economic way with the least possible impact on the local environment.

Flexible, efficient and environmentally friendly transport solutions that accelerate the green shift are a high priority for Norwegian authorities and it is important to ensure short-sea shipping is competitive in order to increase freight carried at sea.

The Norwegian Coastal Administration (NCA) has introduced a grant scheme, which aims to support more cargoes being transferred from road to sea, due to the benefits in terms of environment and socio-economic.

The NCA has said that CRYO Shipping's LNG seaborne transport services in Northern Norway will have a great value for both environment and society and, as a result, the

company has been awarded €1 mill in grants to establish an LNG trade lane.

"We are very proud of the positive market acceptance we have received for our planned shipping services in Northern Norway and are very grateful for the support granted by the Coastal Administration.

"This is a valuable contribution to becoming the first company to establish a sea-based LNG supply chain in northern Norway, thus ensuring transport of LNG is carried out in an environmentally friendly and socio-economic way. We naturally strive to deliver at the market's most competitive price level and expect that this will be the foundation for even more Norwegian companies and ships to be able to use LNG as fuel," said Nicolai Olsen, CRYO Shipping's managing director.

CRYO Shipping is an independent shipping company, which has ambitions to become a leading global operator in supply of environmentally friendly cryogenic fuels, such as LNG, biogas and hydrogen, for both industry and shipping.

"We have been working for a long time in establishing market-oriented and competitive infrastructure and logistics solutions based on seaborne transport. Currently, we are working to commercialise a unique concept that can supply LNG to land-based industry, as well as bunkering ships in an efficient and cheaper way compared to today's existing solutions.

"We have many interesting global projects that we will realise, but we are incredibly pleased and proud to be the first company to offer LNG supply and bunkering by ship in northern Norway," Olsen said. ■



Conceptual illustration of the LNGC to be employed in North Norway.



STORAGE



5,100 m³ LNG bunker vessel courtesy of Gas4Sea

BUNKERING

LNG – Clean Fuel for the Future

TGE Marine Gas Engineering provides customised solutions for LNG fuel gas handling systems and tanks for merchant and passenger vessels. With its vast experience as leading contractor for the design and construction of liquefied gas handling systems in the Marine and Offshore Industry, TGE Marine is also your best partner for all aspects of the LNG supply chain.

- LNG fuel gas storage tanks
- LNG fuel gas systems for 4- and 2-stroke engines (up to 350 bar)
- LNG bunker vessels
- LNG carriers

www.tge-marine.com

PROCESSING



TRANSPORT



Gothia Tanker Alliance favours dual-fuel technology

Thun Tankers and its partner in the Gothia Tanker Alliance have been champions of dual-fuel for their coastal and intermediate size tanker fleet.

Thun Tankers, together with alliance partners Furetank Rederi and Rederi AB Älvtank, have ordered six 16,300 dwt intermediate tankers with LNG propulsion and epoxy coated tanks.

One of the six vessels will be owned by Thun Tankers, three will come under Furetank ownership and two will be controlled by Älvtank. These vessels are being built to a FKAB design at Avic Dingheng shipyard in China and will be delivered between May, 2018 and early January, 2020.

In addition to the six intermediate size tankers, Thun also contracted four 8,000 dwt tankers again with dual fuel propulsion units, able to run on LNG and/or gasoil, but with Interline coated tanks.

These coastal tankers will be built at Sheepswerf Ferus Smit in the Netherlands with delivery between November, 2018 and January, 2021. They are intended to replace Thun's 'G' type vessels, which will be phased out.

They were designed for an increased performance, an improved manoeuvrability

with a nozzle fitted propeller, the latest hull design for further improved performance and reduced bunker consumption, improved cargo handling, cargo heating with heat exchangers, vegoil and easy chemical resistant coatings, full IMO II type design.

PROPULSION PACKAGE

Wärtsilä was contracted to supply the engines, propellers, and fuel supply systems for the four 8,000 dwt coastal tankers.

Wärtsilä's full scope of supply for each of the four vessels includes a 6-cylinder Wärtsilä 34DF dual-fuel main engine, a Wärtsilä LNGPac fuel supply system, a Wärtsilä Gas Valve Unit (GVU), and a controllable pitch propeller (CPP) with HP nozzle. The equipment will be delivered to Ferus Smit commencing in 2018.

A notable feature of the fuel system to be supplied is its open type Tank Connection Space (TCS) that allows natural ventilation. The benefits of this system are its reduced weight, a combined cargo heating medium that controls the temperature both inside the TCS, as well as for evaporating the LNG,

less installation work for the yard and a reduced power supply requirement, Wärtsilä claimed.

