LNG journal
The World's Leading LNG publication

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January 2019

In this issue:

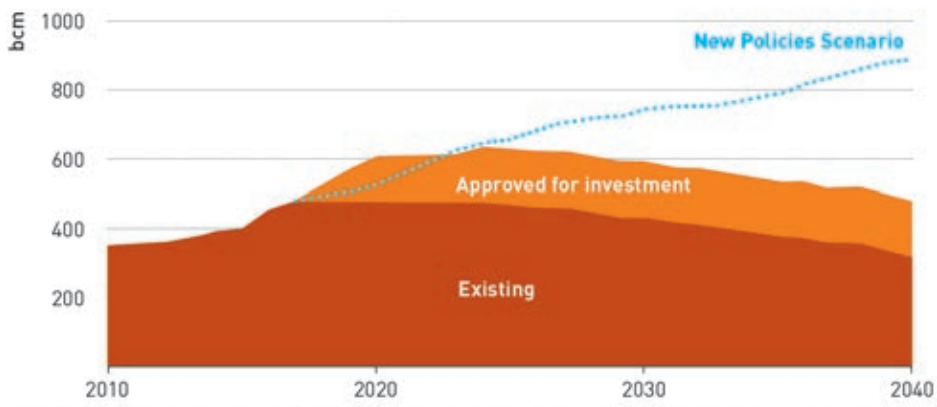
Prime role forecast for LNG with plant investment of $35Bln a year

International Energy Agency expects output, demand and infrastructure to increase through 2040

Natural gas remains the second-fastest growing energy source after renewables through to 2040, with global consumption seen rising 45 percent and LNG infrastructure investment amounting to $35 billion per annum on average, according to the latest World Energy Outlook from the International Energy Agency.

"Natural gas demand in 2040 has been revised up by almost 100 billion cubic metres compared with 2017," said the Outlook, with demand growing 1.6 percent per year to 2040.

Global liquefaction capacity, existing and approved, compared with requirements in the New Policies Scenario



Recent project approvals have narrowed the gap between expected liquefaction capacity and projected demand in 2025.

Spending on export and regasification facilities is forecast to rise

Revision

The Outlook attributes a large part of this revision to a tripling of gas demand in China due to strong policy efforts in improving air quality, in a drive to "turn China's skies blue again".

"Emerging economies in Asia as a whole account for around half of total global gas demand growth: their share of global LNG imports doubles to 60 percent by 2040," said the report from the France-based body.

The EIA said that in the New Policies Scenario, the required investment for LNG infrastructure amounts to $35Bln per year on average.

Around $380Bln of investment is needed each year for overall natural gas supply. Upstream investment accounts for two-thirds of that total, with shale-gas plays taking an increasing share.

Since its peak in 2014-15, investment in LNG had declined to $20Bln in 2017.

"Although there are signs of a pick-up in new project approvals, the lack of final investment decisions in recent years still points to a possible risk of market tightening in the 2020s," said the report.

Unconventional gas such as US shale gas increasingly underpins future natural gas supply.

"Shale-gas production expands by 770 Bcm in the period to 2040, which exceeds growth in conventional gas production," said the IEA report. "The United States accounts for 40 percent of total production growth to 2025. After 2025, additional growth comes from a more diverse range of countries including China, Mozambique and Argentina," it added.

The Outlook stated that LNG import flows continue to go mostly to Asia, while the export picture becomes more diverse with a new roster of suppliers.

"The global gas market comfortably absorbed a recent ramp-up in LNG liquefaction capacity," it said.

"New LNG investment decisions are starting to come through, but it remains challenging to reconcile buyer expectations of greater flexibility on contractual terms with supplier needs for bankable longer term commitments," added the Outlook.

Implications

However, the report said that gas demand in the European Union has been revised downwards on the back of new targets for efficiency and renewables, but gas infrastructure retains a strong role in ensuring security of supply.

In the New Policies Scenario, gas faces varying prospects in each of the emerging Asian economies.

Gas makes a rapid transition from a niche fuel to a mainstream fuel in certain markets, while in others it faces intense competition to defend its prime position.

Emerging

"Nevertheless, a common feature is their growing need for LNG imports. Emerging Asian economies account for over 80 percent of the growth in global LNG imports in the period to 2040, and their share in LNG imports more than doubles from less than 30 percent to 60 percent in 2040," said the report.

The consumers driving the increase of LNG imports have differing demand profiles, which means that their interactions with global LNG markets may vary substantially.

To give a sense of these variations, the IEA considered this import demand in three indicative categories:

- "Baseload" LNG imports: these include natural gas demand in industry, particularly the energy-intensive segments, and transport which tends to be relatively constant throughout the year. In addition, where gas provides baseload power generation or there is not much excess capacity in the market, demand for gas in power generation could also be well suited to regular shipments of imported gas.
- "Semi-flexible" LNG imports: include demand in the buildings sector, which

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can have significant seasonal load variations. When there is insufficient storage capacity to balance seasonality (as in most emerging Asian countries), LNG is an option for dealing with seasonal demand variation, providing flexibility to ramp up and down as needed.

- "Flexible" LNG imports: demand in power generation (especially peak or mid-load demand) is likely to depend on price competition with other available fuels on an annual basis as well as over the long term. This segment is more opportunistic and is likely to value contractual terms that offer flexibility and have shorter duration.

In the New Policies Scenario, the largest increment in LNG consumption between today and 2040 comes from the baseload segment, underpinned by demand growth in industry.

"This is the largest source of demand growth in all major countries except for India. The baseload segment represents around half of total LNG demand in 2040," said the IEA.

"The importance of the baseload segment suggests that Asian importers could provide the sort of longer term offtake commitments that might underpin new upstream and infrastructure developments elsewhere in the world. At the same time, the more price-sensitive flexible segments that may vary their purchases depending on the price of gas, stand to benefit from movement towards a more liquid and competitive LNG market," it added.

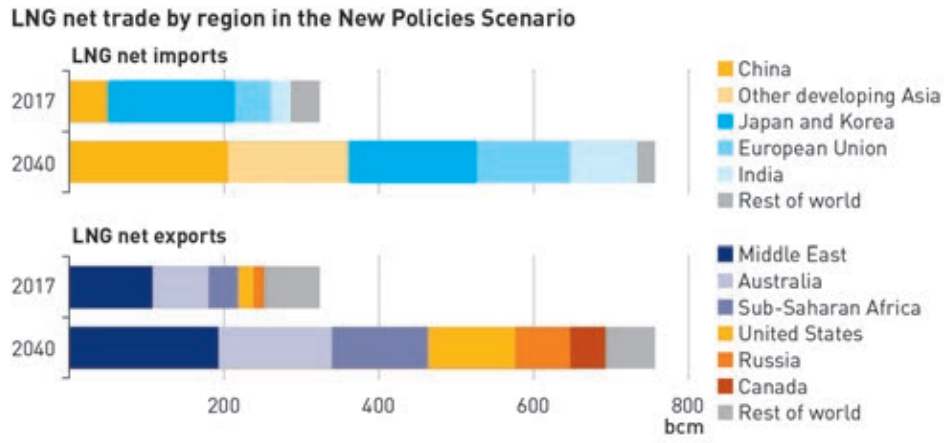
Portfolios

Aggregators, or portfolio players, who can provide shorter term volumes on demand promise to be an important source of gas for these more opportunistic consumers.

According to the Outlook, the way that this market evolves will have implications far beyond Asia.

"A more flexible LNG market, combined with a price-responsive segment of gas demand in Asia's power sector that can switch away from gas if prices rise too high, would be an important contributor to overall gas security," it said.

"Such a market could potentially serve as a buffer to absorb any supply or demand shocks to the system, compensating for a loss of flexibility in Europe and the United States as coal-fired capacity falls and reduces fuel-switching capabilities in these region," added the report.



Global LNG trade flows show contrasting trends; imports concentrate in Asia and export supply sources diversify.

Trading by regions is evolving under various market outcomes

"This though would depend critically on the progress made in developing well-functioning gas and electricity markets in Asia that allow price signals in international markets to feed into decisions throughout the value chain," it stated.

Policies

The IEA explained that to the extent that policy makers in Asia feel that gas represents a reliable, affordable option that helps to meet their economic and environmental objectives, they will be ready to commit to the policies and the infrastructure necessary for its growth - as China is demonstrating.

"For exporters and suppliers, this creates an imperative to keep the cost gap with competing fuels as narrow as possible and to develop commercial strategies that are adapted to the demands of Asia's new consumers," said the report.

"The development of a liquid and competitive LNG market is therefore closely linked with the prospects of gas demand in emerging Asian economies and vice versa," it added.

The agency's report said that by leveraging their supply chain presence, large creditworthy portfolio players such as integrated oil and gas majors can underpin new supply capacity on the strength of their balance sheets without necessarily locking in significant long-term volume commitments from buyers.

These companies can then break up their contracted output from large-scale projects to match the volume, tenure and flexibility requirements of smaller buyers across multiple markets.

Economics

Their investment decisions may be driven not just by the stand-alone economics of single projects but also by the value that a project might add to an integrated portfolio of assets, for example by opening up optionality and hedging opportunities.

"For players with less easy access to credit, LNG developers in the United States are offering prospective buyers equity stakes in new liquefaction terminals in exchange for bearing some of the market risk associated with the commissioning of new capacity," said the report.

"Mid-sized independent players are also experimenting with multiple small-volume, short-term contracts with buyers of various credit ratings, which together can attract enough financing for a larger project, while mid-stream players are adding power generation capabilities to floating storage and regasification units, tempting buyers to sign up to integrated, "plug-and-play" options to use LNG for electricity," it added.

In aggregate, these multiple strategies, which in various ways leverage the expanding middle ground and the opportunities to spread market risks more evenly along the value chain, offer scope to ensure the health of the global gas balance.

The final investment decision for LNG Canada in late 2018 is a case in point: a joint venture partnership between Royal Dutch Shell, Malaysia's Petronas, PetroChina, Mitsubishi Corp. and Korea Gas Corp., the project is not backed by any long-term contracts.

"Rather, its partners are responsible for their own gas supply and marketing strategies, implying a greater spread of risk among a diversified, creditworthy ownership pool," said the IEA.

"Strong government support has also been essential to overcome exceptionally complex land use, regulatory and social issues," it added.

The IEA emphasized, however, that the changes that are taking place should not lead to the conclusion that the old order has ceased to exist, or that every buyer is looking to maximise the flexibility of their contracts. ■

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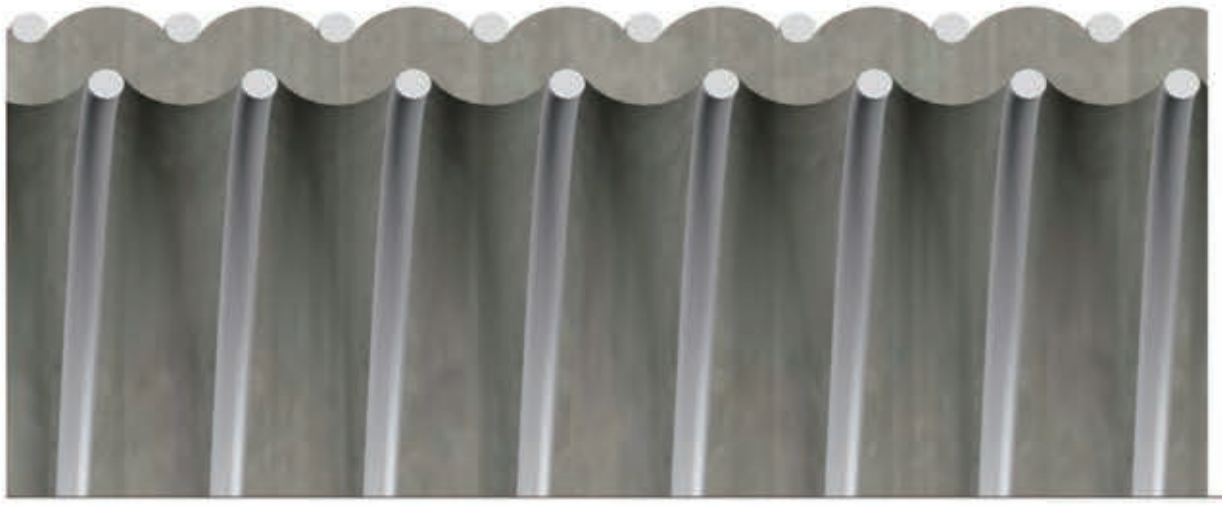

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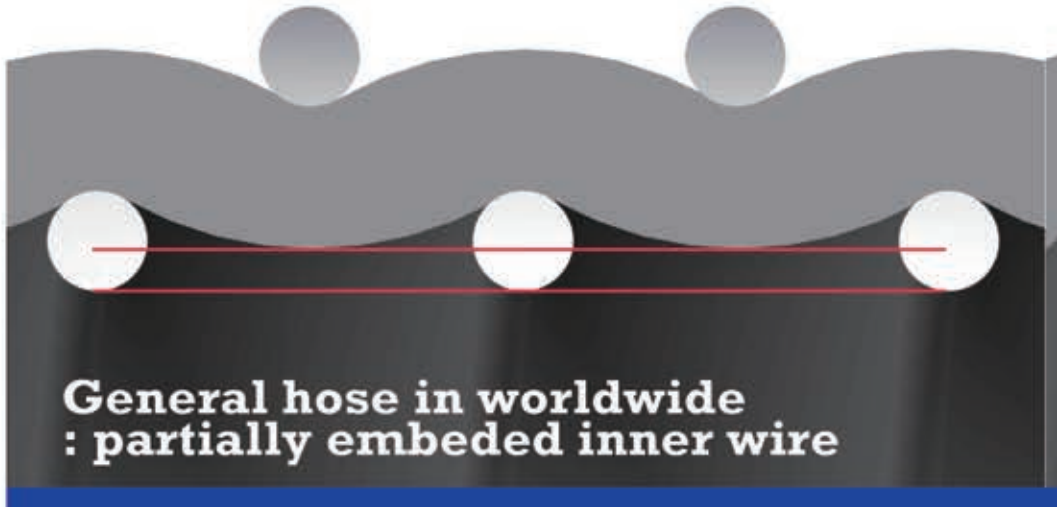

General hose in worldwide
: partially embeded inner wire

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DOLPHINFLEX

Export strategies adapt to changing markets for LNG and pipeline gas transactions

Marketing modes will evolve with additional volumes of liquefaction capacity coming on stream by 2023

International natural gas markets, business models and pricing arrangements are all in a state of transition. Thus far, increasing LNG supply is being absorbed by robust demand, particularly in Asia.

The International Energy Agency noted in a section of its world outlook that marketing modes will change with an additional 100 billion cubic metres of LNG liquefaction capacity coming on stream by 2023, as the expansion of capacity continues in the US and elsewhere..

Positioning

"With a host of new players positioning themselves between buyers and sellers, the market itself is becoming more contestable, with signs of more flexibility in contractual provisions on destination and re-sale, more gas-on-gas competition and a greater share of gas being sold on a spot or short-term basis," said the IEA report.

That said it is not clear that the expectations of buyers of new, more flexible contractual terms are a good match for what sellers will need to underpin major new infrastructure projects, which continue to require long-term commitments.

The IEA report examines the implications of changes in the market for suppliers, consumers, as well as for business models and investment.

Qatar's plans to expand its LNG capacity are an important test of market sentiment.

"With a geographical position ideally situated to serve both Asian and European markets, Qatar is in a strong position to develop a sizeable part of new LNG liquefaction projects scheduled to come on stream in the mid-2020s," said the IEA.

Its potential to tap into gas and leverage its existing infrastructure complex at Ras Laffan means that it "sits firmly at the bottom of the cost curve" for new supply.

Moratorium

Following the lifting of a self-imposed moratorium on further development of the huge North Field resources in the Arab Gulf, Qatargas announced its intention to add around 45 billion cubic metres per annum to its supply portfolio by constructing four new liquefaction Trains.

"The eventual pricing and contracting structures underpinning these future volumes will give some indication of whether traditional exporters are willing to countenance changes to the way the market works," said the report.

The early indications received by the IEA are that there is still an appetite for longer term contract arrangements.

Qatargas recently announced a new 22-year oil-linked contract with PetroChina, which would follow a 15-year contract signed in 2017 by Qatargas with Bangladesh.

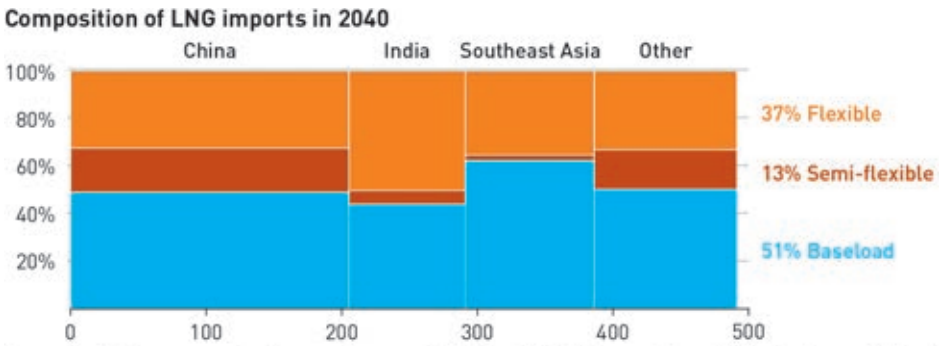
The report explained that many other countries are looking to expand or announce their presence in international gas markets.

Provinces

The commissioning of Yamal LNG in Russia on time and on budget in 2017, against market expectations, has reignited discussions about future prospects in the Arctic, and the Russian government's exemption of Yamal LNG from mineral extraction and export taxes may provide the template for future projects.

Mozambique has long been exporting gas via pipeline to South Africa, though its horizons have expanded since the major discoveries in the offshore Rovuma Basin.

...Qatar is in a strong position to develop a sizeable part of new LNG liquefaction projects ...



Emerging Asian economies become heavyweights in global LNG markets, with their share of global LNG trade more than doubling to 60% by 2040.

Asia's share of global import volumes will change through 2040

The southeast African nation's Coral floating LNG project was approved in 2017 and there is now the prospect of larger onshore liquefaction investment to develop these resources at scale.

The report also noted that the decision in October 2018 to move ahead with the LNG Canada project in British Columbia is Canada's first large-scale move into LNG, allowing the country to look beyond its regional role as a pipeline supplier to the United States.

Resources

In West Africa, the gas discovered on the maritime border between Mauritania and Senegal also looks destined for export using floating LNG facilities.

Argentina was expected to be drawn towards the LNG market for expanding production from the Vaca Muerta shale play. The South American nation has already announced its first FLNG project for seasonal cargoes.

The likelihood of a second wave of LNG investment in the US looms large in the investment calculations facing projects elsewhere in the world.

"New US LNG projects are not the least expensive option for incremental gas delivery into either European or Asian markets; it is highly unlikely that any project will be able to undercut Qatar on this score," stated the IEA.

"However the size of US resources, the large number of proposed LNG export projects, the scope for production flexibility, together with an LNG export industry actively seeking arbitrage opportunities, combine to put a ceiling price in the market, a deterrent

for any project that requires a gas price higher than the delivered cost of US supply," explained the report.

"The long shadow of US LNG adds to the complexity facing other projects as potential sellers try to align their interests with those of potential buyers," it said.

"There is, for the moment, little consensus on the appropriate choice of pricing mechanisms, contract durations and degree of flexibility, or on whether the world is still in a buyers' market or is seeing bargaining power gradually shifting back towards sellers," it added.

In addition, LNG projects in different parts of the world all carry their own unique challenges.

The recently approved LNG Canada project, for example, will require 670 kilometres of new pipeline infrastructure to transport gas to the LNG facility on the coast.

In sub-Saharan Africa, the lack of a developed governance framework and undercapitalised market players could lead to delays and financing problems. The latter has already affected Fortuna LNG's deepwater project in Equatorial Guinea.

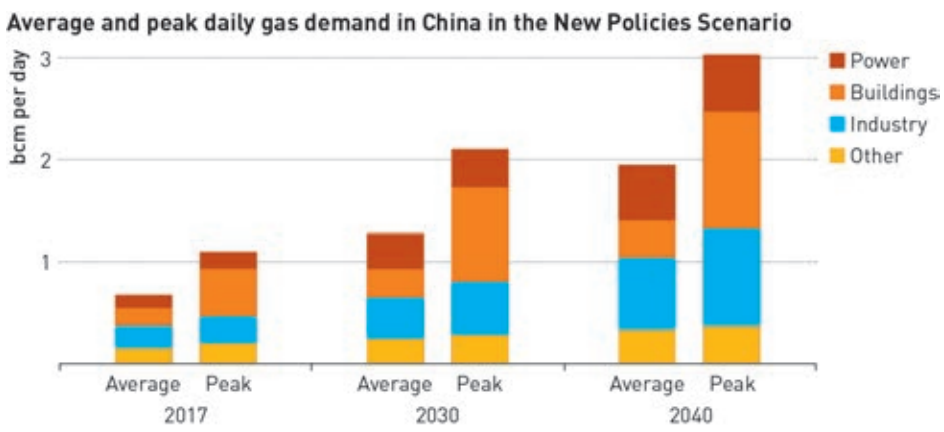
Pipeline market

For pipeline exporters, the IEA found that they are even more reliant on minimum capacities and firm delivery commitments to justify the considerable upfront costs of construction, the new gas order may create an enduring disadvantage relative to LNG.

