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2023 WORLD LNG REPORT

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What is "e-methane"?
"e-methane," alternative natural gas, is synthesized from CO_2 and H_2.
e-methane
Methanation
Technology for recycling CO_2 to synthesize methane, the main feedstock for the gas supplied to the market, from CO_2 and H_2
CO_2
CO_2
H_2
Emission
Emissions and captured amounts are equal!
Capture
Synthetic gas (e-methane)
CH_4
H_2O
Renewable energy
Supply
Continued effective use of existing gas infrastructure, including pipelines and appliances, with no need for replacement or modification costs
THE JAPAN GAS ASSOCIATION
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MESSAGE FROM THE PRESIDENT OF THE INTERNATIONAL GAS UNION

Dear Colleagues,

It is my pleasure to present to you the 14th annual edition of the IGU World LNG report.

The 2023 report provides a comprehensive review of the global LNG industry and markets after the most turbulent year in its history. It also offers important insights as the gas industry prepares for delivering reliable, flexible, efficient, secure, and sustainable energy for the years ahead.

Global LNG trade grew by an impressive 6.8% last year reaching a new record of 401.5 million tonnes (MT). As of April 2023, global LNG trade network connected 20 exporting markets with 48 importing markets, including first-time LNG importers Germany and the Philippines. 2022 also saw Mozambique join the LNG exporters club with the long-awaited startup of Coral South FLNG.

In the midst of the crisis, many European markets imported LNG at maximum capacity to meet demand and replace lost Russian pipeline gas. France ran its LNG import terminals at full capacity for most of 2022, and Belgium's terminals regularly exceeded capacity. Spiking LNG demand from Europe and a lack of growth in global LNG supplies resulted in soaring gas prices amidst a tight market. Since the conflict between Russia and Ukraine broke out, more than 10 European markets initiated remarkable new regasification terminal construction plans with 26 projects totalling 104.5 MTPA. Nearly 70% of the new capacity will come from floating terminals, which can be brought online faster and relocated when needed.

The ongoing global energy crisis has reminded the world about the critical importance of energy security and the high cost of its absence. LNG has played a crucial role bolstering energy security and delivering energy to the European consumers when they were faced with a sudden supply shock amidst the Russia-Ukraine conflict. The industry demonstrated incredible flexibility and agility again, delivering an additional 66% of LNG to Europe in 2022 to replace the lost Russian pipeline gas. The competitive global gas market played a key conducting role to redirect global energy flows at possibly the biggest scale ever seen in such a short period. This was a great demonstration of the working market's value for energy security.

However, the cost of keeping the lights on in crisis was unsurprisingly high.

Securing energy supply in the current environment came at a high cost to the European consumers who had to pay a high price premium to receive priority new volumes in record short periods, rerouting them from other buyers and having to overcome infrastructure bottlenecks. It came at a high cost to the market participants, operating in a difficult supply-constrained volatile environment. It came at a high cost to consumers in other parts of the world, especially Asia, who were priced out of the market and could not afford the high spot market prices, having to switch to dirtier fuels and shed demand. And it came at a high cost to the environment, because of the resulting increased emissions from greater coal and oil fuel use.

I commend great leadership shown by governments in steering economies through this crisis, and I truly applaud the LNG industry for delivering.

LNG saved the day and supplied more than just fuel, it provided energy security and kept the lights on. We saw a demonstration of the undeniable value of LNG, as the optimal source of flexible, reliable, and efficient energy for the world. The flexible energy that will be necessary for the world to continue securely on its energy transition journey. It is the fuel which itself is a pathway to decarbonisation, as projects designs are increasingly implementing future-proofing to minimise operational emissions today and enable deep decarbonisation going forward. I look forward to closely following the evolution of the great recent trend of emissions reporting transparency by the industry players who have done an incredible job in continuously driving down emissions throughout the value chain.

Finally, the prices eased in 2023, but the level of risk and uncertainty remains high; the market is still out of balance; and the crisis is not yet over. In this moment of respite, it is imperative that governments around the world better define their long-term energy security plans – both in the coming 2-3 years and after 2030 as the world will continue to demand more energy.

Sincerely,

Li Yalan
President of the
International Gas Union

1. State of the LNG Industry

The IGU is grateful to its Members, the report Sponsoring Members, the IGU LNG Committee, and the World LNG Report Study Group, including partners from S&P Global Commodity Insights and GIIGNL, as well as our Knowledge Partner Rystad Energy, for making this report possible.

Courtesy Qatargas

LNG Trade

401.5 MT
Global LNG Trade in 2022

Global LNG trade grew by 6.8% between 2021 and 2022 to about 401.5 million tonnes (MT). The pipeline gas supply shock following the onset of the Russia-Ukraine conflict led to a surge in LNG demand in Europe, where high prices pulled marginal cargoes away from Asia. The growth in exports from 2021 to 2022 was mainly driven by the US (+10.5 MT, +15%), following the start-up of the Sabine Pass Train 6 and Calcasieu Pass projects. The US overtook Qatar as the world's second-largest LNG producer last year, exporting 80.5 MT in 2022 compared to 70 MT in 2021. Russia exported an additional 3.4 MT (+11.6%) in 2022, with Qatar exporting an additional 3.1 MT (+4%), as facilities attempted to maximise production in response to the high prices. Last year also saw Mozambique join the LNG exporters' club with the first shipment from Coral South FLNG in November.

Australia retained its position as the largest LNG exporter in 2022, exporting 80.9 MT versus 79.0 MT in 2021. The largest exporting region continued to be Asia Pacific which saw total exports of 136.6 MT compared to 131.4 MT in 2021. The Asia Pacific region also continued to be the largest importing region with net imports of 160.9 MT last year, marking a 4.6 MT increase compared to 2021. Owing to China's COVID-19-related lockdowns and high international prices which dissuaded spot LNG imports in Asia, Japan once again became the world's largest LNG importer, bringing in 73.6 MT compared to 74.9 MT in 2021. As of April 2023, global LNG trade now connects 20 exporting markets with 48 importing markets[1], including first-time LNG importer Germany in Europe and, more recently, the Philippines which unloaded its maiden cargo at the Philippines LNG import terminal in Batangas Bay at the end of April.

The increase in LNG imports was significantly driven by Europe in 2022, which saw the largest annual increase of 50.4 MT (+66%) compared to 2021. Europe managed to import 126.6 MT last year to compensate for the loss of Russian gas pipeline volumes, making it the second-largest LNG importing region in the world. Asia Pacific retained its spot in first place with a total 160.9 MT of LNG imported in 2022, a 4.6 MT annual increase.

[1] Including Myanmar which has stopped importing LNG as of 2021

Price Trends

The Platts TTF assessment reached a record high at
$93.813/mmBtu
on 26 August 2022

The Platts JKM benchmark hit an all-time high at
$84.762/mmBtu
on 7 March 2022

The LNG market experienced a tumultuous year in 2022. The emergence of market tightness in late-2021 continued and accelerated through 2022 following the onset of the Russia-Ukraine conflict at end-February. Europe's sudden and urgent need to replace Russian piped gas with short-term LNG deliveries, coupled with forced gas demand destruction to ensure stock-filling ahead of the northern hemisphere winter, created an imbalanced and volatile global LNG market.

The Platts Japan-Korea Marker (JKM) benchmark, which reflects cargoes delivered into Northeast Asia, averaged $33.98 per million British thermal units (mmBtu) in 2022, reaching an annual daily low of $18.945/mmBtu on 20 January 2022 and hitting an annual high, also an all-time high for the benchmark, at $84.762/mmBtu on 7 March 2022.

The year also saw a significant decoupling of LNG cargo benchmarks and gas hub prices. JKM was at a discount to Europe's main gas hub, the Netherlands-based Title Transfer Facility (TTF), for approximately 85% of the time from February 2022 to January 2023, averaging $7.94/mmBtu. The largest discount of $30.225/mmBtu was seen on 24 August 2022, with TTF close at $86.053/mmBtu and JKM close at $55.828/mmBtu.

TTF reached its record high at $93.813/mmBtu on 26 August 2022, while JKM closed at $66.559/mmBtu.

Asian demand reduced significantly in most locations, with the two fastest-growing major LNG markets in recent years, China, and India, both taking a major step back in procurement, reducing imports by 19.3% and 17.7% respectively. While prices moderated closer to historically average levels at the start of 2023, they remain elevated with an ongoing risk of a return to 2022 conditions, Meanwhile, the European reliance on the LNG spot market remains strong (around 70% of the continent's imports in 2022 are estimated to be sourced from the spot market) and this would increase the volatility of European gas prices.

Liquefaction Plants

478.4 MTPA[2]
Global liquefaction capacity, end-2022

In 2022, a total 19.9 million tonnes per annum (MTPA) of liquefaction capacity was brought online to reach a global total of 478.4 MTPA, across 22 markets. New liquefaction capacity in the US market accounted for 75% of the capacity increase in 2022. Sabine Pass LNG T6 (5.0 MTPA) and Calcasieu Pass LNG T1-T18 (10 MTPA) in the US became operational in February and May 2022 respectively, giving the US the largest operational liquefaction capacity worldwide in 2022 with total of 88.1 MTPA.

Amidst the ongoing Russia-Ukraine conflict, Russia's Portovaya LNG T1 (1.5 MTPA) finally started commercial operation in November 2022, after delays. In Mozambique, Coral South FLNG (3.4 MTPA) successfully shipped its first LNG cargo in November 2022, bringing additional LNG volumes to the global gas market. As of April 2023, Altamira FLNG in Mexico and Tangguh LNG T3 in Indonesia are the two liquefaction projects expected to become fully operational this year. Altamira FLNG (2.8 MTPA) is currently on schedule to become operational in the third quarter of 2023 with about 80% of construction work on the first two FLNG liquefiers already completed, and construction permits in place for offshore work in the Altamira area. Tangguh LNG T3 (3.8 MTPA) is currently commissioning with first cargo delivery expected later this year.

In 2022, the volume of approved liquefaction capacity declined to 25.2 MTPA compared to capacity approved in 2021 (50 MTPA).

Venture Global's Plaquemines LNG T1-T18 (10 MTPA) and Cheniere's Corpus Christi LNG Stage 3 T1-T7 (10 MTPA) in the US both took final investment decisions (FID) in 2022. Located in Louisiana, Plaquemines LNG is being developed in two phases and has nameplate capacity of 20 MTPA. Plaquemines Phase 1 T1-T18 (10 MTPA) was approved in May 2022 with first LNG production anticipated in 2024. Venture Global took FID on Phase 2 of the Plaquemines LNG project T19-T36 (10 MTPA) in March 2023 with $7.8 billion in financing, bringing total financing for this project to $21 billion. Corpus Christi LNG is located on Corpus Christi Bay in Texas and is Cheniere's second LNG export facility on the US Gulf Coast (after Sabine Pass LNG). The facility now has three trains (T1-T3) in commercial operation with a total authorised capacity of 13.5 MTPA. Cheniere's current priority is to expand the facility by adding seven trains, each with capacity of approximately 1.42 MTPA. FID was announced in June 2022, with first LNG production anticipated in 2027. In addition to Altamira FLNG (2.8 MTPA), another FLNG unit (2.4 MTPA) is currently under-construction by Wison Heavy Industry for Eni to be deployed in Congo.

[2] Includes Yemen and Libya, although Yemen LNG and Marsa El Brega LNG have suspended operations, this number excludes the liquefaction capacity of Kenai LNG, which has announced plans to be converted to an import terminal.

Proposed New Liquefaction Plants

997.1 MTPA
Proposed aspirational liquefaction capacity in pre-FID stage, end-April 2023

Currently, 997.1 MTPA of aspirational liquefaction capacity is in the pre-FID stage. Most proposed capacity is in North America (611.4 MTPA), with 333 MTPA situated in the US, 229.6 MTPA in Canada, and 48.8 MTPA in Mexico. This is followed by Africa (101.9 MTPA), Russia (137 MTPA), Asia Pacific (68.9 MTPA) and the Middle East (71.5 MTPA). About 6.4 MTPA of liquefaction capacity is proposed in the rest of the world. Overall, the market upheaval caused by the Russia-Ukraine conflict has stimulated interest in liquefaction facilities as markets seek to re-establish energy security priorities, while balancing decarbonisation goals. Global liquefaction capacity would increase three-fold if all these projects materialise. However, a fair portion of pre-FID projects are unlikely to progress due to the weak economic or political landscape in some proposed areas, combined with difficulties to access financing for fossil fuel projects.

Decarbonisation of LNG

Decarbonisation is becoming a more prominent feature in recent developing and newly proposed projects. Decarbonising the liquefaction segment of the LNG value chain offers a significant opportunity to minimise lifecycle emissions today. There is a positive trend with numerous projects globally incorporating decarbonisation in operations. Cedar LNG and Woodfibre LNG in Canada, for example, are prioritising decarbonisation using renewable hydroelectricity to power their liquefaction operations. Cheniere, Sempra Energy, Egyptian LNG are also considering using carbon capture, utilisation and storage (CCUS) in their liquefaction plants to reduce carbon emissions. As demand for low-carbon LNG grows, more stakeholders in the industry are expected to prioritise the decarbonisation of their operations. It is important for this trend to continue yet keeping in mind that it will generally tend to increase project development cost, hence prudent policy and effective emission pricing schemes are going to play an important role strengthening the business case for decarbonisation investments.

Looking further toward 2050, the future of the LNG value chain holds several possible decarbonisation scenarios. Many members of the IGU are actively working to advance the LNG energy transition pathways, for the gas industry to continue delivering efficient, reliable, resilient, flexible, and cost-effective gaseous energy sustainably long into the future. Some examples of the deep decarbonisation possibilities include renewable natural gas, or biomethane; low-carbon and renewable hydrogen; ammonia; e-methane; carbon capture utilisation and storage (CCUS), and the pace of technology innovation is so rapid that the list is never static. It remains to be seen whether a clearly dominant technology option will emerge through the transition process, or there will be a mix of liquefied gas technologies at play, but it is clear that this work needs to continue and to accelerate to deliver the technological revolution required for the world to meet the mammoth challenge of decarbonising the 80% of its energy use that still relies on fossil fuels today.

Regasification Terminals

970.6 MTPA

Global nominal regasification capacity, end-April 2023

Global regasification capacity reached 970.6 MTPA across 48 markets as of end-April 2023. In 2022, the highest capacity additions were in Europe, which saw an additional 14.5 MTPA of regasification, followed by Asia Pacific with 8.5 MTPA of new regasification, Asia with 6 MTPA and Latin America with 2.2 MTPA. Of the 31.2 MTPA regasification capacity additions in 2022, more than 80% came from new terminals. Nine new terminals were commissioned globally, with an unprecedented growth in Europe. Another three expansion projects were brought online in the Netherlands, China and Croatia. Project-specifically, the largest new capacity addition in 2022 was the 7.5 MTPA Nong Fab onshore LNG project in Thailand, followed by the 5.9 MTPA Eemshaven FSRU in the Netherlands, and the 5.5 MTPA Wilhelmshaven FSRU in Germany. Wilhelmshaven FSRU became the first LNG terminal in Germany, with terminals at another three sites planned or under construction. Germany – the largest gas consumer in Europe – rapidly developed regasification construction plans in 2022 following the outbreak of Russia-Ukraine conflict. Last year also saw the first regasification facility go live in El Salvador, with the start-up of the 2.2 MTPA BW Tatiana FSRU. Utilisation rates of global regasification facilities averaged 41% in 2022, keeping flat compared to a year earlier, which can be explained by the rerouting of the global LNG consumption toward Europe.

Many other European markets are planning a wave of LNG import terminals following heightened geopolitical tensions as they look to reduce dependency on Russian gas and strengthen energy security. Four regasification projects were commissioned in Europe in 2022: one in Germany, two in the Netherlands and one in Finland. Four terminals have come online in Europe so far in 2023, with another three terminals and one expansion kicking off construction in the region and aiming to commission later in 2023. There has been a notable trend in Europe towards floating terminals given their ability for redeployment and speed to market compared to onshore terminals.

Asia and Asia Pacific have shown a preference for onshore terminals, which are set to meet increasing LNG demand in the short to long term and allow for further capacity expansions. Currently, the two regions hold the largest share of global regasification capacity, with major plans and projects under construction. It is worth noting that projects in South Asia and Southeast Asia have faced notable delays in recent years due to a lack of incentives for investors given the risks to LNG demand in the price-sensitive region. Even so, the Philippines imported its first cargo in April 2023, and Vietnam is set to commission the Thi Vai import terminal later this year.

Floating and Offshore Regasification

177.2 MTPA

Global floating and offshore regasification capacity, end-April 2023

As of end-April 2023, there are 44 floating and offshore terminals around the world with a total import capacity of 177.2 MTPA, accounting for around 18% of global regasification capacity. There are 16 floating and offshore terminals under construction, with total regasification capacity of 58.3 MTPA. Five new markets – Vietnam, Estonia, Senegal, Ghana and Nicaragua – are expected to emerge this year if floating terminal projects progress as planned. In the past two years, four new markets started importing LNG following the commissioning of FSRU-based terminals, including Croatia in 2021, El Salvador and Germany in 2022, and most recently as of April 2023, the Philippines.

As of April 2023, five new floating-based terminals have been commissioned so far this year, including Lubmin FSRU and Elbehafen FSRU in Germany, Inkoo FSRU in Finland, Batangas Bay floating storage unit (FSU) with onshore regasification in the Philippines, and Gulf of Saros FSRU in Turkey with a combined regasification capacity of 21.8 MTPA. Another 12 floating terminals are under construction and planning to start up in 2023, with a combined capacity of 40.2 MTPA. India's 5 MTPA Jafrabad FSRU and 6 MTPA H-Gas LNG Gateway have postponed their startup from previous years and may see further delays due to tight supply globally for FSRU vessels and tepid local LNG demand due to recently high and volatile prices. The Hong Kong FSRU, which was previously planned to be completed and to come online in 2022, was yet to be commissioned as of April 2023.

LNG Shipping

668 Vessels

LNG fleet, end-April 2023

There were 668 active vessels as of end-April 2023, including 45 FSRUs and eight floating storage units (FSUs). The global fleet grew by 4% with the delivery of 27 carriers in 2022. Most vessels delivered last year were in the 170,000 to 180,000 cubic metres (cm) size range.

The second generation of X-DF and the new generation M-type electronically controlled gas admission (ME-GA), which are advanced propulsion systems for LNG carriers, have gained in popularity, with 146 X-DF systems across both generations and 122 ME-GA systems on the order book, making up a large share of the total 312 vessels on order as of end-April 2023.

The number of LNG voyages last year grew by about 2.7% from 2021, although the focus on energy security meant charterers were reluctant to release any excess shipping capacity and preferred to float vessels rather than release them to the market, as observed in Europe in the third quarter of 2022. As such, charter rates were driven by ton-days rather than ton-miles, hitting a peak of $250,000/day for steam turbine vessels, $355,000/day for TFDE/DFDE vessels and $450,000/day for X-DF/ME-GI vessels by end-October 2022. In line with global gas prices, this reversed rapidly as the northern hemisphere winter turned out to be much milder than expected and months-long demand reduction in Europe helped build very comfortable gas storage volumes.

LNG Bunkering Vessels and Terminals

14 Units

Global LNG Bunkering vessel order book, end-April 2023

In 2022, global LNG bunkering activity declined as oil-based fuels traded at significant discounts to global LNG prices. Any dual-fuel vessels that could switch to fuel oil did so. However, as of early 2023, LNG prices have once again become competitive with fuel oil, while the longer-term fundamentals of a rapidly expanding LNG-fueled orderbook and accelerating decarbonisation measures remain robust. As a result, 2023 is widely expected to be a revival year for the LNG bunkering market. As the global shipping fleet turns to LNG to decarbonise and adhere to stricter environmental regulations, the case for LNG bunkering remains strong. As of end-April 2023, the global operational LNG bunkering and bunkering-capable small-scale vessel fleet has reached 35 units, including both self-propelled and tug-propelled vessels and barges.

There are an additional 14 vessels on the order book, to be delivered across the globe. The typical size of these vessels is increasing over time with the average capacity of the active fleet rising to 7,700 cm by end-2022, up from 6,900 cm in 2021. The orderbook averages 9,800 cm.

Courtesy Tsakos

2. The Impact of Global Energy Crisis on the LNG Industry

The gas markets were already evidently tightening since 2021, driven by a combination of factors on the supply and demand sides. Demand was surging with the robust global economic re-start after lengthy COVID lockdowns, and coming on the back of a universally cold northern hemisphere winter with major consumers refilling storages. A series of extreme weather events, including droughts in Turkey and Brazil added to spiking LNG demand to offset hydroelectricity shortages. On the supply side, there were still lingering post-COVID maintenance related reductions and the fluctuating pipeline gas supply from Russia to Europe.

Courtesy Dynagas

By end-2021, prices started seeing record escalation rates and volatility levels, and Europe had already become the premium market for marginal Atlantic LNG supply. The decline in Russian pipeline gas supply to Europe following the onset of the Russia-Ukraine conflict left a structural gas supply deficit in continental Europe that led to a scramble for replacement energy supply to restore energy security. Price levels and volatility became extreme in the context of the largest global energy crisis on memory.

LNG ultimately saved the day, maintaining Europe's energy security allowing it to make it through the winter 2022 and keep the lights on. Europe imported over 66% additional LNG in 2022 (+50.4 MT), compared with 2021 to offset the shortage. Very high prices at the European market entry point helped to make the massive redirection possible and balance the short-term market, while also causing demand destruction in some Asian markets, and prompting the next wave of LNG investments to improve supply security.

2.1 IMPACTS ON LNG TRADE

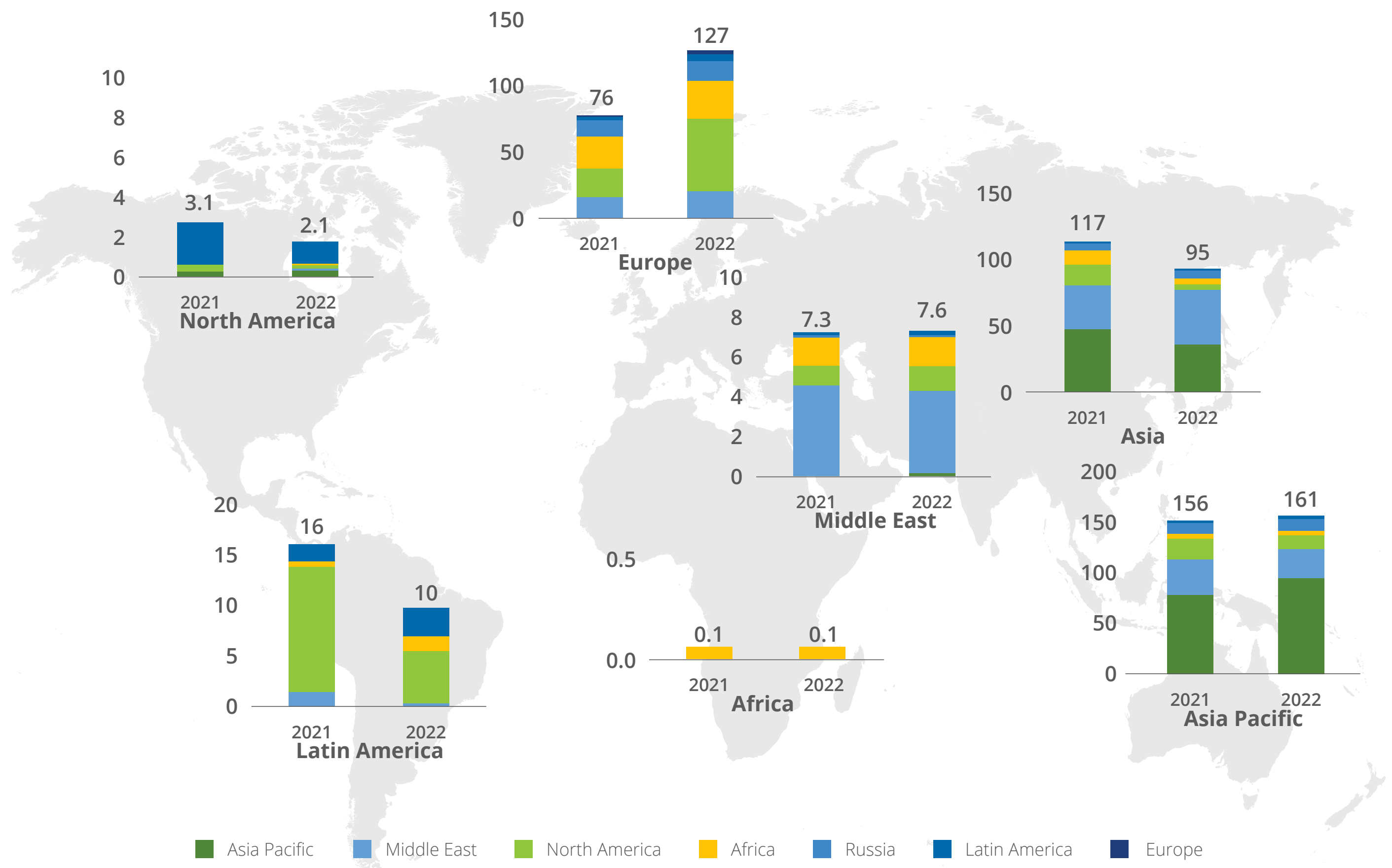
LNG trade was heavily impacted by the global energy crisis, mainly driven by a surge in LNG demand in Europe to offset lower flows of natural gas pipeline imports from Russia, coupled with unplanned disruptions in LNG supply. At the beginning of 2022, Rystad Energy projected LNG trade would grow 10.4% year-on-year to reach 415 MT for 2022, with imports in China having been expected to exceed 85 MT (up from 79 MT in 2021) and 14 MT of export growth in the US. The global energy crisis was made worse by the Russia-Ukraine conflict and multiple unexpected outages were seen at liquefaction sites. Global LNG trade grew to 401.5 MT in 2022, up 6.8% from 2021. LNG imports to Europe grew by 50.4 Mt. Amidst high spot LNG prices which triggered demand destruction in Asia, imports to China were down by 15.2 MT.

The key impact of the energy crisis was the combination of the unprecedented surge in prices and volatility with the similarly unprecedented shift in inter-regional LNG trade patterns. Europe provided higher price premiums than the rest of the world to attract additional LNG cargoes. US producers managed to export 55.2 MT to Europe, a 148% increase compared to 2021 levels, despite Freeport LNG in Texas being taken offline following an accident[1] in June 2022. The event dented Freeport LNG's production capacity by 15.3 MTPA.

LNG volumes from the US accounted for 44% of Europe's total LNG imports while Europe accounted for 69% of total US LNG exports last year. Moreover, rare cargo movements from Asia Pacific to Europe, despite being a long distance with high shipping costs, were observed.

Trade flows towards China dimmed as it continued wrestling with COVID-19-related lockdowns in 2022 and the fact that spot market purchases turned unaffordable, China maximised its LNG imports from long-term contracts. As a result, the share of spot trades to China fell to about 10%, from the usual level of 40%.

Figure 2.1: LNG regional imports by origin, 2021 and 2022 (MT)



Source: Rystad Energy

[1] A fire at the facility stemming from a pipeline rupture.

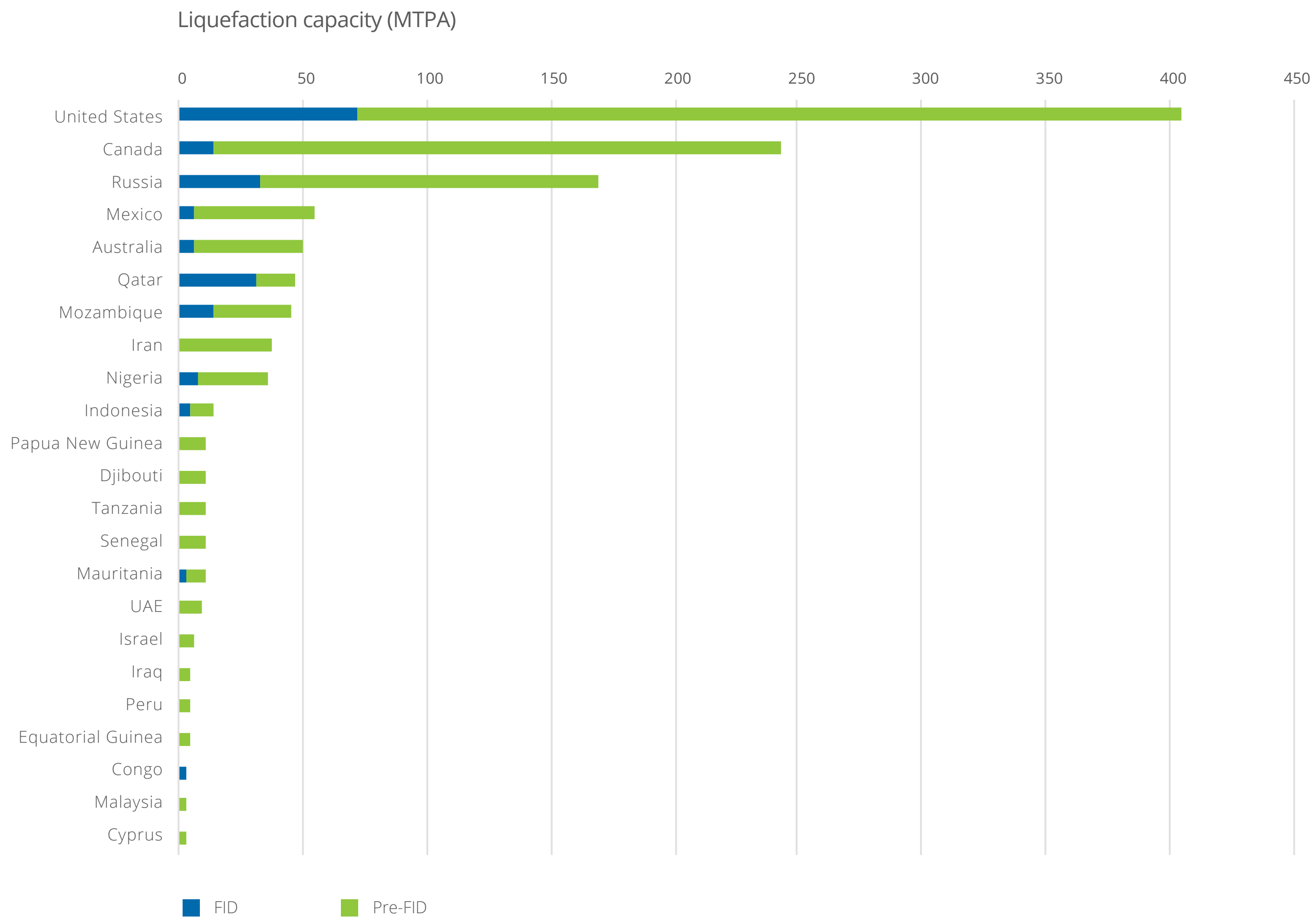
2.2 IMPACTS ON LIQUEFACTION

Liquefaction operators and investors are fast-tracking liquefaction capacity expansion plans and project FIDs and optimising existing floating units. This follows more incentives to maximise the utilisation of liquefaction facilities due to soaring European LNG demand following a sharp decline in Russian pipeline gas supplies, the rise of market prices, and many outages at some key liquefaction facilities.

The start-up of Sabine Pass LNG T6 (5 MTPA) and the commissioning of Calcasieu Pass LNG (10 MTPA) made the US the producing market with the largest operational LNG export capacity, surpassing Australia. Meanwhile, Russia's Portovaya LNG (1.5 MTPA) also initiated LNG production despite the conflict in Ukraine, with Coral South FLNG sending out its first LNG cargo in the fourth quarter of 2022. The existing Tango FLNG (0.6 MTPA) acquired by Eni will be deployed in Congo in the second half of 2023. Another FLNG unit for Congo (2.4 MTPA) is being built by Wison Heavy Industry in China.

The growth of proposed LNG projects is on an accelerated pathway following the approval of two FIDs at Plaquemines LNG Phase 1 (10 MTPA) and Corpus Christi LNG Stage 3 (10 MTPA) in 2022 and two more at Plaquemines LNG Phase 2 (10 MTPA) and Port Arthur LNG (13.5 MTPA) in the first quarter of 2023. It is worth noting that it took just a year for Venture Global to decide to move forward with its Phase 2 LNG expansion project.

Figure 2.2: Global FID and pre-FID liquefaction capacity by market, end-April 2023



Source: Rystad Energy

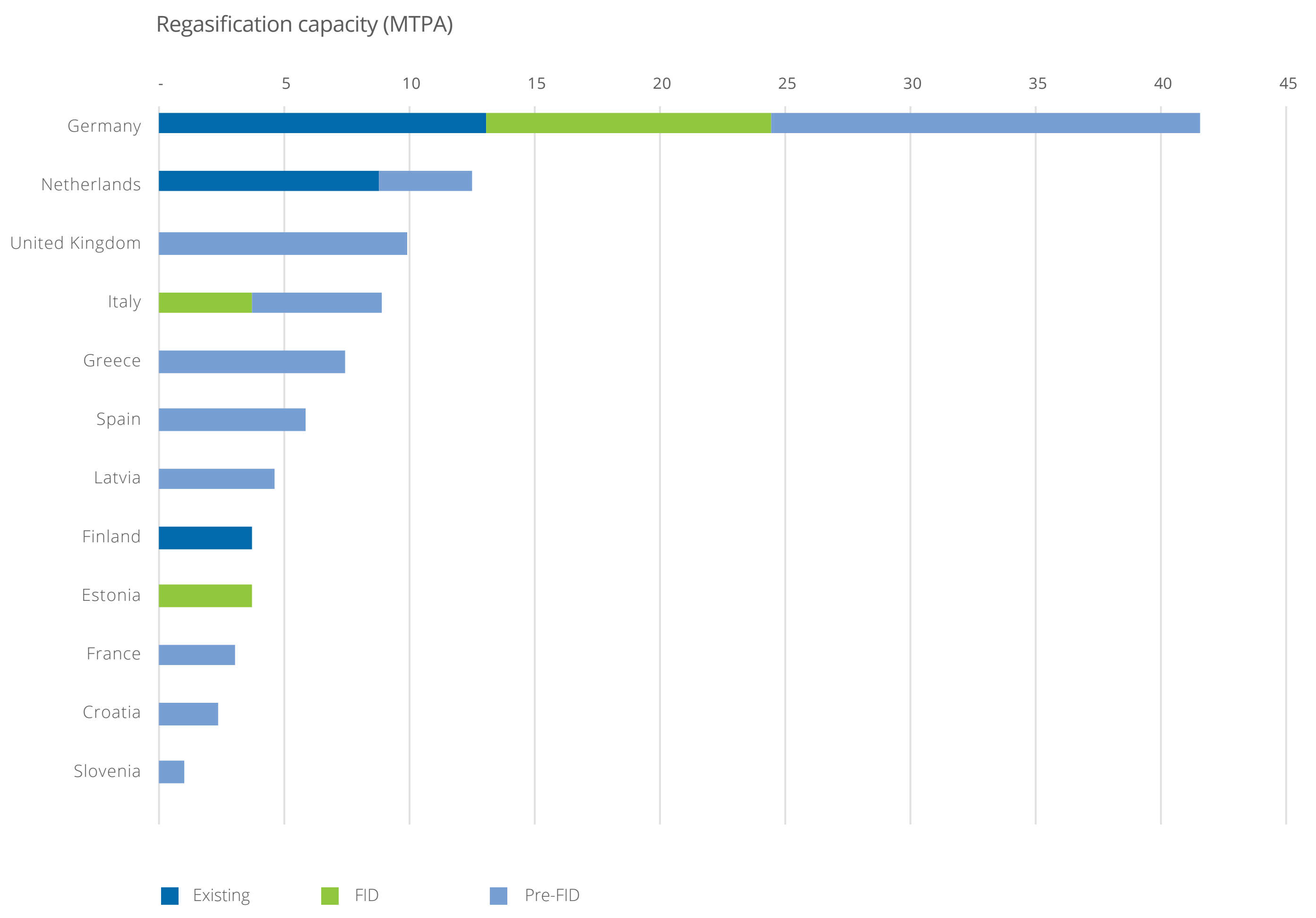
2.3 IMPACTS ON REGASIFICATION

Regasification development has been boosted by the global energy crisis, especially in Europe where many regasification projects have been launched with the support of respective governments. This is to ensure energy security in response to heightened geopolitical tensions in the region and reduce dependence on Russian pipeline gas by importing more LNG into Europe.