When delivered, the ice-class 1A vessels

Coastal 8,000 dwt Newbuildings - Principal Particulars

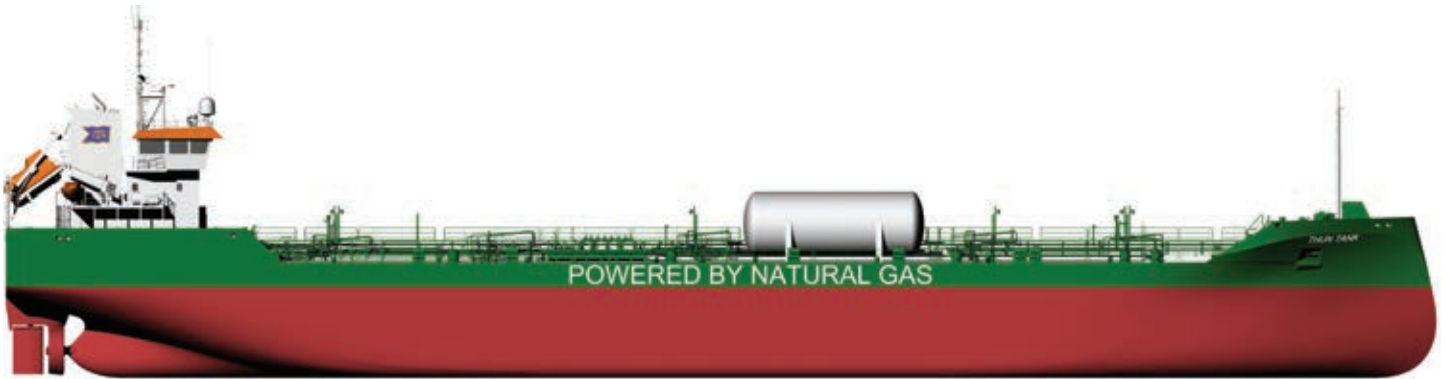
IMO IBC code type II chemical tanker, Finnish/Swedish Ice class 1A

LOA	114.95 m
LBP	112.22 m
Design draft	6.9 m
Beam	15.87 m
Deadweight	7,999 t
Cu m capacity	9,540 (100%) – 9,350 (98%)
Main engine	Wärtsilä type 6L34DF
Main engine output	3,000 kW
Bow thruster output	450 kW
Aux engines for cargo ops	3 x 350 kW each
Cargo tanks	Nine
Double valve segregations	Five
Max. Spec gravity of cargo	1.025 t/m
Cargo pumps	Framo
Cargo pump capacity	350 cu m/h per pump or up to 1,500 cu m/h provided shore facility permits
Loading capacity tank pair	800 cu m/h per

Gothia Tanker Alliance newbuildings

Vessels	Owner	Dwt	Delivery
Coastal (4) LNG fuelled	Thun Tankers	7,999	2018-2021
Intermediate (1) LNG fuelled	Thun Tankers	16,300	2018-2019
Intermediate (2) LNG fuelled	Älvtank	16,300	2018-2019
Intermediate (3) LNG fuelled	Furetank	16,300	2018-2019
Intermediate (5) Gasoil	Thun Tankers	17,500	2019-2020
Total - 15 vessels			

Source: Thun Tankers



Thun Tankers' 8,000 dwt coastal tankers will be fitted with dual-fuel engines.

will be capable sailing year round in the Baltic Sea.

With latest Thun intermediate type newbuildings, the Gothia Tanker Alliance

has 15 vessels on order (see previous page), most of which will be fitted with dual-fuel engines. Its members are Rigel Schifffahrts, Northern Energy Services, Uni-Tankers,

Rederi AB Älvtank, Furetank, Wisby Tankers and Thun Tankers and there are currently around 40 vessels commercially managed in the grouping. ■

LNG Journal & Gas to Power Journal Subscription Package



The journals' comprehensive coverage is dedicated to the entire gas-value-chain. In addition to our LNG Journal & Gas to Power Journal Daily newsletters, each platform provides exclusive, accurate and up-to-date news and analysis divided in the following sector-focused publications:

- ➔ LNG Journal - Monthly issues
- ➔ Gas to Power Journal - Daily e-newsletter + PDF
- ➔ Gas Power Tech Quarterly - Quarterly PDF
- ➔ LNG Unlimited - Weekly magazine + PDF
- ➔ LNG Shipping News - Fortnightly e-newspaper + PDF
- ➔ LNG Fuelling - Fortnightly e-newspaper + PDF
- ➔ LNG North America - Monthly e-newspaper + PDF

United Kingdom	GBP 750
Europe and Africa	EUR 925
Asia and Americas	USD 1150

Multiuser options under request
***new subscribers only*

For further information on subscribing please contact us at elena@lngjournal.com or + 44 20 7017 3416

Wärtsilä offers multiple solutions for LNG propulsion

In conversation with Timo Koponen, Wärtsilä's Vice President, Marine Solutions, Flow and Gas and CEO of the Wartsila-Hamworthy group of companies plus Fraser Scott, Global Sales Development Director, Wärtsilä Services, LNG Shipping Review was told that the group has a wide variety of products and process technology solutions for the entire LNG value chain.

The company is also present in many size ranges spanning larger ocean going LNGC vessels and LNGCs to LNG terminals, smaller LNG shuttle tankers and LNG bunkering vessels. This comprehensive offering is coupled with Wärtsilä's global after sales presence and competences.

Wärtsilä's solution package is the most suitable for small and medium sized terminals, as well as small scale LNGCs, such as Thun's coastal tankers (see page 32).

The amalgamation with Hamworthy has enabled the group to provide customers with more complete packages of offerings and solutions both in the building phase and in commercial operations.