"The Caspian region is emblematic of the current strategic dilemma for landlocked gas exporters," said the report.

"For Turkmenistan, for example, potential export markets are limited by its geographical position between Russia and Iran, both of which are themselves large gas producers and therefore have few incentives to provide transit," it added.

The report said that partnership with



China's peak daily gas demand is almost 60% higher than average daily demand.

Projects for natural gas demand in China remain on upwards curve

China has enabled the financing and construction of the first three lines of the 55 billion cubic metres per annum Turkmenistan-China Gas Pipeline, but reaching other large gas-consuming markets is proving challenging.

"The most advanced of the current diversification projects is the 33 Bcm per annum Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline, but its viability is compromised by transit risk through Taliban-held areas of Afghanistan, as well as by Pakistan and India's access to LNG," it said.

Gas streams

"In Russia, the vast majority of exports take the form of pipeline supply to Europe, where long-term demand reduction is partially offset by declines in indigenous production," added the IEA.

Russia, therefore, continues to pursue further large-scale pipeline projects into Europe such as the 55 Bcm per annum Nord Stream II project and the two-string Turkstream link through the Black Sea, each with a capacity of 15.75 Bcm.

The Russian "Power of Siberia" project opens up a direct route to China, with the possibility of further expansion linked to China's import needs.

"It may become increasingly difficult, though, for a rigid pipeline gas strategy based on exclusive rights for Gazprom to coexist with flexible LNG supplies marketed by competing Russian players. LNG could therefore gradually force changes in Russia's overall approach to gas export," said the report.

The IEA stated that Russia and the Middle East, led by Qatar, retain their positions as the top two net exporters of gas, with a combined market share of 43 percent of total global gas trade by 2040.

Diversity

"The overall picture is one of increased diversity and competition. In a globalising LNG market where destination-flexible US volumes provide an upper bound on price in each region, competing exporters sell into markets where they have a competitive geographical advantage," it said.

The Middle East, Russia and East Africa in particular benefit from favourable access to the two key importing regions of Europe and Asia; Australian and US LNG exports gravitate towards Asia.

The increase in new LNG project approvals in the second half of 2018 suggests that the risk of an abrupt tightening in gas markets around the mid-2020s may be easing, although a steady flow of additional projects would still be required to meet demand.

"There is also considerable uncertainty about what kind of business models and contracting structures will underpin new investment decisions," said the report.

"Projects that can come to market relatively quickly and at relatively low cost are the ones most amenable to the industry's current focus on capital discipline and short-cycle investments," it added.

"This works in favour of established low-cost exporters such as Qatar. It is likely to work in favour of brownfield projects elsewhere, notably in the US, where there is already a queue of new projects and expansions with regulatory approvals that are waiting for the right market conditions to move ahead," the report explained.

The IEA analysis suggests that large-scale greenfield projects can also find a place in the new gas order. The creditworthiness and risk-sharing arrangements among the players involved in a given project can overcome uncertainty about future market conditions and the need for bankable guarantees for capital-intensive gas supply projects. ■

For the Record

AIR PRODUCTS, the US LNG equipment-maker and industrial gas company, and Algerian state-owned oil and gas company Sonatrach have signed two gas production and delivery agreements. Through the deal, Sonatrach will recover helium from two existing liquefied natural gas processing Trains (GL1Z and GL3Z), and that helium will be delivered to an existing liquid helium plant in the Algerian port of Arzew, where one liquefaction plant is located. Algeria's second LNG production plant is at Skikda, also on the Mediterranean coast. The Helios plant, an Air Products joint venture with Sonatrach, is an important part of the US company's total global helium source portfolio, and the new feedstock will increase the amount of liquid helium produced by the Helios facility. "The potential for helium production in Algeria is significant thanks to its large, established natural gas industry and LNG operations," said Walter Nelson, vice president and general manager–Global Helium at Air Products. "Connecting the Helios plant to Sonatrach's other LNG facilities in Arzew is a further illustration of how unlocking Algeria's helium potential can further diversify the helium supply chain and improve the reliability of supply for customers in Africa and Europe," added Nelson.

The US company said that another important component of the agreement is that Air Products will design and build, and Helios will own and operate, two new air separation plants in Algeria. One will be located in the Hassi Messaoud district, with the second in Arzew. The latest deals signed with Sonatrach are valued by Air Products at about $100 million. Once in operation, these plants will produce nitrogen, oxygen and argon, which will be supplied to the Algerian and Maghreb markets through Sonatrach's subsidiary, Cogiz. "Underpinned by our strong relationship with Sonatrach and successful track record of execution, Air Products has built a solid platform in Algeria from which to grow," said Ahmed Hababou, vice president, Southern Europe and Maghreb, at Air Products. "We are very pleased to make our investments jointly with Sonatrach and build on the success of our partnership in Helios," he stated. "These latest agreements show our continued commitment and willingness to invest in the Algerian industrial gas market, bringing greater competitiveness, security of supply and enhanced service to our customers," said Hababou.

AVENIR LNG, a small-scale niche market joint venture involving Stolt-Nielsen Ltd, the shipping and storage group and its Norwegian peers, Hoegh LNG and Golar LNG, is now registered on the Oslo over-the-counter market after holding a private share placement. The Avenir joint venture will pursue opportunities to deliver LNG to areas of stranded demand as well as the development of bunkering capabilities. Avenir was first formed by Stolt-Nielsen in 2017 and it will consolidate all its LNG activities into Avenir, including four small-scale LNG newbuilds on order at Keppel Singmarine in Nantong, China, and a joint venture LNG terminal and distribution facility to be constructed in the port of Oristano in Sardinia. Avenir plans to source and ship LNG to terminals using small carriers and to distribute LNG in trucks and through regasification into local network grids. The first step in the capitalization of Avenir has now been carried out in the form of private placement of 110 million shares at a par price of US$1.00 per share.

This placement was split in two tranches. Tranche A consisted of 99 million shares that were subscribed for by Stolt-Nielsen and a further 49.5 million shares split between Golar LNG and Hoegh LNG with each having 24.75M shares. Tranche B consisted of 11M shares and was placed with a group of institutional and other investors on 8 November. Stolt-Nielsen LNG now holds a total of 45 percent of the shares while Golar and Hoegh each hold 22.5 percent. The remaining 10 percent will be initially held by the subscribers in Tranche B. The shares are now on the Norwegian OTC list with effect from November 14. Managers of the share placement included the leading Nordic investment banks and brokerages. They were Clarksons Platou Securities, Danske Bank, DNB Markets, Fearnley Securities, Nordea Bank, Pareto Securities and Swedbank Norge, a branch of Swedbank AB in cooperation with Kepler Cheuvreux and Skandinaviska Enskilda Banken (Oslo Branch).

BAHRAIN said it would receive its commissioning cargo from Abu Dhabi National Oil Company when the facility becomes operational in 2019. Bahrain has completed the construction of the jetty and offshore sections of its first LNG import facility at a location about 5 kilometres from the existing breakwater at the Khalifa Bin Salman Port. The new facility, whose subsea pipeline has also been installed east of the port, will have capacity to receive 800 million standard cubic feet a day. "We have an LNG terminal in Bahrain that is going to be commissioned next year and our first commissioning cargo is going to be imported from Adnoc. They gave us the best price," said the Bahrain Oil Minister Mohammed bin Khalifa Al Khalifa at an energy conference in Abu Dhabi. Bahrain is moving forward with the LNG facility even as it recently made new oil and gas discoveries, including extensive tight oil reserves amounting to 200,000 barrels per day and deep natural gas resources of between 10 and 20 trillion cubic feet. Bahrain would become the latest of the Gulf Cooperation Council states to have LNG import facilities installed following the United Arab Emirates and Kuwait.

The main contractor of the terminal and infrastructure is GS Engineering & Construction on behalf of the joint venture known as Bahrain LNG. The completed facility will include the offshore jetty and breakwater to receive LNG shipments, as well as a floating storage unit (FSU) and a regasification platform. The Bahrain LNG consortium comprises four companies, the Gulf state's National Oil & Gas Authority (30 percent), Teekay LNG (30 percent), South Korea's Samsung C&T (20 percent) and the Gulf Investment Corporation (20 percent). The Bahrain project is aimed at supplementing natural gas production in the kingdom and ensuring capacity to meet peak-season demand and industrial growth. Bahrain is the region's smallest oil producer. The country, which is not a member of the Organization of Petroleum Exporting Countries, announced its large oil and gas discoveries earlier in 2018. "We're trying to develop our indigenous gas and we have the new discoveries. We're working on the geology and we're drilling wells onshore," said Oil Minister Al Khalifa.

BALEARIA, the Spanish ferry company, is continuing with its build-out of dual-fueled ferries with liquefied natural gas capability by starting sea trials for its latest vessel as it increases cleaner LNG fuel use for its Mediterranean routes. Balearia's ferries link the Spanish mainland to Spain's islands such as Majorca, Menorca, Ibiza and the Spanish territories in North Africa, Ceuta and Melilla. Naturgy Energy Group, the Spain-based utility company and prominent LNG market participant, formerly known as Gas Natural Fenosa, has signed a 10-year bunkering contract to supply LNG fuel to the ports served by Balearia's ferries. The Spanish ferry line's second new vessel to use LNG fuel will be the "Marie Curie", which has just left the Italian shipyard, Cantiere Navale Visentini, based in Donada near Venice, to begin sea trials. The sister ship of "Marie Curie" is already near full completion and fitting at the Italian yard and is named "Hypatia de Alejandria". "Both vessels will be the first LNG-propelled ferries to sail the Mediterranean," said Balearia. "The investment in building these two smart ships, which will be pioneers in the Mediterranean, totals 200 million euros ($225M)," said Balearia. Each vessel is 186.5 metres in length with a maximum speed of 24 knots and capacity to carry 810 people, 2,100 linear metres of cargo and 150 vehicles. The dual-fuel LNG engines have 20,600 KW of power.

"The 'Hypatia de Alejandria' is to begin operating at the beginning of the year and the 'Marie Curie' a few months afterwards," added the company. Balearia said the use of LNG as a fuel is a strategic commitment to comply with social responsibility and to help with profitability. The company has pledged to have at least half of its fleet of 25 ferries sailing with clean energy within the next three years and for all its vessels to be LNG-powered within 10 years. Besides these two ships, Balearia has ordered a large fast ferry with LNG engines from the Armon shipyard in Asturias in northern Spain. "Furthermore, the first of the six ships in the fleet to switch to natural gas-propelled engines was refitted in November," added the company. Balearia said the retro-fitting project was being partially funded by the European Union with 12 million euros in grants out of the total 72M euros of investment.

BGC Partners of the US, a leading global brokerage and financial company, has completed the acquisition of Poten and Partners Group, a ship brokerage, consulting and business intelligence firm specializing in LNG, tankers and the liquefied petroleum gas markets. Poten has about 170 employees worldwide and

aims to provide its clients with insights into the international oil, gas and shipping markets. Under the terms of the agreement, Nasdaq-listed BGC acquired 100 percent of Poten, which includes operations in New York, London, Singapore, Houston, Athens, Guangzhou in China and Perth in Western Australia. Poten will become part of BGC's energy and commodities business. The financial details of the transaction were not disclosed. Shaun D. Lynn, President of BGC Partners, said his firm was excited by what it regards as a strategic acquisition. "The addition of physical LNG, LPG and tanker brokerage, and energy consulting capabilities will allow BGC to expand its operations in the oil, gas and shipping sectors," explained Lynn.

"Poten's access to market intelligence and its highly regarded price reporting and analytical products, including LNG, LPG and Asphalt will also add to our existing energy and commodities suite of market data solutions under Fenics Market Data," added the BGC President. Poten generated revenues of around $60 million in the last financial year. The BGC takeover of Poten is expected to immediately boost the company's revenues. "In addition to its brokerage, Poten provides value-added services including commercial advisory, technical consulting, project due diligence and multi-client reports," said BGC. "We are very excited to be part of BGC and feel BGC is uniquely positioned to support us in our next stage of growth," said Steven M. Garten, Chairman and Chief Executive of Poten & Partners. "The combination of BGC and Poten will enable us to accelerate this, both organically and through targeted acquisitions," added Garten.

CNP Corp., the Taiwanese energy company, said it received its first cargo on November 26 from the Ichthys LNG export plant in the Northern Territory of Australia, as the Asian country claimed as part of China broadens its supply sources. Taiwan, known by China and in international organizations as "Chinese Taipei", was the third-largest Asian importer of LNG until 2011 when it was overtaken by the Chinese mainland for the first time. Taiwan is now the fifth-largest Asian importer of LNG and last year received 16.6 million tonnes of cargoes. The latest cargo for Taiwan from the Ichthys project, owned by Inpex of Japan and the French major Total, was delivered to the Yung-An terminal on the 182,000 cubic metres capacity carrier "Pacific Breeze" The "Pacific Breeze" was built by Kawasaki Heavy Industries of Japan and is the world's largest vessel with spherical Moss-type LNG tanks. The ship had left the Bladin Point export terminal near the Australian port of Darwin on November 17. "Taiwan's CNPC in line with the government's new green energy policy is actively widening its sources of imported LNG," said CPC. "Ichthys LNG signed an agreement with CPC in January 2012 to supply 1.75 million tons per year from the Australian plant," it added. Taiwan already receives shipments from other projects in Australia.

The Yung-An import facility that received the cargo has been on line since 1990 and the newer Tai-Chung terminal has operated since 2009. Tai-Chung is undergoing an expansion and now has five storage tanks in operation with 800,000 cubic metres of capacity. CPC in July 2018 signed an accord with US LNG producer Cheniere Energy for the supply of 2 MTPA of cargoes for 25 years. The company also holds a 5 percent interest in production from the Prelude Floating LNG project offshore northwest Australia. The venture is currently being brought on stream by Royal Dutch Shell to produce 3.6 MTPA. However, Qatar remains Taiwan's biggest supplier and last year the Arab Gulf nation shipped 5.23MT to the two Taiwanese terminals. Taiwan additionally receives shipments from Asian nations such as Indonesia and Malaysia as well Brunei. Other regular suppliers are Papua New Guinea and Russia and the Atlantic Basin LNG producing nations Nigeria and Trinidad.

EAGLE LNG Partners received a draft environmental impact statement from the Federal Energy Regulatory Commission for the mid-scale Jacksonville project in Florida to supply regional power and fuel markets. Eagle LNG is planning its facility for the north bank of the St. Johns River in Jacksonville and would comprise about 1 million tonnes per annum of LNG output from three small liquefaction Trains, each was capacity of around 330,000 tonnes. One LNG storage tank is also proposed with a net capacity of 45,000 cubic metres. The marine facilities would have a loading platform and two liquid loading arms capable of docking and mooring a range of LNG vessels with cargo capacity of up to 45,000 cubic metres. LNG truck-loading facilities would have a dual bay capable of handling between 260 and 520 trucks per year. Eagle has said that the facility would serve both domestic and international markets. The company will load the fuel onto ocean-going vessels for export to countries in the Caribbean where heavy fuel oil or diesel is currently in use for power generation. It will also supply the domestic marine fuel market.

Feed-gas would be delivered to the Jacksonville plant via a 120-foot-long non-jurisdictional pipeline that would be constructed, owned and operated by Peoples Gas, a subsidiary of Teco Energy. "We determined that construction and operation of the project would result in some limited adverse environmental impacts, but impacts would not be significant with the implementation of Eagle LNG's proposed and our recommended mitigation measures," said a FERC statement. The regulator added that its decision was based on a review of the information provided by Eagle and further developed from data requests, field investigations, scoping and contacts with federal, state and local agencies. "Although many factors were considered in this determination, the principal reasons are: the LNG terminal site would be in an area currently zoned for industrial use and is along an existing, maintained ship channel in the St. Johns River," the FERC stated. The draft EIS comment period closes on January 7, 2019. "The Commissioners will take into consideration the FERC environmental staff's recommendations when they make a decision on the project," the agency added.

ENI, the Italian energy company, signed an agreement for the sale of a 20 percent interest to Mubadala Petroleum from Eni's share in the Nour North Sinai Offshore block after Mubadala had previously invested in the Zohr field that enabled the Egyptians to re-start LNG exports. Nour is a block located in the prolific East Nile Delta Basin of the Mediterranean Sea, about 50 kilometres offshore in water depths ranging from 50 metres to 400 metres and covers a total area of 739 kilometres. Mubadala Petroleum is a wholly owned subsidiary of Mubadala Investment Company of the United Arab Emirates. The sales agreement was signed by the Chairman of Mubadala Petroleum, Musabbeh Al Kaabi, and the Chief Executive of Eni, Claudio Descalzi. In the concession, which is in participation with Egyptian Natural Gas Holding Company (EGAS), Eni holds an 85 percent stake in partnership with Tharwa Petroleum Co. The partnership holds a 15 percent stake of the contractor's share where Eni and Tharwa are collectively the contractor. Eni and Tharwa are currently carrying out the drilling of the exploration well as foreseen in the first exploration period of the Nour concession.

Eni previously sold Mubadala a stake in the Shorouk concession containing the huge Zohr natural gas field that has enabled the Egyptians to halt LNG imports as most of their domestic gas requirements are being met. Eni's other partners in that Shorouk licence are Russian oil company Rosneft and BP of the UK. The Egyptian Zohr field has estimated resources of at least 30 trillion cubic feet and has helped the nation to again become an LNG exporter, as other discoveries have been made and are also being developed. "This transaction strengthens our partnership after the successful relationship in Zohr and confirms Mubadala's trust in Eni's robustness as operator, both in projects development and exploration activities," said Eni CEO Descalzi. Mubadala Chairman Al Kaabi, said that latest investment enables his company to further expand its position in Egypt while deepening its strategic partnership with Eni, the operator of both the Shorouk and Nour concessions.

FLEX LNG, the growing LNG shipping company with four vessels operating and nine others on order and whose shareholders include trusts connected to Norwegian magnate John Fredriksen, reported rising third-quarter revenues of $19 million and a booming winter charter market. Flex, which is listed on the Oslo bourse, reported nine-month revenues of $41.1M. Gross quarterly earnings were 12.7M compared with a loss of $4.1M in the same three months of 2017. Third-quarter net profit came in at $1.2M compared with losses of $4.0M in the same 2017 quarter. Flex Chief Executive Oystein M. Kalleklev, who is also acting as Chief Financial Officer, said his company had "rapidly become the largest owner of modern fifth-generation LNG carriers" with a fleet expansion from six to 13 vessels since May 2018. "Unlike the vast majority of other LNG shipping companies, we decided to strategically pursue shorter term employment until the shipping market showed signs of rebalancing," explained Kalleklev. "As

interest for large modern vessels have been very high in the winter season, Flex LNG is pleased to announce that it has already covered all available days for the fourth quarter," said the company, in reference to its four ships in operation. Flex said that because of the charter positions it expected revenues for the fourth quarter would be around $35M, almost double the third-quarter's $19M. "The market has now rebalanced with current fixtures now being agreed at all-time high rates. Thus, Flex LNG is very well positioned to reap the benefit of our strategy," said the CEO. "This is somewhat evidenced by the company's improved financial performance in the third quarter, but more importantly highlighted by the very strong guidance for the fourth quarter as well as the outlook for next year," he added.

"We think the LNG shipping market will remain tight due to a combination of large increase in liquefaction capacity in the near, medium and long-term, limited fleet growth, increased ton-mileage and increased focus on improving air quality, favoring the ongoing switch from coal to natural gas," stated Kalleklev. Flex held a private share placement in October 2018 to help finance five newbuilds at a cost of under $1 billion. The five LNG newbuilds comprised three ships with M-type, electronically-controlled, gas injection (MEGI) engines currently under construction at Daewoo Shipbuilding and Marine Engineering Co. in South Korea. The three vessels are scheduled for delivery in 2020. A further two vessels with dual-fuel propulsion being built at Hyundai Samho Heavy Industries for Fredriksen's Geveran Trading and due for delivery in 2021 are also set to come under Flex ownership. The company completed its private placement on October 11. Flex's share placement involved new ordinary shares for gross proceeds of 2.46 billion Norwegian crowns, or around $300M. Fredriksen's Geveran Trading, Flex's largest shareholder, guaranteed that the share placement was fully subscribed. It retained its 44.6 percent ownership of Flex following the placement.