More than 10 European markets – including Germany, the Netherlands, Finland, France, Croatia and Italy – have initiated the construction of new capacity since the Russia-Ukraine conflict broke out. This includes 26 projects with a combined regasification capacity of 104.5 MTPA. Of these, six have been commissioned, adding 25.5 MTPA to global capacity as of April 2023. It took just a few months in 2022 to bring online the 5.9 MTPA Eemshaven FSRU in the Netherlands and the 5.5 MTPA Wilhelmshaven FSRU in Germany. Another four terminals have taken FID and are under construction, with total capacity of 18.8 MTPA. About 70% of the new capacity will come from floating terminals, due to the urgency of expanding regasification capacity. As noted elsewhere in this report, FSRU-based terminals can be brought online earlier and faster than onshore terminals.

As the fastest growing market by regasification capacity, China has continued to strengthen LNG import capacity along its coastline, with policy support to diversify gas supplies. Last year, 14 regasification projects were approved in China. Of these, five have kicked off construction, including one expansion project Zhoushan ENN LNG 3 (5 MTPA), and four new terminals Jiangsu Ganyu Huadian LNG (3 MTPA), Shanghai LNG (3 MTPA), Huizhou LNG (6.1 MTPA) and Yingkou LNG (6.2 MTPA).

Figure 2.3: Europe regasification construction plans proposed since March 2022, by status and market



Source: Rystad Energy

2.4 IMPACTS ON LNG SHIPPING

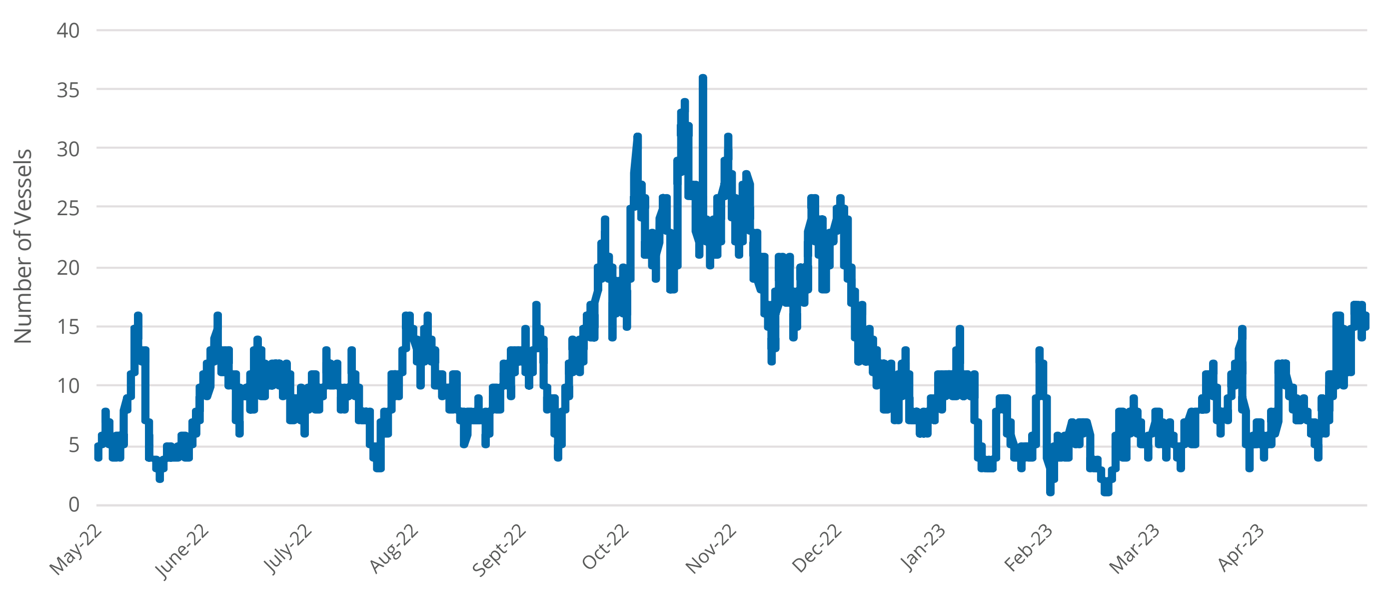
As international gas prices surged and LNG became critical to Europe's energy security, the spot charter market soon began to display similarly bullish characteristics. The importance of US LNG in balancing the European market placed additional emphasis on LNG shipping to ensure supply security, especially given the nature of US LNG commercial agreements, many of which are structured on free on-board (FOB) terms. Even though US-Asia voyages can easily exceed 30 days one way compared to US-Europe voyages which take around 12 days, charterers were reluctant to release shipping length onto the market. As such, the market focus turned from ton-miles to ton-days as a key indicator of shipping demand through much of 2022.

The wave of LNG cargoes headed to Europe quickly overwhelmed the continent's regasification capacity leading to wide spreads in regional benchmarks, exposing pipeline infrastructure bottlenecks that hindered gas from being transported to the demand centres in the Northwest from regions with spare regasification capacity, such as in southern Europe. At one point in October, more than 35 vessels were observed floating including off the European coast and in the Mediterranean Sea, either unable to secure regasification slots, or postponing discharge on the expectation that prices would rise towards winter.

Spot charter rates, which had languished around $40,000/day (West of Suez, two-stroke) before the Russia-Ukraine conflict, hit an all-time high of $450,000/day at end-October 2022. Spot charter rates were also boosted by the propensity of charterers to pay. Despite the very high charter rates, shipping cost was not a major component of the overall sales price.

It is worth noting that even before the conflict, charterers' preference had been starting to slant towards multi-month and term charters since late 2021, which reduced prompt vessel availability in 2022 and likely exacerbated volatility caused by the conflict. As of April 2023, even as spot charter rates (TFDE) have reduced to around $30,000/day (in line with global gas prices), the term market remains extremely robust, driven by newbuild demand from the wave of project development activity (primarily US LNG and Qatar's North Field expansions), fleet renewal demand from impending impact of the International Maritime Organisation (IMO) Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations, structural labour and material shortages at shipyards. The timeline for newbuild deliveries from South Korean yards has shifted to around four years and the surge in newbuild prices has brought in first-time conventional LNG carrier shipbuilders from China – namely Jiangnan, Dalian Shipbuilding, Yangzijiang, and China Merchants Heavy industries.

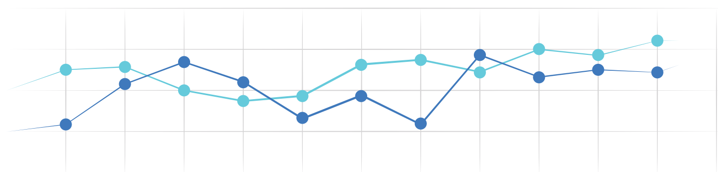
Figure 2.4: Floating vessel count



Source: Rystad Energy

3 LNG Trade

Global LNG trade increased to **401.5 MT**[1] in 2022, an increase of **25.4 MT**.



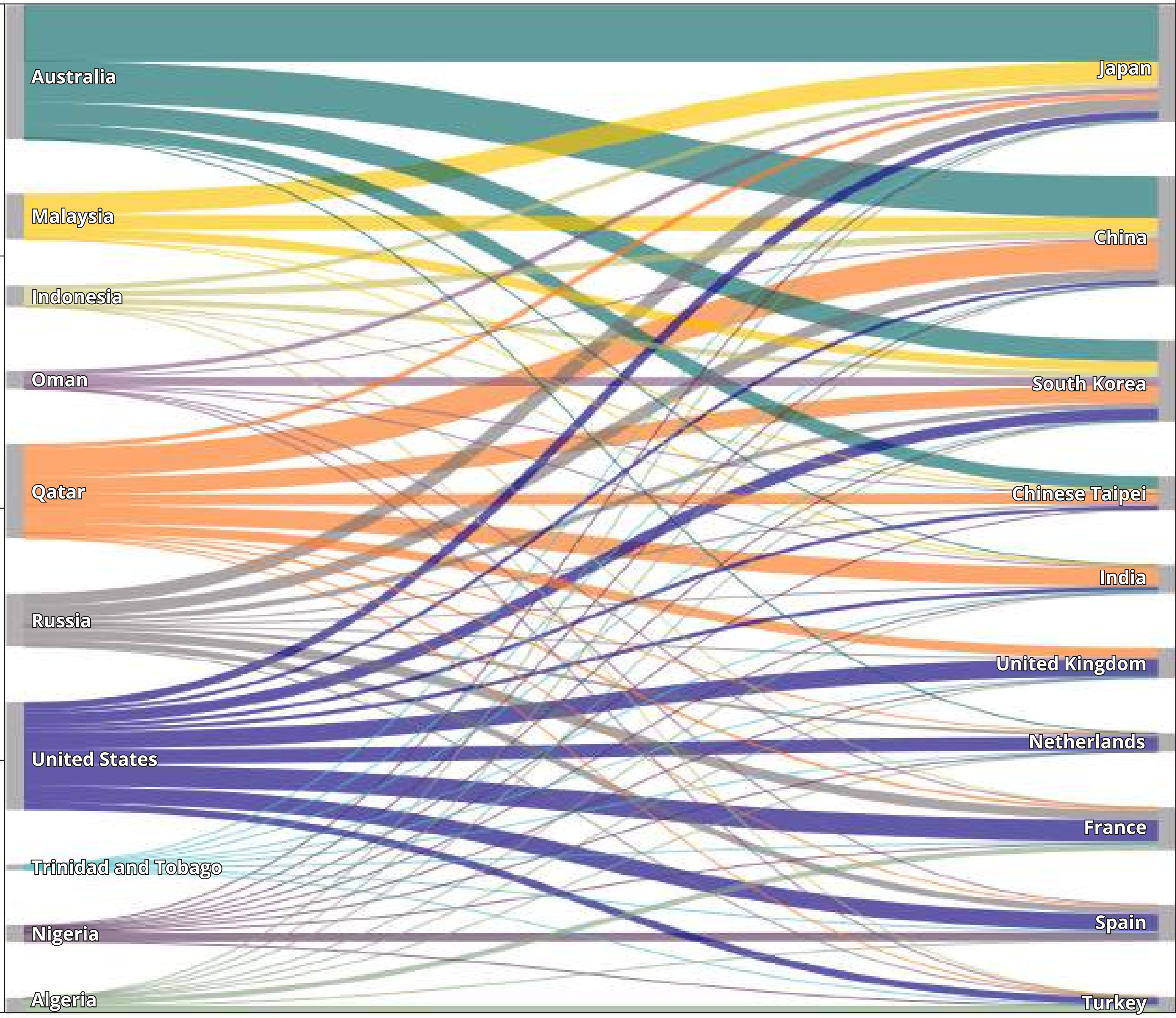
Japan regained its place as the largest importer with a total of **73.6 MT** of import (-1.3 MT vs. 2021)

1st Australia retained its position as the largest exporter in 2022 with a total of **80.9 MT** of exports

2nd The US became the second largest exporter, exporting **80.5 MT** 10.5 MT more than in 2021

3rd Qatar exported **80.1 MT**

4th Russia remained the world's fourth largest exporter at **33 MT**



China imported **63.7 MT** (-15.2 MT vs. 2021)

The largest global LNG trade flow route continues to be intra-Asia Pacific trade **97.9 MT**

India imported 4.2 MT less than in 2021 **19.4 MT**

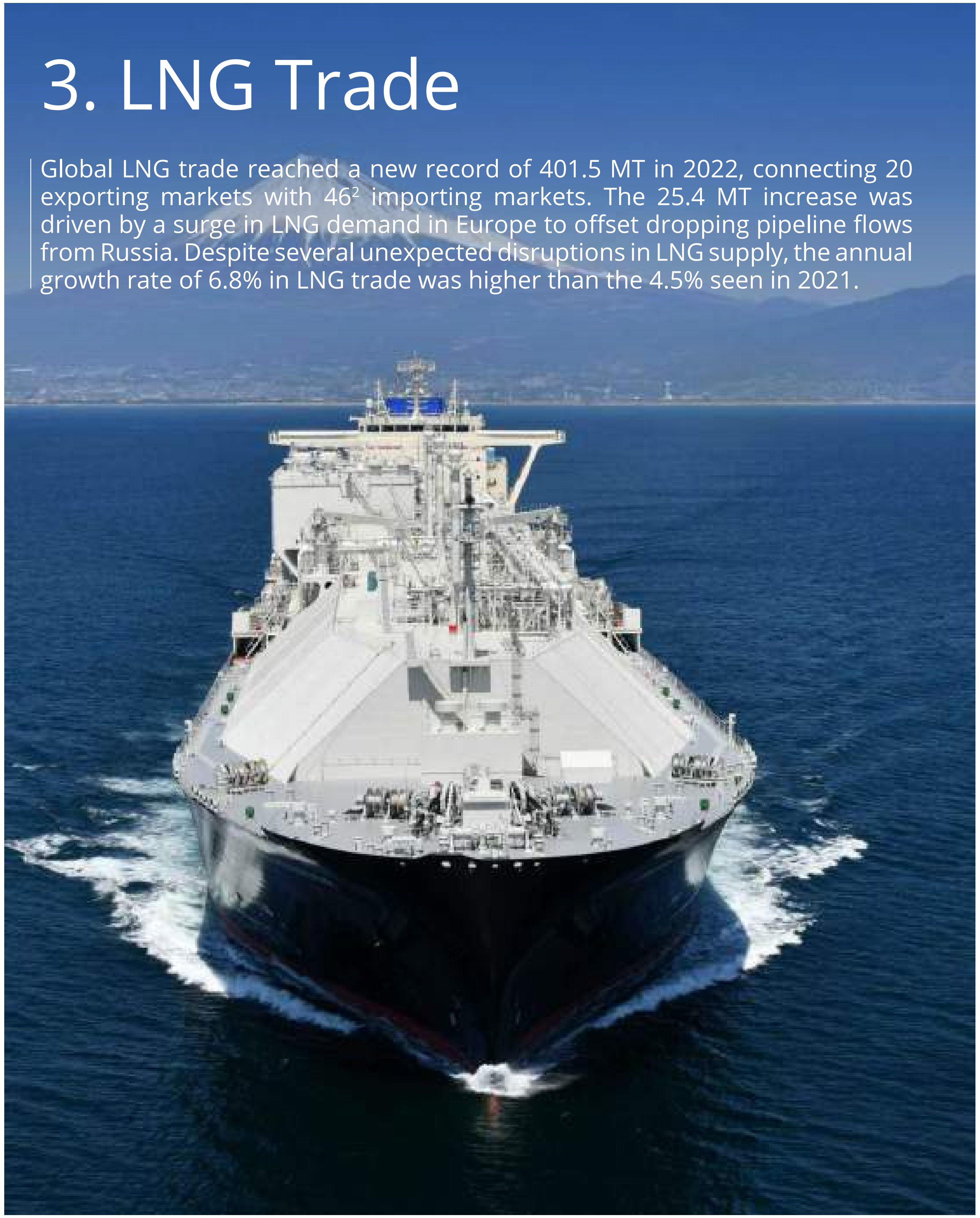
European imports increased to **126.6 MT** (+50.4 MT)

[1] Source: Rystad Energy. Owing to improved data availability, some historical trade numbers have been restated.

The diagram only represents trade flows between the top 10 exporters and top 10 importers.

3. LNG Trade

Global LNG trade reached a new record of 401.5 MT in 2022, connecting 20 exporting markets with 46[2] importing markets. The 25.4 MT increase was driven by a surge in LNG demand in Europe to offset dropping pipeline flows from Russia. Despite several unexpected disruptions in LNG supply, the annual growth rate of 6.8% in LNG trade was higher than the 4.5% seen in 2021.



Courtesy Tokyo Gas

[2] 2022 count excludes Myanmar which has stopped importing LNG as of 2021.

3.1 OVERVIEW

Growth in LNG exports in 2022 was largely driven by the US (+10.5 MT), Russia (+3.4 MT) and Qatar (+3.1 MT). Australia kept its crown as the world's largest LNG producer, exporting 80.9 MT in 2022 compared to 79 MT in 2021. The US overtook Qatar as the world's second-largest LNG producer last year, coming a close second to Australia and exporting 80.5 MT in 2022 compared to 70 MT in 2021. Qatar, closely following the US, exported 80.1 MT in 2022, exceeding its 77.1 MTPA of nameplate capacity. Russia retained its position as the fourth-largest exporter with 33 MT of output in 2022. Malaysia, the fifth-largest exporter, contributed 2.5 MT to the growth with exports totalling 27.3 MT last year. Norway's Snøhvit LNG complex, which had been offline since September 2020, resumed operations in June 2022 and managed to produce 2.7 MT last year. The largest exporting region continued to be Asia Pacific with a total of 136.6 MT in 2022, a 5.2 MT increase compared to 2021. The Middle East with 96.5 MT (+3.9 MT) of output remained in second position, followed by North America which exported 80.5 MT in 2022, recording the largest growth of 10.5 MT over 2021.

The increase in LNG imports was significantly driven by Europe in 2022, which saw the largest annual growth of 50.4 MT compared to 2021. Europe managed to import 126.6 MT last year to compensate for the loss of Russian pipeline volumes, making it the second-largest LNG importing region in the world. Asia Pacific retained its first place as the largest importer with a total 160.9 MT of LNG imported in 2022, a 4.6 MT annual increase. Asia slipped to third place behind Europe with 94.5 MT imported in 2022, a 22.2 MT drop compared to 2021. This was mainly due to lower imports from China which imported 63.7 MT in 2022, a 15.2 MT decrease compared to 2021, driven by lower demand due to pandemic-related lockdowns and fewer spot market purchases in the high price environment. India's LNG imports fell by 4.2 MT in 2022 and Brazil's were down 5.6 MT.

Global LNG trade	LNG exporters and importers	LNG re-exports
+25.4 MT Growth in global LNG trade	El Salvador commenced LNG imports in 2022, making it the world's 41st[3] importing market	+0.8 MT Re-exported volumes increased by 20% year-on-year in 2022
Global LNG trade reached a new record of 401.5 MT in 2022, up 6.8% compared to 2021	Germany received its first FSRU Hoegh Esperanza at Wilhelmshaven with a 0.07 MT shipment	Re-export activity increased to 4.7 MT in 2022 compared to 3.9 MT in 2021
Europe provided 50.4 MT in increased net imports, with Asia Pacific increasing net imports by 4.6 MT	Europe increased net imports by lifting the utilisation rate of its receiving terminals and expanding import capacity	Europe received the largest volume of re-exports (2.5 MT) and re-exported the largest volumes (2.9 MT)
Contractions were greatest in Asia (-22.2 MT) and Latin America (-6.6 MT)	Growth in exports came from the US (+10.5 MT), Russia (+3.4 MT) and Qatar (+3.1 MT)	

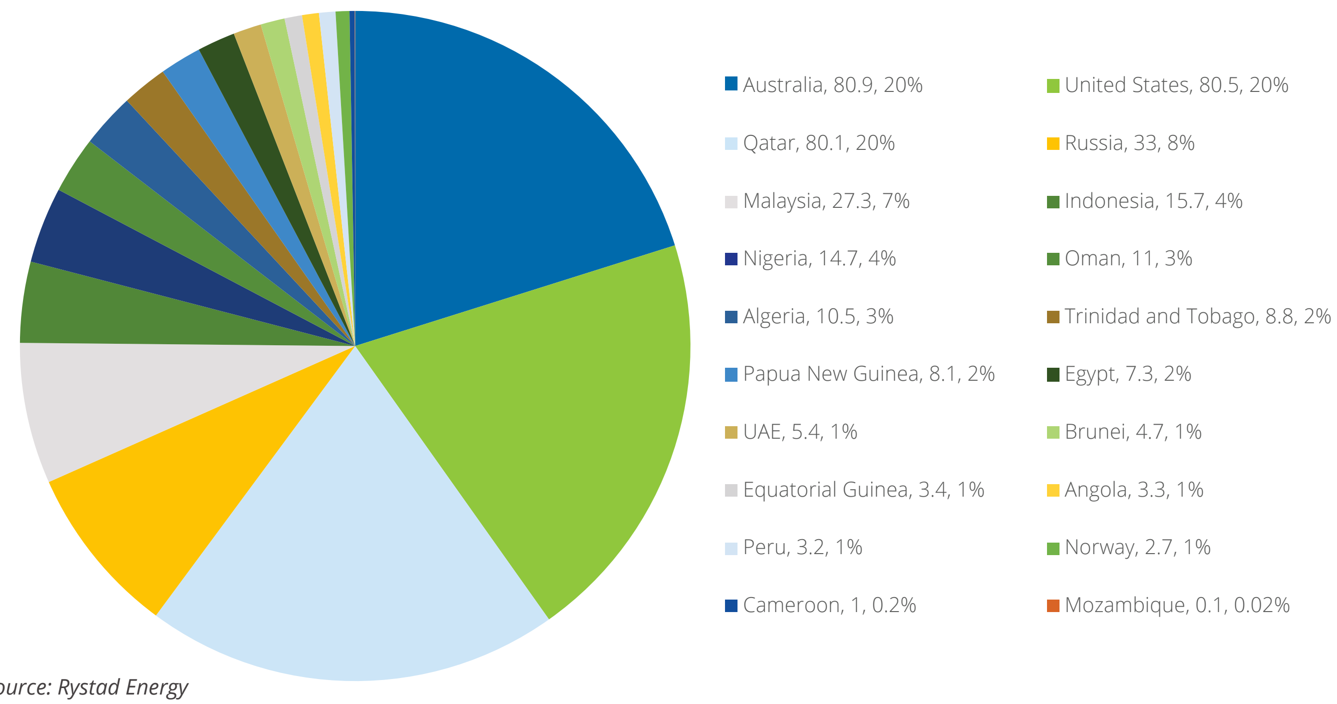
Source: Rystad Energy

Courtesy CNOOC

[3] This report excludes those with only small-scale (<0.5 MTPA) regasification capacity but includes markets where small-scale terminals add large impact on import for the market, such as Finland (as of 2022), Norway, Sweden and Malta.

3.2 LNG EXPORTS BY MARKET

Figure 3.1: 2022 LNG exports and market share by export market (MT)

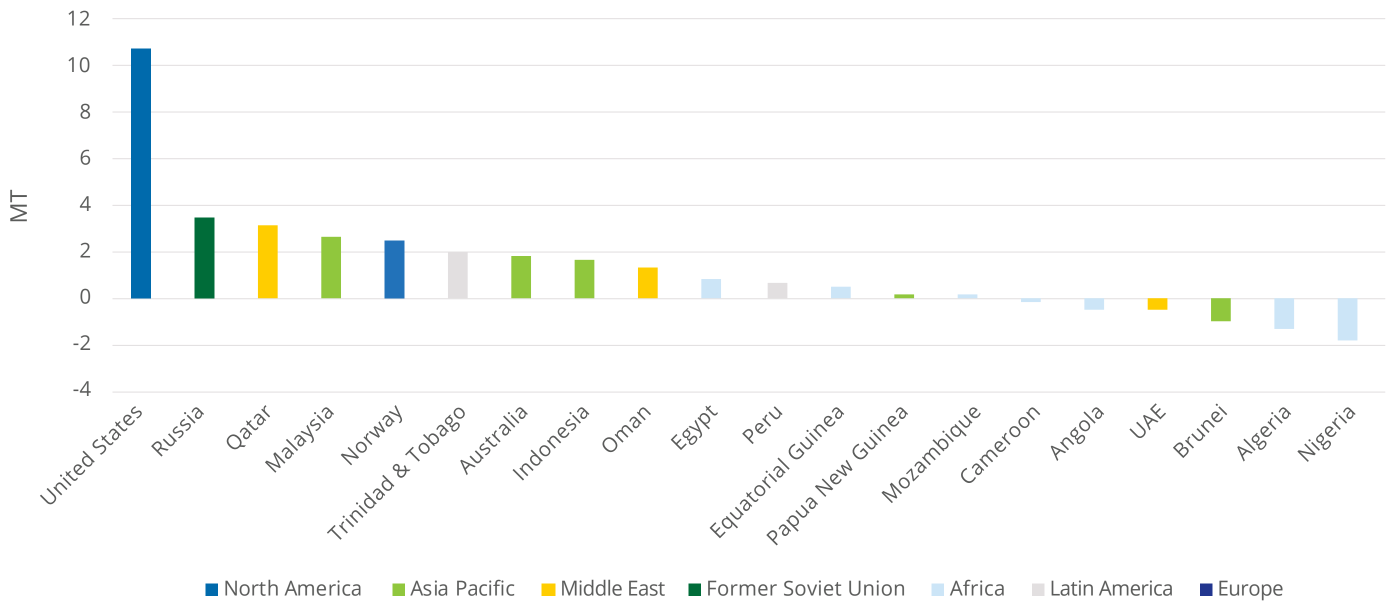


Source: Rystad Energy

A total of 19.9 MTPA of liquefaction capacity was added globally in 2022, of which 15 MTPA was from the US, 3.4 MTPA from Mozambique and 1.5 MTPA from Russia. Mozambique exported its first LNG shipment from its Coral South FLNG project in November 2022.

Australia remained the world's largest LNG exporter in 2022, exporting 80.9 MT, an annual increase of 1.9 MT, supported by reduced planned maintenance. The US overtook Qatar to become the world's second-largest LNG exporter in 2022. Despite Freeport LNG in Texas being taken offline following a fire in June 2022 which dented production capacity by 15.3 MTPA, the US managed to export 80.5 MT in 2022, a 10.5 MT increase on 2021, mainly driven by the startup of Calcasieu Pass LNG and Sabine Pass LNG T6. Qatar fell behind the US slightly, exporting 80.1 MT last year despite running above nameplate capacity of 77.1 MTPA. The top three exporters were together responsible for 60% of global LNG output in 2022. The world's fourth-largest exporter Russia exported 33 MT in 2022, up 3.4 MT on 2021 levels. Malaysia kept its spot in fifth place in 2022 with 27.3 MT of exports, 2.5 MT more than in 2021. In Norway, Snøhvit LNG came back online in June 2022 after being shut down in September 2020, contributing an additional 2.4 MT of supply to the global market.

Figure 3.2: 2022 Incremental LNG exports by market relative to 2021 (MT)



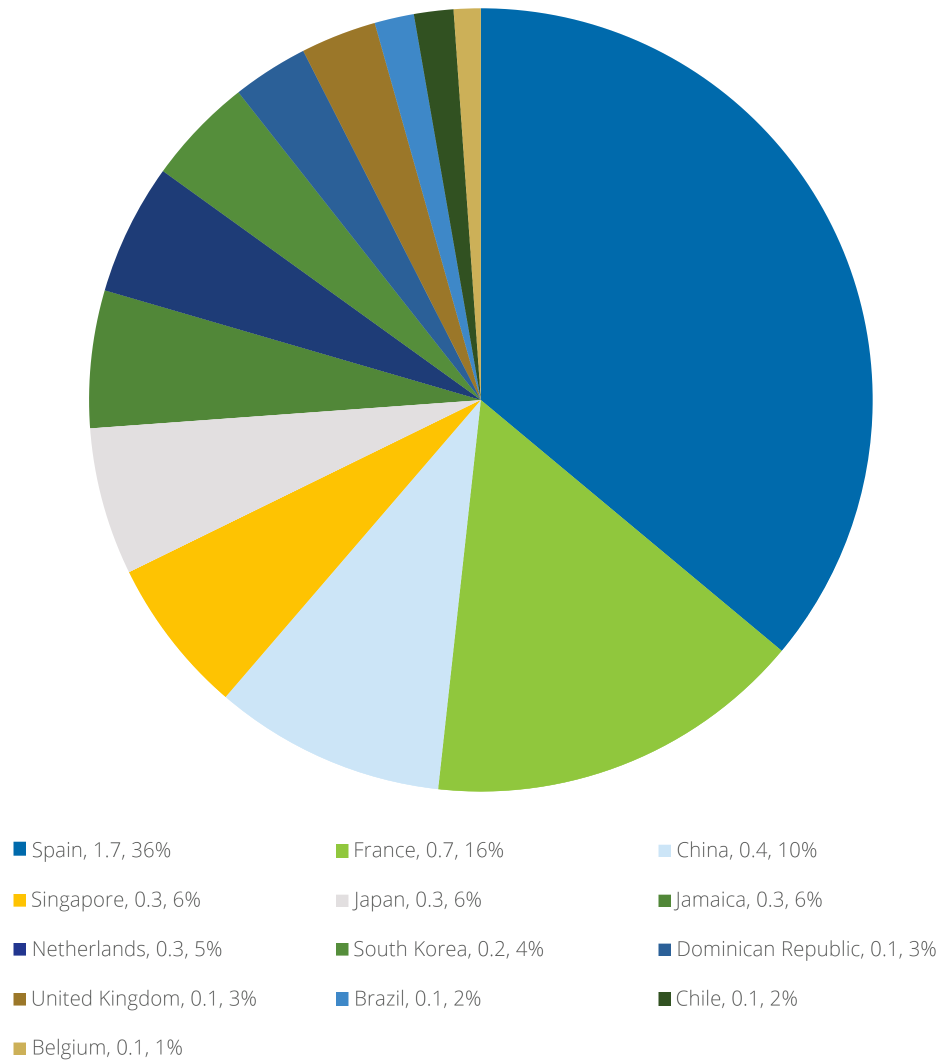
Source: Rystad Energy

Of the 20 LNG exporting markets, six reduced exports last year. Large reductions in LNG exports were observed in Nigeria (-1.8 MT) due to low feedstock and force majeure being declared following extreme flooding, Algeria (-1.4 MT) due to rising domestic gas demand, and Brunei (-1 MT) due to declining natural gas production. UAE, Angola and Cameroon saw LNG exports decline by a combined 1.3 MT last year.

Asia Pacific remained the largest export region, exporting a total of 136.6 MT in 2022, a 5.2 MT increase compared to 2021, mainly driven by Malaysia (+2.5 MT), Australia (+1.9 MT) and Indonesia (+1.7 MT) offsetting the decline from Brunei (-1 MT). The largest regional increase in exports came from North America (+10.5 MT), namely the US. The only regional decrease in exports was seen in Africa (-2.6 MT).

Re-exported trade increased by 20% in 2022 from 3.9 MT to 4.7 MT, equal to roughly 1% of global LNG trade in 2022. Re-exports were loaded in 13 markets, with Spain (1.7 MT) and France (0.7 MT) topping the list as seen in 2021. China was ranked in third place with 0.45 MT of LNG re-exported in 2022, followed by Singapore (0.3 MT), Japan (0.29 MT), Jamaica (0.27 MT) and the Netherlands (0.25 MT). Markets that re-exported volumes in 2021 but did not do so in 2022 were Argentina and Thailand. Conversely, China and the UK did not re-export in 2021, but in 2022 re-exported 0.45 MT and 0.15 MT respectively. Europe loaded 61% of all re-exported volumes, followed by Asia Pacific with 17%.

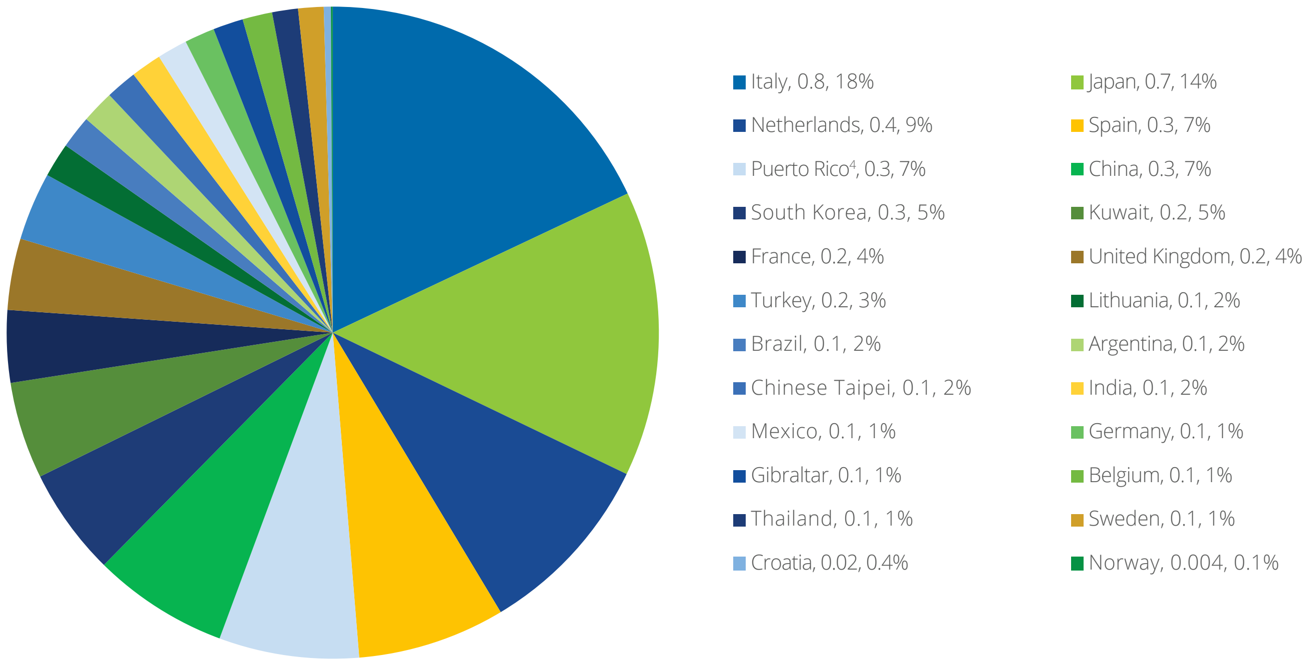
Figure 3.3: Re-exports loaded by re-loading market in 2022 (MT)



Source: Rystad Energy

In total, 24 markets received re-exported volumes in 2022, compared to 27 in 2021. Markets that received re-exported volumes in 2022, but did not do so in 2021, were Argentina, Mexico and Belgium. Conversely, markets that received re-exported volumes in 2021, but did not do so in 2022, were Bangladesh, the Dominican Republic, Pakistan, Panama, Greece and Portugal.