The benefits include ease of vendor management, systems integration and compatibility, future obsolescence management, maintenance efficiency, as well as overall efficiency of equipment.

Wärtsilä has focused on the service sector for several decades. In that time, several segments in both the marine and the energy markets have seen peaks and troughs. The picture in the LNG

market is no different from those that were seen in the merchant, offshore or baseload power plant sectors over the years. Wärtsilä's interest lies not only with the LNGCs, but also with the booming FSRU market, both for newbuild, as well as retrofit projects.

Wärtsilä was recently awarded the contracts to supply re-liquefaction plants to three new LNGCs currently under construction.

One ship is being built at Samsung Heavy Industries (SHI) for Gaslog, while the other two are for Norwegian-based Knutsen and are being built at Hyundai Heavy Industries (HHI).

The order was booked for the Gaslog LNGC in April, 2017 and for the Knutsen ships in May/June 2017.

The re-liquefaction plants ordered for these vessels feature Wärtsilä's latest mixed refrigerant (MR) technology, an energy efficient solution for smaller liquefaction applications. This new installation will have a capacity of 1.5 - 2.5 tonnes per hour. The equipment is scheduled for delivery commencing February, next year.

Gaslog has been a Wärtsilä customer for many years and several ships in its fleet are

fitted with group solutions, while Knutsen's two latest vessels delivered in 2016 are fitted with Wärtsilä's nitrogen based re-liquefaction plants.

"These orders are a demonstration of our capability to develop markets and help LNGC owners to become more flexible in their operations. Equipping an LNGC with a re-liquefaction system enables more versatile and efficient use of the vessel in evolving LNG markets, which supports the trend towards more spot based trade," Koponen said.

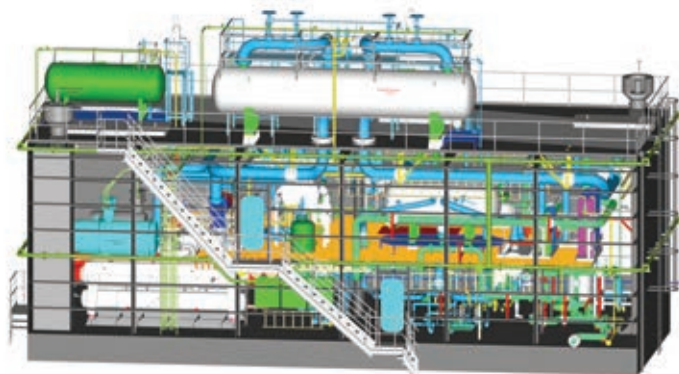
SMALL SCALE DEVELOPMENTS

As for small scale/bunkering market developments going forward, Koponen said that large infrastructure projects are currently under construction and will come on stream in the coming years. This development, coupled with the drive towards LNG as the sustainable fuel of the future, will result in an increasing number of smaller scale LNG terminals, shuttles and bunkering vessels.

These will be needed to deliver the gas to the points of use. Furthermore, the implementation of the global sulfur cap in 2020 is accelerating the move towards LNG-propelled ships. This means that the bunkering infrastructure has to be in place. "Wärtsilä believed that all this will drive the development in the market," he said.

Koponen explained that November's Gasfest in the Netherlands, with which the group is involved, was conceived to create an industry to industry forum to discuss and tackle challenges and development over the whole LNG value chain - and not limited to LNG as fuel only.

As for training, Wärtsilä's Land & Sea



A 3D model of a typical deckhouse for a 2.5 tonnes per hour MR reliquefaction plant.

Academy offers extensive training programmes both in the group's own in-house training facilities, as well as on board customers' vessels or at their power plants. Training is always planned together with the customer, taking into account the special characteristics of each business case.

As already mentioned on page 32, Wärtsilä has won orders to supply the engines, propellers and fuel supply systems for four new coastal tankers.

The ships will run on both liquefied natural gas (LNG) and diesel and are being built at the Scheepswerf Ferus Smit yard in the Netherlands for Sweden based Erik Thun.

The order was booked by Wärtsilä in the first quarter of 2017.

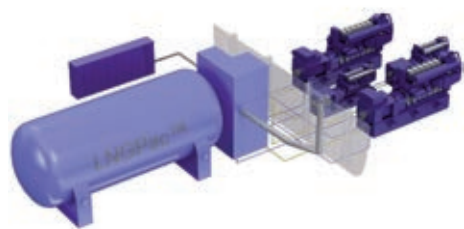
In 2014, Ferus Smit built two cement carriers for Erik Thun. They are now operated by JT Cement; a joint venture company with Norwegian-based KG Jebsen Cement. They also feature Wärtsilä dual-fuel propulsion.

The 115 m long coastal tankers feature a 'next generation' design focusing on high energy efficiency, low noise levels both above and below the water, and environmental sustainability.

The full scope of supply for each of the four vessels includes a 6-cylinder Wärtsilä 34DF dual-fuel main engine, a Wärtsilä LNGPac fuel supply system, a Wärtsilä Gas Valve Unit (GVU), and a Controllable Pitch Propeller (CPP) with HP nozzle. The equipment will be delivered to the yard commencing in 2018.