FLUXYS of Belgium and Enagas of Spain, the natural gas network and LNG terminal owners, have closed their joint sale to First State Gas Transport AB of their stake in Swedegas, owner and operator of the high-pressure gas grid in Sweden. FS Gas Transport AB is a subsidiary of First State Investments, a managed European diversified infrastructure fund. First State, which also owns the largest Swedish gas distribution network, approached Fluxys and Enagas earlier in 2018 with an offer to purchase Swedegas. Both companies, each owning a 50 percent stake in Swedegas, agreed to this proposal in September 2018 and the transaction has just been closed after approval by the Swedish competition authority. Fluxys and Enagas closed the sale for an amount of 1.03 billion Swedish Krona (SEK) each, around 100 million euros ($114M) at the current exchange rates. Enagas and Fluxys had acquired Swedegas in March 2015 from EQT Infrastructure and each invested around 100M euros in equity and third-party debt financing. The Swedegas acquisition had given the Belgian and Spanish firms a highly experienced staff and around 600 kilometres of natural gas pipelines and an underground storage facility at Skallen.

Fluxys and Enagas had both continued with developing a bunkering and small-scale LNG terminal in the Swedish port of Gothenburg. Enagas is the largest European LNG import terminal owner with five facilities in Spain at Barcelona, Cartagena, Huelva, Bilbao and El Musel. In addition, Enagas owns joint venture stakes in two terminals at Altamira on the Gulf Coast of Mexico and at Quintero in Chile. Besides its pipeline and storage assets, Fluxys owns and operates the Euronext-listed Fluxys Belgium and controls the Zeebrugge LNG terminal and the Dunkirk LNG terminal in France. "Over the past three years Swedegas has developed Sweden into a major growth market for small-scale liquefied natural gas in both shipping and industry," said Fluxys and Enagas in confirming the sale. "The company also is a frontrunner in the transmission of low-carbon gas and has successfully completed preparations for a joint balancing zone with Denmark," they noted.

GRTGAZ and Terega, the French natural gas network operators, , are confident they have lined up sufficient underground storage and supplies of LNG to ensure the smooth operation of the nation's gas system throughout the winter. "This year, the gas transmission operators do not have anything particularly alarming to report at the start of this winter gas season," said both companies in presenting their "Winter Outlook 2018-2019". GRTgaz Chief Executive Thierry Trouve and his Terega counterpart Dominique Mockly stressed that the gas system should be able to meet the demands of all French gas consumers, even in the event of an exceptional cold spell. "This analysis is based on the capacity offered to shippers as well as the level of volumes booked for supplying the network at the various entry and exit points (cross-border interconnections, LNG terminals, underground storage facilities)," said the Outlook. "Projections show that a minimal supply of LNG and/or entries from Spain are nonetheless necessary to cover the balance and manage the network bottlenecks for cold winter scenarios or in the event of a spike in gas demand," it added. At the start of November, the level of volumes booked in the storage facilities totalled 128 billion kilowatt hours, the highest level since 2010. "Regulation of storage introduced in early 2018 led to an intense injection campaign from May to October," added the report. "GRTgaz (national network) and Terega (southern regional network) have no particular alert to give before the start of this winter," it stated. "Indeed, the capacities offered to the shippers as well as their subscription levels for the winter of 2018-2019 (all points taken together) are sufficient to cover the supply for French consumers in the event of a cold peak, even if the shipping customers decide to maximise their use of the subscribed exit capacities to Switzerland and Spain," explained the report.

Since the start of November, there has been a single French gas marketplace called the Trading Region France (TRF). Created jointly by GRTgaz and Terega, the new TRF market has a single exchange point for gas known as the PEG and which was previously divided into the PEG North and the PEG South. This followed the commissioning of the infrastructure of the Val de Saone project, comprising 188 kilometres of pipelines and additional compression facilities between Etrez and Voisines in eastern France. The completed infrastructure was considered an essential link to improve the transit between markets in the North and South. Most of France's gas supply is imported, 70 percent by pipelines from Russia and Norway via the Netherlands and 30 percent as LNG delivered to four terminals, mostly from Algeria, Nigeria, Qatar and Norway. Three of France's LNG import terminals are operated by Elengy, a subsidiary of GRTgaz within the Engie Group. France has a dozen gas-fired power stations and the GRTgaz network operates 32,414 kilometres of pipelines. The network is interconnected with the German, Belgian, and Swiss networks, as well as with the Terega network which serves the south-west of France where the network has two connections to Spain. While GRTgaz is the dominant partner, Terega still transports 12 percent of France's gas supply and has 24 percent of French storage capacity.

HOEGH LNG, the Norwegian fleet owner, posted a rise in third-quarter net income and higher revenues from new floating storage and regasification unit (FSRU) charters, while it was in the final round of tenders for four other projects. Hoegh reported quarterly net profit of $5.96 million, up from $1.10M in the year-ago quarter, though down on the $7.84M recorded in the second quarter. The company said total revenue for the period was $82.3M compared with $64.4M a year ago and $75.8M in the second quarter. "The increase is mainly a result of higher revenues generated by 'Hoegh Giant' and 'Hoegh Esperanza', as well as $2.1M in revenue recognition of insurance proceeds," said Hoegh. The company also noted that its growing earnings during the third quarter were offset by a one-off impairment of $9.0M relating to jetty equipment previously installed for the Ain Sokhna import project in Egypt, which was part of the "Hoegh Gallant" FSRU charter to Egyptian Natural Gas Holding Company. According to President and Chief Executive Sveinung J.S Stohle, the results were Hoegh's best underlying quarterly results on record. Among company highlights, the "Hoegh Esperanza" commenced FSRU operations in Tianjin port in northeast China. The FSRU arrived in Tianjin in early November and started commissioning for operations on a three-plus-one-year FSRU-carrier charter with China National Offshore Oil Corp.

Hoegh LNG also announced an investment in October of $24.75M in Avenir LNG, a joint venture also involving Norwegian peers, Golar LNG and Stolt-Nielsen. The venture involves pursuing opportunities in the small-scale LNG market, including the delivery of LNG to power generation projects currently running on oil, the development of bunkering services and supply of fuel to the transport sector. Combined equity commitments from the Avenir venture partners will help fund four 7,500 cubic metres capacity LNG carriers and two

20,000 cubic metres capacity carriers, as well as the development of a small-scale LNG terminal on the Italian island of Sardinia. The first of the two 7,500 cubic metres capacity vessels is scheduled for delivery in November 2019. "The results reflect continued operational excellence and a full quarter of income from 'Hoegh Esperanza' under its contract with CNOOC in China," said CEO Stohle. "Our financial position is solid, and with debt commitments received for the financing of our two newbuildings," he added. "Meanwhile, we continue to see an improving FSRU market and are currently in the final selection round for four different long-term FSRU projects," stated Stohle.

JERA CO. Inc., the largest Japanese liquefied natural gas importer with around 40 million tonnes per annum of requirements, said it was still replacing ageing oil-fired thermal power plants in Japan with coal-fired units instead of gas for economic reasons. Jera has been completing the integration of the joint venture company formed by Tokyo Electric Power Co and Chubu Electric Power in 2017, combining their power assets and directing their global LNG purchasing and trading activities. Japan's Minister of Economy, Trade, and Industry has just issued an Environmental Impact Statements for the two latest coal-fired generating units at the Yokosuka Thermal Power Station Kanagawa Prefecture, south of Tokyo. In addition to its LNG imports, Jera also brings around 30 million tonnes per annum of coal shipments into Japan. Jera agreed in July 2018 to merge its LNG activities with French firm EDF Trading Ltd. Under the deal the LNG trading activities of both EDF and Jera were merged into Jera Trading Pte. Ltd. (Jerat). This transaction followed an earlier deal with coal trading involved when the Japanese firm completed the acquisition of EDFT's coal business in April 2017. Jera's newest LNG volumes are coming from the Ichthys plant in Australia of Japan's Inpex Corp. and France's Total and from the Freeport LNG plant in Texas from 2019.

However, it is going ahead with new coal projects while at the same time has pledged to increase its gas-fired plants over time. It is also continuing to boost its LNG carrier fleet to around 30 vessels as it increases its trading activities in the Atlantic and Pacific basins. "The new Yokosuka-1 and Yokosuka-2 coal-fired power units will each have a capacity of 650 megawatts and will be commissioned in 2023 and 2024," said the Japanese environmental statement. They will replace the current Yokosuka oil-fired units, which consists of six 350 MW oil-fired generators commissioned between 1964 and 1970, one 144 MW gas turbine dating from 2007 and a 30 MW emergency turbine in operation since 1971. "This acknowledgement notice confirms that no changes are required to the EIS that was submitted for review on 15 November 2018," explained Jera of its coal-fired project. "Jera will continue to move the project forward with the understanding of the local community and other parties concerned," said the company. "The EIS will be made available for public review from 18 December 2018 through 25 January 2019 at the related administrative agencies," added Jera.

JGC Corp. of Japan, one of the leading global energy engineering companies, has given a frank assessment of the risks posed by some overseas projects in terms of potential losses and outlined its activities and plans for the LNG Canada project, Ichthys LNG In Australia and the Russian Yamal LNG venture. JGC has also explained how it was changing its structure to become a holding company to alleviate the risk factors in the business. Its statement was described as a fuller explanation of its latest quarterly financial results. The increasing values of LNG plant construction contracts, running into billions of dollars, are

raising the threshold of corporate risks. "Our business is currently centered on engineering, procurement and construction (EPC) in the overseas oil and gas sector, and the company is dependent on the success or failure of projects in this field," explained JGC. "To break free of this, we need to develop a new pillar in our business to create a multi-pronged business system that integrates the overseas infrastructure sector, the domestic EPC business and the manufacturing business," said the company. "Our aim is to change to a system of group-style management to enhance it," it added. JGC stated that the purpose of this corporate overhaul, was not to open the way for mergers and acquisitions but to develop a more workable structure so that, as a group, the company would not be affected as much by the overseas plant construction market. JGC was awarded the contract with Fluor Corp. of the US for the LNG Canada project in British Columbia at the coastal town of Kitimat. The joint venture is led by Royal Dutch Shell with other participants being the Asian companies Petronas of Malaysia, PetroChina, Mitsubishi Corp. of Japan and Korea Gas Corp. JGC noted that the use of modular methods would limit on-site construction work and admitted that its gross profit ratio for LNG Canada was around 10 percent.

"In the LNG Canada project, the use of modular construction for the entire facility, and the use of larger modules are expected to cut the amount of on-site construction work by around 70 percent compared to conventional stick-built construction," said JGC. "We believe it meets our requirements in margin," it added. JGC and Fluor have been retained for the first two Trains at LNG Canada and the joint venture is also planning third and fourth Trains. "That is the client's decision, so we cannot comment, but we would love to acquire the contract. In a project to build additional Trains, many of the existing utility facilities can be shared, so the contract amount will be slightly less, but still a large amount," explained JGC. The Japanese company also outlined the problems encountered at the Ichthys LNG project in Australia's Northern Territory, led by Inpex Corp. of Japan and French major Total and which suffered delays and other contract problems. "We are continuing negotiations regarding recovery of reimbursable costs and unapproved change orders with the client, and a part of these are undergoing arbitration," said JGC. "Furthermore, regarding the construction of the combined cycle power plant, which is a part of this project, the subcontractor abandoned their responsibilities before completion despite working under a fixed-price EPC contract for the power plant," it explained. "This led to our joint venture group having to hire another subcontractor and pay the costs to continue construction of the power plant," said JGC. "The costs have been charged to the subcontractor and were taken to arbitration. As for the accounting, we have taken the assessed recoverable value with certainty after taking into account relevant professional advice from independent auditors and lawyers," it stated. "A certain estimate of the overall amount under dispute that we believe recoverable has been included in accounts receivable of our financial statements with totals around 100 billion yen (US$878 million) for our 40 percent share," it said. On the more positive side of the business, JGC said that the Yamal LNG project in Siberia has been making good progress and the second Train has been completed. "There has been talk of giving out bonuses, and the improved profits have been reflected in this fiscal quarter, as well as our full-year financial forecast," said JGC.

KBR INC., the leading US liquefied natural gas engineering company, said it was retained by the Papua New Guinea Department of Petroleum to provide consulting, advisory and engineering services for multiple projects linked to the Oceania nation's LNG expansion. "Under the terms of the agreement, KBR will provide these services utilizing strategy and technical specialists from multiple offices including Singapore, Australia, London and Houston," said the US company. KBR is one of the most experienced global LNG engineering companies and has been part of joint ventures that built plants in Africa, the Middle East and the Asia-Pacific region, including most recently the Ichthys and Gorgon LNG plants in Australia. The ExxonMobil-operated PNG LNG plant and a related venture called Papua LNG are planning to build three new liquefaction Trains to double output to more than 16 million tonnes per annum. The other stakeholders in addition to the US major include Australian-listed Oil Search and Santos, French energy major Total, Japan's JX Nippon Oil & Gas and the PNG government and its agencies.

The shareholders in the expansion are still finalizing the details of the financial aspects of the joint ventures before a final investment decision in 2019. Two new processing Trains are to be supported by the Papua LNG feed-gas from the Elk-Antelope field and one for the existing PNG LNG plant by the P'nyang field and associated resources. Houston-based KBR said the PNG award was a testament to KBR's long-term strategic commitment to this promising and rapidly developing market. "KBR is proud to help the Government of Papua New Guinea harness the full potential of their future energy developments," stated Jay Ibrahim, KBR President for regions outside the US. "We are excited to showcase our extensive expertise to help grow this key market," added Ibrahim. The PNG resource shareholders are continuing with their marketing efforts for the planned additional LNG volumes to be sold into the expanding Asian market, including to customers in China and Japan.

KINDER MORGAN, the US pipeline company and two equity funds are making progress on receiving permits to transform the existing Gulf LNG import terminal in Pascagoula in Mississippi into an export plant. The proposed Gulf LNG export facility would consist of two Trains, each with capacity of about 5 MTPA. The Pascagoula terminal had originally been constructed to import LNG cargoes from Angola in southwest Africa from a production plant developed by international oil companies, including Chevron Corp. However, the US shale-gas boom made LNG imports into the US uneconomic and Kinder later decided to consider the export option. The Gulf terminal was originally owned by US pipeline company El Paso and later acquired by Kinder, which has sold 50 percent of the project to US equity funds. The existing Pascagoula terminal is located next to the Bayou Casotte Navigation Channel and already includes a five-mile send-out pipeline and two LNG storage tanks, each with a capacity of 160,000 cubic metres. It is interconnected to several downstream pipelines, including Transco, Florida Gas Transmission, the Destin Pipeline and the Gulfstream Natural Gas Pipeline from where feed-gas can be transported for processing and export from Pascagoula. The Federal Energy Regulatory Commission has just prepared a draft environmental impact statement for Gulf LNG. This is Kinder's second LNG export project and it is currently completing the Elba Island export plant near Savannah in the state of Georgia.

"The FERC staff concludes that approval of the proposed Gulf project, with the mitigation measures recommended in the EIS, would have some adverse environmental impacts," said the FERC. "However, these impacts would be avoided or reduced to less-than-significant levels," it added. The draft EIS comment period for Gulf LNG is scheduled to close on January 7, 2019. In addition to the storage tanks and pipeline, the terminal has a single dock facility that is currently permitted to receive LNG carriers of up to 170,000 cubic metres capacity and is designed to handle even larger vessels. "The proposed project will include the installation of natural gas pre-treatment, liquefaction, and export facilities at the terminal with a total capacity of up to 11.5 MTPA," said Gulf LNG. "The Gulf export plant would also have its own utilities and truck loading and unloading. This would be for unloading refrigerants and loading condensate produced during the gas liquefaction process," according to the plans. "Four flares (including one spare flare) are planned in a single flare tower to incinerate excess gases associated with maintenance, start-up, shutdown and in emergencies," the filing added. An earthen berm would also be constructed extending from the northeast to the southeast boundaries of the terminal expansion site. This would be connected to new segments of the storm surge protection wall on the coast. The project is 50 percent owned by Kinder Morgan subsidiary Southern Gulf LNG Company, while 30 percent is held by Thunderbird LNG, a unit of the Blackstone Group fund managers. The remaining 20 percent is held by Gulf LNG Holdings, comprising Arc Logistics Partners and Lightfoot Capital Partners equity funds.

LINDE of Germany was awarded a contract by a Chinese chemical and energy company to supply a mid-scale liquefied natural gas liquefaction plant at an industrial site near Beinichuan in Inner Mongolia, an autonomous region of northern China. The agreement with Inner Mongolia Huineng Coal Chemical Co. is Linde's seventh and largest LNG plant project contract to date in China and is in response to growing Asian demand. The engineering division of

Munich-based Linde will be responsible for the venture and supplying site services for the LNG plant with a nameplate capacity of 750,000 tonnes of LNG per annum. The plant's technology is based on Linde's proprietary LIMUM(R) process, a multi-stage mixed refrigerant process that provides best-in-class energy efficiency, and proprietary core cryogenic heat exchangers. Linde pioneered its LNG plants in the Nordic region of Europe by constructing small-scale facilities in Sweden and Norway.

Its first Chinese facilities were constructed at Shan-Shan in the northwest and Jimunai in the Xinjiang Uyghur Autonomous Region. Linde Engineering noted that it had world-class experience across the entire natural gas processing chain, including proprietary process technology, manufacturing specialised, tailor-made cryogenic equipment and the delivery of turn-key plants. The Linde Group generated revenue of 17.11 billion euros ($19.54Bln) last year, making it one of the leading gases and engineering companies in the world, with approximately 58,000 employees. The strategy of The Linde Group is geared towards long-term profitable growth and focuses on the expansion of its international business. The company said it was committed to technologies and products that combine the goals of "customer value and sustainable development" in the market place.

LLOYD'S Register, the UK maritime classification society, presented South Korean shipbuilder STX with an approval in principle for a tanker design capable of using liquefied natural gas as a fuel. The approval is for a 50,000 deadweight tons medium-range tanker. Lloyd's said STX incorporated an LNG-fueled propulsion system into their existing conventional MR tanker design with technical assistance and support from LR. The UK class society said that this has ensured that the design is in compliance with the new IGF code as well as the Lloyd's Gas Fuelled Rules, covering other applicable requirements. Lloyd's also supported STX in carrying out a risk assessment of the LNG-fueled propulsion system.

"STX has an extensive reference list for designing and building MR tankers," said EK Choi, Chief Technical Officer of STX. "The experience and know-how that has been built to date has been utilized to develop this new LNG-powered MR tanker," he added. "The design enables the lowest possible fuel consumption and allows owners to select a design that will meet the future sulfur oxide and nitrogen oxide emission challenges," he stated. The AiP certificate was presented by Young Doo Kim, the Lloyd's North Asia Technical Support Office Manager. "It's been an exciting project where we are delighted to have been able to support STX in incorporating LNG as a fuel option," added Young.

MISC BERHAD, the Malaysian shipping line, has taken its liquefied natural gas fleet to 30 vessels by acquiring two older ships from Italy's energy company Eni and chartering them back to the Italians in a deal with the potential for the carriers to be future conversions for floating LNG projects. MISC said that under the agreement with Eni's tanker shipping subsidiary it has acquired ownership of two mid-scale carriers known as "LNG Portovenere" and "LNG Lerici". The two vessels were delivered from the shipyard in 1996 and 1998 respectively and are Med-class vessels of 65,000 cubic metres capacity, originally ordered to ship cargoes from Algeria to Europe. However, the "LNG Portovenere" and "LNG Lerici" are currently trading in the Asia-Pacific region. "The five-year charter period (for Eni) will tentatively commence in December 2018 for 'LNG Portovenere' and January 2019 for 'LNG Lerici', with an estimated combined contract value of US$133 million," said the Malaysian company. During the signing of the charter-party agreements in the Italian city of Milan, MISC was represented by its Vice President of LNG Business, Zahid Osman, while the contracts were signed for the Italian by their head of the LNG Shipping unit, Riccardo Baratozzi. MISC's President Group Chief Executive Yee Yang Chien said the acquisition of the two vessels as well as the charters will further strengthen MISC's position as one of the leading international LNG shipping fleet owners. "In view of the evolving marketplace, there is certainly potential for us to diversify our solutions by including mid-scale and small-scale LNG transportation," said Yee.

"This is especially true when applied to the growing spot market demand for LNG trading and this will enable MISC to develop its capability in the trading of multiple-sized vessels," stated the CEO. MISC's main client for charters is the Malaysian energy company and prominent LNG market participant Petronas. It currently charters most of MISC's LNG fleet comprising 28 LNG carriers and two floating storage units with a combined deadweight tonnage capacity of over 2 million dwt. "The delivery of 'LNG Portovenere' and 'LNG Lerici', will increase MISC's fleet of LNG carriers to 30," said the company. CEO Yeo added that the mid-sized LNG carriers also presented "unique opportunities" that support MISC's efforts to venture into non-conventional LNG shipping projects. "Upon expiry of the charter parties, these vessels will have the potential to be converted into mid-sized Floating Storage Regasification Unit (FSRU), Floating Storage Unit (FSU) or other alternative LNG floating projects," he explained. The LNG carrier acquisitions come as MISC's group revenue for the third quarter dropped 3.7 percent to 2.22 billion Malaysian Ringgit ($532.05M). Group operating profit came to 354.5M Ringgit ($84.7M) for the quarter, down 47.7 percent from the same quarter of 2017. MISC said the decrease was mainly from the Heavy Engineering segment as additional cost provisions were made for ongoing projects and additional costs incurred on conversion works.