Figure 3.4: Re-exports received in 2022 by receiving market (MT)



Source: Rystad Energy

Courtesy Tokyo Gas

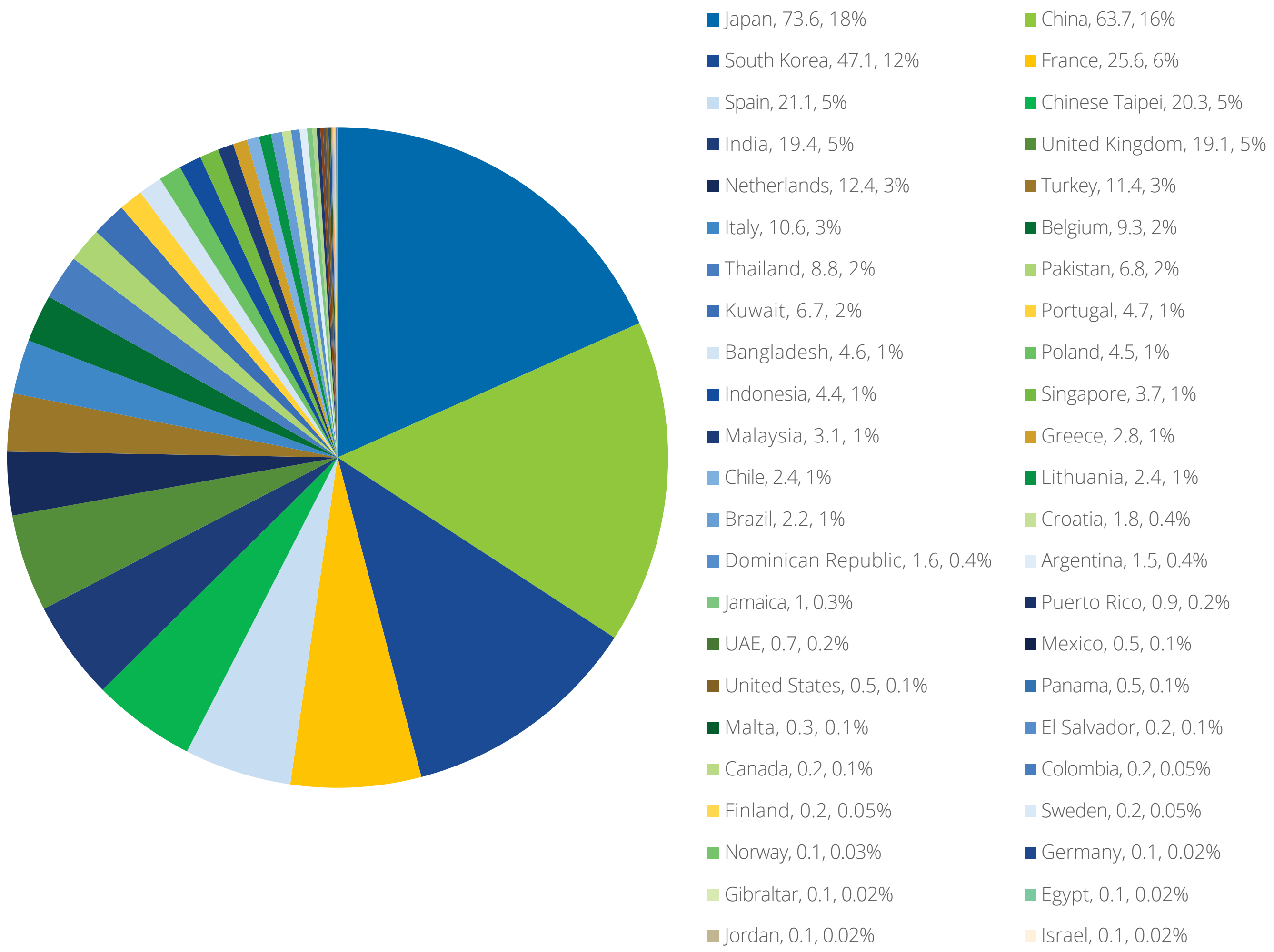
[4] Puerto Rico (United States)

3.3 NET LNG IMPORTS BY MARKET

In 2022, with El Salvador and Germany joining the ranks, 46 markets[5] imported LNG from 20 exporting markets. El Salvador imported 0.2 MT in 2022, with the first shipment delivered by Bilbao Knutsen in April 2022. Germany received its first FSRU Hoegh Esperanza at Wilhelmshaven with a 0.07 MT shipment onboard in December 2022.

The global energy crisis changed LNG import patterns during 2022. Thanks to a robust number of long-term LNG contracts, Japan regained its place as the world's largest LNG importer, importing 73.6 MT in 2022 despite it being a 1.3 MT decrease compared to 2021. China was the top importer in 2021 with 78.9 MT of imports, but featured in second place in 2022 after falling to 63.7 MT. The 15.2 MT import drop, the largest reduction seen last year, was mainly driven by COVID-19-related lockdowns and reduced spot market purchases by Chinese buyers. South Korea remained in third place with 47.1 MT of imports last year, relatively flat (+0.6 MT) compared to 2021. France, which ranked seventh in 2021, claimed fourth position in 2022 after importing 25.6 MT, up 109% year-on-year and the largest increase seen in 2022. Spain was the world's fifth-largest importer with 21.1 MT (+7.3 MT) in 2022, followed by Chinese Taipei with 20.3 MT (+0.5 MT). India imported 19.4 MT last year, a 4.2 MT drop on 2021. The Asian market lost its fourth place to France, ranking seventh in 2022.

Figure 3.5: 2022 LNG imports and market share by market (MT)



Source: Rystad Energy

[5] The count in 2022 excludes Myanmar which has stopped importing LNG in 2021. This report excludes those with only small-scale (<0.5 MTPA) regasification capacity but includes markets where small-scale terminals add large impact on import for the market, such as Finland (as of 2022), Norway, Sweden and Malta.

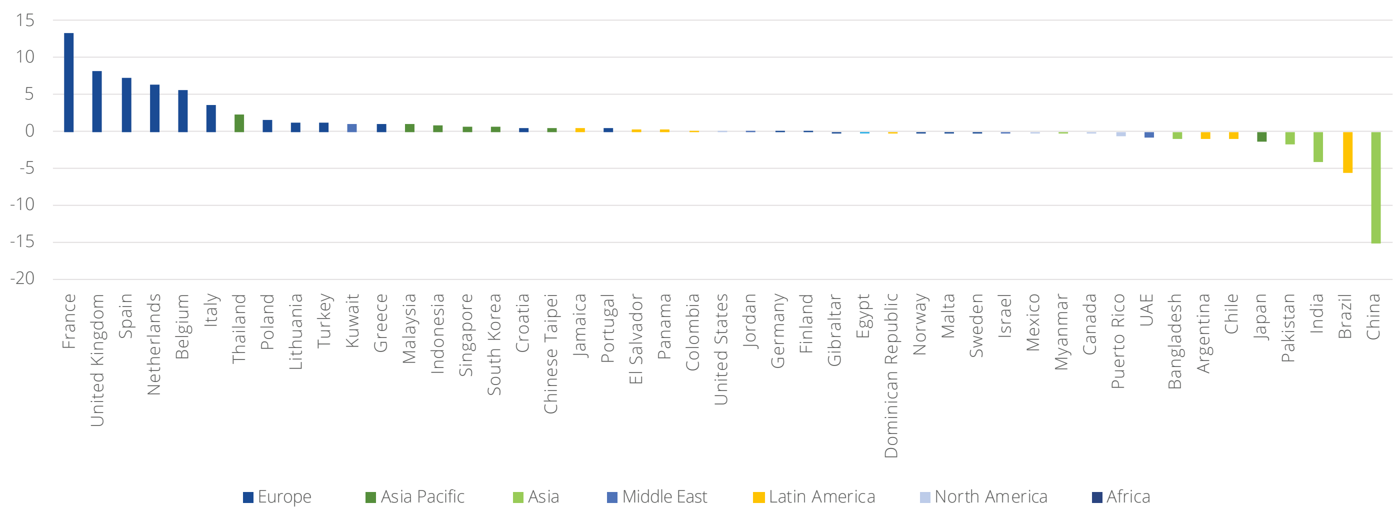
Asia Pacific – which comprises large LNG importers Japan, South Korea and Chinese Taipei as well as medium-sized LNG markets Thailand, Indonesia, Singapore and Malaysia – remained the world's largest importing region in 2022 with 160.9 MT of total imports, a 2.9% or 4.6 MT increase on 2021. Imports increased in all markets in the region except for Japan (-1.3 MT). Thailand imported a record 8.8 MT in 2022, largely driven by the commissioning of the Map Ta Phut Terminal 2 in June 2022 which has regasification capacity of 7.5 MTPA. Among all regions, Asia experienced the largest decline (-22.2 MT) from 116.7 MT in 2021 to 94.5 MT in 2022, with 68% of the drop coming from China (-15.2 MT). All markets in the region imported less LNG in 2022 than in 2021. The rest of the 32% decline was due to lower imports by India (-4.2 MT), Pakistan (-1.7 MT), Bangladesh (-1 MT) and Myanmar (-0.1 MT) due to high spot prices.

LNG imports to Europe grew to an historical high of 126.6 MT, making the region the second largest in the world in 2022, a record growth of 50.4 MT compared to 2021. Nearly all markets in the region increased their LNG imports, with France (+13.4 MT) topping the list, followed by the UK (+8.2 MT), Spain (+7.3 MT), the Netherlands (+6.4 MT), Belgium (+5.6 MT) and Italy (+3.6 MT). LNG imports played a leading role in helping Europe secure energy supply and compensate for the loss of Russia piped gas supplies which were down 70% by end-2022. Average utilisation rates at European regasification terminals exceeded 70% in 2022, suggesting receiving capacity was at risk of becoming bottlenecked. Dozens of new receiving terminals have been planned since the Russia-Ukraine conflict broke out on the 24th of February 2022. A total of 14.5 MTPA of new regasification capacity was added in Europe last year, of which 8.8 MTPA was in Netherlands (Gate LNG expansion and Eemshaven FSRU), 5.5 MTPA in Germany (Wilhelmshaven FSRU) and 0.1 MTPA in Finland (Hamina LNG terminal).

Latin America saw LNG imports fall by 40% last year from 16.3 MT in 2021 to 9.7 MT in 2022. This was mainly driven by Brazil which has been using less gas for power generation in the past 10 years due to favorable hydropower conditions. The exception was in 2021 when Brazil experienced one of the worst droughts in its history and imported 7.8 MT in emergency LNG supplies. In 2022, Brazil imported 2.2 MT, just under the 2.4 MT imported in 2020. Argentina also imported less LNG last year, with volumes at 1.5 MT compared to 2.5 MT in 2021 due to higher domestic production. With its domestic gas production limited by infrastructure constraints, Argentina imports LNG as a complementary source of supply for power generation. Chile saw LNG imports drop 1 MT to 2.4 MT in 2022. By contrast, imports rose in Jamaica (+0.5 MT), Panama (+0.2 MT), El Salvador (+0.2 MT) and Colombia (+0.1 MT) to supply power generation facilities.

North America recorded a 1 MT reduction in LNG imports to 2.1 MT in 2022, mainly driven by Puerto Rico (-0.7 MT). The Middle East saw imports rise 0.2 MT last year, with Kuwait increasing imports by 1.1 MT, but UAE reducing them by 0.8 MT.

Figure 3.6: Incremental 2022 LNG imports by market and incremental change relative to 2021 (MT)



Source: Rystad Energy

3.4 LNG INTERREGIONAL TRADE

In 2022, global LNG trade flows continued to be dominated by intra-Asia Pacific trade (97.9 MT), mainly driven by a rise in exports from Australia to Japan (31.2 MT), South Korea (11.6 MT) and Chinese Taipei (7.6 MT) and from Malaysia to Japan (11.8 MT). Most of the remaining supply from Asia Pacific went to Asia (37.8 MT), as seen in previous years. Exports from Australia to China alone totalled 22.8 MT in 2022. It is worth noting that Asia Pacific shipped 0.2 MT to Europe, including one cargo from Australia to the Netherlands, one cargo from Indonesia to France and one from Indonesia to Turkey. Despite being a long distance with high shipping costs, the cargoes helped meet Europe's immediate needs for LNG to offset lower Russian piped gas volumes.

The second-largest LNG interregional trade flow was from North America to Europe at 55.2 MT, a 148% increase compared to 2021, again largely compensating for Europe's loss of Russian piped gas volumes. North America sent 14.2 MT to Asia Pacific (6.2 MT to South Korea and 4.4 MT to Japan) and only 1.9 MT to China. The third-largest trade flow was from the Middle East to Asia at 40.6 MT (+6.7 MT over 2021), most of which was exported from Qatar (36.1 MT, +9.1 MT).

Trade from the Middle East to Asia Pacific fell to 30.7 MT last year from 36.3 MT in 2021. Africa prioritised Europe's need for LNG in 2022, exporting 28.6 MT to Europe, compared to 23.8 MT in 2021. By contrast, African exports to Asia fell to 4.3 MT last year from 11.4 MT in 2021, mainly driven by a reduction in exports there from Egypt (-3.1 MT), Nigeria (-1.5 MT) and Angola (-1.4 MT).

Even though Russia pipeline exports to Europe fell significantly in 2022, Russian LNG exports to Europe increased by 2 MT to 14.8 MT. The second largest offtaker of Russian LNG was the Asia Pacific region which imported 11.5 MT from Russia in 2022. Most of Russia's remaining LNG went to Asia, with China the main customer. Europe was the largest offtaker of LNG from Latin America, receiving 5 MT of LNG from the region, a 95% or 2.4 MT increase compared to 2021. In Europe, Norway was the sole LNG producer after bringing Snøhvit LNG back online in mid-2022 following an outage. Norway exported all of its 2.7 MT of LNG output to Europe last year.

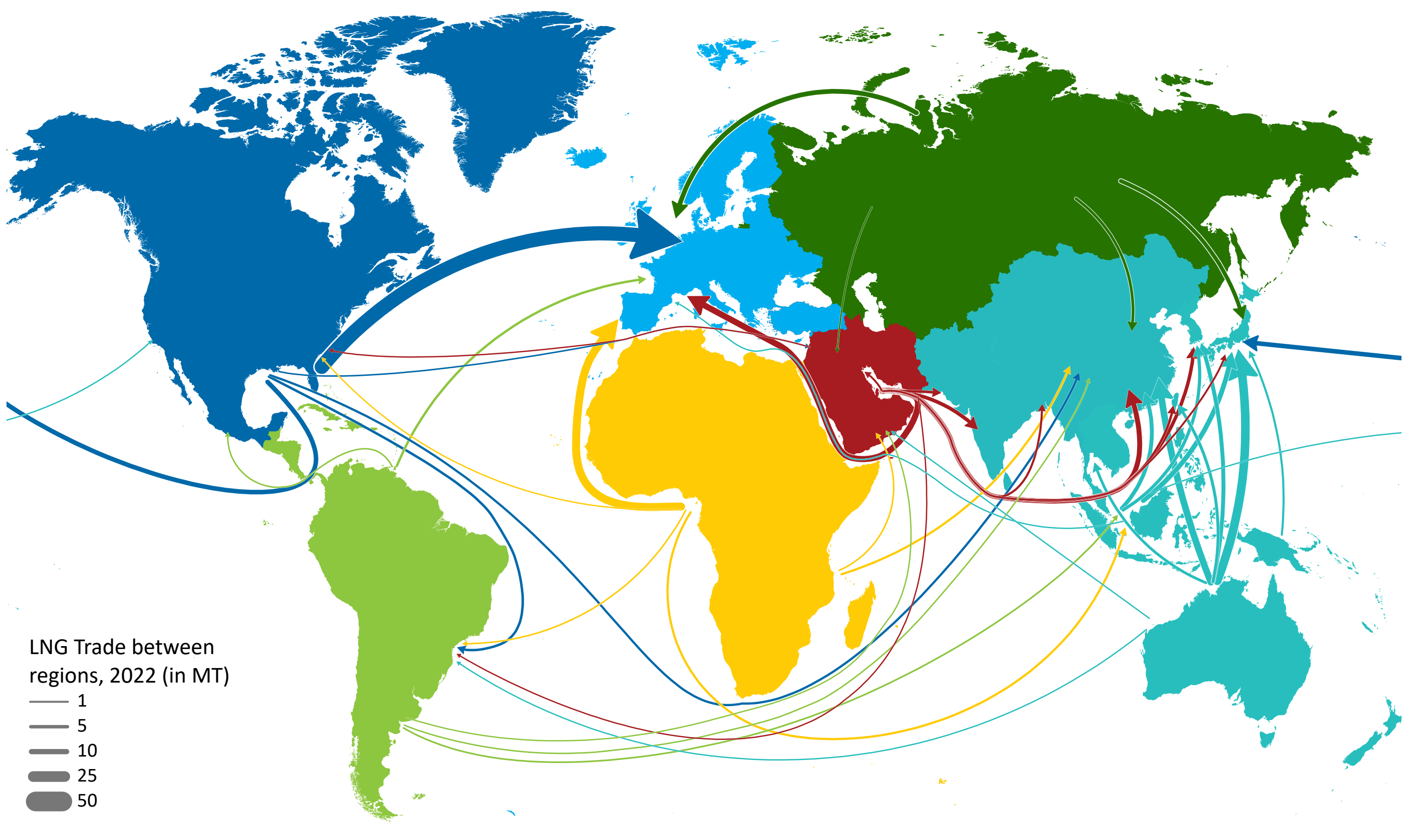
Table 3.1: LNG trade between regions, 2022 (MT)

Exporting Region / *Importing Region*	Asia Pacific	Middle East	North America	Africa	Russia	Latin America	Europe	Re-exports Received	Re-exports Loaded	**Total**
Asia Pacific	97.9	30.7	14.2	4.3	11.5	2.0	-	1.0	-0.8	**160.9**
Europe	0.2	20.6	55.2	28.6	14.8	5.0	2.7	2.5	-2.9	**126.6**
Asia	37.8	40.6	4.4	4.3	6.6	0.9	-	0.4	-0.4	**94.5**
Latin America	0.2	0.2	5.4	1.4		2.8	-	0.2	-0.6	**9.7**
Middle East	0.1	4.2	1.2	1.5	0.1	0.2	-	0.2	-	**7.6**
North America	0.3	0.1	0.1	0.1		1.1	-	0.4	-	**2.1**
Africa	-	-	-	0.1	-	-	-	-		**0.1**
Total	**136.6**	**96.5**	**80.5**	**40.3**	**33.0**	**12.0**	**2.7**	**4.7**	**-4.7**	**401.5**

Source: Rystad Energy

Courtesy KOGAS

Figure 3.7: LNG trade between regions, 2022



Source: Rystad Energy

3.5 UPDATE ON CARBON-OFFSET LNG

Despite carbon-offset LNG having faded from public view since 2021 as the global focus was redirected towards energy security, there is evidence to suggest that demand for this product is structural, especially in North Asia. Carbon-offset LNG involves the offsetting of carbon emissions resulting from the production, liquefaction, transportation, regasification and combustion of LNG through the purchase of carbon credits.

Since 2019, there has been a growing interest in the use of carbon offsets to support actions towards lower emissions targets. At least 53 carbon-offset cargoes have been traded since 2019, though many more have likely been traded without public announcements. Japan and China have remained the most important destinations for carbon-offset cargoes, importing at least 17 and 20 cargoes respectively to date, equal to 70% of all known carbon-offset trades. Carbon-offset LNG remains popular in these markets to support their net-zero emissions commitments. In Japan, at least 47 downstream customers have signed on to carbon-offset gas sales, while China holds a 'carbon-neutral' sales and purchase agreement (SPA), between Shell and PetroChina. In addition, Pavilion Energy has SPAs with Qatar Energy Trading, Chevron, and BP, all of which involve value-chain specific measurement and reporting of greenhouse gas (GHG) emissions of the delivered LNG cargoes. This will enhance visibility and transparency of the value chain emissions, a positive step to continue minimising lifecycle emissions, as well as facilitating credible emissions offsetting in regimes with already prevalent carbon taxes or emissions trading.

In line with increasing public scrutiny on the emissions-integrity of carbon-offset LNG, recent traded cargoes have been using offsets not just for CO2 but also for CO2-equivalent emissions, which includes methane and other greenhouse gas emissions. The emissions coverage has grown from just production-side emissions to the entire value chain through to combustion, which is a requirement under GIIGNL's industry framework for cargoes to be termed 'carbon-neutral'. Industry participants have also supported the move towards higher transparency on emissions identification, quantification, reporting, and verification. In November 2021, Pavilion Energy, Qatar Energy, and Chevron jointly published a quantification and reporting methodology[6] to develop a GHG emissions statement for an LNG cargo. In June 2022, Cheniere began issuing 'emissions tags' which quantify the GHG impact of an LNG cargo from wellhead to delivery point.

[6] https://www.chevron.com/-/media/chevron/sustainability/documents/SGE-methodology.pdf

While carbon-offset cargoes coupled with high-integrity emissions reporting can be considered an incremental step in the decarbonisation of the LNG sector, carbon mitigation solutions, such as renewable energy-sourced electrification of the production chain and carbon capture, utilisation and storage (CCUS) will be required to make large-scale emissions reductions. Indeed, these are becoming increasingly common in upcoming projects to ensure support from lenders and to prolong the project lifetime.

The decarbonisation of the LNG sector will require a multi-pronged approach. As monitoring, reporting and verification (MRV) of emissions becomes increasingly stringent, high-integrity carbon-offsets – in line with principles of additionality, permanence, and non-deterrence – can play a helpful role in mitigating remaining emissions after other emission reduction and avoidance measures have been implemented in the project design.

Future-proofing LNG projects to ensure compatibility with the energy transition and Paris Agreement goals is a priority for the industry. In addition to the immediate and short-term measures above, there is ongoing work on the longer-term deep decarbonisation options toward 2050. The future of the LNG value chain can see several deep decarbonisation pathways, including renewable natural gas, biomethane, low-carbon and renewable hydrogen, ammonia, e-methane and carbon capture utilisation and storage (CCUS). It remains to be seen whether a clearly dominant technology option will emerge through the transition process, or there will be a mix of liquefied gas technologies at play, but it is clear that this work needs to continue and to accelerate to deliver the technological revolution required for the world to meet the mammoth challenge of decarbonising the 80% of its energy use that still relies on fossil fuels today.

Table 3.2: Known carbon-offset cargoes trade flow, 2019-2022

To Market / *From Market*	China	India	Italy	Japan	Mexico	Nether-lands	Singapore	South Korea	Spain	Chinese Taipei	United Kingdom	**Total**
Australia	1			5				2		2		**10**
Brunei	1			1								**2**
Indonesia										1		**1**
Malaysia	3			2								**5**
Nigeria										1		**1**
Oman	1	1								1		**3**
Portfolio	13			5								**18**
Qatar	1								1			**2**
Russia				2						1	1	**4**
Trinidad and Tobago					1							**1**
UAE		1										**1**
United States			1	2		1	1					**5**
Total	**20**	**2**	**1**	**17**	**1**	**1**	**1**	**2**	**1**	**6**	**1**	**53**

Source: Rystad Energy

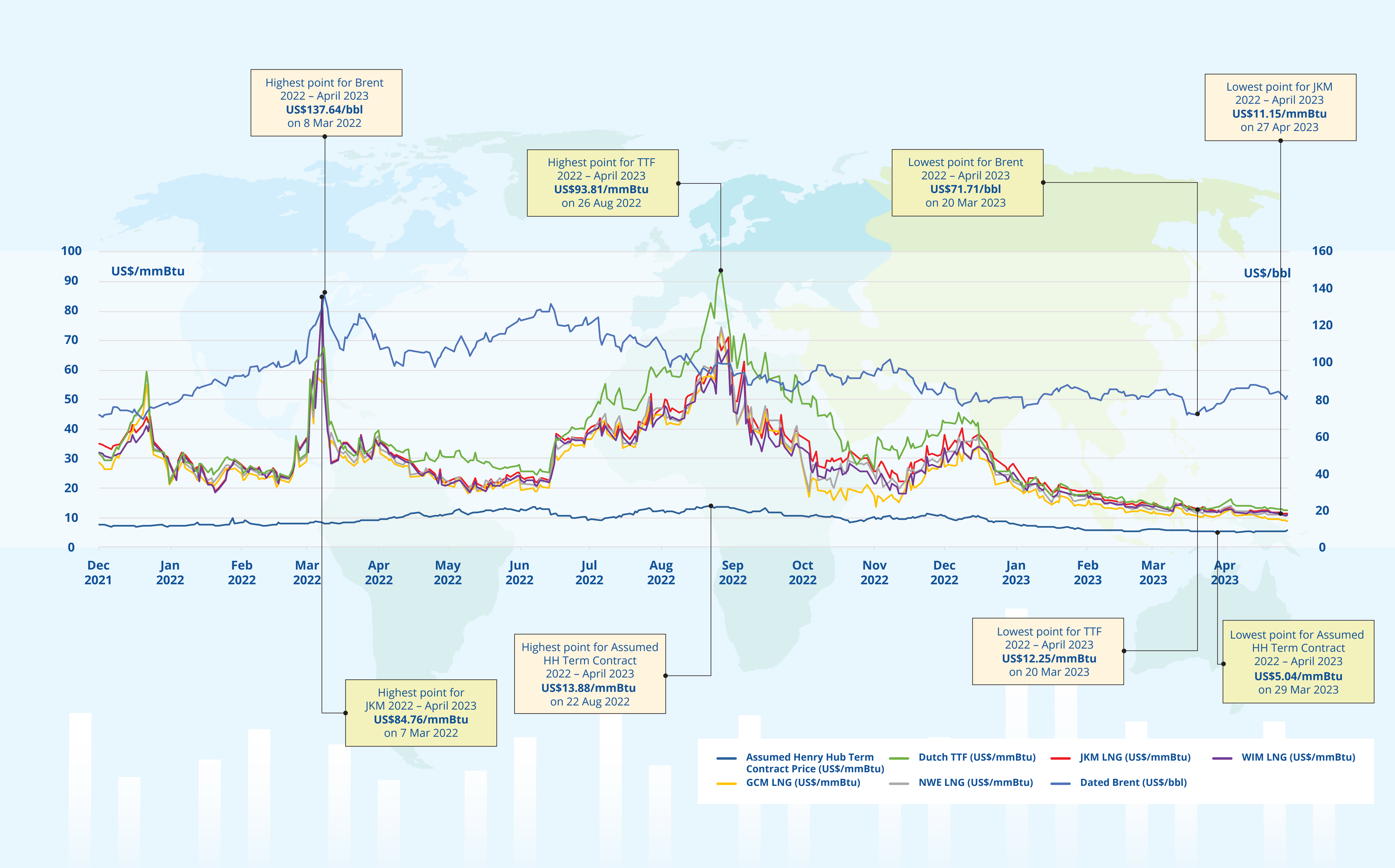
Courtesy Dynagas

Table 3.3: LNG trade volumes between markets, 2022 (MT)

Markets	Algeria	Angola	Australia	Brunei	Cameroon	Egypt	Equatorial Guinea	Indonesia	Malaysia	Mozam-bique	Nigeria	Norway	Oman	Papua New Guinea	Peru	Qatar	Russia	Trinidad & Tobago	UAE	United States	Re-exports Received	Re-exports Loaded	2022 Net Imports	2021 Net Imports
China	0.08	-	22.80	0.33	-	0.20	0.38	4.05	7.45	-	0.36	-	0.80	2.45	0.22	15.84	6.34	0.52	0.12	1.89	0.32	-0.45	63.69	78.89
India	0.14	0.69	0.38	-	0.29	0.14	0.14	0.15	0.08	-	0.96	-	0.92	-	-	10.30	0.29	0.11	2.59	2.16	0.07	-	19.41	23.58
Pakistan	0.07	0.07	-	-	-	0.07	-	-	0.06	-	0.32	-	-	-	-	6.04	-	-	0.14	0.08	-	-	6.83	8.52
Bangladesh	0.06	-	-	-	-	0.07	0.07	-	0.08	-	0.21	-	-	-	-	3.89	-	-	-	0.22	-	-	4.60	5.60
Asia	0.35	0.76	23.18	0.33	0.29	0.48	0.58	4.19	7.67	-	1.84	-	1.72	2.45	0.22	36.07	6.63	0.63	2.84	4.35	0.39	-0.45	94.54	116.72
Japan	0.08	-	31.22	3.35	-	0.20	0.07	2.92	11.84	-	1.01	-	2.69	3.76	0.21	2.82	7.05	0.13	1.40	4.44	0.66	-0.29	73.58	74.89
South Korea	0.07	-	11.61	0.20	0.08	0.60	0.23	3.28	5.31	-	0.54	-	4.57	0.51	0.71	9.53	3.06	0.14	0.38	6.21	0.25	-0.21	47.07	46.43
Chinese Taipei	-	-	7.57	0.06	-	-	0.13	1.23	0.47	-	0.33	-	0.34	1.27	0.12	5.27	1.13	-	0.18	2.11	0.07	-	20.28	19.79
Thailand	0.07	0.07	1.54	0.13	-	0.18	0.08	0.22	1.70	-	0.27	-	0.65	0.06	-	2.37	0.08	0.63	0.13	0.53	0.06	-	8.78	6.55
Indonesia	-	-	0.47	-	-	0.04	-	3.34	-	-	0.07	-	-	-	-	-	0.13	-	-	0.34	-	-	4.39	3.58
Singapore	-	0.07	2.68	-	-	0.08	0.08	0.03	-	-	-	-	-	-	-	0.38	0.07	0.08	-	0.58	-	-0.30	3.74	3.02
Malaysia	-	-	2.16	0.60	-	-	-	-	0.32	-	-	-	-	-	-	-	-	-	-	-	-	-	3.08	2.08
Asia Pacific	0.22	0.14	57.24	4.34	0.08	1.10	0.58	11.03	19.65		2.23	-	8.25	5.61	1.04	20.37	11.52	0.98	2.09	14.20	1.05	-0.80	160.92	156.34
France	3.19	0.76	-	-	0.13	0.64	0.18	0.07	-	-	0.91	0.81	0.08	-	0.04	1.51	5.59	0.31	0.06	11.89	0.17	-0.73	25.59	12.22
Spain	0.53	0.21	-	-	0.14	1.16	0.43	-	-	0.08	4.50	0.06	0.40	-	0.13	0.98	3.69	0.83	-	9.23	0.34	-1.69	21.06	13.80
United Kingdom	0.47	0.48	-	-	-	0.16	-	-	-	-	0.40	0.19	-	-	1.61	5.55	0.37	0.23	-	9.66	0.17	-0.15	19.12	10.94
Netherlands	0.14	0.69	0.08	-	0.21	0.36	0.21	-	-	-	0.08	0.44	-	-	-	0.09	1.81	0.43	-	7.74	0.43	-0.25	12.45	6.01
Turkey	3.92	0.07	-	-	-	1.77	0.07	0.07	-	-	0.59	-	0.08	-	-	0.07	0.23	0.29	-	4.05	0.16	-	11.35	10.19
Italy	1.11	0.07	-	-	-	0.49	0.21	-	-	-	0.11	0.06	0.08	-	-	5.22	0.07	0.29	-	2.07	0.84	-	10.63	7.00
Belgium	0.08	0.07	-	-	0.15	0.08	0.07	-	-	-	-	0.11	-	-	-	4.69	2.32	-	-	1.78	0.07	-0.05	9.35	3.73
Portugal	-	-	-	-	-	-	0.08	-	-	-	2.24	-	-	-	-	-	0.23	0.57	-	1.57	-	-	4.69	4.25
Poland	-	-	-	-	-	0.07	-	-	-	-	0.15	-	-	-	-	1.63	-	0.07	-	2.56	-	-	4.49	2.90
Greece	0.39	-	-	-	-	0.36	-	-	-	-	0.06	0.13	0.07	-	-	-	0.15	-	-	1.63	-	-	2.78	1.77
Lithuania	-	-	-	-	-	0.08	-	-	-	-	-	0.73	-	-	-	-	0.05	-	-	1.42	0.08	-	2.36	1.18
Croatia	-	-	-	-	-	0.23	-	-	-	-	-	-	-	-	-	0.07	-	-	-	1.47	0.02	-	1.78	1.25
Malta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19	-	0.12	-	-	0.31	0.35
Finland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	-	-	-	-	-	0.20	0.13
Sweden	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	-	-	0.07	-	-	-	0.06	-	0.18	0.27
Norway	-	-	-	-	-	-	-	-	-	-	-	0.09	-	-	-	-	0.01	-	-	-	0.00	-	0.10	0.14
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	0.07	0.00
Gibraltar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	0.07	0.07
Europe	9.82	2.35	0.08	-	0.63	5.39	1.24	0.14	-	0.08	9.04	2.67	0.70	-	1.78	19.81	14.77	3.22	0.06	55.18	2.48	-2.87	126.58	76.20
Chile	-	-	0.23	-	-	-	0.90	-	-	-	-	-	-	-	-	-	-	0.79	-	0.58	-	-0.08	2.42	3.44
Brazil	-	-	-	-	-	-	0.08	-	-	-	0.08	-	0.08	-	-	0.09	-	-	-	1.86	0.08	-0.08	2.19	7.78
Dominican Republic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.84	-	0.94	-	-0.15	1.64	1.66
Argentina	-	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-	0.07	-	0.14	-	1.16	0.08	-	1.47	2.47
Jamaica	-	-	-	-	-	-	-	-	-	-	0.35	-	-	-	-	-	-	0.70	-	0.23	-	-0.27	1.01	0.55
Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	0.45	-	-	0.51	0.27
El Salvador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25	-	-	-	-	0.25	0.00
Colombia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	-	-	0.20	0.10
Latin America	-	-	0.23	-	-	0.02	0.98	-	-	-	0.43	-	0.08	-	-	0.16	-	2.77	-	5.42	0.15	-0.56	9.68	16.27
Puerto Rico	0.06	-	-	-	-	-	-	-	-	-	-	-	0.12	-	-	-	-	0.36	-	-	0.32	-	0.87	1.53
Mexico	-	-	-	-	-	-	-	0.31	-	-	-	-	-	-	-	-	-	-	-	0.14	0.07	-	0.53	0.65
United States	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.52	-	-	-	-	0.52	0.43
Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14	-	-	0.08	-	-	-	-	0.22	0.51
North America	0.06	-	-	-	-	-	-	0.31	-	-	-	-	0.12	-	0.14	-	-	0.96	-	0.14	0.39	-	2.14	3.12
Kuwait	0.07	-	0.14	-	-	0.14	-	-	-	-	1.17	-	0.14	-	-	3.01	0.07	0.23	0.36	1.18	0.23	-	6.75	5.69
UAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.63	-	-	0.06	-	-	-	0.69	1.46
Jordan	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	0.00
Israel	-	-	-	-	-	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	0.18
Middle East	0.07	-	0.14	-	-	0.27	-	-	-	-	1.17	-	0.14	-	-	3.65	0.07	0.23	0.42	1.18	0.23	-	7.57	7.32
Egypt	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	0.07
Africa	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	0.07
2022 Exports	10.52	3.25	80.87	4.67	1.00	7.33	3.38	15.67	27.31	0.08	14.72	2.67	10.99	8.06	3.18	80.05	33.00	8.80	5.42	80.48	4.68	-4.68	401.48	-
2021 Exports	11.88	3.70	79.02	5.64	1.25	6.56	2.89	14.02	24.79	0.00	16.56	0.30	9.63	7.90	2.59	76.96	29.56	6.84	5.99	69.96	3.93	-3.93	-	376.05

Source: Rystad Energy

4 Price Trends



Source: S&P Global Commodity Insights

4. Price Trends

Courtesy CNOOC

The LNG market experienced a tumultuous year in 2022. The market tightness that emerged in 2021 continued and accelerated following Russia-Ukraine conflict in February 2022. Europe's sudden and pressing need to offset Russian piped gas volumes with short-term LNG deliveries, coupled with government-induced energy saving and gas demand destruction driven by high gas prices and stock-filling, contributed to an imbalanced and volatile market globally.