A notable feature of the Wärtsilä fuel system to be supplied is its open type Tank Connection Space (TCS) that allows natural ventilation. The benefits of this system are its reduced weight, a combined cargo heating medium that controls the temperature both inside the TCS as well as for evaporating the LNG, less installation work for the yard, and a reduced power supply requirement.

"The fuel efficiency of the Wärtsilä 34DF engine, whether in gas or diesel mode, was a prime consideration in its selection for these 'next generation' tankers. Similarly, the



Wärtsilä's LNGPac fuel supply system will be fitted on Thun Tankers' newbuildings.



Shell will charter a new bunker barge featuring a Wärtsilä cargo handling system.

successful track record of both the CPP and LNGPac solutions, and the proven efficiencies that they have demonstrated, were convincing arguments in our favour," says, Aaron Bresnahan, Vice President, Sales, Wärtsilä Marine Solutions, speaking at the time of the contract announcement.

When delivered, the Ice Class 1A vessels will be capable of handling the year round sailing conditions in the Baltic Sea.

LNG EQUIPMENT CONTRACTS

Several other contracts involving LNG-fuelled vessels have also been announced this year, including the supply the engines and other propulsion machinery for a new offshore construction vessel being built at the Cosco shipyard in China for Belgian operator Dredging International (DEME).

This will be the first vessel of its kind to be fuelled by LNG and in addition to the dual-fuel engines, Wärtsilä will also provide its LNGPac fuel storage and supply system and propulsion systems.

This 210 m long vessel, 'Orion', will be powered by four 9-cylinder Wärtsilä 46DF dual-fuel electric propulsion engines, and two 6-cylinder Wärtsilä 20DF dual-fuel engines.

Wärtsilä will also supply two custom made retractable thrusters, four underwater demountable thrusters, the Wärtsilä LNGPac storage and supply system, as well as commissioning, site supervision and extended project management services. The Wärtsilä equipment is scheduled for delivery to the yard in the latter part of this year.

A little while ago, Wärtsilä and COSCO shipping Heavy Industry (CHI) announced the joint development of a natural gas operating fleet concept. This design has since obtained Lloyd's Register's (LR) Approval in Principle (AiP) certificate.

The development project was carried out under the terms of a MoU signed in June, 2016 between the three companies.

The aim of the concept is to offer global

operators a more efficient and economical fleet design that meets current and anticipated environmental requirements, according to the classification rules. The fleet comprises four vessels; a pusher tug, LNG storage barge, LNG regasification barge, and a floating liquefaction natural gas barge. The pusher tug can be used to transport the three barges.

The number and choice of units will depend on the project, since not all of the concept's units are necessarily needed for every project. For example, the concept can be used as an LNGC (using only the pusher tug and LNG storage barge), or it can be used for more complex projects involving liquefaction and regasification systems (using all units).

The modular design of Wärtsilä's liquefaction and regasification units makes this an ideal concept for gas plants in the 50-200 MW range, the group claimed. The low draft design also makes it very attractive for gas power plant projects in Southeast Asia.

It is expected that when ordered, the vessels will include Wärtsilä dual-fuel engines and steerable thrusters, the Wärtsilä LNGPac gas storage and supply system, a Wärtsilä liquefaction module, a Wärtsilä LNG cargo handling system, and a Wärtsilä regasification module.

In addition, Wärtsilä will supply the cargo handling system and cargo tanks for a new 3,000 cu m capacity LNG bunker barge.

The vessel will be owned by LNG Shipping, a consortium involving Belgium-based Victrol and CFT Corp based in France.

The barge is being built in Romania and will be outfitted in the Netherlands. When delivered, it will be chartered by Shell Western LNG (Shell), operating out of Rotterdam to provide the company with additional flexibility to bunker LNG fuelled ships, including vessels operating on Europe's inland waterways.

The full scope of Wärtsilä solutions comprises the cargo handling system, the cargo tanks, and installation of the cargo arrangement on board the vessel. ■



LNG Bunkering Summit 2018

Technical Focus Day: 29th January 2018
Main Conference: 30th & 31st January 2018
Amsterdam, The Netherlands

Regulation, Technology and Supply Chain Development to Drive LNG as the Fuel of the Future

Join the summit and:

-  Learn about the latest regulatory updates and discuss operational procedures designed to **reduce risk and ensure your team remains safe and compliant**
-  Assess the commercial viability of LNG as a marine fuel and **calculate accurate payback predictions** through our technical focus day
-  Discover how LNG affects the design of various vessel types and how to **operate reliable, cost effective and ECA compliant vessels**: Evaluate Furetank, Tote, MSC Cruises, Samuel LNG, Arista Shipping, and Anthony Veder's successful projects
-  Hear about the European Commission's latest funding options, their availability and methods for obtaining investment for infrastructure and vessel project
-  Receive the latest progress reports on LNG infrastructure developments in the ports of Oslo, Dragages, Rotterdam, Amsterdam, Zeebrugge and Antwerp to help you to **build your business case for shifting to LNG as a marine fuel** and ensure you make the right decisions

Learn from the experts:



Arjan Stavast,
Team Lead, DLNG BD
Marine, Global DLNG,
Shell



Antonis Trakakis,
Technical Director,
Arista Shipping



Steve Esau,
General Manager,
SEA/LNG



Lars Höglund,
Managing Director,
Furetank



Xavier Pfeuty,
LNG Manager,
Total Marine Fuel
Global Solutions

Sponsored by:



See inside for the full list of speakers

"Nice mix of ports, terminals, suppliers and ship owners"

Stefaan Adriaens, Commercial Manager, Gate Terminal

Containment systems increase to cater for new services

Both marine, offshore and onshore containment systems continue to evolve, as indeed the ships themselves continue to evolve.

