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Looking at evolution of FSRU market in project development and LNG finance

Philip Weems, Nick Kouvaritakis and Richard Nelson of King & Spalding law firm in Houston and Singapore

The growth of the floating storage and regasification unit (FSRU) market has been exponential over the past decade.

The birth of the Floating LNG industry can be traced back to mid-2001, when El Paso contracted with Belgian ship-owner Exmar to fit regasification units on board three existing new-build LNG ships and one new contracted LNG ship at Korea's Daewoo Shipbuilding & Marine Engineering.

The market has grown significantly ever since, with 18 FSRU projects now operational across the world.

Surprisingly, such growth has been achieved against the backdrop of a slowdown in emerging markets driven by weak commodity prices. This article looks at the key drivers behind the growth in the FSRU market and how we expect the market to evolve in the future.

Cost differential

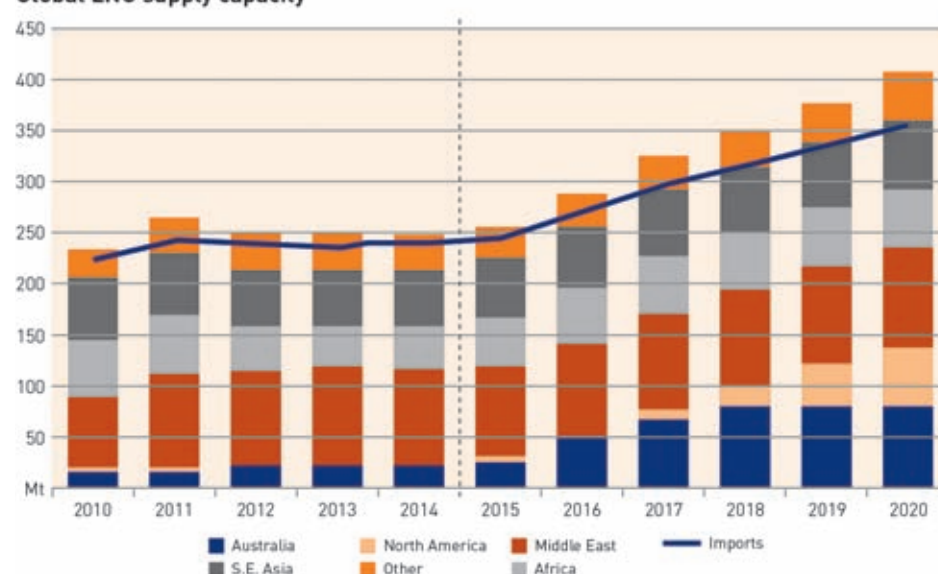
Developers have a multitude of options to consider when structuring regasification projects. An important initial decision is whether to opt for an onshore regasification terminal or procure a floating regasification vessel.

If the latter, some consideration should also be given to the type of vessel: FSRU, floating storage unit (FSU) with onshore regasification or floating power plant unit (FPPU).

In terms of FSRU procurement, developers need to decide whether to lease or purchase and whether to elect for a new-build vessel or convert an existing LNG carrier (new-build vessels often being preferred due to the cost savings associated with superior boil-off efficiency).

The cost differential between FSRUs and onshore regasification terminals is significant: a new-build 170,000 cubic meter FSRU typically would cost in excess of US\$250 million to

Global LNG supply capacity



Note: Nameplate reduced by 6 percent for plant maintenance

Increasing global production creates FSRU import opportunities

purchase, whereas the cost of developing a land-based terminal of comparable size is likely to be in the region of US\$1 billion^[1].

However, developers typically opt to lease FSRUs rather than purchase, which can be explained by a number of factors.

Owners

First, the conventional FSRU owners (BW, Excelerate, Golar, Hoegh and Mitsui OSK Lines) have long-standing relationships with the dominant ship manufacturing yards and usually secure options for multiple FSRUs on the basis of discounted individual unit's costs.

Such discounts are unlikely to be available to developers wishing to procure individual units directly from the yards.

Second, the lack of operational experience is a deterrent for developers wishing to purchase FSRUs directly - there are only 18 operational FSRU projects in the world^[2] and very few companies that have operational experience of FSRUs.

Typically developers would opt to lease FSRUs on the basis of a day rate, which can vary between US\$130,000 and US\$155,000 per day^[3].

However, it is hard to determine a "market rate" for FSRUs given the number of different variables that need to be taken into account including: capacity of the vessel; new-build versus converted LNG carrier; length of the charter; terms and conditions of charter; credit support provided by charterer; and jurisdiction specific risks such as the prevailing legal and taxation regimes in the country where the FSRU is deployed.

Cleaner fuels

While there has always been a significant cost differential between FSRUs and onshore regasification terminals, the evolution of a preference towards FSRUs is rooted in several other factors including the need to reutilize excess shipping capacity and the necessity to cater for seasonal gas demand.

In certain jurisdictions such as China and Indonesia, the move towards FSRUs was in large part driven by the need to

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diversify the energy mix and switch away from crude and coal to cleaner fuels such as gas. For Indonesia, FSRUs offered the lowest cost and fastest option to effect the switch to gas when compared with other gas procurement options such as onshore regasification or pipeline supply.

Speed of deployment is influenced by regulatory backdrop of relevant jurisdiction. It has been stated that FSRUs are up and running as much as six times faster than onshore regasification terminals^[4].

While it is accurate to say that generally FSRUs are faster to deploy than onshore regasification terminals, some of the obstacles and hurdles surrounding the deployment of FSRUs should be considered in detail before making any presumptions. Despite the fact that FSRUs are moored offshore there is often a complex permitting regime that needs to be navigated prior to deploying an FSRU.

This may require a number of different licenses and permits relating to (among others) environmental impact and management, marine operation, gas processing and trading, employment/social security of shipboard personnel and often a general business or commercial license.

Perspective

Additionally, from a tax perspective the FSRU owner will typically have to apply for an import tax exemption (in respect of the tax treatment of the vessel), in some cases an exemption from local employment laws in connection with shipboard personnel and a Value Added Tax (VAT) exemption in relation to the importation of goods and equipment in connection with the vessel.

Such regulatory requirements vary significantly from project to project and can cause significant delays to the deployment of the FSRU in the relevant jurisdiction.

That said, there are recent examples where FSRUs have been deployed swiftly to address acute power shortages. BW recently concluded a five year FSRU charter with Egyptian Natural Gas Holding Co. (EGAS) which operated on the basis of a five month timeframe from project inception to first gas – which represents a record short time for implementation^[5].

Egypt is battling with significant power shortages and has had to significantly increase the level of imported LNG in order to meet domestic

demand and has already deployed two FSRUs (“Hoegh Gallant” is moored next to “BW Singapore” in Ain Sokhna) with plans for the procurement of a third FSRU in 2016.^[6]

The contracting structures for FSRUs have changed since Golar finalized the time charter for the world’s first two FSRUs to Petrobas back in 2007.

The market in 2007 was characterized by long-term charters with a minimum of 10 to 15 years.

Flexibility

The contracting structures adopted in the early years were more conventional and rigid. This was likely driven by the lending banks, which, at the time, were cognizant of the development/technology risks associated with this fledgling industry.

Fast forward almost a decade and the market fundamentals have evolved. Flexibility for the charterer is a fundamental theme.

We have seen the emergence of some seasonal FSRU charters such as Golar’s 2013 charter with Kuwait National Petroleum Co. (KNPC) where the vessel is deployed as an FSRU for nine months of the year and is free to pursue spot carrier and other short-term business opportunities for the remaining three months of the year^[7].

offshore gas discoveries are commercialized (Egypt).

Bangladesh

We have also seen conventional infrastructure concepts adopted in FSRU projects - in Bangladesh, PetroBangla has signed an agreement with Excelerate which operates on a build-own-operate-transfer basis, where the FSRU is transferred to PetroBangla at the end of the 15 year term^[8].

In some instances, FSRU owners are willing to make investments further downstream – Golar LNG has recently announced that it is in talks with Brazilian power partners to provide an FSRU to fuel a 1.5GW combined cycle power station in Sergipe (Northern Brazil).

Golar is reportedly participating in up to 25 percent of the power project, which envisages Golar making an equity investment in the project^[9].

Often developers have requested that the FSRU owner is responsible for operating and maintaining offshore infrastructure such as the jetty and potentially any interconnecting facilities.

This envisages the FSRU owner taking on an entirely different risk profile than a conventional FSRU charter and will typically be priced into the rate of hire.

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The charter length for FSRUs now varies considerably. Shorter term charters, particularly in Middle Eastern countries such as Egypt and Kuwait, are being used as a bridging solution for the development of land-based terminals (Kuwait) or as a mid-term solution until

The ways in which FSRUs are financed have also changed significantly - a number of banks have entered the market and have found flexible, creative ways of tackling fundamental financing issues such as development risk and sovereign



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credit. FSRU owners have adopted new financing structures such as master limited partnerships (MLPs) to optimize returns - predominantly used to maximize cash flow and distribution growth from “dropping down” multiple shipping and FSRU charters into a limited partnership fund structure.

Careful prior assessment of gas demand is key to optimizing sustained utilization.

The ability accurately to calculate future gas and electricity demand, taking into account any geographical discrepancies and changes in market fundamentals, is critical to the success of any FSRU project. Hoegh’s Lampung FSRU illustrates some of the risks associated with the development of gas infrastructure projects.

The Lampung terminal is estimated to have cost approximately US\$400 million and has the capacity to process 2 MTPA, which could satisfy 14 percent of Indonesia’s total power demand (based on last year’s figures)^[10]. However, the FSRU mostly sat idle in 2015.

The market fundamentals in the locality have changed since the project’s

inception. Gas demand has plummeted as the economic situation deteriorated and the decrease in oil price has created fuel-on-fuel competition, with gas from LNG becoming less competitive than oil in some parts of West Java.

It is not always possible to account for such changes in the market fundamentals, but this example illustrates the importance of ensuring flexible contractual structures that allow for redeployment of the FSRU at alternative locations, variations to the length of the charter and potentially even the ability to sub-charter for use as an LNG carrier in low utilization periods.

Project delays

Project delays and re-configurations of regasification projects are common in the FSRU industry.

In Uruguay, the government recently cancelled its contract with GNLS S.A. (a 50/50 joint venture between Engie and Marubeni Corp.) for the development of a regasification project in the port of Montevideo, which envisaged GNLS S.A. chartering an FSRU from MOL for 20 years.

The government has since announced plans to continue the project by using MOL’s FSRU and directly charter from MOL - it is the first project where MOL will solely build, own and operate the facility. The FSRU proposed for the project will be the world’s largest - with a storage capacity of 263,000 cubic metres - and is expected to commence service in mid-2017^[12].

Re-deployment is also a fundamental risk mitigation strategy for FSRU projects.

In 2008, Engie (then GDF-Suez) and MOL agreed to charter two FSRUs from Hoegh LNG (co-owned by MOL) on 20-year time charters to support its Neptune LNG Deepwater Port project in the US state of Massachusetts.

However, as the price of gas plummeted in the US, GDF-Suez decided to suspend the operations when the economics of importing gas became uncertain.

The vessels originally planned for use at the Neptune LNG Deepwater Port have since been repurposed. The “GDF-Suez Cape Ann” is currently operating as China’s first FSRU in Tianjin, China, having been sub-chartered in 2013 to China National Offshore Oil Corp

(CNOOC) for 5 years. The GDF Suez Neptune is currently utilised as an LNG carrier, having delivered LNG cargoes to the Everett import terminal earlier this year from Trinidad and Tobago ^[13].

Small-scale

The geographical profile of certain South East Asian countries such as Indonesia and the Philippines highlights the future growth opportunities for small scale FSRUs.

In Indonesia, the population is scattered across thousands of islands with varying levels of gas demand. The Eastern part of Indonesia, has certain areas with marginal gas demand in the range of 3 to 30 million standard cubic feet ^[14].

The procurement of a conventional FSRU (120,000 to 170,000 cubic metres) would be wholly unsuitable and uneconomical - in certain areas the water depth is too shallow for a conventional FSRU to operate.

A number of domestic companies have now identified that small scale LNG transportation and receiving terminals are the most suitable and efficient way

	FSRU	Commencement Year	Storage Capacity (m³)	Peak Regas Capacity (mmscf/d)	Yard	Owner	Charterer	Initial Charter Period	Location
1.	Express	2009	150,900	690	DSME	Excelerate Energy	YPF	N/A	Bahia Blanca GasPort, Argentina
2.	Golar Spirit	2009	129,000	250	Keppel (conversion)	Golar LNG	Petrobras	10 years	Pecem, Brazil
3.	Golar Winter	2009	138,000	500	Keppel (conversion)	Golar LNG	Petrobras	15 years	Bahia, Brazil
4.	GdF Suez Cape Ann	2010	145,000	750	Samsung Heavy Industries (SHI)	Höegh LNG, MOL and Tokyo LNG Tanker Co. Ltd	Engie (sub-chartered to CNOOC)	20 years	CNOOC Tianjin LNG, Tianjin, China
5.	Golar Freeze	2010	125,00	500	Keppel (conversion)	Golar LNG	Dubai Supply Authority	10 years	Dubai, UAE
6.	Exemplar	2011	150,900	690	DSME	Excelerate Energy	Repsol - YPF	N/A	GNL Escobar, Parana River, Argentina
7.	Nusantara Regas Satu	2012	125,00	500	Sembcorp Marine (conversion)	Golar LNG	Nusantara Regas	11 years	Jakarta Bay, West Java, Indonesia
8.	Excellence	2013	138,000	690	DSME	Excelerate Energy	Israel Electric Corp	N/A	Hadera Gateway, Israel
9.	FSRU Toscana	2013	137,500	530	Converted by Drydockas World in Dubai	E.ON Group, Iren Group, OLT Energy Toscana S.p.A. and Golar Offshore Toscana Limited	OLT Offshore LNG Toscana S.p.A.	20 years	Livorno, Italy
10.	Experience	2014	173,400	800	DSME	Excelerate Energy	Petrobras	15 years	Guanabara Bay, Rio de Janeiro, Brazil
11.	Independence	2014	170,000	384	Hyundai Heavy Industries Co., Ltd (HHI)	Höegh LNG	Klaipėdos Nafta	10 years	Klaipėda, Lithuania
12.	PGN FSRU Lampung	2014	170,000	360	HHI	Höegh LNG	Perusahaan Gas NegaraLNG	20 years	Sumatra, Indonesia
13.	Explorer	2015 (bridging solution prior to 2016 fully operational)	151,000	690 (800 post-upgrade)	Daewoo Shipbuilding & Marine Engineering Co., Ltd	Excelerate Energy	Dubai Supply Authority	10 years	Dubai, UAE
14.	Exquisite	2015	150,900	690	DSME	Excelerate Energy	Engro Corporation	N/A	Port Qasim LNG, Karachi, Pakistan
15.	Golar Eskimo	2015	160,000	750	SHI	Golar LNG	Jordan LNG	10 years	Port Aqaba, Jordan
16.	Golar Igloo	2015	170,000	750	SHI	Golar LNG	Kuwait National Petroleum Company	5 years	Mina al-Ahmadi, Kuwait
17.	Höegh Gallant	2015	170,000	500	Hyundai Heavy Industries Co., Ltd	Höegh LNG	Egyptian Natural Gas Holding Company (EGAS)	5 years	Ain Sokhna, Egypt
18.	BW Singapore	2015	170,000	750	SHI	BW Maritime	EGAS	5 years	Ain Sokhna Port, Egypt

The market has grown significantly since the first FSRU project in 2001. There are facilities planned for areas such as Africa and Latin America

for gas distribution in certain parts of Indonesia.

There are currently plans for a range of smaller scale FSRUs ranging from as little as 3,000 cubic meters to cater for certain isolated regions of Indonesia.

Issues

Small-scale LNG projects create a number of unique legal issues to consider such as the delivery mechanism, nomination procedure and take-or-pay mechanisms behind new forms of gas transportation such as LNG truck and container deliveries.

It is important to synchronise the terms of the primary LNG supply and FSRU charter agreements with the various downstream supply and end-user distribution agreements to ensure that risks are allocated appropriately.

However, further analysis of the economies of scale in the small scale FSRU market is required to understand whether such developments will be economically viable in the future.

The fundamentals show that smaller scale FSRUs on a per unit basis are more expensive than conventional FSRUs^[15].

As noted earlier, the capital expenditure required for a 170,000 cubic meter vessel is in the region of US\$250 million (although the cost would be closer to US\$100 million for a second-hand converted LNG carrier).

It is estimated that the cost for a 20,000 to 50,000 cubic meter FSRU would be in the region of US\$50 to US\$70 million (which would have to be a new build vessel as no FSRUs of this size have been constructed to date).

Conclusion

Over the past decade, the

FSRU market has changed considerably. This change has manifested itself in the now increasingly flexible charter party agreements and in some instances, a

number of risks are now being shifted on to the FSRU owners - we are now seeing seasonal charters and some shorter length charters.

On the financing side we have seen a variety of new financing options available for FSRU projects as lending banks' scepticism over the technology and



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development risk of FSRU projects seems to have abated.

In South East Asia, geographical and regional fluctuations in gas demand present significant opportunities for the small scale FSRU market – although the

economics of such projects need to be carefully considered.

There are a number of challenges on the horizon for the FSRU industry as it grapples with a change in some of the fundamentals that have underpinned the

industry for the past decade - cheaper oil presents fuel-on-fuel competition and the growth in the number of FSRU owners potentially presents a threat to profit margins.

However, looking ahead to the next

decade demand is continuing to increase – there are a further 30 FSRU projects currently being considered - and therefore any argument that suggests the industry will experience a slowdown should be carefully scrutinized. ■

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Opportunities exist in LNG and global natural gas markets even in uncertain times like these

Hoe Wai Cheong, President, Oil & Gas, Black & Veatch

The prolonged drop in oil prices continues to change the outlook for the global natural gas sector, including future infrastructure investment decisions. Not all prospects are gloomy, however.

What we are seeing is a new economic normal emerge. The gas sector is shifting from a sellers' to a buyers' market, and this shift will see winners and losers.

Changes

As recently as 18 months ago, optimism was high regarding the supply of gas, particularly in the form of liquefied natural gas (LNG) from North America to Asia. The shale-gas boom meant that a new, abundant lower-priced Henry-Hub-traded gas supply was available to export.

Demand in Asia for LNG was also robust. There was a growing demand for an alternative fossil fuel post the Fukushima tragedy and China's continued growth and its hunger for energy represented a potentially huge market for imported LNG.

Critically, indexed against the price of crude oil, Asia's considerably lower gas price meant a sizeable arbitrage

opportunity existed for shipping cooled natural gas from North America to Asia's shores.

A new normal

The oil price slump, a softening of the Chinese economy and recent thawing of opposition to nuclear power means that today the demand and price for gas in Asia has weakened.

Outside of long-term contracting, the spot market, although seasonal, is often a reasonable indicator of demand.

For seven consecutive months last year, between March and September, prices on Platts' Japan Korea Marker ranged at \$7-8/MMBtu (one million British thermal units). This contrasts with (winter) prices from recent years beyond \$15 MMBtu rising up to \$20 MMBtu in early 2014 and also shows a convergence of pricing with European hubs' prices.

Demand for LNG could be further hit in Japan if more nuclear facilities restart in what has been the world's largest importer of the fuel and accounts for more than a third of the total trade.



The Erdos facility in Inner Mongolia, China, will produce 200,000 tonnes per year for transportation, industrial and domestic fuel use in the country

The supply scenario is evolving also. The global LNG market is tipping into a state of structural oversupply as we move to 2020. Worldwide, according to the International Energy Agency, supply of LNG already exceeds demand.

Capacity

The last few years' dash to supply gas to Asia prompted a glut of liquefaction capacity development particularly in Australia and North America. By end of 2016, the first wave of increased supply from a number of these projects in Australia, Malaysia, Indonesia and the first US export Trains at Sabine Pass were coming into operation.

Most of these projects, however, are already committed to buyers as part of long-term negotiated contracts. One of the biggest near term effects will be to reduce Asia's reliance further on the spot market, leading to potentially even lower trading prices in Asia and a shift of these cargoes to trading markets in Europe.

This may also weaken the need of European buyers on pipeline gas from Russia and other locations. In addition, it would lend a strong hand to buyers' negotiating long-term contracts from the second or third wave of liquefaction projects both potentially delaying these projects as well as reducing price. We also foresee the terms of long-term deals evolving in favour of buyers in terms of flexibility volume and pricing.

Adding further to this picture was the lifting of economic sanctions on Iran. Home to some of the world's largest reserves including the giant South Pars

gas field, the government is looking to take advantage of post-sanction export deals. The discovery of gas resources off Egypt will also in time add further supply to the market.

Good visibility of future supply can be attained given the long lead of construction timelines for importing and exporting infrastructure. In contrast, this same visibility is not available when determining the projection of future demand.

Demand optimism

Despite near-term threats to demand for LNG in Asia, an optimistic longer term view would hold that demand is still under-developed. In 2013, LNG accounted for only 5 percent of Asia's total energy consumption and represents a considerable future growth prospect.

Asia's geography provides clues to long-term appetites for LNG. Sea separates most demand centers from supply centres whether they are in Asia (even sometimes within the same country) or from further afield locations. LNG, therefore, has a strong possibility of remaining a high-demand, safe-to-transport low carbon-emitting fossil fuel product in Asia.

Beyond power generation too, LNG has other industrial, commercial and residential uses. One such emerging use is as a bunker fuel in shipping.

Fuel market

The international Marpol Annex VI maritime emissions standards is beginning to prompt change.



Energia Costa Azul, LNG receiving terminal located in Ensenada, Mexico. It was the first regasification terminal on North America's Pacific Coast

Restrictions on emissions like sulfur and nitrogen oxide are tightening within designated emission control areas (ECAs), including the waters surrounding North America.

In a move to comply with these regulations, US shipping company Totem Ocean Trailer Express (TOTE) is deploying the world's first container ships fueled by LNG in favour of costly high-grade diesel upgrades or installing scrubbing technology, viewed by some as-of-yet not adequately advanced to meet the regulations.

Moves in Singapore have boosted this sector further. Singapore is the world's largest ship refueling destination with over 42 million tonnes of bunker fuel sold to vessels arriving at the city state.

The Maritime and Port Authority of Singapore launched its first Request for Proposal (RFP) for interested parties to apply for an LNG bunker fuel supply license in July.

LNG fueling facilities are also being built at major Korean ports to help the shipbuilding giants of Samsung, Hyundai, and Daewoo capture that market.

Less developed could be the emergence of LNG used on barge-based electricity trading centers in Asia.

Lower costs

The prolonged oil price drag is also having other impacts on the broader economic situation. Developers stepping back will see opportunities to avail of the lower general commodities prices.

For example, low iron ore and, in turn, steel prices mean construction costs are lower. Given the coinciding oil, gas and mining sector slowdowns, fierce competition prevails within the construction and engineering sector for

companies to compete for contracts. All this means that capital costs for developers to build should be lower than before.

The shale-gas boom has not gone away either. With NYMEX Henry-Hub prices averaging around \$2-3/MMBtu, the arbitrage opportunity of North American

projects, whether supplying Europe or Asia or elsewhere may still remain attractive.

Floating liquefaction may also remain

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appealing to developers globally, given the capital gains from such an emerging approach to processing - they are proving faster to build and more cost effective overall. The mobility of such a solution may also prove advantageous as the global dynamics of spot trading continue to evolve.

LNG investments must also be projected out at a minimum of 3 to 4 years into the future, given the average timelines to build and then supply customers with LNG. The picture being painted of future supply is more certain than how demand will evolve over that period.

Investments

Finally, if we step back and look across the industry, we are not seeing today as many LNG projects being postponed compared to the broader trend facing the upstream oil & gas sector as a whole.

Developers are continuing to press on. Demand within the LNG market is unlikely to be saturated and many developers in advanced stages of project development are conscious of losing momentum against other developers who have also made commitments to the race

to supply LNG over the next three to four years.

What is certain is that the market for LNG is changing. As long as gas prices remain segmented across the world, value for developers remains and a real market opportunity will exist if developers adapt their thinking to this emerging scenario.

In some cases, given the broader economic squeeze playing out today, counter-intuitively, this might indeed be a good time for developers who are low in debt to invest in the right project.

Black & Veatch

My company Black & Veatch has been engaged in LNG liquefaction and regasification for almost five decades, providing technology and a complete engineer, procure and construct (EPC) solution.

Following success on onshore liquefaction plants, Black & Veatch launched its well established liquefaction technology - PRICO® - for floating LNG (FLNG) applications in 2007.

In 2015 the Indian Oil Cor. Ltd awarded a Black & Veatch-led consortium the EPC contract for a new LNG receiving



EXMAR’s FLNG hull, a barge for liquefaction and temporary storage

terminal at Ennore, Tamil Nadu, India. Here are some more of the company’s LNG highlights:

EXMAR Caribbean

EXMAR’s Caribbean floating liquefied natural gas (FLNG) project is the world’s first non-propelled barge for liquefaction and temporary storage.

The Caribbean FLNG project is being completed by Wison Offshore & Marine’s Nantong shipyard in China, under an engineering, procurement, construction, installation and commissioning (EPCIC) contract with EXMAR.

In addition to providing PRICO® liquefaction technology, Black & Veatch is responsible for the detailed engineering and procurement of the topside equipment.

The unit is a non-propelled barge equipped to convert 72.0 million standard cubic feet per day of natural gas into LNG using a single PRICO® single mixed refrigerant train. The barge includes on-board LNG storage in three 6,500 cubic metres tanks.

Costa Azul

This, the first LNG terminal on North America’s Pacific Coast incorporates receiving, storage and regasification facilities.

Energía Costa Azul selected Black & Veatch to lead a global alliance to deliver the project. The scope of work included LNG berthing and unloading facilities, two LNG storage tanks, and regasification and send-out facilities.

The terminal and new marine facilities can receive carriers capable of holding up to 220,000 cubic metres of LNG.

The two, 18-storey storage tanks, hold LNG until it is gasified via open-rack vaporizers and delivered to the 42-inch pipeline.

The terminal can regasify up to 1.3 billion standard cubic feet per day of natural gas with room for expansion. It is fully self-sufficient and generates its own power, utility air, potable water and service water.

China operations

In China, Black & Veatch has undertaken 16 distributed LNG projects, more are planned.

The project at Erdos, is typical of this work. Erdos Xingxing Energy selected Black & Veatch and Chemtex to design and build an LNG facility in Erdos, inner Mongolia, People’s Republic of China.

The facility produces 200,000 metric tonnes of LNG per year for a variety of uses including transportation, industrial and domestic fuel.

China’s natural gas pipeline infrastructure is developing, and the country’s size presents challenges in supplying the much-needed clean fuel.

Black & Veatch’s patented PRICO® technology enables Erdos to quickly move LNG to market by reducing the gas volume 600 times by liquefaction and then transporting it by tank truck.