The market conditions contributed to a reversal in the Asian demand trend, as it reduced significantly in most locations throughout the region, with the two fastest-growing major LNG markets in recent years, China, and India, both taking a major step back in procurement. One of the adverse effects of this has been a slowdown in coal to gas switching. While prices modulated closer to more historically average levels at the start of 2023, they remain elevated with the risk of a return to 2022 conditions still present as long as Europe remains strongly reliant on short-term LNG (which accounts for around 70% of the continent's imports) and LNG supply additions continue to be scant.

4.1 APAC[1] LNG MARKET PRICE TRENDS

The Platts JKM benchmark, which reflects cargoes delivered into Northeast Asia, averaged $33.98/mmBtu in 2022, reaching an annual daily low of $18.945/mmBtu on 20 January 2022 and hitting an annual high, also an all-time high for the benchmark, at $84.762/mmBtu on 7 March 2022.

Europe became the epicentre for LNG demand in 2022, as a consequence of the Russia-Ukraine conflict and the resulting energy security crisis, which has brought a newfound reliance on LNG imports. This kick-started intense inter-regional competition for marginal spot cargoes between Europe, Northeast Asia, and South Asia.

In June 2022, the fire-related closure of the Freeport LNG export facility in the US and the indefinite stoppage of Russian gas flows through the Nord Stream 1 pipeline due to its destruction coincided with an urgent need to fill gas storage inventory requirements by European companies. This lifted Asian LNG prices to an average of $46/mmBtu from August to October during the northern hemisphere's autumn season.

With high spot LNG prices throughout most of 2022, Asian buyers, particularly those that contributed to the highest demand growth in 2021, reduced spot procurement significantly. Instead, Asia's largest LNG importers relied on volumes from long-term LNG contracts and/or switched to other competing fuels wherever possible to avoid paying hefty prices for spot LNG cargoes. Other than Chinese Taipei (+2.4%), almost all the top LNG importers in the region reduced their LNG imports in 2022. China (-19.3%) and India (-17.7%) saw the steepest fall, while Japan (-1.8%) saw a more modest decline.

Price-sensitive buyers from China and India faced negative import margins as domestic gas markets remained heavily price regulated and capped at relatively low levels, even as India raised its domestic gas price ceiling by $2.540/mmBtu to $12.460/mmBtu and China partially incorporated the JKM into its domestic gas supply contract pricing formula[2].

Meanwhile, Thailand saw the most significant import growth during 2022 with a marked 29.7% year-on-year increase as it continued to struggle with limited gas production from its domestic Erawan gas field, the nation's single largest source of gas.

On the supply side, Malaysia added most significantly (12.6%) to the growth in exports amongst Asian producers despite seeing lower gas supplies from MLNG Dua due to a leak on the Sabah Sarawak gas pipeline in September. On the flipside, exports from Brunei fell by 14.0% on the back of declining domestic natural gas production.

Last year saw a significant decoupling of LNG cargo benchmarks and gas hub prices. JKM was at a discount to Europe's main gas hub, the TTF, for approximately 85% of the time from February 2022 to January 2023, averaging $7.940/mmBtu, with the largest discount of $30.225/mmBtu seen on 24 August 2022. This relationship has continued into 2023 and, according to the JKM forward curve as of April 2023, is likely to persist until 2028.

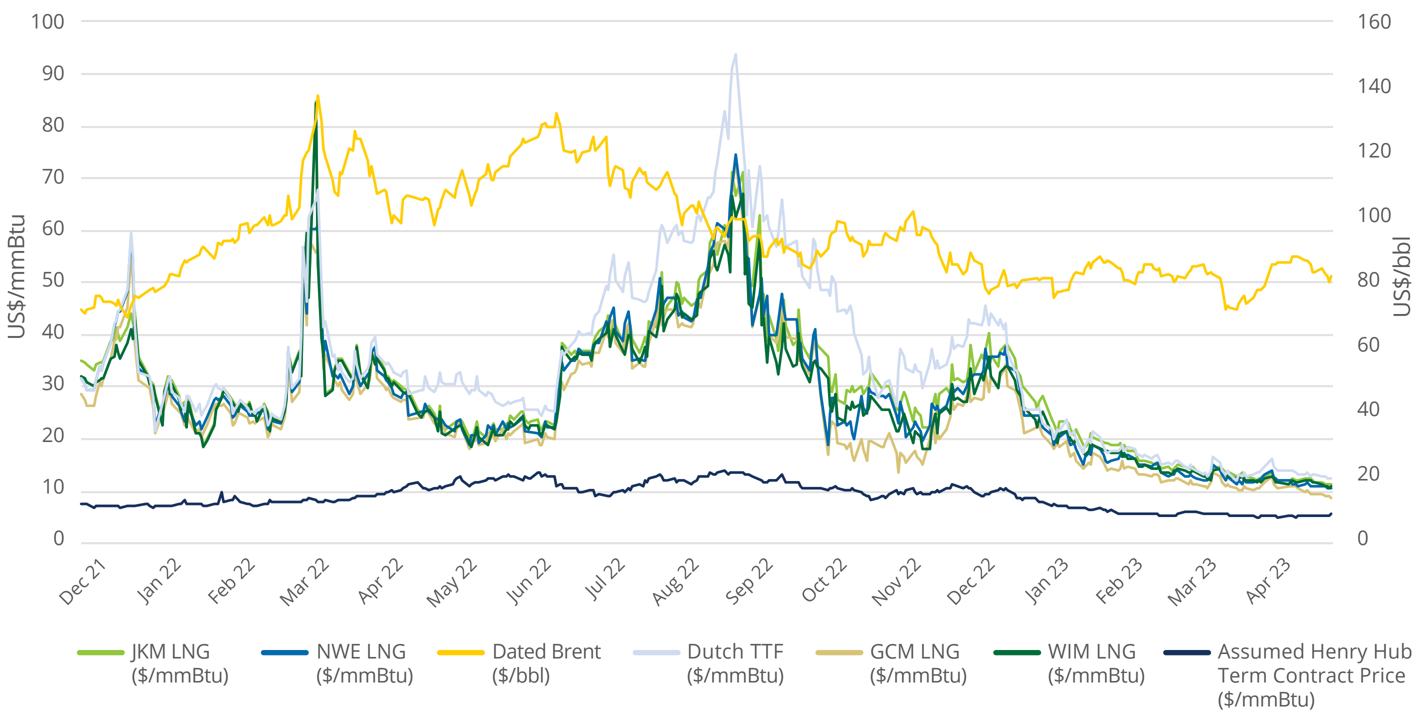
In Europe, the Platts Northwest Europe (NWE)[3] LNG Marker, which serves as the benchmark for cargoes delivered into Europe, averaged at $32.738/mmBtu throughout 2022. NWE price represented a large discount of $7.624/mmBtu compared to the Platts TTF assessment average price of $40.362/mmBtu in 2022. The East-West spread – the price difference between Platts JKM and Platts NWE – was so compressed in 2022 that France, the UK, and Spain came out on top as the largest LNG importers in 2022 from markets such as the US, replacing China, South Korea, and Brazil as top importers in 2021.

Mild winter temperatures in the northern hemisphere, coupled with higher inventories in Northeast Asia, has resulted in the JKM trending lower since the start of 2023, sliding below the $15/mmBtu mark on 17 February and hitting a 20-month low at $13.013/mmBtu on 7 March. The Platts West India Marker (WIM) also fell to $12.663/mmBtu on 7 March, the lowest it has been since July 2021. Lower spot LNG prices have already spurred spot procurement activity from buyers in India, Bangladesh, and Thailand.

Furthermore, greater market volatility and supply uncertainties caused by Russia-Ukraine conflict have largely driven an industry-wide pivot away from trading spot cargoes on a fixed-price basis to a floating-price basis. In 2021, 66% of all bids, offers and trades published in the Platts APAC LNG physical Market on Close (MOC) process were index-linked, with the remainder on a fixed price basis. In 2022, the proportion of index-linked spot trades on MOC increased to 93%. With spot cargoes in Asia trading in a narrower price band of $19 to $22/mmBtu in January 2023, there was an uptick in flat price bases to 32% of total share of data published in the Platts APAC LNG physical MOC process. Spot trading physical activity reduced in 2022 due to high cargo prices and heightened margin requirements at financial exchanges. The higher costs of hedging affected the ability of companies to manage risks associated with volatility in global gas markets. But there were signs of greater spot activity in the first quarter of 2023, with firms from South Asia and Southeast Asia kick-starting procurement due to lower price levels.

[1] APAC: Markets that are located on the east of Suez.
[2] PetroChina and Sinopec introduced JKM into their pricing formulas in 2022 for 10-20% of the total contracted volumes. https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/lng/111822-chinese-nocs-introduce-market-based-gas-pricing-in-downstream-contracts.
[3] Platts NWE reflects deliveries into the Netherlands, Belgium, Atlantic France, and the UK.

*Figure 4.1: Comparison of major LNG, pipeline gas and oil benchmarks, December 2021 to April 2023**



Note: Assumed Henry Hub (HH) Term Contract Price = HH*115% + $2.75/mmBtu
Source: S&P Global Commodity Insights

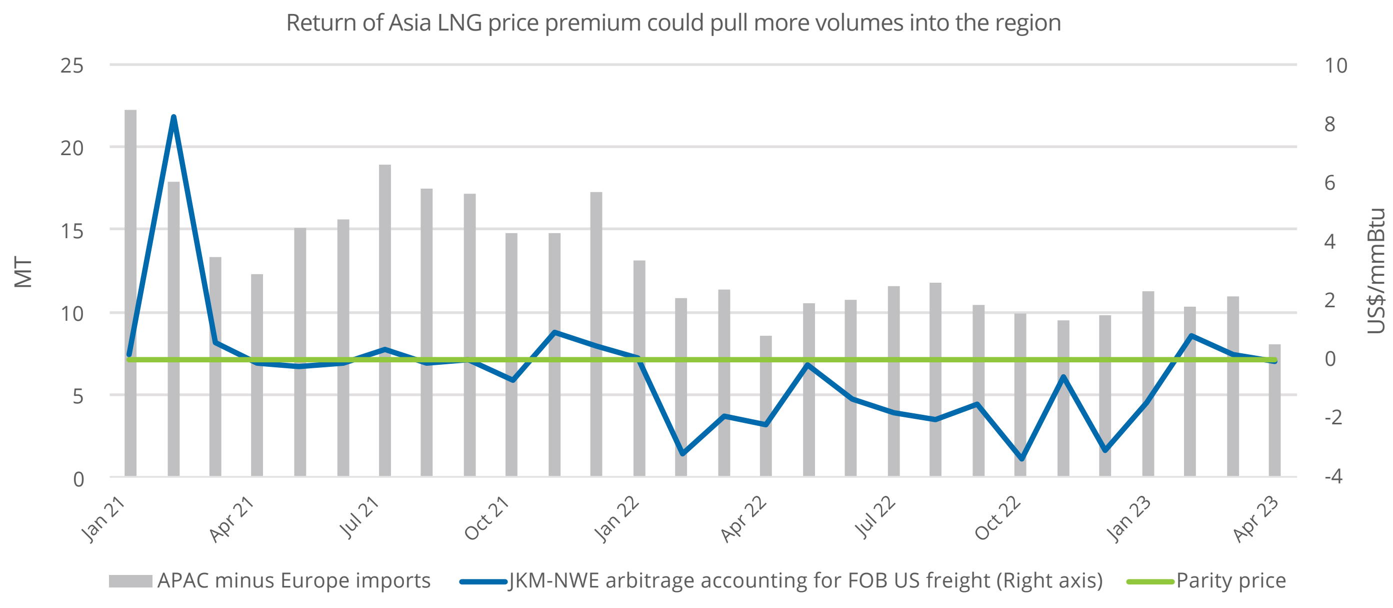
Courtesy Mitsui OSK Lines

4.2 ATLANTIC LNG MARKET PRICE TRENDS

S&P Global Commodity Insights Atlantic[4] LNG price assessments moved in a close band during 2022. However, gas hub prices on either side of the Atlantic (HH in the US and TTF in Europe) diverged the most on record. Logistics played a major part in this extraordinary trend in 2022: both a lack of sufficient liquefaction capacity on the US side and a lack of regasification capacity in North Europe.

The premium for TTF over HH peaked at $84.157/mmBtu on 26 August 2022. It averaged $33.728/mmBtu in 2022, compared to $6.697/mmBtu during 2020-2021. This reflected the impact of reduced gas pipeline flows into Europe and the sudden adjustment that the market needed to make to accommodate the significant supply shortage.

Figure 4.2: Comparison of LNG price and import volume between Asia and Europe, January 2021 to April 2023



Source: S&P Global Commodity Insights

Another way of observing this is through the difference between delivered LNG prices and gas pipeline prices in Europe. Platts NWE LNG price benchmark was at a discount versus the TTF of $8.497/mmBtu on average in 2022. By contrast, in 2021 the difference averaged a premium of a few cents. The most severe period of discounts was during September 2022, when Platts NWE LNG was on average at a discount of $19.628/mmBtu relative to the TTF.

The price difference is partially attributable to a lack of available regasification capacity in the Netherlands and Germany, reflecting the extremely high lump sums capacity holders or terminal operators have been asking to secure slots.

Nonetheless, a reduction in spot demand in Asia Pacific contributed to more supply being pushed to the Atlantic, while a build-up of floating storage[5] also contributed to an over-supply situation in the LNG cargo market early in the fourth quarter of 2022 relative to onshore gas supplies.

This evident basis risk between onshore gas hub prices in Europe and LNG deliveries has resulted in the rapid rollout of derivatives contracts that settle against European LNG price benchmarks. The first exchange-based trades on a European LNG derivatives contract went through in the fourth quarter of 2022 on the Chicago Mercantile Exchange's (CME) Northwest Europe Marker (NWM) contract, which settles against the monthly average of Platts NWE.

2023 has seen some easing of the issues described above, with price differences between the TTF and HH narrowing down and the discount for European LNG also reducing against the TTF. However, both these differentials are still considerably wider than historical norms. For instance, Platts NWE averaged a discount of $1.731/mmBtu to the TTF January-April 2023, versus a discount of just $0.029/mmBtu in 2020-2021.

Indeed, it appears that with Europe continuing to require LNG to meet around 40% of its gas needs vs around 20% in 2021, gas hubs in North Europe such as the TTF and The Hub Europe (THE) in Germany will need to continue to be priced at a larger premium to major LNG markets, especially delivered ex-ship (DES) Europe LNG, in order to attract sufficient volumes.

The constant throughout this period of turmoil has been how closely LNG prices have tracked each other, reacting to arbitrage opportunities and price incentives in different parts of the world and adjusting to different demand and supply signals.

In the Atlantic, the Platts NWE and Platts Gulf Coast Marker (GCM), reflecting the prevailing price of LNG cargoes on a US FOB basis, had a simple correlation of 98% in 2022, indicating how closely the two locations tracked each other.

Perhaps the best reflection of how gas market infrastructure created dislocations in 2022 is comparing how Platts GCM, NWE and the TTF compared to each other. Platts GCM averaged $2.50/mmBtu below Platts NWE in 2022, even though the geographical distance between the locations reflected in each benchmark is around 5,000 miles. Platts NWE averaged a $8.497/mmBtu discount to the TTF, even though the downstream market of the Netherlands is central to TTF and is also reflected as part of the standard delivery terms for Northwest Europe LNG cargoes.

Courtesy Osaka Gas

[4] Atlantic: Markets that are located on the west of Suez.
[5] Floating storage refers to the LNG carriers that are on water for a significant length of time.

5 LNG Liquefaction Plants

Global liquefaction capacity reached **478.4 MTPA** in 2022.

Capacity Additions for 2022

19.9 MTPA of liquefaction capacity brought online

4% year-on-year growth vs 2021

United States
88.1 MTPA
Market with the highest liquefaction capacity

Australia
87.6 MTPA

Qatar
77.1 MTPA

Pre-FID

997.1 MTPA of liquefaction capacity currently in pre-FID stage

333 MTPA from USA

137 MTPA from Russia

229.6 MTPA from Canada

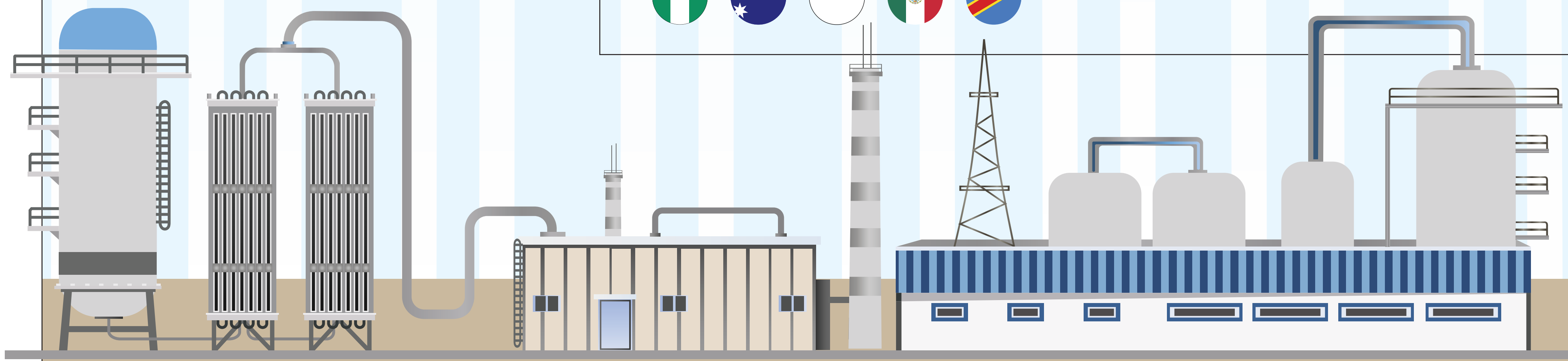
45.5 MTPA from Australia

FIDs and Under Construction

FID in 2023
23.5 MTPA

Plaquemines LNG, Port Arthur LNG

178.3 MTPA of liquefaction capacity under construction or approved for development as of April 2023



5. Liquefaction Plants

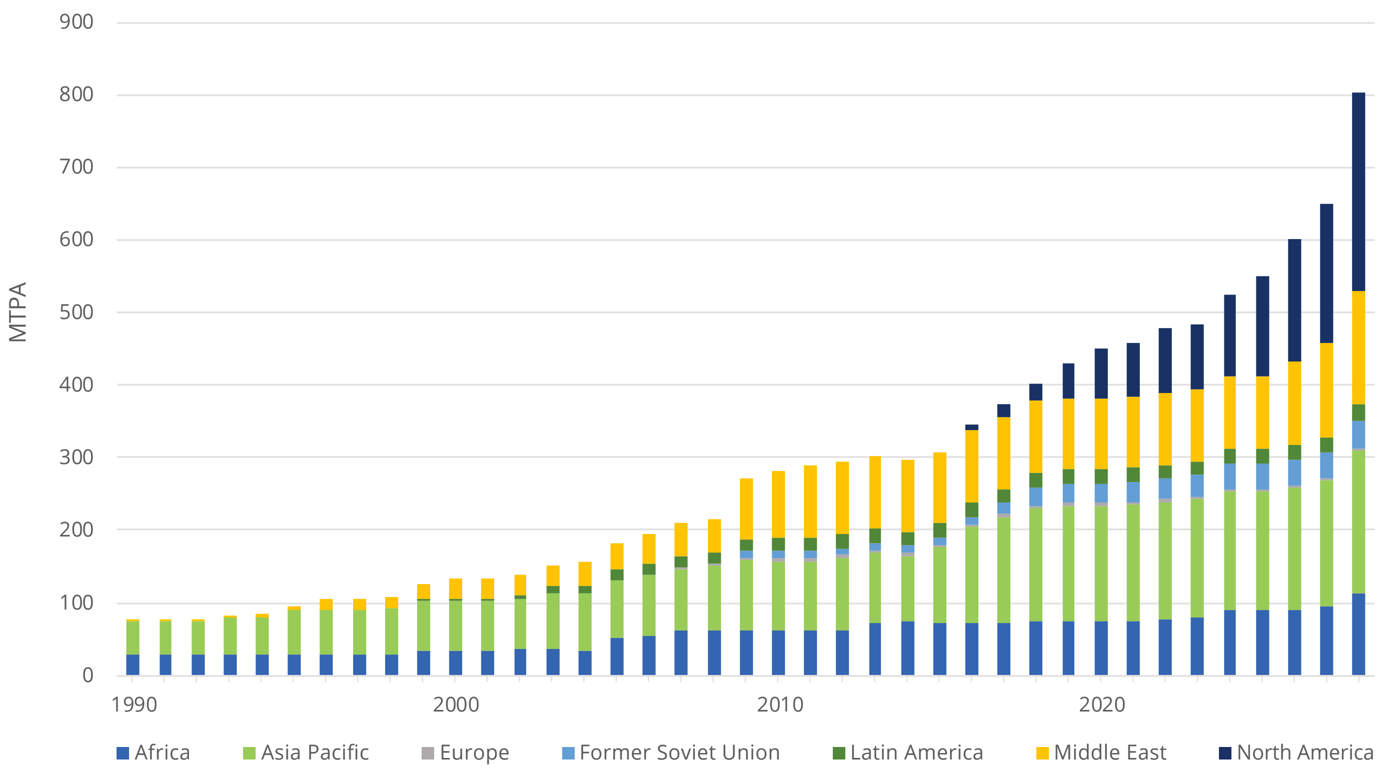
A total of 19.9 MTPA of liquefaction capacity was added in 2022, boosting global liquefaction capacity to 478.4 MTPA[1] as of end-2022. The average global utilisation rate in 2022 was 89%, compared to 80.4% in 2021. This was due to an increase in LNG imports in Europe to offset the significant drop in Russian pipeline gas volumes to Europe. In the first quarter of 2023, two liquefaction projects in the US with a combined capacity of 23.5 MTPA took FID, increasing the total capacity of FID projects to 178.3 MTPA as of April 2023.

Courtesy Qatargas

[1] Includes Yemen and Libya, although Yemen LNG and Marsa El Brega LNG have suspended operations, this number excludes the liquefaction capacity of Kenai LNG, which has announced plans to be converted to an import terminal.

5.1 OVERVIEW

Figure 5.1: Global liquefaction capacity growth by region, 1990-2028

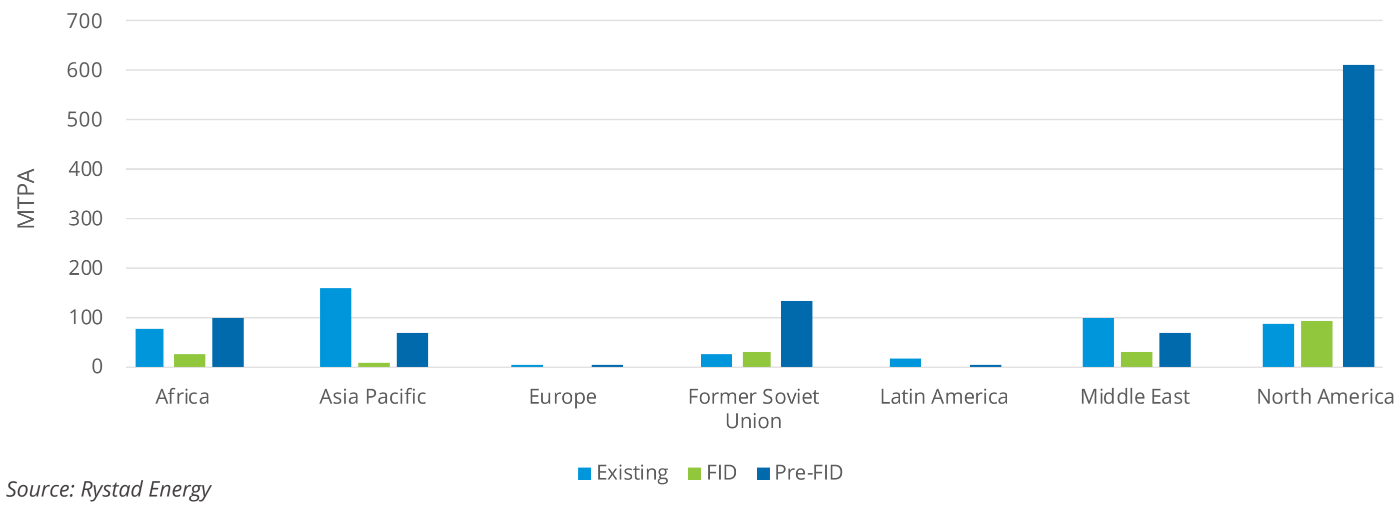


Source: Rystad Energy

In 2022, a total of 19.9 MTPA of liquefaction capacity was brought online globally, primarily due to capacity added in the US. The US export terminal Sabine Pass LNG T6 (5.0 MTPA) started commercial operations in February with Calcasieu Pass LNG T1-T18 (10 MTPA) commissioned in May 2022, lifting total operational US liquefaction capacity to 88.1 MTPA. Amid the ongoing conflict between Russia and Ukraine, Russia's Portovaya LNG T1 (1.5 MTPA) started commercial operations in November 2022 despite some international players such as BP, Shell, Equinor and ExxonMobil withdrawing from joint ventures in Russia. In Africa, Coral South FLNG (3.4 MTPA) in Mozambique successfully shipped its first LNG cargo in November 2022, bringing additional LNG volumes to the global gas market.

As of April 2023, Altamira FLNG and Tangguh LNG are the two liquefaction projects that are expected to become operational in 2023. Altamira FLNG (2.8 MTPA) is currently on schedule to become operational in the third quarter of 2023. About 80% of construction work on the first two FLNG liquefiers has been completed, with construction permits for offshore work in the Altamira area in place and awaiting the arrival of the FLNG unit. Tangguh LNG T3 (3.8 MTPA) is in the commissioning phase with the facility aiming to deliver its first cargo by end-June 2023.

Figure 5.2: Global liquefaction capacity by region and status, end-April 2023



Source: Rystad Energy

Compared to the high levels seen in 2021, the volume of approved liquefaction capacity in 2022 declined to 25.2 MTPA. This was primarily contributed by Plaquemines LNG T1-18 (10 MTPA) and Corpus Christi LNG Stage 3 T1-T7 (10 MTPA) in the US. Plaquemines LNG, located in Louisiana, has a nameplate capacity of 20 MTPA and is being developed in two phases. Plaquemines Phase 1 T1-T18 (10 MTPA) was approved in May 2022 with first LNG production anticipated in 2024. In March 2023, Venture Global progressed to FID on Phase 2 of the Plaquemines LNG project T19-T36 (10 MTPA) with $7.8 billion of financing, lifting total financing for this project to $21 billion. Corpus Christi LNG is located on Corpus Christi Bay in Texas and is Cheniere's second LNG export facility on the US Gulf Coast after Sabine Pass LNG. Corpus Christi LNG now has three trains (T1-T3) in commercial operation with a total authorised capacity of 13.5 MTPA. Cheniere's current priority is to expand the facility by adding seven trains, each with capacity of approximately 1.42 MTPA. Positive FID on its Corpus Christi Stage 3 project of seven trains was announced in June 2022, with first LNG production anticipated in 2027.

Currently, 997.1 MTPA of aspirational liquefaction capacity is in the pre-FID stage. Most proposed capacity is in North America (611.4 MTPA), with 333 MTPA situated in the US, 229.6 MTPA in Canada, and 48.8 MTPA in Mexico. This is followed by Africa (101.9 MTPA), Russia (137 MTPA), Asia Pacific (68.9 MTPA) and the Middle East (71.5 MTPA). About 6.4 MTPA of liquefaction capacity is proposed in the rest of the world. Overall, the market upheaval caused by the Russia-Ukraine conflict has created the conditions to stimulate investment in additional liquefaction facilities as there is a need to find an appropriate balance between energy security and decarbonisation goals in this fast-changing landscape. If all projects materialise, global liquefaction capacity would increase three-fold. However, a fair portion of pre-FID projects are not likely to progress due to economic or political landscape in some proposed areas, combined with difficulties to access financing for fossil fuel projects.

Decarbonisation is becoming a more prominent feature in recent, developing and newly proposed projects. Decarbonising the liquefaction segment of the LNG value chain offers a significant opportunity to minimise lifecycle emissions today. There is a positive trend with numerous projects globally incorporating decarbonisation in operations. Cedar LNG and Woodfibre LNG in Canada, for example, are prioritising decarbonisation using renewable hydroelectricity to power their liquefaction operations. Cheniere, Sempra Energy, Egyptian LNG are also considering using carbon capture, utilisation and storage (CCUS) in their liquefaction plants to reduce carbon emissions. As demand for low-carbon LNG grows, more stakeholders in the industry are expected to prioritise the decarbonisation of their operations. It is important for this trend to continue yet keeping in mind that it will generally tend to increase project development cost, hence prudent policy and effective emission pricing schemes are going to play an important role strengthening the business case for decarbonisation investments.

5.2 GLOBAL LIQUEFACTION CAPACITY AND UTILISATION

478.4 MTPA

Global liquefaction capacity, End of 2022

Global operational liquefaction capacity totaled 478.4 MTPA[2] as of end-2022 with the utilisation rate averaging 89% of pro-rated capacity[3], a notable increase compared to 80.4% in 2021. Global liquefaction plants have seen higher utilisation rates following the start of the Russia-Ukraine conflict at end-February 2022 with Europe increasing LNG imports to offset reduced piped gas flows from Russia. At the same time, some export facilities have been running below average. For example, a fire at the Freeport LNG export facility in the US took the liquefaction plant offline for several months from June 2022. In Australia, a fire and employee strike at Prelude FLNG led to sporadic liquefaction production disruptions with similar issues or technical hurdles seen at NLNG in Nigeria, Snøhvit LNG in Norway and MLNG in Malaysia. As a result, operational liquefaction plants maximised LNG production to meet surging European LNG demand leading to a high price premium compared to other regions worldwide. Despite outages and upstream supply disruptions, nine out of 22 LNG exporting markets achieved higher-than-average utilisation rates in 2022, including Cameroon, Papua New Guinea, Russia, Oman, Qatar, UAE, Equatorial Guinea, the US and Australia.

Liquefaction plants in the US were fully utilised in 2022 with a utilisation rate of 100% compared to 103% in 2021. This was despite Freeport LNG going offline in the second half of 2022, suggesting the loss of its export volumes was partially offset by increased supply from other operational liquefaction plants in the US. This was also boosted by Calcasieu Pass LNG which added total capacity of 10 MTPA in February 2022. Similarly, liquefaction plants in the Middle East ran at high utilisation rates over the year, with Qatar and UAE performing at 107% and 99% respectively. Liquefaction plants in other regions that did not operate above average utilisation rates in 2022 were constrained by feedgas supplies from linked upstream fields, unexpected maintenance, or industrial action which limited liquefaction production levels through the year.

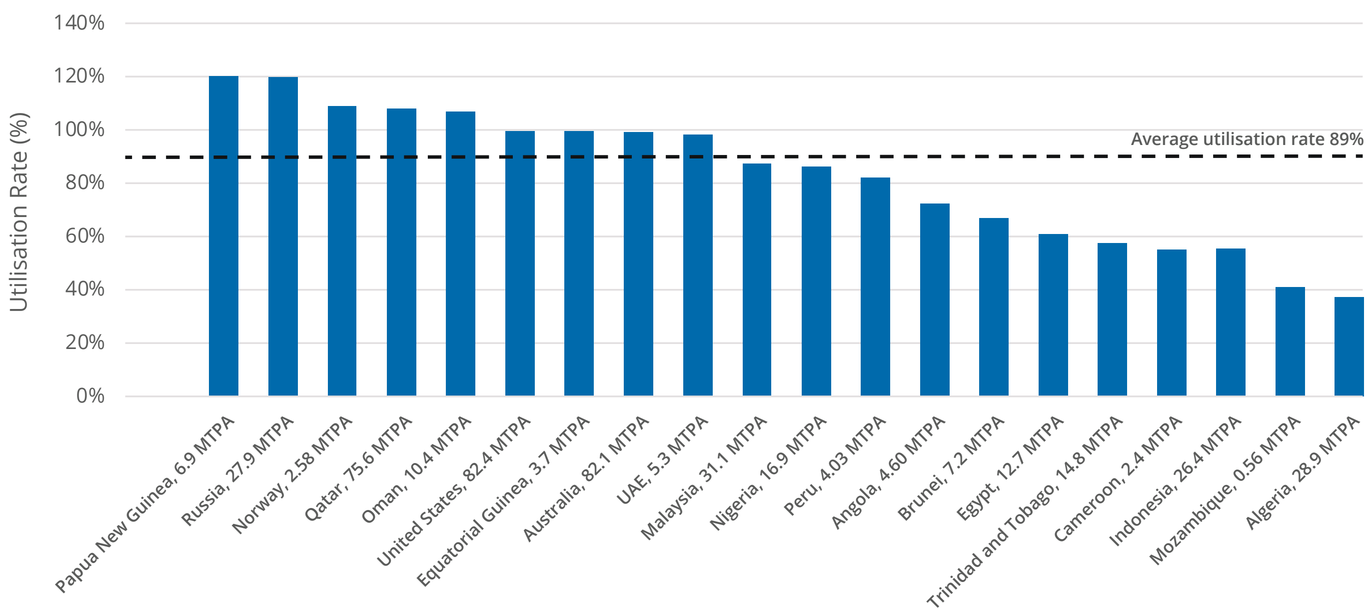
In Africa, utilisation at the Nigeria LNG (NLNG) liquefaction plant averaged 67% in 2022, after averaging 72% in the first half of 2022 and 61% in the second half of 2022. The reduced overall rate was caused by significant flooding across its upstream gas supplies' production regions which required several gas production wells to be shut. NLNG has experienced multiple outages since August 2022 and declared force majeure from October 2022 to end-November 2022.

[2] Includes Yemen and Libya, although Yemen LNG and Marsa El Brega LNG have suspended operations, this number excludes the liquefaction capacity of Kenai LNG, which has announced plans to be converted to an import terminal.
[3] Utilisation is calculated on a pro-rated basis, depending on when the plants are commissioned or when the plants went offline due to outages, upstream supplies disruption or other factors. Only operational facilities are considered.

In Australia, the 3.7 MTPA Darwin LNG (DLNG) operated by Santos experienced issues with feedgas supply from the Bayu-Undan gas field. Gas production from the Bayu-Undan gas field is estimated to cease at end-2023 with the operator considering backfilling options to support future LNG production once Bayu-Undan has been fully depleted. Santos had decided to proceed with the $311 million Darwin pipeline duplication project to enable gas from its offshore Barossa field to flow to DLNG with the first gas expected in 1H 2025.