Apart from the two main types - membrane and the MOSS-type containment systems - there are others primarily aimed at the more specialist markets, such as bunkering.

For example, the increase in the number of LNG-fuelled ships has led to more tank designs to cater for the gas containment on board ship and in the bunkering vessels.

We start with the more familiar systems that have been around since the birth of the large LNGCs in the 1970s - 1980s - membrane and MOSS.

Both are aimed at the larger deepsea LNGCs. Membrane tends to be favoured by South Korean and Chinese shipbuilders, who have signed licensing agreements with French containment system supplier GTT (the merged GazTransport & Technigaz), while its Norwegian counterpart MOSS Maritime has found a home with Japanese shipbuilders.

GTT remains the largest supplier of containment systems. The company said that it originally developed its membrane technologies to cut the cost of shipping LNG and loading it, in bulk, into the vessel's holds.

To cope with the cargo, holds need to be coated with a cryogenic lining that can withstand the load. Envelopes, known as membranes, contain the LNG at a temperature of -163 deg C, sealing it with a totally impermeable layer between the liquid cargo and the vessel's hull, while also limiting cargo loss through evaporation.

GTT has two main membrane tank technologies - Mark and NO systems. These systems are continuously being improved in response to shipowners' operational and financial requirements and changes in regulations.

The company claims that its membrane containment systems use thinner and lighter materials than rival systems. They have

several advantages:

- Optimisation of cargo storage space.
- Reduced vessel construction and operation costs.
- Modular design allowing for flexible assembly in vessels of all sizes without significant capital expenditures.

Basically, GTT offers the Mark III and Mark V, NO96 and NO96 Max and GTT MARS technologies.

Last month, GTT announced that it was re-validating some aspects of its Mark V system after discovering a technical problem.

The company stressed that it was fully confident in the potential of the technology but the re-validation might cause a delay in its availability.

GTT also said it recognised that today's market conditions, including LNG prices, were not propitious to the general application of the current version of Mark V, considering the system's incremental cost, compared to other GTT technologies.

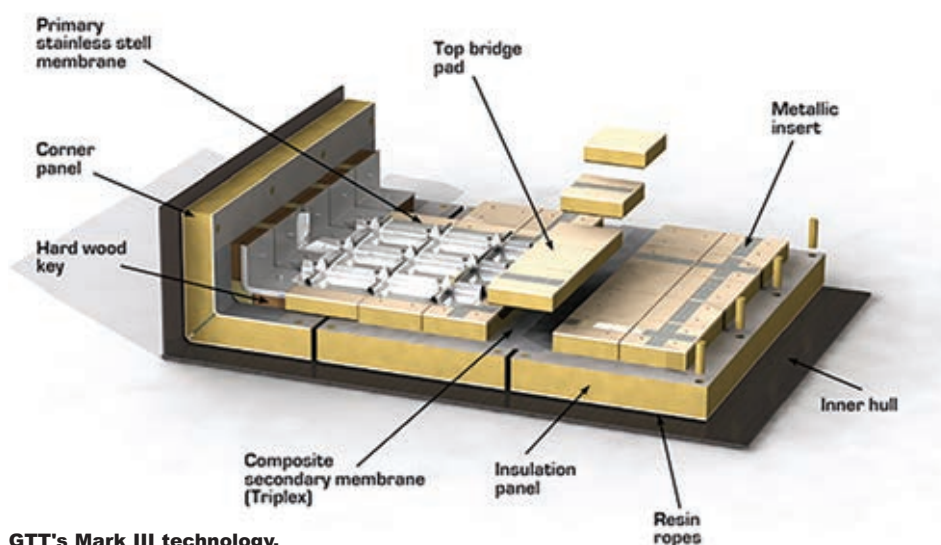
Therefore, the company said it was taking more time to try to improve the cost of the system.

In late September, Philippe Berterottière, GTT CEO, said: "We are working with all our customers who have considered using Mark V, both to discuss the timing of the modification to this new system and other containment options, including our recently introduced Mark III Flex technology improved version."