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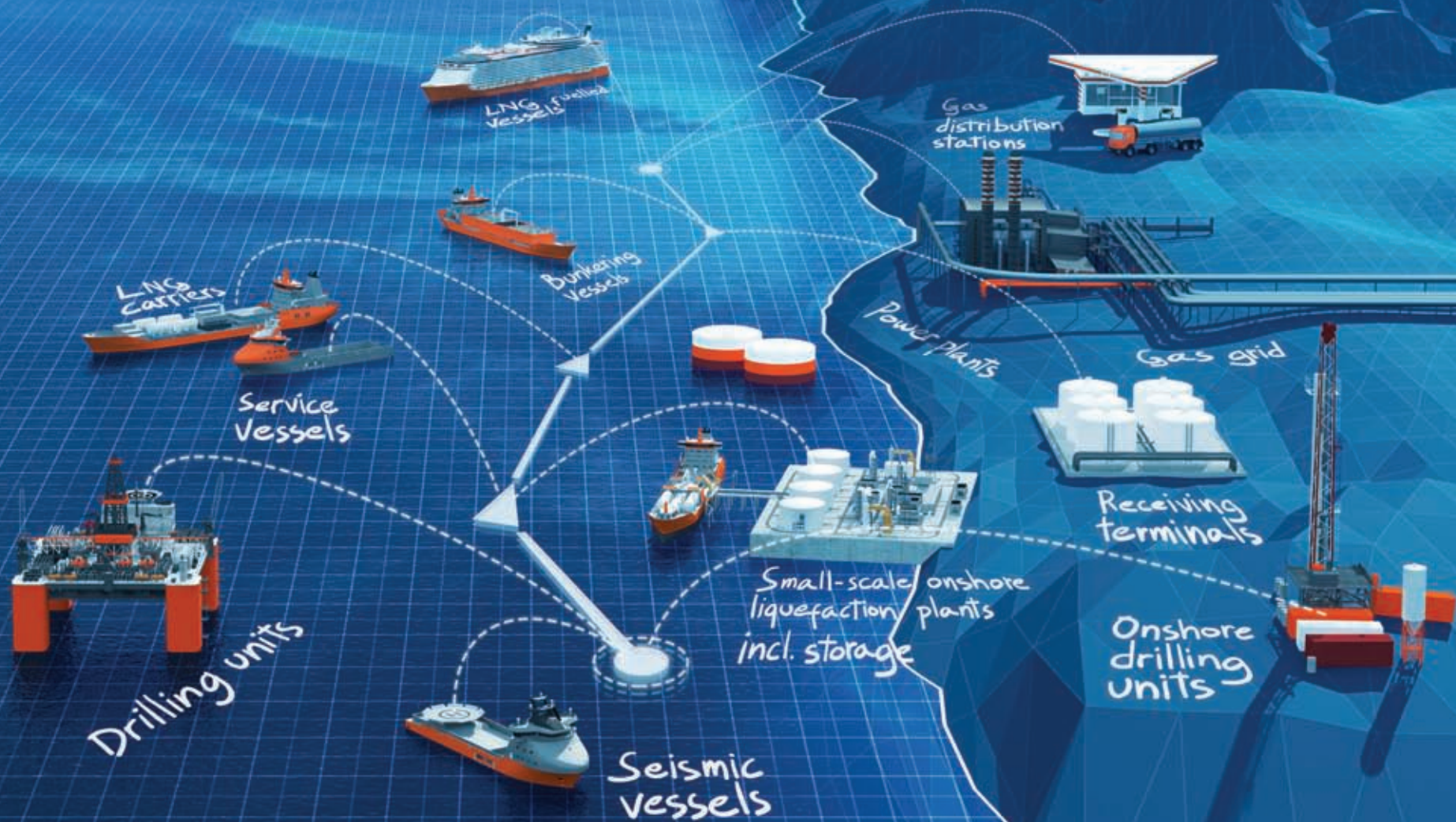
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For the Record

ANADARKO PETROLEUM, one of the developers of the main liquefied natural gas project of Mozambique, posted fourth-quarter and annual losses of \$1.25 billion and \$6.69Bln respectively as the oil downturn hit hard, though still remained upbeat about the southeast African nation's LNG venture. To handle the downturn, Anadarko had lowered its 2015 budget by almost 40 percent to \$3.37Bln compared with \$9.3Bln in 2014. Anadarko Chairman, President and Chief Executive Al Walker, said he would be following an even stricter strategy in 2016, while setting priorities. "As we consider capital allocation for 2016, greater market dislocation appears likely, and the need to again materially lower our capital spending, while continuing to pursue value creation and preservation, is our best course of action," stated Walker. "In light of this, we anticipate recommending to our Board an initial 2016 budget of approximately \$2.8Bln, which would be nearly 50 percent lower than our actual 2015 capital investments and almost 70 percent lower than 2014. On March 1, we will host an investor conference call and look forward to going into greater detail at that time about our definitive 2016 capital plans and expectations," he stated. "We believe the accomplishments achieved in 2015, coupled with the steps we are taking in 2016 to materially reduce our capital spending, leverage our competitive advantages and protect our balance sheet, will serve our shareholders well. These actions should enable us to successfully manage through the current market volatility and position Anadarko for future success," Walker added. "During 2015, Anadarko made significant progress in advancing its Mozambique LNG project," the CEO said. Walker pointed out that the

Mozambique LNG project highlight was the signing of an operating agreement with Italy's Eni for the development of the natural gas resources that straddle Anadarko's offshore licence Area 1 and Eni's Area 4 in addition to the overall project itself. The Area 1 shareholders led by Anadarko have an estimated 70 trillion cubic feet of feed-gas for LNG, while the Area 4 licence has a similar amount of resources. The straddling natural gas reservoirs that had been a point of contention will now be developed in a separate but coordinated manner by the two operators until 24 Tcf of natural gas, 12 Tcf from each Area, have been developed. "Anadarko also signed a Memorandum of Understanding with the Government of Mozambique to provide natural gas from the development for domestic use, selected a contractor for the initial onshore development and made progress in turning more than 8 million tonnes per annum of LNG into long-term sales contracts," the company said. The scope of Anadarko's onshore Mozambique LNG complex to be sited in the country's northeast coast, includes an initial two liquefaction Trains, each with capacity of 6 million tonnes per annum, which is an increase of 1 MTPA per Train over the original plan. That concept, however, was more ambitious and envisaged 10 Trains each with 5 MTPA of capacity and a total

output of 50 MTPA. The onshore liquefaction plant also includes a first phase comprising two LNG storage tanks, each with capacity of 180,000 cubic metres, condensate storage, a multi-berth marine jetty and associated utilities and infrastructure. Eni for its part is focusing on one or possibly two floating LNG projects in the Rovuma Basin

AWILCO LNG, the Norwegian shipping company with just two vessels currently operating in its fleet after two were laid up and another was sold, has found life tough as it has struggled to make money from the shorter-term charter market. Awilco has just posted a \$12 million loss for the fourth quarter and took its losses for the whole of 2015 to \$36.3M, according to its latest earnings statement. Awilco, a subsidiary of the Awilhelmsen Group, is the smallest LNG carrier fleet operator and was set up and listed on the Oslo Stock Exchange in 2011 to play the short-term charter market. It said freight income for the year amounted to \$37.4M compared with \$78.5M in 2014. "The decrease was due to low rates and reduced utilization caused by new vessel deliveries, reduced ton-mile as the price arbitrage West to East was limited," Awilco said. Fleet utilization for the company in 2015 ended at 61 percent compared with 86 percent in 2014. The

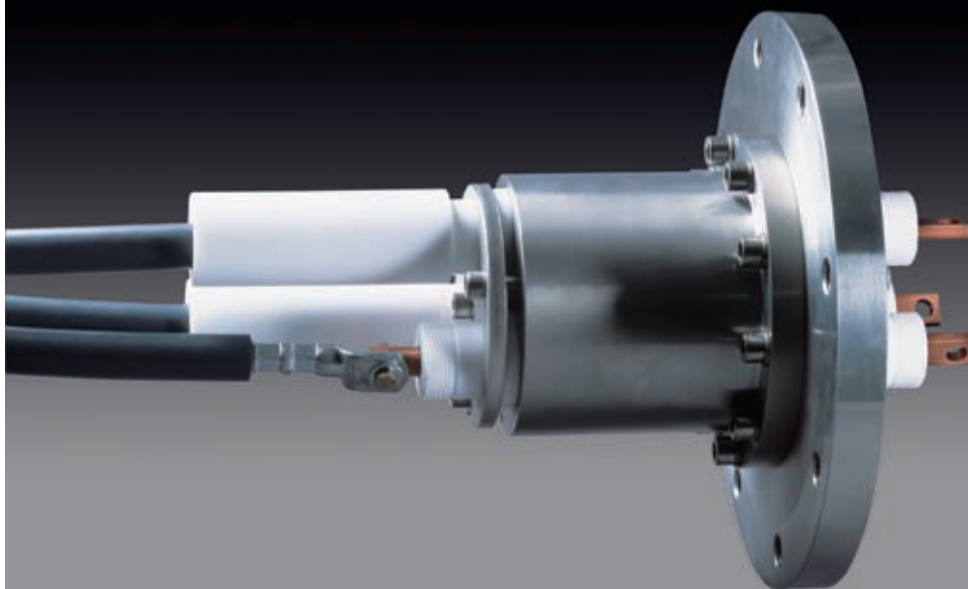
company said freight income for the fourth quarter was \$9.6M, up from \$8.3M in the previous quarter. The increase was due to a minor improvement in charter rates and more use being made of the "WilPride" carrier currently operating in the spot market. Voyage-related expenses were \$700,000, down from \$1.1M in the previous three months, due to the positioning of the "WilGas" in cold lay-up in the third quarter. Awilco owns two modern vessels of 156,000 cubic metres capacity with tri-fuel, diesel-electric propulsion and membrane storage tanks, the "WilForce", presently on a three-year charter, and the "WilPride". The company previously owned three modern vessels but the "WilPower" was sold to Teekay LNG in July 2015. It also owns two 125,000 cubic metres capacity Moss-type LNG vessels, bought second-hand and built in Japan before being renamed the "WilGas" and "WilEnergy". These two older vessels are laid-up and are being offered as possible conversion vessels for Floating LNG projects. Awilco said administration expenses for the fourth quarter were \$800,000, down from \$900,000 in the previous three months. Depreciation for the quarter was recorded at \$4.1M compared with \$4.0 in the previous quarter. An impairment loss of \$5.0M on "WilPride" and \$3.4M in total on the two older vessels, "WilGas" and

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"WilEnergy, was recognized in the quarter. Interest expenses on the "WilForce" and "WilPride" financial leases amounted to \$6.0M in the three months.

BEAR HEAD LNG project in the Canadian Atlantic coast province of Nova Scotia has become the most permitted liquefaction venture in the western world,

with 10 permits from Canada and two from the US and only the federal government in Ottawa could now stand in its way. The US Department of Energy

issued the final necessary permit when it said that feed-gas derived from US pipeline imports can be sold to countries that don't even have a free trade

agreement (FTA) with the US. The Bear Head LNG project is located on Nova Scotia's Strait of Canso near Port Hawkesbury on a site permitted and partially developed a decade ago. The liquefaction plant will process 8 million tonnes per annum from the facility which the developers point out is about half the shipping distance to major European markets compared with US Gulf Coast ports. The Bear Head venture is being developed by Australian company LNG Ltd, also responsible for a similar-sized project in the US state of Louisiana. The Nova Scotia venture now has both US DoE's authorization to re-export LNG made from US feed-gas to both FTA and non-FTA countries. The US decision is a determination that these exports are not inconsistent with the US public interest. The Nova Scotia venture now has the US export permits in addition to the 10 initial Canadian federal, provincial and local regulatory approvals needed to commence project construction, including the Canadian National Energy Board authorization to export up to 12 MTPA of LNG, the natural gas equivalent of around 1.8 billion cubic feet per day of natural gas. Additionally, Bear Head has been placed on the list of approved North American LNG Export Terminals by the US Federal Energy Regulatory Commission. Analysts said one possible remaining hurdle for the project is the new Liberal government of Prime Minister Justin Trudeau. The Ottawa government is seeking an



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overhaul of Canada's permit process for energy projects, with the federal cabinet saying it would have a veto on any project the does not fulfil its as yet undefined aims as regards leading the world on halting climate change. "Bear Head LNG is appreciative of the cooperation between the US and Canada in working out key energy regulatory issues," said Bear Head LNG President Maurice Brand, who is also Chief Executive of Australian parent company LNG Ltd. "Bear Head LNG is the first and only proposed Canadian LNG export facility to receive both the non-FTA authority from the DoE and all the initial regulatory approvals to commence project construction," the company said. Brand said his Nova Scotia venture was currently negotiating for feed-gas supplies from Western and Central Canada, from offshore Nova Scotia and from the abundant supplies available in the US. "With the DoE's non-FTA export approval, we are able to continue forward on US gas production as the third leg of our gas supply portfolio," said Brand. Bear Head LNG's Project Director John Godbold said that prompt

action by the US that gave both permits after only 12 months "was a tribute to the productive and open pre-filing discussions with DoE, coordination between the US and Canadian governments and Bear Head's submittal of an extremely robust application." Godbold noted that only two minor comments were received during the public comment period, further confirming the quality of the application and studies provided. In tandem with the non-FTA export permit, the US DoE determined that Bear Head LNG does not require DoE authorization for Canadian natural gas to pass through US pipelines (in transit) on its way to the export facility in Nova Scotia. Godbold said this outcome enhances Bear Head's commercial gas supply options by allowing a portion of supply requirements to come from Western and Central Canada largely using existing pipeline facilities. The Bear Head project previously said the front-end engineering and design work was being carried out by Houston, Texas-based engineering and construction company KBR. KBR has knowledge of the local Bear Head site

since it carried out the initial engineering work when the facility was first proposed as an LNG import terminal rather than an export plant before the shale-gas boom. The US company is also the lead engineer for the LNG Ltd. Magnolia plant in Louisiana that will also produce at least 8 MTPA of LNG when completed.

BRITISH COLUMBIA Premier Christy Clark said her provincial government was pursuing Canada's liquefied natural gas development policies in the face of several setbacks and "unforeseen global conditions" posing new challenges. The government's LNG strategy was reiterated in a speech delivered by the speaker of the provincial parliament in Victoria that came after Royal Dutch Shell delayed its final investment decision on starting the LNG Canada project until the end of 2016 at the earliest. BC admitted that the timeframe for bringing LNG to Asian markets had been pushed back by global circumstances. "A major component of your government's plan for a growing and diverse economy is the opportunity

presented by LNG," the statement said. There are 20 active projects at various stages of development. Over 30 investment partners are involved, and between them, they have invested some \$20 billion. "The government has done everything it set out to do to attract investment for the cleanest LNG in the world. As companies consider their best opportunities to reach final investment decisions, your government will continue to work to bring home the opportunity of LNG to BC," according to the speech. "Success is not for quitters. Success demands steadfast attention, and resiliency in the face of global challenges," the government stated. Question marks have also been raised about the regulatory process for LNG projects as the federal government in Ottawa takes more control of an energy policy focusing on the effects of climate change caused by fossil fuels like oil and gas. The BC government said it was not just a case of keeping the province's natural gas industry stable or deciding to expand in the future, but also saving the jobs of people who depend on the industry today.

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"As the world's cleanest-burning fossil fuel, demand for LNG will increase, and with it, the price," the statement continued. "And your government will ensure there is equity for future generations of British Columbians by establishing a Prosperity Fund, to leave an endowment for future generations, to pay down and eliminate the debt, and to invest in the services and infrastructure that British Columbians rely on to get ahead. As part of BC's innovative clean energy and tech sector, LNG has a vital contribution to make in the world. "Developing and growing economies in countries like China and India are looking for cleaner energy to power their future."BC has the potential to be a clean energy superpower, helping others reduce emissions - whether by replacing coal-fired plants with LNG overseas, or by supplying hydroelectric power to Alberta," it said. "Being a vital supplier of the things our neighbours and trading partners need is exactly how we are succeeding today. It is equally the plan for tomorrow. "But these accomplishments - and the prosperity that British

Columbians are working so hard to achieve - are at risk. "The global economy is fragile. Oil and gas and commodity prices have fallen drastically. And our country faces immense economic challenges. "Consider our neighbours in Alberta - a province of similar size, and also blessed with natural resources. "Over the decades, Alberta lost its focus. They expected their resource boom never to end, failed to diversify their economy and lost control of government spending. "So today, with the price of oil at historic lows, global markets shutting down, and the Canadian dollar falling, it has never been more important to stay vigilant. "To protect British Columbia from global trends - we must continue to work hard with determination, and resist the temptation to spend our way into trouble," the statement said.

CANADA's main liquefied natural gas project province British Columbia is sending a delegation to the federal capital Ottawa to seek answers to the outbreak of hostility towards LNG and pipeline projects under new Liberal Prime

Minister Justin Trudeau. BC Premier Christy Clark will lead the delegation, including four of her provincial ministers whose portfolios cover energy and the economy. The BC delegation will also include energy industry executives, members of the First Nations who support LNG ventures. The Pacific Northwest LNG project, regarded as the largest resources development project in BC's history at over US\$30 billion, is scheduled for an environmental approval by the Federal Government of Canada in 2016. However, this and other projects have been thrown into confusion on the regulatory front by words and actions from Trudeau and his supporters in areas such as Quebec. The Ottawa government outlined new measures last week for greater environmental scrutiny over pipeline projects and LNG ventures. BC Minister of Natural Gas Development, Rich Coleman said he was confident that progress would continue and Pacific NorthWest LNG, backed by Malaysia's Petronas, will finalize its investment, as will other LNG proponents such as Royal Dutch Shell's LNG Canada. "That could

all happen while the expansion of FortisBC's Tilbury LNG facility continues in Delta, near Vancouver," Coleman said in his most recent statement. "These are positive developments for just three of the 20 facilities now proposed in our province," Coleman said. "The progress made in BC in the last year is remarkable because these are challenging times in the industry, for reasons beyond our control. Global prices have fallen since we launched our LNG Strategy and just as companies are considering making huge investments - some of the largest in Canadian history. But here's what's important to remember: BC is in this for the long-term," he stated. The BC delegation is expected to discuss with the Trudeau federal government its plans for a new process that allows any current National Energy Board review to run its course, while giving the federal cabinet the final say until a new system is put in place. In addition to LNG, the new process is likely to lead to the delay or cancellation of two pipeline projects, TransCanada's US\$11 billion Energy East venture and Kinder Morgan's

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US\$4.7Bln expansion of the existing Trans Mountain pipeline from Alberta to Vancouver

CHINESE imports of liquefied natural gas declined by just over 1 percent year-on-year, the first fall in Chinese shipments since they first began at the Dapeng facility in Guangdong province in 2006, though growth is expected to return by 2017 because of lower prices. Energy majors such as France's Total, Royal Dutch Shell and ExxonMobil expect Chinese LNG imports to stay around the 20 million tonnes per annum mark in 2016. Their forecasts are also matched by the US Energy Information Administration in a report on Chinese LNG just published. LNG imports into China reached 2.6 billion cubic feet per day, the annual equivalent in tonnes of 19.63 million tonnes, in 2015 as Asia's economic powerhouse slowed down and other fuels such as coal were at even lower prices than LNG. China still remains the world's largest energy consumer and the third-largest importer of LNG after Japan and South Korea and will remain for now, though it should have overtaken Korea into second place by 2020. At the end of 2015, China had 13 LNG regasification import terminals with a combined capacity of 5.4 billion cubic feet per day, allowing the nation currently to import more than 40 MTPA if required. Several more terminals are under construction, with a combined capacity of 3.4 Bcf/d. These terminals are scheduled to come online in 2016 through to 2019. "However, the start-up of several terminals has been delayed because of a lack of

downstream demand," the US Energy Information Administration said. For example, construction of Jieyang LNG terminal in Guangdong was completed

last year, but the terminal has not been connected to a provincial pipeline network serving end users. "Additionally, many contracts to supply LNG at the new

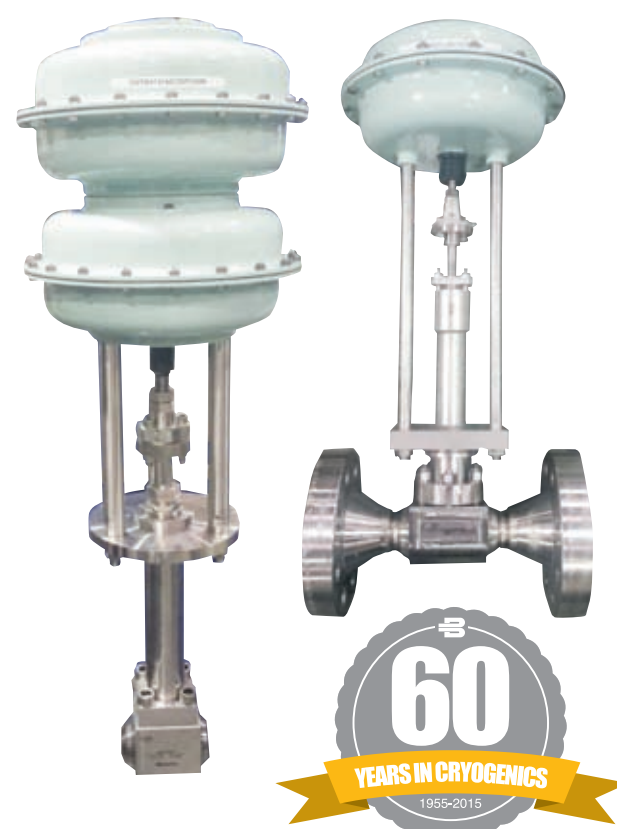
regasification terminals were signed when oil prices were above \$100/barrel, which makes long-term LNG prices less competitive than spot LNG," the EIA

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pointed out. "Chinese oil and gas companies have been trying to postpone shipments of contracted LNG to the new terminals and instead purchase lower-

priced spot cargoes," the report added. The EIA pointed out that in November 2015, the Chinese government lowered the ceiling for city-gate natural gas prices

for non-residential sectors by \$2.95 per million British thermal units (MMBtu), a decrease of around 28 percent. "Lower prices are expected to stimulate natural

gas demand growth going forward, particularly in the power generation and transportation sectors," the EIA stated.



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CHIYODA CORP., one of the leading LNG companies, said it was awaiting a final investment decision on building a liquefaction plant in the southeast African nation of Mozambique as its contract backlog remained high through awards in North America, Russia and Japan. Chiyoda said in its latest earnings that its backlog of LNG and natural gas work at the end of December 2015 amounted to 1,002Bln yen (\$8.6Bln). There was, however, a slowdown in the industry in terms of new orders. Chiyoda said its own new orders for LNG projects for the nine months of fiscal 2016 amounted to 152 billion yen (\$1.3Bln) compared with 552Bln yen (\$4.7Bln) in the corresponding period of fiscal 2015. The Yokohama-based company, which is almost 40 percent owned by Mitsubishi Corp, said nine-month revenues from LNG and natural gas project activities through December 2015 amounted to 277Bln yen (\$2.4Bln) compared with 191Bln yen (\$1.6Bln) in the same prior-year period. "In LNG and other gas-related works, the group was selected as an engineering, procurement and construction (EPC) contractor for an LNG plant in Mozambique, contracts for which are being negotiated with the client and are to be finalized in the near future," Chiyoda stated. "The EPC execution of LNG plants, two in the USA and one each in Russia and Australia, is in progress as planned and front-end engineering and design work for LNG plants in Mozambique, Canada and the USA, as well as a Floating LNG facility in

Indonesia, are also advancing," the Japanese company added. Chiyoda pointed out it was additionally working in Qatar on the engineering, procurement and construction management for the maintenance and modification of the existing LNG and gas processing plants for the world's largest LNG producer. "In Japan, EPC work on LNG receiving terminals and the expansion and modification of existing plants is in progress," it said. The company headed by President and Chief Executive Shogo Shibuya, said that during the first nine months of this fiscal year, the global economic environment remained uncertain. "While the US began to normalize its interest policy, the economic slowdown in emerging countries including China continued, and the global financial markets were in turmoil. In addition, there was geopolitical risk, especially the conflict between Iran and Saudi Arabia, the rise of IS (Islamic State) in the Middle East and the destabilization of Europe due to recurrent terrorist attacks," the company said. "The prolonged tumble in oil prices had an impact on the plant industry which is the Chiyoda Group's main business. We noted the lack of predictable patterns in short-term investment decision making for numerous oil and gas-related facilities," Chiyoda added. "The Japanese economy had ups and downs such as some capital investment backed by the government's easing of fiscal and monetary policies, the depreciation of the yen and lower oil prices, whether positive or negative, as well as the market contraction due to a declining birth rate," the company said.

CLEAN ENERGY Fuels Corp. of California said its sales of liquefied natural gas and compressed natural gas vehicle fuel made from organic waste

methane increased to 50 million gasoline gallon equivalents from 20 million gallons the previous year. Any natural gas vehicle from a taxi to an 18-wheeler truck can use

the fuel in LNG or CNG form under its marketing name "Redeem". The fuel, launched in 2013, is derived from biogenic methane that is naturally generated by

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OLT Offshore LNG Toscana S.p.A., mainly owned by E.ON Group and Iren Group, is the company which operates the floating regasification terminal 'FSRU Toscana'. The terminal is technologically innovative and well-advanced. It guarantees the maximum standards in terms of environmental sustainability and safety. "FSRU Toscana" is permanently moored off the Italian coast - between Livorno and Pisa - in the heart of the Mediterranean Sea. The terminal has a regasification capacity of 3.75 billion cubic meters per year and an LNG storage capacity of 137.500 cubic meters. The terminal is versatile in design and operation which allows the possibility for future LNG bunkering and distribution.

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the decomposition of organic waste at landfills and agricultural waste sources. According to the California Air Resource Board estimates, the LNG-CNG, which Clean Energy also calls "renewable natural gas", enables up to a 90 percent reduction in carbon emissions when replacing diesel or gasoline. Clean Energy, which is listed on the Nasdaq stock exchange and has its headquarters in Newport Beach, said the fuel brand's distribution had spread from stations in California to Oregon and Texas. The company said "Redeem" sales have expanded from its public-access re-fueling stations in California to become the contracted fuel choice of large customers like parcel delivery firm UPS, waste and recycling group Republic Services, the City of Santa Monica's public bus transportation and the University of California in San Diego for its fleet of 52 vehicles. "UPS is already its largest user and currently fuels close to 400 vehicles in California alone, and will now take delivery for portions of its delivery vehicle fleet in Texas," Clean Energy said. "Transportation leaders like UPS know that Redeem is the most cost-effective and environmentally friendly alternative to traditional diesel that they can use in their fleet vehicles," said Harrison Clay, President of Clean Energy Renewables. "No other fuel provider has the

infrastructure network and supply to offer RNG on the scale of Clean Energy. We believe our ability to expand geographically and add additional supply will result in more and more fleets relying on Clean Energy as their alternative fuel provider," Clay added. Clean Energy also produces standard LNG from natural gas at its liquefaction plant in Boron, California, and has almost 70 LNG and CNG fueling stations. It also recently supplied marine fuel for the launch at the General Dynamics NASSCO shipyard in San Diego of the "Isla Bella" container ship, which has LNG fuel propulsion.

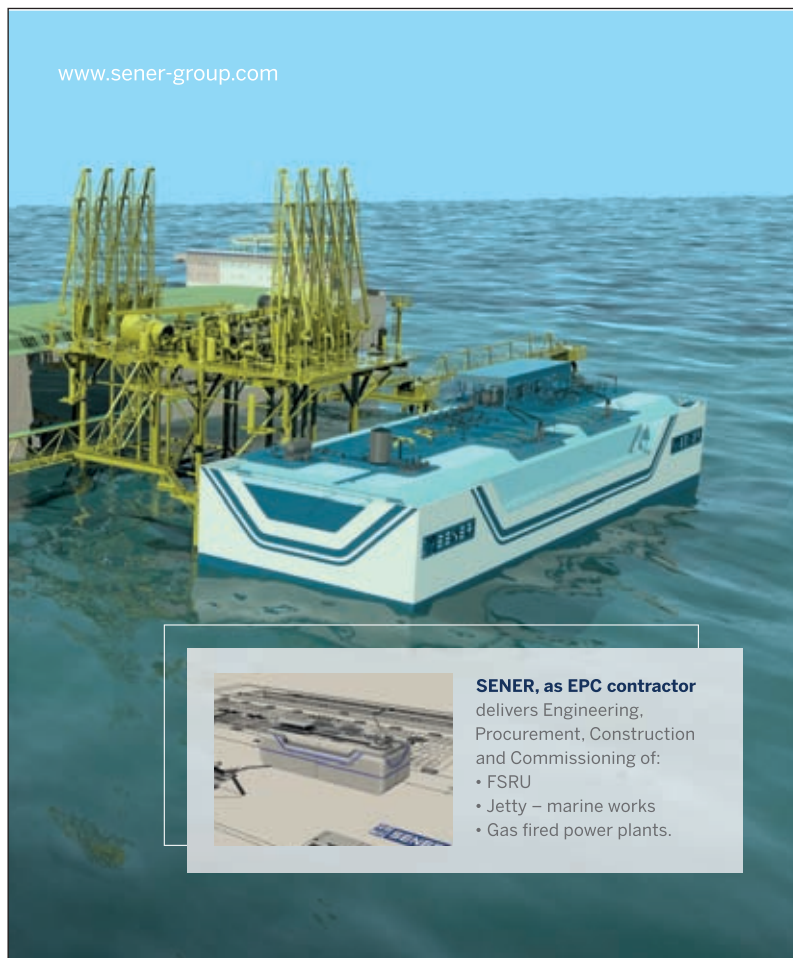
DELEK GROUP of Israel, one of the leaders of natural gas and LNG development in the Eastern Mediterranean's Levant Basin through its stakes in the Tamar and Leviathan gas fields, has signed a US\$1.3 billion agreement to supply two gas-fired power plants under Israeli and Turkish ownership. Israeli company Edeltech will buy the gas from the Leviathan field operated by Noble Energy of the US and which has Delek subsidiaries as partners. Edeltech said it would receive the gas for the plants it owns with Turkish partner Zorlu Energy in Ashdod and Mishor Rotem. Delek and its partners have already signed letters of intent to supply Leviathan natural gas to customers in

Jordan, Egypt and the Palestinian Authority. These include options to supply feed-gas to an Egyptian LNG production plant. Delek's subsidiaries Avner Oil and Delek Drilling own just over 45 percent of the field resources and main partner Noble has 40 percent. The 15 percent balance is held by Ratio Oil Exploration. Under the latest deal, the Leviathan partners will supply a total of 6 billion cubic metres to the Edeltech-Zorlu plants. Delek said the 18-year agreement will come into force as soon as the Leviathan field begins commercial production of natural gas. The parties are entitled to extend the term of the Supply Agreement by a period of up to two additional years. "The gas price determined in the supply agreement shall be linked to the electricity production tariff, as determined from time to time by the Public Utilities Authority-Electricity, and includes a floor price," Delek said. "The Leviathan partners estimate that the aggregate revenues from the sale of the natural gas to Edeltech during the term of the agreement may amount to approximately US\$1.3Bln, assuming that the buyer shall consume the total contractual quantity," it added. The agreement includes several conditions, including the approval of the Leviathan reservoir's development plan and receipt of a license for the gas transportation

system from offshore to Israel. Edeltech company is a private firm owned by the Edelsburg family. The buyer and Turkey's Zorlu are partners also in the Dorad power plant and other cogeneration businesses, Ashdod Energy and Ramat Negev Energy. Delek is focusing its East Med energy business on the Leviathan and Tamar fields with about 40 trillion cubic feet of reserves. BG has additionally signed a preliminary accord for feed-gas from the Leviathan field for the Idku LNG export plant in Egypt, located near the city of Alexandria. Delek and its partners are also developing the Aphrodite field, offshore Cyprus, with LNG feed-gas supply options.

DNV GL, Western Europe's leading classification society and the Russian Maritime Register of Shipping signed a cooperation agreement in St. Petersburg covering the Polar Code, including the transport of liquefied natural gas and other fuels and the development of gas-fuelled ships. The accord was signed between Hamburg, Germany-based DNV GL Chief Executive of Maritime activities Knut Orbeck-Nilssen and his Russian counterpart Konstantin Palnikov, Director General of RS. The accord was in the form of a bilateral framework agreement for broad cooperation between both class societies. DNV GL is one of the

largest global class societies after it was formed in 2013 from the merger of Norway's Det Norske Veritas and Germany's Germanischer Lloyd. During the talks in Russia, DNV GL and RS expressed satisfaction at the positive experience of cooperation in the dual classification of ships. Currently there are 20 ships that are in the dual RS-DNV GL class. These include mostly oil tankers, though LNG shipping using the Northern Sea Route through Arctic waters will begin to appear in the NSR when the Russian Yamal LNG project is completed by 2018. The two companies discussed prospective areas of further cooperation that would enable them to effectively complement each other's competencies. Priority cooperation areas



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include ensuring compliance of ships with the requirements of the Polar Code, rendering of relevant expert assistance to stakeholders and developing interpretations of the Code's provisions building on RS and DNV GL's experience. The talks also touched upon cooperation aimed at improving technical standards for the safety of LNG-fuelled ships. "The new framework document sets out the general procedure for delegating authority in cases where one society performs surveys of ships classed by the other, and lays down general terms and conditions for cooperation in the area of dual classification of newbuildings and ships in service, surveys of materials and equipment for ships," they said. "We look forward to strengthening our cooperation with RS, which will benefit the Russian maritime industry and our long-term partnerships with Russian clients," said Orbeck-Nilssen.