PTT Exploration & Production, Thailand's state energy company, said the Mozambique LNG export project it is a part of is progressing well towards a final investment decision in the first half of 2019 as the joint venture partners sold more volumes. PTT E&P is a 10 percent shareholder in the Area 1 licence of the Rovuma Basin offshore the southeast African nation held by Anadarko Petroleum of the US. Other shareholders with PTT are Japanese trading house Mitsui & Co. and three Indian companies, Bharat Petro Resources, ONGC Videsh and Oil India Ltd., as well as the Mozambique state-owned oil and gas firm ENH. "PTTEP and its joint venture partners additionally secured a sales and purchase agreement with Tohoku Electric Power for 280,000 tonnes per annum and with Electricite de France, S.A. (EDF) for volumes of up to 1.2 million tonnes per annum to support the final investment decision, while first production is anticipated to commence in 2023," said PTT. PTT E&P had earlier reported net profits in the third quarter of 10.40 billion Thai baht ($315 million) with increasing sales volumes from the Bongkot natural gas and condensate field in the Gulf of Thailand. The Thai company acquired Royal Dutch Shell's 22 percent interest in the Bongkot field earlier in 2018 for $750M.

PTT E&P also boosted its nine-month performance by generating revenues of $3.96 billion, an increase of 22 percent compared with the same period of 2017. "Our strong operating performance reflected the success of our investment strategy to refocus on our key areas like Southeast Asia," said Phongsthorn Thavisin, PTT E&P Chief Executive. "Our increased stake in the Bongkot field, our core producing project, enabled higher sale volumes with immediate cash flow," added Thavisin. "We will keep prioritizing investments in strategic area through acquisitions in exploration blocks in petroleum prolific areas, both in the Middle East and Southeast Asia," stated the CEO. PTT E&P is also renewing its expiring concessions in both Bongkot and Erawan fields offshore Thailand. The company said it had solely submitted its bid for the Bongkot field, while partnering with United Arab Emirates-based Mubadala Petroleum in its bid for Erawan assets. PTT E&P said it was ready to be the operator in both fields.

REPSOL, the Spanish energy company, has completed its largest LNG bunkering operation by refueling a Canadian ship at the Cartagena import terminal in southeast Spain with 11 truckloads of fuel. The refueled Canadian vessel was the "Paul A. Desgagnes", the third in a series of four product carriers being built at the Besiktas shipyard in Turkey for the Desgagnes shipping company, based in Quebec City in Canada. The "Paul A. Desgagnes" is a tri-fuel vessel that can be powered by fuel oil, marine diesel oil or LNG. The newbuild is double-hulled and holds a Polar 7 ice-class confirming her capacity to navigate in ice-laden waters. Desgagnes said that the "Paul A. Desgagnes" represented an investment exceeding C$50 million (US$38M), of which almost C$9M was spent on the dual-fuel and LNG motorization.

With a deadweight of 15,000 tons and with 7.8 metres draft, the cargo tanks can hold up to 17,505 cubic metres. "Repsol has achieved another goal consolidating its position as LNG bunker spot supplier," said the Madrid-based company. "Developing the LNG bunker business, both on a spot and mid-term to long-term basis, is one of the key work areas of Repsol's strategy to provide solutions to its clients, adding LNG to its portfolio of bunker fuels," added Repsol. Repsol

coordinated and managed the operation in collaboration with companies such as the Spanish natural gas network and terminal operator Enagas and the Port Authority of Cartagena. The previous record LNG bunkering operation by Repsol had been the supply of 10 LNG truck-loads on the quayside to another Canadian newbuild on its way back to Canada, the "Mia Desgagnes".

RWE, the German energy utility, has signed a cooperation accord with Tokyo Gas of Japan on procurement of liquefied natural gas as well as trading and shipping activities. Tokyo Gas has a similar accord with UK energy and utility company, Centrica. The Japanese company has major long-term agreements with LNG production plants in the Asia-Pacific region, the Middle East and Mozambique, as well as with the new US LNG export facilities at Cove Point in Maryland and Cameron LNG in Louisiana. RWE, one of Europe's leading energy companies and based in the city of Essen, said the Tokyo Gas agreement was signed by its RWE Supply & Trading subsidiary. It is initially a memorandum of understanding for strategic cooperation. Among its LNG projects, RWE has reserved much of the regasification capacity at the first planned German LNG import terminal at Brunsbuettel on the Elbe River near Hamburg. "As the first concrete step under the MOU, a framework has been agreed for cost reduction through LNG shipping optimization utilizing the US LNG procured by Tokyo Gas," said RWE. "The discussion is underway towards concluding a legally binding agreement on this framework and is expected to be finalized shortly," said the German company. "The two companies will also increase the values of their portfolios through taking advantage of short-term trading opportunities," it added. RWE said it continued to expand its LNG activities across all regions as the global LNG market continues to grow.

"We are pleased to be entering into this agreement with Tokyo Gas which provides us with the opportunity to strengthen our ties with one of the most important LNG players in Asia," said Andree Stracke, Chief Commercial Officer of RWE Supply & Trading. "As new production comes online in the next few years, especially from the US, Europe will undoubtedly play a larger role as a key demand hub and we will continue to take advantage of these opportunities through LNG trading," added Stracke. Takashi Higo, Senior General Manager of Tokyo Gas's Gas Resources Department, said the Japanese company was delighted with the RWE cooperation accord. "Through the collaboration with RWE with its diverse LNG portfolio both in the Atlantic and Asian markets, we aim to expand flexible LNG transactions bridging Asia, North America and Europe," stated Higo. "It should contribute to price competitiveness and stability of our LNG supply and maximize the values for our customers," he added. In its agreement with the UK's Centrica, Tokyo Gas has signed a co-purchasing off-take agreement for delivered ex-ship (DES) supplies from the onshore Mozambique LNG export plant being developed in southeast Africa. That accord is with the Area 1 licence-holder of Rovuma Basin assets, Anadarko Petroleum of the US and its partners. Centrica and Tokyo Gas will provide the shipping and receive 2.6 million tonnes per annum from the start-up of production at the plant until the early 2040s.

SANTOS, the Australian liquefied natural gas LNG stakeholder, said the first feed-gas had been produced from the third and final well of the Bayu Undan gas and condensate field offshore northwest Australia for the Darwin LNG plant operated by ConocoPhillips. A final investment decision had been made in January 2017 as part of the long-term development plan for the Bayu Undan field located in the Timor Sea. The drilling programme consists of two platform wells and one subsea well connecting into existing offshore infrastructure. Santos said the delivery of the whole project was under budget and ahead of schedule. Santos holds an 11.5 percent interest in the Bayu Undan field as well as the Darwin LNG facility. Santos, which is operator of the Gladstone LNG plant in Queensland and a shareholder in the Papua New Guinea LNG plant and its expansion, also has a 25 percent interest in the Barossa gas field joint venture affiliated to Darwin LNG. "The Barossa gas field is currently in front-end engineering and design and is the leading candidate to backfill Darwin LNG when Bayu Undan production ceases," explained Santos. "Barossa would more than double Santos' production in Northern Australia with a final investment decision targeted for late 2019," added the Adelaide-based company.

The Darwin facility was the nation's second to come on stream in 2006 after Western Australia's North West Shelf plant operated by Woodside Petroleum. The single-Train Darwin plant ships its 3.7 million tonnes per annum of output to Japanese utilities. Santos Chief Executive Kevin Gallagher said the drilling campaign has been very successful, providing strong results, with the whole project having been executed at 40 percent below budget and the final well brought online more than three months ahead of schedule. "The program's success means that we have delivered higher liquids production and increased offshore well capacity," said Gallagher. "Operator ConocoPhillips has done an excellent job in executing such an efficient drilling program," he added. The wells were drilled with the Noble Tom Prosser rig, which has now been contracted by Santos to undertake a 2019 drilling program, including appraisal of the recent Dorado oil discovery offshore Western Australia.

SANTOS has received competition clearance from regulators for its US$2.15 billion takeover of Quadrant Energy whose operations are centred on Western Australia. The Australian Competition and Consumer Commission (ACCC) said in a statement that the acquisition would be unlikely to reduce competition in the supply of natural gas to Western Australia. "The ACCC considers that a combined Santos-Quadrant will continue to face strong competition from a range of suppliers, including large LNG producers such as Chevron and Woodside," said ACCC Chairman Rod Sims. "Most market participants believe the Western Australian domestic gas market is currently oversupplied. While the demand-supply balance could tighten in future, the ACCC considers that the proposed acquisition will not have a significant impact on future gas prices," the Chairman added. "In Western Australia, gas exporters are required to reserve 15 percent of their gas for the domestic market, so this should ensure that gas available for domestic customers continues to grow, and from a range of players," he explained.

Santos had announced its move for Quadrant in late August just weeks after its joint venture partner Carnarvon Petroleum discovered an oil field that was suggested to be the biggest discovery off Western Australia for more than 20 years. After the ACCC ruling Santos Chief Executive Kevin Gallagher said the Quadrant acquisition delivered increased ownership and operatorship of "a high-quality portfolio of low cost, long life conventional Western Australian natural gas" assets. "It is materially value accretive for Santos shareholders and advances Santos' aim to be Australia's leading domestic natural gas supplier," said the CEO. "We already have very significant growth projects across our five core assets, and Quadrant's recent oil discovery at Dorado is another exciting opportunity for us," added Gallagher. According to Santos, Quadrant proven reserves were around 220 million barres of oil equivalent. Quadrant's conventional natural gas assets include significant portfolio overlap with Santos holdings. The Quadrant portfolio of high-margin conventional domestic natural gas assets is backed by medium to long-term offtake contracts.

SAUDI ARAMCO, the Saudi Arabian oil producer and one of the world's largest companies by revenue, and Abu Dhabi National Oil Company have signed a framework agreement to explore opportunities for cooperation in the natural gas and liquefied natural gas sectors between Saudi Arabia and the United Arab Emirates. "The cooperation brings together two of the world's leading energy producers from the Arabian Gulf to work together in an area of strategic importance for both companies as they seek to boost revenues from the natural gas and LNG business segments," stated the companies. The agreement was signed by Ahmed Al Jaber, the UAE Minister of State and Adnoc Group Chief Executive and Amin Nasser, the Saudi Aramco President and CEO. Under the terms of the agreement, Adnoc and Saudi Aramco will jointly assess investment opportunities across the LNG value chain that could unlock value and drive revenue growth for both companies.

They will partner with each other on techno-economic feasibility studies and exchange knowledge and experience in LNG growth markets. "The UAE and the Kingdom of Saudi Arabia have a strong relationship built on shared strategic interests," said the UAE's Al Jaber. "Increased cooperation between Adnoc and Saudi Aramco will ensure greater energy security and long-term economic prosperity for both nations," he added.

The UAE is one of the oldest LNG producers from the Das Island plant offshore Abu Dhabi consisting of three

Trains with nominal capacity of 5.5 million tonnes of LNG per annum from associated and non-associated gases. The Das Island plant, commissioned in 1977, is run by Adgas, a subsidiary of Adnoc and mainly supplies Japan. The UAE is also an LNG importer at facilities in Dubai and Ruwais to help meet its own domestic gas needs. Saudi Arabia for its part has no LNG import nor export facilities, though natural gas demand in increasing in the Kingdom in line with economic development needs and the growing population. LNG is the fastest-growing hydrocarbon sector with a growth rate of 4 percent per annum. Global LNG demand is expected to exceed 500 million tonnes per annum by 2035, up from nearly 300 MTPA in 2017. "Our partnership with Adnoc continues to strengthen, after the recent decision to jointly develop a major refinery in India," said CEO Nasser of Dhahran-based Saudi Aramco. "We have shared strategic interest to expand our gas businesses, and this new agreement underlines our confidence in strong global gas demand growth," he added. "Our cooperation further supports the corporate transformation strategy of both Adnoc and Saudi Aramco to pursue opportunities that help unlock greater value for both companies and meet the growing needs of stakeholders around the world that depend on our energy to develop and grow their economies," explained Nasser.

SHELL and Santos, the operators of two LNG export plants in eastern Australia, Queensland Curtis LNG and Gladstone LNG, plan to work in partnership on new coal-seam gas acreage in the Surat and Bowen Basins. Santos and Shell plan to work in a 50-50 basis on the Petroleum Land Releases (PLR) 201718-2-5 licence covering around 400 square kilometres, located 19 kilometres east of the town of Surat. The acreage was opened by the Queensland state government exclusively to boost domestic gas supply on the East Coast. "The acreage is immediately south of the Wallumbilla hub which means the Santos-Shell joint venture can take advantage of existing infrastructure, lowering development costs and accelerating the delivery of natural gas to the domestic market," said Santos. Exploration in the new acreage will target natural gas in deep sandstone reservoirs of the Bowen Basin, beneath the Surat Basin. "If the results are positive, the Santos-Shell joint venture will potentially unlock a material new gas supply source for the Australian East Coast domestic gas market," Santos explained. Santos said it was on track to supply about 70 petajoules of natural gas, the equivalent of 1.67 billion cubic metres (Bcm), to the East Coast domestic market in 2018, which is almost 13 percent of expected demand this year.

"As Australia's lowest cost onshore natural gas developer, I am very pleased that Santos will be the operator to develop these blocks exclusively for the domestic market because low cost supply is the best way to put downward pressure on gas prices," said Santos Chief Executive Kevin Gallagher. "Santos has reduced connected well costs in Queensland by 84 percent and completed well costs in the Cooper Basin by 50 percent since 2015," added the CEO. "This has enabled us to drill a record 300 Gladstone LNG wells in Queensland this year and - 90 wells in the Cooper - the most wells in a year since 2014," said Gallagher. "Drilling more wells and lowering production costs, extracting more gas for less money, is good for competition and good for consumers," he stated. The CEO added that Santos appreciated the support of the Queensland government for the gas industry which is making Queensland communities stronger through jobs, small business opportunities, investment and economic growth.

SOUTH KOREA, the world's largest builder of liquefied natural gas carriers and other ships, has brought in a package of measures to help ease the financial pressures facing medium-sized shipyards, including confirmation of government backing for the ordering of 140 LNG-powered vessels. The South Korean Minister of Trade, Industry and Energy, Sung Yun-Mo, outlined the plans at a meeting of shipbuilders and industry associations in Seoul. The shipbuilding

industry has been emerging slower than expected from periods of losses caused by an industry-wide slump and increased costs. South Korea's three major shipyards, Hyundai Heavy Industries, Samsung Heavy Industries and Daewoo Shipbuilding & Marine Engineering, have experienced rises in new orders, especially for LNG vessels, though smaller yards are still experiencing difficulties. The new measures confirm plans for government backing for private companies to place orders for a combined 140 vessels powered by LNG by 2025, including at least two shops in 2019. "South Korean shipbuilders are expected to win new orders worth 12 million compensated gross tons (CGTs) this year, a level close to their 2014 records," said Minister Sung.

"A full-fledged recovery is expected to start in the second half of next year, when they begin work on new orders," added the minister. The government and the private sector plan to invest 2.8 trillion Korean won ($2.5Bln) by 2025 to build infrastructure for the operation of LNG-powered vessels, and some of this work will go to smaller yards. The minister said he expected the initial new orders to have a value of around 1 trillion Korean won ($880 million) for small and medium-sized shipyards. Under the measures, the government will also provide shipbuilders and suppliers with 700 billion Korean won ($620M) in new financing and roll over maturing loans and debt guarantees. In addition, the government will push to extend the period of special state support for employment in the shipbuilding industry by six months to June 2019. "The package may help local shipyards overcome their current crisis and take the top spot in the global shipbuilding industry, whose focus is shifting to eco-friendly and smart vessels," said Sung.

Diary of events

February
3rd Annual LNG USA Summit
26-27 February, 2019
Houston, Texas
www.lng-usa.com

April
19th International Conference & Exhibition on LNG
1-5 April, 2019
Shanghai, China
www.LNG19.com

May
Canada Gas & LNG Exhibition and Conference
21-23 May, 2019
Vancouver, Canada
www.canadagaslng.com

SWEDEGAS, the Swedish gas network operator and liquefied natural gas distributor, said its LNG bunkering station at the Port of Gothenburg is ramping up for growing demand expected from Nordic shipping companies as using clean-fuel also qualifies operators for lower port charges. The LNG bunkering facility is the first in Sweden that allows vessels to take fuel from a fixed pipeline as they load and discharge cargoes, reducing the turn around time in port. The Port Authority has also introduced an environmental discount on the port charge as part of a drive to increase the number of calls by vessels powered by LNG. "The discount has been a strong contributing factor behind many companies switching to LNG. In our endeavour to sustain this trend, we decided to extend the discount period by a further two years to 2020," said Jill Soderwall, Vice President of Business Energy at the Port. The International Maritime Organization's 0.5 percent sulfur cap on fuel is being introduced in 2020 while Sweden and its Nordic neighbour already operate in an Emission Control Area, encouraging the use of cleaner fuel such as LNG. The shipping company Terntank was the very first operator to take on LNG at the facility in Gothenburg, while liquefied biogas (LBG) made from waste has also been sold as fuel. "Being able to offer this unique opportunity represents a major breakthrough, not only in facilitating the transition to LNG, but also in gradually increasing the proportion of renewable gas," said Johan Zettergren, Chief Executive of Swedegas, which owns and runs the bunkering facility.

The LNG bunkering station is the only one of its kind in Sweden. Designed from the very outset to handle both LNG and LBG, which in terms of chemical composition are largely identical, makes the new facility flexible to meet the needs of the clean-fuel transition of the shipping sector. "LNG is the first step. The ambition to increase the volume of biogas has taken a new turn, as this technology and related infrastructure work equally well for both gases," said Tryggve Moller, Chief Executive of Terntank Ship Management, which has invested in LNG-powered vessels chartered by the North European Oil Trade (NEOT) Group. "We are delighted to be working with companies that are driving the industry forward and with a firm focus on promoting clean shipping," added Moller. The LNG and LBG that has been bunkered in Gothenburg was supplied by the Norwegian company, Barents NaturGass, which has long experience of gas distribution. "We are looking forward to being part of this unique concept where we can offer customers both LNG and LBG," said Gudrun Rollefsen, CEO at Barents NaturGass. Rollefsen added that the LBG was produced by FordonsGas at its facility in Lidkoping north of Gothenburg. "A green energy wave is gathering momentum in the marine sector, and we are looking forward to being part of this pioneering venture and continuing our close and fruitful collaboration," said Emil Glimaker, the FordonsGas CEO

TOTAL, the French energy major, said it was accelerating its expansion along the liquefied natural gas and gas value chains with a strategy based on strong growth in the LNG divisions. The strategy was outlined by Philippe Sauquet, President of Total's Gas, Renewables & Power division in a newsletter sent to Total shareholders and investors. "Commodities on the entire energy supply chain follow cycles, but if we are present along the entire supply chain, the impact of these cycles is more limited," said Sauquet. "We saw this happen with oil, when its price was halved in 2014-2015. The Upstream segment was under pressure, but our downstream business helped us to resist. We are following the same strategy in the gas chain," he stated. "Our integration starts quite high upstream on the gas chain that leads all the way to electricity, considering that 60 percent of all gas is used to generate electricity," explained Sauquet. Total is a world leader in LNG, with solid and diversified positions amounting to around 40 million tonnes. The French group is involved in LNG plants in Indonesia, Nigeria, Norway, Oman, Qatar, the United Arab Emirates, Yemen, Angola, Australia and Russia. Its most recent LNG joint venture production plants to come on stream are the Yamal project in the Arctic region of Russia and Ichthys facility in Australia's North Territory. Total noted that it was also present in renewable energies, which are expected to experience strong growth along with gas and LNG. Sauquet recalled that the acquisition of the LNG assets of French utility Engie allowed Total in 2017 to expand and reach a 10 percent global market share before the Yamal and Ichthys plants came on stream.

"Gas is the ideal complement to intermittent renewable sources of energy and offers many advantages in that it's abundant, flexible and contributes to reducing atmospheric pollution," the executive told shareholders in explaining the advantages of being an integrated gas chain player. "We are present all along the supply chain, from production, through liquefaction, trading and shipping where we hold the second position worldwide for LNG, regasification, where we are the major European player, all the way to gas and electricity marketing," he said. "Historically, in the gas business, we were mostly upstream, in production and liquefaction, and not as much downstream, because gas and electricity markets were organized as public service monopolies. But those markets then opened up to competition," explained Sauquet. "We are faced with Utility company competition, of course. These are often former public service monopolies, trying to defend their market shares," he said. "As far as we are concerned, we are not trying to be monopolies. We consider that competition is natural. Our advantage is not having old assets to manage such as coal-fired power plants," added Sauquet. The Total executive added that the company was seeking to develop new outlets in transportation for LNG and gas fuel. "To meet this objective, we purchased PitPoint, a Dutch company and the third natural gas vehicle fuel operator in Europe, and acquired 25 percent of Clean Energy, a leading supplier of natural gas for the trucking industry in the United States," he said. "We are also developing our activities in maritime transportation. Total signed an LNG supply contract with CMA CGM, a leading shipping group worldwide," he added. "LNG as a marine fuel will be boosted by new regulations set to be implemented on January 1, 2020, and designed to reduce air pollution. Besides new uses for gas, we are also trying to develop new gas markets in Africa and Asia, in countries with growing energy needs," said Sauquet.