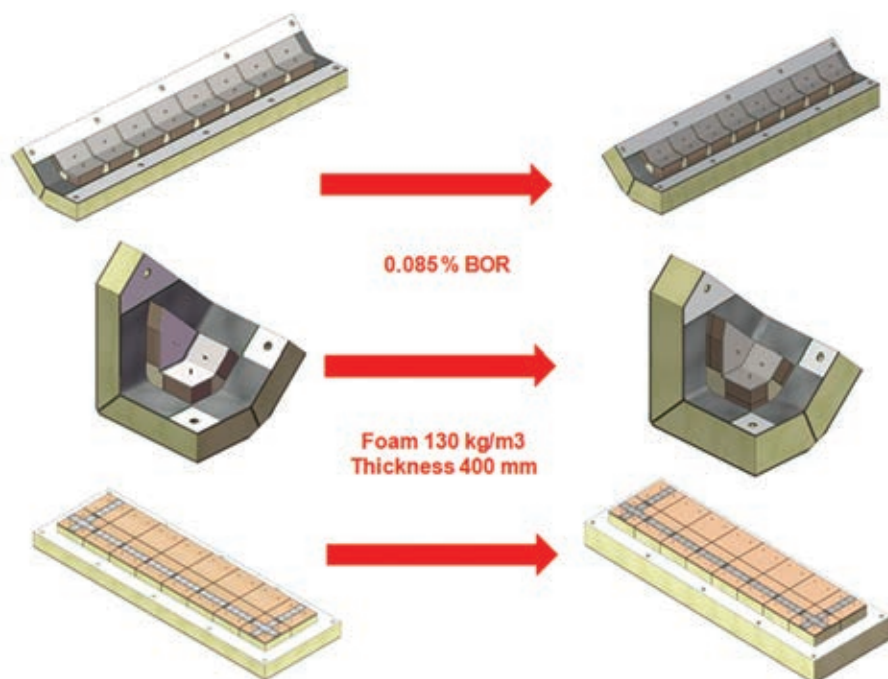
A week or so earlier, GTT had announced that with the growth in the use of increasingly efficient propulsion systems, the LNG shipping industry is continuously looking to reduce the level of daily evaporation of the LNG cargo (boil-off rate (BOR)) in modern vessels.

In order to counter this GTT said that it was continuously upgrading its technologies. As a result, a new evolution of its Mark III Flex technology was developed and has recently received General Approval from the class society ABS.

Mark III



GTT's Mark III technology.



Mark Flex low BOR concept.

This latest version of the Mark III Flex technology benefits from an improved insulation performance through an increase in thickness and an enhanced secondary membrane solution already in service on ethane carriers. It allows for a daily BOR of 0.07%V (compared to the 0.085%V per day of the previous version), equivalent to that of Mark V.

GTT continues to receive orders under license from shipyards. One of the latest came from Hyundai Heavy Industries last month to fit a containment system in a new FSRU, which was recently ordered by Triumph Offshore, a subsidiary of the Indian ship-owner Swan Energy. The FSRU's delivery is scheduled for late 2019.

GTT will design the LNG integrated tanks, which will give a total capacity of 180,000 cu m. These tanks will be equipped with the Mark III membrane containment system. This insulation system benefits from an unparalleled track record, as it has been already been fitted in more than 140 vessels, which are still in service today, the company claimed.

The Mark III membrane system is a cryogenic liner directly supported by the ship's inner hull. This liner is composed of a primary metallic membrane positioned on top of a prefabricated insulation panel including a complete secondary membrane.

The primary membrane is made of corrugated stainless steel 304 L, 1.2 mm thick. It contains the LNG cargo and is directly supported by and fixed to the insulation

system. Standard size of the corrugated sheets is 3 m x 1 m.

This membrane is folded to create corrugations. The knot is the intersection of the corrugations (small and large corrugations).

The secondary membrane is made of Triplex, a composite laminated material - a thin sheet of aluminum between two layers of glass cloth and resin. It is positioned inside the prefabricated insulation panels between the two insulation layers.

Insulation consists of a load-bearing system made of prefabricated panels in reinforced

polyurethane foam, including both primary and secondary insulation layers and the secondary membrane. The standard size of the panels is 3 m x 1 m, while the total thickness of the insulation is 270 mm.

The panels are bonded to the inner hull by resin ropes, which serve a double purpose - anchoring the insulation and spreading the loads evenly.

COMPETITIVE ADVANTAGES

The corrugated membrane technology has been continuously improved since 1967 and is approved by all the major class societies.

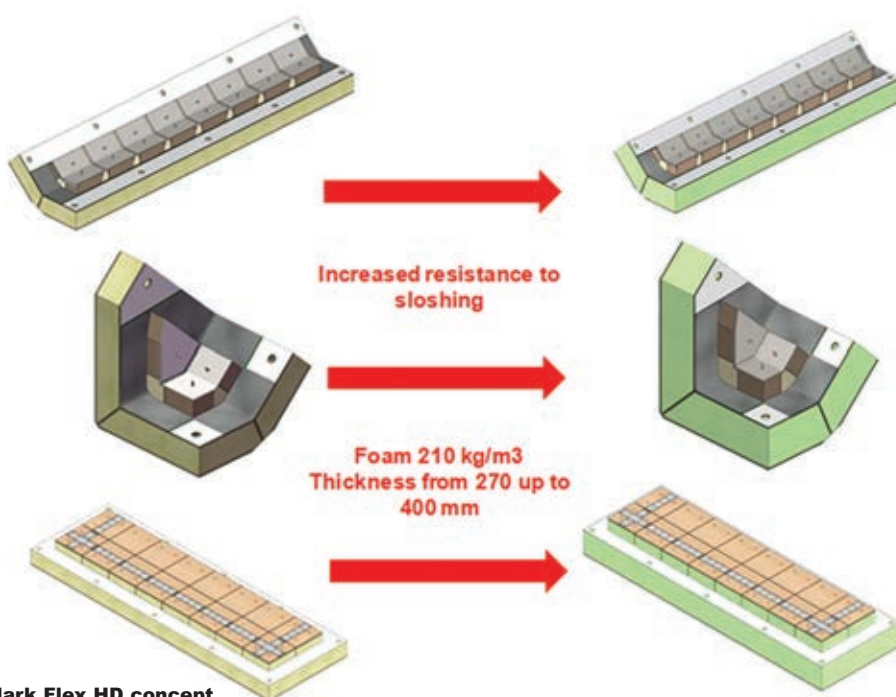
The two independent insulation spaces are continuously flushed with nitrogen gas, thus the integrity of both membranes is permanently monitored by detection of hydrocarbon in the nitrogen.