ENERGY TRANSFER EQUITY said it was still on course to make a final investment decision on the Lake Charles LNG export project in Louisiana with new partner Royal Dutch Shell and the facility could be in operation by 2020. Energy Transfer has a controlling stake in the Lake Charles project and the balance is held by Shell in its share inherited from BG Group in the oil major's takeover of the UK company. "Royal Dutch Shell completed its acquisition of BG and final investment decisions from Shell and LCLNG are expected to be made in 2016, with construction to start immediately following a positive decision, and first LNG exports anticipated about four years later,"

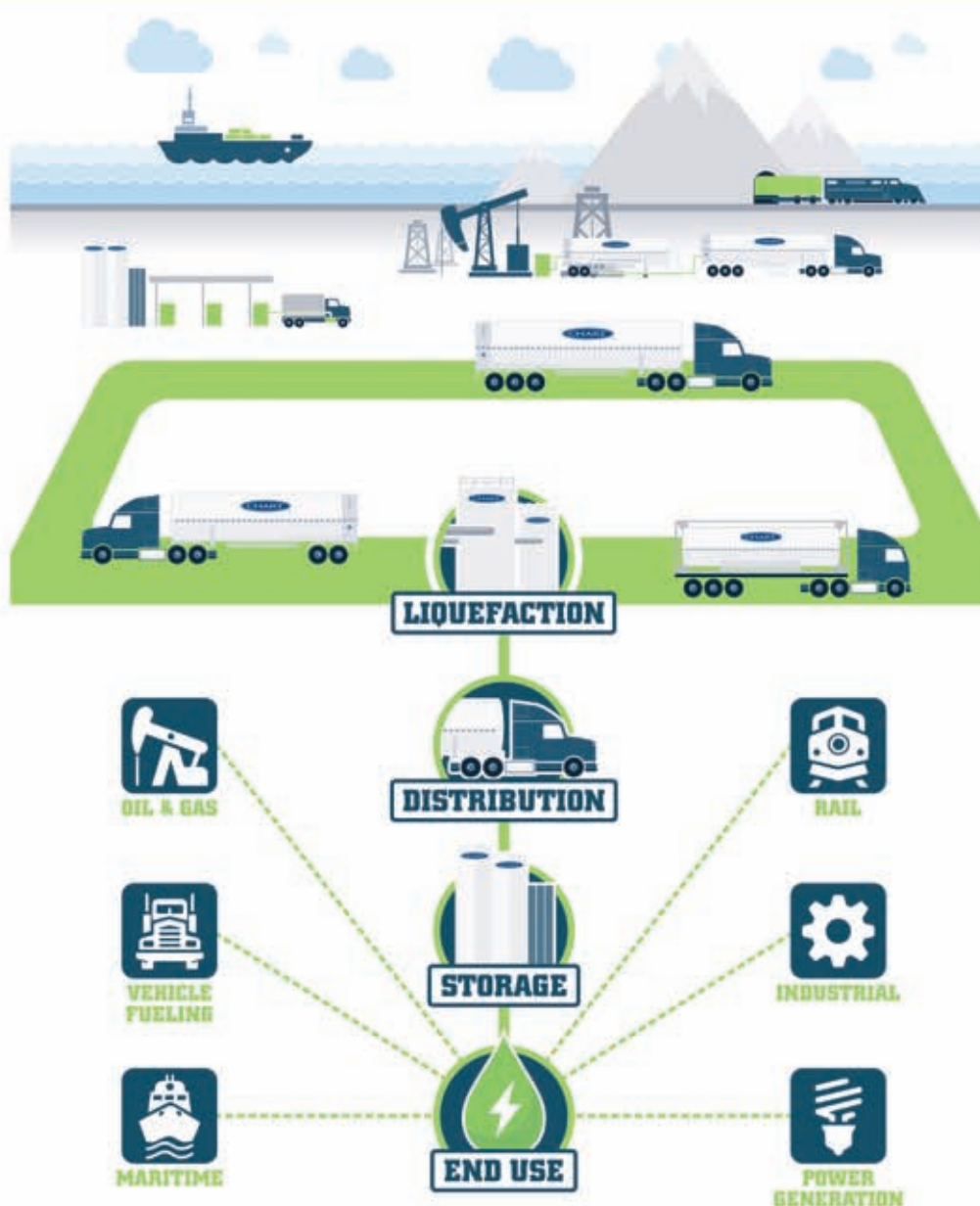
Energy Transfer said. The Lake Charles terminal is one of the oldest in the US, having been certified by the US Federal Energy Regulatory Commission as an

import terminal since 1977. BG had been an LNG importer there since 1982. ETE, based in Dallas, has a controlling stake in the Lake Charles terminal and the export

project. The FERC in December 2015 gave the final approval for the transformation of the Lake Charles facility to produce and export 16.5 million

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tonnes per annum of LNG. Through its midstream operations, Energy Transfer owns and operates about 35,000 miles of natural gas pipelines and more than 50 natural gas processing and treatment facilities. However, one hold-up for the Lake Charles LNG project could be the fact that Energy Transfer is also in the middle of a \$33 billion merger with fellow midstream and pipeline company Williams. The agreed ETE-Williams combination would create the third-largest energy company in North America and one of the five largest in the world. The initial Energy Transfer-Williams merger was announced in September of 2015 and since then the US energy markets have plunged even further. Reports say that Energy Transfer may be contemplating abandoning the Williams deal and offering Williams a \$2 billion cash payment to walk away. Energy Transfer and Williams both recently reported their latest earnings. Neither company gave clarification on the ongoing merger process, though Energy Transfer spoke positively on the Lake Charles project.

ENERGY WORLD Corp. said it was aiming to complete the first LNG import terminal in the Philippines by December 2016 as it outlined its strategy for the facility. EWC also intends to finish the Indonesian Sengkang liquefaction plant by the same deadline and may expand the output to 5 million tonnes per annum in the longer term. The Australian-listed company from Hong Kong said in its half-year earnings report that it was still finishing the final sections of what it calls the Philippines LNG Hub and the Sengkang production plant, with 2016 commissioning on course for both. The LNG import terminal at Pagbilao in Quezon province of the Philippines will have initial throughput capacity of 3 MTPA. Adjacent to the facility, EWC is also developing a 600 megawatts gas-fired power plant to sell electricity into the main Luzon power grid. The 130,000 cubic metres capacity LNG storage tank for the Philippines terminal is already complete along with the carrier-loading jetty. "Our Philippines Hub will primarily be used to facilitate the distribution of LNG and natural gas,

including receipt, storage and dispatch of LNG cargoes, to four main markets," EWC said. "The users will be throughout the Philippines, with distribution by sea to other small-scale coastal terminals. We expect these terminals to have facilities for LNG to be sold and shipped by road tanker. "Other domestic sales in the Philippines is in the form of LNG and compressed natural gas fueling vehicles. Marketing of LNG will also be to other purchasers in the Asia Pacific region," it added. "For medium and long-term purposes, our Philippines power plant will serve as a principal purchaser of LNG from our Hub," it said. "The availability of these sales channels will be subject to our obtaining necessary licences and approvals, including export approval if we decide to market the LNG outside of the Philippines," EWC said. "We believe the location of the Philippines Hub along international LNG trade routes will facilitate the development of an Asian LNG spot market. However, we have not yet entered into any binding arrangements for the sale of LNG or gas from the Philippines Hub," it said. EWC said it envisaged supplying LNG sourced from its own gas fields and produced at the Sengkang liquefaction plant in the Indonesian region of South Sulawesi. The Sengkang project will consist initially of one modular LNG Train with a capacity of 500,000 tonnes per annum, with the three additional Trains planned of the same capacity depending on gas field development, giving a potential total output of 2 MTPA. Because of hold-ups that came after approval of development plans for the Wasambo gas fields, major equipment for the liquefaction plant has been at the site since June 2013 and is slowly being installed.

FLUOR Corp., the US LNG and energy engineering company, was awarded the contract for another phase of the Cutbank Ridge project as part of the long-term development of natural gas resources in northeast British Columbia that will eventually underpin LNG production plants. The Cutbank Ridge partnership involves Canada's Encana Corp. and Japanese trading house Mitsubishi Corp., which has been building up its North American natural gas and LNG assets. Mitsubishi paid US\$2 billion for a 40 percent partnership interest in about 409,000 net acres of Encana's undeveloped Montney Shale play. The Montney formation is part of Encana's Cutbank Ridge resource that spans northeast BC and the northwest of the province of Alberta. The Montney has produced natural gas since 1998 and Encana has been active in the area since 2004. Fluor will now execute the engineering, procurement and construction management for a venture called the Saturn 15-27 Phase 2 Sweet Gas Plant Project near Dawson Creek, BC. The project is part of a larger Cutbank Ridge programme to develop natural gas and natural gas liquid production with three similar projects: Sunrise 04-26, Tower 03-07 and Saturn 15-27 Phase 2. Fluor is currently executing the EPCM for all three projects. "Fluor has been supporting these projects since the initial conceptual stages, and we look forward to taking them through the EPCM phase and delivering the completed facilities," said Jim Brittain, President of Fluor's Energy & Chemicals business in the Americas. "We will leverage the best practices and synergies gained from each of the projects to deliver a capital-efficient solution to the Cutbank Ridge Partnership," Brittain added. The new



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May

Flame - Europe's Leading Natural Gas & LNG Conference

May 9-12, 2016
Hotel Okura - Amsterdam
Netherlands
www.icbi-flame.com

June

The 11th Annual Conference FLNG 2016

June 6 - 9, 2016
Hyatt Regency - The Churchill
London, UK
www.icbi-events.com

14th World LNG Series: Americas Summit & Exhibition

June 7-10, 2016
Houston, Texas
USA
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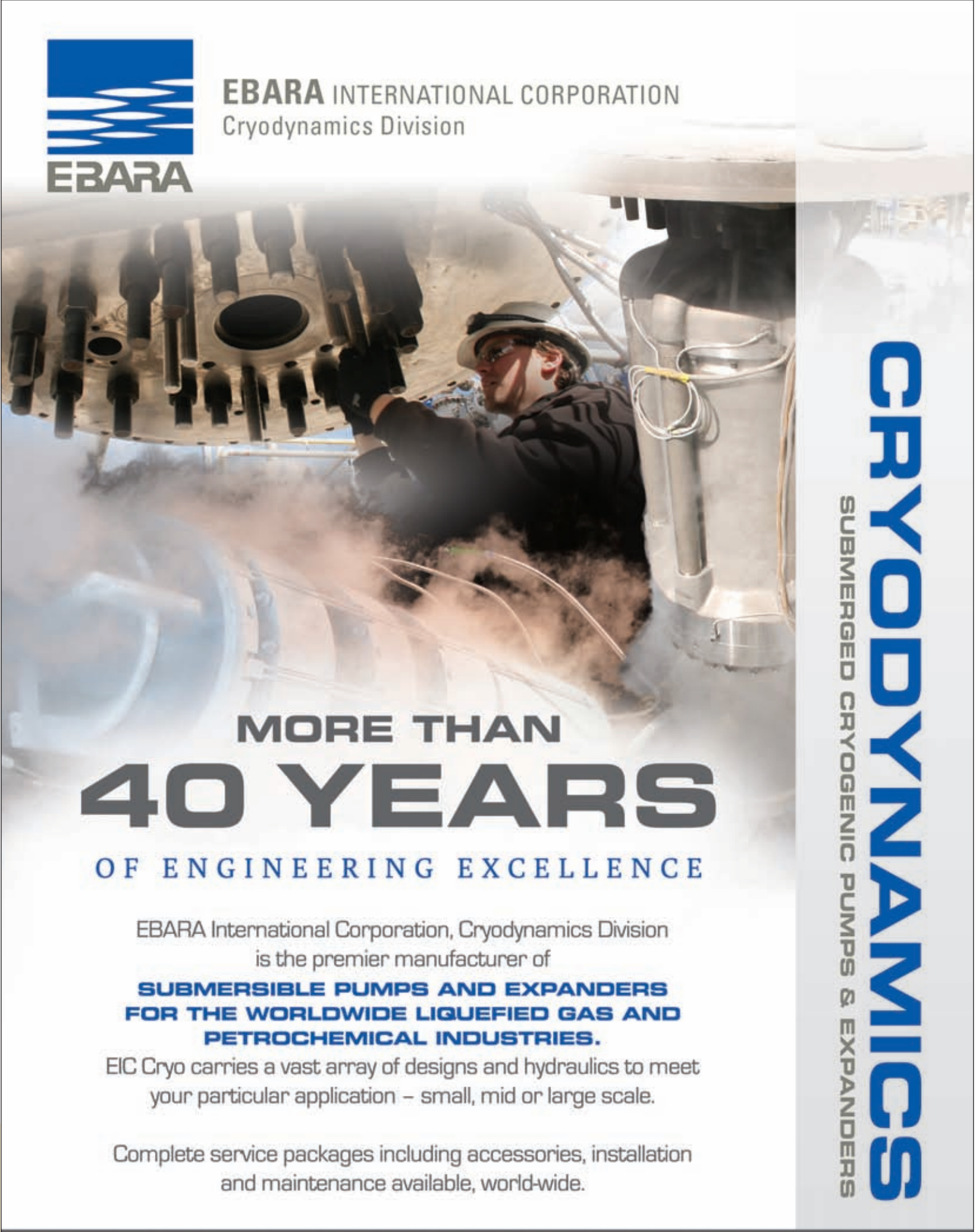
facilities will receive sweet natural gas, remove water and hydrocarbons, chill and compress the gas to meet transmission pipeline requirements and recover NGL from the gas streams. The plants will have the capacity to process a combined additional 800 million cubic feet of gas per day. Mitsubishi, a shareholder in nine liquefaction projects worldwide, is part of the LNG Canada project near Kitimat in BC, led by Royal Dutch Shell. However, the final investment decision has now been postponed until at least the end of 2016. The Japanese conglomerate also recently completed a transaction to take over the whole of US natural gas and oil marketing company Cima Energy to strengthen its position in LNG projects in North America at a time when other companies are cutting back. Mitsubishi, which already held 34 percent of Cima, has now formally taken full control of the Houston-based company for an undisclosed sum. The Japanese company also has LNG stakes in ventures such as Cameron LNG in Louisiana, and projects in Australia, including the Browse Floating LNG venture. It even brought on stream its own liquefaction project in Indonesia in 2015. The Donggi Senoro LNG export plant in Sulawesi marked a revival in Indonesia's LNG capacity previously hit by under-investment in new feed-gas fields.

GAS AUTHORITY of India (GAIL), the transmission company and LNG importer, has won a supreme court ruling in New Delhi to resume pipeline construction to revive the Kochi LNG terminal in the state of Kerala that has been

hindered by a lack of inter-connections. GAIL currently has regasification capacity at three of India's four operating LNG import terminals at

Dahej and Dabhol on the west coast near Mumbai and at the Kochi import terminal in the southwest Kerala state. The Kochi terminal, the nation's newest,

was commissioned in 2013 with only 45 kilometres of pipeline connected. The Dahej and Kochi terminals are owned by Petronet LNG. However, the Kochi



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facility has been unable to operate effectively and has been restricted to supplying local industrial customers because of a lack of progress on pipelines. The court ruling means that GAIL can now proceed with the Kochi-Kottanad-Bangalore-Mangalore Pipeline project along its original route in coordination with the Government of Tamil Nadu. The pipe-laying work will now resume on the 310-kilometre stretch passing through the state of Tamil Nadu. The Kochi LNG terminal can also now be expanded to boost capacity. "GAIL is committed and deeply engaged in creating the national gas infrastructure which is the backbone for economic development of the country," the company said after the ruling. "GAIL will continue to work closely with the Government and people of the State of Tamil Nadu to execute this project in a time-bound manner. On completion, the project will provide access to modern and clean fuel critical for economic growth and quality of living for citizens in the state," it added. The completion of the inter-state pipeline from Kochi LNG will allow the wider distribution of regasified LNG after delays already lasting three years. "Once laying of the remaining pipeline is completed, Kerala will find a place on the gas pipeline map of India," GAIL said.

GAZTRANSPORT and Technigaz (GTT), the French LNG storage tank technology provider for carriers, signed a cooperation agreement with the South Korean shipbuilder Daewoo Shipbuilding and Marine Engineering for the manufacture of its new type No. 96 Max design and the commercialization of the system in 2016. GTT said the agreement stipulates that DSME will build a mock-up aiming at validating both the assembly and the cryogenic performance of the membrane containment system. Philippe Berterottiere, Chairman and Chief Executive of GTT said the development of the new version of the storage system illustrated the continuous innovation efforts at the French firm to support the LNG industry. "The agreement shows once again that the partnership we have with DSME is strong and that this shipyard trusts our technologies," Berterottiere added. GTT said the accord also included a study on the adaptation of industrial techniques to optimize manufacturing costs. As sector leader in LNG storage, GTT is able to sell licensing agreements around the world for around \$10 million per licence to install its technology in vessels. "After some years of research and development, the No. 96 Max technology is an optimized version of the No. 96 system used in more than 120

vessels to date," GTT said. "The innovative design offers significant mechanical and thermal improvements (boil-off rate). "This technology has already received AIPs (Approval in Principal) from the main classification societies," GTT stated.

GHANA National Petroleum Corp. and Quantum Power, the pan-African energy infrastructure investment firm, signed an agreement setting out terms for the construction and operation of LNG storage, regasification and delivery facilities at the port of Tema. The Tema project, also backed by a Golar Floating LNG regasification vessel to be deployed offshore and Nigerian cargo deliveries, will be able to handle 3.40 million tonne per annum of LNG, equivalent to 500 million standard cubic feet of gas per day. An associated subsea and onshore pipeline will deliver the natural gas to GNPC and its customers onshore. The Tema project, comprising a capital outlay of over \$550 million, will be implemented on a build-own-operate-transfer basis with the assets transferring to GNPC after the project's 20-year term. The start of operations is scheduled for the end of 2016 and will meet the West African nation's growing energy needs. "The Tema project will provide GNPC with the flexibility to manage volatility in power

demand and fluctuations in domestic gas supply, while mitigating the effect of unpredictable rainfall on Ghana's power balance," a statements said. The Tema venture has been under development for three years and the Golar FSRU will be moored 12 kilometres offshore in the Gulf of Guinea. Alexander Mould, Chief Executive of GNPC, said the agreement with Quantum Power was a step forward. "As the national gas sector aggregator, GNPC is leading Ghana's efforts to develop the gas-to-power value chain supporting the Government's vision of energy security for accelerated economic growth. The Tema LNG project is a critical component in achieving this vision as it allows for the diversification of fuel supply sources," Mould said. Matty Vengerik, CEO of Quantum Power, which has offices in London and Cyprus, said he was delighted to partner GNPC to deploy this "cost-efficient and clean" fuel supply infrastructure for Ghana. "This is the first such project to be implemented in sub-Saharan Africa," said Vengerik. "The combination of increased certainty-of-supply with the cost-savings inherent in LNG supply has a significant multiplier effect on the economy at large, as it reduces risk for commercial and industrial activities and increases Ghana's attractiveness as an investment destination," he added. Quantum has

current operations in many African countries, including Kenya, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa and Zambia.

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GOLDBORO LNG has become the second export project in the Canadian Atlantic coast province of Nova Scotia to receive all its US regulatory approvals to use feed-gas from across the border, process it and export it to third countries. The Goldboro parent company, Calgary-based Pieridae Energy, said it received a permit for Non-Free Trade Agreement (FTA) countries following authorization given to the nearby Bear Head LNG venture in the province. Pieridae President and Chief Executive Alfred Sorensen said the permits would

allow Nova Scotia to take a Canadian "leadership position" in LNG. The DoE permits allow both liquefaction ventures to use US-sourced natural gas to export as LNG to countries which do not have an FTA with the US. The Goldboro LNG project plans to produce around 10 million tonnes per annum of LNG, the equivalent of 487 billion cubic feet per annum of natural gas. Pieridae has already entered into a long-term LNG sales agreement with the commodities subsidiary of a German utility group. The Canadian company said the latest authorization supplements the permit received from the DoE in 2015 to export to FTA nations. The Non-FTA permits allow US exports to nations like Japan, China and the European Union while FTA authorization is for US regional allies in the Caribbean and Latin America, as well as some Asian and Mideast countries and South Korea. These US permits, combined with the National Energy Board of Canada authorizations to import US-sourced natural gas to Canada and then re-export it, will allow the Goldboro LNG project to serve substantially all global LNG markets. "It will also allow Pieridae to more efficiently manage gas supply feedstock for LNG deliveries to Western and Southern Europe, where its primary customer Uniper Global Commodities (formerly E.ON Global Commodities), has its base of operations," Pieridae said. "We appreciate the support we received from the federal Ministers of both Global Affairs Canada and Atlantic Canada in advocating for Canadian business as Pieridae proceeded through the US regulatory permitting process," said Pieridae CEO Sorensen. "This support,

along with the continued support of the Nova Scotia Minister of Energy and the Minister of Natural Resources, will help the province take a leadership position in

this industry," Sorensen stated. Pieridae earlier acquired 265 acres of land from the District of Guysborough, located in the Goldboro Industrial Park, where it

will build the liquefaction plant. The company has retained US engineering and construction company Chicago Bridge and Iron (CB&I) for the front-end



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engineering and design ahead of the final investment decision scheduled for late 2016. The Goldboro LNG plant will also have at least two full containment LNG storage tanks, each with a capacity of up to 230,000 cubic metres and the facility is expected to enter production by 2020.

KINDER MORGAN, the US pipeline and terminal operator, has received the go-ahead for its Elba Island liquefied natural gas export plant at an existing import terminal near Savannah in the state of Georgia and in which Royal Dutch Shell was previously a partner. The Federal Energy Regulatory Commission recommended authorizing the project as there were no significant adverse impacts that could not be alleviated with mitigation measures recommended by the regulator. The FERC issuance of the environmental assessment kicks off the 90-day countdown to a Federal authorization decision set for May 5, 2016. The Elba Liquefaction project plans to produce and export up to 350 million cubic feet of LNG per day, amounting to 2.5 million tonnes per annum of the fuel. Under the current schedule, the Georgia liquefaction plant could be producing LNG by the start of 2018. Kinder agreed in July, 2015, to buy Shell's 49 percent stake in the Elba Island terminal, leaving the pipeline company with 100 percent of the facility. The transaction cost Kinder \$630 million, bringing its total investment in all the

liquefaction and terminal facilities at Elba Island to about \$2.1 billion. While Shell sold its stake in the terminal, the Anglo-Dutch company will remain as a customer. Changes to the existing Elba Island import terminal include the installation of up to 10 small modular liquefaction units, a flare system, other infrastructure and modifications to the terminal piping system. To facilitate the supply of natural gas to the Elba LNG terminal for liquefaction, the company is proposing to add compression along its existing Elba Express Pipeline in Georgia, the FERC was told. These new facilities would include the addition of various compressor stations and some interconnecting pipelines. Kinder's operating company, Southern LNG, proposes to construct and operate new and modified compression and metering facilities in Hart, Jefferson, and Effingham Counties, Georgia, and in Jasper County, South Carolina. However, to avoid any regulatory delays, the Kinder project abandoned existing LNG truck-loading facilities at the LNG Terminal in Chatham County, Georgia. "The FERC staff concludes that approval of the proposed project, with appropriate mitigating measures, would not constitute a major federal action significantly affecting the quality of the human environment," the statement said. The existing terminal is on Elba Island, an 840-acre private island near Savannah, and was first authorized by

the FERC in 1972 as an import facility. The terminal is about 8 miles upstream from the mouth of the Savannah River. "Construction of the liquefaction facilities would generally take place on the island and within the LNG terminal boundaries. However, the companies are proposing some dredging work within the South Channel (on the south side of Elba Island), expansion of the access road to the island, and the use of one off-site staging area," the FERC was told. "The existing truck-loading facilities would be abandoned as part of the first phase of the project. The liquefaction facilities would share common equipment and infrastructure such as storage and loading-unloading areas, LNG storage tanks, pumps, piping and docks to support both the import and export of LNG," according to the FERC statement.

LNG LTD, the Australian developer of the US Magnolia liquefied natural gas project in Louisiana has extended for six months the date for a financial closing of a tolling agreement that will see cargoes shipped from the US Gulf Coast to a new UK terminal. The developer, LNG Ltd, had planned to close a transaction with Meridian LNG Holdings Corp., a unit of a Canadian-based equity fund, for up to 2.00 million tonnes per annum of LNG from the Magnolia liquefaction plant. The accord was for firm annual capacity of 1.7 MTPA with a further 0.3 MTPA to be offered at Magnolia's discretion out of the

planned 8 MTPA of total output at the plant to be built on the Calcasieu Shipping Channel near the Port of Lake Charles. With no other binding accord in place for the remaining 6 MTPA of capacity, LNG Ltd. said the deadline for the agreement to be formalized has been pushed back from June 30, 2016, to December 31, 2016. "The overall financial close date for the Magnolia LNG project is dependent on the execution of more binding agreements (on capacity) which is uncertain due to current market conditions," said LNLG Chief Executive Maurice Brand. "The extension of time with Meridian LNG provides additional time for Magnolia LNG to finalize additional offtake agreements," Brand added. Meridian's accord was for the 2 MTPA of booked tolling to be delivered to a UK floating import facility it planned to develop at Barrow-in-Furness in Cumbria, northwest England. Under the deal, Meridian LNG is responsible for procurement and delivery of feed gas to the liquefaction plant and for arranging all LNG shipping required to transport the LNG from the Magnolia liquefaction plant in Louisiana to its customers. The UK Port Meridian facility was to have been provided and operated by Norway's Hoegh LNG and the regasified cargoes provided to Germany's E.ON Global Commodities (EGC) for distribution in the UK market. In April of 2015 Meridian and E.ON signed a 20-year gas sales agreement and under it the German company agreed to purchase the regasified cargoes from the Meridian terminal. The Magnolia cargo agreement marked a critical step towards the completion of the Port Meridian project in getting a commitment for the delivery of up to 750 million standard cubic feet a day of natural gas to E.ON in the UK from 2019.

MITSUBISHI CORP. of Japan has completed the transaction to take over the whole of US natural gas and oil marketing company Cima Energy to strengthen its position in liquefied natural gas projects in North America at a time when other companies are cutting back. Mitsubishi, which already held 34 percent of Cima, has now formally taken full control of the Houston-based company for an undisclosed sum. The Japanese trading house has worldwide LNG interests with stakes in ventures such as Cameron LNG in Louisiana, LNG Canada in British Columbia and projects in Australia, including the Browse

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partners. Large delegations will be taking part in the conference from companies such as Chevron, Shell, Woodside, ConocoPhillips, China National Offshore Oil Corp., France's Total, Pavilion Energy of Singapore and French engineering company Technip.

The LNG series of events began in 1968 and the previous conference was held in 2013 in Houston, Texas.

The conference comes at a time of change in the industry with challenges from the slump in energy prices offset by Australian output growth, the arrival of the US as a large-scale producer and a debate over the future structure of supply contracts and prices.

Perth, the state capital of Western Australia, previously held the conference in 1998.



Australian Prime Minister Malcolm Turnbull

The April 2016 event is under the auspices as usual of the respected industry bodies, the Gas Technology Institute, the International Gas Union and the International Institute of Refrigeration.

The LNG 18 theme is "Redrawing the Global Map of Gas" and highlights the changing world of natural gas in terms of reserves, trade, geopolitics, technology, pricing and investment. ■

Floating LNG venture. It even brought on stream its own liquefaction project in Indonesia in 2015. The Donggi Senoro LNG export plant in Sulawesi marked a revival in Indonesia's LNG

capacity previously hit by under-investment in new feed-gas fields. It was financed by Japan, built by JGC Corp., the Japanese engineering company, and the lead investor is Mitsubishi with a 47 percent stake. Other stakeholders include Indonesian energy company Pertamina. Mitsubishi will use its Cima marketing company to secure supplies for its North American liquefaction plants where it currently has stakes. Mitsubishi said its new Cima subsidiary trades about 1 billion cubic feet of gas a day. The Japanese conglomerate previously bought a stake in Cima in 2008 to market natural gas supplied from LNG imports. "Cima is active on all major pipelines and markets across the US and Canada, providing reliable and competitively priced services to hundreds of natural gas wholesale and end-user customers," Mitsubishi explained. "Cima has a customer base of more than 1,500 across North America. In addition to its existing business, Cima will play a key role in assisting feed-gas procurement as well as the transportation and delivery of natural gas to MC's LNG projects, a move which is expected to strengthen MC's LNG value chain," the company stated. Among its US feed-gas needs is the Cameron venture on the US Gulf Coast. Mitsubishi has a 16.6 percent stake in the LNG plant being built in Louisiana, along with Japan's Mitsui & Co. and France's Engie. California-based Sempra Energy retains its 50.2 percent majority stake in the

Cameron facility it originally built as an import terminal. "MC has been expanding its natural gas business in North America over the past several years, including its

participation in Cameron LNG and the development of natural gas resources and an LNG project in Canada. The LNG produced will be marketed to customers

around the world including Japan and Europe as well as emerging markets in Asia through Diamond Gas International, MC's wholly owned subsidiary for global



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LNG marketing, based in Singapore," the company had explained in its statement announcing the deal. "Additional sourcing of LNG from North America will enable the diversification of energy supply sources and pricing mechanisms, and enhance the ability of Japan and other LNG importing countries to secure a stable supply of energy," it added.

NATURAL GAS Fuels, a bellwether US company with operations in all segments of the natural gas industry, including shale-gas that will underpin LNG exports, pipeline and storage as well as exploration and production, posted a loss in its fiscal 2016 first quarter. The company, based in Williamsville, New York state, posted a consolidated net loss of \$189.1 million, or \$2.23 per share. NGF said it had price-related natural gas production curtailments of 14.6 billion cubic feet in Appalachia amid average natural gas and crude oil prices after hedging of \$3.16 per thousand feet and \$59.76 per barrel. Pipeline and storage operating revenues were \$75.5M, a 3.2 percent increase over the previous year's first quarter. NGF operates the Empire Pipeline that provides interstate transmission services through a high-pressure system that extends throughout western and central New York state over 245 miles from the New York-Canadian border. It also interconnects with the Millennium Pipeline near Corning, NY, and Marcellus Shale producers in North-Central Pennsylvania. "Due to ongoing low prices in the natural gas market, National Fuel is revising its near-term upstream and midstream development plans in Appalachia, while its long-term strategic plans remain intact," it said. NGF said its wholly owned exploration and production subsidiary, Seneca Resources Corp., has elected to further reduce the pace of its drilling program in the Marcellus Shale. Having already dropped one of its three rigs in January, Seneca plans to lay down an additional rig in March and operate a single rig in Appalachia for the remainder of fiscal 2016 and fiscal 2017. "While Seneca's operational success in the Marcellus has significantly improved the economics of its development program, near-term natural gas prices have fallen to levels such that a reduction in activity is warranted," NGF said. Ronald J. Tanski, President and Chief Executive of NGF, said operationally, the first quarter was "a good start" to the 2016 fiscal year, particularly for the pipeline and storage

segment. "We continue to see opportunities to capitalize on our valuable midstream footprint in Appalachia and meet the increasing demand for pipeline infrastructure to move natural gas production from the Marcellus and Utica shales," Tanski said. "However, persistently low commodity prices continued to weigh on our quarterly financial results, leading to a significant write-down of our natural gas and oil properties and lower price realizations on our natural gas and crude oil production. Magnified by warmer weather this winter in the Northeast, which also reduced earnings in our utility segment, national and regional commodity prices have continued to trend lower, creating volatility in the energy markets and clouding the near-term outlook for the sector," the CEO stated. "Our decision to slow our pace of drilling in the Marcellus and revise the in-service date of the Northern Access expansion project demonstrates the ability of our integrated model to react quickly to changing market conditions," Tanski added.