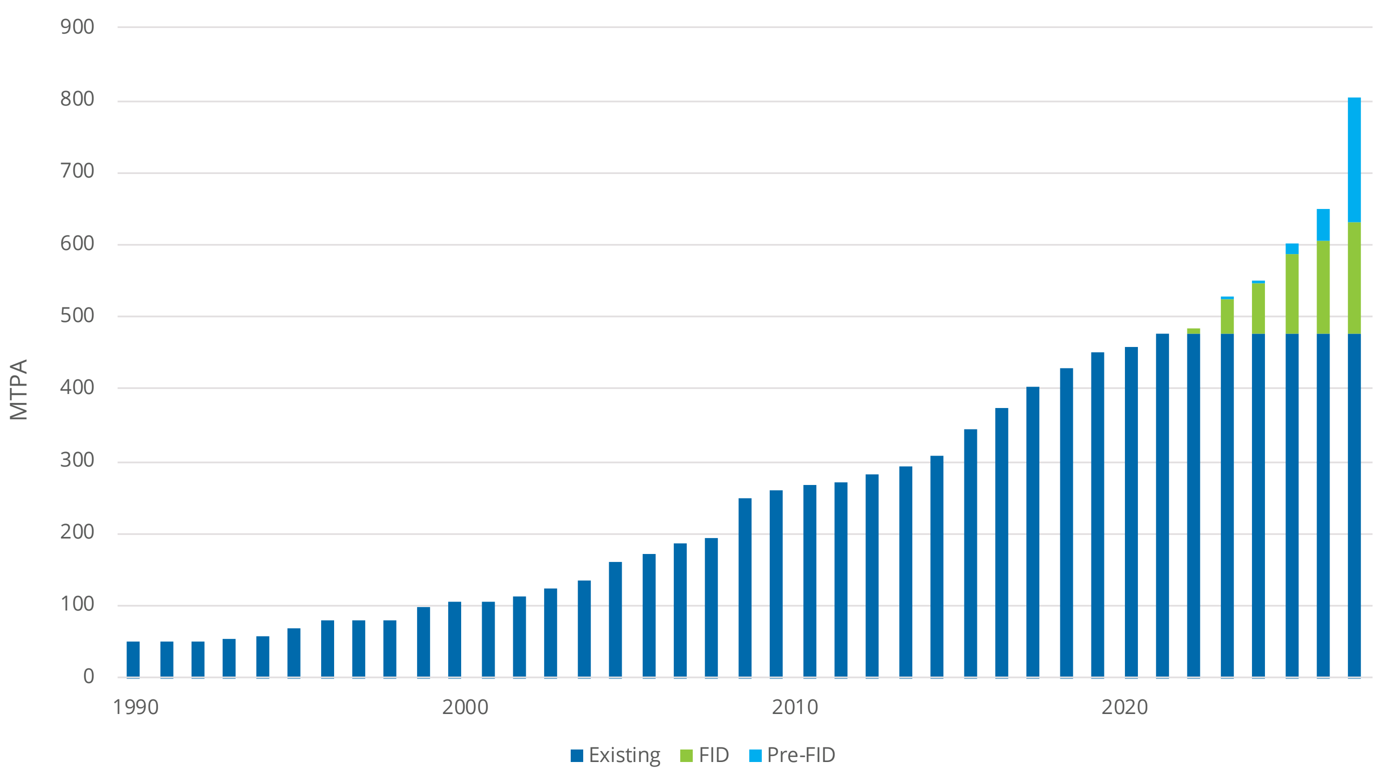
Offshore Australia, Prelude FLNG (3.6 MTPA) performed far below capacity last year with its utilisation rate averaging just 32%. It followed a four-month maintenance period from December 2021 to early April 2022 after a fire. Production was halted again due to industrial action which lasted from June to late August 2022. Another fire-related shut-down occurred in December 2022 following a 46-day maintenance period, causing Prelude's production to remain muted.

Figure 5.3: Global liquefaction capacity utilisation, 2022 (capacity is pro-rated)



Source: Rystad Energy

Figure 5.4: Global liquefaction capacity development, 1990-2028



Source: Rystad Energy

5.3 LIQUEFACTION CAPACITY BY MARKET

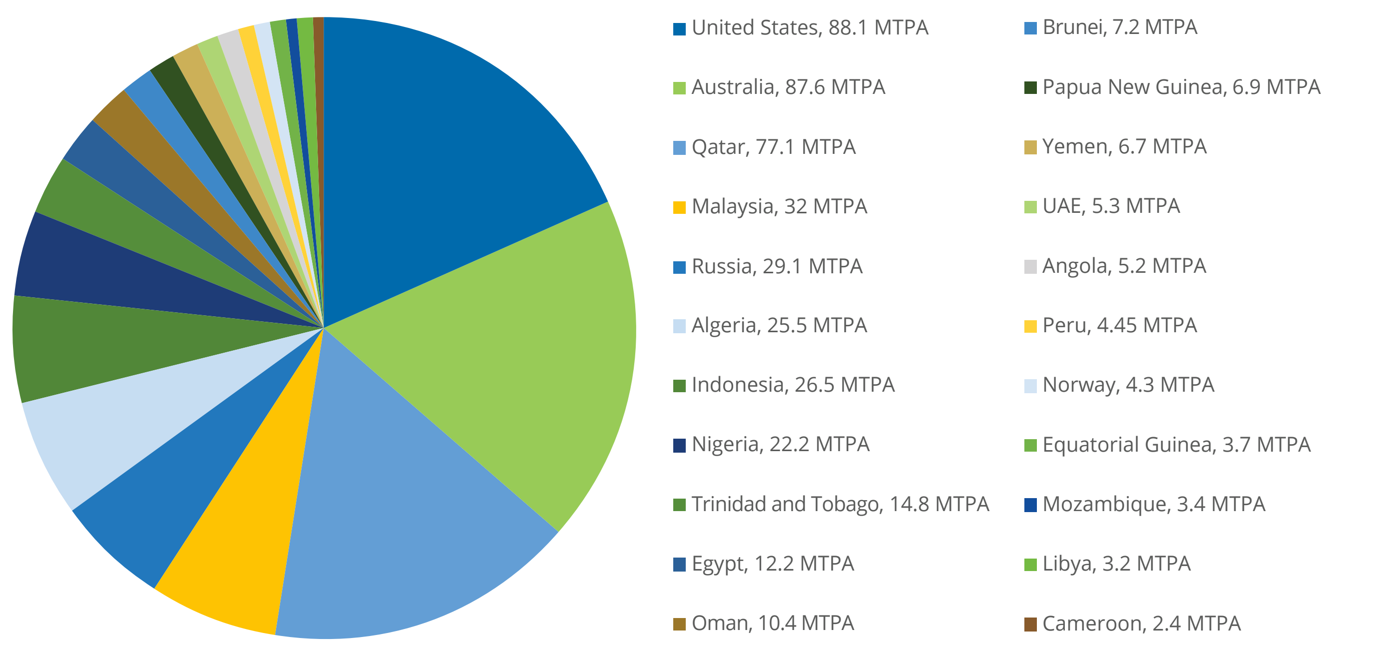
88.1 MTPA

Operational Liquefaction Capacity in the United States, as of end April 2023

Operational

As of April 2023, there were 22 markets operating LNG export facilities. The US surpassed Australia to become the market with the largest operational liquefaction capacity at 88.1 MTPA, followed by Australia with liquefaction capacity of 87.6 MTPA, and Qatar with 77.1 MTPA. The US increased its total operational capacity to 88.1 MTPA by April 2023, with Calcasieu Pass liquefaction facility (10 MTPA) and Sabine Pass LNG T6 (5 MTPA). The top three LNG export markets currently represent more than half of global liquefaction capacity.

Figure 5.5: Global operational liquefaction capacity by market, end-April 2023



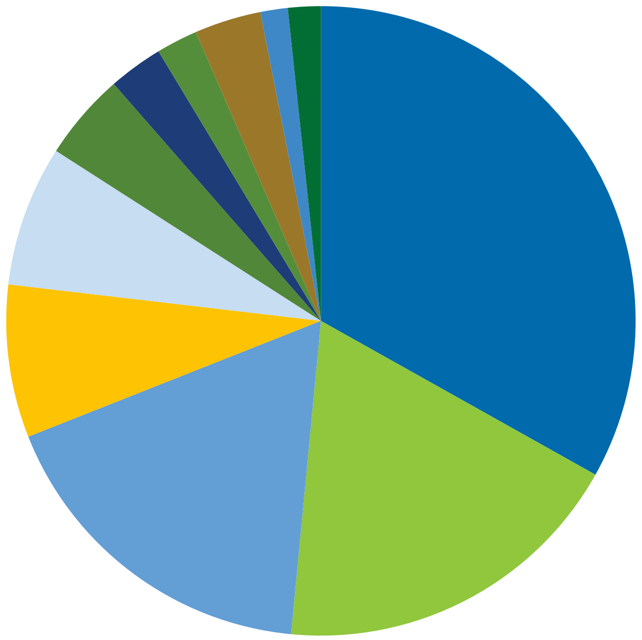
Source: Rystad Energy

Under-construction/FID

As of April 2023, 178.3 MTPA of liquefaction capacity is either under construction or approved for development, of which approximately 44% is in North America. In 2022, a total of 25.2 MTPA of liquefaction capacity was approved, contributed by the Plaquemines LNG (10 MTPA) and Corpus Christi LNG Stage 3 (10 MTPA) in the US. In addition to Altamira FLNG (2.8 MTPA), another FLNG unit (2.4 MTPA) is currently under-construction by Wison Heavy Industry for Eni's exploration in Congo.

Several liquefaction facilities are under construction or have taken FID recently. Altamira FLNG and Tangguh LNG are expected to become operational in the second half of 2023. Altamira FLNG (2.8 MTPA) is close to completing construction work and relocating its 'Fast LNG' liquefaction design offshore Mexico. In Indonesia, Tangguh LNG T3 (3.8 MTPA) is being commissioned with start-up expected this year. Tangguh LNG's capacity will be expanded to 11.4 MTPA along with its existing two operational trains (7.6 MTPA). In the US, Venture Global took FID on Phase 2 of the Plaquemines LNG project (10 MTPA) after securing project permits and financial support less than a year after sanctioning Phase 1 in March 2023. The same month, Sempra took FID on its Port Arthur LNG project in Texas which has total capacity of 13.5 MTPA.

Figure 5.6: Global approved liquefaction capacity by market, end-April 2023



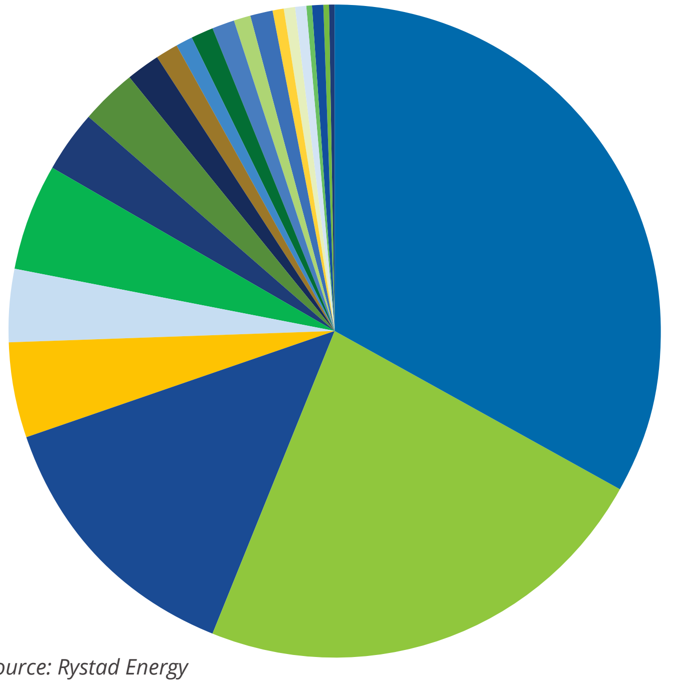
Source: Rystad Energy

Courtesy Qatargas

Proposed

There is currently 997.1 MTPA of potential liquefaction capacity in the pre-FID stage, a slight drop of 37.4 MTPA compared to 2022. With the Russia-Ukraine conflict still ongoing and a huge decline in Russian piped gas volumes being sent to Europe, a wave of proposed liquefaction projects has emerged to offset the loss of Russian supply. Some projects have also been fast-tracked to help meet demand. However, a fair share of pre-FID projects is unlikely to proceed due to weak economic conditions and increasingly stringent environmental restrictions on fossil fuel projects. Saying that, small-scale LNG remains a growing segment with significant potential.

Figure 5.7: Global proposed liquefaction capacity by market, end-April 2023



Source: Rystad Energy

Of the 997.1 MTPA of proposed liquefaction capacity in the pre-FID stage, the US accounts for 33.4% (333 MTPA), followed by Canada at 23% (229.6 MTPA) and Russia at 13.7% (137 MTPA). The large portion of US planned liquefaction plants is supported by gas production growth in the Permian and Hayesville basins in recent years, which are close to the Gulf of Mexico LNG exporting region. While most operational US LNG projects are brownfield conversion projects, currently proposed US LNG projects are mainly greenfield projects that consist of multiple small to mid-scale LNG trains delivered in a phased manner. This provides flexibility in securing long-term offtakers and increases competitiveness in project economics through modular construction. For example, Plaquemines LNG (20 MTPA) in Louisiana plans to accommodate up to 36 liquefaction trains configured in 18 blocks. Additionally, Driftwood LNG (27.6 MTPA) in Louisiana consists of 20 liquefaction trains and is designed to be built in four phases.

Out of the 229.6 MTPA of liquefaction capacity proposed in Canada, facilities on the western coast have the advantage of lower shipping costs to the Asian LNG market when competing with other planned projects on the US Gulf Coast. Due to strict environmental standards, those LNG export projects have adopted various strategies to reduce carbon emissions to comply with environmental regulations. Cedar LNG 1 (3.0 MTPA), Kitimat LNG (18.0 MTPA) and Woodfibre LNG (2.1 MTPA) are planned to be powered by clean and renewable hydropower. Similarly, LNG Canada T3-T4 (14.0 MTPA) has selected high-efficiency aero-derivative gas turbines to minimise fuel use and will also power a portion of the liquefaction plant with renewable energy. Another three proposed projects on Canada's east coast will add 38.5 MTPA of liquefaction capacity by 2040: Bear Head LNG (12.0 MTPA), Saguenay LNG (11.0 MTPA) and AC LNG (15.5 MTPA).

With the significant reduction in gas flows to Europe, Russia is looking to increase LNG production and exports via a series of liquefaction projects. Russia currently has 137 MTPA of proposed liquefaction capacity, in addition to the Arctic LNG 2 (19.8 MTPA), which was approved in 2019. In Eastern Russia, Far East LNG, often referred to as Sakhalin-1 LNG (6.2 MTPA) is a major project in the pre-FID stage which is aiming to commercialise produced gas from the Sakhalin-1 gas fields. Sakhalin-2 LNG T3 (5.4 MTPA), another project in the pre-FID stage, may face difficulties with sourcing feed gas since it plans to purchase this from the abandoned Sakhalin-1 gas fields with developed gas reserves in the Sakhalin-2 region not yet sufficient. After commissioning Yamal LNG (17.4 MTPA) and taking FID on Arctic LNG 2 (19.8 MTPA), Novatek aims to boost LNG production in the Arctic region via the proposed Arctic LNG 1 (19.8 MTPA), Arctic LNG 3 (12.2 MTPA) and Obskiy LNG (5.0 MTPA) projects. Meanwhile, Yakutsk LNG (17.7 MTPA) situated in Russia's Far East is estimated to start exports to Asian and Asia Pacific markets from 2031. This project involves a gas pipeline from Yakutia to the Sea of Okhotsk, and a condensate pipeline with capacity of 1.5 MTPA. Several international players such as ExxonMobil and TotalEnergies have exited or withdrawn their investments in Russia since the start of the Russian-Ukraine conflict. This, combined with a series of sanction packages towards Russia in technology export controls, could lead to planned liquefaction projects facing challenges when substituting foreign technologies such as turbines with local alternatives. Nevertheless, Russia still has major export potential in the long run for its huge resource base.

Recent gas discoveries in Africa have increased the continent's proposed liquefaction capacity to 101.9 MTPA. In East Africa, Djibouti LNG is expected to bring 10 MTPA of liquefaction capacity online if the project progresses further. Tanzania is also planning its first long-delayed LNG plant, Tanzania LNG (10 MTPA) with the latest FID target scheduled for 2025. However, it is expected that FID may occur a few years behind schedule due to the project's institutional constraints and the market's underdeveloped operating environment.

Mozambique has the largest pipeline of proposed projects, with a combined capacity of 32.2 MTPA. Rovuma LNG (15.2 MTPA), which has yet to reach an FID, has been put on hold due to security issues in Cabo Delgado province and economic effects of the COVID-19 pandemic. Brass LNG (10.0 MTPA) in Nigeria was proposed in 2003 and has been subject to numerous attempts to reach FID amid ownership changes and project alterations. Earlier in 2022, the Nigerian government announced plans to revive the project in the Niger Delta, citing increasing demand for gas as a transitional fuel. Plans for an eighth train at NLNG are underway. NLNG T8 (4.0 MTPA) is said to be different from the existing ones, with a focus on reducing carbon emissions. In Mauritania, further evaluation for Phase 2 of the Greater Tortue Ahmeyim (GTA) project, operated by BP and partners, has been confirmed with the Phase 2 expansion project expected to add another 2.5 MTPA. Timely execution of these proposed projects will be critical for Africa's LNG sector as competing markets such as Qatar and the US look to ramp up LNG exports to meet global demand. However, a series of economic, governmental and security challenges need to be overcome for Africa to realise this.

In Asia Pacific, Australia still takes lead with the largest planned capacity of 45.5 MTPA in the region in 2022. Inpex, operator of the Ichthys project, is planning to boost its current capacity of 8.9 MTPA to 9.3 MTPA by 2024. Other proposed projects such as Abbot Point LNG T1-T4 (2.0 MTPA), Darwin LNG T2 (3.5 MTPA), Gorgon LNG T4 (5.2 MTPA) and Wheatstone LNG T3-T5 (15.9 MTPA) have yet to progress, with most still in the feasibility stage. In Papua New Guinea, TotalEnergies has been progressing the Papua LNG project (5.4 MTPA) which is expected to be approved in 2024 and to start production in 2027. In Southeast Asia, Indonesia has proposed 17.33 MTPA of liquefaction capacity, mainly from Abadi LNG (15.0 MTPA), which will be supplied by the Abadi gas and condensate field in the Masela PSC. Despite the project being in development since 2006, it remains in the planning stage. It is expected to be approved in the second half of this decade but is unlikely to come online before 2035.

Decommissioned and idle

There were no announcements of LNG plants that had been decommissioned or were scheduled to be decommissioned in 2022. The Kenai LNG plant in Alaska, which has been dormant since autumn 2015, garnered approval from the US Federal Energy Regulatory Commission (FERC) in December 2020 to convert the liquefaction plant into a regasification terminal with exports unlikely to resume. The Marsa El Brega LNG plant in Libya halted production in 2011, and there are currently no plans to bring it back online.

There is currently 47.9 MTPA[4] of capacity at operational LNG liquefaction trains that are more than 35 years old, including trains at Brunei LNG, ADGAS LNG in UAE, Arzew LNG in Algeria, and MLNG in Malaysia. No major upgrading plans were announced for these plants in 2022.

5.4 LIQUEFACTION TECHNOLOGIES

Air Products Technologies Account For

68% of Global Operational Capacity

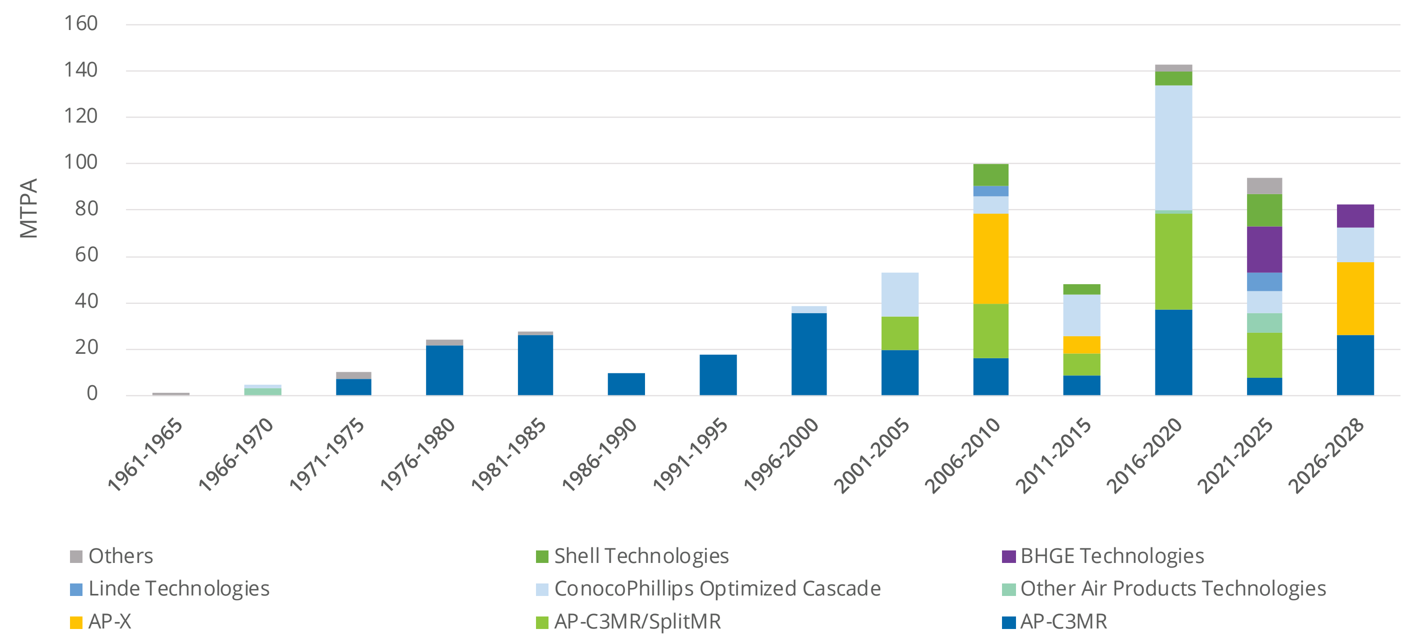
Among the liquefaction trains that became operational in 2022, BHGE's Single Mixed Refrigerant (SMR) technology was applied at the Calcasieu Pass LNG project with ConocoPhillips' Optimized Cascade deployed at Sabine Pass T6 in the US. Coral South FLNG in Mozambique adopted Air Products' AP-DMR technology with Portovaya LNG in Russia using Linde's LIMUM technology for liquefaction processes.

Currently, Air Products' liquefaction technologies dominate the market in liquefaction methodology, representing about 68% of total operational capacity in 2022. By contrast, AP-C3MR and AP-C3MR/SplitMR together hold about 57% share. ConocoPhillips' Optimized Cascade technology is estimated to grow its use to 130 MTPA once Corpus Christi Stage 3 and Pluto LNG's expansion have been deployed.

The evolution of liquefaction technologies dates to the early 1960s. Among the earliest LNG export facilities, Arzew GL4Z T1-T3 used ConocoPhillips' Classic Cascade, with Kenai LNG using the early version of ConocoPhillips' Optimized Cascade process. Air Products entered the liquefaction technology market in the 1970s with its Single Mixed Refrigerant technology (AP-SMR), implemented at Marsa El Brega LNG. At that time, the nameplate capacity for liquefaction trains was limited to 1.5 MTPA per train. Early facilities were used as testing grounds for liquefaction technologies, which continue to improve in cooling methane to approximately -162 degrees Celsius.

[4] This does not include Kenai LNG as plans to convert it to an import facility were approved in December 2020.

Figure 5.8: Installed and approved liquefaction capacity by technology and start-up year, 1961-2028



Source: Rystad Energy

Since the AP-C3MR was first introduced at Brunei LNG in 1972, it has attained the dominant position among liquefaction technologies, representing close to 57% of operational capacity globally as of April 2023 (including the SplitMR variation). The growing share of AP-C3MR technology was primarily driven by QatarGas, totaling around 30 MTPA since the start-up of QatarGas 1 T1 in 1996. Damietta LNG was the first LNG plant to deploy the C3MR/SplitMR technology, which further improves AP-C3MR technology by optimising its machinery configuration, achieving higher turbine utilisation.

Air Products' AP-X technology was first used in 2009 on the QatarGas 2 project, supporting a liquefaction capacity of 7.8 MTPA per train, the highest capacity per train in the history of LNG developments. The AP-X technology will also be employed on the North Field East (NFE) project in Qatar which was approved two years ago and consists of four mega-trains, each with 8.0 MTPA of liquefaction capacity. The high liquefaction capacity is achieved mainly through an additional nitrogen refrigeration loop to the C3MR technology for sub-cooling functions, effectively providing additional refrigeration power. The technology has also been used in existing and under-construction floating liquefaction.

The smaller-scale derivative of the AP-X subcooling technology, AP-N, is installed on Petronas' PFLNG Satu and PFLNG Dua, while Coral Sul FLNG will install the AP DMR process. The AP-N is the only EXP (expander-based) technology used in offshore developments. Compared to the MR process, the EXP process has the advantage of simplicity and low equipment count. The Golar Gimi FLNG, a converted Moss-type LNG carrier, will use the Black & Veatch PRICO technology.

Faced with more competition through the 2000s, the market share of Air Products' liquefaction technologies has declined from over 90% in the 1980s and 1990s to 67.7% as of April 2023, mainly due to rising use of ConocoPhillips' Optimized Cascade Process such as at Sabine Pass LNG. The widespread uptake of ConocoPhillips' Optimized Cascade Process means it is now used in 115.3 MTPA of operational capacity (22.5%), making it the second leading liquefaction technology on the market. ConocoPhillips' Optimized Cascade Process was first used at Kenai LNG in the late 1960s and reappeared on the market in 1999 with the start-up of Atlantic LNG T1. With QatarGas LNG T12-T13 and Rio Grande LNG signaling FID in 2023, Air Products' dominance may again be reinforced with 24.6 MTPA of liquefaction capacity approved. From 2023 and 2028, an increasing number of new liquefaction projects are expected to enter the liquefaction technology market, driven primarily by growing demand for small to mid-scale LNG trains.

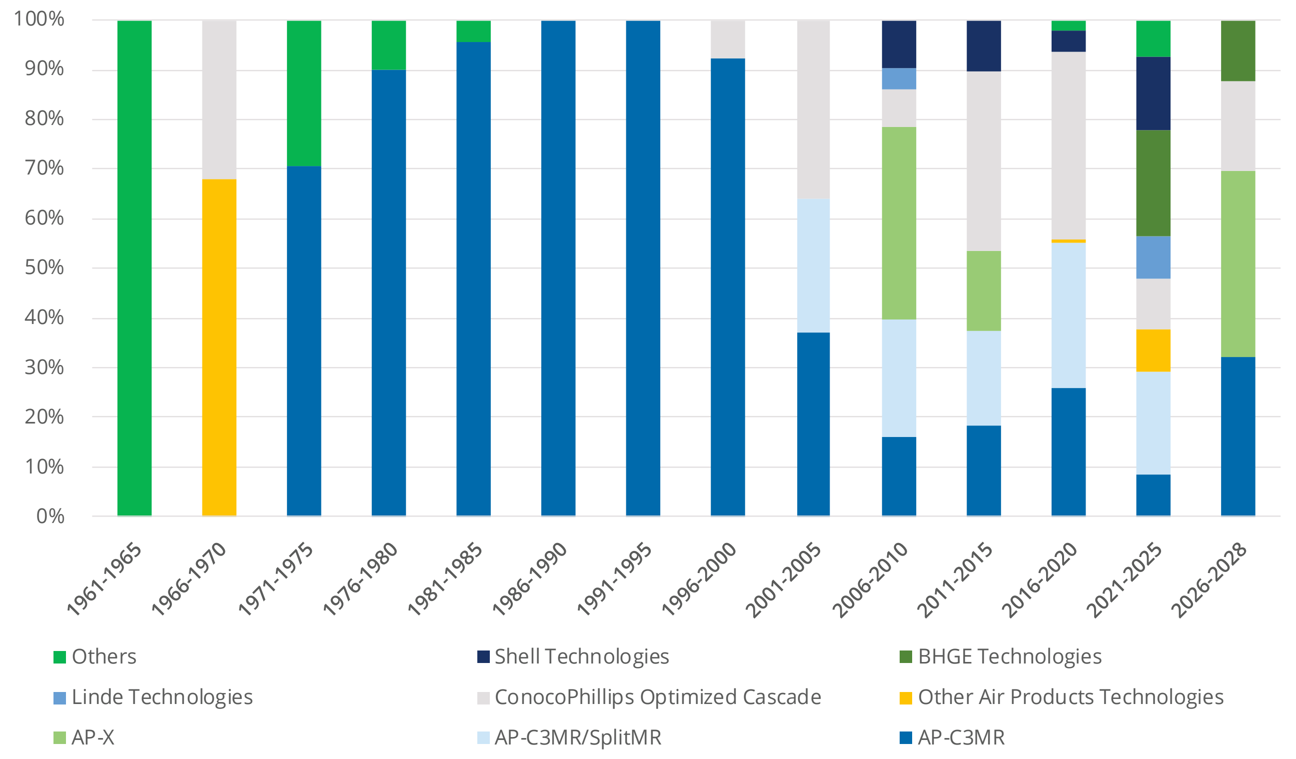
As interest in exploring smaller volumes of stranded gas increases, and access to LNG project financing and off-takers becomes more competitive, small to mid-scale LNG trains may emerge as lower-risk alternatives. These trains are smaller in size and have simpler configurations, allowing for easier standardisation and modularisation, resulting in cost and execution time savings. In early 2022, Venture Global LNG commenced operations at its Calcasieu Pass LNG facility using BHGE's Single Mixed Refrigerant (SMR) liquefaction technology, with each liquefaction module having a capacity of 0.56 MTPA. Additionally, Tortue Ahmeyim FLNG will come online using Black & Veatch's PRICO technology (0.6 MTPA per train, four trains), which is already in use at Tango FLNG. While the liquefaction technology market for large-scale LNG is dominated by a few players, some new technologies have recently entered the market. One of these is Linde's MFC4 process which will be utilised in the three-train Arctic 2 LNG project, each train having capacity of 6.6 MTPA.

Operator-driven liquefaction technologies are continuously attracting more attention. The dual-mixed refrigerant (DMR) process, provided by Shell and APCI, has already been successfully applied at Sakhalin 2 LNG and Prelude FLNG. This technology has a similar configuration process to the AP-C3MR method, but DMR uses mixed refrigerant primarily of ethane and propane for pre-cooling rather than pure propane in an exchanger. The benefits of using the DMR process are more apparent in colder climates, as the precooling MR can be designed to avoid the pressure restrictions that arise with propane at low temperatures. Novatek's Arctic Cascade process, designed for the Arctic climate, is being used at Yamal LNG T4 (0.9 MTPA).

Small FLNGs mostly use relatively simple liquefaction technologies for safety reasons (minimising highly flammable refrigerants) and space limitations due to their small deck footprints. The first operational FLNG, PFLNG Satu, uses Air Products' AP-N technology on a simple nitrogen cooling cycle. Black & Veatch's PRICO process has been successfully applied at Cameroon FLNG. The smaller-size modules of approximately 0.6 MTPA allow for better configurations and better use of the limited deck space compared to larger trains. Increasingly complex technologies are seen in FLNGs with larger capacity, such as Coral South FLNG (3.4 MTPA) which uses Air Products' AP-DMR technology and Prelude FLNG (3.6 MTPA) which uses Shell's DMR technology.

Measures to reduce carbon emissions during the liquefaction process have been growth significantly. Carbon emissions at an LNG liquefaction facility come from three primary sources: CO_2 vented during upstream pre-treatment of acid gas, CO_2 released in flue gas from gas turbines used to power the liquefaction process, and CO_2 released in the generation of power for the remainder of the facility. Emissions are mainly tackled by reducing CO_2 generation within the process, another is to capture and sequester the CO_2 throughout the entire liquefaction process. Innovative solutions are already being explored on some LNG liquefaction plants. For example, Hammerfest LNG has introduced an all-electric concept, which has also been applied at Freeport LNG, using electric motors to drive liquefaction compressors. The facility is also connected to the local grid, which uses renewable energy as part of the electricity mix. This can significantly reduce emissions, depending on the power mix used to fuel the electric motors. Other solutions include installing an acid gas removal unit (AGRU), which absorbs CO_2 from the feed along with several sulfur-bearing gases and eventually emits the CO_2 to the atmosphere. CCS is another solution that is widely discussed in the LNG industry. CCS deployment mainly targets two areas: capturing CO_2 from the reservoir (as demonstrated at Hammerfest LNG) and capturing post-combustion CO_2. Capturing post-combustion CO_2 is more expensive, though cost benefits can potentially be reaped when added to a newbuild liquefaction facility due to design and locational synergies. Venture Global is currently developing CCS at its LNG facilities (Plaquemines LNG and Calcasieu Pass LNG) with the aim of capturing and sequestering an estimated 500,000 tonnes per year of carbon combined. With the increased investment and expansion in global liquefaction assets, it has become more critical to optimise the choice of liquefaction process. Selecting more versatile and cost-effective liquefaction technologies that meet stringent emissions standards will be a key focus area for new projects as both governments and companies commit to decarbonisation efforts.

Figure 5.9: Share of installed and future approved liquefaction capacity by technology and start-up year



Source: Rystad Energy

5.5 FLOATING LIQUEFACTION (LNG-FPSOS)

12.1 MTPA

Operational Floating Liquefaction Capacity Worldwide as of end April 2023

As of end-April 2023, there are currently five operational FLNG units globally. Coral South FLNG (3.4 MTPA) in Mozambique is the latest addition to the global FLNG fleet, with the first LNG cargo departing Coral South FLNG in November 2022. Coral South FLNG is linked to the main Coral reservoir, situated in the offshore Rovuma Basin, and is the first floating LNG facility to be put into operation in the deep waters offshore the Africa continent.

In terms of other operating FLNGs, Petronas FLNG Satu is the world's first FLNG, built by Daewoo Shipbuilding, with a design capacity of 1.2 MTPA. The terminal is in the Kebabangan gas field, offshore Sabah, Malaysia. Petronas FLNG Dua is the second FLNG undertaken by Samsung Heavy Industries for Petronas and has a design capacity of 1.5 MTPA. Petronas FLNG Dua started production in February 2021 and is presently moored at the Rotan gas field in deepwater Block H, offshore Sabah.

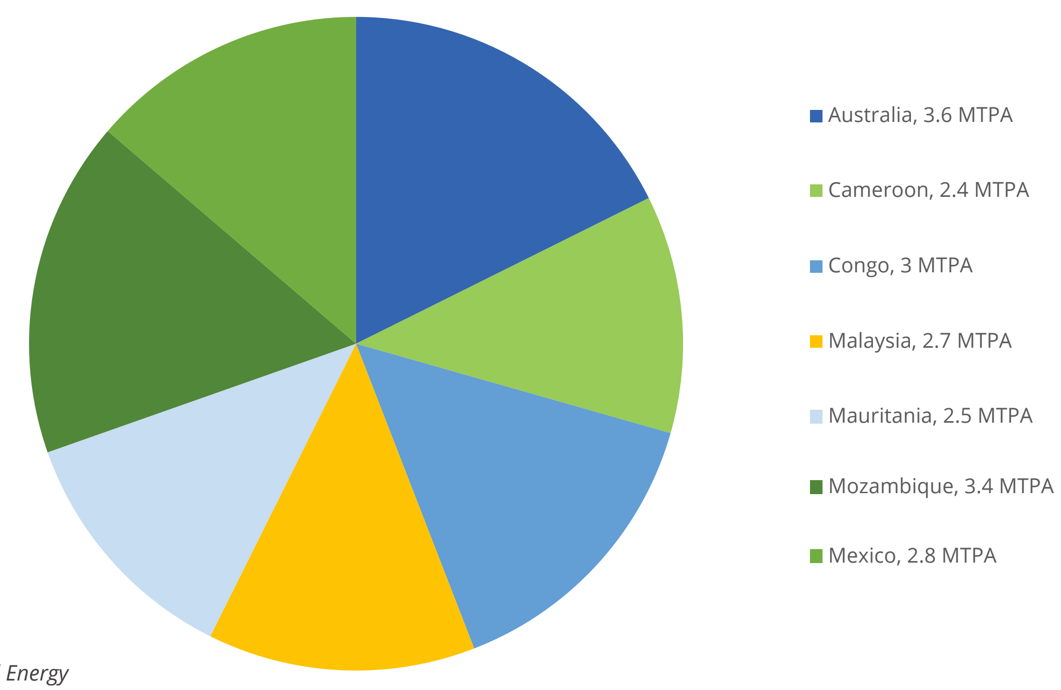
Prelude FLNG was built by South Korea's Samsung Heavy Industries with a design capacity of 3.6 MTPA. The facility performed far below capacity in 2022, initially due to a four-month-long maintenance period which ran from December 2021 to early April 2022 following a fire. As noted above, Prelude FLNG's production has been muted through all of 2022 due to industrial action and other outages.