TOTAL has been awarded a 40 percent concession by the Abu Dhabi National Oil Company, owner of the Das Island LNG export plant and other assets, in the Ruwais Diyab unconventional gas basin which Total says has the potential to be a high impact play ranking alongside the most prolific North American shale-gas plays. Under the terms of the agreement, Total will explore, appraise and develop the concession area's unconventional gas

resources. According to Total, the potential basin spreads over 6,000 square kilometres to the west of the prolific Adnoc onshore concession. Adnoc carried out the first well test six years ago by multi-stage acidic fracturing for the almost impermeable limestone and dolomite of the Diyab formation, which is believed to be the source rock of the emirate's oil fields. Sour gas currently represents Abu Dhabi's major potential source of additional and non-traditional gas supply. Adnoc, which recently announced a strategy to reach one billion cubic feet per day of unconventional gas production before 2030 and to extend LNG output to 2040, said it would retain a 60 percent stake in the Ruwais Diyab unconventional project. The Adnoc-Total agreement includes a six to seven-year exploration and appraisal phase which will then be followed by a 40-year production term. The accord was signed in Abu Dhabi by Ahmed Al Jaber, Adnoc's Group Chief Executive, and Patrick Pouyanne, CEO and Chairman of Total. "The historic unconventionals concession award is the first of its kind in the region," said both companies.

Al Jaber noted that Total was Adnoc's largest and one of its longest-standing international partners, having been active in Abu Dhabi's oil and gas sector since the late 1930s. "This concession agreement marks an important and historic milestone in the development of Abu Dhabi's gas resources, as we deliver our strategic commitment to ensure a sustainable and economical gas supply, in line with the directives of the United Arab Emirates leadership," said Al Jaber. "Total and Adnoc have agreed on commercial terms that will enable the project to deliver maximum value from our unconventional gas reserves as we work towards achieving gas self-sufficiency, for the UAE, and transition to having the capacity to become a net gas exporter," added the Adnoc CEO. "As Adnoc embarks on the exploration and development of Abu Dhabi's unconventional gas resources, it will undergo an accelerated learning curve which will help drive efficiencies in drilling and hydraulic fracturing and allow us to create higher value from what is a more challenging resource compared to the giant conventional oil and gas fields of Abu Dhabi." explained Al Jaber. Total CEO Pouyanne said he was pleased to be the first international company to pioneer unconventional gas exploration in Abu Dhabi alongside Adnoc. "We are committed to supporting the UAE in meeting its ambitions to unlock this significant unconventional gas resource," added Pouyanne. "The Diyab play has the potential to be a high impact play ranking alongside the most prolific North American shale gas plays and is an excellent addition to our exploration portfolio," stated the Total CEO. The new integrated gas strategy of the UAE, of which Abu Dhabi is the main oil and gas producer, will enable the nation to become gas self-sufficient and with the potential to become a net gas exporter. "In addition to developing the Ruwais Diyab unconventional gas concession, Adnoc will unlock and maximize value from its Hail, Ghasha and Dalma mega sour gas projects, as well as new natural gas accumulations which will continue to be appraised and developed," said the company.

TURKSTREAM, the natural gas export pipeline from Russia to Turkey, has completed its first offshore phase across the Black Sea, while the second onshore phase will deliver gas to the Turkish market and southern and southeastern Europe in competition to LNG. The TurkStream offshore section has just been completed and runs for 900 kilometres from the Russian town of Anapa across the Black Sea to Turkey and will supply Turkish domestic consumers. The Black Sea section will join an onshore pipeline for gas transit to Turkey's border with neighbouring countries. "TurkStream will substantially enhance the reliability of gas supply to Turkey, as well as to southern and southeastern Europe," said a statement from joint venture partners Gazprom and Botas Petroleum Pipeline Corp. of Turkey, who began the offshore section in May 2017. The first and second phases of TurkStream will each have throughput capacity of 15.75 billion cubic metres. The "Pioneering Spirit" pipe-laying vessel, the world's largest at a length of 477 metres, completed the construction of the offshore section in the Black Sea. The work was carried out by Allseas Group, the subsea company and owner of the "Pioneering Spirit" with its main offices in Switzerland and the Netherlands. The command to weld the final joint of the Black Sea gas pipeline section was given at a ceremony involving Russian President Vladimir Putin and Turkish President Recep Tayyip Erdogan.

The completion of the pipeline in 2019 is expected to put pressure on regional LNG suppliers to the three facilities in Turkey and others in southern Europe, as well as new terminals being developed in the Balkans in the future. Turkey was Europe's third-largest LNG importer last year after Spain and France when it received shipments from nations such as Algeria, Nigeria, Norway, Qatar and the US. The Turks are now among the largest consumers of Russian pipeline gas. At present, Russia supplies gas to Turkey via the existing Blue Stream and Trans-Balkan gas pipelines. Construction of TurkStream will continue in the months ahead and Gazprom said it expected to bring the pipeline into commercial operation before the end of 2019. "The swift pace of this project can be attributed to the concerted and coordinated efforts of the project team," said Alexei Miller, Gazprom Chairman. "In late 2019, the gas pipeline will be brought into operation. It will become an additional guarantee of energy security in Turkey and the countries of southern and southeastern Europe," he added.

US regulators have prepared a draft environmental impact statement for the Plaquemines LNG export plant proposed for the banks of the Mississippi River and its associated Gator Express Pipeline system. The Federal Energy Regulatory Commission said the draft EIS comment period would close on January 7, 2019. Venture Global is the company developing the Plaquemines plant on 630 acres of land near river mile-marker 55 on the west side of the Mississippi, 30 miles south of New Orleans. The Mississippi River project will produce 20 million tonnes per annum of LNG and will also include small-scale liquefaction Trains, four 200,000 cubic metres capacity LNG storage tanks and three marine loading berths. "The FERC staff concludes that construction and operation of the project would result in some adverse environmental impacts, but impacts would be reduced to less-than-significant levels with mitigation," it said. "However, the proposed project combined with other projects in the geographic scope could result in significant cumulative impacts on air quality," it noted. The EIS also stated that no dredging related to the LNG project would occur within the Mississippi River. Venture Global is run by joint chief executives Michael Sabel and Robert Pender and is in the FERC permit process for two Louisiana liquefaction plants.

The company is also developing the Calcasieu Pass facility on a 1,000-acre site at the intersection of the Calcasieu Ship Channel and the waters of the Gulf of Mexico. Calcasieu Pass will produce 10 MTPA of LNG. The proposed Plaquemines project would include two 42-inch-diameter pipeline laterals in Plaquemines Parish, Louisiana. The first is a 15.1-mile-long southwest lateral to the Tennessee Gas Pipeline (TGP) and the second is an 11.7-mile-long southwest lateral to the Texas Eastern Transmission (TETCO) Pipeline. "Venture Global would mitigate wetland impacts associated with the construction and operation of the proposed LNG terminal and the pipeline system," said the FERC. The FERC added that the company was also required to minimize impacts on environmental resources during construction and operation of the project. "An environmental inspection program would be implemented to ensure compliance with the mitigation measures that become conditions of the FERC authorization," the regulator stated.

VITOL, the global commodities company, is continuing to increase its liquefied natural gas trading volumes from international oil and gas companies and state-owned energy firms. Malaysian energy company Petronas, the first floating LNG producer offshore Sarawak and whose volumes include its own onshore liquefaction Trains at Bintulu with nine Trains as well as volumes in Australia and a stake in the LNG Canada project, has signed an agreement to supply shipments to Switzerland-based Vitol. Under the terms of the Petronas-Vitol deal, the commodities firm will start receiving 800,000 tonnes per annum of cargoes from Petronas for a period of 15 years starting in 2024. The cargoes will be shipped on Vitol-chartered vessels as well as on carriers provided by Petronas. "The primary supply to Vitol will come from LNG Canada as well as from the Petronas global LNG supply portfolio," said the Malaysian company. LNG Canada is a project being developed by Royal Dutch Shell near the town of Kitimat in British Columbia and Petronas holds a 25 percent stake in the joint venture whose other shareholders are PetroChina, Mitsubishi Corp of Japan and Korea Gas Corp.

"With a strong global supply portfolio, Petronas is able to provide flexible solutions within a changing and evolving LNG market," said Petronas Vice President of LNG Marketing and Trading, Ahmad Adly Alias. "Petronas is pleased to

sign this long-term LNG supply deal with Vitol and hopes that it will continue to enhance the long history of business collaboration with the Vitol Group," he added. Vitol's Head of LNG, Pablo Galante Escobar, said the commodities firm was pleased to sign its latest deal with Petronas to add to its volumes for trading that last year reached 7 million tonnes of LNG. "Petronas supplied our first LNG cargo in 2005 and we have now extended our LNG relationship until at least 2038," said Escobar. "Vitol is committed to the long-term development of the LNG market and its evolution to become a more flexible and tradeable commodity," he added. "This supply deal with Petronas will further strengthen our ability to offer reliable and flexible LNG solutions to customers worldwide," stated the Vitol LNG chief.

WINTERSHALL, the German oil and gas major, has purchased a 10 percent stake in the Ghasha natural gas mega-project in Abu Dhabi in the United Arab Emirates, boosting the future merger between Wintershall and Deutsche Erdoel AG (DEA) set for 2019. Abu Dhabi National Oil Company (Adnoc), which also produces LNG at the Das Island plant in the Gulf and is extending output until 2040, said that in return for its stake Wintershall would contribute 10 percent of the project capital and operational development expenses. The value of the Adnoc-Wintershall transaction has not been disclosed. The Ghasha sour gas project is expected to produce more than 1.5 billion cubic feet of gas per day. The Ghasha concession the Germans are buying into also includes the Hail and Dalma offshore sour gas fields. "Germany's largest crude oil and natural gas producer joins Italy's Eni as a partner with Adnoc in the project," said Adnoc. Eni was awarded a 25 percent stake in the Ghasha concession earlier in November. "The agreement marks the first time a German oil and gas company has been awarded a stake in an Abu Dhabi concession area and underscores Adnoc's objective to expand and diversify its strategic partnership base," said the UAE company. The concession agreement, which has a term of 40 years, was signed by Ahmed Al Jaber, UAE Minister of State and Adnoc Chief Executive, and Mario Mehren, CEO of Wintershall. "This builds on Adnoc's new integrated gas strategy, targeted to unlock and maximize value from Abu Dhabi's substantial, available gas reserves, as the UAE moves towards gas self-sufficiency and aims to transition from a net importer of gas to a net gas exporter," stated Adnoc. "Wintershall has extensive experience of appraising and developing ultra-sour gas resources in technically complex fields," explained the UAE company. "It is a partnership in which each company will benefit from the experience of the other as, together, we optimize costs and ensure we extract the maximum value from all the available gas resources," it added.

The Ghasha ultra-sour concession will tap into the Arab basin, which is estimated to hold multiple trillions of standard cubic feet of recoverable gas. Wintershall CEO Mehren said he was delighted to be a partner in this project, supporting Adnoc's growth strategy. "The project also fits excellently with our strategy. We have been working since 2010 on strengthening the Middle East region by investing here and developing it into another growth region for Wintershall," added Mehren. "Wintershall is particularly qualified for the offshore operations in the Ghasha concession. We are experts in drilling technically demanding wells and developing fields efficiently. And we know precisely what counts in ecologically sensitive areas," explained Mehren. Mehren will also head the combined Wintershall DEA combination that will be the merger of Wintershall, currently owned by German chemicals and energy group BASF, and DEA, a subsidiary of LetterOne, the investment vehicle of Russian billionaire Mikhail Fridman. The merger is expected to be completed early in 2019 and the company would operate under the name Wintershall DEA. Analysts said the merger gives Germany a higher profile energy company in a sector where it has lagged behind other nations, given the dominant size of its economy in the European Union. Until 2019 closing of the transaction, Wintershall and DEA are continuing to operate as independent companies. The combined business of Wintershall and DEA had pro-forma sales last year of 4.7 billion euros ($5.47Bln), and net income of 740 million euros. Maria Moraeus Hanssen, the Norwegian CEO of DEA, will be deputy CEO and Chief Operating Officer of the Wintershall DEA entity.

WOODFIBRE LNG, the Canadian venture in the district of Squamish in British Columbia, has reached a final agreement with the Squamish First Nation, giving the native people benefits of more than C$225 million (US$170M) in cash over the planned 40 years of operations. The project is backed by Singapore-based Pacific Oil & Gas Ltd, part of the Royal Golden Eagle Group, and has full regulatory permit approvals in place. The liquefaction plan will be built on the site of a former pulp mill at Squamish, north of Vancouver, and is licensed to export more than 2 million tonnes per annum of LNG. The relatively small-scale project is expected to begin building in the first quarter of 2019 and to start commercial operations in about four years' time. "As a company, we are pleased to have fulfilled another key condition of the Squamish Nation's environmental certificate," said Woodfibre Vice President Byng Giraud in relation to the agreements passed by the Squamish First Nation Council. "We believe the Squamish Nation process and the resulting conditions are an important pathway to economic reconciliation," he added. The First Nation Council voted to support the project by eight votes to six and requires Woodfibre to meet 25 legally binding environmental conditions. "The next steps will be holding the proponents accountable through the construction, operation and decommissioning of the Woodfibre LNG project," said the First Nation Council statement. "This includes environmental, cultural, employment, and training conditions. As agreed by the proponents, we will be co-developing management plans for the project and will have our own monitors on the ground to report any non-compliance," explained the First Nation.

"Similar to other levels of government that benefit economically from the project, the Squamish Nation as a government will share in the economic benefits this project offers," it added. "Revenue collected from this project will go to the Squamish Nation and contribute to programs and services it operates for its members. In addition, there will be jobs and training opportunities and spin-off business opportunities for members," stated the Council. The Squamish project is one of the few moving forward on the Canadian West Coast where more than a dozen were previously planned. The largest with approval permits and planning to produce more than 20 MTPA is the LNG Canada joint venture involving Royal Dutch Shell and its major Asian partners, PetroChina, Mitsubishi Corp. of Japan and Korea Gas Corp. Woodfibre has already chosen US energy project construction company KBR Inc. for the engineering work on its plant. The selection of KBR for the engineering phase followed the completion of a competitive front-end engineering and design tender process. Woodfibre has additionally signed a preliminary supply deal with a subsidiary of the largest Chinese LNG importer, China National Offshore Oil Corp. ■

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Australia emerges as largest LNG exporter with Prelude FLNG start and more to come from Pluto

Shell, Inpex and Woodside have taken nation to No. 1 spot over the past year and more gas resource investment is planned

Australia has overtaken Qatar as the world's largest exporter of liquefied natural gas for the first time in November, according to data, though will not be the largest on an annual basis until the end of 2019.

According to export figures, Australia shipped 6.79 million tonnes of LNG while Qatar exported 6.20MT during November.

Australia's LNG exports jumped by more than 15 percent from the previous month, while Qatar's exports dropped by 3 percent.

Key project

The start-up of the Ichthys project in the Australian Northern Territory near the port of Darwin in October 2018 placed the nation in a position to overhaul Qatar as the world's biggest producer.

Annualised LNG production in October had hit 76 million tonnes per annum, while total LNG capacity reached an annualized 79.7 MTPA with the start of Train 1 at Ichthys.

This exceeded Qatar's nominal capacity of 77 MTPA and at the end of 2019, Australia's annual exports will formally surpass the Qatari total.

Australian LNG production began to surge after the start-up of the Chevron-operated Wheatstone LNG plant in Western Australia in 2017 following on from the previous coming on stream of the Gorgon plant on Barrow Island, also in Western Australia and operated by Chevron.

Wheatstone, with a total capacity of 8.9 MTPA, was the eighth LNG project to be completed in Australia and also helped put the nation on track to overtake Qatar.

The Ichthys plant has now pushed Australia ahead at year-end and since then the Prelude floating LNG venture offshore northwest Australia, developed by Royal Dutch Shell, has also come on stream.

Qatari expansion

However, the Australian leadership in global LNG is likely to last only about five years as the Qataris have a planned expansion project.

Qatar will take its output to more than 100 MTPA when three liquefaction Trains with 7.8 MTPA each of output are completed by 2024, while a fourth Train is proposed in a second phase.

The new Qatari onshore facilities will receive about 4.6 billion standard cubic feet per day of feed gas from the southern sector of Qatar's North Field, which is the largest single non-associated gas field in the world.

The Shell-led Prelude FLNG venture is adding 3.6 MTPA of LNG to Australian output and is the nation's 10th LNG plant.

Shell and minority shareholders, including Inpex Corp. of Japan, said at the end of December 2018 that the gas wells had been opened and the initial phase of production had commenced.

Prelude is the first deployment of Shell's FLNG technology and comprises a 488-metre long floating facility extracting and liquefying gas at sea before it is exported to customers.

The project hull is located about 475 kilometres north-northeast of the town of Broome in Western Australia.

Anchored

It is anchored in the Browse Basin and is the world's third FLNG venture to start operations after one developed by Petronas of Malaysia and a second offshore Cameroon in West Africa.

For the Shell project, the Concerto gas field and the nearby Prelude field, with combined resources of around 3 trillion cubic feet, are being used to produce the LNG.

The Prelude joint venture is owned 67.5 percent by Shell and 17.5 percent by Inpex.

A further 10 percent is held by LNG buyer Korea Gas Corp. and 5 percent by CPC Corp. of Taiwan.

The project's start is the eighth new LNG development for Australia in 10 years.

Inpex noted that most of its share of Prelude FLNG production, amounting to 560,000 tonnes per annum, would be supplied to Japanese company Jera Co. Inc and the balance to Shizuoka Gas of Japan.

Inpex is also expected to eventually expand the Ichthys plant for its northwest Australian gas field assets.

The Pluto plant will host the development of the Scarborough gas field now operated by Woodside. Four engineering contracts have been awarded

The Shell's Prelude hull, built by Samsung Heavy Industries, has been designed to withstand the most powerful tropical cyclones. It will remain permanently moored at the Australian location for at least 20 years.

The hull is attached to a mooring system in 250 metres of water by four groups of chains. Each chain will be held to the sea floor by piles.

A series of seven production wells will send feed-gas and condensate from the reservoirs via four flexible risers into the facility.

Meanwhile, Woodside Petroleum has awarded a contract to US engineering company Bechtel to carry out front-end engineering design work for the expansion of the Pluto LNG export plant in Western Australia.

Bechtel is best known in Australia for leading the engineering and construction of three coal-seam-gas-to LNG plants on Curtis Island in Queensland.

Woodside said the FEED work for the Pluto facility on the Burrup Peninsula includes final costings and technical definition for the proposed second LNG Train at the plant.

The Pluto plant was started up in 2012 and currently has one Train operating with nameplate capacity of 4.8 MTPA and 240,000 cubic metres of storage.

The Australian company said the award also included an option for Woodside to progress to a lump-sum engineering, procurement and construction contract.

"This option is subject to, among other conditions, a positive final investment decision being taken on the project," said Woodside.

Woodside Chief Executive Peter Coleman said the decision to enter the FEED phase for the Pluto Train 2 project was a significant step towards progressing with the Burrup Hub, a regional LNG production centre in the northern part of Western Australia.

"Our Burrup Hub vision is taking shape as we work with Bechtel to progress the Pluto Train 2 Project, which will create a pathway for the globally cost-competitive development of Western Australian gas resources," said Coleman.

Feed-gas

The Pluto Train 2 Project will underpin Woodside's preferred concept for the development of the offshore Scarborough gas field with 7.3 trillion cubic feet of gas in place.

Woodside is operator of the Scarborough field with a 75 percent stake after acquiring a 50 percent shareholding in 2018 from ExxonMobil. The minority shareholder in the field licence is Australian commodities company BHP Billiton.

Woodside added that the second LNG Train at the Pluto site would have a targeted capacity of 5 MTPA and the project would also involve installation of domestic gas infrastructure.

The Perth-based company is targeting its investment decision for 2020 and is scheduling the start-up for 2024. ■

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Experts question suitability of current European norm for construction of large-scale LNG tanks

Dr. M. Krol, N. Bruckhaus, P. Weidner and T. Waas of Linde AG Engineering Division, Tank Design Group

Natural gas has attracted wide attention as a clean energy source with reduced environmental impact in combustion compared to other fossil energy sources like oil or coal.

In line with the worldwide increased demand for LNG, installation of new large-scale, aboveground type LNG tanks with sizes up to 200,000 cubic metres and more are in discussion for Europe, as well.

Regulations

The authors will review and interpret the technical state-of-the-art regulations existing in Europe for the design and construction of large-scale LNG storage tanks.

They will also summarize results of studies, executed tank projects, interpretations and arguments on why the application of the European Norm (EN 14620) for large-scale LNG storage tanks should be scrutinized.

By reviewing selected definitions of EN 14620 and EN 1473, the authors also take reference to the British Standard and American regulations and norms available for the design and construction of LNG storage tanks.

The main part of this study reviews the decisions taken during the evolution from the BS 7777 into the European Norm (EN 14620).