ORIGIN ENERGY, a stakeholder in the Australia Pacific coal-seam-gas-to-LNG plant in Queensland, has signed a preliminary agreement with China's ENN LNG Trading Co. for the supply of 500,000 tonnes per annum for five years. The parties also reserve the right by mutual agreement to extend the period of the contract to 10 years. Shipments are expected to start sometime in 2018 when ENN's Zhoushan LNG import terminal in China's eastern Zhejiang province is completed. Origin is the upstream feed-gas supplier for the APLNG plant on Curtis Island near Gladstone with a 37.5 percent stake. US energy major ConocoPhillips has the same shareholding as Origin in APLNG, while China Petroleum & Chemical Corp. (Sinopec) holds the remaining 25 percent. Sinopec has signed up for 7.7 million tonnes per annum of LNG from APLNG for 20 years from the two processing Trains, while 1 MTPA will be supplied to Japanese utility Kansai Electric. ENN LNG is a subsidiary of ENN Energy Holdings and operates in 146 cities across 17 provinces and autonomous regions. ENN has been building up its LNG supplies going forward. In February 2016, it signed a binding accord with France's Total for 500,000 a year of LNG over 10 years from 2018. Origin said it expected to sign a binding LNG sale and

purchase agreement with ENN during the second half of 2016. "The heads of agreement represents a significant milestone in the relationship between Origin and ENN, and in the development of Origin's LNG business," said David Baldwin, Origin's Chief Executive for Integrated Gas. Origin said it had the "flexibility" under the heads of agreement to supply ENN from its portfolio interests, including third-party purchases where market conditions create an opportunity to lower cost of supply. "As LNG and commodity markets strengthen in the future, Origin together with its partners, has the option to bring forward the development of its resource positions on Australia's east coast. For example, the Ironbark resource is an economic source of supply for ENN when tolled through existing LNG infrastructure and can be developed at a time when it becomes the lowest cost source of supply," Origin said of a CSG field located in south-central Queensland. The first LNG shipment left the APLNG plant on January 9, 2016, about a year after the first cargo from the neighbouring Shell-owned Queensland Curtis LNG plant and three months after the Australian Santos-led Gladstone LNG facility sent out its initial cargo to Asia. The three plants are the first industrial scale CSG-to-LNG facilities ever built and are located on the island off the eastern Australian port of Gladstone. Origin, the upstream operator of the APLNG plant, took seven years with partners ConocoPhillips and Sinopec to bring the plant on stream.

OREGON LNG, one of only two export projects in the US Northwest, has been informed by regulators of a five-month delay in releasing the final environmental impact statement. The export-import plant planned at Warrenton on the Skipanon Peninsula, near the mouth of the Columbia River, will now have its EIS issued in early June 2016 instead of February 12. Oregon LNG is owned by Leucadia National Corp., a US diversified holding company engaged through its subsidiaries in a variety of businesses, including investment banking, manufacturing and energy. The US Federal Energy Regulatory Commission said additional data was required to respond to comments on the draft EIS issued last year. "As a result, staff have requested supplemental information from the applicants and revised the schedule for issuance of the final EIS," the FERC

said. In August, 2015, the FERC ruled on the Oregon LNG project, saying that any adverse issues at the proposed sites "can be reduced to less than significant levels with mitigation measures" and set the now cancelled February 12 EIS issuance date. The revised schedule for the environmental review means that the final EIS will be available on June 3, which would give a 90-day Federal authorization decision deadline on September 1, 2016. The new schedule also affects two related pipeline projects, the Oregon Pipeline Co.'s terminal inter-connection and Northwest Pipeline's Washington Expansion Project. The Oregon LNG project will also have a pipeline of almost 87 miles in length and bi-directional to extend from the terminal to the interstate transmission system of Northwest Pipeline near Woodland in neighbouring Washington state. The Oregon LNG facility would include a marine terminal with a berth for LNG carriers, two full-containment storage tanks, each designed to store 160,000 cubic metres of LNG and a natural gas pre-treatment facility. The other project in the state, Jordan Cove LNG, is more advanced than Oregon LNG and in December 2015 said it was on course for a final investment decision in the second half of 2016 after receiving its regulatory permits. The Jordan Cove project is planned for Coos Bay in Oregon and has a budget of \$6 billion. It completed its environmental impact regulatory process with the FERC on September 30, 2015. The venture is being developed by Calgary, Canada-based Veresen Inc. and the company said it expected to have an FERC "Notice to Proceed" in mid-2016, leading to a final investment decision thereafter.

PAKISTAN has signed 15-year liquefied natural gas supply deal with Qatar that is expected to open the way for more import facilities in the Asian nation in addition to the one currently operating at Port Qasim near Karachi. The agreement with Qatargas is for 3.75 million tonnes per annum, more than its current single import facility can handle, and the first cargo is expected to be delivered next month. The LNG will come from Train II at Qatargas, one of the two production companies in the Gulf state along with RasGas. The Qatargas Train II shareholders are Qatar Petroleum, ExxonMobil, France's Total, and Japanese trading houses Marubeni Corp, and Mitsui & Co. The agreement was

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signed in the Qatari capital Doha by Saad Sherida Al-Kaabi, Qatar Petroleum's President and Chief Executive, and Imran ul Haque, CEO of Pakistan State Oil. The signing came after talks between the visiting Pakistani Prime Minister Nawaz Sharif and Qatar's ruler Emir Tamim bin Hamad Al-Thani. Pakistan's first LNG import facility at Port Qasim, located on a channel of the Indus River east of Karachi, has regasified more than 1 million tonnes of shipments since start-up in April 2015, including spot cargoes from Qatar. As part of the commissioning process, the FSRU "Exquisite" loaded its first LNG cargo at the Qatari LNG terminal at Ras Laffan on March 24, 2015, and brought it to Port Qasim. The regasified LNG is delivered directly to a pipeline of the Pakistani regional utility, Sui Southern Gas Co. The operating company of the Port Qasim import and regasification terminal is Engro Elengy Terminal Pakistan Ltd. The port-side facility is the floating storage and regasification unit (FSRU), the "Exquisite", owned and operated by Excelerate Energy of the US. Since the start-up of the terminal the cargoes have been provided on a spot basis by Qatar and several commodities trading companies. The single LNG facility at Port Qasim has helped alleviate some of the huge energy shortages in the south of the country since being commissioned, though officials have said more import terminals are needed. The terminal operating company has said the government was aiming to import around 1.5 million tonnes of LNG at Port Qasim in the first year. Pakistan natural gas limited production and supply is around 4 billion cubic feet per day compared with demand of more than 6 Bcf/day. The demand would be even higher if more

pipelines and infrastructure were in place. Officials have said the country needed another three to four more LNG import facilities to keep pace with the current demand. On the new supply accord with Pakistan, Qatar Petroleum CEO Al-Kaabi said: "Qatar is constantly looking to expand and enhance its LNG market share while at the same time helping countries around the world meet their growing energy needs. I would like to take this opportunity to register my sincere appreciation to Sheikh Khalid bin Khalifa Al-Thani, Chief Executive of Qatargas, and his team for their excellent work to finalize this important agreement." For his part, Sheikh Khalid bin Khalifa Al-Thani, CEO of Qatargas, said the Pakistani deal was part of Qatar's strategy to establish new markets with a new portfolio of customers. "The signing of this agreement represents a momentous occasion for Qatargas as we continue to play a key role as a world leader in the supply of clean, reliable energy to global markets," he said. "After delivering the commissioning cargo in April last year, we are delighted that our discussions with PSO regarding a long-term agreement have come to fruition. Taking this opportunity, we thank the team at PSO for their hard work and we look forward to a strong and enduring partnership with PSO and Pakistan," the Qatargas CEO stated.

SHELL has postponed the final investment decision on the LNG Canada project in British Columbia because of the economics of the venture after the slump in energy prices. The decision came as the Anglo-Dutch company posted full-year income of just \$1.93 billion, down 87 percent from the 2014 total of \$14.87Bln. The irony of the LNG Canada

postponement was that it came as Shell completed the \$50 billion takeover of BG Group, clearing the last main hurdle to creating the world's largest LNG trading company. Shell's partners in the LNG Canada venture are three other heavyweight market players, PetroChina, Korea Gas Corp. and Japan's Mitsubishi Corp. Canada's National Energy Board on January 8 had awarded its first 40-year LNG export licence to the Shell-led venture. The building of the liquefaction plant was to have started soon at the industrial site acquired by Shell near the town of Kitimat. The first phase plan was for two LNG processing Trains, each with the capacity to produce 6.5 million tonnes per annum, with an option to add two more Trains. Kitimat is a coastal community in northern BC with just over 9,000 residents and is about 650 kilometres north of Vancouver. The LNG Canada project is one of around 20 export proposals in BC. Four of them, including LNG Canada venture, have received environmental approvals in the province. One other outstanding issue for Shell in BC is what will happen with the proposed LNG export venture BG is developing at the Port of Prince Rupert after the Shell merger. In taking over BG, Shell said that the new enlarged entity expects to save about \$3.5 billion in overlapping costs after the two companies completed the merger process. The Shell-BG merger will create a company commanding more than 15 percent of the global LNG market. "The completion of the BG transaction, which we are expecting in a matter of weeks, marks the start of a new chapter in Shell, rejuvenating the company, and improving shareholder returns," said Shell Chief Executive Ben Van Beurden. "We are making substantial changes in the company, reorganizing our Upstream, and reducing costs and capital

investment, as we refocus Shell, and respond to lower oil prices," added Van Beurden. "As we have previously indicated, this will include a reduction of some 10,000 staff and direct contractor positions in 2015-16 across both companies," he said. "In 2015, we significantly curtailed spending by reducing the number of new investment decisions and designing lower-cost development solutions. For 2016, we have exited the Bab sour gas project in Abu Dhabi, and are postponing final investment decisions on LNG Canada and Bonga South West in deep water Nigeria. Operating costs and capital investment have been reduced by a total of \$12.5Bln as compared to 2014, and we expect further reductions in 2016," he added.

STATOIL, the Norwegian energy company and operator of Europe's largest LNG production plant at Hammerfest, said most of its future energy projects already have a break-even oil price below \$50 per barrel as it posted full-year losses of 37.3Bln Norwegian crowns (\$4.4Bln). "The result in the fourth quarter is highly impacted by the weak commodity price," said Statoil President and Chief Executive Eldar Saetre. Fourth-quarter losses amounted to 9.2Bln crowns (\$1.07Bln). "However, we continue to make strong progress on costs and efficiency. We are now further stepping up our improvement programme, and tightening our capital and exploration expenditures. "These are key elements in navigating the business during a period of low oil prices," Saetre added. "Statoil is well positioned to capture value from an expected upturn in the market," the CEO said. "We have substantially improved our non-sanctioned project portfolio. More than 80 percent of the operated projects,



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with start-up by 2022, have a break-even oil price below \$50 per barrel of oil," he explained. Among its activities, Statoil markets LNG made from feed-gas transported by pipeline from the Snohvit gas field in the Barents Sea through to its Hammerfest liquefaction plant in Northern Norway. The company and its partners have produced around 4.2 million tonnes per annum of LNG since 2007 at the liquefaction plant on Melkoya Island, though plans were never pursued to expand the plant. LNG cargoes from Hammerfest are delivered to countries such as Spain, Lithuania and South America. Statoil is also part of a group of energy companies with licence stakes offshore the East African nation of Tanzania where they intend to develop an LNG export project. It is also exploring offshore Mozambique. In the earnings statement, Statoil gave more details of a new dividend programme. The Norwegian Government, as majority shareholder in Statoil, has supported a dividend maintenance proposal that will also need the approval of the Norwegian Parliament. Statoil proposes the introduction of a two-year cash or shares dividend programme. It would give shareholders the option to receive quarterly dividends in cash or in newly issued shares at a 5 percent discount.

TOTAL has signed long-term liquefied natural gas sale and purchase agreements with state-owned Indonesian company Pertamina, itself an LNG producer, whereby the French company will also take some of its volumes booked from a Texas liquefaction plant. Total will supply LNG volumes to

Indonesia over a 15-year period starting in 2020. "These agreements allow the Group to further expand its longstanding cooperation with Pertamina and to

enhance both companies' LNG portfolios," said Laurent Vivier, President of the gas division at Total. "Strengthening our presence in

Asia, in particular through innovative relationships with new LNG buyers such as Pertamina, is an important part of our strategy," Vivier said. "Under the terms



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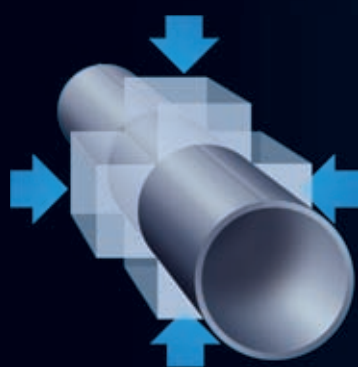
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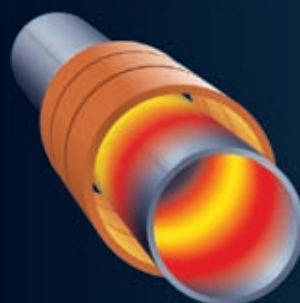


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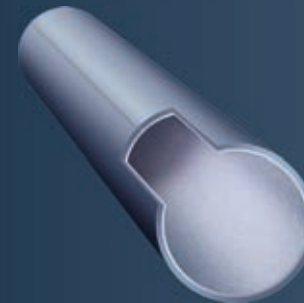
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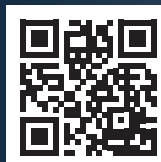
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of the agreements, Total will purchase from 2020 around 0.4 million tonnes per year of Pertamina's contracted LNG volumes from Corpus Christi LNG

(Texas), currently under construction in the United States," he added. The Texas liquefaction plant will be built on the northern shore of Corpus Christi Bay, at

the north end of the La Quinta Channel. The plant will export around 22.5 million tonnes per annum of LNG from five processing Trains and has eight overseas

customers, including the Indonesian energy company, European utilities and the Australian LNG producer Woodside. Corpus Christi LNG developer Cheniere

Energy is also building the Sabine Pass plant in Louisiana that will be the first industrial-scale US LNG exporter to come on stream in the weeks ahead. In parallel with the buying of US cargoes from Pertamina, Total will supply the Indonesians with volumes which will grow over time from 400,000 tonnes per annum to 1 million tonnes per year.

Total is a world leader in LNG, with solid and diversified positions along the entire value chain and LNG production of 10.2 MTPA in 2015. The French company has maintained its ambitious LNG targets through to 2020 and beyond even amid the downturn in energy markets caused by oil. Totals liquefaction plant production volumes come from Nigeria, Angola, Yemen, Qatar, Abu Dhabi, Qalhat LNG in Oman and the long-standing Bontang plant in Indonesia. Total aims to boost its LNG carrier fleet from two vessels to 12 over the next four years or so, to increase its regasification terminals capacity network from four to five facilities and will see cargo volumes surge from just over 10 MTPA to 20 MTPA and more. Behind this growth strategy is the Yamal LNG project in Arctic Russia, two ventures in Australia and the advent of LNG cargo trading out of the US Gulf coast at plants such as Corpus Christi.

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Corp., the main Canadian LNG feed-gas pipeline company with contracts to bring shale-gas from the Montney shale in northeast British Columbia to the Pacific

coast, swung to a huge quarterly loss after it embarked on a lawsuit against the US government over an oil pipeline. TransCanada posted a loss for the fourth quarter of \$2.5 billion compared with net income of \$458 million for the same period in 2014. As the company faced regulatory pressures at home and across the border in the US, as well as the consequences of the oil price slump, it also gave updates on its three Canadian LNG feed-gas projects, which it said were also now facing delays. In reference to the recently announced LNG project delays in British Columbia province, TransCanada said that it will be able to recover all its costs if ventures are eventually cancelled. The Calgary-based company referred to its Prince Rupert Gas Transmission connection for the Pacific Northwest LNG project in British Columbia and the two conditions that needed to be satisfied for a final investment decision. "The first condition, approval by the Legislative Assembly of British Columbia of a Project Development Agreement between PNW LNG and the Province of B.C., was satisfied in July 2015." "The second condition is a positive regulatory decision on PNW LNG's environmental assessment by the Government of Canada, which has not yet been received," it said. "Prince Rupert Gas Transmission has all of the primary regulatory permits required from the BC Oil and Gas Commission and the BC Environmental Assessment Office for the project. We are continuing our engagement with Aboriginal groups and have now signed project agreements with ten First Nations along the pipeline route," the company said.

"The in-service date for PRGT is estimated to be 2020 but will be aligned with PNW LNG's liquefaction facility timeline. Should the project not proceed,

our project costs (including carrying charges) are fully recoverable," it explained. As regards the Coastal GasLink in BC for the Royal Dutch Shell-

led LNG Canada project, TransCanada said: "We continue to engage with stakeholders along the pipeline route and are progressing detailed engineering and

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construction planning work. We have received eight of 10 pipeline and facilities permits from the BC OGC and anticipate receiving the remaining two permits in

first quarter 2016. With these permits, Coastal GasLink will hold all of the required primary regulatory permits for the project."

VENTURE GLOBAL LNG, the US developer, said it signed a sales and purchase agreement with Shell North America for one million tonnes per

annum of LNG from its export project at Calcasieu Pass in Louisiana, one of two it is building on the US Gulf Coast. The accord with Shell is for 20 years with the

cargoes being supplied on a free-on-board basis (FOB), whereby the Anglo-Dutch company supplies the ships, for a purchase price indexed to the monthly Henry Hub price plus a facility fee indexed to inflation. Michael Sabel and Robert Pender, the co-founders of Venture Global LNG, said they were delighted with the agreement as "we implement our strategy to become the lowest cost producer of LNG in the world." Venture Global is developing the 10 MTPA Calcasieu Pass facility on a 1,000-acre site located at the intersection of the Calcasieu Ship Channel and the Gulf of Mexico. The Calcasieu Pass liquefaction plant is expected to be operational by the end of 2019. The Washington DC-based company is also proposing a second export venture, the 20 MTPA Plaquemines LNG facility in Plaquemines Parish, Louisiana, on a 630-acre site at river mile marker 55 on the Mississippi River, 30 miles south of New Orleans. The VG LNG founders Sabel and Pender are respectively a banker and a lawyer. Sabel is an equity fund manager and venture capitalist, while Pender is a former partner at Hogan Lovells, a global law firm. Both are now joint chief executives and co-chairmen of the VG LNG company. The Plaquemines project planned for the banks of the Mississippi River is the most advanced in terms of the permitting process with the US Federal Energy Regulatory Commission. That facility will have 20 small-scale liquefaction Trains, four LNG storage tanks, and three marine loading berths for ocean-

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going vessels, according to the plans filed with the FERC. The Mississippi's river project being pursued by VG LNG is on a site owned by the Plaquemines Port Harbor & Terminal District.

The Port, which is a political sub-division of the State of Louisiana, is located 20 miles south of the Port of New Orleans. The project site has been secured under an exclusive agreement with a lease option for up to 70 years. Co-CEO Pender previously served as a partner at Hogan Lovells, where he was co-leader of its Energy and Natural Resources team and oversaw transactions in South America and Asia, including projects owned by LNG importer China. Sabel was previously Executive Vice President of First Sierra Financial, a publicly traded commercial finance company.

WOODSIDE, Australia's largest liquefaction natural gas producer, has made a second gas discovery about 100 kilometres offshore Myanmar in the Rakhine Basin of the Bay of Bengal. The Australian company said its Thalín-1A exploration well in Block AD-7 of the Rakhine Basin intersected a gross gas column of around 64 metres. "Approximately 62m of net gas pay is interpreted within the primary target interval," Woodside said. Water depth at the Thalín-1A well location is 836m. The gas discovery at Thalín-1A follows an earlier gas find by Woodside at the Shwe Yee Htun-1 well in Block A-6 offshore Myanmar, announced on January 4, 2016. Woodside Chief Executive Peter Coleman said the two discoveries at opposite ends of the Rakhine Basin was a "great result" for the company. "These results are very

encouraging for future exploration and appraisal activity, given the significant footprint we have in Myanmar," he said. Coleman said Thalín-1A had successfully

proved a working petroleum system and a new play type different to that encountered at Shwe Yee Htun-1. "These discoveries provide evidence of the high

quality of offshore Myanmar as an exploration focus area," he said. The Thalín-1A well reached a total depth of 3,034m, referenced from the rig rotary

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table. "Following drilling, wireline logging was conducted and confirmed the presence of a gas column through pressure measurements and gas sampling," Woodside said. Thalin-1A is located in the northern part of the Rakhine Basin about 60km west of the Daewoo-operated producing Shwe Field, which has an onshore gas plant and pipeline gas export facilities. With a 40 percent interest in AD-7, Woodside Energy is the operator with respect to deepwater drilling. South Korea's Daewoo International Corp., with a 60 percent interest, is operator for all other activities. "The AD-7 Block's area was recently expanded north to the Myanmar maritime boundary," Woodside added. The AD-7 joint venture has approved the acquisition of an additional 1200 square kilometres of 3D seismic data over this area. "The seismic survey is scheduled to commence in March 2016 and will facilitate further evaluation and expansion of the prospect portfolio," the Australian company said. Woodside is currently the largest acreage holder in the offshore Rakhine basin with interests

in six blocks. The six permits make up 47,000 square kilometres and represent 20 percent of Woodside's global exploration acreage. Woodside's first gas discovery at the Shwe Yee Htun-1 well in Block A-6 of the Rakhine intersected a gross gas column of around 129 metres. The company is one of the Asia-Pacific region's largest LNG players with two plants in Western Australia, the Northwest Shelf facility and Pluto LNG. Woodside in 2014 also bought into two other LNG projects in a deal with Apache Corp. of the US for its Australian Wheatstone project stake and its share of the Canadian Kitimat venture.

WOODSIDE said the Chevron-operated Wheatstone liquefied natural gas project being constructed onshore Western Australia has been delayed by about six months until mid-2017. Chevron is developing the Wheatstone project near Onslow, in the Pilbara region of Western Australia with Woodside as a partner. It will have an initial capacity of 8.9 MTPA of LNG and was originally expected to come on stream at the end of

2016 or the start of 2017. The Chevron-operated development comprises the Wheatstone, Iago, Julimar and Brunello gas fields, an offshore platform, a pipeline to shore and the onshore plant. The six-month Wheatstone delay would not affect any cargoes sales contracts. "Delivery commitments under the applicable LNG Sales Agreements can be met under the revised schedule," Woodside said. The overall Wheatstone venture was currently 65 percent complete. Woodside has been a shareholder in Wheatstone since April, 2015, when it completed a deal to buy the stake of Apache Corp. of the US for US\$2.8 billion. In the same transaction, Woodside also acquired a share in the Kitimat LNG project in Canada in which Chevron is also the operator. Chevron Chairman and Chief Executive John Watson made no specific mention of the Wheatstone delay in his January 29 earnings statement, though confirmed it later. He said only that the US major had made progress on both Australian projects and that Gorgon LNG, which is being developed on Barrow Island in Western Australia, was close to shipping

its first cargo after also suffering delays and cost overruns. "We made significant progress on our LNG projects in Australia, in particular the Gorgon Project where we expect to be producing LNG within the next few weeks," Watson said. "Successful completion and start-up of these and other major capital projects will translate into significantly lower capital spending, higher production and growing cash generation in the months ahead," the CEO added. Chevron is the operator of Gorgon LNG with a 50 percent interest while Australian subsidiaries of Royal Dutch Shell and ExxonMobil each hold a 25 percent stake. With the commercial start-up set for February, the Gorgon venture is now a year behind schedule and well over budget, because of its complexity as a construction project and the environmental challenges. It is Australia's most expensive resources project with overall costs now put at US\$54 billion. The original budget for Gorgon was \$US37Bln when it was first given the go-ahead and costs have risen by US\$17Bln. ■

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ExxonMobil adopts new approach for design of modularized onshore LNG export plants

Ashley Guy, Sorin Lupascu, Donna J. Parker, Don Victory and Greg Henke, ExxonMobil Development Co.

Various modularization approaches have been used in an attempt to control cost and mitigate execution risk for onshore LNG export projects in remote locations where availability and accessibility of skilled labor is a concern.

ExxonMobil has leveraged its experience across multiple energy projects, including nearly 50 years of industry leading LNG performance, and an understanding of current industry challenges to develop design and execution principles that constitute a new approach to onshore modularized LNG projects to enhance their global competitiveness.

Introduction

ExxonMobil developed a new design and execution approach for onshore modularized LNG after reviewing lessons from past projects, surveying capability of the EPC and fabrication sectors, and engaging in a multidisciplinary effort to identify new solutions for unlocking the full possibilities of modularization for LNG facilities.

The new approach was framed within the ExxonMobil Capital Project Management System (EMCAPS) and is being considered for implementation on project opportunities around the globe. ExxonMobil is currently evaluating multiple LNG opportunities within its portfolio, some of which are in remote, higher cost areas where availability and accessibility of skilled labor is a concern.

This article summarizes lessons learned from previous projects and the new design and execution guidance developed by a multidisciplinary team to enable successful deployment of modularization for world class onshore LNG export projects.

ExxonMobil examined multiple modularized LNG projects and learnings from other non-LNG onshore and offshore modular projects. The general themes that emerged from this review are listed in Table 1 and are addressed by the new guidance for modularized LNG projects outlined in this article.

A new approach is required to more successfully design and install

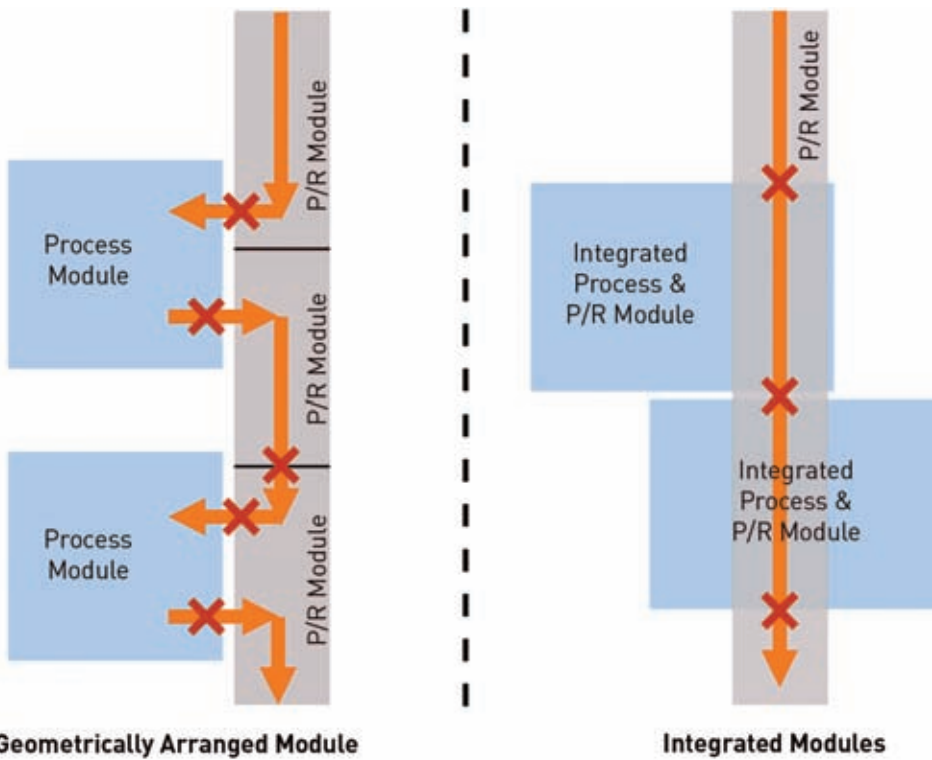


Figure 1: Comparison of geometrically arranged modules and integrated

modularized LNG facilities in remote locations where availability and accessibility of skilled labor is a concern. Additionally, with socioeconomic research indicating that impact on local housing is the main drawback of industrial development for communities^[3], an optimized modularization strategy can also reduce impacts not only on housing, but also on social services and infrastructure.

Management

ExxonMobil’s project management system, EMCAPS, requires the development of a clear and concise Project Objectives and Strategy (POS) document that drives project teams towards clear and measureable project objectives and defines key issues, opportunities and strategies.

A sample POS mission statement was developed to differentiate objectives for onshore modularized LNG projects, and additional guidance was provided to address themes from our new vision:

An environment where availability and accessibility of skilled labor requires a paradigm shift in project design and execution planning such that the primary objective is to reduce site hours. This requires clear design guidance with

constructability focus, as well as ensuring that the facilities layout and the engineering, procurement and fabrication sequence are driven by the construction, commissioning and start-up plan.

- Eliminate stick build scope wherever practical.
- Challenge existing layout strategies.
- Increase modular density and consolidate modules where appropriate.
- Incorporate offshore electrical/instrumentation strategies to drive towards a plug and play solution.
- Demonstrate commissioning and construction planning in the design.
- Calibrate cost and execution models with project experience and data to quantify the effect of design and execution decisions and optimizations.

Design

Modularization of an LNG plant is inherently more difficult than for conventional oil and gas processing plants and needs to accommodate higher equipment tonnage, larger diameter piping, and cryogenic metallurgy and insulation. Industry routinely starts with a reference design onto which they overlay a modularization strategy based on weight and size limitations by

Theme	Description
Scope	Even “fully modularized” projects included significant stick build scope components.
Labor	Residual stick built scope may have contributed to modularized LNG projects not achieving the intended benefit of significantly reducing site labor requirements to the typical industry targets ranging from one-third to two-thirds of workforce requirements expected for fully stick built facilities ^[1] .
Layout	Onshore modularized LNG plant designs appear to leverage reference layouts from past stick built LNG facilities, which are then packaged into modules using legacy geometric arrangements. LNG contractors and operators naturally tend to leverage their past onshore plant stick built experience to capture engineering and operations learnings. Additionally operators share a desire to limit front-end engineering duration in the belief it will reduce overall execution schedules ^[2] . Using legacy layouts as a starting point, however, may preclude identifying constructability opportunities.
Density	Where conventional onshore equipment spacing practices are applied to modular LNG projects the result may yield lower density in modules than in offshore facilities and modules spaced further apart than may be necessary.
Execution Planning	While the criticality of execution planning and maintaining work sequence for onshore modularized LNG projects approaches is comparable to offshore oil and gas facilities, it could be underestimated by projects under schedule pressure and by practitioners approaching modularized LNG with a traditional onshore stick built mentality.

Table 1: Observations and lessons learned from past project reviews

splitting the layout into modules using geometric division^[4].

Recent modularized LNG facilities resemble stick build facilities with a central piperack and processing units arranged alongside. The heritage of these designs seems to draw from a stick built execution basis where skilled labor was generally readily available. To reduce costs the designer minimizes the most expensive piping quantities and other site bulks.

Space is used to separate electrical switchgear from hazardous classified areas to avoid increasing the costs and complexity of heating, ventilation and air conditioning (HVAC) systems.

Typical onshore maintenance access requirements drive equipment spacing and yield greater separation between process equipment. The designer is more focused on bulk material quantities than on the amount of work required for installation.

Approach

For modularized projects where site execution risks and costs are high, an alternate approach is to focus on site labor as the leading quantity to be optimized. The layout should minimize stick built scope and site hook-up and commissioning.

To pursue a step change in project execution performance, ExxonMobil re-engineered an onshore LNG layout to develop a design that is more suited for accomplishing these objectives.