In February 2023, BP and partners confirmed the development concept for the second phase of the BP-operated Greater Tortue Ahmeyim (GTA) LNG project, agreeing to take it forward to the next evaluation stage. The GTA LNG project, also known as Golar Gimi FLNG, initially received FID in 2018 and was estimated to supply up to 10 MTPA of LNG via subsequent project phases. GTA phase 1 experienced delays due to the COVID-19 pandemic, leading the operator to declare force majeure. First gas is now expected in the third quarter of 2023 with first LNG production by end-2023.

Tango FLNG was built in 2017 with a nameplate capacity of 0.6 MTPA. After the outbreak of the pandemic in 2020, Tango FLNG remained idle until August 2022 when Eni announced it had reached an agreement with Exmar to acquire Export LNG Ltd, which owns Tango FLNG. Once the mooring and construction work to connect with the Marine XII network and infrastructure has been completed, Tango FLNG is expected to start production in Congo in the second half of 2023. Meanwhile, Eni has signed a contract with China's Wison Heavy Industry for the construction and installation of an FLNG unit with capacity of 2.4 MTPA. This will be the second FLNG to be deployed in Congo together with Tango FLNG. With the second FLNG project, the overall LNG production capacity of Marine XII is expected to reach 3 MTPA in 2025.

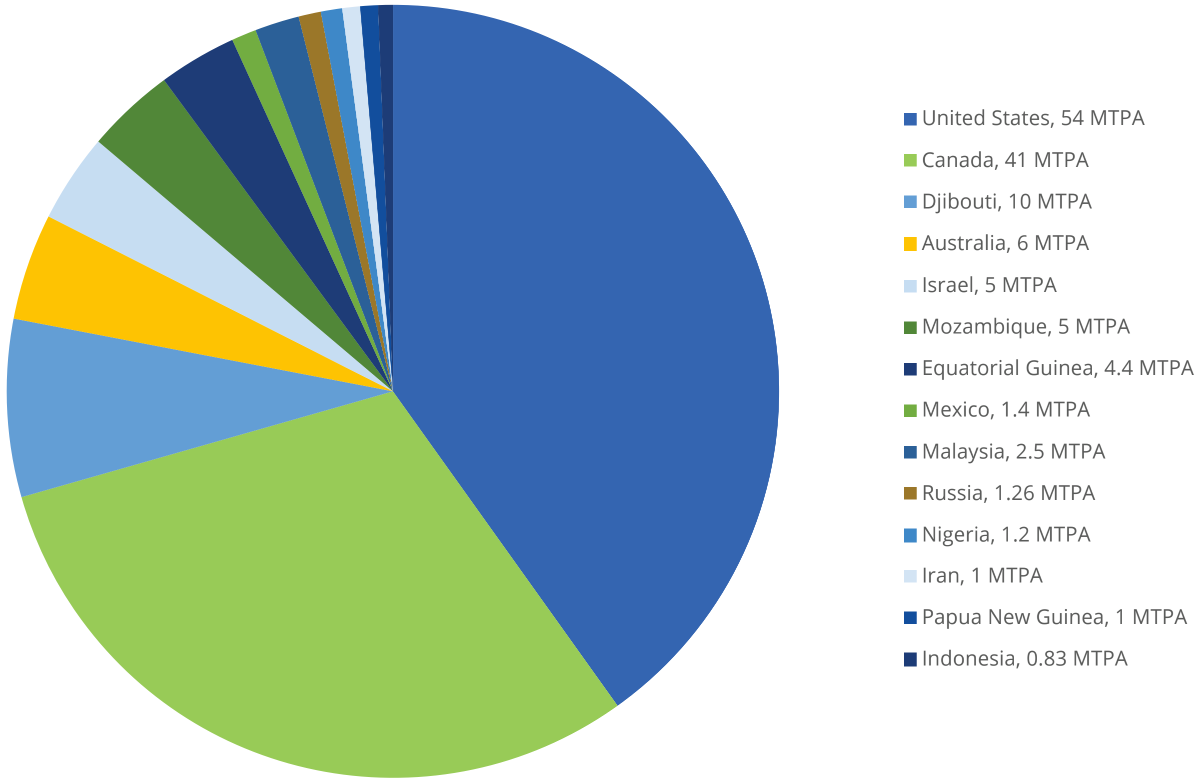
Eni's second FLNG and Altamira FLNG were the two FLNG projects to take FID in 2022, mainly due to uncertainty over the global economic outlook and global LNG trade due to the Russia-Ukraine conflict, which has softened the pace of investments in floating liquefaction plants. Additionally, supply chain disruptions and corporate efforts to defer CAPEX in general have also caused delays.

Figure 5.10: Global operational and approved FLNG liquefaction capacity, end-April 2023



Source: Rystad Energy

Figure 5.11: Global proposed FLNG liquefaction capacity, end-April 2023



Source: Rystad Energy

As of April 2023, there are currently 134.6 MTPA of aspirational liquefaction capacity proposed as FLNG developments. Of this, 96.4 MTPA is in North America.

In the US, the Delfin FLNG project completed front-end engineering and design (FEED) in October 2020, after being delayed because it was unable to secure long-term LNG contracts during the pandemic. In 2017, the US FERC authorised Delfin to put its project into service by September 2019. Since then, FERC has granted several one-year extensions to complete the project. Delfin LNG was granted another year-long extension in July 2022, giving it until September 2023 to put the onshore part of the proposed Gulf of Mexico FLNG project into service. Delfin LNG was planning to take FID on its FLNG project in 2022, but this is still pending. The remaining FLNG projects in the US – such as Point Comfort FLNG, Main Pass Energy Hub FLNG and Cambridge Energy FLNG – have been progressing at a slow pace for years.

In Africa, there has been rising interest in FLNGs in recent years, with proposed capacity currently at 20.6 MTPA. This includes the Djibouti FLNG project which is planned in three phases with total liquefaction capacity of 10.0 MTPA. In the rest of the world, some 17.6 MTPA of FLNG liquefaction capacity has been proposed.

There have been significant developments in floating liquefaction technology in recent years, primarily in the design of FLNG units. Rapid innovation has meant the cost of expensive, first-generation, highly bespoke FLNGs built by Shell, Petronas and Eni has been greatly reduced in second-generation FLNGs, commonly referred to as standardised FLNGs. Keppel Shipyard and Black & Veatch (B&V) first introduced the concept by converting the Moss-design LNG carrier Hilli into an FLNG retrofitted with B&V's PRICO liquefaction technology. Over the years, SBM Offshore has also patented its FLNG conversion solution, the TwinHull FLNG concept which maximises efficiency and cost savings to optimise offshore gas fields. This design comprises two LNG tankers converted into a single integrated hull, allowing for greater storage capacity and optimisation of deck space. While these newer vessels are typically not as 'customised' with regards to the targeted field, they have greater flexibility in deployment and reduced lead times combined with significant cost savings. As well as their suitability for smaller, remote offshore gas fields, FLNGs can offer advantages over onshore projects which can face land constraints and environmental challenges. They can even serve as a stopgap solution for larger fields until onshore liquefaction trains come online.

Courtesy Qatargas

5.6 RISKS TO PROJECT DEVELOPMENT

Market balances

Global LNG supply and demand balances are one of the main indicators for assessing the need for new investments in LNG projects. Comparing the supply of LNG through the pipeline of upcoming and proposed liquefaction projects versus demand outlooks is key to determining the market balances. New liquefaction projects typically have a lead time of around 3-6 years between FID and commercial operation, which makes it relatively easy to see what is coming on the supply side, given the long lead times for liquefaction projects. However, forecasting demand is far more challenging due to large fluctuations in demand and LNG's historic role as a marginal energy source in main importing markets.

While there can be shocks to both LNG supply and demand, the market has experienced its strongest shock on the demand side in the past three years. This includes demand plunging during the start of the global COVID-19 pandemic in 2020, followed up by two years of spiking demand during the energy crunch in 2021, and the supply crisis caused by the conflict outbreak between Russia and Ukraine in early 2022.

Supply and demand risks

Since the start of the Russia-Ukraine conflict, LNG demand has spiked as Europe has slashed its import of Russian pipeline gas. In combination with a shift in LNG demand, this has created a double whammy for global LNG balances, increasing the need of new LNG supplies. However, while the energy crisis triggered by the conflict has mainly driven balances in favor of new LNG supplies, higher prices have led to price-induced demand risk in addition to prevailing policy-driven long-term demand risk under the low-carbon emissions trend. This has caused a significant upwards shift in global LNG balances over both the short and long-term. The conflict has also triggered a risk for future Russian LNG developments, as well as existing supplies, as Western companies providing equipment, technology and services have pulled out of Russian projects due to sanctions.

As energy transition targets and emission reduction plans set out in REPowerEU, "Fit for 55" package and European Green Deal, which may lower European gas consumption by 30% by 2030, EU members would need to continue to reduce their natural gas consumption by boosting investments in renewables, hydrogen and renewable gas or biomethane, and improving energy efficiency and conservation. Uncertainty remains high on whether Europe will manage to meet these targets, which may reuslt in some potential risks and uncertainties to gas and LNG demand in the future. This fundamental risk may discourage LNG supply investment for market rebalance and price return, as LNG is naturally long-term oriented. Addtionally, high LNG prices globally are also pressuring demand for gas and LNG, leading price-sensitive buyers to turn to cheaper alternatives, particularly coal and traditional biomass. For example, both Pakistan and Bangladesh have communicated that they will build more coal-fired power generation capacity because of higher gas prices. This poses a risk for future LNG demand in Asia that previously had been expected to be key region for LNG demand growth in the coming decades, and a risk of throwing the world farther off the mark on reaching emissions neutrality and meeting climate targets. Overall, last year's shift in LNG balances has driven a spike in LNG contracting activity and LNG project approvals, but uncertainty looms, triggered by the doubts over the long-term role of natural gas in key importing markets.

Contracting trend

Monitoring LNG contracting activity is key to assessing upcoming LNG project approvals. Project financing is highly dependent on firm offtake deals for future supplies due to the multi-billion dollar investments needed to progress projects. The energy crisis has put security of supply back on the agenda, driving increased appetite for long-term LNG contracts in contrast to relying on spot market supply. In 2022, over 70 MT of LNG contracts were concluded, more than double the average over the last five years. In 2022, 90% of contracts concluded had a duration over 15 years in length, with 65% over 20 years in length, signaling a long-term commitment to LNG from buyers. This will support project financing and development. Of the deals signed in 2022, Asian markets driven by China and LNG aggregators dominate as offtakers, with US exporters dominating as sellers. Aggregators play an important role as they support LNG project development by building up global LNG portfolios which in turn generate future LNG demand through increased availability of supplies. This is particularly important when building new markets for LNG imports which may not yet be ready to commit to gas and LNG through long-term contracts. Several proposed LNG projects are close to signing over 80% of their capacity through long-term deals, a significant step towards FID.


Courtesy Qatargas

Figure 5.12: Global Liquefaction Operational Plants and FID Liquefaction Plants Expected to Commission by 2028, April 2023

Note:
1. Numbers in parentheses behind project names refer to Appendix 1: Table of Global Liquefaction Plants and Appendix 2: Table of Global Liquefaction Plants Sanctioned or Under Construction

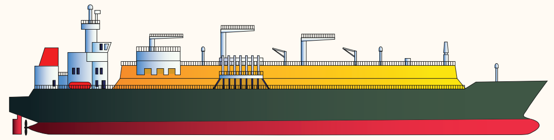
Source: Rystad Energy

6 LNG Shipping

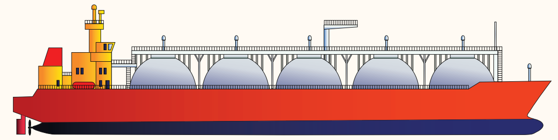
The global LNG fleet grew by **4% year-on-year** in 2022.

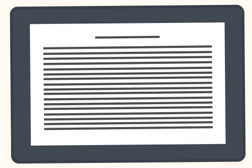
6,888
trade voyages, an increase of
2.7% year-on-year

668 active vessels / **38** new vessels[1]

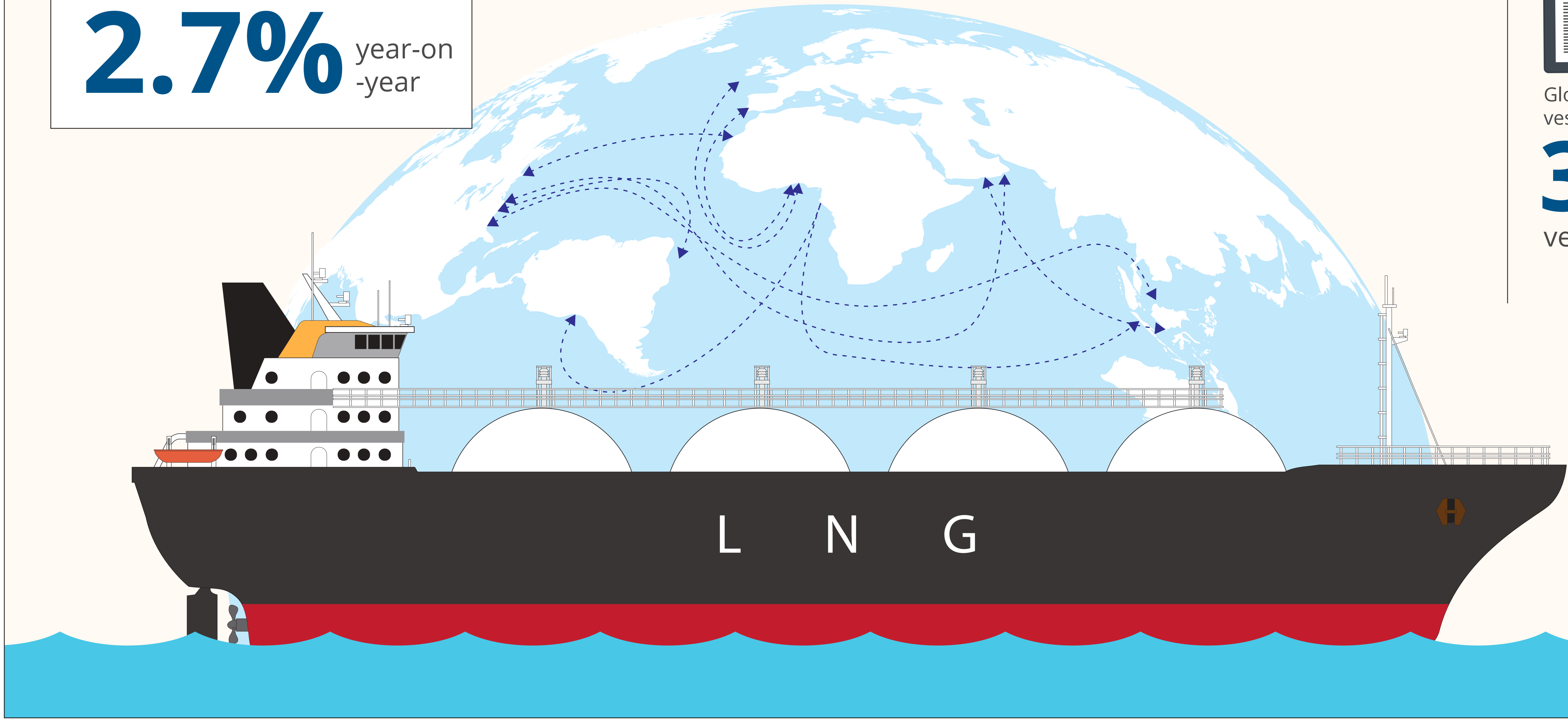


Including **45** FSRUs / **8** FSUs





Global LNG vessel orderbook:
312 vessels



[1] During 2022 and the first four months of 2023

6. LNG Shipping

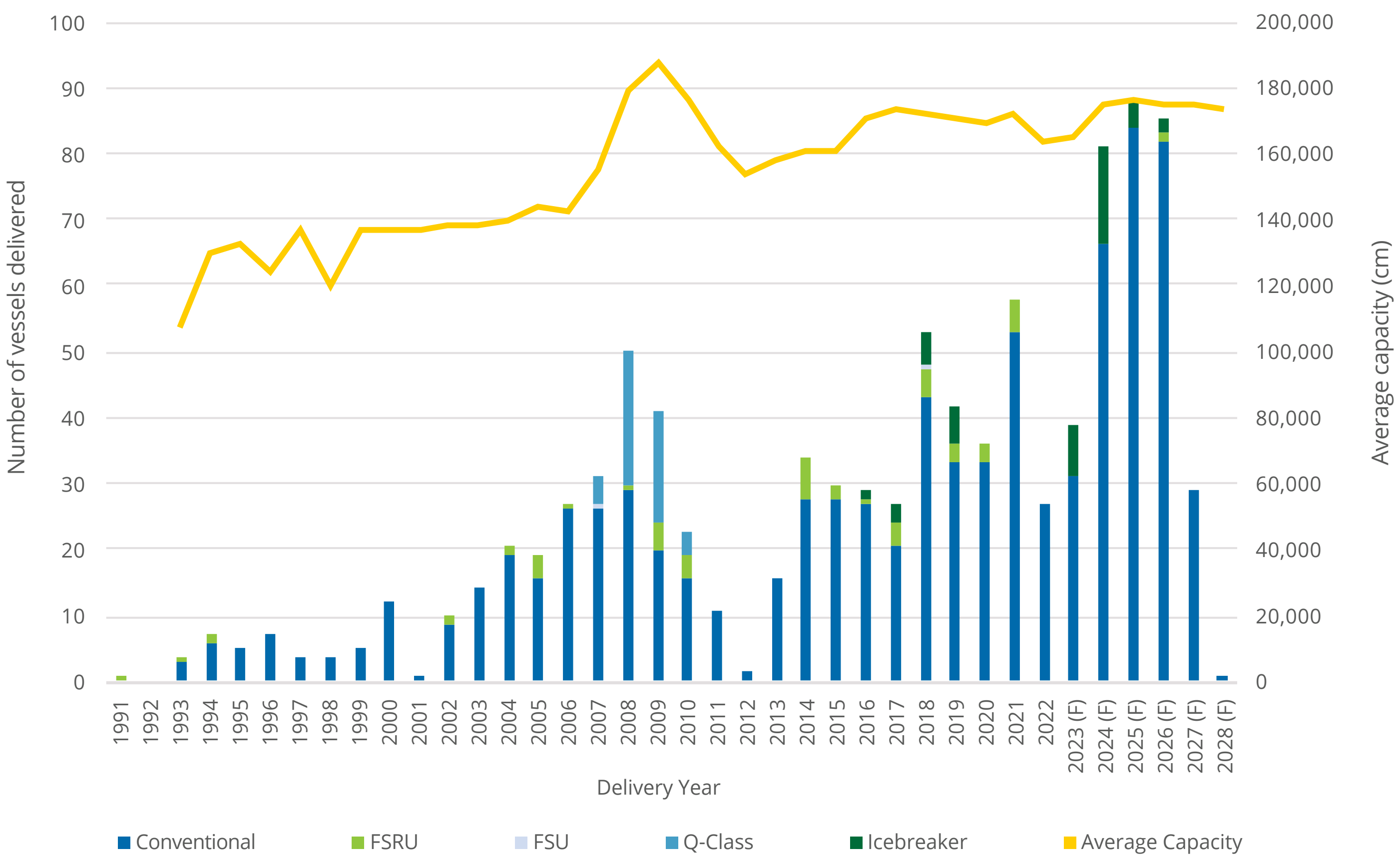
With the delivery of 27 vessels in 2022 and 11 in the first four months of 2023, the global LNG carrier fleet consisted of 668 active vessels[2] as of end-April 2023, including 45 operational FSRUs and eight FSUs. This represents a 4% growth in the fleet size from 2021 to 2022, comparable to a 2.7% growth in the number of LNG voyages. It follows Europe's efforts to significantly increase LNG imports for energy security purposes following the start of the Russia-Ukraine conflict and the subsequent reduction in Russian gas pipeline flows to Europe.

Courtesy NYK

[2] This section of the report only considers vessels with capacity of 30,000 cubic metres or more.

6.1 OVERVIEW

Figure 6.1: Global active LNG fleet and orderbook by delivery year and average capacity, 1991-2028



Source: Rystad Energy

312 LNG Vessels
Under Construction as of end-April 2023

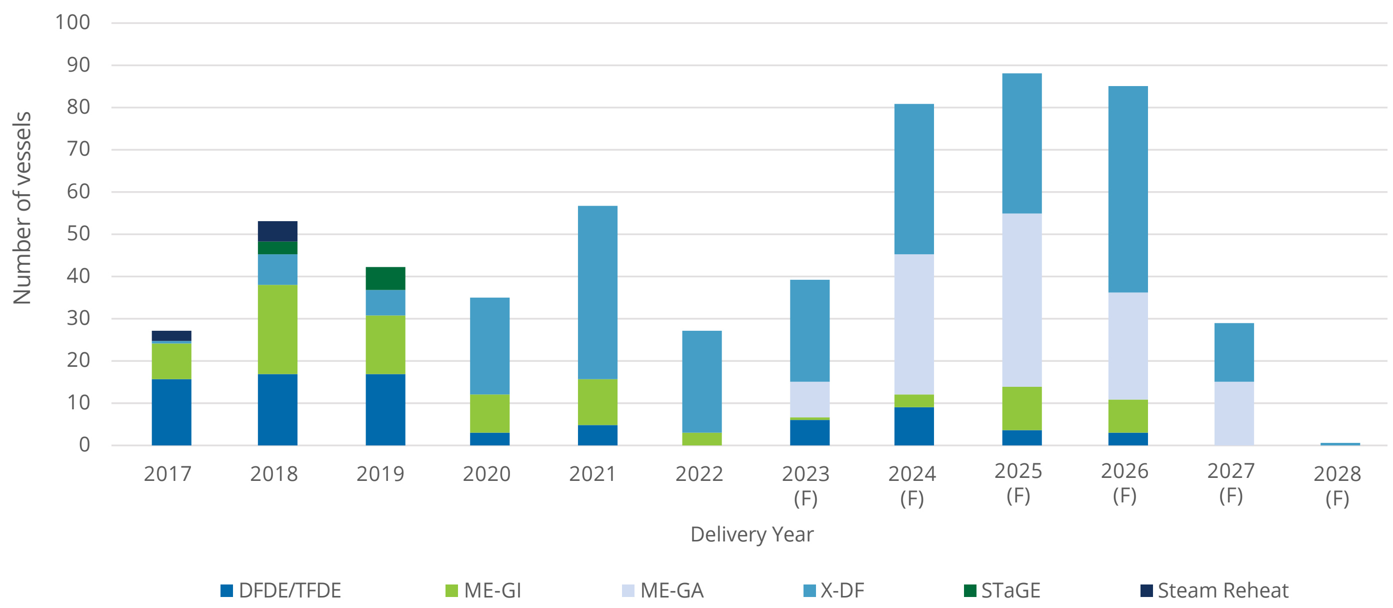
Of the 27 newbuilds delivered in 2022, all except three have a capacity of between 170,000 and 200,000 cm. Vessels of this size remain within the upper limit of the Panama Canal's capacity following its expansion in 2016, while still benefiting from economies of scale, particularly as additional LNG capacity is developed in the US Gulf Coast (USGC) for long-haul delivery to Asia. Although larger vessels have become more common over time, newbuild capacity has still not matched the maximum capacities observed during the 2007-2010 period, when 45 Qatari Q-Class newbuilds larger than 200,000 cm were delivered. However, moving forward, 200,000 cm vessels could find favour due to their economies of scale for long-haul voyages. The current orderbook comprises 15 vessels, each with capacity of 200,000 cm, for delivery during the period 2023-2026.

Given the short timeline in the increase in LNG trade over the past two decades, the global LNG fleet is relatively young. Vessels under 20 years of age make up 87.7% of the active fleet. Newer vessels are larger and more efficient and have superior project economics over their operational lifetime. Only 14 active vessels are 30 years or older, including six that were converted into FSRUs or FSUs.

The global LNG orderbook had 312 newbuild vessels under construction as of end-April 2023, equivalent to over 46% of the current active fleet. This illustrates shipowners' expectations that LNG trade will continue to grow in line with scheduled increases in liquefaction capacity, particularly from the US. An expected 28 additional carriers will be delivered by the end of 2023 and 81 in 2024. The orderbook includes 29 Icebreaker-class vessels for the Arctic LNG 2 project. These are highly innovative and CAPEX-intensive ships with the capabilities required to traverse the Arctic region. Due to the Russia-Ukraine conflict, these vessels have faced a risk of delayed deliveries or cancellations due to international sanctions on Russia that have complicated equipment delivery and payments. In November 2022, Daewoo Shipbuilding and Marine Engineering (DSME)[3] cancelled three icebreaker orders for Russian owner Sovcomflot. However, it understood that DSME is continuing construction on these carriers.

[3] DSME has recently changed name to Hanwha Ocean

Figure 6.2: Historical and future vessel deliveries by propulsion type, 2017-2028



Source: Rystad Energy

In 2020, more low-pressure slow-speed dual-fuel Winterthur Gas & Diesel engine (X-DF) systems were delivered than any other type, while 2023 will be the first year in which a vessel with the Man B&W (M-type electronically controlled Gas Admission) ME-GA engine will be delivered. Capitalising on improved fuel efficiencies and lower emissions, two generations of X-DF systems will dominate in the years 2023-2024, with 146 systems on order as of end-April 2023. There are 22 competing M-type, electronically controlled (ME-GI) high pressure injection system vessels under construction. The efficient new generation M-type, electronically controlled gas admission (ME-GA) system is set to become one propulsion of choice in competition with the X-DF technology for newbuilds further out in time with 122 orders, of which 81 will be delivered from 2025 onwards. The ME-GI, ME-GA, and X-DF systems represent a major shift in favour of efficiency, economies of scale, and environmental performance from the popular propulsion systems of the previous generation – steam turbine, dual-fuel diesel-electric (DFDE) and tri-fuel diesel electric (TFDE).

South Korean shipbuilders Hyundai Heavy Industries Group, Samsung Heavy Industries and Daewoo Shipbuilding & Marine Engineering remain the top three LNG carrier builders in the market, although Hudong Zhonghua has gained prominence in recent years. Chinese yards Jiangnan, Dalian Shipbuilding, Yangzijiang, and China Merchants Heavy Industries have also forayed into the lucrative market for conventional LNG carrier construction, with their business case bolstered by exorbitant newbuild prices and capacity constraints at South Korean yards. The latter four have a combined orderbook of 23 vessels to be delivered before end-2027.

In 2022, the LNG spot charter market was characterised by extreme volatility, with charter rates repeatedly recording new all-time highs. The Russia-Ukraine conflict led to a sharp reduction in Europe's pipeline gas imports from Russia, leading to Europe importing large volumes of LNG to help bridge the subsequent supply deficit. Despite the large reduction in average voyage distances as more US LNG was directed to Europe, the spot charter market was buoyed by ton-days as vessels preferred to float outside Europe through much of 2022's third quarter and early fourth quarter instead of being diverted to Asia. Spot charter rates (West of Suez) reached a peak of $250,000/day for steam turbine vessels, $355,000/day for TFDE/DFDE vessels and $450,000/day for X-DF/ME-GI vessels by end-October 2022.

In total, 6,888 LNG trade voyages were undertaken in 2022, a 2.7% increase from the 6,708 seen in 2021. This is in line with limited growth in global LNG production. While Asia remains the dominant demand centre, European trade voyages grew significantly by 44.8% to 2079 in 2022 because Europe imported large volumes of LNG (more than 66% up on 2021 levels) to offset reduced Russian piped gas flows.

Courtesy KOGAS

6.2 LNG CARRIERS

Vessel Age and Capacity

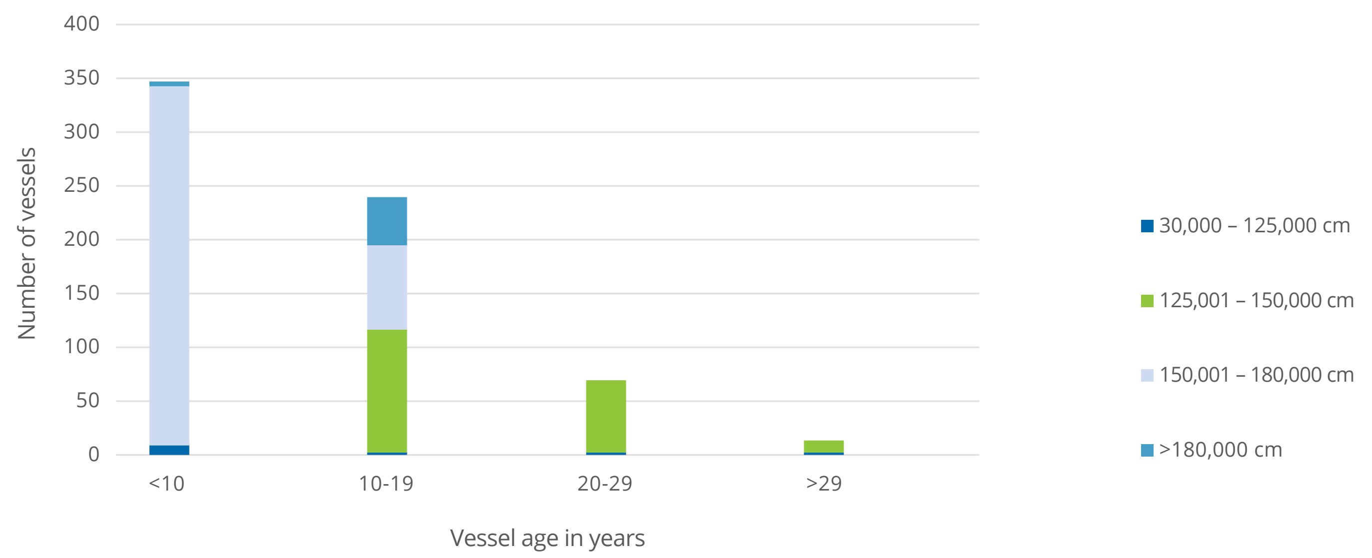
The current global LNG fleet is relatively young, considering the oldest LNG carrier operating was constructed in 1977. Some 87.7% of the fleet is under 20 years of age, consistent with the rapid growth of liquefaction capacity since the turn of the century. In addition, newer vessels are larger and more efficient, with superior project economics over their operational lifetime.

With financial and safety concerns in mind, shipowners plan to operate a vessel for 35-40 years before it is laid-up, although challenges from upcoming emissions reduction regulations (notably, the IMO's EEXI and CII) could reduce this or incentivise retrofits or conversions. Due to the rapid development of technology and emissions regulations, the life duration may become shorter.

At the end of its operating life, a decision can be made on whether to scrap a carrier, convert it to an FSU/FSRU, or return it to operation should market conditions improve materially.

When commissioning a newbuild, a shipowner determines vessel capacity based on individual needs, ongoing market trends, technologies available at the time, and increasingly, with a view to future environmental regulations and demand for LNG. Liquefaction and regasification plants also have berthing capacity limits, while certain trade-lanes may limit vessel dimensions, all of which are important considerations regarding ship dimensions and compatibility. The needs of individual shipowners are also largely affected by market demand, which means newbuild vessel capacities have stayed primarily within a small range around period averages, as illustrated in Figure 6.3.

Figure 6.3: Fleet capacity by vessel age, end-April 2023



Source: Rystad Energy

Due to the early dominance of steam turbine propulsion, vessels delivered before the mid-2000s were exclusively smaller than 150,000 cm as this was the range best suited for steam turbine propulsion systems, many of them equipped with Moss-type cargo tanks. The LNG carrier landscape changed dramatically when Qatari shipping line Nakilat introduced the Q-Flex (210,000 to 217,000 cm) and Q-Max (263,000 to 266,000 cm) vessels, specifically targeting large shipments of LNG to Asia and Europe. These vessels achieved greater economies of scale with their SSDR propulsion systems, representing the 45 largest LNG carriers ever built.

After the wave of Q-Class vessels, most newbuilds have settled at a size between 150,000 and 180,000 cm. This capacity range now makes up 62% of the current fleet. The technological developments that steered adoption of this size are two-stroke propulsion systems, such as the ME-GI, X-DF, STaGE and more recently ME-GA types, that maximise fuel efficiency between 170,000 and 180,000 cm. Another crucial factor is the new Panama Canal size limit – only vessels smaller than this size were initially authorised to pass through the new locks, imperative for any ship engaged in trade involving US LNG supply. The Q-Flex LNG carrier Al Safliya, which is larger than 200,000 cm, became the first Q-Flex type LNG vessel and the largest LNG carrier by cargo capacity to transit the Panama Canal in May 2019.

While 174,000 cm remains the most common newbuild size, larger ships have once again gathered interest from shipowners. There are fifteen 200,000 cm vessels currently on order. With further improved two-stroke propulsion solutions, the second-generation X-DF and ME-GA systems, 200,000 cm carriers might become a popular choice from an efficiency standpoint, although other aspects such as flexibility and terminal compatibility must also be considered.

Containment Systems

LNG containment systems store LNG at a cryogenic temperature of approximately -162°C (-260°F), a key design element. LNG containment systems can be split into two categories: membrane systems and self-supporting systems. Membrane systems are mostly designed by Gaztransport & Technigaz (GTT), while self-supporting systems mainly comprise spherical 'Moss' type vessels and IHI Corporation's Type B vessels. Due to the advantages highlighted below, modern newbuilds have almost entirely adopted the membrane type.

Table 6.1: Overview of containment systems

	Membrane	Self-supporting
Current fleet count	545	123
Current fleet proportion (%)	81.6%	18.4%
Systems	GTT-designed: Mark III, Mark III Flex, Mark III Flex+, NO96 series, NO96 Super+, CS1, Next1 (under development) KC LNG TECH Designed: KC-1	Moss Maritime-designed: Moss Rosenberg IHI-designed: SPB LNT Marine-designed: LNT A-BOX
Advantages	• Space-efficient • Thin and lighter containment system • Higher fuel-efficiency • Lower wheelhouse height	• More robust in harsh conditions • Partial loading possible • Faster construction
Disadvantages	• Partial loading restricted • Less robust in harsh conditions	• Spherical design uses space inefficiently • Slower cool-down rate • Thicker, heavier containment system

Source: Rystad Energy

In both systems, a small amount of LNG is naturally vaporised during a voyage. This boil-off gas is a direct result of heat transferred from the atmospheric environment, liquid motion or sloshing, the tank-cooling process, and the tank-depressurisation process. Boil-off rates in new membrane carriers at laden conditions are usually below 0.10% of tank capacity per day, with partial re-liquefaction systems reducing this even further. This contrasts with older self-supporting carriers, which average about 0.15% of tank capacity per day. Membrane and self-supporting systems can be further split into specific types, which are examined below.

The two dominant membrane type LNG containment systems are the Mark III designed by Technigaz and the NO96 by Gaztransport. The two companies subsequently merged to form Gaztransport & Technigaz (GTT). Membrane-type systems have primary and secondary thin membranes made of metallic or composite materials that shrink minimally upon cooling. The Mark III has two foam insulation layers, while the NO96 uses insulated plywood boxes purged with nitrogen gas and filled up originally with perlite, then glass wool and more recently foam insulation. GTT is developing the Next 1 containment system, which includes two metallic membranes supported by a layer of insulating reinforced polyurethane foam.