Starting with Seveso directive as the superordinate regulation for installations operated within the European Economic Area (EEA) and considering the fact that Europe is a densely populated zone where major accident could cause serious consequences to human health and environment, the Seveso III Directive 2012/18/EU of the European Parliament and Council of 4 July 2012 "lays down rules for the prevention of major accidents which involve dangerous substances, and the limitation of their consequences for human health and the environment, with a view to ensuring a high level of protection throughout the Union in a consistent and effective manner."

Directives

All Seveso directives classify LNG as dangerous substance and requests that EEA member states "ensure that appropriate precautionary action is taken to ensure a high level of protection throughout the Union for citizens, communities and the environment."

Further on, the Seveso III directive requests with Article 5, clause 1 "that the operator is obliged to take all necessary measures to prevent major accidents and to limit their consequences for human health and the environment." [1] [2], [3].

By following the superordinate Seveso directive, tank designer and operator are obliged to comply with EN 1473 "Installation and equipment for liquefied natural gas - Design of onshore installations" which does not take direct normative reference to Seveso Directives, but refers under definition of "hazard" and "Safety Management System" to it. Considering the EN 1473 as applicable for installation of LNG storage facilities within the EEA, this regulation refers under normative references and chapter 6 "Storage and retention systems" to EN 14620.

However, it should be mentioned that additional national regulations within the member states of the EEA might be applicable in addition to EN 1473 and EN 14620. For example, Germany requires also compliance with the Major Accident Ordinance of the Federal Emission Control Act (BImSchV), and other regulations.

Avoid confusion

For the avoidance of misunderstandings, it should be mentioned that this article does not intend to be understood as instruction how to build a large-scale LNG storage tank.

However, it shall highlight selected definitions and analyze the philosophy behind in the present EN 14620 edition.

Following the European regulations, the EN 14620 applies for the design and construction of LNG storage tanks within the EEA. The present EN 14620 standard consists of five parts as shown with Table 1. Table 2 indicates a brief overview and relation of the three most common LNG tank codes under consideration of subcategories and the related regulation landscape of the particular code.

For the preparation of this paper part 1 and 2 of EN 14620 had been reviewed carefully under comparison of other tank regulations like part 1 and 2 of BS 7777 including PD 7777:2000, basic section of API 620 plus annex P and Q including API 625. Additionally, the basic design calculation of the Japanese LNG tank code JGA 108 has been considered.

EN 14620-1	Part 1: General
EN 14620-2	Part 2: Metallic components
EN 14620-3	Part 3: Concrete components
EN 14620-4	Part 4: Insulation components
EN 14620-5	Part 5: Testing, drying, purging and cool-down

Table 1: structure of EN 14620:2006

	EN 14620	BS 7777	API 620
General	Part 1	Part 1	Refer to API 625
Metallic Components	Part 2	Part 2	Basic section & Annex Q
Concrete Components	Part 3	Part 3	Refer to ACI 376
Insulation Components	Part 4		Refer to API 625
Testing & Commissioning	Part 5	Part 1	Basic section & Annex P

Table 2: Comparison of most common codes for LNG storage tanks

Relevance of EN 14620

Considering the fact that presumably the biggest number of all LNG full containment steel tanks worldwide are designed and built according to API standards 620 & 625 and NFPA 59A, the relevance of the EN 14620 as state-of-the-art guideline seems to be limited. Up to now, there are only a few large-scale LNG tanks designed and built according to EN 14620 and brought into operation.

Therefore, the feedback and experience from the practise is very limited for the EN 14620. Comparing with other accepted tank design and construction codes like the British Standard BS 7777 or the API standards API 620 with 625, the EN 14620 should be recognised as a very "young" and "unexperienced" regulation. This is also supported by the fact that the present edition of EN 14620 represents still its first version without any revision since published in September 2006.

In comparison to this, the American standards used for design and construction of LNG storage tanks are subject to continuous maintenance procedure.

For instance, in the period between 2006 and 2018 the API 620 standard was available in the tenth edition with addendum one and has been revised five times, and API 625 published as first edition in 2010 had been reworked twice, to date.

However, the authors of this paper understand that the EN 14620 shall be an evolution of the well-established BS 7777

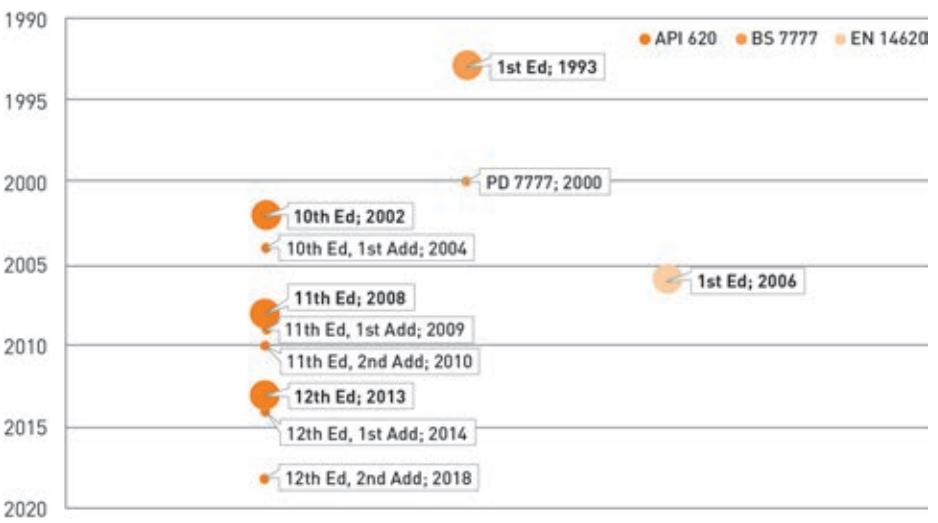

Figure 1: Revision history of selected LNG tank codes

in combination with the published document PD 7777:2000. [4]

Past codes

To comprehend the development of the EN 14620 it is deemed to be important to review the situation of codes and standards in Europe in the past.

First, BS 7777 obviously served as a basis for the EN 14620. Second, it should be stated that the EN 14620 represents a European industry standard formed through a process of compromises between the participating national representatives and finally passed the voting process through the national councils of the EEA members.

Second, the development of European standards should be understood as an agreement between experts delegated from operators, designers, authorities, technical associations, manufacturers, universities and others.

Third, it should be noted that the time for the development of a European standard is usually very limited and it is very unlikely that all necessary experts are available exactly at the time of the code development and evolution, respectively.

Additionally, the latest request by the European Commission to shorten the time for the development of standards without provision of funds by the EU does not improve the technical level.

Fourth, for the review and revision of a European norm a positive majority is needed by the members of the CEN (European Committee for Standardization) voting for. Otherwise, there will not be any legalized activity possible for the improvement of the related standard. At this point it might be worth glancing at the North American way of standardization, where a continuous maintenance of the applied standards is in place.

Missing continuity

In the authors' view the missing continuity regarding maintenance of the standard is one of its biggest disadvantages.

Even, if the reality provides important feedback from the design, construction and operation of tank installations complying with EN 14620 there is no procedure in place ensuring implementation of experiences or correction of mistakes.

Risk assessment

Besides the applicable design code, an important decision for and within an LNG storage project will be the verification of the appropriate storage concept. The selection of the storage concept and the consequent tank system integrity will have direct impact on the Authority approval process and the final investment decision.

Possible LNG storage concepts are addressed in the EN 1473 and implemented in the EN 14620. These storage concepts are single, double or full containment.

The main tank technologies used for LNG storage containments are the self-supporting 9%Ni-steel tank, the membrane tank and the concrete tank. By the way, EN 1473 does not permit penetrations of the primary and secondary container base or walls for LNG storage tanks.

The definition of the storage concept must be part of a thorough risk assessment. By executing the risk assessment, it shall be demonstrated that the risk is acceptable, both inside and outside the storage area boundary.

Following part 1 of the EN 14620, the risk assessment can be carried out either by means of a probabilistic or deterministic approach. The deterministic approach was already used in the BS 7777.

Criteria

Since the deterministic approach for risk assessment of LNG storage tanks had been commonly used within Europe in the past and due to that this method is still favoured by certain authorities and in particular in Germany. The typical storage concept for LNG storage in Europe is the full containment type with a nine percent nickel inner tank and a pre-stressed concrete outer tank.

However, many member states of the EEA are going to or do already accept the probabilistic approach as the state-of-the-art method for risk assessments of LNG facilities. For the execution of a probabilistic risk assessment it is crucial to refer to acceptance criteria.

Such criteria describe the accepted limit of risk to human health and environment agreed by the society in the respective country. Unfortunately, only national but no European regulations list these acceptance criteria, to date.

An overview of acceptance criteria is indicated for selected European countries through the North American regulation NFPA 59A with figure A.15.10.

For the execution of the risk assessment and the selection of the adequate storage concept and derivation of further design consequences of LNG storage tanks it should be recognized that the EN 1473 as the superordinate regulation for the installation of LNG facilities within the EEA defines that loss of containment must be considered as a credible scenario.

STRESS	Applied design stress level of the metal structure
MATERIAL	Material properties regarding resistance against crack initiation and propagation, and capability of arresting a running crack
IMPERFECTIONS	Existence of cracks; Stress concentration caused by construction; Residual welding stresses

Table 4: Three factors are dominant for evaluation of brittle fracture

Wondering about what reasons of a loss of containment in the primary container could be, the authors studied the BS 7777 and recognized, beside others, that "major metal failure" caused by brittle fracture should be subject of investigation in the risk assessment.

Although, there is common understanding between tank design experts that consideration of appropriate selection for base and weld filler material, supposed to be used in low-temperature storage like LNG, must be treated with utmost attention.

Neither EN 1473 nor EN 14620 request an investigation for a brittle fracture-safe design. For understanding why the current European norms for installation of LNG storage tanks do not ask for it, the authors of this paper started an extensive research of available literature to retrace the results and the philosophy regarding toughness requirements for low-temperature storage tanks at the time when the EN 14620 had been developed.

For the review of the brittle fracture resistance philosophy in the EN 14620, numerous reports which were mainly published during the 1960's to early 1990's and which are assumed as basis for the development of PD 7777:2000 had been studied.

One of the most important sources were the reports which resulted out of a multi-national research program organized and sponsored by the U.S. American Gas Research Institute (GRI), today part of the US Gas Technology Institute (GTI), with co-sponsoring from 13 European, Japanese and other US organizations.

Through 1982 to 1986, the GRI sponsored an experimental and analytical research program to examine the performance of nine percent nickel steels and their welds under LNG storage conditions. Many papers and fracture toughness tests are derived from the GRI research program. For an overview of studied references please refer to the bibliography.

Brittle fracture resistance

The occurrence of brittle fracture in steel structures is caused by conditions which support the fracture initiation and the propagation of a crack towards the inherent material property to arrest a running crack.[5] For the evaluation of brittle fracture aspects in metal structures, three main factors are dominant, as such (see above table 4):

With regard to a brittle fracture-safe design for large-scale LNG storage tanks these factors will be described in the following.

Applied design stress

As mentioned above, one important factor for the evaluation whether a metallic tank structure is sufficiently safe against the risk of catastrophic brittle failure is the amount of external stresses applied in service.

For understanding of the applied design stress, the authors assumed a large-scale LNG tank with main technical data for the primary container as shown in Table 3.

It can be seen in Figure 2 that for the design of the wall thickness in the bottom shell course according to API 620, PD 7777:2000 and JGA 108 the maximum allowable design stress in service is governing.

Primary Container	
Stored product	LNG
Specific product gravity	0.48
Net working capacity	200'000 m³
Geometric volume	209'000 m³
Tank diameter	80.0 m
Shell plate height	3.5 m
No. of shell courses	12
Shell height	42.0 m
Design liquid level	41.5 m
Design over-pressure	0 mbar-g
Corrosion allowance	0 mm
Seismic loads	N/A

Table 3: Assumed technical data for 200,000 cubic metres capacity LNG storage tank

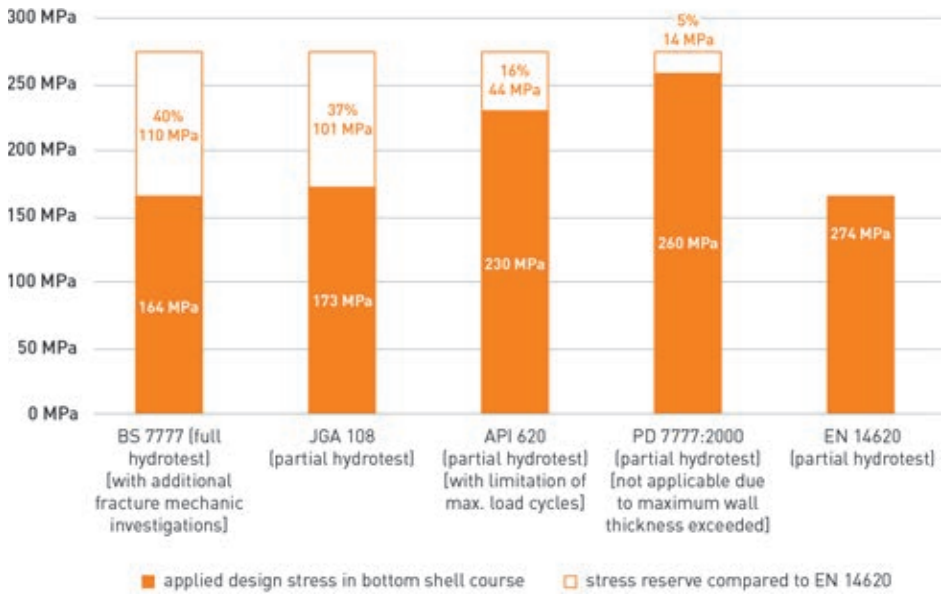

Figure 2: Design stress comparison and stress reserve versus EN 14620

For bottom shell course thickness verification according to BS 7777 and EN 14620 the maximum allowable design stress under hydrostatic test condition is determining.

However, it must be highlighted that in comparison of the absolute values the highest applied design stress is observed for the EN 14620 with 274 MPa.

The lowest applied design stress value in this theoretical comparison is given with 164 MPa by the rules of BS 7777 followed by the Japanese regulation JGA 108 with 173 MPa.

According to literature [7], [8], [5] fracture initiation in metallic structures cannot be avoided in an absolute sense during the lifetime of a cryogenic tank due to inhomogeneity in material and potentially possible abnormal conditions like extreme life cycles, vibrations of in-tank pumps, earthquake, or others.

Therefore, it is of importance that sufficiently tough surrounding material can arrest such initiated, growing cracks. A low stressed structure is one factor of an adequate crack arrest approach.

Consequently, the applied design stress level as shown with Figure 2 should be considered as a significant integrity factor of the LNG tank system.

Material Properties

Another factor for a brittle fracture-safe design is the behaviour of the selected material. Design codes for LNG storage tanks identify preselected steels which shall provide adequate material toughness in low-temperature service as required like for LNG storage systems.

For LNG, the predefined steel for the metal structure is typically a nine percent nickel-alloyed steel grade. It becomes obvious that the production process for steels in low-temperature service with high brittle fracture toughness is depending on certain parameters, as such:

1. Steelmaking process according to either quenching and tempering (Q&T) or a thermo-mechanical controlled process (TMCP) during rolling;
2. Limitation of impurities like sulphur and phosphorus;
3. Strict compliance with standardized chemical and mechanical properties;
4. Production based upon comprehensive and repetitive processes verified continuously by means of a certified quality assurance and control program.

These general requirements to the steelmaking process of selected steel grades are defined by the known design and construction codes for LNG storage tanks; refer to [9], [10], [11].

However, the selected material shall provide sufficient resistance against crack initiation and inherent capability for arresting a brittle crack.

Crack initiation

There is a matter of fact that the fracture initiation approach using conventional Charpy impact energy requirement became dominant in the tank building industry. The two main reasons for this were that fracture initiation conditions are inherently simpler to define, and there was a significant cost-penalty associated with steels capable of arresting fast running cracks.

Although, the fracture initiation approach has proved generally successful there have been a number of significant failures which showed that this approach is not fail-safe. [12] As already mentioned, crack initiation can occur due to upset or accidental conditions. Therefore, the capability of the adjacent area around an initiated crack to arrest the propagating crack is important.

Welding electrode

According to the studied literature the proper use of welding filler material can achieve the lowest embrittled zone.

For LNG storage systems, the welding electrode must be highly nickel-enriched. BS 7777 2 defined for the selection of welding consumables for LNG tanks that "the minimum average impact energy for the weld metal for types IV and V is based on the high nickel, austenitic weld metal. In the event of weld metal being offered in composition matching that of 9% nickel plate, additional specialist advice should be obtained."

Unfortunately, EN 14620 does not provide similar definitions for the selection of the adequate welding electrode for LNG tanks.

Crack arrest

For the verification of the material property of arresting a fast propagating crack, different methods are available. An excellent overview about crack arrest tests and experiments is provided with [12]. According to [12] crack arrest test methods may be divided in three categories:

1. Large-scale, structurally representative tests
2. Small-scale tests which correlate empirically with crack-arrest properties
3. Small-scale, fracture mechanics-based crack-arrest toughness tests

Large-scale crack arrest tests

Large-scale experiments have been carried out to model the geometry and the loading of the actual structure as close as possible. If the test set-up is such that the conditions of the actual structure can be modelled, the experiment is described as 'structurally representative'. With respect to crack-arrest, two main types of large-scale tests are used:

a) Component testing, as such:
- Pipe burst tests
- Thermal shock experiments of pressure vessels

b) Wide plate testing as such:
- Robertson test
- ESSO test
- Double tension test (improved ESSO test developed in Japan)
- Short crack arrest test

For the evaluation of tank structures, the wide plate double tension and short crack arrest tests are regarded as the most reliable experiments. "Because of their cost, these tests are normally employed as validation test for fracture assessment purposes or to establish correlation with standardised small-scale tests." [12]

Empirical small-scale crack arrest tests

Typical empirical small-scale tests which have been used to describe crack arrest properties. Such small-scale empirical tests are standardized in relevant national and international test specifications.

- Charpy V-notch impact energy test; standardised for example by ASTM E23
- Instrumented Charpy V-notch impact energy test; standardised for example by ASTM E2298
- Drop-weight tear test; standardised for example by ASTM E436
- Drop-weight ("Pellini") test; standardised for example by ASTM E208 or EN 10274
- Dynamic tear test; standardised for example by ASTM E604

It is explained in [12] that the most suited small-scale test to characterise crack arrest behaviour available at this time is the "Pellini" drop-weight test. The PD 7777:2000 used the same for its concept of crack arrest capabilities of selected tank materials.

As opposed to the large-scale, structurally representative tests, the predictive capabilities of small-scale tests rely on empirical correlations based on experience.

This means that developed correlations must be re-established for new materials but also for the applied range of thickness. For example, the application of reduced hydrotest filling height according to PD 7777:2000 [4] was based on reference to material investigations which do not exceed shell wall thicknesses of 19 mm for LNG storage service.

However, it should be noted that these empirical small-scale tests assume a correlation between the test result and the actual material property for stopping a running crack. Charpy V-notch impact test and drop-weight tear test are not direct indicators of crack-arrest toughness.

It should be noted that the Charpy V-notch and drop-weight tear test are measuring the driving force needed to initiate and propagate a crack, while crack-arrest tests measure the driving force to stop a running crack.

Especially for the conventional Charpy impact test, the correlation between the measured impact energy and the material capability for crack arrest should not be treated as close.[12]

In terms of fracture toughness, EN 14620 is requesting for Charpy V-notch impact testing, only. Several publications including ASTM E23 standard for notched bar impact testing of metallic materials say that only for some materials and temperatures the results of Charpy V-notch impact tests have been found to predict the likelihood of brittle fracture accurately. [7], [8], [5]

Small-scale fracture mechanics-based crack arrest tests

For the sake of completeness, fracture mechanics-based crack arrest tests should be mentioned as well. These tests are similar in size to empirical small-scale tests. The aim of using fracture mechanics-based crack arrest tests is to produce a crack arrest event in relatively small, inexpensive specimens and use fracture mechanics principles to calculate the applied stress intensity factor at arrest. Typical fractur mechanics-based crack arrest tests are:

- Double cantilever beam test
- Tapered double cantilever beam test
- Compact crack arrest (CCA) test
- Moment modified compact tension test

"All fracture mechanics-based crack arrest tests are aimed at obtaining crack arrest toughness values." [12] It should be noted that these tests are not considered as simple due to the fact that most of these tests are affected by dynamic effects and the calculation of the actual crack arrest value requires the involvement of experts in fracture mechanics.

Of these tests, the CCA test has been standardised by ASTM E1221, but, due to its complexity fracture mechanics-based crack arrest tests are not considered in tank building industry.

PD 7777

On May 15th, 2000, the PD 7777:2000 came into effect which had been developed and published by the British Standards Institution (BSI), and which should be read in conjunction with BS 7777.

Although not regarded as British Standard, PD 7777:2000 provided the opportunity of reducing the full height hydrostatic test down to a water level sufficient to impose a stress in the bottom course equivalent to 1.25 times the design stress arising from product hydraulic loading.