Utilizing concepts employed on past ExxonMobil oil and gas projects, a conceptual LNG layout has been developed for use in locations where skilled labor availability

and accessibility is a concern. The integrated module approach philosophy underpinning this layout is illustrated in Figure 1.

New LNG layout philosophies have been suggested by many, [4] [5] but there are no known examples of these philosophies being fully deployed.

For example, piperacks and coolers should be integrated with the process modules they serve where this does not exceed the maximum module envelope



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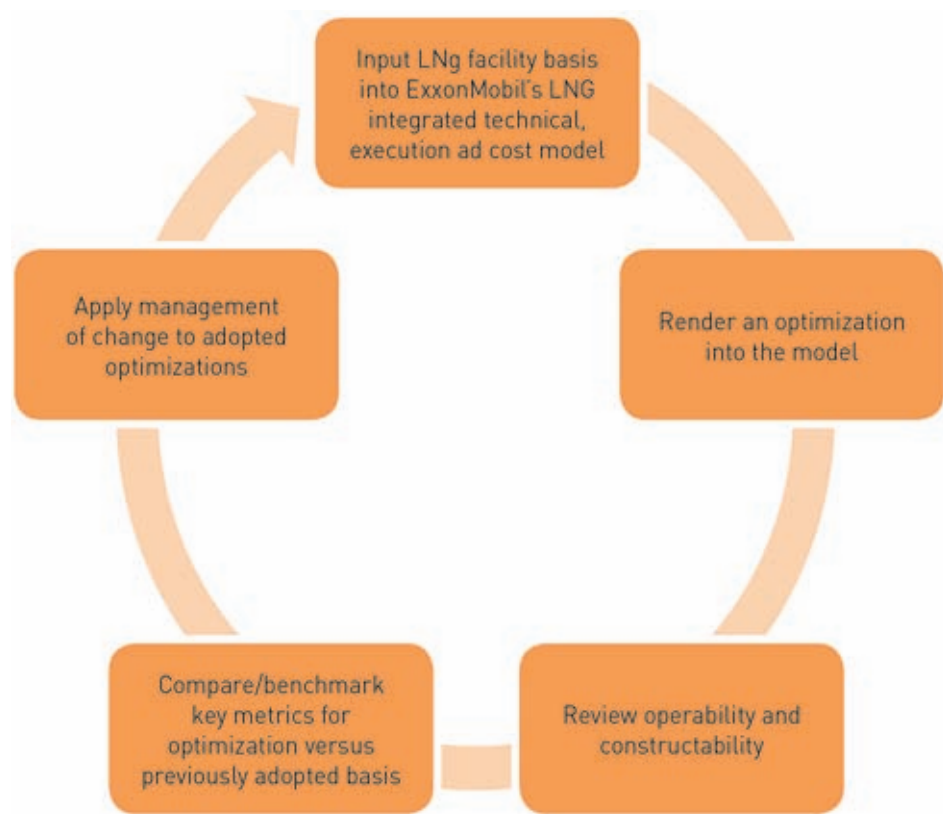


Figure 2. Process for evaluating layout and design with LNG model

(i.e. dimension, weight, transportation requirements).

This eliminates significant interconnection work at site and can reduce the total number of modules.

While piperack modules are seen as low cost and low complexity to fabricate, their simple inclusion as separate modules results in greater interconnection effort at site.

ExxonMobil has developed a conceptual design with a new modularization strategy that reduces site integration activities and is currently assessing benefits with leading LNG contractors.

Layout

Figure 1 shows a modular layout generated geometrically from a traditional LNG layout on the left compared with an integrated module layout strategy on the right. The “x” marks identify interfaces where multiple welded hook-ups are required. Focused layout development offers opportunities to optimize amount of site work.

The modules should contain complete systems to the extent possible to enable mechanical completion and pre-commissioning to occur in the module fabrication yard prior to shipping to site.

The quantity of interconnections and stick built scope should be minimized. To realize this vision the entire design team needs to be focused on these objectives with metrics in place for measuring the effectiveness of the design.

An evaluation tool is required early on

to test different module configurations and estimate quantities, including labor effort, before freezing a layout. Potential metrics include quantity of single weld hook-ups (SWHUs), quantity of stick built piping and piping connections, equipment weight to module weight ratio, equipment area to module area, and linear meters of cable to be pulled at site.

ExxonMobil leveraged site return data to develop an integrated technical, execution and cost model that allows engineers to rapidly test design and layout sensitivities versus key quantities.

This allows a project team to “visualize cost” during the conduct of their work by enabling real time access to the effects of design and execution decisions on yard and field construction quantities and costs.

An illustration of design process utilizing the LNG model is summarized in Figure 2.

The “plug and play” approach to modularization is routinely touted but often not achieved.

One “plug and play” goal is to have as few and as simple electrical and instrumentation (E&I) connections to complete after module arrival.

Using local E&I buildings within modules should result in as few power and instrumentation cables run at site as possible.

Opportunity

The undergrounds can be completed earlier and with less cable termination work at site. An opportunity to reduce

overall costs can be overlooked if designers are solely focused on E&I building costs and total cable quantities, and are not differentiating yard versus site installation and termination costs.

A diagram illustrating site cable reduction opportunities is indicated in Figure 3. This design strategy has been routinely applied in the offshore industry and in modular oil production projects [6]; it, however, has not yet been fully embraced by the onshore LNG industry.

Our benchmarking indicates that equipment packing density tends to be lower for onshore LNG modules than for typical offshore oil and gas facilities.

Some modules could include as much as 30 to 50 percent additional equipment weight. Packing equipment and piping to a lesser degree results in more steel and blank space shipped to site, more modules, greater footprint, and more site bulks than necessary.

This is one of multiple areas where offshore designers could positively influence LNG onshore modularization design practices.

Onshore designers without an offshore skillset tend to apply routine, stick built layout practices to modular LNG facilities, including use of experience-based approaches to spacing, when more analytical approaches similar to those often used for offshore facilities could be applied to optimize designs and mitigate risk scenarios.

Benefits

The offshore approach to risk and loss prevention can be evaluated and adopted where greater packing densities and closer spacing could be beneficial for onshore LNG modules.

Further, 3D model reviews for human factors, operability and maintainability

can be enhanced to ensure fit for purpose designs.

The onshore industry could augment its approach with offshore design principles to achieve the same safety and availability of prior designs while enabling successful modularization and integration of the facilities.

Stick build scope is simply not viable in offshore designs. Modularized onshore LNG projects, however, routinely include stick built areas. Project return data indicates that stick built items should be aggressively eliminated from the design.

Trade-offs

Systems perceived to be lower criticality or complexity, as well as fixtures such as eye wash stations, lights and utility stations, have been noticed to be omitted from some modularized scope. Project teams may elect to stick build items designed late due to their lower criticality and in order to minimize fabrication yard changes.

While this approach is less disruptive to the fabrication schedule, it may inadvertently transfer an expanding volume of scope to the site, eroding some of the gains from prefabricating portions of the design.

It is critical that all systems and ancillary equipment are fully considered for incorporation into the modularized and pre-assembled scope. Including all scope within modules may require larger module sizes.

While recognizing there are always cost trade-offs between yard fabrication, site installation, marine offloading facilities (MOF), heavy haul road and transportation vessels, larger module sizes generally seem to provide a more optimal design solution.

The definitions of “large,” “very large” and “mega” modules vary by site and

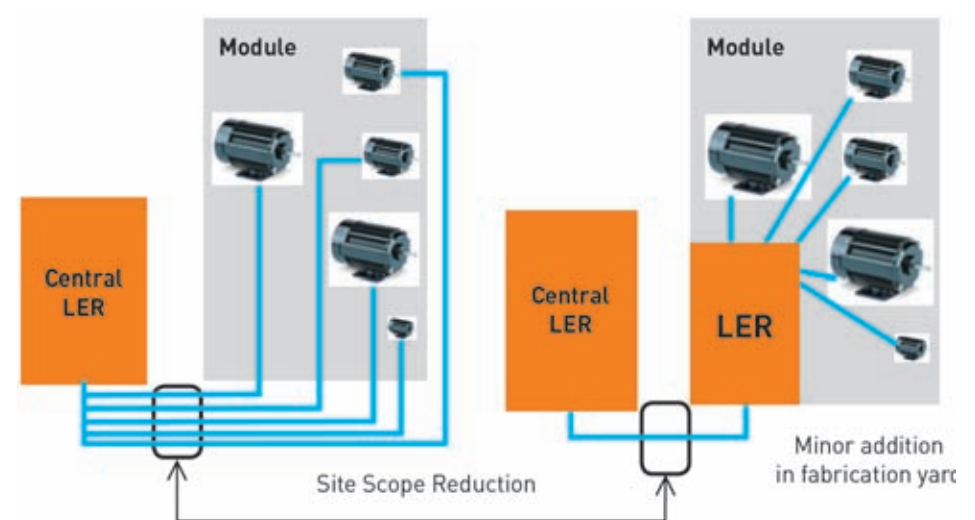


Figure 3. Application of offshore electrical and instrumentation strategies

application – yet there is general agreement regarding their benefits [7]. Weights of 5,000 metric tons and above appear appropriate for many plant applications.

Execution planning

This section reviews observations related to project management, contracting, construction and execution and provides guidance for improving the execution planning of modularized LNG projects.

To ensure project objectives are achieved, an optimized execution plan should be developed to incorporate key design decisions and ensure the design and execution basis are continually realigned, conflicts are visible, and solutions are implemented.

Site and plant layout represent a key area where the priorities of design, construction, execution planning and logistics teams must be optimally evaluated with trade-offs properly characterized.

The overall project plan, as well as the layout and engineering design, should be fundamentally built around the way the plant will be commissioned and started up.

The design should anticipate starting up power generation with a commissioning gas source; bringing the utilities, plant inlet and gas treatment units online; and eventually starting up and cooling down the refrigeration, liquefaction, storage and loading systems.

The layout should be conducive to gradually energizing succeeding areas while reducing simultaneous operation impacts on areas under construction. Figure 4 highlights key design and execution planning elements for layout development.

The layout must accommodate site specific constraints such as footprint available for permanent facilities, siting of operations support facilities, temporary

construction laydown areas and heavy haul roads to enable more efficient construction. Design, fabrication, shipping, installation, commissioning and

start-up sequences must be aligned as the design is developed.

Project experience to date suggests that the overall schedule for a



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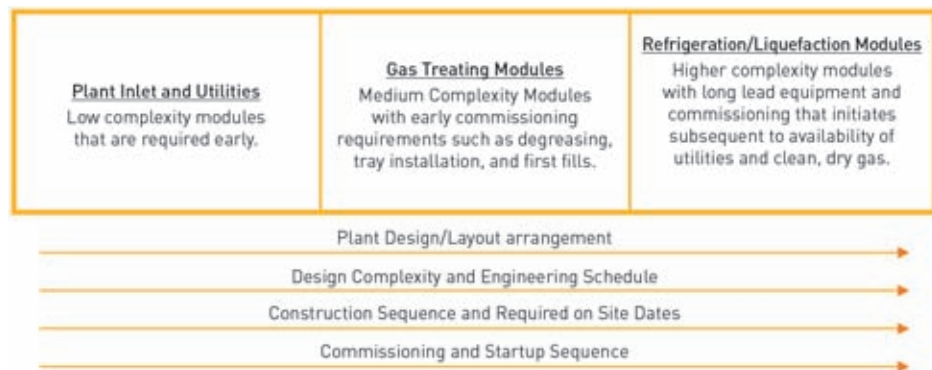


Figure 4. Indicative layout sequencing diagram

modularized LNG project will require a longer duration than stick built LNG project benchmarks.

Engineering must be substantially complete and of high quality to support fabrication and minimize disruptive changes to fabrication yard sequence and productivity, whereas more overlap with engineering can be tolerated for stick built construction.

The longer engineering and offsite fabrication phase should theoretically be made up on site by having a reduced construction scope.

Project experience indicates stick-built scope, residual work at site following module arrival, such as yard carryover, hookup, and commissioning, as well as camp or skilled labor constraints in remote environments, may be behind the longer schedules.

Alignment

Deploying an appropriate modularization philosophy focused on reducing the work at site may help reduce the schedule gap with historical stick built benchmarks.

In order to reduce overall execution risk and cost, the contracting strategy must be aligned with the objectives of modularization.

The selection and engagement of EPC contractors, vendors, fabrication yards and subcontractors must support the

overall execution objectives and ensure the participants are aligned to fabricate or pre-dress, pre-commission and install kit within a sequence that is consistent with the execution plan - whether executing within a lump sum, reimbursable cost or other EPC arrangement.

The design team is usually well advised on fabrication yard quantities since module weight is critical and is routinely tracked. What has not historically been estimated or controlled satisfactorily for onshore modularized LNG facilities are the bulk quantities that must be stick built on site.

The design team should invest the same level of rigor around bulk quantities generated for site installation as this will drive incremental site burdens.

If not actively measured and controlled during the design, increases in site bulks may result in late identification of site execution scope with potential adverse impacts such as late recruitment of additional skilled professionals to locations where the available labor, camp capacity and logistics may already be constrained and prolonged execution schedules.

Sequence

The site plan should be developed with module sequence and arrival dates in

mind in order to complete undergrounds and foundations required for module arrivals at the right time and in the proper sequence.

The site plan should also include provisions to accommodate “out of sequence” module arrival and adequate nearby laydown for all phases of construction. The importance of maintaining schedule sequence on a modular job cannot be overstated.

While always prudent, staying in sequence is of significantly higher criticality for a module installation site than for a stick built site.

If a project falls behind plan, starting the next scheduled activity before earlier prerequisite activities are completed will likely not help recover schedule and may cascade into even more significant schedule delays under more stressed execution conditions, especially if camp space or logistics become constraining.

To prevent this situation, projects should leverage completion milestones instead of start milestones to document and reward progress. Rewarding start milestones may incentivize teams to lose focus and ignore completing the sequence required to successfully deliver the overall project.

It is critical to complete site development and required civil works and undergrounds before the modules begin to arrive.

Engineering and procurement for site development and civil scope must be completed prior to module arrival even if this may require greater allowances for cables and foundations. E&I frequently account for the final components to be designed, resulting in insufficient time allocated for cable procurement and underground installation.

A similar dynamic can also impact

underground drainage and firewater systems. Fully optimizing the design to reduce the cost of bulks may be a false economy if it prolongs the schedule and delays completion of the civil works.

Key elements

Ensuring early start and completion of civil works before substantial site mechanical activities commence will help even out and lower peak workforce and camp requirements.

Many recent modularized LNG projects, as well as non-LNG projects, have suffered from late completion of engineering and procurement (E&P) with late changes impacting yard scope after start of fabrication.

Mapping out E&P activities based on a backward pass from commissioning and start-up and then testing timelines against realistic benchmarks in a forward pass analysis are key elements to help mitigate late changes and delays.

Module “required on site” (ROS) dates and sequence must drive the fabrication schedule and in turn the E&P schedule. Planning durations must be based on realistic benchmarks and focused on delivering in sequence.

Critical vendor data needs to be prioritized in order to complete model reviews. Fabrication should not begin until E&P is truly complete to the extent required by the yard(s) to support sustained progress without IFC holds and ongoing revisions.

Conclusions

A new approach is required to reduce the schedule and competitiveness gap between modularized LNG plants in remote areas and stick built plants in more accessible areas.

Key objectives and strategies have been developed leveraging past LNG design experience, incorporating innovative approaches and applying lessons from other oil and gas projects beyond the LNG industry.

ExxonMobil’s analysis indicates significant cost and schedule reductions for modularized LNG plants can be achieved by incorporating the elements described in this article.

Project proponents with the capability and experience to apply these lessons to large scale LNG projects will lead the industry and develop facilities that provide the lowest overall cost of supply while meeting the expectations of the communities where they are installed. ■

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Malaysian shipping executives say LNG carrier fleet is in long-term game of changing fortunes

Company will gradually add to its vessels and modernize amid new opportunities in Asia-Pacific region

The liquefied natural gas shipping market is a tough place to be and the veteran operator, Malaysia International Shipping Corp. (MISC), is conscious of the challenges that lie ahead for its current LNG fleet of 25 carriers.

Spot charter rates continued to drop last year as did overall vessel utilisation, with average reported daily spot rates for steam vessels of \$26,100 per day compared with around \$49,300 the previous year.

Overhang

A glut of new ships coming into the market coupled with stagnation in the LNG trades and delays in the completion of new LNG projects all conspired to create a disheartening market.

Shutdowns at liquefaction plants in Yemen, Angola and Egypt for various reasons have added to the difficult times.

With no sign of a recovery in the oil prices, MISC expects the market for LNG to remain below desired levels, prolonging low vessel utilisation and in-charter hire rates.

Globally, more than 40 newbuilds are expected to be delivered this year. Most of these vessels are likely to be deployed to Australian and US-based liquefaction projects, but around 20 percent will have no contracted employment.

These events lead MISC to expect low vessel earnings to continue well into next year.

Although low rates are not helpful for any operator, their impact on the MISC fleet is largely dampened by the company's strategy of fixing most of its tonnage on long-term charters to Malaysian national oil company Petronas.

Affiliate

While MISC is majority-owned by Petronas, the company competes at arm's length for business and proves its credentials in the same way that any first-class operator must do.

That said, Petronas is a hugely valuable customer and MISC has 21 of its 25 ships on long-term charter to the Malaysian affiliate.

MISC's Puteri class vessels of 130,000 cubic metres capacity and numbering five



The 'Seri Bakti' LNG carrier was active at the start-up of the Gladstone LNG plant where Petronas is a shareholder

ships are all around 20 years old but a recent renewal deal struck with Petronas has allowed a contract extension.

Conditions of the extension require that each vessel undergoes a repair and life extension (RLE) programme involving a comprehensive retro-fitting of equipment alongside containment analysis and enhancements to ensure each vessel remains fit for service.

Core client

Late last year, "Puteri Intan", "Puteri Delima" and "Puteri Nilam" were delivered back to Petronas following successful RLE attention and have renewed their activities, while the remaining two ships were scheduled to take up their Petronas charters again soon.

Petronas will always remain a core client, says MISC, but a refocussing of strategy has encouraged the company to search for and build relationships with other LNG companies.

As a result, two of the company's ships are now chartered to Yemen LNG (currently closed because of the conflict) and were expected to be moving cargo again soon from that country into Asia.

MISC is also actively seeking to build additional long-term relationships to secure more third-party contracts.

Only two of its vessels are trading on the spot market and they are playing a useful role in establishing relationships with potential new customers for MISC and proving the company's credentials more widely.

In September of 2015, the "Seri Bakti" of 152,000 cubic metres capacity became MISC's first vessel to berth at the Gladstone LNG (GLNG) Santos terminal in Queensland, Australia to carry out a range of interface and operational tests.

This later resulted in the loading of a 150,000 cubic metres capacity of LNG cargo and its successful delivery to the Pyeongtaek terminal in South Korea.

Charters for GLNG have continued into 2016 and MISC hopes to extend the relationship further.

Wish list

Moving more Australian cargoes is firmly on MISC's wish list but the company recognises that new orders stemming from the country's growth in liquefaction have largely been soaked up by existing contracts.

However, some spot business is likely to be up for grabs for operators who can position their vessels intelligently. Aside from GLNG, MISC has been active in securing a range of other spot cargoes from a number of LNG producers

including, for the first time, Chinese charterers.

MISC is on record as saying that it will continue to grow its LNG fleet but only on the back of secured contracts. Speculative building is not an option.

In early 2015, the company took over five newbuilding contracts that had been previously agreed between Petronas and the South Korean shipbuilder Hyundai Heavy Industries.

At the same time, MISC successfully concluded a long-term time charter deal with Petronas subsidiary, Petronas LNG for the employment of these ships. All five ships have Moss-type storage tanks and the first is due to be delivered in September of 2016, with the others following next year and in early 2018.

MISC has chosen to power all five new ships with a rehear steam main engine. Many believe this to be old technology and most new carriers are fitted with dual-fuel diesel engines or the new low-speed diesel engine.

Review

The decision was taken after a thorough review of the new ships' operating pattern and an assessment of the total cost of owning and operating the vessels based on their long-term time charter agreements.

About MISC

MISC is a subsidiary of Petronas and was incorporated in 1968. It is one of the world’s leading providers of international energy related maritime solutions and services.

The principal businesses of MISC comprise:

LNG shipping:	A fleet of 25 LNG carriers delivering over 10% of global LNG demand. Additionally, two floating storage units.
Petroleum shipping:	Wholly owned subsidiary, AET, operates a fleet of 81 petroleum tankers providing ocean transportation services as well as specialist lightering and dynamic positioning solutions.
Chemical shipping:	A fleet of 14 double-hull IMO II vessels provide safe and reliable transport solutions for clean liquid cargoes including petroleum products, chemicals and vegetable oils.
Offshore solutions:	Complete, comprehensive and innovative solutions from design to operations and catering for small, marginal and deepwater field developments. MISC owns and operates 13 offshore floating facilities.
Marine and heavy engineering:	A separately listed subsidiary offers the full spectrum of oil and gas production facilities and services in offshore construction, offshore conversion and marine repair. It also operates the largest yard facilities in South East Asia.
Maritime education & training:	MISC’s Malaysian Maritime Academy (ALAM) is a world leading training centre for the development of seafaring professionals. For over 30 years, ALAM has tutored more than 10,000 seafarers through a structured training and education system. The academy is ranked amongst the top 10 percent in the world.

MISC believes the steam option is more economic over the entire lifecycle of the vessel. Dual-fuel and diesel alternatives generate better economies over the longer haul trades, though for ships that will work the shorter routes, MISC says that the steam option will be

more advantageous. LNG shipping has been a major part of the MISC Group since the 1980s and the company is now one of the world’s largest single operators, delivering around 9 percent of the world’s total LNG traded.

Ever keen to innovate and deliver

complementary services, the company has now involved itself in floating storage units (FSU).

Two of its 130,000 cubic metres capacity carriers, “Tenaga Satu” and “Tenaga Empat”, were converted at MISC’s own repair and conversion

facilities in Malaysia in 2012 and are now fully operational.

They were converted to support Malaysia’s first LNG regasification terminal operated by Petronas LNG in Sungai Udang, an island located three kilometres offshore.

These two FSUs are able to receive and discharge LNG simultaneously and have been built and equipped to perform their duties continuously for a long-term period.

MISC recognises that the LNG market is challenging and its strategically diverse business portfolio of petroleum and chemical shipping, marine and heavy engineering and offshore activities can soak up the current challenging conditions of the LNG sector.

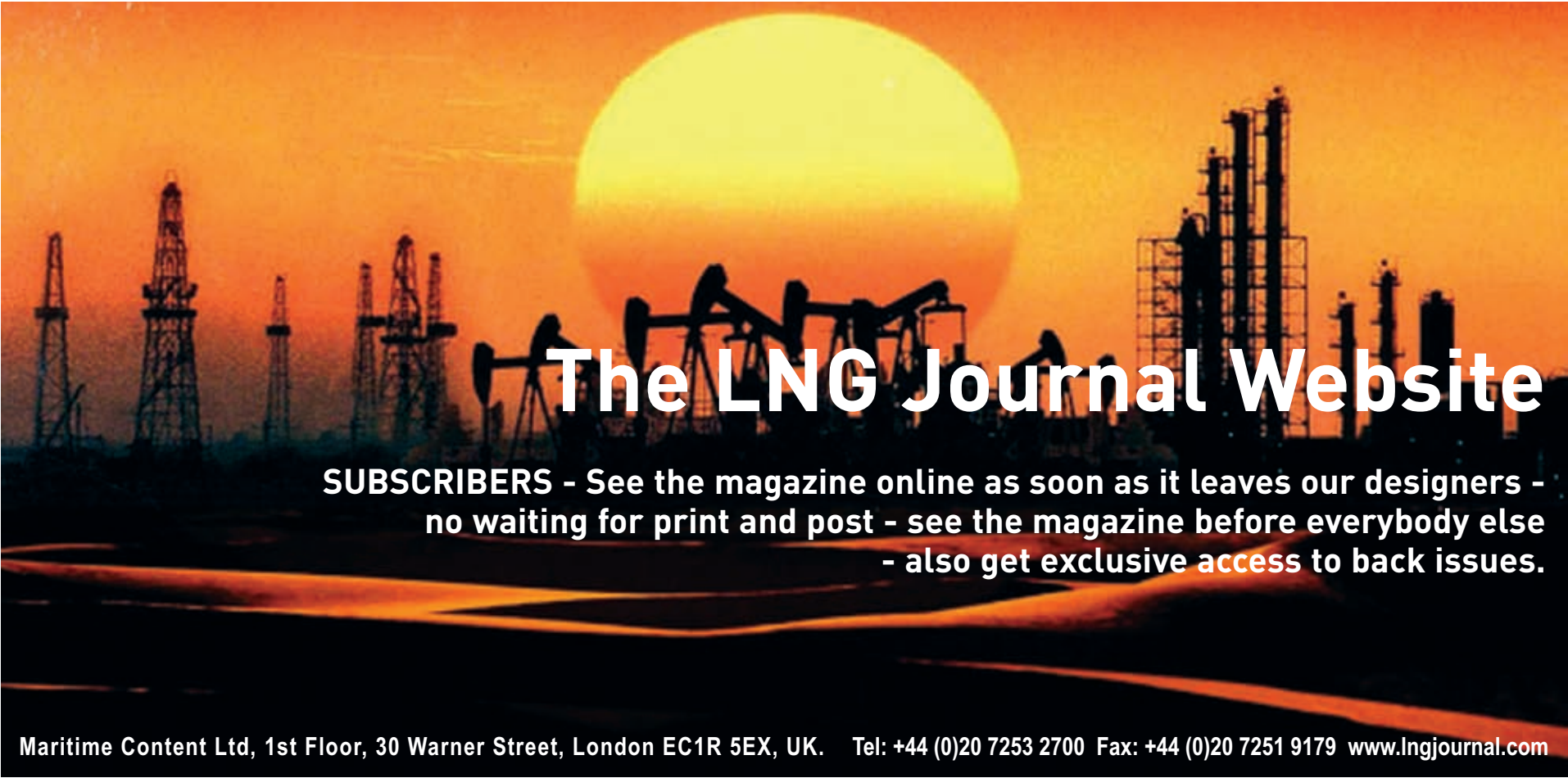
Still, it does have great confidence in the future and is willing to invest its time, energy and resources.

Trade patterns will alter and economies will adjust, but investing in the long-term future of LNG shipping seems like a safe bet for MISC.

This article is based on interviews with senior executives of Malaysia International Shipping Corp.

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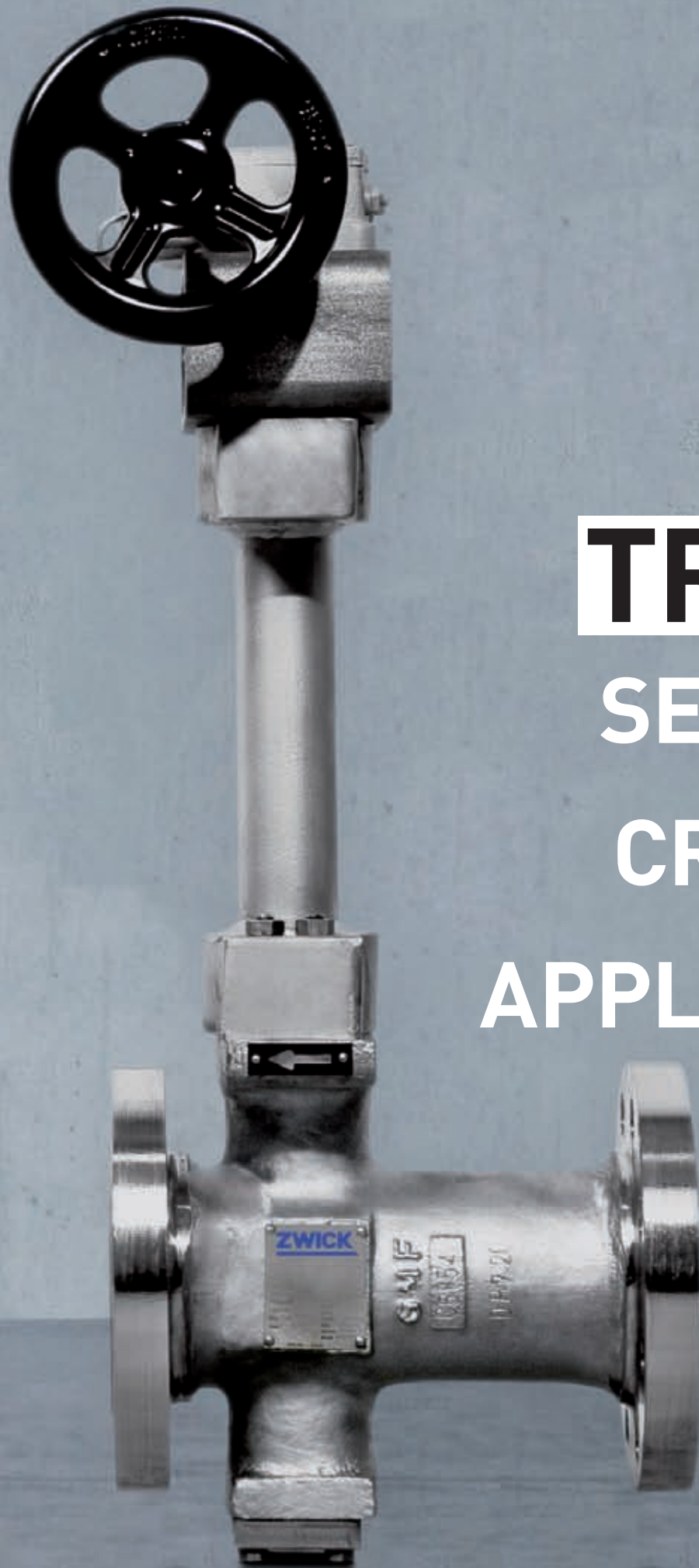
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LNG as fuel, now and in the future: How North American shipping is a main mover

Roy Bleiberg, American Bureau of Shipping Director of Global Gas Solutions

Two liquefied natural gas projects continue to demonstrate the leadership of North American shipowners and service providers in the use of LNG as a fuel.

The ventures also illustrate the complex decision-making required to plan, finance and realise the next generation of shipping assets.

The establishment of the North American Emissions Control Area (ECA) has proven to be a powerful driver for owners and operators engaged in Jones Act trades that in the last few years have seen some notable firsts.

Construction

These include the construction of the first dual-fuel LNG powered containerships and offshore support vessels in the US as well as the building of the first series of LNG-ready product tankers.

The development of related bunkering infrastructure also has continued, with both fixed and mobile applications emerging to meet the growing demand.

Despite the progress, there is a realisation that in order to support the trend towards the use of LNG as fuel, bunkering infrastructure needs to grow - and not just in North America.