An orthogonal corrugation pattern enables the membrane to accommodate any thermal or hull deflection stresses and to work under the fatigue limit, providing outstanding lifetime.

Because of low stress on the primary membrane, prefabricated foam corner panels can be used to anchor the membrane to the hull thus minimising thermal flux.

Fibreglass inserted in the polyurethane foam gives high mechanical properties to the panels. The density of the foam (130 kg/m³) and the plywood covering both sides of the panels - for an even load distribution - allow the insulation to withstand high impact pressures and absorb the energy resulting from liquid motion.

The low thermal conductivity of the foam



Mark Flex HD concept.

and of the corners results in a thin insulation; thus maximising the cargo capacity for any ship external constraints.

Mark III's modular system calls for standard prefabricated components that can accommodate any tank capacity and are designed for mass production techniques and easy assembly.

As for the MARK III FLEX, in order to meet requirements for lower BOR, the insulation thickness can be increased up to 400 mm without changing the R-PUF density (130 kg/m³) or changing the thickness of the primary insulation space.

As a result, with the standard foam density and a global thickness equal to 400 mm, a guaranteed BOR of 0,085% of tank volume per day can now be proposed, using efficient R-PUF, GTT claimed.

Another version, the Mark III Flex HD, has been designed to meet requirements for systems sustaining higher sloshing loads.

The R-PUF density can be increased up to 210 kg/m³ (more glass fibres), which could provide more than twice the compressive strength. Depending on the intensity of the expected sloshing loads, intermediate densities can be used.

These reinforcements can be optimised according to shipowner specifications.

The strength of the bonded joints is increased by the application of polyurethane glues and the latest bonding procedure.

MOSS INNOVATION

The latest news coming out of the MOSS camp was that DNV GL had awarded Kawasaki Heavy Industries an Approval in Principle (AiP) for the recently developed non-spherical (MOSS) tank.

This new tank is a IMO Independent Type B LNG tank that has been developed for use in 180,000 cu m LNGCs designed to pass through the new Panama Canal.

"It is always a great pleasure to work with KHI, to continue what has been such a long and enjoyable co-operation," said Johan Petter Tuttren, Business Director for Gas Carriers at DNV GL – Maritime at the time of the announcement. "We worked with KHI on the delivery of the first Japanese built LNG carrier – 'Golar Spirit' – in 1981 and that co-operation continues to this day, as she remains in DNV GL class after her successful conversion to a FSRU - a world's first."

KHI said that the new tank has the same reliability as a spherical (MOSS) tank, but has an increased cargo capacity of 15%. It can also be used with the Kawasaki Panel System, a



KHI's new non-spherical (MOSS) tank is a IMO Independent Type B LNG tank that has been developed for use in 180,000 cu m LNGCs. Credit: KHI.

heat insulation system developed by the Japanese shipbuilder.

DNV GL carried out comprehensive sloshing and buckling analyses together with KHI, which demonstrated that the new tank provided an equivalent level of safety performance to the more traditional spherical tank with no filling restrictions.

"As DNV GL's experience with LNG has grown over the years, so too has our conviction that LNG can make a significant and positive contribution to the efficiency and sustainability of the energy and maritime industries," said Tuttren. "To keep this momentum for the use of LNG growing, DNV GL will continue to work with innovative partners like KHI to ensure that owners and yards can be confident that this technology will continue to advance, while meeting strict safety and reliability standards."

An Approval in Principle is an independent assessment of a concept within an agreed framework, confirming that the design is feasible and no significant obstacles exist to prevent the concept from being realised.

The AiP is typically carried out at an early stage of a project to confirm its feasibility for the project team itself, company management, external investors or regulators.

TORGY DESIGN

Last April, Torgy LNG's updated LNG Type A tank design was granted a General Approval for Ship Application (GASA) by DNV GL.

The original design was the first LNG tank based on the IMO A atmospheric design to have been awarded a GASA certificate.

Torgy LNG had received an GASA statement for a previous LNG tank design, but this design was modified with a total redesign of materials and geometrical design solutions of the secondary barrier. These modifications have been tested and documented by numerical analysis. The upgraded tank design is claimed to be well suited for larger cargo tanks.