GTT states a boil-off-rate of 0.07% for its Mark III Flex+ and is aiming for a similar rate for its Next 1 system, while the new NO96 Super+ has a boil-off rate of 0.085%. Within a range of tank filling levels, the natural pitching and rolling movement of the ship at sea and the liquid free-surface effect can cause the liquid to move within the tank in membrane containment systems, which may place high-impact pressure on the tank surface. This effect is called 'sloshing' and can cause structural damage. The first precaution is to maintain the level of the tanks within the required limits given by the tank designer (GTT). This is typically lower than a level corresponding to 10% of the height of the tank or higher than a level corresponding to 70% of the height of the tank. The membrane-type system has become the popular choice due to space efficiency of the prismatic shape and its lower boil-off-rate, despite restrictions on part-filling due to the sloshing effect.

The new generation of 200,000 cm vessels have four-tank membrane vessels, contrasting with five-tank Q-flex ships.

Celebrating 50 years in operation, the Moss Rosenberg system was first delivered in 1973. LNG carriers of this design typically feature four or five self-supporting aluminium spherical tanks, insulated by polyurethane foam flushed with nitrogen. The spherical shape allows for accurate stress and fatigue prediction of the tank, increasing durability and removing the need for a complete secondary barrier. A partial secondary barrier in the form of a tray covers the bottom of the tank to capture any LNG leakage. Unlike membrane tanks, independent self-supporting spherical tanks allow for partial loading during a voyage. However, due to its spherical shape, the Moss Rosenberg system uses space inefficiently compared to membrane storage and its design necessitates a heavier containment unit.

The Sayaendo-type vessel, produced by Mitsubishi, is a recent improvement on the traditional Moss Rosenberg system. The spherical tanks are elongated into an apple shape, increasing volumetric efficiency. They are then covered with a lightweight prismatic hull to reduce wind resistance. Sayaendo vessels are powered by ultra-steam turbine plants, a steam reheat engine, which is more efficient than a regular steam turbine engine.

The Sayaringo Steam Turbine and Gas Engine (STaGE) type vessel, also produced by Mitsubishi, was a further improvement on the Saeyendo type vessel. The STaGE vessel adopts the shape of the Sayaendo alongside a hybrid propulsion system, combining a steam turbine and gas engine to maximise efficiency. Eight STaGE newbuilds were delivered from 2018-19.

The IHI-designed Self-supporting Prismatic type B (SPB) system was first implemented in 1993 in two 89,900 cm LNG carriers, Polar Spirit and Arctic Spirit. Since then, it has been used in several LPG and small-scale LNG vessels before Tokyo Gas commissioned four 165,000 cm vessels with the design, primarily for transportation from Cove Point. The design involves four tanks subdivided internally, allowing for partial loading during the voyage. The tanks have one longitudinal and one transversal subdivision internally to reduce sloshing. The result mitigates the issue of sloshing and does not require a pressure differential, claiming a relatively low boil-off-rate of 0.08%. It is worth noting that the SPB system has higher space efficiency and is lighter than the Moss Rosenberg design.

Moss Rosenberg and IHI SPB tank types represent just under 20% of the fleet in service. There is currently only one small LNG vessel under construction at Hyundai Mipo Dockyard with a self-supporting tank of type C, owned by Anthony Veder. Although membranes have become the tank of choice for LNG carriers, self-supporting technology is still available and fully approved in accordance with international regulations.

Lastly, the LNT A-BOX is a self-supporting design of type A aimed at providing a reasonably priced LNG containment system with a primary barrier made of stainless steel or 9% nickel steel, and a secondary barrier made of liquid-tight polyurethane panels installed in the ship bulkheads, deck and ceiling of the cargo holds. Similar in shape to the IHI-SPB design, the system mitigates sloshing by way of an independent tank, with the aim of minimising boil-off gas. The first 45,000 cm newbuild with this system in place, Saga Dawn, was delivered in December 2019.

Propulsion Systems

Propulsion systems influence levels of capital expenditure, operational expense, emissions, vessel size range, vessel reliability, and compliance with regulations. Before the early 2000s, steam turbine systems running on boil-off gas and heavy fuel oil were the only available propulsion solution for LNG carriers. Increasing fuel oil costs and stricter emission regulations led to the development of more efficient alternatives such as the DFDE, TFDE and the slow-speed diesel with re-liquefaction plant (SSDR).

In recent years, modern containment systems that generate lower boil-off gas and the rise of short-term and spot trading of LNG have spawned demand for more flexible and efficient propulsion systems to adapt to varied sailing speeds, distances, and conditions. These factors have resulted in a new wave of dual-fuel propulsion systems that also burn boil-off gas with a small amount of pilot fuel or diesel. This includes the high-pressure MAN B&W M-type electronically controlled, gas injection (ME-GI) system, the newly popular M-type electronically controlled, gas admission system (ME-GA) of low-pressure injection, and two generations of low-pressure injection Winterthur Gas & Diesel (WinGD) X-DF.

Special mention should be made of ABB's Azipod units, which have been deployed in the 15 ARC7 icebreaker units in service for the Yamal LNG project in Russia. The electrical motors of this propulsion system are housed in a submerged pod outside the LNG carrier's hull, with 360-degree rotational capabilities. The resulting heightened maneuverability enables the highly powered units to navigate efficiently through the Arctic, including through ice up to 2.1 metres thick. This propulsion system will be deployed in the ARC7 icebreakers ordered for Novatek's Arctic LNG 2 project.

Additional systems in place to reduce fuel consumption on board include air lubrication systems and PTO-Shaft generators in the propulsion lines. These technologies are being implemented in many vessels currently on order. Other systems are currently being assessed such as wind-assisted propulsion or fuel cells to mention some.

Steam turbine

Steam turbines for ship propulsion are now mostly considered to be a superseded technology and hiring crew with steam experience has become difficult. In a steam turbine propulsion system, two boilers supply highly pressurised steam at over 500°C (932°F) to a high and then low-pressure turbine to power the main propulsion and auxiliary systems. The steam turbine's main fuel source is boil-off gas, with heavy fuel oil used as an alternative if the former proves insufficient. The fuels can be burned at any ratio and excess boil-off gas can be converted to steam, making the engine reliable and eliminating the need for a gas combustion unit. Maintenance costs are also relatively low.

The key disadvantage of steam turbines is their low efficiency, running at 35% efficiency when fully loaded (most efficient). The newer generations of propulsion systems, DFDE/TFDE and ME-GI/ME-GA/X-DF engines, are approximately 25% and 50% more efficient respectively than steam. There are currently 221 active steam-turbine propulsion vessels, making up 33% of the total active fleet. As newer technologies have been adopted rapidly, there are no steam turbine vessels currently on order.

An improvement of the steam turbine was introduced in 2015, involving reheating the steam in-cycle to improve efficiency by more than 30%. Aptly named the steam reheat system (or ultra-steam turbine), there are 12 such active vessels with the propulsion in place and zero newbuilds due.

Dual-fuel diesel electric/triple-fuel diesel electric (DFDE and TFDE)

DFDE propulsion was introduced in 2006 as the first alternative to steam turbine systems, able to run on both diesel and boil-off gas. It does so in two separate modes, diesel or gas, powering generators which produce electricity used to drive electric motors for propulsion. Auxiliary power is also delivered through these generators, and a gas combustion unit (GCU) is in place should there be excess boil-off gas. In 2008, the arrival of TFDE vessels improved the adaptability of this type of vessel with the option of burning heavy fuel oil as an additional fuel source. Being able to choose from different fuels during different sailing conditions and prevailing fuel prices increases overall efficiency by up to 30% over steam turbine propulsion. In addition, the response of these vessels under a dynamic load, such as during adverse weather conditions, is considered excellent.

However, the DFDE and TFDE propulsion systems also have certain disadvantages. Capital outlays as well as maintenance costs are relatively high, in part due to the necessity for a GCU and the number of engines and cylinders. In gas mode, knocking and misfiring can happen if the boil-off gas composition is out of the engine-specified range. Knocking refers to ignition in the engine prior to the optimal point, which can be detrimental to engine operation. There are 193 active TFDE/DFDE vessels as of end-April 2023, representing 29% of the current fleet. There are currently 22 newbuild vessels with TFDE systems to be delivered, 21 icebreakers to service the upcoming Arctic LNG 2 project, and one newbuild FSRU for Excelerate Energy.

Slow-speed diesel with re-liquefaction plant (SSDR)

The SSDR was introduced together with the DFDE propulsion system, running two low-speed diesel engines and four auxiliary generators with a full re-liquefaction plant to return boil-off gas to LNG tanks in a liquid state. The immediate advantages are the negligible boil-off, which optimised cargo value during the high gas price environment of 2022, and the option to efficiently use heavy fuel oil or diesel as a fuel source. However, the heavy electricity use of the re-liquefaction plant can negate efficiency gains and restrict the SSDR only to very large carriers (to achieve economies of scale). There are currently 48 SSDR vessels in the active LNG fleet, 44 of which are Nakilat's Q-Class vessels. The Q-Max vessel (Rasheeda) previously ran an SSDR engine before being converted to a ME-GI-type vessel in 2015. Due to more stringent environmental regulations and the introduction of third-generation engines, there are currently no SSDR engines on order.

M-type, electronically controlled (MAN B&W ME-GI, ME-GA)

Introduced in 2015 by MAN B&W, the two-stroke M-type electronically controlled, gas injection system (commonly known as ME-GI), pressurises boil-off gas up to around 350 bar and burns it with a small amount of injected diesel fuel (pilot fuel). Efficiency is maximised as the slow speed engine is able to run off a high proportion of boil-off gas while minimising the risk of knocking. Similar efficiency and reliability levels are observed when switching fuel sources as the engine is always running on diesel thermodynamic cycle.

Fuel efficiency is maximised for large-sized LNG carriers, which make up the majority of newbuilds today. As such, the current modern LNG fleet in service reflects the apparent advantages of the ME-GI propulsion system. A total of 72 newbuild vessels fitted with ME-GI systems have been delivered since 2015, with 22 additional newbuilds with the system under construction. However, low-pressure injection engines have become more compelling.

MAN B&W has developed a new engine based on the ME-GI, the two-stroke M-type electronically controlled, gas admission system (ME-GA), which is specifically designed for the LNG carrier segment and runs on the Otto thermodynamic cycle. This system allows for a low gas supply pressure and is better suited for use of boil-off gas as a fuel. The ME-GA is also touted to have lower capital expenditure, operational expenditure, and NOx emissions than current-generation engines. Exhaust recycling systems in place improve methane-slip by up to 50%. The popularity of the ME-GA engine has surged: there are 122 ME-GA vessels currently on order, eight of which will be delivered in 2023, 33 in 2024, 41 in 2025, 25 in 2026, and 15 in 2027.

Low-pressure slow-speed dual-fuel (Winterthur Gas & Diesel X-DF)

Originally introduced by Wärtsilä, the Winterthur Gas & Diesel (WinGD) X-DF was premiered on the South Korean newbuild SK Audace in 2017. The X-DF burns fuel and air, mixed at a high air-to-fuel ratio, injected at a low pressure in the Otto thermodynamic cycle. When burning gas, a small amount of fuel oil is used as pilot fuel. As the maintained pressure is low, the system is easier to implement and integrate with a range of vendors.

In terms of overall ship fuel consumption and efficiency, LNG carriers equipped with ME-GI and first-generation X-DF are comparable. Safety and emissions are the areas where the first-generation X-DF stands out, winning over the ME-GI due to low levels of nitrogen emissions without needing an after-treatment system. The ME-GI compensates for this with slightly lower fuel/gas consumption and better dynamic response.

In 2020, WinGD introduced the second-generation X-DF systems, building on its earlier success. The second-generation X-DF reduces methane slip by half and improves fuel consumption by between 3% and 5% through exhaust recycling systems. Overall efficiency has improved to over 50% as operations and maintenance requirements have remained excellent. The second-generation X-DF will compete with ME-GA systems. There are currently 114 vessels with the X-DF system in service. The orderbook for LNG carriers contains 146 X-DF vessels across both generations, representing 47% of total newbuilds to be delivered.

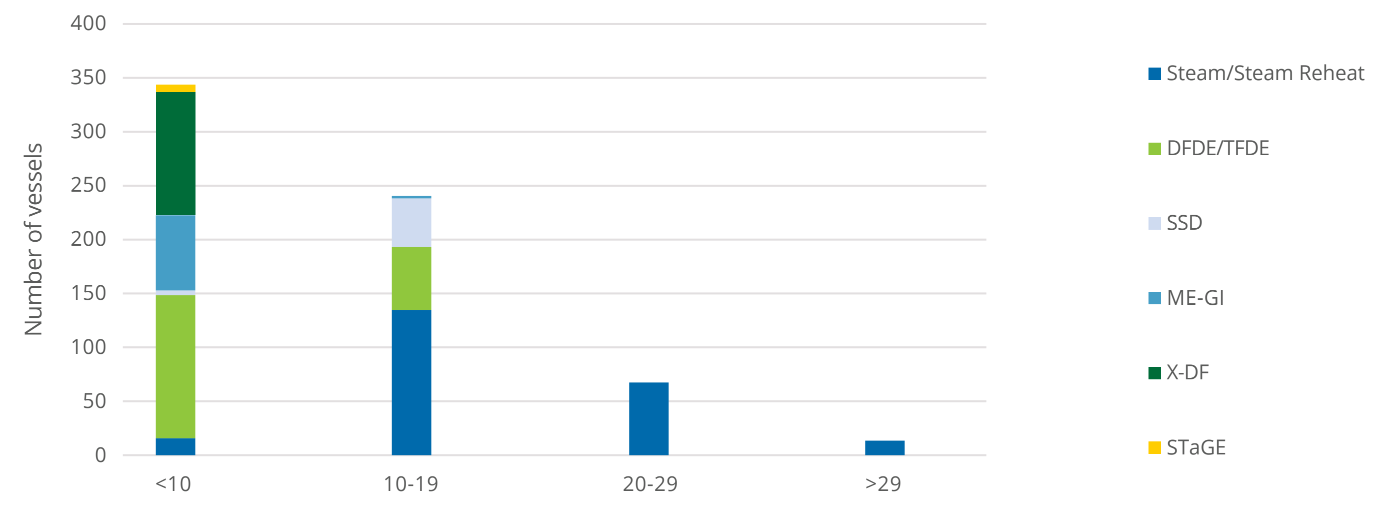
Steam turbine and gas engine (STaGE)

First introduced in a 2018 delivery, the Sayaringo STaGE propulsion system runs both a steam turbine and a dual-fuel engine. Waste heat from running the dual-fuel engine is recovered to heat feedwater and to generate steam for the steam turbine, significantly improving overall efficiency. The electric generators attached to the dual-fuel engine power both a propulsion system and the ship, eliminating the need for an additional turbine generator. In addition to efficiency, the combination of two propulsion systems improves the ship's adaptability while reducing overall emissions. A Japanese innovation, STaGE systems have been produced exclusively by Mitsubishi, with eight newbuilds delivered during 2018 and 2019. There are currently no STaGE vessels on order.

Fleet propulsion system breakdown by vessel age

Steam turbine systems make up the majority of older vessels, with DFDE/TFDE and SSDR representing a small proportion of vessels aged over 10 years. As almost all the SSDR vessels comprise Qatari Q-Class ships, the age range is in line with when they were delivered. The entirety of ME-GI, ME-GA, X-DF, and STaGE vessels are new due to the recent nature of these innovations. The global orderbook shows that moving forward, both generations of X-DF systems will make up a significant portion of delivered vessels until 2025, after which ME-GA systems gain prominence.

Figure 6.4: Fleet propulsion type by vessel age, end-April 2023

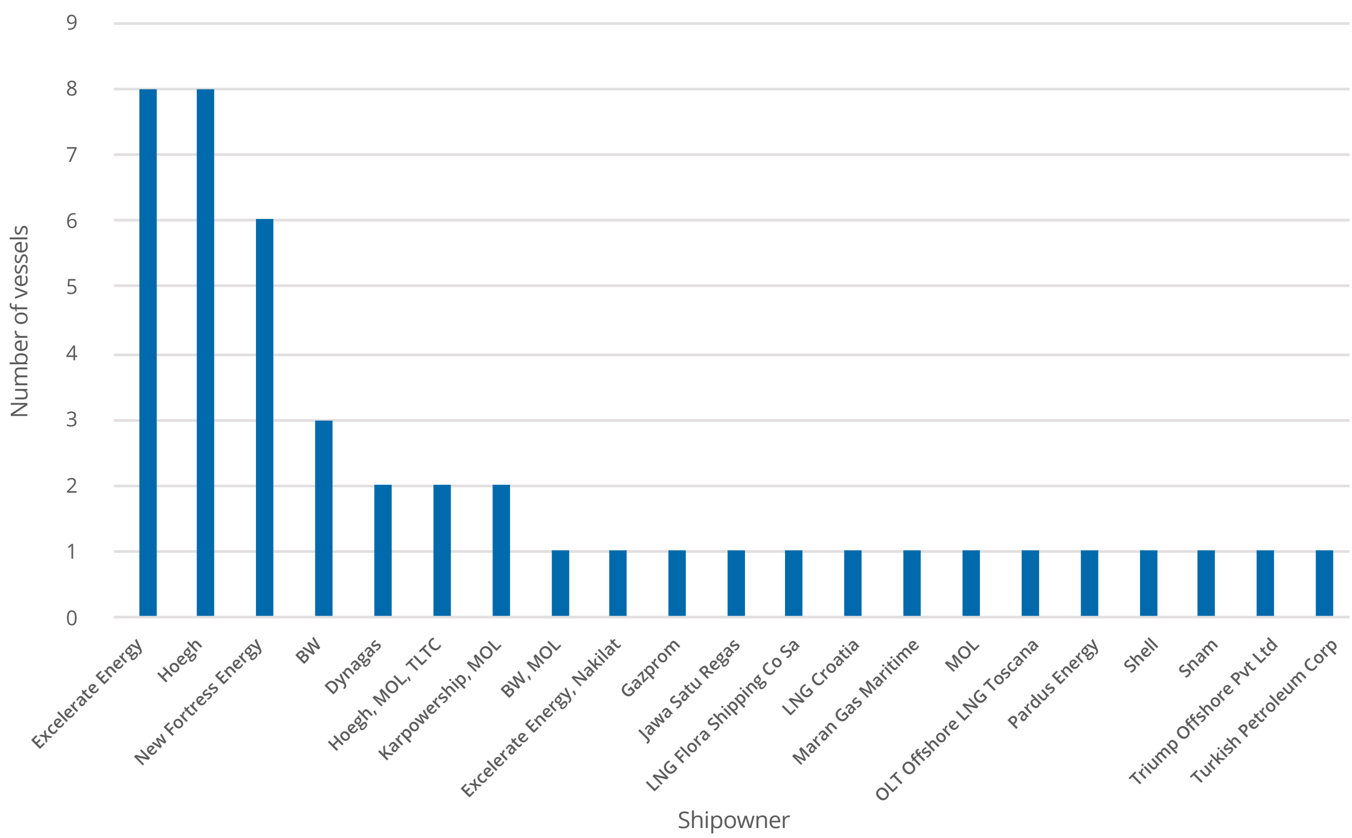


Source: Rystad Energy

Courtesy Qatargas

6.3 FLOATING STORAGE AND REGASIFICATION UNIT (FSRU) OWNERSHIP

Figure 6.5: FSRU fleet by shipowner, end-April 2023



Source: Rystad Energy

FSRUs are used for LNG storage and regasification in addition to being regular LNG carriers, except for a few examples of non-propelled units. Compared to traditional onshore regasification plants, FSRUs offer better flexibility, lower capital outlay and a faster means of importing LNG. In 2022, no new FSRUs were delivered with a total of 45 FSRUs making up 6.7% of the active global LNG fleet. Shipowners Hoegh, Excelerate Energy and BW continue to operate the largest fleets of active FSRUs, while new player New Fortress Energy entered the market in 2021 through the acquisition of Golar's FSRUs. Currently one newbuild FSRU is under construction for Excelerate, while four LNGCs are undergoing conversion to FSRUs: Golar Arctic, Etyfa Prometheas, LNG Vesta, and Alexandroupolis.

With the ability to import LNG via a 'plug-and-play' solution, FSRUs offer the flexibility of meeting demand as and where it is needed before being redeployed elsewhere. For example, in Brazil, Petrobras has swapped out FSRUs to optimise LNG send-out. Another important consideration is that FSRUs are deployed off the coast of the markets they serve instead of on land, offering an advantage in land-scarce regions or hard-to-reach areas.

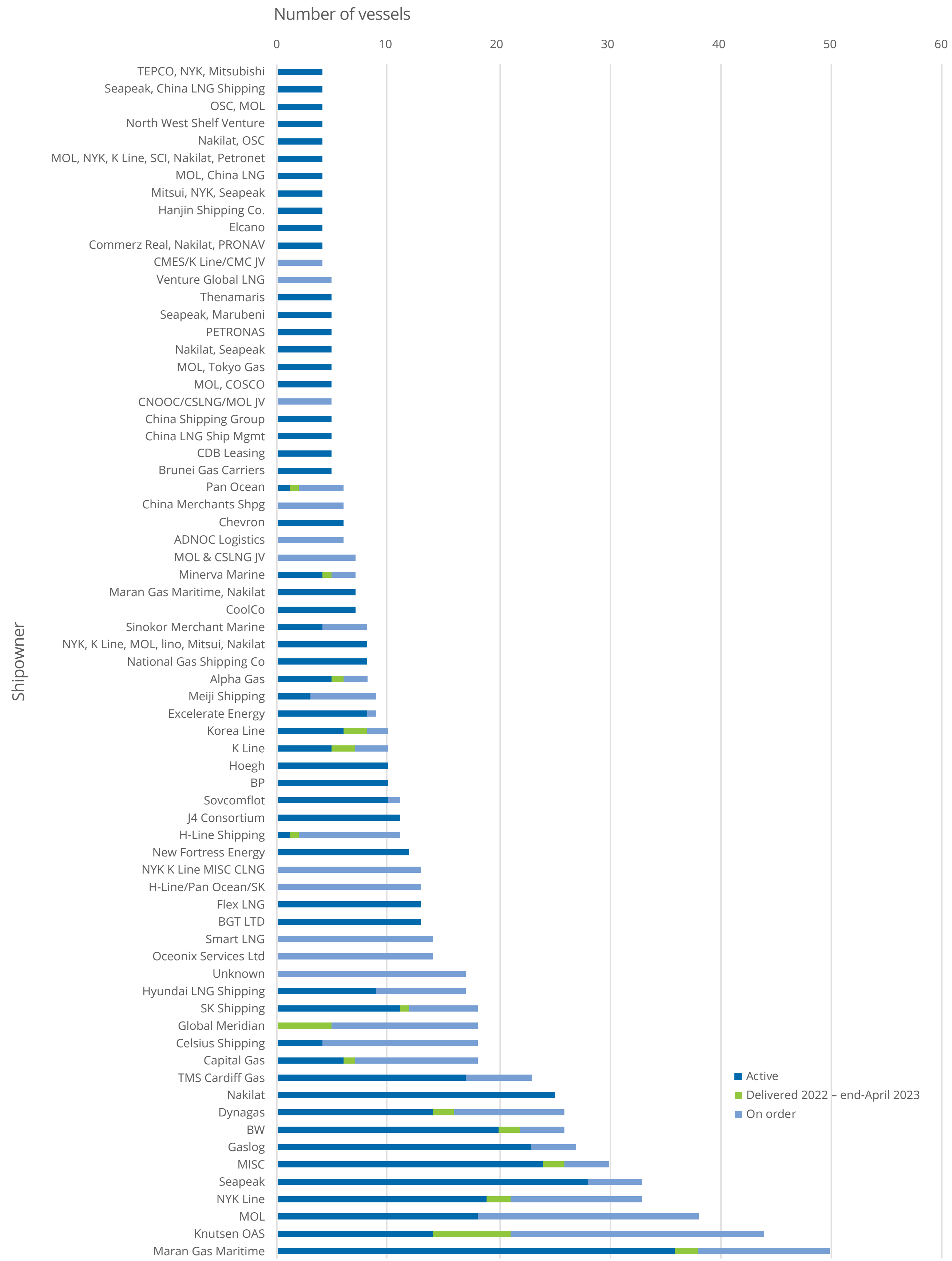
Capital expenditure of an FSRU can be as little as half that of an onshore terminal, while installation in regions with existing infrastructure can happen in months, though this is offset by higher operating expenditure. FSRUs can be newbuilds or conversions from existing LNG carriers. Newbuild FSRUs offer design flexibility and a wider range of outfitting options but are higher in cost and take longer to build.

FSRUs have not been free of issues. Delivery delays, power cuts and rising costs have affected certain projects, slightly dampening demand for the vessel type. In addition, spikes in LNG transportation charter rates can motivate shipowners to use the ships as LNG carriers, reducing the number of FSRUs operating as regasification or storage units. The current order book has only one FSRU newbuild, set to be delivered in 2026. The ability of firms to order FSRU newbuilds is challenged as most shipyards are currently constructing the fleet of standard LNG carriers required for a wave of project capacity additions from 2026-28.

The flexibility of FSRUs has proven useful for markets with changing natural gas needs. FSRUs are expected to remain a popular storage and regasification solution for years to come. The Russia-Ukraine conflict has further piqued FSRU interest across Europe, with their speed-to-market advantage helping alleviate the supply crunch and reduce dependence on Russian piped gas. FSRU charter rates which were languishing at sub-$100,000/day levels in 2021 quickly surged to around $200,000/day for vessels deployed to Germany. Since the conflict began, six FSRUs have become operational in Northwest Europe: two in the Netherlands, three in Germany, and one in Finland.

6.4 2023 LNG ORDERBOOK

Figure 6.6: Global fleet and orderbook by shipowner, end-April 2023[4] *Source: Rystad Energy*



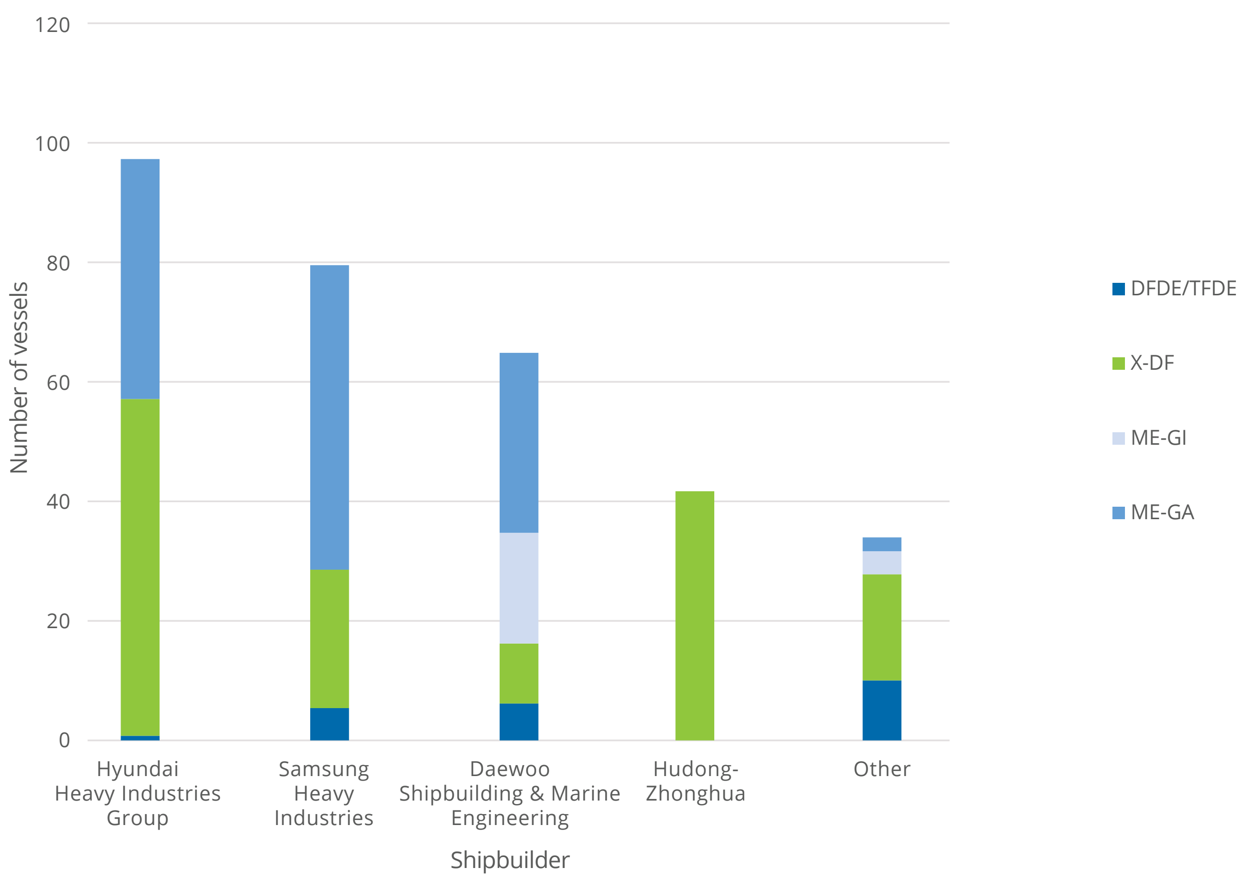
[4] Shipowners or consortiums with four or more total vessels included.

28 additional

LNG vessels scheduled for delivery in 2023

There were 312 LNG carriers under construction as of end-April 2023. Of the 312 vessels, 28 are scheduled for delivery later in 2023, 81 in 2024, 88 in 2025, 85 in 2026, 29 in 2027, and one in 2028. The past year has been a record year in terms of orders with South Korean and Chinese shipbuilders expected to continue accommodating orders. These are being driven by large projects under discussion, such as with Qatar Energy, and the ongoing wave of development in US LNG for which shipping is critical to maximise flexibility.

Figure 6.7: Newbuild orderbook by propulsion type and shipbuilder, end-April 2023



Source: Rystad Energy

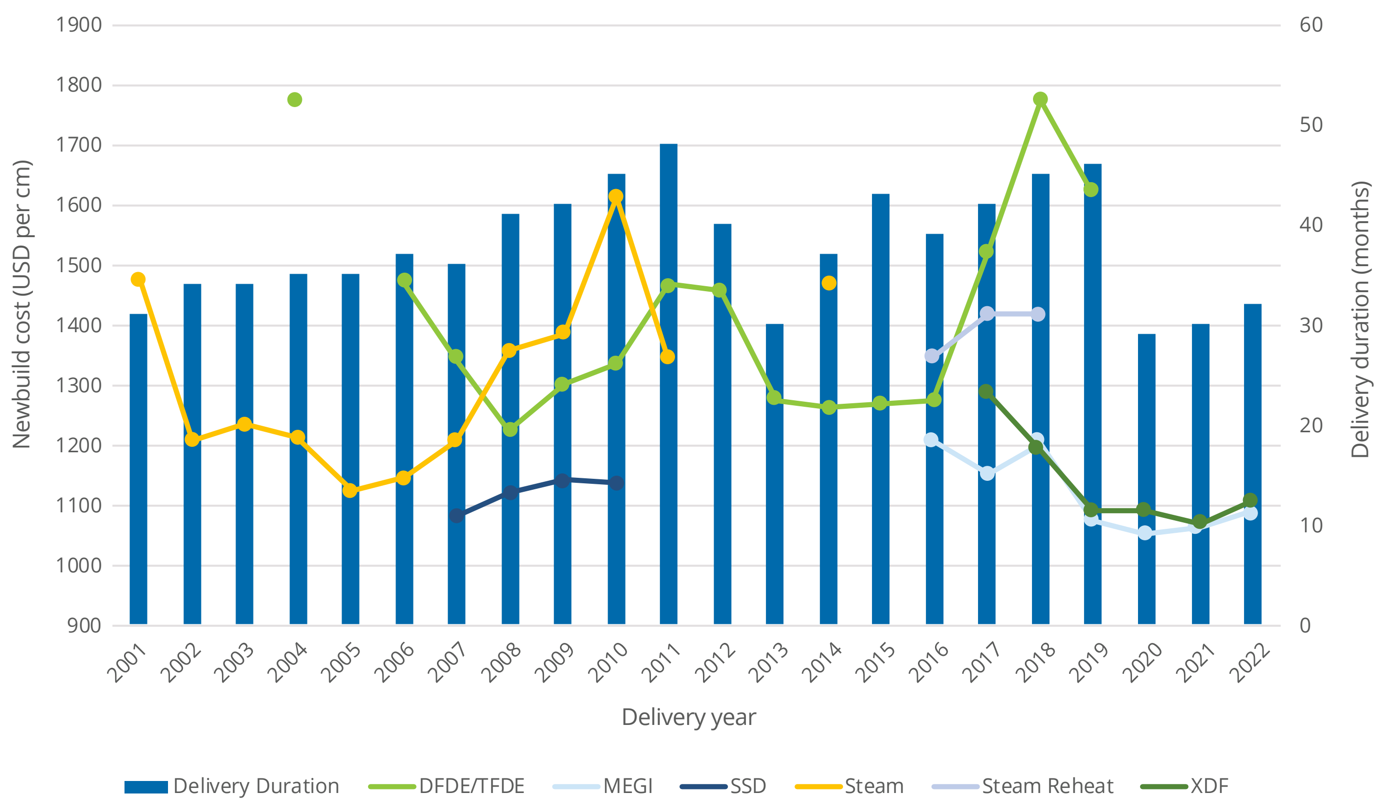
Capitalising on better fuel efficiencies and lower emissions, both generations of X-DF are currently the main propulsion systems of choice, with 146 currently on order. The competing ME-GI system has 22 orders, while the new generation of ME-GA system has 122. TFDE/DFE systems account for 22 vessels. Some 99% of the vessels on order are at or above 170,000 cm in size, showing a clear trend towards larger vessels which can now be accommodated by new locks on the Panama Canal. With the new generation of two-stroke propulsion systems, vessel size might progressively trend towards 200,000 cm moving forward due to economies of scale for long-haul voyages. Fifteen such vessels are currently on order, 10 of which are for Dynagas. In 2022, two Dynagas-owned ships of 200,000 cm were delivered to charterer Cheniere Energy, namely Clean Cajun and Clean Copano.

South Korean shipbuilders Hyundai Heavy Industries Group, Samsung Heavy Industries and Daewoo Shipbuilding & Marine Engineering are the top three shipbuilders for LNG vessels, with 96, 78, and 64 units on order, respectively. In addition, Samsung is assisting Zvezda shipyard in Russia in building 10 icebreakers for Arctic LNG 2. Hyundai and Samsung are working on a large proportion of newbuilds with both generations of X-DF systems, while Daewoo's orders cover X-DF, ME-GI, and a small number of DFDE/TFDE vessels. All three have a small number of ME-GA vessels due for delivery from 2023 onwards. Chinese builder Hudong-Zhonghua is currently working on 41 vessels, all of which are equipped with X-DF propulsion systems.

The Russia-Ukraine conflict has impacted the LNG shipbuilding sector with about 26 vessels on the order book due for Russian customers (either charterer or owner). South Korean shipbuilders and Zvezda Shipbuilding (through joint ventures with Samsung Heavy Industries or Daewoo Shipbuilding & Marine Engineering) are said to be continuing work on Russian vessels, although suppliers of various components could potentially withhold parts due to sanctions which could then lead to delays in delivery. As of April 2023, contracts for three vessels under construction for Arctic LNG 2 had been cancelled by DSME, although DSME is believed to be continuing construction.