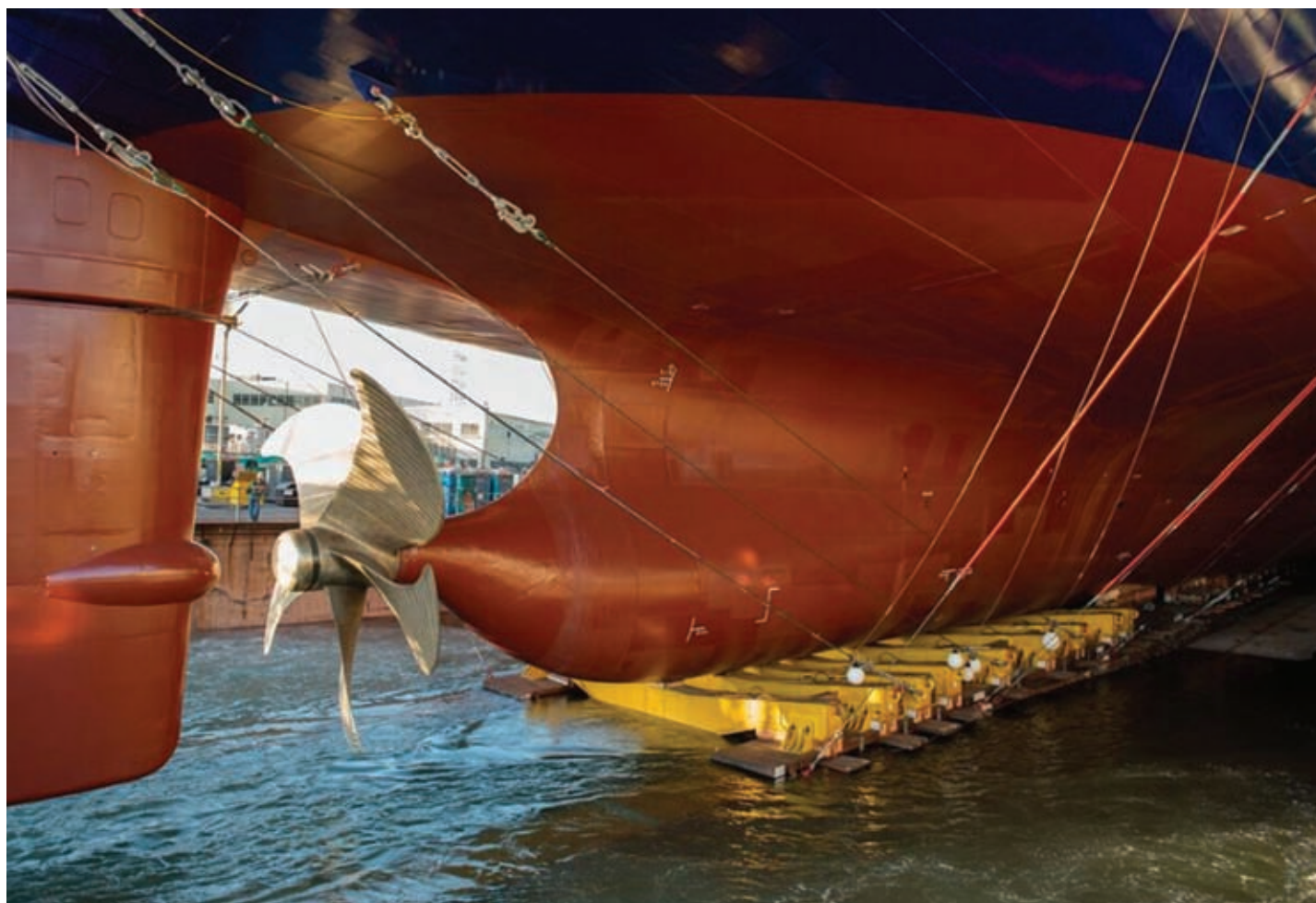
Whatever their strategy, owners and operators are working in a nascent market that requires that they also adopt an innovative approach to financing. They must consider the timing of investments in relation to the trading patterns of their assets, with an eye on future regulation but in the context of the current operating environment.

Through this era of change, ABS has played a critical supporting role in the development of LNG fuel infrastructure and the construction of commercial deepsea vessels in North America, providing classification services for LNG powered and LNG Ready vessels as well as LNG bunkering assets.

Supply chain

ABS has taken part in two very different recent projects with clients working towards an LNG-fuelled future at different parts of the supply chain.

The granting of the first LNG Ready class notation by ABS to a product tanker built by Crowley Maritime Corp



Emissions Control Areas are a powerful driver for owners and operators around the world

demonstrated that owners are planning for a future with LNG in the energy mix but also with a phased approach to its adoption.

ABS also will class an LNG bunker barge under construction at Conrad Orange Shipyard for WesPac Midstream and Clean Marine Energy (CME) in a project that will bolster LNG bunkering infrastructure.

Bunkering

Clean Marine Energy was founded to assist shipowners in complying with tightening emissions standards, specifically related to the sulphur limitations in ECA zones.

By recognising the sometimes slow pace of shipping companies in meeting new requirements as well as the need for specialised finance, the group developed a proprietary funding mechanism to eliminate the upfront capital cost that shipowners face in complying with regulations.

In February 2015, CME placed an order for a 2,200 cubic metres capacity LNG bunker barge with Conrad Shipyard to further the development of a

comprehensive mobile distribution system for LNG as bunker fuel.

The barge, featuring a GTT membrane containment system, is being constructed in conjunction with Bristol Harbor Group acting as naval architect and gas handling equipment by GAS Entec.

CME is actively involved with construction of the barge and will act as marketing agent upon its delivery in Jacksonville, Florida in mid-2016.

The project has a close relationship to the Marlin Class dual-fuelled containerships built by Totem Ocean Trailer Express (TOTE).

CME worked closely with TOTE and other parties to build a barge unit appropriate for TOTE's needs but with the capability and flexibility to serve other customers. Important design criteria for the barge included its freeboard and water draft, loading height, LNG transfer rate, transit speed and blue water capability.

Financing

The barge initially will work loading LNG from JAX LNG and delivering the fuel to TOTE's Blount Island facility where the

Marlin Class containerships will be berthing.

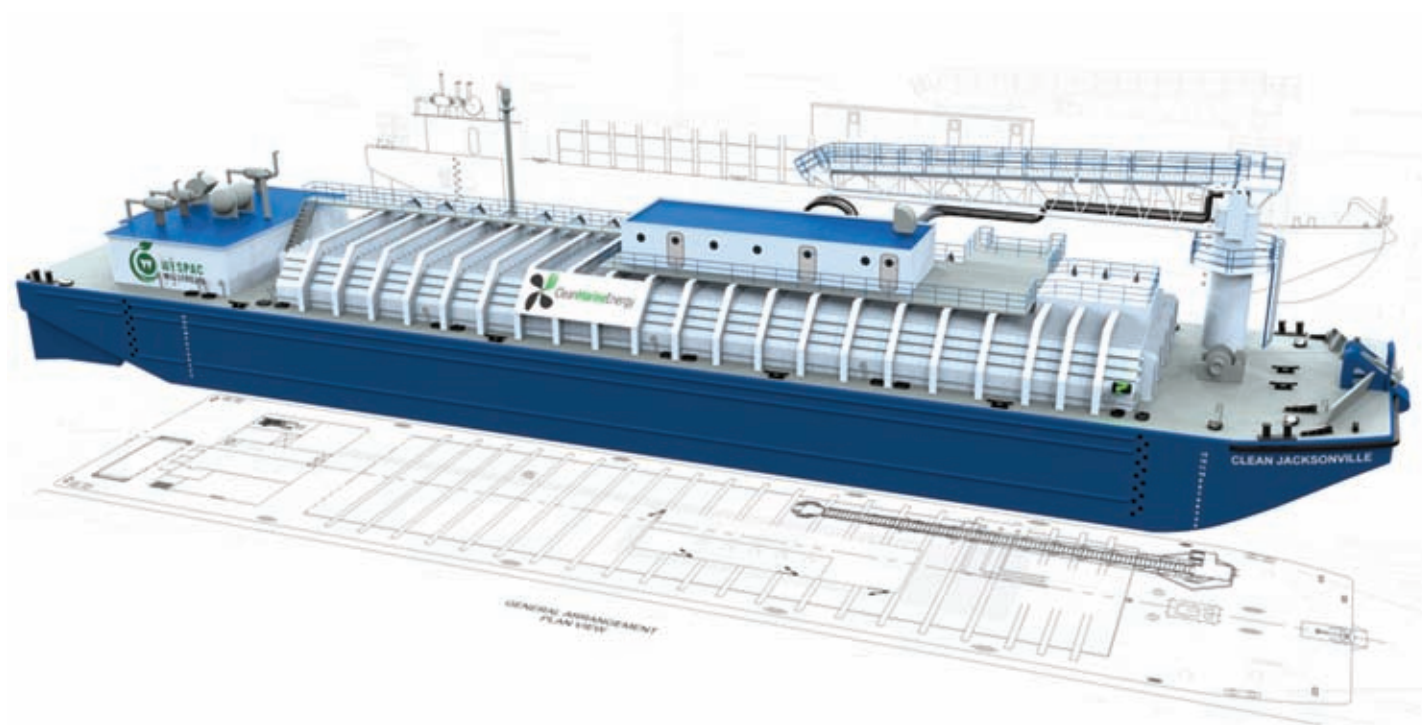
CME is working with other shipowners to deliver LNG out of the JAX LNG facility to locations around the South-eastern United States.

CME's proprietary financial offering is called the Emissions Compliance Service Agreement, or ECSA, which transfers the expense of LNG assets to a third party. Under the ECSA model, CME provides the capital, and the fuel buyer - usually the shipowner or charterer - repays the amount over a period of time based on the spread of fuel savings between LNG and Marine Gas Oil (MGO) and the preferences of the specific fuel buyer.

At the end of the contract, the shipowner retains the asset and enjoys 100 percent of the fuel savings, increased asset value and the flexibility of a dual fuel capable vessel.

Along with its partner WesPac Midstream, CME will guarantee LNG supply to a shipowner in any location.

CME and WesPac together have identified and advanced more than 15 marine LNG fueling facilities in various stages of development throughout North



LNG bunkering barge will be delivered in Jacksonville in mid-2016.

America and have a catalogue of roughly 40 LNG bunker vessel configurations that can be customized for any fueling scenario.

Crowley - LNG Ready

In a very different, but highly significant project, in early November 2015, Crowley christened the first of four new, Jones Act 50,000 dwt product tankers.

Built by Philly Shipyard, Inc., the “Ohio” is the first tanker ever to receive the ABS LNG-Ready Level 1 approval, meaning Crowley has the option to convert the tanker to LNG propulsion in the future.

ABS published the Guide for LNG Fuel Ready Vessels in 2014. The LNG-Ready endorsements allow shipowners and yards the flexibility to limit their initial investment while planning for the future conversion to dual fuel or gas-powered combustion engines.

A strategy which reflects future regulatory requirements can help shipowners prepare for ever-increasing environmental controls while saving time and money by considering basic gas-fuelled ship requirements during the preliminary design, thereby minimizing the potential changes during the future conversion.

Though Crowley foresees the future possibility of more widespread adoption of LNG as fuel, the certainty of the change in all segments of the shipping industry and the timing of such a switch remains unclear at present, according to Ray Martus, Vice President of Construction Management.

Unlike liner services working between a very limited number of ports or

geographic region, these tankers trade widely all over the US. Martus says the infrastructure required, specifically the supply of LNG bunkers, is not available yet in all the varied areas that these ships might operate, and the timing of future availability of LNG still remains vague.

“Because the capital equipment costs of the LNG tanks, dual-fuel engines and fuel gas supply systems are extremely high, it is not economically feasible to perform the full dual-fuel modification on vessels that may not be able to utilize LNG for some years,” he explains.

Instead, Crowley working together with the shipyard and ABS, decided to prepare for the future by performing the functional level engineering, planning to a significant extent the full modification, and then deciding which limited elements were cost-effective to install initially.

In order to reduce the expected time for a future modification and to avoid future damage to the cargo tank linings, the decision was made to install the underdeck structure necessary to support the future installation of the LNG tanks on deck, amongst other smaller modifications.

Martus says the technical challenge in building LNG Ready capability into the tankers was to create an LNG-ready design that, if ultimately implemented, would cause the least amount of future work and rework and thereby facilitate a shorter out-of-service interval for such a retrofit.

“The future sites of the LNG tanks and other equipment were selected, not only for system functionality, but also to avoid, to the extent possible, existing interferences that would cost time and

money to rework,” he explains.

For maximum flexibility, the tankers can utilize up to three on-deck LNG type C storage tanks, depending on what range under LNG power is determined as necessary.

Economics

As Crowley’s experience indicates, the economics of LNG Ready operations are multi-faceted.

CME’s Bradley Neuberth says a thorough understanding of the incremental cost of dual fuel versus diesel-only and the estimated payback period are critical.

“There are a lot of variables that go into the conversion of a vessel to run on LNG, and the costs that are circulating the industry vary widely. As a result, we think it makes sense for a shipowner to build their new vessels LNG ready, even if they decide that investing in a fully LNG capable vessel isn’t prudent today,” Neuberth explains.

Under its model, CME provides the financing for the owner to take the next step to be LNG fuelled at no upfront cost to the shipowner.

This offsets the most expensive items in the LNG system - the tanks and the fuel gas supply system - because the engine prices are well known and are less of a barrier to the decision.

The potential loss of cargo space also needs to be taken into account, but with an efficient design, this should be an issue that can be accounted for.

As to payback, he says the period will ebb and flow with the spread between LNG and MGO prices. “Of course, the forward price of marine fuels is unknown,

especially for diesel products. In one year we have seen a greater than 50% drop in prices in many regions,” he continues.

But with some degree of certainty, Neuberth predicts there will be an abundant supply of natural gas in North America and expects LNG prices to remain steadily low and the spread between LNG and MGO to widen.

“Making the upfront investment in LNG provides an affordable option to burn LNG if diesel prices rise again over the next 25 years. If history is any indicator, it is likely they will. The environmental benefit, of course, will be felt as soon as the first molecule of LNG is burned,” Neuberth adds.

Infrastructure

Despite the work being done to build the necessary infrastructure, the developing state of LNG bunkering in the US is still perceived as a barrier to the broader adoption of LNG as fuel, irrespective of the regulatory drivers.

Operators such as Harvey Gulf have found it necessary to develop their own land-based infrastructure rather than rely on third-party installations as they would for conventional fuel.

With the LNG marine fuel industry still in its infancy, the issues to consider are different from those expected in a mature industry, says Neuberth.

“Long-term contracts of roughly 10 years are necessary to justify the investment needed to build a liquefaction facility and provide point specific, low cost LNG,” he suggests.

CME estimates roughly 50,000 gallons per day of demand is needed as a baseload for a dedicated small-scale liquefaction facility.

Even so, moderately priced interim solutions, such as trucking, are available to seed the market, and shore-based or water-based storage facilities that are filled only on demand can be used to pipe LNG directly to customers, meaning not every market needs a dedicated liquefaction facility.

However, just as in LNG-fuelled shipping, Neuberth says a long-term vision is necessary to realise LNG bunkering projects.

“The bottom line is, multiple parties need to step forward together. A shipping company needs to be willing to take a long-term fuel contract, and a development company needs to invest significant capital to build infrastructure. There are advantages to be had for the early adopters, who will benefit from preferred

pricing as anchor tenants once the rest of the industry catches up," he says.

Conclusions

Whether building a bunkering barge, planning fixed bunkering facilities or building LNG ready vessels, there is no doubt that the demands are stringent in all respects.

They include compliance with state and federal regulations and co-operation on technical standards as well as the specific requirements of gas handling, transport and storage.

Martus says Crowley is proud to own and operate the first vessel in the world to achieve the ABS LNG Ready notation and adds that the challenges of using LNG as fuel for commercial vessels meant co-operation and collaboration among the owner, the shipyard, the shipyard's design partners and ABS was vitally important.

"Many meetings and discussions were had in order to refine the design and implement the initial changes," Martus says.

Neuberth agrees that partnerships are critical to success. The close co-ordination that is required between teams to ensure success is both paramount and difficult, he says, but committed operators have the greatest probability of success as they take the steps forward necessary to advance the LNG marine fuel industry.

"Our experience is that working with the best in class operators and providers is necessary to move projects forward at this early, pioneering stage," Neuberth says.

The use of trusted advisors also is important since the knowledge base on this subject is still comparatively small. Some vendors and suppliers are just beginning to become

involved in this area; so companies should choose their partners wisely.

However challenging, the marine industry already has begun the process of

adopting LNG as fuel in North America. Pioneers, including Crowley, CME and others, have a role to play not just in overcoming the technical requirements

but also in building the capacity - both physical and financial - that encourages the wider development of this exciting, innovative sector. ■



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LNG carrier	Capacity m ³	Owned or Ordered by	Builder	Delivery Date	Flag	Power Plant	Cargo System	No. of tanks	Ship built for Export plant
Aamira	266,000	QGTC	Samsung	Dec-10	Liberia	DRL	TZ Mk. III	5	Qatargas IV
Abadi	135,000	Brunei Gas Carriers	Mitsubishi Nagasaki	Jun-02	Brunei	S	Moss	5	Brunei LNG
Abdelkader	177,000	MOL-Itochu	Hyundai	Feb-09	Panama	DFDE	TZ Mk. III	4	Various
Adam LNG	162,000	Oman LNG	Hyundai	Dec-14	Marshall Is.	DFDE	TZ Mk. III	4	Oman LNG
Al Aamriya	210,100	J5 Consortium	Daewoo	Feb-08	Marshall Is.	DRL	GT NO 96	4	Qatargas
Al Areesh	151,700	Teekay LNG	Daewoo	Jan-07	Qatar	S	GT NO 96	4	Ras Gas II
Al Bahiya	266,000	QGTC	Samsung	Oct-09	Liberia	DRL	TZ Mk. III	5	Qatar-Atlantic
Al Biddah	135,275	J4 Consortium	Kawasaki Sakaide	Nov-99	Japan	S	Moss	5	Qatargas
Al Daayen	151,700	Teekay LNG	Daewoo	Apr-07	Qatar	S	GT NO 96	4	RasGas II
Al Dafna	266,000	QGTC	Samsung	Oct-09	Marshall Is.	LR DRL	GT NO 96	4	Qatar-Atlantic
Al Deebel	145,000	Peninsular LNG	Samsung	Dec-05	Bahamas	S	TZ Mk. III	4	Qatargas
Al Gattara	216,200	OSG/Nakilat	Hyundai	Oct-07	Marshall Is.	DRL	TZ Mk. III	4	Qatargas II
Al Ghariya	210,100	ProNav	Daewoo	Feb-08	Bahamas	DRL	GT No. 96	4	Qatargas
Al Gharaffa	216,200	OSG/Nakilat	Hyundai	Jan-08	Marshall Is.	DRL	TZ Mk. III	4	Various
Al Ghashamiya	216,000	QGTC	Samsung	Mar-09	Liberia	DRL	TZ Mk. III	4	Qatar-Atlantic Basin
Al Ghuwairiya	261,700	QGTC	Daewoo	Aug-08	Marshall Is.	DRL	GT NO. 96	5	Qatar-Atl'c Basin
Al Hamla	216,000	OSG	Samsung	Feb-08	Marshall Is.	DRL	TZ Mk. III	4	QatarGas
Al Hamra	137,000	National Gas Shipping	Kvaerner-Masa	Jan-97	Liberia	S	Moss	4	ADGAS
Al Huwaila	217,000	Teekay	Samsung	May-08	Bahamas	DRL	TZ Mk. III	4	RasGas III
Al Jasra	137,100	J4 Consortium	Mitsubishi Nagasaki	Jul-00	Japan	S	Moss	5	Qatargas
Al Jassasiya	145,700	Maran-Nakilat	Daewoo	May-07	Greece	S	GT No 96	4	RasGas
Al Kharaitiyat	216,200	QGTC	Hyundai	May-09	Liberia	DRL	TZ Mk. III	4	Qatargas III
Al Kharaana	210,000	QGTC	Daewoo	Oct-09	Marshall Is.	DRL	GT NO 96	4	Qatargas IV
Al Kharsaah	217,000	Teekay	Samsung	May-08	Bahamas	DRL	TZ Mk. III	4	RasGas III
Al Khattiya	210,000	QGTC	DSME	Oct-09	Marshall Is.	DRL	GT No. 96	4	Qatargas IV
Al Khaznah	135,500	National Gas Shipping	Mitsui Chiba	Jun-94	Liberia	S	Moss	5	ADGAS
Al Khor	137,350	J4 Consortium	Mitsubishi Nagasaki	Dec-96	Japan	S	Moss	5	Qatargas
Al Khuwair	217,000	Teekay LNG	Samsung	Jul-08	Korea	DRL	TZ Mk. III	4	RasGas
Al Mafyar	266,000	OSG/Nakilat	Hyundai	Oct-07	Marshall Is.	DRL	TZ Mk. III	4	Qatargas II
Al Marrouna	151,700	Teekay	Daewoo	Nov-07	Bahamas	S	GT NO 96		Ras Gas I
Al Mayeda	266,000	QGTC	Samsung	Jan-09	Liberia	DRL	TZ Mk. III	5	Qatar-US/Var.
Al Nuaman	210,000	QGTC	DSME	Dec-09	Marshall Is.	DRL	GT No. 96	4	Qatargas IV
Al Oraiq	210,000	J5 Consortium	Daewoo	Apr-08	Marshall Is.	DRL	GT No. 96	4	Various
Al Rayyan	135,360	J4 Consortium	Kawasaki Sakaide	Mar-97	Japan	S	Moss	5	Qatargas
Al Rekayyat	216,200	QGTC	Hyundai	Jun-09	Bahamas	DRL	TZ Mk.III	4	Qatar-Atlantic
Al Ruwais	210,100	ProNav	Daewoo	Nov-07	Germany	DRL	GT NO 96	4	Qatargas II
Al Sadd	210,100	QGTC	Daewoo	Mar-09	Liberia	DRL	GT NO 96	4	Qatar-Atlantic Basin
Al Safliya	210,100	ProNav	Daewoo	Dec-07	Bahamas	DRL	GT NO 96	4	Qatargas II
Al Sahla	216,200	J5	Hyundai	Jun-08	Japan	DRL	TZ Mk. III	4	Ras Gas III
Al Samriya	261,700	QGTC	Daewoo	Sep-08	Marshall Is.	DRL	GT NO. 96	5	Qatargas II
Al Sheehaniya	210,100	QGTC	Daewoo	Feb-09	Liberia	DRL	GT NO 96	4	Qatar-Atlantic Basin
Al Shamal	217,000	Teekay LNG	Samsung	Jun-08	Qatar	DRL	TZ Mk. III	4	RasGas
Al Thakhira	145,000	Peninsular LNG	Samsung	Sep-05	Bahamas	S	TZ Mk. III	4	Qatargas
Al Thumama	216,000	J5 Consortium	Hyundai	Apr-08	Japan	DRL	TZ Mk. III	4	Rasgas
Al Utouriya	215,000	J5	Hyundai	Sep-08	Panama	DRL	TZ Mk. III	4	RasGas
Al Utourma	215,000	J5	Hyundai	Sep-08	Panama	DRL	TZ Mk. III	4	Ras Gas III
Al Wajbah	137,350	J4 Consortium	Mitsubishi Nagasaki	Jun-97	Japan	S	Moss	5	Qatargas
Al Wakrah	135,360	J4 Consortium	Kawasaki Sakaide	Dec-98	Japan	S	Moss	5	Qatargas
Al Zhubarah	137,570	J4 Consortium	Mitsui Chiba	Dec-96	Japan	S	Moss	5	Qatargas
Alto Acrux	147,000	LNG Marine Transport	Mitsubishi	Mar-08	Bahamas	S	Moss	4	Various
Amali	148,000	Brunei-Shell	DSME	Jul-11	Brunei	DFDE	GT No. 96	4	Brunei LNG
Amanl	154,800	Brunei-Shell	Hyundai	Nov-14	Brunei	DFDE	TZ Mk. III	4	Brunei LNG
Aman Bintulu	18,928	Perbadanan / NYK Line	NKK Tsu	Oct-93	Malaysia	S	TZ Mk. III	3	Petronas
Aman Hakata	18,800	Perbadanan / NYK Line	NKK Tsu	Nov-98	Malaysia	S	TZ Mk. III	3	Petronas
Aman Sendai	18,928	Perbadanan / NYK Line	NKK Tsu	May-97	Malaysia	S	TZ Mk. III	3	Petronas
Arctic Aurora	160,000	Dynagas	Hyundai	Jul-13	Marshall Is.	DFDE	TZ Mk. III	4	Various
Arctic Discoverer	140,000	K Line	Mitsui Chiba	Jan-06	Bahamas	S	Moss	4	Various
Arctic Lady	147,200	MOL/Hoegh LNG	Mitsubishi Nagasaki	Apr-86	Norway	S	Moss	4	Various
Arctic Princess	147,200	MOL/Hoegh LNG	Mitsubishi Nagasaki	Jan-06	Norway	S	Moss	4	Various
Arctic Sun	89,880	Arctic LNG Shipping	IHI Chita	Dec-93	Liberia	S	IHI SPB	4	ConocoPhillips/Marathon
Arctic Voyager	140,000	K Line	Kawasaki	Jul-06	Bahamas	S	Moss	4	Statoil
Arkat	148,000	Brunei-Shell	DSME	Feb-11	Brunei	DFDE	GT. No. 96	4	Brunei LNG
Arwa Spirit	165,000	Teekay LNG	Samsung	Sep-08	Marshall Is.	DFDE	TZ Mk. III	4	Various
Asia Endeavour	160,000	Chevron	Samsung	Dec-14	Bahamas	DFDE	TZ Mk. III	4	Various
Asia Energy	160,000	Chevron	Samsung	Sept-14	Bahamas	DFDE	TZ Mk. III	4	Various
Asia Excellence	160,000	Chevron	Samsung	Sept-13	Bahamas	DFDE	TZ Mk. III	4	Various
Asia Vision	160,000	Chevron	Samsung	June-14	Bahamas	DFDE	TZ Mk. III	4	Various
Barcelona Knutsen	173,400	Knutsen	Daewoo	May-10	N.I.S.	DFDE	GT NO 96	4	Various
Bebatic	75,060	Brunei Shell Tankers	Atlantique	Oct-72	Brunei	S	TZ Mk. I	6	Brunei LNG
Beidou Star	172,000	MOL	Hudong	Oct-15	Hong Kong	DRL	GT NO. 96	4	Various
Berge Arzew	138,088	BW Gas	Daewoo	Jul-04	Norway	S	GT NO 96	4	Sonatrach
BW GDF-Suez Boston	138,059	BW Gas	Daewoo	Jan-03	Norway	S	GT NO 96	4	Suez LN
BW GDF Suez Everett	138,028	BW Gas	Daewoo	Jun-03	Norway	S	GT NO 96	4	Suez LNG
Bilbao Knutsen	138,000	Knutsen / Marpetrol	IZAR Sestao	Jan-04	Spain	S	GT NO 96	4	Atlantic LNG
Bilis	77,730	Brunei Shell Tankers	La Seyne	Mar-75	Brunei	S	GT NO 82	5	Brunei LNG
Bishu Maru	162,000	K Line-Transpacific	Kawasaki Sakaide	Dec-15	Panama	S	Moss	4	Australia-Japan
British Diamond	155,000	BP Shipping	Hyundai	Sep-08	IOM	DFDE	TZ Mk. II	4	Indonesia-Various
British Emerald	155,000	BP Shipping	Hyundai	Jun-07	UK	DFDE	TZ Mk. III	4	Tangguh LNG