Norwegian-based Torgy LNG supplies a range of products and services, including IMO A and IMO C LNG containment systems.

BRAEMAR RECEIVES APPROVAL

More recently, Bureau Veritas (BV) issued a General Design Approval for Braemar Technical Services' FSP Type B LNG containment system (FSP).

Starting with the General Dynamics NASSCO-patented tank design, for which ABS and Lloyd's Register had issued Approval in Principle (AiP) several years ago, Braemar engineered a new and improved containment system to meet the demands of LNG storage in marine, offshore, and onshore applications.

The containment system technology development project was a result of joint co-operation with Honghua Offshore, EnTX Group, and Jamestown Metal Marine Services.

BV issued the approval after witnessing the successful cryogenic testing of a prototype built by Shanghai Aerospace and outfitted at Honghua's facility in Shanghai.

The enhanced FSP design incorporates several elements that is claimed to differentiate it from its competition:



Braemar - FSP's flexible design can be tailored to a wide range of project requirements – pictured above is a 1,000 cu m tank with its dimensions sized to meet wide load restrictions to a remotely located project currently under development.

- Cost to construct FSP tanks is lower than equivalent IMO Type A, spherical Type B, other prismatic Type B, and Type C tanks for most size ranges.
- FSP tanks are fabricated and outfitted in a clean, dedicated facility in parallel with hull or plant construction, shortening the critical path relative to projects using membrane or conventional land-based tankage and ensuring the highest levels of quality control.
- Volumetric efficiency of FSP tanks is flexible to meet project specific requirements and is higher than the latest spherical IMO Type B and all IMO Type C tanks, and is comparable to equivalent IMO Type A tanks.
- FSP tanks are inherently more robust than IMO Type A and membrane tanks, and are less sensitive to construction tolerances

than other IMO Type B tanks.

The FSP containment system is currently being incorporated in the design of the LNG 21 export project, which is under development in the US Gulf of Mexico. In its capacity as owner's engineer, Braemar, in conjunction with Wood Group, is carrying out the FEED for the project, which includes an FSP system with a total storage volume of 300,000 cu m.

NEW COMPANY

LNT Marine was established in June of this year as a result of a merger between LNG New Technologies and MGI Thermo.

The patented LNT A-BOX, an IMO type A containment system for LNG and other liquefied gasses, was designed by the two companies.

LNT Marine now offers a full range of marine insulation for tanks, cargo holds and

pipes, enabling the company to act as a 'one-stop-shop' for IMO type A and type C LNG containment systems and fuel tanks, as well as solutions for other cold temperature cargoes.

"During our co-operation on the LNT45 project, it became clear that in order to continue optimising the design and further reduce the cost of our LNT A-BOX system, core competencies needed to be integrated under one roof," said LNT Marine CEO Stein Foss.

The LNT45 project is a 45,000 cu m LNGC, based on the LNT A-BOX containment system being built for Saga LNG Shipping at China Merchants Heavy Industry (Jiangsu) in Haimen, China.

In combining the capabilities and services of the two companies, LNT Marine said it will:

- Continue to invent and develop new technologies in order to provide optimised and cost competitive marine LNG solutions to our partners and clients.
- Be a turnkey supplier, providing design and engineering, system supply, technical support, and installation services, all based on its proprietary technologies.
- Focus on growing the market share of the LNT A-BOX containment system across the size spectrum, from small-scale solutions for fuel tanks and bunker vessels to large-scale applications for floating units.
- Focus on driving the development of the emerging mid-size LNG segment, where a lack of robust and cost-effective solutions has impeded market growth. ■

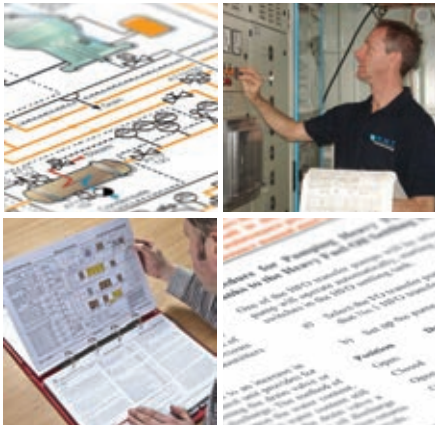


Hull of the LNT45 45,000 cu m LNGC seen under construction at China Merchant's shipyard.

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

Worldwide standard for:

- LNGC
- FSRU
- FLNG
- Bunkering



Project Technical Documentation and Training:

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

WMT
MARINE
www.wmtmarine.com

Head Office - Tel: +44 (0)1244 287 850
Dee House, Parkway, Zone 2, Deeside
Industrial Park, Flintshire, CH5 2NS, UK



Worldwide Offices -



Korea



China



Japan

Vacuum Insulated Pipelines for LNG bunkering

World's first LNG-Powered Hopper Dredger

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



Superior Insulation - Smallest Footprint - Durable - Double containment

Superior Insulation:

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

Smallest Footprint:

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

Durable:

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

Double containment:

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

Contact:

Demaco Holland BV
Oester 2,
1723HW, Noord-Scharwoude
Website: www.demaco.nl
Email: info@demaco.nl
Tel: +31 226 33 21 00