But this option was bound to more stringent requirement for material selection and fracture toughness concept which is briefly described for LNG storage as follows:

1. Nine percent nickel steels shall be certified in accordance to EN 10028-4 which are produced either by a thermo-mechanical controlled process (TMCP) or by quenching and tempering (Q&T).
2. The steelmaker shall provide evidence that produced heats of nine per cent nickel steel have got an NDTT of -196 °C based on the 'Pellini' drop weight test in accordance to ASTM E208. [13]
3. The maximum allowable wall thickness for the storage of LNG is limited to 19 mm. [14]

With respect to the limitation of the maximum wall thickness in PD 7777:2000 the authors of this paper reviewed once more the publications derived from the GRI program carried out through 1982 to 1986. It can be seen in [15], [5], [14] that the maximum thickness of used specimens was limited to 28 mm.

Wall thickness

For larger thicknesses, there are no data available. However, following the literature, it should be noted that the found material property of arresting a brittle crack is related to the wall thickness of the tested specimen.

With the results of the GRI research program it had been demonstrated that nine percent nickel-alloyed steel grades with thicknesses not exceeding 28 mm can provide high crack arrest values. [15] However, PD 7777:2000 requires a fracture toughness investigation in case the maximum wall thickness exceeds 19 mm.

Furthermore, the GRI results, summarized by Mounce [15], indicate that the applied stress level has got a significant impact on the found crack arrest value of the test plate. Specimens verified by means of a compact crack arrest test have shown that the crack arrest behaviour is significantly decreasing by a factor 2 to 3 with an increase of the applied stress from 160 MPa to 260 MPa.

Construction imperfections

After reviewing the applied stress situation and the material properties in terms of brittle fracture-safe design, the third main factor remaining would be the consideration of constraints resulting out of fabrication and construction imperfections. Due to the nature of tank construction, which applies usually under non-ideal and sometimes harsh conditions, it should be understood as a process which is accompanied with certain imperfections.

These construction imperfections could result from welding deficiencies, construction tolerances, potential inhomogeneity of the base material or, not to ignore, human errors. For example, local stress raisers, local brittle zones, welding residual stresses or flaws could cause local crack initiation.

Hydrostatic test

One factor in the fracture mechanics analysis is the assumption of residual stresses in the welded metallic tank structure. It is commonly known that residual stresses must be considered existent in welded constructions like steel storage tanks. But, there is no exact determination in place which allows conclusion for the actual value of such residual stresses. However, it iscommon practice and understanding that residual stresses can be reduced by means of the hydrostatic test.

At this point, it should be highlighted that the execution of the hydrostatic test can support two factors of brittle safe tank design. One, would be a reduction of the applied stress level in case the used design code and tank dimensions result in a way that hydrostatic test condition is dimensioning the applied wall thickness of the metal container. Another, is the fact that the hydrostatic test will significantly reduce the level of residual stresses in the metallic tank structure.

Last but not least, it should be noted that EN 14620 extended the maximum allowable wall thickness for tanks in LNG service to 50 mm with partial hydrostatic test and without describing any requirement for fracture toughness verification of the used materials.

For comparison BS 7777 allows maximum 30 mm thickness with a full hydrostatic test and asks for "additional requirements to maintain the same level of safety" [9] in case the maximum wall thickness is exceeded. PD 7777:2000 specifies 19 mm as the maximum wall thickness with partial hydrostatic test and dropweight testing in accordance with ASTM E208.[4]

Welding flaws

Beside residual stresses, it is further important to understand the acceptable level of welding flaws. The definition of acceptance criteria for the testing of the weld seams by means of non-destructive examinations is essential in two ways. One, is the judgement of the brittle fracture-safe design approach. The other, is related to economic considerations how long detected welding deficiencies need to be repaired to achieve acceptable conditions.

With respect to the stipulations in the EN 14620, there are no acceptance criteria defined for ultrasonic examination which is

The aim of using fracture mechanics-based crack arrest tests is to produce a crack arrest event in relatively small, inexpensive specimens and use fracture mechanics principles to calculate the applied stress intensity factor at arrest

considered as the most preferred volumetric test method of the main tank weld seams, today.

Conclusions

The authors of this paper tried to understand how the current version of the EN 14620 had been evoluted from the BS 7777 in conjunction with the brittle fracture philosophy described by PD 7777:2000.

For this purpose, the authors studied numerous publications resulting from international researches regarding crack initiation and crack arrest of materials used for LNG storage tanks.

Furthermore, main design aspects had been studied comparing different LNG tank design codes on an exemplary 200,000 cubic metres capacity LNG storage tank.

It had been found that:

- EN 14620 is still valid in its first edition which let assume no feedback from the reality,
- EN 14620 represents the LNG tank code with the highest applied stress level,
- EN 14620 does not consider a concept for the selection of materials based on crack arrest behaviour,
- EN 14620 extended the maximum allowable wall thickness to 50 mm for LNG service without asking for additional requirements,
- EN 14620 reduces the hydrostatic test level generally from full to partial test height without additional measures,
- EN 14620 does not provide fracture mechanics-based acceptance criteria for ultrasonic examination,
- EN 14620 does not provide information how to achieve a brittle fracture-safe design,
- EN 14620 does not provide requirements for the qualification of new materials with maybe improved properties.

Unfortunately, the authors came to the conclusion that EN 14620 lost in some essential questions the ideas of the BS 7777 and the PD 7777:2000.

Further, available knowledge about brittle fracture considerations have not been implemented into EN 14620. Applied alternative solutions have not been adequately formulated which might be based on believing rather than technical knowledge and understanding.

With respect to the Seveso directive, compulsory for industrial installations within the EEA, the authors doubt that EN 14620 complies with Seveso's main requirement that all necessary measures are taken to prevent major accidents.

The EN 14620 is currently under revision by the CEN technical committee TC 265. The authors wish and hope that the original ideas of the BS 7777 along with current knowledge in brittle fracture toughness will be re-considered and implemented in the first revision of EN 14620.

An excellent example of a comprehensive approach to the qualification of a brittle fracture resistant material had been presented by a group of Japanese experts with [16].

These Japanese experts explained which base measures in steelmaking and material testing are recommended to demonstrate that the new seven percent nickel TMCP steel grade can be considered as appropriate for the installation of a new 230,000 cubic metres capacity aboveground LNG tank for Senboku Terminal 1 of Osaka Gas Co. ■

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LNG sector is continuing to change amid growing demand in Latin America and the Caribbean

Law firm Baker Botts gives overview of diversity of region's natural gas economies. This is part Part II of extracts continued from the previous edition

There is a significant diversity in the gas economies in Latin America and the Caribbean and a dynamic interaction between LNG imports and other factors, including changes in domestic gas production, gas pipeline imports, hydro power generation levels, seasonal gas demand, and other factors.

There are opportunities for other nations in the region to follow Jamaica in their adoption of LNG (LNG Journal November-December edition).

Operations at the AES-backed Costa Norte project in the Central American nation of Panama

Proposals

One of those countries in particular is El Salvador and it has already announced plans to import LNG.

El Salvador does not have any LNG import terminals. It is no stranger, however, to LNG proposals.

Houston-based Cutuco Energy announced plans more than 10 years ago to construct a 525 MW LNG-to-power project at La Union port in El Salvador, though that project was not developed.

Since then, Energía del Pacifico (EDP) has proposed the development of a 355 MW LNG-to-power project in Acajutla, El Salvador.

EDP has signed an LNG supply contract with Royal Dutch Shell and 20-year power purchase agreements (PPAs) with seven power distribution companies.

According to EDP, it expects to select an FSRU supplier in the near future then finalize financing commence operations in 2020.

Components

Most of the key components in the development of EDP's project are falling into place and the most significant outstanding component appears to be the financing.

Whether an LNG-to-power project like EDP's project can be financed depends on a variety of factors, but key requirements typically include:

- Long-term PPAs with creditworthy power purchasers;
- LNG supply arrangements that align with the terms of the PPAs, with an LNG supplier that is creditworthy or otherwise can provide assurances that it will perform;
- Terminal and power plant engineering procurement and construction (EPC) agreements, typically lump-sum turn-key, with creditworthy or otherwise acceptable EPC contractors;
- FSRU charter or other contractual arrangements, if an FSRU will be utilized, with a world-class FSRU provider;
- All governmental permits and approvals;
- All land leases, purchases, and rights-of-way;
- Full sponsor support and equity commitments, and sufficient local support of the project.

Should any of these requirements fail to be satisfied, LNG-to-power projects like EDP's project can face significant delay and potentially never achieve a final investment decision (FID). So far, EDP's project looks promising.

The sole LNG import terminal in Puerto Rico is the Ecoelectrica Penuelas LNG terminal, an LNG-to-power project with a 263 MW combined cycle power plant.

The Ecoelectrica Penuelas LNG terminal also fuels the Costa Sur power plant. In addition, Excelerate Energy has proposed the Aguirre Offshore GasPort, for delivery of regasified LNG to the Central Aguirre Power Complex.

It is no secret that Puerto Rico's power sector is not doing well. Hurricanes Irma and Maria in 2017 only exacerbated the problems, which "The Economist" noted in 2018 were caused by, among other things, lack of proper maintenance, declining revenues, political patronage, corruption and inefficiency. That presents challenges for developing new LNG terminals, which in the past have focused on supplying gas to power plants and in the near future would likely continue this focus.

There is also the poor credit of the current counterparty for any LNG or LNG-to-power project, the Puerto Rico Electric Power Authority (PREPA), which further complicates investments.

Getting past these problems will require, at a minimum, well-designed legal reforms that get to the heart of the problems and encourage economic behavior that allows long-term improvements.

In the absence of such legal reforms, the LNG import industry in Puerto Rico appears unlikely to grow in the near future.

Panama

Panama inaugurated its first LNG terminal in 2018. The AES Colón LNG-to-power project is located near the Atlantic Ocean entrance to the Panama Canal.

The LNG-to-power project includes a 381 MW power plant. The project won a power tender in a competition against other fuel types.

As discussed above in connection with its Andres terminal in the Dominican Republic, AES plans to use the Colón project for delivering ISO containers and providing LNG trans-shipment services.

The delivery of ISO containers is particularly interesting given Colón's location next to the Panama Canal. For many years, containers have been transported across Panama not only on cargo ships traveling the Panama Canal, but also by being unloaded at one end of the Panama Canal, transported by train to the other end of the Panama Canal and loaded onto a different cargo ship at the other end.

The same approach could be taken with ISO containers, subject to obtaining any approvals necessary to transport LNG by rail and subject to such activities being permitted in Panama.

That means that any ISO containers filled at the Colón terminal could potentially be delivered in the Caribbean, loaded on a cargo ship and shipped through the Panama Canal, or transported to the Pacific coast of Panama via train.

AES also plans to utilize the Colón terminal for bunkering LNG-fueled ships.

Thousands of ships transit the Panama Canal each year, and the number of LNG-fueled ships in-service and on-order globally has increased in recent years, hitting the 200 mark in March 2017.

This number is expected to increase further in the next two years, in light of the International Maritime Organization (IMO)'s reduction in the global sulfur limit from 3.5 percent m/m (mass/mass) to 0.50 percent m/m effective January 1, 2020 which is expected to cause more ships to convert to LNG as a fuel.

The Colón terminal appears to be well-positioned to supply LNG to those ships.

Other LNG-to-power projects have been discussed in Panama, including one that was proposed by LNG Group Panama, but the Colón project appears to

be the only LNG terminal under active development or construction.

Colombia

The nation of Colombia is seeking a back-up to hydro power. Colombia is an active producer and consumer of natural gas.

From 2006 and 2007, Colombia produced approximately the same quantities of gas that it consumed. Then, starting in 2008 and continuing through 2015, Colombia was a net exporter, producing more gas than it consumed.

By 2016, however, the tide had changed and Colombia had become a net importer.

What changed in 2016? Late in 2016, the LNG terminal in Cartagena de Indias, Colombia, commenced operations.

The terminal, developed by Sociedad de Portuaria El Cayao (SPEC), is on the Atlantic Ocean side of the country and consists of an FSRU and 10km pipeline connecting to Colombia's gas pipeline system.

The terminal has been installed primarily to fuel existing gas-fired power plants, particularly in years with low rainfall when less power is produced by hydro, and is designed to fuel up to 2,000 MW of gas-fired power generation capacity.

Colombia is also eyeing a second LNG terminal, this time on the Pacific Ocean side of the country. The new import terminal is to be located in the port of Buenaventura. It will serve a 2,000 MW gas-fired power plant and be connected to Colombia's gas pipeline system.

Brazil

Brazil has three LNG import terminals developed by Petrobras: the Pecem Port, Guanabara Bay and Bahia LNG terminals. As with Colombia's Cartagena LNG terminal, one of the primary purposes of Brazil's three terminals is to keep the lights on in years with low hydro power production.

Historically Petrobras's three regasification terminals have served to pump regasified LNG into the national pipeline system and have had one customer: Petrobras.

In late 2016, however, Total acquired capacity at Petrobras's Bahia LNG regasification terminal.

Other LNG projects have recently been announced or progressed. In early 2017, Norwegian aluminum company Norsk Hydro announced plans to develop an LNG import terminal and replace fuel oil with LNG at its Alunorte alumina refinery.

In June 2017, Prumo Logistica agreed to acquire the proposed 1,238 MW Novo Tempo LNG-to-power project from Bolognesi Energia, and more recently Prumo received regulatory approval to take control of that proposed project and move it to Porto de Acu in Rio de Janeiro state.

Prumo has also announced plans to build the proposed 1,672 MW Porto de Acu 3 LNG-to-power project, based on Prumo's successful bid in Brazil's energy auction in late 2017.

One project under construction is the Porto de Sergipe LNG-to-power project, with its proposed 1,500 MW power plant.

That project is being developed by Cetrais Electricas de Sergipe (CELSE), owned by EBRASIL and Golar Power. The project achieved a final investment decision in 2016, and the power plant is being constructed by General Electric pursuant to a lump sum turn-key EPC contract.

The project has chartered the FSRU "Golar Nanook" for a 25-year period. The project will be purchasing 1.3 MTPA of LNG from Ocean LNG, a joint venture of Qatar Petroleum and ExxonMobil.

These projects reveal a current trend in Brazil's gas economy: LNG import terminals are being developed to service specific, nearby customers with dedicated end users, whether power plants, alumina refineries, or otherwise.

They are no longer being developed to pump additional gas into the national gas pipeline system, nor is it likely that additional LNG terminals will be built anytime soon to accomplish the same.

Argentina

Argentina has two LNG import terminals, the Bahia Blanca GasPort and GNL Escobar GasPort. Both terminals are run by Enarsa, the state-owned oil and gas company. Enarsa recently considered a third terminal but ultimately scrapped those plans last year.

If a third terminal is added in the future, it would likely be installed primarily to service seasonal demand during the winter.

Enarsa is currently the sole customer of both terminals. That could change soon, however, as Argentina's government has called for public input on proposed regulations that would allow third parties to import LNG through the two LNG import terminals in Argentina. LNG imports in Argentina serve to supplement domestic production and imports from Bolivia, particularly during the winter.

The pilot programs in Vaca Muerta (shale basin) and their expansion into full-scale production are not without their challenges. Labor costs are high, driven in part by labor union requirements.

There is also a need for greater investment in midstream infrastructure; while currently gas transportation capacity is generally sufficient for current levels of production, substantial investments will be needed for gas gathering, processing and transportation facilities to move full-scale production volumes of gas from the wellhead to the market.

The transportation of gas between Chile and Argentina is a relatively new concept, as exports of gas from Argentina to Chile were cut off by Argentina in the mid-2000s.

More recently, however, under President Macri's leadership, the pipelines were opened back up, and in May 2016, Chile began exporting regasified LNG to Argentina on the GasAtacama and Gas Andes pipelines, to support Argentina's higher winter demand.

Argentina hopes to be exporting gas back to Chile during its summer months, starting in the 2018-2019 summer.

The growth in unconventional gas production and the new gas pipeline imports from Chile are good developments for Argentina, but they appear insufficient to displace LNG imports in Argentina in the near term.

Chile

Chile has two LNG import terminals and at least three proposed terminals under development.

The two existing terminals are GNL Quintero, located near Santiago, and GNL Mejillones, located in the northern region of Chile.

Proposed projects include the GNL Penco and Central El Campesino LNG-to-power project and Talcahuano import project, both of which are to be located in the Bay of Concepcion, and the LNG-to-power project under consideration by Shell and Mitsui near Vallenar.

Conclusion

LNG imports and import facilities in Latin America are constantly changing in response to changes in domestic gas production, gas consumption and gas pipeline imports and exports, as well as a number of other factors. A summary of this paper's conclusions, on a country-by-country basis, are as follows:

1. In **Mexico**, the key question is how quickly Mexico will build out its natural gas pipeline network to ensure it can transport US shale gas to the many demand centers throughout Mexico.
2. In the **Dominican Republic,** ISO container deliveries and trans-shipment services look to grow in the near term, subject to satisfactory economics.
3. **Jamaica** is an example of active conversion to LNG and may act as a model for certain countries in Central America in the future.
4. **El Salvador** is seeing good advancements on its proposed LNG-to-power project and the key next step is to obtain financing.
5. **Puerto Rico** needs well-designed legal reforms to address the problems with its power sector, before it is likely to see growth in its LNG industry.
6. **Panama** looks to be a good location for ISO containers and LNG bunkering, but it is not likely that any additional LNG terminals will be developed in the near term.
7. **Colombia** is looking to LNG as a back-up to hydro power and seems likely to need to build additional LNG import terminals in the next five to 10 years, in addition to the existing Cartagena terminal and proposed Buenaventura terminals, to ensure enough spare terminal capacity is available for LNG to continue to serve as a back-up to hydro power.
8. **Brazil** offers opportunities for LNG-to-power developers that win a local power tender and for other special-purpose applications, but importing LNG for the sale of regasified LNG into the national pipeline system will continue to be challenging until Brazil revises many burdensome regulations and tax laws.
9. **Uruguay** looks to remain quiet unless and until domestic gas consumption increases.
10. **Argentina** is likely to continue importing LNG but may eventually reduce its reliance on LNG imports as gas production in the Vaca Muerta expands.
11. **Chile** is not likely to see any new LNG-to-power projects emerge from future power tenders in the near term, as renewables continue to take center stage. ■

This article is based on extracts from the paper entitled:"The Dynamic Role and Future of LNG Imports in Latin America and the Caribbean" by David Jetter, Partner, Baker Botts LLP and was presented at recent conferences

World LNG Carrier Fleet

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
Abalamabie	174,900	Bonny Gas	Samsung	June-16	Bermuda	DFDE	TZ Mk III	4	Nigeria LNG
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	210,185	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
Aseem	154,850	K Line-Petronet	Samsung	Nov-09	Malta	S	GT No 96	4	Qatar-India
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 Venture	160,000	Chevron	Samsung	Sept-17	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
Boris Vilkitsky	172,000	Dynagas	Daewoo	Oct-17	Cyprus	DFDE	GT No. 96	4	Various
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
BW Integrity	170,000	BW Gas	Samsung	May-17	Singapore	DFDE	TZ Mk. III	4	FSRU
BW Pavilion Leeara	161,880	BW Gas	Hyundai	Feb-15	Singapore	DFDE	TZ Mk. III	4	Various
BW Pavilion Vanda	161,880	BW Gas	Hyundai	Feb-15	Singapore	DFDE	TZ Mk. III	4	Various
BW Singapore	170,000	BW Gas	Samsung	May-15	Singapore	DFDE	TZ Mk. III	4	FSRU
BW Suez Paris	162,400	BW Gas	Daewoo	May-09	N.I.S.	DFDE	GT NO 96	4	Yemen-Atlantic
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
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
Cape Ann	145,000	Hoegh LNG/MOL	Samsung	May-10	Liberia	DFDE	TZ Mk. III	4	Various
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
Cesi Beihai	174,100	MOL-China LNG	Hudong	June-17	Hong Kong	S	GT No 96	4	Australia-China
Cesi Gladstone	174,100	MOL-China LNG	Hudong	Oct-16	Hong Kong	S	GT No 96	4	Australia-China
Cesi Lianyungang	174,100	MOL-China LNG	Hudong	June-18	Hong Kong	S	GT No 96	4	Australia-China
Cesi Qingdao	174,100	MOL-China LNG	Hudong	Nov-16	Hong Kong	S	GT No 96	4	Australia-China
Cesi Tianjin	174,100	MOL-China LNG	Hudong	Sept-17	Hong Kong	S	GT No 96	4	Australia-China
Challenger FSRU	263,000	MOL LNG	Daewoo	Oct-17	St Kitts	DFDE	GT No. 96	4	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
Christophe de Margerie	172,600	SCF	Daewoo	Nov-16	Cyprus	DFDE	GT NO 96	4	Various
Clean Energy	150,000	Dynagas	Hyundai	Mar-07	Marshall Is.	S	TZ Mk. III	4	Various
Clean Force	150,000	Dynagas	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
Creole Spirit	174,000	Teekay	Daewoo	Jan-16	Bahamas	MEGI-DF	NO. 96 GW	4	Cheniere
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
Diamond Gas Orchid	165,000	MOL-Jera	MHI-Nagasaki	Aug-18	Japan	S-gas	Moss	4	US-Japan
Diamond Gas Rose	165,000	MOL-Jera	MHI-Nagasaki	Aug-18	Japan	S-gas	Moss	4	US-Japan
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
Eduard Toll	172,000	Teekay-CLNG	Daewoo	Dec-17	Bahamas	MEGI-DF	GT No. 96	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 Atlantic	159,924	Alpha	STX Jinhae	Sep-15	Malta	DFDE	No. 96	4	Various
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 Glory	165,000	Tokyo LNG Tankers	JMU	Sept-18	Japan	S	Moss	4	Various
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
Esshu 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
Fedor Litke	172,636	Dynagas	Daewoo	Nov-17	Cyprus	DFDE	GT No. 96	4	Various