CARRIER FLEET

British Innovator	138,200	BP Shipping	Samsung	Jul-03	Isle of Man	S	TZ Mk. III	4	Various
British Merchant	138,000	BP Shipping	Samsung	Apr-03	Isle of Man	S	TZ Mk. III	4	Various
British Ruby	155,000	BP Shipping	Hyundai	Jan-08	U.K.	DFDE	TZ Mk. III	4	Various
British Sapphire	155,000	BP Shipping	Hyundai	Sep-08	IOM	DFDE	TZ Mk. III	4	Tangguh
British Trader	138,000	BP Shipping	Samsung	Dec-02	Isle of Man	S	TZ Mk. III	4	Engas
Broog	135,466	J4 Consortium	Mitsui Chiba	May-98	Japan	S	Moss	5	Qatargas
Bu Samara	266,000	QGTC	Samsung	Dec-08	Qatar	DRL	TZ Mk. III	5	Qatargas
BW Suez Paris	162,400	BW Gas	Daewoo	May-09	N.I.S.	DFDE	GT NO 96	4	Yemen-Atlantic
BW Suez Brussels	162,400	BW Gas	Daewoo	May-09	N.I.S.	DFDE	GT NO 96	4	Yemen-Atlantic
Cadiz Knutsen	138,826	Knutsen / Marpetrol	IZAR Puerto Real	Jun-04	Spain	S	GT NO 96	4	Engas
Castillo de Santisteban	173,600	Elcano	STX	Aug-10	Malta	S	GT NO. 96		Various
Castillo de Villalba	138,000	Elcano	IZAR	Nov-03	Spain	S	GT NO 96	4	Sonatrach
Catalunya Spirit	138,000	Teekay LNG Partners	IZAR Sestao	Mar-03	Liberia	S	GT NO 96	4	Atlantic LNG
Celestine River	145,000	KLNG	Kawasaki	Dec-07	Bahamas	S	Moss		Various
Cheikh Bouamama	75,500	Skikda LNG Transport	USC	Jul-08	Bahamas	S	TZ Mk. III	4	Sonatrach
Cheikh El Mokrani	75,500	Med LNG Corp	USC	Jun-07	Bahamas	S	TZ Mk. III	4	Sonatrach
Clean Energy	150,000	Pegasus Shiph'd	Hyundai	Mar-07	Marshall Is.	S	TZ Mk. III	4	Various
Clean Force	150,000	Seacrown Mariti	Hyundai	Jan-08	Marshall Is.	S	TZ Mk. III	4	Various
Clean Ocean	155,900	Dynagas	Hyundai	Mar-14	Marshall Is.	DFDE	TZ Mk. III	4	Various
Clean Planet	155,900	Dynagas	Hyundai	Mar-14	Marshall Is.	DFDE	TZ Mk. III	4	Various
Clean Vision	160,000	Dynagas	Hyundai	Jun-15	Marshall Is.	DFDE	TZ Mk. III	4	Various
Cool Explorer	160,000	Thenamaris	Samsung	Oct-13	Bermuda	DFDE	TZ Mk. III	4	Various
Cool Runner	160,000	Thenamaris	Samsung	May-14	Bermuda	DFDE	TZ Mk. III	4	Various
Cool Voyager	160,000	Thenamaris	Samsung	Oct-13	Bermuda	DFDE	TZ Mk. III	4	Various
Corcovado LNG	160,106	TMSC Gas	Daewoo	Jun-14	Malta	TFDE	GT No 96	4	Various
Cubal	160,400	Mitsui/NYK/Teekay	Samsung	Jan-12	Bahamas	DFDE	TZ Mk. III	4	Various
Cygnus Passage	145,400	Cygnus LNG	Mitsubishi	Feb-09	Panama	S	Moss	4	Various
Dapeng Moon	147,000	China Ships	Hudong	Jul-09	China	S	GT NO 96	4	Various
Dapeng Star	147,000	China Ships	Hudong	Nov-09	China	S	GT NO 96	4	Various
Dapeng Sun	147,000	China Ships	Hudong	Jul-07	China	S	GT NO 96	4	Woodside Energy
Disha	136,000	Petronet LNG Ltd.	Daewoo	Jan-04	Malta	S	GT NO 96	4	Qatargas
Doha	137,350	J4 Consortium	Mitsubishi Nagasaki	Jun-99	Japan	S	Moss	5	Qatargas
Duhail	210,100	ProNav	Daewoo	Jan-08	Germany	DRL	GT NO 96	4	Various
Dukhan	135,000	J4 Consortium	Mitsui Chiba	Oct-04	Japan	S	Moss	4	Qatargas
Dwiputra	127,385	Humpuss Consortium	Mitsubishi Nagasaki	Mar-94	Bahamas	S	Moss	4	Pertamina
Ebisu	147,547	Golar LNG	Kawasaki	Sep-08	Bahamas	S	Moss	4	Various
Ejnan	145,000	4J	Samsung	Jan-07	Bahamas	S	TZ Mk. III		RasGas
Ekaputra	136,400	Humpuss Consortium	Mitsubishi Nagasaki	Jan-90	Liberia	S	Moss	5	Pertamina
Energy Advance	145,000	Tokyo LNG Tankers	Kawasaki Sakaide	Mar-05	Japan	S	Moss	4	Darwin
Energy Confidence	155,000	Tokyo LNG Tankers	Kawasaki	Apr-09	Panama	S	Moss	4	Various
Energy Frontier	147,600	Tokyo LNG Tankers	Kawasaki Sakaide	Sep-03	Japan	S	Moss	4	Darwin
Energy Horizon	177,000	Tokyo LNG Tankers	Kawasaki	Jul-11	Japan	S	Moss	4	Pluto LNG
Energy Navigator	147,000	Tokyo LNG Tankers	Kawasaki Sakaide	May-08	Japan	S	Moss	4	Various
Energy Progress	145,000	MOL	Kawasaki	Nov-06	Japan	S	Moss	4	Bayu Undan LNG
Essshu Maru	162,000	K Line-Transpacific	Kawasaki Sakaide	Dec-14	Panama	S	Moss	4	Australia-Japan
Excalibur	138,200	Exmar/ Excelerate	Daewoo	Oct-02	Belgium	S	GT NO 96	4	Various
Excel	138,106	Exmar/ MOL	Daewoo	Sep-03	Belgium	S	GT NO 96	4	Various
Excelerate	138,000	Exmar/Excelerate	Daewoo	Oct-06	Belgium	S	GT NO 96	4	Various
Excellence	138,000	GKFF Ltd.	Daewoo	May-05	Belgium	S	GT NO 96	4	Excelerate Energy
Excelsior	138,000	Exmar	Daewoo	Jan-05	Belgium	S	GT NO 96	4	Various
Exemplar	150,900	Excelerate	Daewoo	Jun-10	Belgium	S	GT NO 96	4	Various
Expedient	151,000	Excelerate	Daewoo	Nov-09	Belgium	S	GT NO 96	4	Various
Experience RV	174,000	Exmar/Excelerate	Daewoo	Jul-14	Marshall Is.	DFDE	GT NO 96		Various
Explorer	150,900	Exmar/Excelerate	Daewoo	Mar-08	Belgium	S	GT NO 96	4	Excelerate
Express	151,000	Exmar/Excelerate	Daewoo	May-09	Belgium	S	GT NO 96	4	Various
Exquisite	150,900	Excelerate	Daewoo	Sep-09	Belgium	S	GT NO. 96	4	Various
Fraiha	210,100	J5 Consortium	Daewoo	Sep-08	Marshall Is.	DRL	GT NO 96	4	Qatargas
FSRU Independence	170,000	Hoegh	Hyundai	Feb-14	NIS	DFDE	TZ Mk. III	4	Various
FSRU Lampung	170,000	Hoegh	Hyundai	May-14	Indonesia	DFDE	TZ Mk. III	4	Various
Fuji LNG	147,895	TMSC Gas	Kawasaki	Jun-04	Malta	S	Moss	4	Various
Fuwairit	138,000	Peninsular LNG	Samsung	Jan-04	Bahamas	S	TZ Mk. III	4	RasGas II
Galea	134,425	Shell Shipping	Mitsubishi Nagasaki	Oct-02	Singapore	S	Moss	5	Shell
Galicia Spirit	140,620	Teekay LNG Partners	Daewoo	Jul-04	Liberia	S	GT NO 96	4	Engas
Gaselys	153,500	GdF/NYK	Atlantique	Mar-07	France	DFDE	CS 1	4	Engas
Gallina	134,425	Shell Shipping	Mitsubishi Nagasaki	Oct-02	Singapore	S	Moss	5	Shell
GasLog Chelsea	153,000	GasLog	Hanjin Korea	Dec-09	Panama	TFDE	TZ Mk. III	4	Various
GasLog Salem	165,000	GasLog	Samsung	Apr-15	Liberia	TFDE	TZ Mk. III	4	various
GasLog Santiago	155,000	GasLog	Samsung	Mar-13	Liberia	TFDE	TZ Mk. III	4	Various
GasLog Saratoga	155,000	GasLog	Samsung	Dec-14	Bermuda	TFDE	TZ Mk. III	4	Various
Gaslog Savannah	155,000	GasLog	Samsung	May-10	Bermuda	DFDE	TZ Mk. III	4	Various
GasLog Seattle	155,000	GasLog	Samsung	Oct-13	Bermuda	TFDE	TZ Mk. III	4	Various
GasLog Shanghai	155,000	GasLog	Samsung	Jan-13	Liberia	TFDE	TZ Mk. III	4	Various
Gaslog Singapore	155,000	GasLog	Samsung	Jul-10	Bermuda	DFDE	TZ Mk. III	4	Various
Gaslog Skagen	155,000	GasLog	Samsung	Oct-13	Bermuda	DFDE	TZ Mk. III	4	Various
Gaslog Sydney	155,000	GasLog	Samsung	May-13	Bermuda	DFDE	TZ Mk. III	4	Various
GDF-Suez Global Energy	74,000	Gaz de France	Chantiers	Dec-06	France	DFDE	CS1	4	Sonatrach
GDF-Suez Cape Ann	145,000	Hoegh LNG/MOL	Samsung	May-10	Liberia	DFDE	TZ Mk. III	4	Various
GDF-Suez Neptune	145,000	Hoegh LNG/MOL	Samsung	Dec-09	Liberia	DFDE	TZ Mk. III	4	Various
GDF-Suez Point Fortin	154,200	LNG Japan	Imabari/Koyo	Feb-10	Panama	DFDE	TZ Mk. III	4	Various
Gemmata	138,100	Shell Shipping	Mitsubishi Nagasaki	Mar-04	Singapore	S	Moss	5	Shell
Ghasha	137,510	National Gas Shipping	Mitsui	Jun-95	Liberia	S	Moss	5	ADGAS
Golar Arctic	140,645	Golar LNG	Daewoo	Dec-03	Marshall Is.	S	GT NO 96	4	Shell Spot
Golar Bear	160,000	Golar	Samsung	Mar-14	Bermuda	DFDE	TZ Mk. III	4	Various

Golar Celsius	160,000	Golar LNG	Samsung	Sep-13	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Crystal	160,000	Golar LNG	Samsung	Oct-13	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Eskimo (FSRU)	160,000	Golar LNG	Samsung	Jan-15	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Freeze	125,850	Golar LNG	HDW	Feb-77	UK	S	Moss	5	Various
Golar Glacier	162,000	Golar LNG	Hyundai	Sep-14	Marshall Is.	DFDE	TZ Mk. III	4	Various
Golar Grand	145,880	Golar LNG	Daewoo	2006	IoM		GT NO 96	4	Various
Golar Ice	160,000	Golar LNG	Samsung	Feb-15	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Igloo (FSRU)	160,000	Golar LNG	Samsung	Oct-13	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Kelvin	160,000	Golar LNG	Samsung	Jan-15	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Maria	145,950	Golar LNG	Daewoo	2006	Marshall Is.		GT NO 96	4	Various
Golar Mazo	135,225	Golar LNG/PPP	Mitsubishi	Jan-00	Liberia	S	Moss	5	Pertamina
Golar Penguin	160,000	Golar LNG	Samsung	Mar-14	Marshall Is.	DFDE	TZ Mk. III	4	Various
Golar Seal	160,000	Golar LNG	Samsung	Aug-13	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Singapore (FSRU)	160,000	Golar LNG	Samsung	June-15	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Snow	160,000	Golar LNG	Samsung	Jan-15	Bermuda	DFDE	TZ Mk. III	4	various
Golar Tundra (FSRU)	160,000	Golar LNG	Samsung	Dec-15	Bermuda	DFDE	TZ Mk. III	4	Various
Golar Viking	140,000	Golar LNG	Hyundai	Jan-05	Marshall Is.	S	Moss	4	Various
Golar Winter	138,250	Golar LNG	Daewoo	Apr-04	Marshall Is.	S	GT NO 96	4	Petrobras
Grace Acacia	150,000	Algaet Shipping	Hyundai	Jan-07	Japan	S	TK MK III	4	Various
Grace Barleria	150,000	Swallowtail Ship	Hyundai	Oct-07	Japan	S	TZ Mk. III	4	Various
Grace Cosmos	150,000	AGH Shipping	Hyundai	Mar-08	Japan	S	TZ Mk. III	4	Various
Grace Dahlia	177,000	Tokyo Gas	Kawasaki	Oct-13	Japan	S	Moss	4	Various
Gracilis	138,830	Golar LNG	Hyundai	Jan-05	Marshall Is.	S	TZ Mk. III	4	Shell BG
Granatina	140,645	Shell Shipping	Daewoo	Dec-03	Singapore	S	GT NO 96	4	Shell
Grand Aniva	147,200	Sovcomflot/NYK	Mitsubishi	Jan-08	Japan	S	Moss	4	Various
Grand Elena	147,200	Sovcomflot/NYK	Mitsubishi	Oct-07	Japan	S	Moss	4	Various
Grand Mereya	147,200	Primorsk/MOL/K Line	Chiba	May-08	Japan	S	Moss	4	Sakhalin II
Hanjin Muscat	138,200	Hanjin Shipping	Hanjin	Jul-99	Panama	S	GT NO 96	4	Oman Gas
Hanjin Pyeong Taek	130,600	Hanjin Shipping	Hanjin	Sep-95	Panama	S	GT NO 96	4	Pertamina
Hanjin Ras Laffan	138,214	Hanjin Shipping	Hanjin	Jul-00	Panama	S	GT NO 96	4	Qatar Gas
Hanjin Sur	138,333	Hanjin Shipping	Hanjin	Jan-00	Panama	S	GT NO 96	4	Oman Gas
Hispania Spirit	140,500	Teekay LNG Partners	Daewoo	Sep-02	Spain	S	GT NO 96	4	Atlantic LNG
Hoegh Gallant FSRU	170,050	Hoegh LNG	Hoegh Hyundai	May-14	Marshall Is.	DFDE	TZ Mk. III	4	chartered
Hoegh Grace FSRU	170,050	Hoegh LNG	Hoegh LNG Hyundai	May-15	Marshall Is.	DFDE	TZ Mk. III	4	various
Hyundai Aquapia	135,000	Hyundai MM	Hyundai	Mar-00	Panama	S	Moss	4	Oman Gas
Hyundai	135,000	Hyundai MM	Hyundai	Jan-00	Panama	S	Moss	4	RasGas
Hyundai Ecopia	145,000	Hyundai	Hyundai	Nov-08	Panama	S	TZ Mk. III	4	Various
Hyundai Greenpia	125,000	Hyundai MM	Hyundai	Nov-96	Panama	S	Moss	4	Pertamina
Hyundai Oceanpia	135,000	Hyundai MM	Hyundai	Jul-00	Panama	S	Moss	4	Oman Gas
Hyundai Technopia	135,000	Hyundai MM	Hyundai	Jul-00	Panama	S	Moss	4	RasGas
Hyundai Utopia	125,182	Hyundai MM	Hyundai	Jun-94	Panama	S	Moss	4	Pertamina
Iberica Knutsen	138,000	Knutsen OAS	Daewoo	Aug-06	Norway	S	GT 96	4	Gas Natural
Ibra LNG	147,100	Oman Gas	Samsung	Jun-06	Panama	S	TK Mk. III	4	Oman LNG
Ibri LNG	145,000	Oman Gas	Mitsubishi	Jul-06	Panama	S	TK Mk. III	4	Oman LNG
Ish	137,540	National Gas Shipping	Mitsubishi Nagasaki	Nov-95	Liberia	S	Moss	5	ADGAS
K Acacia	138,017	Korea Line	Daewoo	Jan-00	Panama	S	GT NO 96	4	Oman Gas
K Freesia	135,256	Korea Line	Daewoo	Jun-00	Panama	S	GT NO 96	4	RasGas
K Jasmine	145,700	Korea Line	Daewoo	Mar-08	Panama	S	GT NO 96	4	Kogas offtake
K Mugungwha	152,000	K Line	Daewoo	Nov-08	Panama	S	GT NO 96	4	Various
Kita LNG	160,106	TMSC Gas	Daewoo	Jun-14	Malta	TFDE	GT No 96	4	Various
Kotawaka Maru	125,200	J3 Consortium	Kawasaki Sakaide	Jan-84	Japan	S	Moss	5	Darwin
Lala Fatma N'Soumer	145,000	Algeria Nippon Gas	Kawasaki Sakaide	Dec-04	Japan	S	Moss	4	Sonatrach
Larbi Ben M'Hidi	129,750	SNTM-Hyproc	La Seyne	Jun-77	Algeria	S	GT NO 85	5	Sonatrach
Lijmilya	261,700	QGTC	Daewoo	Sep-08	Marshall Is.	DRL	GT NO. 96	5	Various
LNG Abuja	126,530	Bonny Gas Transport	GD Quincy	Sep-80	Bahamas	S	Moss	5	Nigeria LNG
LNG Adamawa	141,000	Bonny Gas Transport	Hyundai	Jun-05	Bermuda	S	Moss	4	Various
LNG Akwa Ibom	141,000	Bonny Gas Transport	Hyundai	Nov-04	Bermuda	S	Moss	4	Various
LNG Aquarius	126,300	MOL/LNG Japan	GD Quincy	Jun-77	Marshall Is.	S	Moss	5	Various
LNG Barka	153,000	NYK	Kawasaki	Jan-09	Bahamas	S	Moss	4	Various
LNG Bayelsa	137,500	Bonny Gas Transport	Hyundai	Feb-03	Bermuda	S	Moss	4	Nigeria LNG
LNG Benue	145,700	BW Gas	Daewoo	Mar-06	Bermuda	S	GT NO 96	4	Nigeria LNG
LNG Bonny	177,000	Bonny Gas Transport	Hyundai	Oct-15	Bermuda	DFDE	TZ Mk III	4	Nigeria LNG
LNG Borno	149,600	NYK Line	Samsung	Aug-07	Japan	S	TZ Mk. III	4	Nigeria LNG
LNG Capricorn	126,300	MOL/LNG Japan	GD Quincy	Jun-78	Marshall Is.	S	Moss	5	Pertamina
LNG Cross River	141,000	Bonny Gas Transport	Hyundai	Sep-05	Bermuda	S	Moss	4	Various
LNG Dream	145,000	Osaka Gas	Kawasaki	Sep-06	Japan	S	Moss	4	Woodside Energy
LNG Ebisu	147,500	MOL	Kawasaki	Sep-08	Bahamas	S	Moss	4	Various
LNG Edo	126,530	Bonny Gas Transport	GD Quincy	May-80	Bahamas	S	Moss	5	Nigeria LNG
LNG Enugu	145,000	BW Gas	Daewoo	Oct-05	Bermuda	S	GT NO 96	4	Nigeria LNG
LNG Fimina	175,000	Bonny Gas Transport	Samsung	Oct-15	Bermuda	DFDE	TZ Mk III	4	Nigeria LNG
LNG Flora	127,700	J3 Consortium	Kawasaki Sakaide	Mar-93	Japan	S	Moss	4	Pertamina
LNG Fukurokuju	165,000	MOL	Kawasaki	June-15	Japan	S	Moss	4	Various
LNG Gemini	126,300	MOL/LNG Japan	GD Quincy	Sep-78	Marshall Is.	S	Moss	5	Pertamina
LNG Imo	148,300	BW Gas	Daewoo	Jun-08	Bermuda	S	GT NO 96	4	Nigeria LNG
LNG Jamal	135,330	Osaka Gas/J3 Consortium	Mitsubishi Nagasaki	Oct-00	Japan	S	Moss	5	Oman Gas
LNG Jupiter	145,000	NYK Line	Kawasaki	Jul-09	Bahamas	S	Moss	4	Various
LNG Kano	148,471	BW Gas	Daewoo	Jan-07	Bermuda	S	GT No. 96	4	NLNG
LNG Lagos	177,000	Bonny Gas	Hyundai	Oct-15	Bermuda	DFDE	TZ Mk III	4	Nigeria LNG
LNG Leo	126,400	MOL/LNG Japan	GD Quincy	Dec-78	Marshall Is.	S	Moss	5	Pertamina
LNG Lerici	65,000	Exmar	Italcantieri Sestri	Mar-98	Italy	S	GT NO 96	4	Sonatrach
LNG Libra	126,400	Hoegh LNG	GD Quincy	Apr-79	Marshall Is.	S	Moss	5	Various
LNG Lokoja	148,300	BW Gas	Daewoo	Dec-06	Bermuda	S	GT No. 96	4	Nigeria LNG
LNG Ogun	148,300	NYK Line	Samsung	Aug-07	Japan	S	TZ Mk. III	4	Nigeria LNG

CARRIER FLEET

LNG Ondo	148,300	BW Gas	Daewoo	Sep-07	Bermuda	S	GT NO 96	4	Nigeria LNG
LNG Oyo	140,500	BW Gas	Daewoo	Dec-05	Bermuda	S	GT NO 96	4	Nigeria LNG
LNG Pioneer	138,000	MOL	Daewoo	Jul-05	Bahamas	S	GT No 96	4	Idku
LNG Port Harcourt	175,000	Bonny Gas	Samsung	Oct-15	Bermuda	DFDE	TZ Mk III	4	Nigeria LNG
LNG Portovenere	65,000	Exmar	Italcantieri Sestri	Jun-96	Italy	S	GT No 96	4	Sonatrach
LNG River Niger	141,000	Bonny Gas Transport	Hyundai	May-06	Bermuda	S	Moss	4	Various
LNG River Orashi	145,910	BW Gas	Daewoo	Nov-04	Bermuda	S	GT No 96	4	Nigeria LNG
LNG Rivers	137,231	Bonny Gas Transport	Hyundai	Jun-02	Bermuda	S	Moss	4	Nigeria LNG
LNG Saturn	153,000	MOL	MHI	Nov-15	Japan	S	Moss	4	Various
LNG Sokoto	137,231	Bonny Gas Transport	Hyundai	Aug-02	Bermuda	S	Moss	4	Nigeria LNG
LNG Taurus	126,300	MOL/LNG Japan	GD Quincy	Aug-79	Marshall Is.	S	Moss	5	Various
LNG Venus	155,000	Osaka/MOL	MHI	Oct-14	Japan	S	Moss	4	Various
LNG Vesta	127,547	Tokyo Gas Consortium	Mitsubishi Nagasaki	Jun-94	Japan	S	Moss	4	Pertamina
LNG Virgo	126,400	MOL/LNG Japan	GD Quincy	Dec-79	Marshall Is.	S	Moss	5	Pertamina
Lobito	160,400	Mitsui/NYK/Teekay	Samsung	Oct-11	Bahamas	DFDE	TZ Mk. III	4	Various
Lusail	138,000	Peninsular LNG	Samsung	May-05	Bahamas	S	TZ Mk. III	4	Qatar
Madrid Spirit	138,000	Teekay LNG Partners	IZAR Puerto Real	Jan-05	Spain	S	GT No 96	4	Engas
Magellan Spirit	165,500	Teekay LNG Partners	Samsung	Sep-08	Denmark	DFDE	TZ Mk. III	4	Various
Malanje	160,400	Mitsui/NYK/Teekay	Samsung	Jul-11	Bahamas	DFDE	TZ Mk. III	4	Various
Maran Gas Apollonia	161,870	Maran	Daewoo	Jan-14	Greece	DFDE	GT No 96	4	Various
Maran Gas Asclepius	145,000	Kristen Navigation	Daewoo	Jul-05	Bermuda	S	GT No 96	4	Qatar
Maran Gas Coronis	145,700	Maran	Daewoo	Sep-07	Greece	S	GT No 96	4	Rasgas II
Maran Gas Delphi	159,800	Maran	Daewoo	Feb-14	Greece	DFDE	GT No 96	4	Various
Maran Gas Efessos	159,800	Maran	Daewoo	Jun-14	Greece	DFDE	GT No 96	4	Various
Maran Gas Mystras	155,900	Maran Gas	Maran Gas Daewoo	May-15	Greece	DFDE	GT No 96	4	various
Maran Gas Posidonia	161,870	Maran	Daewoo	May-14	Greece	DFDE	GT No 96	4	Various
Maran Gas Troy	155,900	Maran Gas	Maran Gas Daewoo	May-15	Greece	DFDE	GT No 96	4	various
Maria Energy	174,000	Tsakos	Hyundai	Mar-15	Marshall Is.	TFDE	GTT Mk II	4	Various
Marib Spirit	165,000	Teekay LNG	Samsung	May-08	Marshall Is.	DFDE	TZ Mk. III	4	Various
Matthew	126,540	Suez LNG Shipping	Newport News	Jun-79	Bahamas	S	TZ Mk. I	6	Atlantic LNG
Mekaines	266,000	Nakilat	Samsung	Mar-09	Liberia	DRL	GT No 96	4	Qatar-Atlantic Basin
Meridian Spirit	165,500	Teekay LNG	Samsung	Jan-10	Denmark	DFDE	TZ Mk. III	4	Various
Mesaimeer	210,100	Nakilat	Hyundai	Mar-09	Liberia	DRL	GT No 96	4	Qatar-Atlantic Basin
Methane Alison Victoria	145,000	GasLog	Samsung	Aug-07	Bermuda	S	TZ III	4	Eq.Guinea LNG
Methane Becki Anne	170,000	GasLog	Samsung	Sep-10	Bermuda	TFDE	TZ Mk. III	4	Various
Methane Heather Sally	145,000	GasLog	Samsung	Jul-07	Bermuda	S	Tz Mk. III	4	Eq.Guinea LNG
Methane Jane Elizabeth	145,000	GasLog	Samsung	Jun-06	Bermuda	TFDE	TZ Mk. III	4	Engas
Methane Julia Louise	170,000	GasLog	Samsung	Dec-09	Bermuda	TFDE	TZ Mk. III	4	Various
Methane Kari Elin	138,200	Shell	Samsung	Jun-04	Bermuda	S	TZ Mk. III	4	Various
Methane Lake Charles	145,000	Shell	Samsung	Feb-07	Bermuda	S	TZ Mk. III	4	Marathon Oil
Methane Lydon Volney	145,000	Shell	Samsung	Aug-06	Bermuda	S	TZ Mk. III	4	Engas
Methane Mickie Harper	170,000	Shell-GasLog	Samsung	Nov-10	Bermuda	TFDE	TZ Mk. III	4	Various
Methane Nile Eagle	145,000	Shell-GasLog	Samsung	Dec-07	Bermuda	S	TZ Mk. III	4	Engas
Methane Patricia Camila	170,000	Shell-GasLog	Samsung	Oct-10	Bermuda	TFDE	TZ Mk. III	4	Various
Methane Princess	138,159	Golar LNG	Daewoo	2003	UK	S	GT No 96	4	Spot BG
Methane Rita Andre	145,000	GasLog	Samsung	Mar-06	Bermuda	S	TZ Mk. III	4	Engas
Methane Shirley Elizabeth	145,000	GasLog	Samsung	Apr-07	Bermuda	S	TZ Mk. III	4	Marathon Oil
Methane Sprit	165,000	Teekay LNG	Samsung	Mar-08	Singapore	DFDE	TZ Mk. III	4	Various
Methania	131,230	Distrigas	Boelwerf	Oct-78	Belgium	S	GT No 85	5	Sonatrach
Milaha Qatar	145,000	Milaha	Samsung	Apr-06	Denmark	S	TZ Mk. III	4	Qatar
Milaha Ras Laffan	138,270	Milaha	Samsung	Mar-04	Denmark	S	TZ Mk. III	4	RasGas II
Min Lu	147,000	China Ships	Hudong	Aug-09	China	S	GT No 96	4	Various
Min Rong	147,000	China LNG Ships	Hudong	Feb-09	Hong Kong	S	GT No 96	4	Australia-China
Mostefa Ben Boulaid	125,260	SNTM-Hyproc	La Ciotat	Aug-76	Algeria	S	TZ Mk. I	6	Sonatrach
Mourad Didouche	126,130	SNTM-Hyproc	Atlantique	Jul-80	Algeria	S	GT No 85	5	Sonatrach
Mozah	266,000	QGTC	Samsung	Aug-08	Qatar	DRL	TZ Mk III	5	Qatargas II
Mraweh	137,000	National Gas Shipping	Kvaerner-Masa	Jun-96	Liberia	S	Moss	4	ADGAS
Mubaraz	137,000	National Gas Shipping	Kvaerner-Masa	Jan-96	Liberia	S	Moss	4	Various
Muraq	210,100	J5-K Line	Daewoo	May-08	Marshall Is.	DRL	GT No 96	4	Qatar-Atl'c Basin
Murwab	210,100	J5 Consortium	Daewoo	May-08	Marshall Is.	DRL	GT No. 96	4	Qatargas
Muscat LNG	149,170	Oman Gas/MOL	Kawasaki Sakaide	Mar-04	Japan	S	Moss	4	Oman Gas
Neo Energy	149,700	Tsakos	Hyundai	Feb-07	Liberia	S	GTT Mk II	4	Various
Nizwah LNG	145,000	Oryx LNG Carriers	Kawasaki Sakaide	Dec-05	Japan	S	Moss	4	Oman Gas
Northwest Sanderling	127,525	Australia LNG	Mitsubishi Nagasaki	Jun-89	Australia	S	Moss	4	NWS
Northwest Sandpiper	127,500	Australia LNG	Mitsui Chiba	Feb-93	Australia	S	Moss	4	NWS
Northwest Seaeagle	127,450	Australia LNG	Mitsubishi Nagasaki	Nov-92	Bermuda	S	Moss	4	NWS
Northwest Shearwater	127,500	Australia LNG	Kawasaki Sakaide	Sep-91	Bermuda	S	Moss	4	NWS
Northwest Snipe	127,747	Australia LNG	Mitsui Chiba	Sep-90	Australia	S	Moss	4	NWS
Northwest Stormpetrel	127,600	Australia LNG	Mitsubishi Nagasaki	Dec-94	Australia	S	Moss	4	NWS
Northwest Swallow	127,708	J3 Consortium	Mitsui Chiba	Nov-89	Japan	S	Moss	4	NWS
Northwest Swan	138,000	Australia LNG	Daewoo	Mar-04	Australia	S	GT NO 96	4	NWS
Northwest Swift	127,590	J3 Consortium	Mitsubishi Nagasaki	Sep-89	Japan	S	Moss	4	NWS
Ob River	150,000	Lance Shipping	Hyundai	Oct-07	Marshall Is.	S	TZ Mk. III	4	Various
Onaiza	210,100	Nakilat	Daewoo	Apr-09	Liberia	DRL	GT NO 96	4	Qatar-Atlantic Basin
Pacific Arcadia	147,200	NYK Line	MHI	Oct-14	Bahamas	S	KM		Various
Pacific Enlighten	145,000	LNG MT	Mitsubishi	Mar-09	Japan	S	Moss	4	Various
Pacific Eurus	137,000	LNG Marine Transport	Mitsubishi Nagasaki	Mar-06	Bahamas	S	Moss	4	Darwin
Pacific Notus	137,006	Pacific LNG Shipping	Mitsubishi Nagasaki	Sep-03	Bahamas	S	Moss	5	Darwin
Palu LNG	160,106	TMSC Gas	Daewoo	Jun-14	Malta	TFDE	GT No 96	4	Various
Papua	171,800	MOL-China	Hudong	Jan-15	Hong Kong	DFDE	SSD	4	PNG LNG
Polar Eagle	89,880	Polar LNG	IHI Chita	Jun-93	Liberia	S	IHI SPB	4	ConocoPhillips/Marathon
Provalys	153,500	Gaz de France	Chantiers	Nov-06	France	DFDE	CS1	4	ELNG
Puteri Delima	130,400	MISC	Atlantique	Jan-95	Malaysia	S	GT NO 96	4	Petronas

Puteri Delima Satu	137,100	MISC	Mitsui Chiba	Apr-02	Malaysia	S	GT NO 96	4	Petronas
Puteri Firuz	130,400	MISC	Atlantique	May-97	Malaysia	S	GT NO 96	4	Petronas
Puteri Firuz Satu	137,100	MISC	Mitsubishi Nagasaki	Sep-04	Malaysia	S	GT NO 96	4	Petronas
Puteri Intan	130,400	MISC	Atlantique	Aug-94	Malaysia	S	GT NO 96	4	Petronas
Puteri Intan Satu	137,100	MISC	Mitsubishi Nagasaki	Dec-01	Malaysia	S	GT NO 96	4	Petronas
Puteri Mutiera Satu	137,100	MISC	Mitsui Chiba	Apr-05	Malaysia	S	GT NO 96	4	Petronas
Puteri Nilam	130,400	MISC	Atlantique	Jun-95	Malaysia	S	GT NO 96	4	Petronas
Puteri Nilam Satu	137,100	MISC	Mitsubishi Nagasaki	Sep-03	Malaysia	S	GT NO 96	4	Petronas
Puteri Zamrud	130,400	MISC	Atlantique	May-96	Malaysia	S	GT NO 96	4	Petronas
Puteri Zamrud Satu	137,100	MISC	Mitsui Chiba	Apr-87	Malaysia	S	GT NO 96	4	Atlantic LNG
Raahi	136,000	Petronet LNG Ltd	Daewoo	Dec-04	Malta	S	GT NO 96	4	Qatargas
Ramdane Abane	126,130	SNTM-Hyproc	Atlantique	Jul-81	Algeria	S	GT NO 85	5	Sonatrach
Rasheeda	266,000	QGTC	Samsung	Jun-10	Liberia	DRL	TZ Mk. III		Various
Ribera del Duero Knutsen	173,400	Knutsen	Daewoo	Nov-10	Nor-NIS	DFDE	GT NO. 96	4	Various
Salalah LNG	147,000	Oman Gas/MOL	Samsung	Dec-05	Japan	S	TZ Mk. III	4	Oman
SCF Polar	71,500	Sovcomflot	Kockums	Aug-69	Liberia	S	GT NO 82	6	Sonatrach
Seishu Maru	162,000	K Line-Transpacific	Kawasaki Sakaide	Jan-15	Panama	S	Moss	4	Australia-Japan
Seri Alam	138,000	MISC	Samsung	Oct-05	Malaysia	S	TZ Mk. III	4	Yemen LNG
Seri Amanah	145,000	MISC	Samsung	Mar-06	Malaysia	S	TZ Mk. III	4	Yemen LNG
Seri Anggun	145,000	MISC	Samsung	Nov-06	Malaysia	S	TZ Mk. III	4	Yemen LNG
Seri Angkasa	145,000	MISC	Samsung	Feb-07	Malaysia	S	TZ Mk. III	4	Petronas
Seri Ayu	145,000	MISC	Samsung	Oct-07	Malaysia	S	TZ Mk. III	4	Various
Seri Bakti	152,300	MISC	Mitsubishi	Mar-07	Malaysia	S	GT NO 96	4	Petronas
Seri Balhaf	152,000	MISC	Mitsubishi	Sep-08	Malaysia	S	GT NO 96	4	Various
Seri Balquis	152,000	MISC	Mitsubishi	Dec-08	Malaysia	S	GT NO 96	4	Various
Seri Begawan	152,300	MISC	Mitsubishi	Dec-07	Malaysia	S	GT NO 96	4	Various
Seri Bijaksana	152,300	MISC	Mitsubishi	Feb-08	Malaysia	S	GT NO 96	4	Petronas
Sevilla Knutsen	173,400	Knutsen	Daewoo	Jun-10	N.I.S.	DFDE	GT NO 96	4	Various
Shahamah	135,500	National Gas Shipping	Kawasaki Sakaide	Oct-94	Liberia	S	Moss	5	ADGAS
Shangra	266,000	QGTC	Samsung	Nov-09	Liberia	DRL	TZ Mk. III	5	Qatargas IV
Shen Hai	147,100	China LNG	Hudong Zhonghua	Sep-12	China	AB/CC Steam	GT NO 96	4	Various
Simaisma	147,700	Maran Gas Maritime	Daewoo	Jul-06	Greece	S	GT No 96	4	Qatar
SK Splendor	138,375	SK Shipping	Samsung	Mar-00	Panama	S	TZ Mk. III	4	Oman Gas
SK Stellar	138,375	SK Shipping	Samsung	Dec-00	Panama	S	TZ Mk. III	4	RasGas
SK Summit	138,000	SK Shipping	Daewoo	Aug-99	Panama	S	GT NO 96	4	RasGas
SK Sunrise	138,306	I. S. Carriers	Samsung	Sep-03	Panama	S	TZ Mk. III	4	RasGas
SK Supreme	138,200	SK Shipping	Samsung	Jan-00	Panama	S	TZ Mk. III	4	RasGas
Sohar LNG	137,250	Oman Gas/ MOL	Mitsubishi Nagasaki	Oct-01	Malta	S	Moss	5	Oman Gas
Solaris	155,000	GasLog	Samsung	Jul-14	Bermuda	TFDE	TZ Mk. III	4	Various
Sonangol Benguela	160,500	Sonangol	Daewoo	Sep-11	Bahamas	S	GT No. 96	4	Angola LNG
Sonangol Etosha	160,500	Sonangol	Daewoo	Sep-11	Bahamas	S	GT No. 96	4	Angola LNG
Sonangol Sambizanga	160,500	Sonangol	Daewoo	Sep-11	Bahamas	S	GT No. 96	4	Angola LNG
Southern Cross	172,000	MOL	Hudong	May-15	Hong Kong	DRL	GT NO. 96	4	Various
Soyo	160,400	Mitsui/NYK/Teekay	Samsung	May-11	Bahamas	DFDE	TZ Mk. III	4	Various
Spirit of Hela	177,000	MOL	Hyundai	Oct-09	Panama	DFDE	TZ Mk. III	4	Various
Stena Blue Sky	145,700	Stena	Daewoo	Jan-06	Panama	S	GT No 96	4	Various
Stena Clear Sky	171,800	Stena	Daewoo	Sep-10	Panama	DFDE	GT NO 96	4	Various
Stena Crystal Sky	171,800	Stena	Daewoo	Jul-10	Panama	DFDE	GT NO 96	4	Various
STX Kolt	145,700	STX Panocean	Korea Hanjin	Nov-08	Panama	DFDE	TZ Mk. III	4	Various
Suez Point Fortin	154,200	Trinity LNG	Koyo Japan	Nov-09	Panama	S	TZ Mk. III	4	Yemen LNG
Taitar No. 1	145,000	NYK Line	Mitsubishi	Oct-09	Liberia	S	Moss	4	Various
Taitar No. 3	145,000	NYK Line	Mitsubishi	Jan-10	Liberia	S	Moss	4	Various
Taitar No. 4	145,000	NYK	Mitsubishi	Jan-10	Liberia	S	Moss	4	Various
Tangguh Batur	145,700	Sovcomflot/NYK	Daewoo	Dec-08	Cyprus	S	GT NO 96		Tangguh
Tangguh Foja	155,000	K Line	Samsung	Jul-08	Panama	DFDE	TZ Mk. III	4	Tangguh LNG
Tangguh Hiri	155,000	Teekay LNG	Hyundai	Nov-08	IOM	DFDE	TZ Mk. III	4	Tangguh
Tangguh Jaya	145,700	K Line	Samsung	Nov-08	Panama	DFDE	TZ Mk. III	4	Tangguh
Tangguh Palung	155,000	K Line	Samsung	Mar-09	Panama	DFDE	TZ Mk. III	4	Tangguh
Tangguh Sago	155,000	Teekay LNG	Hyundai	Mar-09	IOM	DFDE	TZ Mk. III	4	Tangguh LNG
Tangguh Towuti	145,700	Sovcomflot/NYK	Daewoo	Oct-08	Cyprus	S	GT NO 96	4	Tangguh
Tembek	216,200	OSG/Nakilat	Samsung	Sep-07	Marshall Is.	DRL	TZ Mk. III	4	Qatargas II
Tenaga Satu	130,000	MISC	Dunkerque	Sep-82	Malaysia	S	GT NO 88	5	Petronas
Trinity Arrow	154,900	K Line	Imabari Shipbuilding	Mar-08	Panama	S	TZ Mk. III	4	Various
Umm Al Amad	210,100	J5	Daewoo	Aug-08	Marshall Is.	DRL	GT NO 96	4	Ras Gas III
Umm Al Ashtan	137,000	National Gas Shipping	Kvaerner- Masa	May-97	Liberia	S	Moss	4	ADGAS
Umm Bab	145,000	Kristen Navigation	Daewoo	Nov-05	Bermuda	S	GT NO 96	4	Qatargas
Umm Slaal	266,000	QGTC	Samsung	Nov-08	Qatar	DRL	TZ Mk. III	5	Qatargas
Valencia Knutsen	173,400	Knutsen	Daewoo	Sep-10	Nor-NIS	DFDE	GT NO. 96	4	Various
Velikiy Novgorod	170,200	SovComFlot	STX	Feb-14	Liberia	DFDE	GT No. 96	4	Various
Wakaba Maru	125,000	J3 Consortium	Mitsui Chiba	Apr-85	Japan	S	Moss	5	Pertamina
WilEnergy	125,500	Awilco LNG	Mitsubishi	Oct-83	NIS	S	Moss	5	Various
WilForce	156,000	Teekay LNG	Daewoo	Aug-13	NIS	DFDE	GT NO 96	4	Various
WilGas	125,500	Awilco LNG	Mitsubishi	Jul-84	NIS	S	Moss	5	Various
WilPower	125,500	Awilco LNG	Mitsubishi	Jul-84	NIS	S	Moss	5	Various
Woodside Donaldson	165,500	Teekay LNG	Samsung	Dec-09	Singapore	DFDE	TZ Mk. III	4	Various
Woodside Goode	159,800	Maran	Daewoo	Jul-14	Greece	DFDE	GT No. 96	4	Various
Woodside Rogers	155,900	Maran Gas	DSME	Jul-13	Greece	DFDE	GT NO 96	4	Various
Yari LNG	159,983	TMSC Gas	Daewoo	Jun-14	Malta	TFDE	GT No 96	4	Various
Yenisei River	155,000	Dynagas	Hyundai	Jul-13	Marshall Is.	DFDE	TZ Mk. III	4	Various
YK Sovereign	127,125	SK Shipping	Hyundai	Dec-94	Panama	S	Moss	4	Pertamina
Zarga	266,000	QGTC	Samsung	Dec-09	Liberia	DRL	TZ Mk. III	5	Qatar-Atlantic
Zekreet	135,420	J4 Consortium	Mitsui Chiba	Dec-98	Japan	S	Moss	5	Qatargas

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LNG Import Terminals

Explanatory Notes

- The tables do not include the following types of LNG facilities :
 - ♦ Small marine satellite terminals receiving LNG from liquefaction plants in their own country (such as exist in Norway) or which receive LNG transhipped from nearby reception terminals in their own country (such as in Japan)
 - ♦ Satellite LNG storage facilities that receive LNG transported only by road or rail
- Expansions of LNG reception terminals are only shown if they involve new storage tanks
- Where there is a blank in the table the information is uncertain or unknown.

Any comments on the tables, and corrections / additional information from terminal shareholders and project developers would be most welcome, and should be sent to John McKay e-mail editor@lngjournal.com

Country	Location (Project)	Owners	Start up	Storage	
				Tanks	Capacity
Belgium	Zeebrugge	Fluxys	1987	4	380,000
Canada	Canaport Saint John	Irving Oil, Repsol	2009	3	480,000
Chile	Quintero	ENAP, Metrogas, Enagas	2009	3	334,000
	Mejillones	Engie, Codelco	2010	1	175,000
China	Beihai LNG, Guangxi	Sinopec	2015	2	320,000
	Dalian	PetroChina	2011	3	480,000
	Dongguan, Guangdong	Jovo Group	2013	2	160 000
	Fujian LNG (Xiuyu)	CNOOC, Fujian I&D Corp.	2008	2	640,000
	Guangdong	CNOOC,BP	2006	3	480,000
	Haikou, Hainan LNG	CNOOC	2014	3	480,000
	Ningbo, Zhejiang	CNOOC, Zhejiang Energy	2012	3	480,000
	Qingdao, Shandong	Sinopec	2014	3	480,000
	Rudong	PetroChina	2011	2	320,000
	Shanghai	CNOOC, Shenergy Group	2009	3	495,000
	Shanghai, Mengtougou	Shanghai Gas	2008	3	120 000
	Tangshan, Hebei	PetroChina	2013	3	480,000
	Tianjin FSRU	CNOOC	2014	1	60,000
	Zhuhai, Gaolan	CNOOC	2013	3	480,000
Dominican Republic	Punta Caucedo	AES Andres	2003	1	160 000
France	Fos Tonkin	Elengy	1972	3	150,000
	Montoir-de-Bretagne	Elengy	1980	3	360,000
	Fos Cavaou	Engie, Total	2010	3	330,000
Greece	Revithoussa	DEPA	2000	2	130,000
India	Dabhol	GAIL, NTPC (Ratnagiri Gas & Power)	2009	3	480,000
	Dahej	Petronet LNG	2004	4	592,000
	Hazira	Shell India, Total	2005	2	320,000
	Kochi, Kerala	Petronet LNG	2013	2	320,000
Indonesia	Arun	Pertamina	2015	5	507,000
Italy	Panigaglia	Snam	1969	2	100,000
	Porto Levante (offshore GBS)	ExxonMobil, Qatar Petroleum, Edison Gas	2009	2	250,000
Japan	Negishi	Tokyo Gas	1969	14	1,180,000
	Sodegaura	Tokyo Gas	1973	35	2,660,000
	Ohgishima	Tokyo Gas	1998	4	850,000
	Higashi-Ohgishima	Tokyo Electric	1984	9	540,000
	Futtsu	Tokyo Electric	1985	10	1,110,000
	Yokkaichi LNG	Chubu Electric	1988	4	320,000
	Kawagoe	Chubu Electric	1997	6	840,000
	Yokkaichi Works	Toho Gas	1991	2	160,000
	Chita LNG Joint	Toho Gas, Chubu Electric	1978	4	300,000
	Chita LNG	Toho Gas, Chubu Electric	1983	7	640,000
	Chita - Midorihama	Toho Gas	2001	2	400,000
	Senboku I	Osaka Gas	1972	4	180,000
	Senboku II	Osaka Gas	1977	18	1,585,000
	Himeji	Osaka Gas	1984	8	740,000
	Himeji LNG	Kansai Electric	1979	7	520,000
	Yanai	Chugoku Electric	1990	6	480,000
	Niigata	Nihonkai LNG, Tohoku Electric	1984	8	720,000
	Oita	Oita Gas, Kyushu Electric	1990	5	460,000
	Tobata	Kitakyushu LNG	1977	8	480,000
	Fukuoka	Saibu Gas	1993	2	70,000
	Sodeshi	Shizuoka Gas	1996	3	337,200
	Hatsukaichi	Hiroshima Gas	1996	2	170,000
	Kagoshima	Nippon Gas	1996	2	136,000
	Shin-Minato	Sendai City Gas	1997	1	80,000
	Nagasaki	Saibu Gas	2003	1	36,000
	Sakai	Kansai Electric, Cosmo Oil	2006	3	420,000
	Mizushima	Nippon Oil, Chugoku Electric	2006	2	320,000
	Sakaide	Shikoku Electric, Cosmo Oil	2011	1	180,000
	Ishikari LNG	Hokkaido Gas, Tokyo Gas	2012	1	180,000
	Okinawa	Okinawa Electric Power	2012	2	280,000
	Naoetsu	Inpex	2013	2	360,000
	Joetsu	Chubu	2011	3	540,000
	Hachinohe LNG	Nippon Oil	2015	2	280,000
	Hitachi LNG	Tokyo Gas	2015	1	230,000
Korea	Incheon	Kogas	1996	20	2,880,000
	Kwangyang	POSCO	2005	4	530,000
	Pyeong-Taek	Kogas	1986	23	3,360,000
	Samcheok	Kogas	2014	3	600,000
Mexico	Tong-Yeong	Kogas	2002	17	2,620,000
	Altamira	Vopak, Enagas	2006	2	300,000
	Energia Costa Azul	Sempre LNG	2008	2	320,000
Netherlands	Manzanillo	Samsung, Kogas, Mitsui	2012	2	300,000
	Gate LNG	Gasunie, Royal Vopak	2011	3	540,000
Poland	Swinoujscie	Baltic Gaz System	2015	2	320,000
Portugal	Sines	REN Atlantico	2004	3	390,000
Puerto Rico	Penuelas	EcoElectrica	2000	1	160,000
Singapore	Singapore	Singapore Energy Authority	2013	3	540,000

LNG Import Terminals (continued)

Country	Location (Project)	Owners	Start up	Tanks	Storage Capacity
Spain	Barcelona	Enagas	1969	8	840,000
	Huelva	Enagas	1988	5	610,000
	Cartagena	Enagas	1989	5	587,000
	Bilbao	Enagas, EVE	2003	3	450,000
	Sagunto	GNF, Osaka Gas, Oman Oil	2006	4	600,000
	Reganosa, Ferrol	GNF, Sonatrach, Tojeiro	2006	2	300,000
	El Musel, Gijón,	Enagas	2013	2	300,000
Taiwan	Yung-An	CPC	1990	6	690,000
	Tai-chung	CPC	2009	3	480,000
Thailand	Map Ta Phut	PTT LNG	2011	2	320,000
Turkey	Marmara Ereglisi	Botas	1994	3	255,000
	Izmir	EgeGaz	2006	2	280,000
USA	Everett	Suez LNG NA	1971	2	155,000
	Lake Charles	Shell, ETE	1982	4	425,000
	Elba Island	Kinder	2001	5	535,000
	Cove Point	Dominion	2003	5	530,000
	Freeport	Freeport LNG Development	2008	2	320,000
	Cameron	Sempra LNG	2009	3	480,000
	Golden Pass, TX	Qatar Petroleum, ExxonMobil	2010	5	775,000
	Pascagoula, MS	Gulf LNG, Kinder	2012	2	320,000
UK	Isle of Grain	National Grid	2005	8	1,000,000
	South Hook	ExxonMobil, Qatar Petroleum, Total	2009	5	775,000
	Dragon LNG, Milford Haven	Shell, Petronas	2009	2	310,000

LNG Import Terminal Projects

Country	Location/Project	Owners/Project Developers	Start up	Storage	
				Tanks	Capacity
China	Swatuo, Guangdong	CNOOC	2016	2	320,000
	Yingkou, Liaoning	CNOOC	2016	2	320,000
	Qidong, Jiangsu	Shell-Guanghui	studies		
	Yuedong LNG, Jieyang, Guangdong	CNOOC	2016	2	320,000
Finland	Pori	Gasum Skangass	2016	1	30,000
	Tornio	Gasum, Skangass	2018	1	30,000
France	Dunkirk LNG	LNG EDF, Fluxys, Total	2016	3	570,000
India	Ennore	Indian Oil Corp	2016	2	320,000
	Mundra	Gujarat State Petroleum, Adani Group	2016	2	320,000
	FSRU Andhra Pradesh	Engie, Andhra Pradesh Gas	2016	1	135,000
	Pipovav LNG (FSRU), Gujarat	Swan Energy	2016	2	320,000
Indonesia	Labuhan Maringgai	Perusahaan Gas Negara	2016	1	135,000
Japan	Soma, Fukushima	Japan Petroleum	2017	1	230,000
Malaysia	Lahad Datu LNG, Sabah	Petronas	2016	studies	
Philippines	Pagbilao LNG	Energy World Corp.	2016	1	130,000
UAE (FSRU)	Fujairah	Mubadala	2016	1	135,000
UK	Port Meridian, Barrow-in-Furness	Port Meridian Energy Ltd.	2016	1	150,000
Uruguay FSRU	Montevideo	Gas Sayago, Mitsui Osk Lines	2017	1	230,000

LNG FSRU Import Facilities

Country	Location (Project)	Owners	Start up
Argentina	Bahia Blanca GasPort	Excelerate/YPF Repsol	2008
	Escobar GasPort	Excelerate/Enarsa	2011
Brazil	Pecem, FSRU	Petrobras	2009
	Guanabara Bay FSRU	Petrobras	2009
	Salvador, Bahia FSRU	Petrobras	2013
Dubai	Jebel Ali Port	DSA of UAE	2010
Egypt	Ain Sokhna, Suez	EGAS, Hoegh	2015
	Ain Sokhna, Suez	EGAS, Golar	2015
Indonesia	Lampung	Hoegh LNG, PGN LNG	2014
	Nusantara (Jakarta Bay)	Golar LNG, Pertamina	2012
Italy	Livorno	OLT Offshore LNG Toscana	2013
Jordan	Aqaba, Jordan	Golar LNG	2015
Kuwait	Mina Al-Ahmadi	KPC	2009
Lithuania	Klaipeda	Klaipedos Nafta Hoegh LNG	2014
Malaysia	Malacca FSRU	Petronas	2012
Pakistan	Port Qasim	Excelerate, Engro Corp	2015
UK	Teesside GasPort	Excelerate	2007

LNG Export Projects

Country	Location/Project	Project Developers	Planned Start Up	Number of Trains	Capacity In MTPA
AUSTRALIA	Browse LNG	Woodside, BHP, BP Chevron, Shell, Mitsubishi, Mitsui	2018+	2	10.0
	Gorgon LNG	Chevron, Shell, ExxonMobil	2016	4	20.0
	Ichthys LNG	INPEX, Total	2017	2	8.4
	Prelude FLNG	Shell, Inpex, Kogas CPC	2017	1	3.5
	Sunrise LNG	Woodside, Osaka Gas, ConocoPhillips, Shell	2020+	1	3.5
	Wheatstone LNG	Chevron, Apache, Shell , Kuwait FPEC	2017	2	9.0
CANADA	Aurora LNG BC	CNOOC, Inpex Corp. and JGC Corp.	2020	4	24.0
	Bear Head LNG, Nova Scotia	LNG Ltd.	2020	4	8.0
	Canaport LNG, New Brunswick	Repsol Irving Oil	2020	studies	
	Cedar 1, 2, 3, Kitimat area	LNG Export Ltd (Haisla)	2020	studies	
	Douglas Channel LNG Bish Cove	Exmar, EDF, ItaGas, Idemitsu	2018	1	1.0
	GNL Quebec, Saquenay	Freestone Capital and Breyer Capital	2020	4	10.0
	Goldboro LNG, Nova Scotia	Pieridae Energy	2020	2	10.0
	Grassy Point LNG	Woodside Petroleum	2020	studies	
	Kitimat LNG, BC	Woodside, Chevron	2020	2	10.0
	LNG Canada, BC	Shell, Mitsubishi, Kogas, PetroChina	2020	2	12.0
	Melford LNG project, Nova Scotia	H-Energy Hiranandani Group	Studies		
	Pacific Northwest LNG, BC	Petronas, Japex, Sinopec, Indian Oil, Brunei Petroleum	2019	2	12.0
	Shell Prince Rupert LNG, BC	Shell	2020	3	21.0
	Steelhead LNG, Bamfield	Steelhead LNG Corp	2020	2	12.00
	Vancouver Tilbury	WesPac Midstream	2020	1	3.25
EQ.GUINEA	Equatorial Guinea Fortuna FLNG	Ophir and Golar LNG	2019	1	2.0
INDONESIA	Abadi FLNG	Inpex, Shell	2019	2	7.5
	Sengkang LNG	Energy World Corp.	2016	4	2.0
MALAYSIA	Bintulu Train 9	Petronas	2016	1	3.6
	Kanowit FLNG (Sarawak)	Petronas	2016	1	1.2
	Rotan FLNG (Sabah)	Petronas	2017	1	1.5
MOZAMBIQUE	Area 1 Onshore	Anadarko Petroleum and partners	2018	2	10
	Area 4 Onshore	Eni and partners	2020	2	10
	Area 4 FLNG	Eni and partners	2019	1	2.5
NIGERIA	NLNG Train 7	NNPC, Shell, BP, Total	2020+	1	8.4
	Olokola LNG	NNPC, Chevron, Shell	2020+	4	20.0
PAPUA NEW GUINEA	Elk-Antelope LNG	Total, InterOil, Oil Search, Petromin	Studies		
RUSSIA	Shtokman LNG Murmansk	Gazprom, Statoil, Total	2019	4	20.0
	Yamal LNG Siberia	Novatek, Gazprom, Total	2018	3	16.5
	Sakhalin II expansion	Gazprom, Shell, Mitsui, Mitsubishi	2017+	studies	
	Vladisvostok LNG	Gazprom, Itochu, various	2018	2	10.0
USA	Alaska LNG Nikiski	ExxonMobil, BP, ConocoPhillips, Alaska State	2020	3	20.0
	Annova LNG, Brownsville	Exelon Corp.	2020	6	6.0
	Cameron LNG, Louisiana	Sempra	2018	5	24.92
	Corpus Christi Liquefaction, Texas	Cheniere	2019	5	22.5
	Cove Point LNG, Maryland	Dominion	2018	1	5.25
	Delfin LNG Louisiana	Delfin, Hoegh	2020	3	9.0
	Freeport LNG, Texas	Freeport LNG	2018	4	20.4
	Golden Pass, Texas	Qatar Petroleum, ExxonMobil	2020	3	15.6
	Jordan Cove Energy	Veresen Inc.	2020	2	6.8
	Lake Charles, Louisiana	Shell, ETE	2019	3	15.0
	Live Oak LNG	Parallax	2020	1	5.0
	Louisiana LNG Energy (Mississippi R.)	Parallax, Cheniere	2020	3	6.0
	Magnolia LNG	Louisiana LNG Ltd.	2019	4	8.0
	Oregon LNG	Leucadia Corp.	2020	2	9.6
	Port Arthur LNG	Sempra	2020	2	10.0
	Rio Grande LNG	NextDecade	2020	6	27.0
	Sabine Pass LNG, Louisiana	Cheniere	2016-19	5	22.5
	Southern LNG	Kinder Morgan	2019	4	2.0
	Texas LNG Brownsville	Chandra, Meyer, Samsung, others	2020	2	4.0
	VG LNG (Cameron Parish)	Venture Global	2019	10	10.0
	VG LNG (Plaquemines)	Venture Global	2019	10	20

LNG Exporters

Country	Location/Project	Shareholders	Start up	Liquefaction		Storage	
				Trains	capacity (nominal) mtpa	No. of tanks	Total capacity m³
ABU DHABI (UAE)	Das Island (Adgas)	ADNOC, Mitsui, BP, Total	1977 1994	2 1	3.2 2.5	3	240,000
ALGERIA	Arzew	Sonatrach GL4Z	1964	3	1.1	3	35,000
	Arzew	Sonatrach GL1Z	1978	6	7.8	3	300,000
	Arzew	Sonatrach GL2Z	1980	6	8.0	3	300,000
	Arzew	Sonatrach	2014	1	4.7		
	Skikda	Sonatrach GL1K II	1980	3	3.0	5	308,000
	Skikda	Sonatrach (rebuild)	2013	1	4.5		
ANGOLA	Soyo	Sonangol, Chevron, BP, ENI, Total	2012	1	5.2	2	370,000
AUSTRALIA	Karratha	NWS Woodside, Shell, BHP	1989	2	5.0	4	260,000
		(BP, Chevron	1992	1	2.5	1	130,000
		(Mitsubishi/Mitsui)	2004	1	4.4	1	130,000
		NWS partners	2008	1	4.4	1	130,000
	Darwin	Darwin (Bayu Undan) ConocoPhillips, Santos, Eni, Inpex, TEPCO, Tokyo Gas	2006	1	3.5	1	188,000
	Australia Pacific LNG	ConocoPhillips, Origin Energy, Sinopec	2016	2	7.5	2	320,000
	Gladstone LNG	Santos, Petronas, Total, Kogas	2015	2	7.8	2	280,000
	Pluto LNG	Woodside, Tokyo Gas, Kansei	2012	1	4.8	2	240,000
	QCLNG	Shell, CNOOC	2014	2	8.0	2	280,000
BRUNEI	Lumut	Brunei/Shell/Mitsubishi/Total	1972-74	5	7.2	3	176,000
EGYPT	Damietta	Union Fenosa, EGPC, EGAS	2004	1	5.0	2	300,000
	Idku	EGPC, EGAS, Shell, Engie, Petronas	2005	2	7.2	2	280,000
EQ.GUINEA	Bioko Island	Marathon, Sonagas, Mitsui, Marubeni	2007	1	3.4	2	272,000
INDONESIA	Bontang I	Pertamina, VICO, JILCO, Total	1977	2	5.2	5	635,000
	Bontang II		1983	2	5.2		
	Bontang III		1989	1	2.8		
	Bontang IV		1993	1	2.8		
	Bontang V		1997	1	2.8		
	Bontang VI		1999	1	3.0		
	Sulawesi LNG	Medco Energi, Pertamina, Mitsubishi	2015	1	2.0	1	170,000
	Tangguh	BP, MI Berau, CNOOC, Nippon, LNG Japan	2008	2	7.6	2	340,000
LIBYA	Marsa el Brega	Sirte Oil (NOC/Shell upgrading)	1970	2	(2.5)	2	96,000
MALAYSIA	Bintulu (MLNG Satu)	Petronas, Sarawak, Mitsubishi	1983	3	8.1	4	260,000
	Bintulu (MLNG Dua)	Petronas, Shell, Sarawak, Mitsubishi	1995	3	7.8	1	65,000
	Bintulu (MLNG Tiga)	Petronas, Shell, Sarawak, Mitsubishi, Nippon Oil	2003	2	6.8	1	120,000
NIGERIA	Bonny Island	NNPC, Shell, Total, Eni	1999	2	6.4	2	168,400
		Nigeria LNG (formed by above)	2002	1	3.2	1	84,200
		Nigeria LNG	2006	2	8.2		
		Nigeria LNG	2008	1	4.1	1	84,200
NORWAY	Snøhvit/Melkoya Island	Statoil, Total, GDF-Suez, Petoro	2007	1	4.2	2	280,000
OMAN	Oman LNG	Oman Govt., Shell, Total, Korea LNG	2000	2	7.1	2	240,000
		Mitsubishi, Mitsui, Partex and Itochu					
		Oman Govt., Oman LNG Union Fenosa, Osaka Gas, & Itochu	2006	1	3.7	2	240,000
PAPUA NEW GUINEA	PNG LNG	ExxonMobil, Oil Search, Santos, JX Nippon Oil	2014	2	6.9	2	320,000
PERU	Peru LNG	Hunt Oil, Shell, Marubeni, SK Group	2010	1	4.4	2	260,000
QATAR	Qatargas 1-T1&2	QP, ExxonMobil, Total, Marubeni, Mitsui	1997	2	6.4	4	340,000
	Qatargas 1-T3	QP, ExxonMobil, Total, Marubeni, Mitsui	1999	1	3.1		
	Qatargas II-T1	QP, ExxonMobil	2009	1	7.8		
	Qatargas II-T2	QP, ExxonMobil, Total	2009	1	7.8	8	1,160,000
	Qatargas III-T1	QP, ConocoPhillips, Mitsui	2010	1	7.8		
	Qatargas IV-T1	QP, Shell	2010	1	7.8		
	RasGas I- T1&2	QP, ExxonMobil, Kogas, Itochu, LNG Japan	1999	2	6.6		
	RasGas II- T3	QP, ExxonMobil	2004	1	4.7		
	RasGas II- T4	QP, ExxonMobil	2005	1	4.7	6	840,000
	RasGas II- T5	QP, ExxonMobil	2007	1	4.7		
	Rasgas III – T6	QP, ExxonMobil	2009	1	7.8		
	Rasgas III – T7	QP, ExxonMobil	2010	1	7.8		
RUSSIA	Sakhalin Island	(Sakhalin Energy) Gazprom, Shell, Mitsui, Mitsubishi	2009	2	9.6	2	200,000
TRINIDAD & TOBAGO	Point Fortin Train 1	BP, Shell, Suez, NGC	1999	1	3.0	2	204,000
	Train 2	BP, Shell	2002	1	3.3	1	160,000
	Train 3	BP, Shell	2003	1	3.3	1	160,000
	Train 4	BP, Shell, NGC	2005	1	5.2	1	160,000
USA	Cheniere Sabine Pass	Cheniere Energy	2016	1	4.5	5	800,000
	Kenai - Alaska	ConocoPhillips, Marathon Oil	1969	2	1.3	3	108,000
YEMEN	Bal-Haf	Yemen LNG, Total, Yemen Gas, Hunt Oil, SK Group, Hyundai	2009	2	6.7	2	320,000



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