Flex Endeavour	173,400	Flex LNG	Daewoo	Jan-18	Marshall Is.	MEGI-DF	NO. 96 GW	4	Various
Flex Enterprise	173,400	Flex LNG	Daewoo	Jan-18	Marshall Is.	MEGI-DF	NO. 96 GW	4	Various
Flex Rainbow	174,000	Flex LNG	Samsung	July-18	Marshall Is.	MEGI-DF	NO. 96 GW	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 Geneva	174,000	GasLog	Samsung	Sept-16	Bermuda	TFDE	TZ Mk. III	4	Shell charter
Gaslog Gibraltar	174,000	GasLog	Samsung	Oct-16	Bermuda	TFDE	TZ Mk. III	4	Shell charter
Gaslog Glasgow	174,000	GasLog	Samsung	Jun-16	Bermuda	TFDE	TZ Mk. III	4	Shell charter
Gaslog Greece	174,000	GasLog	Samsung	Mar-16	Bermuda	TFDE	TZ Mk. III	4	Shell charter
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 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
Gigira Laitebo	177,000	MOL-Itochu	Hyundai	Feb-09	Panama	DFDE	TZ Mk. III	4	Various
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/CPP	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	QatarGas
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 Esperanza FSRU	170,000	Hoegh	Hyundai	April-18	Norway	DFDE	GTT MIII	4	Various
Hoegh Gallant FSRU	170,050	Hoegh LNG	Hyundai	May-14	Marshall Is.	DFDE	TZ Mk. III	4	chartered
Hoegh Giant FSRU	170,050	Hoegh LNG	Hyundai	Jan-18	Marshall Is.	DFDE	TZ Mk. III	4	various
Hoegh Grace FSRU	170,050	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
Kumul	172,000	MOL	Hudong	May-16	Hong Kong	DRL	GT NO. 96	4	PNG-Asia
Lalla Fatma N'Soumer	145,000	Algeria Nippon Gas	Kawasaki Sakaide	Dec-04	Bahamas	S	Moss	4	Various
Lijmilya	261,700	QGTC	Daewoo	Sep-08	Marshall Is.	DRL	GT NO. 96	5	Various
LNG Abalamabie	174,900	Bonny Gas	Samsung	Nov-16	Bermuda	DFDE	TZ Mk III	4	Nigeria LNG
LNG Abuja	126,530	Bonny Gas Transport	GD Quincy	Sep-80	Bahamas	S	Moss	5	Nigeria LNG
LNG Abuja II	174,900	Bonny Gas	Samsung	Oct 16	Bermuda	DFDE	TZ Mk III	4	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 Juno	177,300	MOL-Osaka	Mitsubishi	Oct-18	Marshall Is.	DFDE	Moss	4	Freeport LNG/Various
LNG Jupiter	145,000	NYK Line	Kawasaki	Jul-09	Bahamas	S	Moss	4	Various
LNG Jurojin	155,300	MOL	MHI Nagasaki	Nov-15	Japan	S	KM	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 Mars	155,000	MOL/Osaka Gas	Mitsubishi	Oct-16	Marshall Is.	S	Moss	5	Various
LNG Ogun	148,300	NYK Line	Samsung	Aug-07	Japan	S	TZ Mk. III	4	Nigeria LNG
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
Macoma	173,400	Teekay	Daewoo	Oct-17	Bahamas	DFDE	GT No. 96	4	Various
Madrid Spirit	138,000	Teekay LNG Partners	IZAR Puerto Real	Jan-05	Spain	S	GT No 96	4	Engas
Magdala	173,400	Teekay	Daewoo	Feb-18	Bahamas	DFDE	GT No 96	4	Various
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 Achilles	174,000	Maran	Hyundai Samho	Feb-16	Greece	DFDE	GT No 96	4	Various
Maran Gas Agamemnon	174,000	Maran	Hyundai Samho	May-16	Greece	DFDE	GT No 96	4	Various
Maran Gas Alexandria	161,870	Maran	Hyundai Samho	Sep-15	Greece	DFDE	TZ Mk. III	4	Various
Maran Gas Amphipolis	173,400	Maran	Daewoo	Aug-16	Greece	DFDE	GT No 96	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 Hector	174,000	Maran	Hyundai Samho	Nov-16	Greece	DFDE	GT No 96	4	Various
Maran Gas Lindos	159,800	Maran	Daewoo	Jun-15	Greece	DFDE	GT No. 96	4	Various
Maran Gas Mystras	155,900	Maran Gas	Daewoo	May-15	Greece	DFDE	GT No 96	4	Various
Maran Gas Olympias	174,500	Maran	DSME	Feb-17	Greece	DFDE	GT No 96	4	Various
Maran Gas Pericles	174,000	Maran	Hyundai Samho	June-16	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 Roxana	173,400	Maran	Daewoo	Jan-17	Greece	DFDE	GT No 96	4	Various
Maran Gas Sparta	161,870	Maran	Hyundai Samho	April-15	Greece	DFDE	G TZ Mk. III	4	Various
Maran Gas Spetses	174,000	Maran	Daewoo	Feb-18	Greece	DFDE	GT No 96	4	Various
Maran Gas Troy	155,900	Maran Gas	Daewoo	May-15	Greece	DFDE	GT No 96	4	various
Maran Gas Ulysses	174,000	Maran	Hyundai Samho	Jan-17	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
Marvel Eagle	155,000	MOL-Osaka	Kawasaki	Sept-18	Marshall Is.	S	Moss	4	Cameron LNG/Various
Matthew	126,540	Suez LNG Shiping	Newport News	Jun-79	Bahamas	S	TZ Mk. I	6	Atlantic LNG
Mekaines	266,000	Naklilat	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	Naklilat	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
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
Mourad Didouche	126,130	Hyproc Shipping	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-Atlantic Basin
Murex	173,400	Teekay	Daewoo	Oct-17	Bahamas	DFDE	GT No 96	4	Various
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
Neptune	145,000	Hoegh LNG/MOL	Samsung	Dec-09	Liberia	DFDE	TZ Mk. III	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
Noshu Maru	180,000	MOL-Jera	MHI-Nagasaki	Feb-19	Japan	S-gas	Moss	4	US-Japan
Oak Spirit	173,400	Teekay	Daewoo	Jan-16	Bahamas	MEGI-DF	NO. 96 GW	4	Cheniere
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
Ougarta	171,866	Hyproc Shipping	Hyundai	Mar-17	Algeria	DFDE	GTT Mk III	4	Sonatrach
Pacific Arcadia	147,200	NYK Line	MHI	Oct-14	Bahamas	S	KM	4	Various
Pacific Breeze	182,000	K Line	Kawasaki	Mar-18	Marshall Is.	DFDE	Moss	4	Ichthys LNG
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 Mimosa	155,300	NYK Line	MHI	Nov-17	Bahamas	S	Moss	4	Australia-Japan
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
Pan Americas	174,000	Teekay	Hudong	Mar-18	Hong Kong	TFDE	No. 96 GW	4	US-Asia
Pan Asia	174,000	Teekay	Hudong-Zhonghua	July-17	Bahamas	TFDE	NO. 96 GW	4	Cheniere
Pan Europe	174,000	Teekay	Hudong	Sept-18	Hong Kong	TFDE	No. 96 GW	4	US-global
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
Prachi	173,000	NYK-SCI	Hyundai	Nov-16	Singapore	TFDE	GT No 96	4	Petronet
Provalys	153,500	Gaz de France	Chantiers	Nov-06	France	DFDE	CS1	4	ELNG
Pskov	170,200	SovComFlot	STX	Mar-14	Liberia	DFDE	GT No. 96	4	Various
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	Hyproc Shipping	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
Rioja Knutsen	176,300	Knutsen	Daewoo	Dec-16	Nor-NIS	DFDE	TZ Mk III	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
Seri Camar	150,200	MISC	Hyundai	Feb-18	Malaysia	S	Moss	4	Petronas
Seri Camellia	150,000	MISC	Hyundai	Nov-16	Malaysia	S	Moss	4	Petronas
Seri Cemara	150,200	MISC	Hyundai	Apr-18	Malaysia	S	Moss	4	Petronas
Seri Cempak	150,200	MISC	Hyundai	Feb-18	Malaysia	S	Moss	4	Petronas
Seri Cenderawasih	150,000	MISC	Hyundai	Jan-17	Malaysia	S	Moss	4	Petronas
Sestao Knutsen	138,000	Knutsen	IZAR Sestao	Jan-07	Spain	S	GT NO 96	4	Atlantic LNG
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 Audace	180,000	SK-Marubeni	Samsung	Jul-17	Panama	DFDE	TZ Mk. III	4	Various
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
Tessala	171,866	Hyproc Shipping	Hyundai	Dec-16	Algeria	DFDE	GTT Mk III	4	Sonatrach
Torben Spirit	173,000	Teekay	Daewoo	Feb-17	Bahama	MEGI-DF	No 96 GW	4	Various
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
Vladimir Rusanov	172,000	MOL-China Shipping	Daewoo	Mar-18	Hong Kong	DFDE	GT No 96	4	Yamal
Vladimir Viz	172,000	MOL-China Shipping	Daewoo	Sept-18	Hong Kong	DFDE	GT No 96	4	Yamal
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 Cheney	174,000	Maran	Hyundai Samho	Mar-16	Greece	DFDE	GT No 96	4	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 Reeswithers	173,400	Maran	Daewoo	Nov-16	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	Storage 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	4	640,000
	Dalian	PetroChina	2011	3	480,000
	Dapeng ND Guangdong	CNOOC	2018	4	640,000
	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, Zheijang	CNOOC, Zhejiang Energy	2012	3	480,000
	Qidong, Jiangsu	Guanghui Energy	2018	1	60,000
	Qingdao, Shandong	Sinopec	2014	3	480,000
	Rudong	PetroChina	2011	3	530,000
	Shanghai	CNOOC, Shenergy Group	2009	3	495,000
	Shanghai, Mengtougou	Shanghai Gas	2008	3	120 000
	Shenzen, Diefu	CNOOC	2016	2	320,000
	Tangshan, Hebei	PetroChina	2013	3	480,000
	Tianjin North	Sinopec	2017	2	320,000
	Yuedong, Guangdong	CNOOC	2016	2	320,000
	Zhoushan Zhejiang	Enn Group	2018	2	320,000
	Zhuhai, Gaolan	CNOOC	2013	3	480,000
Dominican Republic	Punta Caucedo	AES Andres	2003	1	160 000
Finland	Pori	Gasum Skangas	2016	1	30,000
	Tornio	Gasum Skangas	2018	1	30,000
France	Fos Tonkin	Elengy	1972	3	150,000
	Montoir-de-Bretagne	Elengy	1980	3	360,000
	Fos Cavaou	Engie, Total	2010	3	330,000
	Dunkirk LNG	EDF, Fluxys, Total	2016	3	570,000
Gibraltar	Gasnor	Shell	2018	1	5,000
Greece	Revithoussa	DEPA	2000	3	225,000
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
	Mundra	Gujarat State Petroleum, Adani Group	2018	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	3	600,000
	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

LNG Import Terminals (continued)

Country	Location (Project)	Owners	Start up	Storage Tanks	Storage Capacity
	Sakaide	Shikoku Electric, Cosmo Oil	2011	1	180,000
Japan (continued)	Ishikari LNG	Hokkaido Gas, Hokkaido Electric	2012	2	380,000
	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
	Soma Fukushima	Japan Petroleum Exploration	2017	1	225,000
Korea	Boryyeong	GS Energy, SK E&S	2017	3	200,000
	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
	Tong-Yeong	Kogas	2002	17	2,620,000
Malaysia	Pengerang Johor	Petronas Gas	2017	2	400,000
Mexico	Altamira	Vopak, Enagas	2006	2	300,000
	Energia Costa Azul	Sempra LNG	2008	2	320,000
	Manzanillo	Samsung, Kogas, Mitsui	2012	2	300,000
Netherlands	Gate LNG	Gasunie, Royal Vopak	2011	3	540,000
Panama	Costa Norte	AES	2018	1	130,000
Phillipines	Pagbilao LNG	Energy World Corp.	2017	1	130,000
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
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	Galicia, 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	5	800,000
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	Storage Capacity
China	Shenzhen	CNPC Yudean Power	2021	2	120,000
	Yangjiang	CNPC Yudean Power	2023	2	120,000
	Zhangzhou Fujian	CNOOC	2022	2	160,000
India	Ennore	Indian Oil Corp	2019	2	320,000
	FSRU Andhra Pradesh	Andhra Pradesh Gas	2019	1	135,000
	Pipovav LNG (FSRU), Gujarat	Swan Energy	2019	2	320,000
	Andhra Pradesh	Hindustan LNG, Andhra Pradesh	studies	1	135,000
UK	Port Meridian, Barrow-in-Furness	Port Meridian Energy Ltd.	2020	1	150,000

LNG FSRU Import Facilities

Country	Location (Project)	Owners	Start up
Argentina	Bahia Blanca GasPort	Excelerate/YPF Repsol	2008
	Escobar GasPort	Excelerate/Enarsa	2011
Bangladesh	Moheshkhali	Excelerate, PetroBangla	2018
Brazil	Pecem, FSRU	Petrobras	2009
	Guanabara Bay FSRU	Petrobras	2009
	Salvador, Bahia FSRU	Petrobras	2013
China	Tianjin FSRU	CNOOC, Hoegh, various	2013
Colombia	Cartagena FSRU	Promigas, Sociedad Portuaria El Cayao	2016
Egypt	Ain Sokhna, Suez	EGAS, Hoegh	2015
	Ain Sokhna, Suez	EGAS, BW Gas	2015
Indonesia	Lampung	Hoegh LNG, PGN LNG	2014
	Nusantara (Jakarta Bay)	Golar LNG, Pertimana	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
Malta	FSU Armada Mediterrana	ElectroGas	2016
Pakistan	Port Qasim	Excelerate, Engro Corp	2015
	Port Qasim	BW-Mitsui, PGP Consortium	2017
Turkey	Aliaga FSRU, Neptune	Etki LNG	2016
	Dortyol FSRU Challenger	Botas	2018
UAE	Ruwais, Abu Dhabi	Gasco (UAE)	2016
	Jebel Ali Port, Dubai	DSA (UAE)	2010
UK	Teesside GasPort	Excelerate	2007

LNG Export Projects

Country	Location/Project	Project Developers	Planned Start Up	Number of Trains	Capacity In MTPA
AUSTRALIA	Pluto LNG expansion	Woodside	2021+	2	10.0
CANADA	Bear Head LNG, Nova Scotia	LNG Ltd.	2024	4	8.0
	Goldboro LNG, Nova Scotia	Pieridae Energy	2024	2	10.0
	Kitimat LNG, BC	Woodside, Chevron	2024	2	10.0
	LNG Canada, BC	Shell, Mitsubishi, Kogas, PetroChina, Petronas	2024	2	12.0
	Melford LNG project, Nova Scotia	H-Energy Hiranandani Group	Studies		
	Kwispaa FLNG, Vancouver	Steelhead LNG	2024	4	12.0
	Vancouver Tilbury	WesPac Midstream	2021	1	3.25
	Woodfibre LNG, Squamish	Pacific Oil & Gas Co	2020	2	2.1
EQ.GUINEA	Equatorial Guinea Fortuna FLNG	Ophir, Golar LNG, GEPetrol	2020+	1	2.0
INDONESIA	Sengkang LNG	Energy World Corp.	2019	4	2.0
MALAYSIA	Rotan FLNG (Sabah)	Petronas, Murphy Oil	2021	1	1.5
MOZAMBIQUE	Area 1 Onshore	Anadarko Petroleum and partners	2023+	2	10.0
	Area 4 Onshore	Eni and partners	2023+	2	10.0
	Area 4 FLNG	Eni and partners	2020	1	2.5
NIGERIA	NLNG Train 7	NNPC, Shell, Eni, Total	2022+	1	7.0
PAPUA NEW GUINEA	Elk-Antelope LNG	Total, ExxonMobil Oil Search, Petromin	Studies		
RUSSIA	Sakhalin II expansion	Gazprom, Shell, Mitsui, Mitsubishi	2021	studies	
	Vladisvostok LNG	Gazprom, Itochu, various	2023+	2	10.0
USA	Alaska LNG Nikiski	Alaska Gasline Development Corp.	2023+	3	20.0
	Annova LNG, Brownsville	Exelon Corp.	2023+	6	6.0
	Cameron LNG, Louisiana	Sempra, Total, Mitsui, Mitsubishi	2019	3	14.95
	Commonwealth LNG, Louisiana	Commonwealth LNG LLP	2022	8	9.0
	Corpus Christi Liquefaction, Texas	Cheniere	2019	2	9.0
	Delfin LNG, Louisiana	Delfin, Hoegh	2021	3	9.0
	Driftwood LNG, Louisiana	Tellurian Investments	2022	6	26.0
	Elba Island, Georgia	Kinder Morgan, EIG Energy	2019	10	2.5
	Freeport LNG, Texas	Freeport LNG	2019	4	20.4
	Galveston Bay LNG	NextDecade	2023+	6	27.0
	Golden Pass, Texas	Qatar Petroleum, ExxonMobil	2021	3	15.6
	Jordan Cove, Coos Bay	Pembina Corp.	2024	2	7.8
	Lake Charles, Louisiana	Shell, ETE	2024	3	15.0
	Magnolia LNG	Louisiana LNG Ltd.	2023+	4	8.0
	Port Arthur LNG	Sempra	2023+	2	10.0
	Rio Grande LNG	NextDecade	2023+	6	27.0
	Sabine Pass LNG, Louisiana	Cheniere	2018-19	2	9.0
	Texas LNG Brownsville	Chandra, Meyer, Samsung, others	2023+	2	4.0
	VG LNG (Cameron Parish)	Venture Global	2021	5	10.0
	VG LNG (Plaquemines)	Venture Global	2021	10	20.0

LNG Exporters

Country	Location/Project	Shareholders	Start up	Liquefaction		Storage	
				Trains	capacity (nominal) mtpa	No. of tanks	Total capacity m^3
ABU DHABI (UAE)	Das Island (Adgas)	ADNOC, Mitsui, BP, Total	1977	2	3.2	3	240,000
			1994	1	2.5		
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
		(Mistubishi/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
	Gorgon LNG	Chevron, Shell, ExxonMobil	2016	3	15.6	2	360,000
	Pluto LNG	Woodside, Tokyo Gas, Kansei	2012	1	4.8	2	240,000
	QCLNG	Shell, CNOOC	2014	2	8.0	2	280,000
	Wheatstone LNG	Chevron, Woodside, Kuwait (KUFPEC), Jera, Kyushu	2017	2	8.9	2	300,000
	Ichthys LNG	Inpex Corp., Total	2018	2	8.9	2	330,000
	Prelude FLNG	Shell, Inpex, Kogas CPC	2019	1	3.5		
BRUNEI	Lumut	Brunei/Shell/Mitsubishi/Total	1972-74	5	7.2	3	176,000
CAMEROON	Hilli Episeyo FLNG	Kribi Perenco	2018	1	1.2	1	125,000
EGYPT	Damietta	Union Fenosa, EGPC, EGAS	2004	1	5.0	2	300,000
	Idku	EGPC, EGAS, Shell, Total, 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
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
	Bintulu Train 9	Petronas	2016	1	3.6		
	Kanowit FLNG	Petronas	2016	1	1.2		
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	Equinor, Total, Petoro	2007	1	4.2	2	280,000
OMAN	Oman LNG	Oman Govt., Shell, Total, Korea LNG Mitsubishi, Mitsui, Partex and Itochu	2000	2	7.1	2	240,000
		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-TI	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
	Yamal LNG Siberia	Novatek, Total, CNPC, Silk Fund	2017	3	16.5	4	640,000
TRINIDAD & TOBAGO	Point Fortin Train 1	BP, Shell, CIC, 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	5	22.5	5	800,000
	Cove Point LNG	Dominion Energy	2017	1	5.3	7	695,000
	Cheniere Corpus Christi	Texas Cheniere	2018	1	4.5	3	480,000
YEMEN	Bal-Haf	Yemen LNG, Total, Yemen Gas, Hunt Oil, SK Group, Hyundai	2009	2	6.7	2	320,000

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