6.5 VESSEL COSTS AND DELIVERY SCHEDULE

Figure 6.8: Vessel delivery schedule and newbuild cost, 2001-2022



Source: Barry Rogliano Salles

40 Months

average delivery time for new LNG vessels contracted in 2022

The cost of constructing an LNG carrier is highly dependent on characteristics such as propulsion systems, capacity, and other specifications involving ship design. Historically, DFDE/TDFE vessels started out being pricier than steam turbine vessels, with the higher newbuild costs offset by efficiency gains from operating more modern ships. DFDE/TFDE newbuild costs have varied heavily over the years due to different specification standards – a prominent example being the 2018 peak of over $1,700 per cm for 15 ice-breaker class vessels ordered to service Yamal LNG. These vessels, contracted from 2017, were priced at about $320 million apiece, which drove up average prices.

While vessels equipped with X-DF systems started out marginally more expensive per cubic metre than vessels with ME-GI propulsion systems, they are now cost competitive. Figure 6.8 shows how the cost for X-DF and ME-GI vessels have trended, falling from an initial $1,200–$1,300/cm to around $1,100/cm.

Barring unusual delays, most new LNG vessels have been delivered between 30-40 months after the order date. Despite changes in average vessel sizes over time, shipyards have been able to construct on a consistent delivery schedule, with variance within this band occurring during introduction of new propulsion systems. This can be attributed to shipyards having to adjust to novel designs with new engines, an example being delivery duration peaks in 2011, reaching almost 50 months in the years following the introduction of DFDE/TFDE systems.

Last year saw price levels for LNG carriers climb steadily as shipbuilding demand for different ship types was strong. Prices for a standard 174,000 cm two-stroke vessel climbed from under $200 million to $250 million by year-end and more recently to almost $260 million, with the orderbook remaining strong for subsequent years. Similarly, the lead time has increased substantially, with preferred newbuild slots at South Korean yards now having shifted to 2027, meaning the average delivery duration is likely to increase going forward.

6.6 CHARTER MARKET

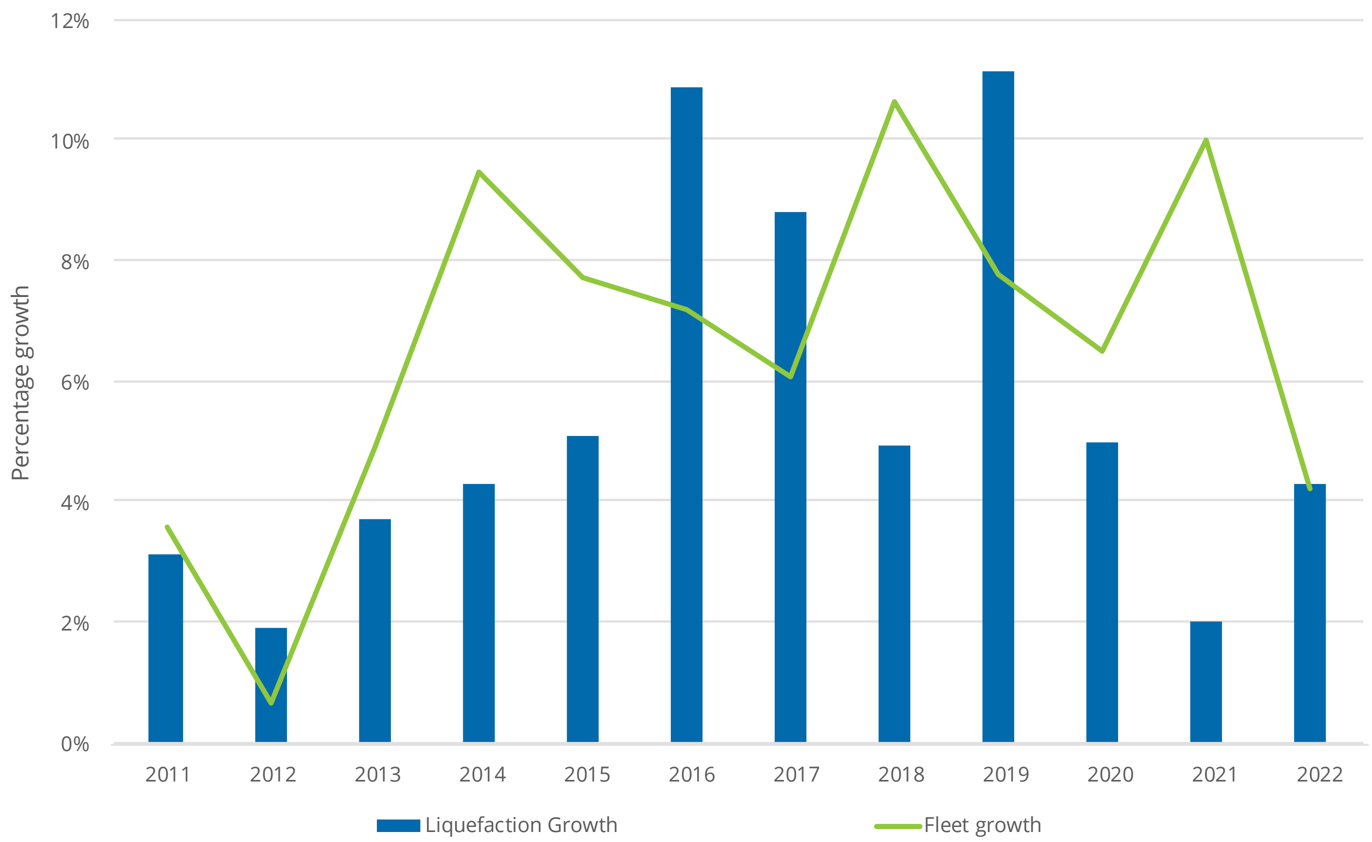
$250,000

for steam turbine, $355,000 for TFDE, and $450,000 for X-DF/ME-GI vessels peak charter day rates in 2022

Shipping costs constitute an important proportion of netback calculations when delivering LNG. Therefore, charter rates are considered seriously when formulating market strategies. Historically, LNG was largely marketed through long-term contracts, encouraging shipowners to enter term charters with large players. As portfolio players have emerged, an increasing number of vessels have become available on the spot market, contributing to market depth of charter fixtures and pricing. However, lack of liquidity can still contribute to charter rate volatility due to a mismatch between supply and demand, and since the Russia-Ukraine conflict charterers have increasingly preferred longer duration charters to ensure supply security.

The price differentials between vessels with X-DF/ME-GI, TFDE/DFDE and steam turbine propulsion can be explained by efficiency gains from using newer propulsion systems. Steam turbine systems are significantly less efficient than TFDE/DFDE systems, which in turn are less efficient than X-DF, ME-GA, and ME-GI engines. In addition, vessels using steam turbines tend to be smaller in size, limiting usability as spot cargoes tend to be at least 150,000 cm. Finally, charterers, conscious about carrier emissions, are demanding newer technologies, further widening the price differential. As IMO regulations (EEXI and CII) take force, steam turbine and other less efficient propulsion types may be limited to certain trade lanes. Market participants must balance fuel efficiencies, boil-off gas savings and higher costs when choosing their carriers and associated propulsion system.

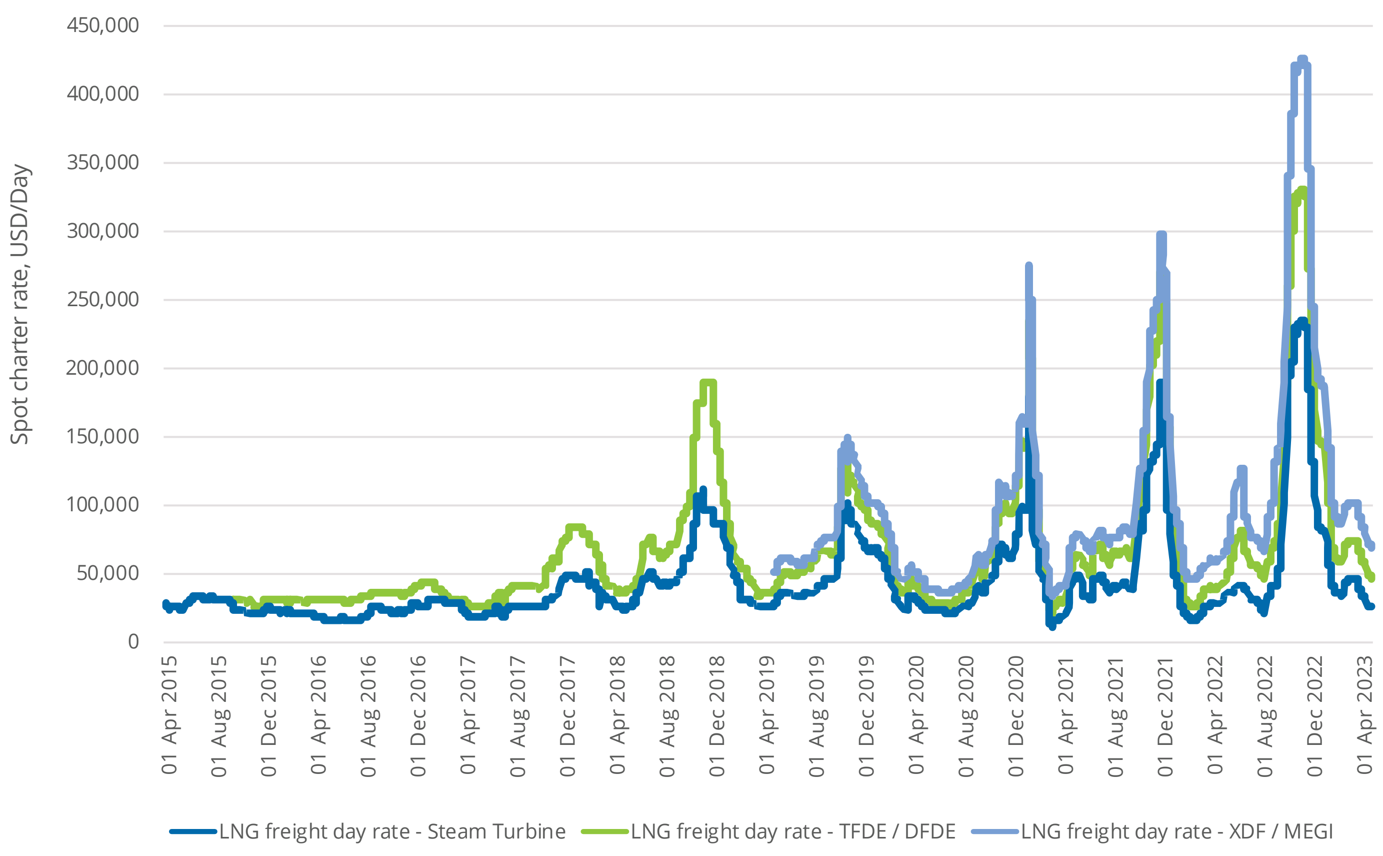
Figure 6.9: Liquefaction capacity growth vs LNG global fleet count growth, 2011-2022



Source: Rystad Energy

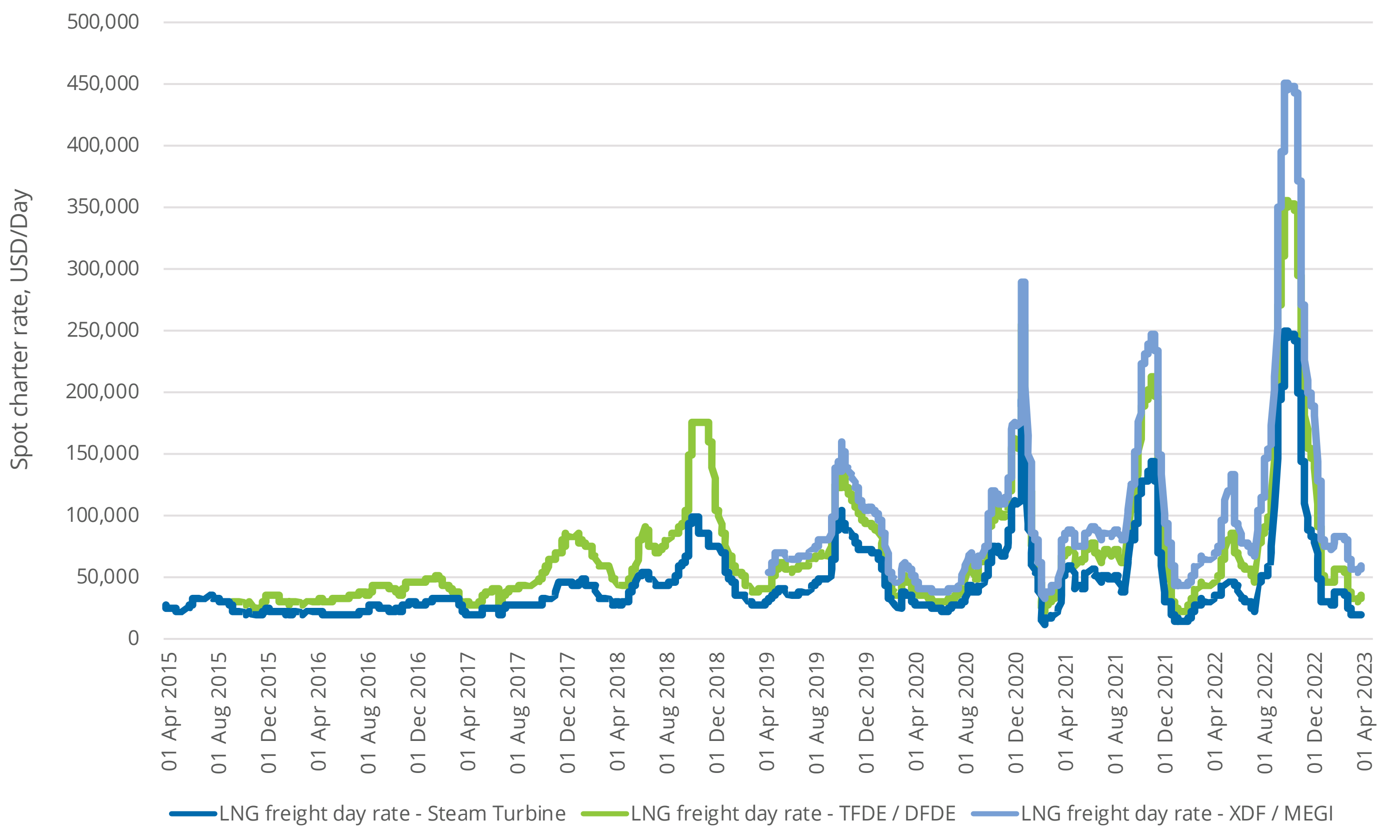
In the early 2010s, fleet growth was well balanced with additional liquefaction capacity coming online, resulting in a stable charter market. However, the rate of vessel deliveries far outweighed that of liquefaction capacity growth from 2013 onwards, resulting in a glut of LNG shipping capacity and a steady decline in charter rates. This continued until 2015, after which they remained between $15,000/day and $50,000/day (for steam turbine) until the fourth quarter of 2017 when a rapid increase in Asian LNG demand sparked an increase in charter rates. Rates were volatile throughout 2018, swinging between previous highs and corrections. Notably, end-2018 saw a spike in charter prices with TFDE day rates reaching $190,000/day for most of November. This was partially attributable to winter storage filling up rapidly, leaving vessels off the charter market while they waited to discharge cargo.

Figure 6.10: Spot charter rates East of Suez, 2015 to end-April 2023



Source: Argus Direct

Figure 6.11: Spot charter rates West of Suez, 2015 to end-April 2023



Source: Argus Direct

After peaking at end-2018, rates slowly returned to regular seasonal variations until October 2019 when US sanctions against Chinese state-owned shipping company COSCO removed many vessels available for charter in both the Atlantic and Pacific basins. Charter rates spiked, hitting a peak of $105,000/day for steam turbine vessels, $145,000/day for TFDE/DFDE vessels and $160,000/day for X-DF/ME-GI vessels, before ticking lower into 2020.

As the outbreak of the global COVID-19 pandemic started to impact demand through 2020, spot charter rates for all vessel types inched lower towards mid-March before a brief rally due to arbitrage opportunities between the Pacific and Atlantic basins. As the interbasin arbitrage closed, slower US exports weighed on freight demand, when depressed charter rates incentivised the use of LNG vessels as floating storage mid-year. It is worth noting that, at such charter rates, shipowners were likely operating at a short-term financial loss.

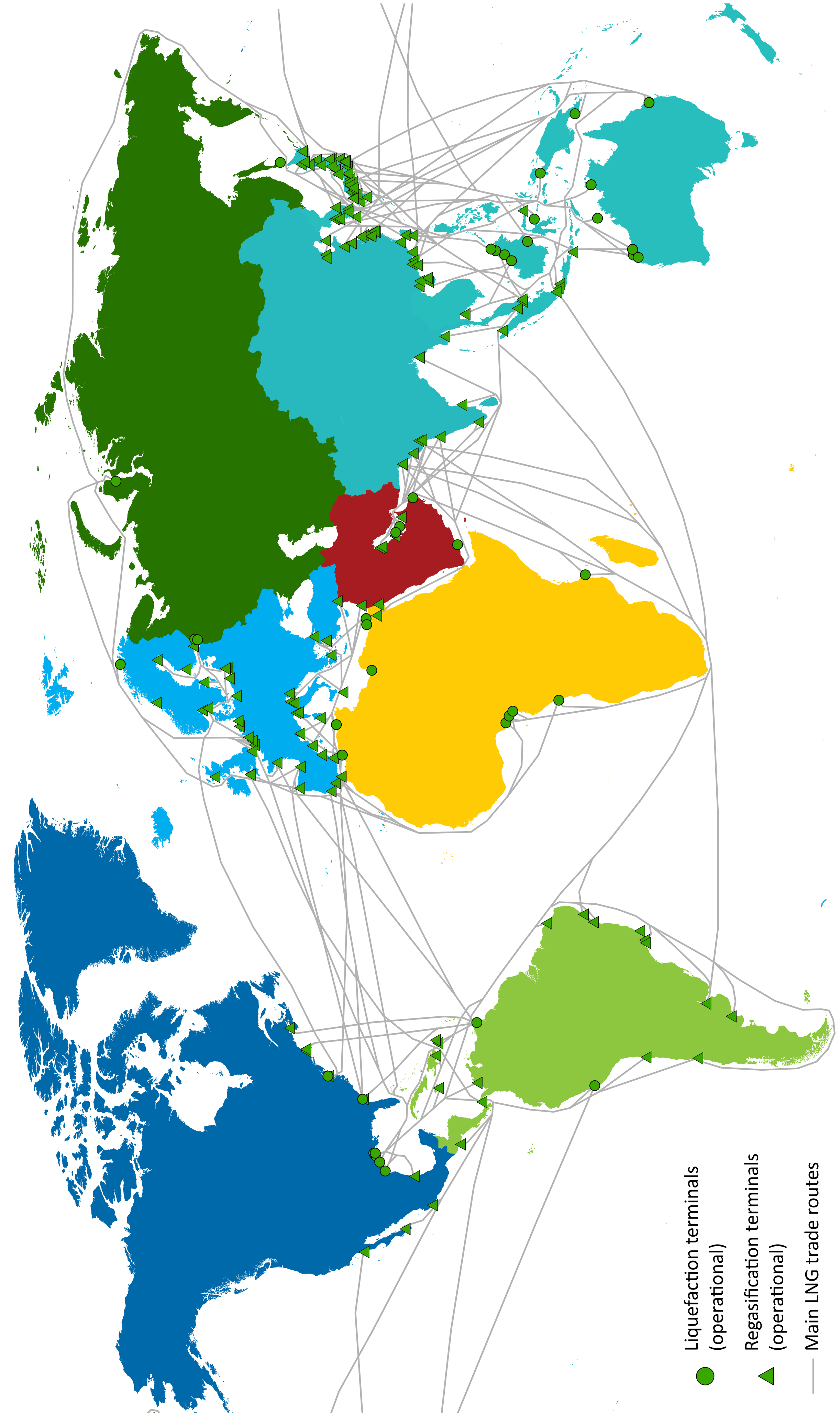
A tighter supply/demand balance from mid-August in 2020 led to rates climbing steadily towards the end of the year, as the Pacific and Atlantic basin price differential increased. This was attributable to strong mid-winter demand in Asia driven by temperature expectations and coal plant decommissioning in South Korea, alongside transit delays in the Panama Canal. With global LNG prices hitting record highs, charter rates soon followed, reaching an unprecedented peak of $190,000/day for steam turbine vessels, $255,000/day for TFDE/DFDE vessels and $290,000/day for X-DF/ME-GI vessels at the beginning of 2021.

2021 proved to be a turbulent year in the history of gas and LNG freight markets, with the charter spike quickly reversing as winter demand eased after February, with rates falling to historical lows in early March. A climb then commenced as the Ever-Given container ship blocked the Suez Canal, while it became clear that Europe and Asia would compete for LNG cargoes to increase filling in underground storage facilities. By October 2021, gas prices hit new record levels as demand growth from the industrial sector coincided with a coal shortage in China, which further strengthened its position as an LNG buyer. Once again, this caused a large spike in charter rates, reaching $140,000/day for steam turbine vessels, $210,000/day for TFDE/DFDE vessels and $250,000/day for X-DF/ME-GI vessels in mid-December.

2022 was a year of soaring LNG freight. At the beginning of 2022, as northern hemisphere winter volumes became accounted for, freight rates eased briefly before ticking upwards as the Ukraine crisis started in February, structurally increasing LNG demand in Europe. Nations previously relying on Russian pipeline gas imports are now looking to increase their LNG imports, while aiming to build out regasification capacity, placing material upward pressure on freight rates. Rates reached $45,000/day for steam turbine vessels, $80,000/day for TFDE/DFDE vessels and $120,000/day for X-DF/ME-GI vessels in end-May 2022. Later, the freight rate decreased briefly with the seasonal trend. In August, Europe prepared in advance for winter and pushed the LNG shipping market into the peak season ahead of schedule. West of Suez rates reached $250,000/day for steam turbine vessels, $355,000/day for TFDE/DFDE vessels and $450,000/day for X-DF/ME-GI vessels by the end of October 2022. Then, as the winter turned out to be milder than expected, with high inventory in European and Asian storage, prices softened considerably into early 2023, after which charter rates also declined.

Courtesy KOGAS

Figure 6.12: Major LNG shipping routes, 2022



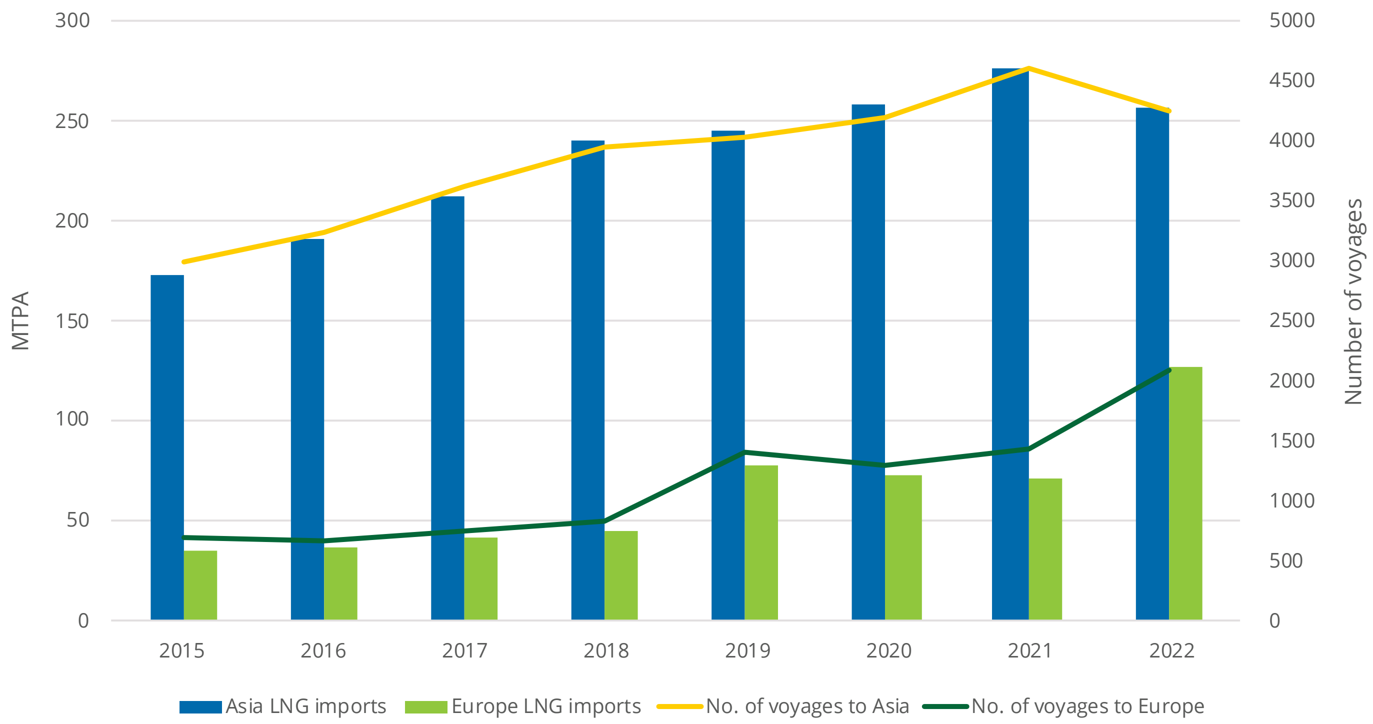
Source: Rystad Energy

6.7
FLEET VOYAGES AND VESSEL UTILISATION

6,888 LNG trade voyages
in 2022

As a result of the Russia-Ukraine conflict, 2022 saw a significant change in voyages and vessel utilisation. Due to the post-pandemic re-opening of most economies and the substitution of LNG shipping for pipeline gas in Europe, a total of 6,888 LNG trade voyages departed in 2022, up 2.7% from 2021. Global growth in LNG trade voyages is lower than growth in liquefaction capacity at 4%.

Figure 6.13: LNG imports and number of voyages to Asia and Europe, 2015-2022



Source: Rystad Energy, Refinitiv

The number of LNG trade voyages both to Europe and Asia have trended upwards since 2015, with growing year-on-year liquefaction and vessel deliveries. The Panama Canal was widened and deepened in 2016, allowing for more transits and vessels. The resulting voyage distance and time from the Sabine Pass terminal in the US to Japan's Kawasaki LNG facility was reduced to 9,400 nautical miles (nm) and 29 days through the Panama Canal, compared to 14,500 nm and 45 days through the Suez Canal and close to 16,000 nm and 49 days around the Cape of Good Hope. However, due to the popularity of the route, the Panama Canal has become a bottleneck for this voyage, with waiting times for unreserved slots exceeding 20 days at certain times in 2022. As Japan started to re-open its economy following the pandemic and China continued its strict COVID-19-related lockdowns with reduced gas demand, Japan became the largest LNG importer again in 2022.

The number of LNG trade voyages from the US to Europe increased to 720 in 2022, up from 306 in 2021. After flows through the Nord Stream 1 pipeline from Russia to Germany ceased at end-September 2022 following alleged sabotage, the number of LNG trade voyages from the US to Europe grew 132% to 58 in October 2022, compared to 25 in October 2021.

The most common voyage globally in 2022 was from Australia to Japan, with 492 voyages. Unlike prior years, this was much higher than Australia-China journeys, which totaled 322. The most common voyage to Europe in 2022 was from the US to Spain at 135 shipments. Japan, China and South Korea took the highest number of cargoes globally, receiving 1,453 in total or 937 and 717 cargoes respectively. The average number of voyages completed per vessel was 9.97 in 2022, lower than in 2021. This was due to an increasing focus on energy security which may have dissuaded charterers from re-letting shipping length to the market.

6.8
NEAR-TERM SHIPPING DEVELOPMENTS

Decarbonisation of the shipping segment is still the most relevant subject and a major challenge for the industry. Many global and regional regulations are progressively entering into force to limit air pollution and reduce carbon emissions in particular. In addition, initiatives such as 'green' funds from finance institutions, initiatives by insurance companies and cargo-owners will put increasing focus on air emissions and vessel efficiency. Therefore, shipping companies are investigating different solutions from a technical and operational perspective and taking steps to minimise the impact of GHG emissions from their fleet by optimising operations and reducing fuel consumption.

New IMO regulations relevant to MARPOL Annex VI, such as the EEXI and CII, have entered into force this year. This is on top of existing regulations from the same organisation and from local or regional regulators in the US, China and the European Union. For instance, extending the EU's Emissions Trading System (ETS) to include ships and a new proposal for an EU regulation entitled FuelEU to be introduced in the coming years will put additional pressure on shipping companies and cargo-owners using EU ports. In addition, a new IMO emission control area for sulphur emissions will enter into force in the Mediterranean Sea in 2025, with the US currently discussing another regulation to limit air emissions, especially GHGs. It is worth noting that the IMO plans to revise its 2050 decarbonisation strategy and is currently working on the lifecycle assessment of marine fuels to cover carbon emissions on a well-to-wake basis, as well as considering market-based measures to further incentivise the transition to a lower carbon future. This year, the Marine Environment Protection Committee (MEPC) 80 committee may shed some light on potential solutions under scrutiny by maritime stakeholders.

Ahead of these initiatives, the shipping industry is considering several options to reduce carbon emissions and align with environmental and regulatory objectives. An important one is still the use of alternative fuels which are cleaner than oil-based fossil fuels. This is directly linked to the technology developments of energy producers, primarily internal combustion engines (ICE) but also fuel cells. There are other technologies under scrutiny that typically reduce the fuel consumption on board and increase the efficiency of transportation in the maritime industry.

In terms of focus on alternative fuels, LNG is still the leading clean fuel, despite reduced momentum on new ship orders and retrofits last year due to the fuel's high price compared to other options. That being said, LNG seems to be the preferred solution since the technology and infrastructure is mature and regulations are in line with emission-reduction efforts by the IMO, such as the IGF code for ships other than gas carriers and the IGC code for gas carriers, including a growing fleet of LNG carriers. As outlined in more detail elsewhere in this report, LNG bunkering infrastructure is growing in step with the availability and orders of LNG bunkering ships. Biogas or synthetic LNG will be progressively introduced as a bunker fuel and some companies have been testing this already. Although it is difficult to forecast the future for LNG as a bunkering fuel, it is likely to help bridge the gap between now and 2050 as bunkering demand is still growing.

Courtesy Osaka Gas

Currently, methanol is gaining in popularity as a marine fuel, mainly due to its CAPEX advantages and fuel handling but also in light of the regulatory framework which facilitates the use of this alternative fuel on board. However, the advantage of methanol currently available for bunkering is reduced due to its energy density and associated CO2 emissions: it is roughly 5% less than oil-based fossil fuels when used in ICEs. Looking ahead, ammonia and hydrogen are also likely to be used to help lower emissions as the energy transition progresses.

Looking at the LNG carrier segment, most ships recently delivered and on order use LNG boil-off in two-stroke mechanically driven propulsion or four-stroke engines in very few applications with diesel electric propulsion. The ability to reliquefy boil-off or sub-cool the cargo adds a valuable flexibility for charterers to determine which fuel to use in each scenario. In this respect, more oil-based fossil fuel has been used in 2022 than in previous years since LNG cargos have become more expensive. This commercial approach may change in light of the above-mentioned regulations since a minimum amount of clean fuel will help reduce CO_2 emissions and improve the CII index for instance.

More recently, developments to help decarbonise the shipping fleet and especially the LNG carrier fleet centre around the potential use of hydrogen in the fuel mix. Emerging technologies to produce hydrogen on board from LNG are being considered as a type of pre-combustion carbon capture system, as opposed to onboard carbon capture that recovers CO2 from the exhaust gas and stores it on board. In terms of GHG emissions, methane fugitive emissions and methane slip from combustion engines are under scrutiny with technology potentially to be implemented to further minimise methane slip in engines, for instance.

Regarding cargo capacity, LNG carriers typically built now are mainly 174,000 cm in design, though we have already seen the delivery in 2022 of two ships of 200,000 cm, with 15 more units still on order in South Korea. This new four-tank concept is being closely followed by stakeholders in terms of vessel efficiency and terminal compatibility. The impact of EEXI remains to be seen, especially in past-generation ships, though most steam turbine ships are already required to reduce power and maximum speed. Operational aspects will need to become more efficient with the CII operational index dependent on many aspects, not just the technology on board but also speed, 'just in time' terminal calls and so forth.

Generally, for the shipping segment, scrapping levels may increase in the coming years for the reasons outlined above. For LNG carriers, the number of ships sold for recycling in the first quarter of 2023 has been more than the total number in each previous year, indicating a potentially new trend. LNG carriers are still typically designed for 40 years of structural fatigue life, but it seems that modern ships will not be in operation for the same long periods as previous generations of carriers, which were specifically designed and built for the purpose of long-term projects. The speed of technology evolution is playing an important role as well as the typical duration of new ships.

The level of newbuild orders in the last two years has been incredibly high with one record after another broken. In 2023, new LNG carrier orders are also likely to be high and similar in number to those seen in 2021. Another new factor in the shipbuilding segment is the number of new shipyards in China that entered the market in 2022. Finally, deliveries of LNG carriers on average are expected to be in the range of 50-60 ships per year.

All the above will have an impact on growth in the LNG carrier fleet which is expected to add more than 300 ships in service in the coming five years, with the fleet number to potentially reach four digits from 2028.

When it comes to small-scale LNG, the focus is on developing infrastructure for ship-to-ship bunkering where the technology is mature and LNG bunkering vessel projects are being developed smoothly compared to pioneering projects about eight years ago. However, this type of ship will also have to wrestle with the decarbonisation challenge, especially in terms of CII compliance since the operational profile is not comparable to a ship involved in transportation.

Last year was an exciting one for floating gas projects, namely FSRUs, with many units relocated in Europe to start LNG imports and offset reduced Russian pipeline gas flows. Floating gas terminals have been tested for many years as a good solution to fast-track projects and will continue to be an option for export projects. Both newbuild and conversions are being considered, depending on project needs. Although we may not see project commissioning at levels seen in 2022, the conversion of old steam turbine LNG carriers into FSU or FSRU projects is still an interesting opportunity to watch.

When it comes to LPG carriers, a boom in the use of LPG as a fuel is underway with many new orders in the last couple of years and some retrofits. Similarly, a new generation of ethane carriers are equipped with main engines able to burn their cargo of boil-off gas. This trend may be applicable for ammonia carriers as well since technology and regulations are under development for the purpose of using ammonia as fuel. New generations of liquefied gas carriers covering very large ethane, LPG or even new designs of LCO2 carriers in the frame of CCUS developments are proposed. Lessons will also likely be learnt from Suiso Frontier which entered service in early 2022 to transport liquefied hydrogen from Australia to Japan.

To reduce emissions for ships, many technologies have already been implemented to a certain extent on board ships and in particular LNG carriers. Technologies with a lower level of maturity or readiness are becoming more interesting such as wind-assisted propulsion, on-board carbon capture or fuel cells for new builds and retrofitted projects.

Among the technologies that are promising and will be possibly implemented in LNG carriers, wind propulsion systems are mature enough. Rotor sails, kites, wing sails and suction wings are among the different technologies being proposed. Major organisations such as the International Windship Association (IWSA) are predicting a significant growth of new installations onboard of ships.

Collaboration among companies is a way of developing more environmentally friendly projects with a significant wave of new ship designs currently proposed to face the decarbonisation challenge.

Courtesy KOGAS

7 LNG Receiving Terminals[1]

31.2 MTPA of receiving capacity was added in 2022.

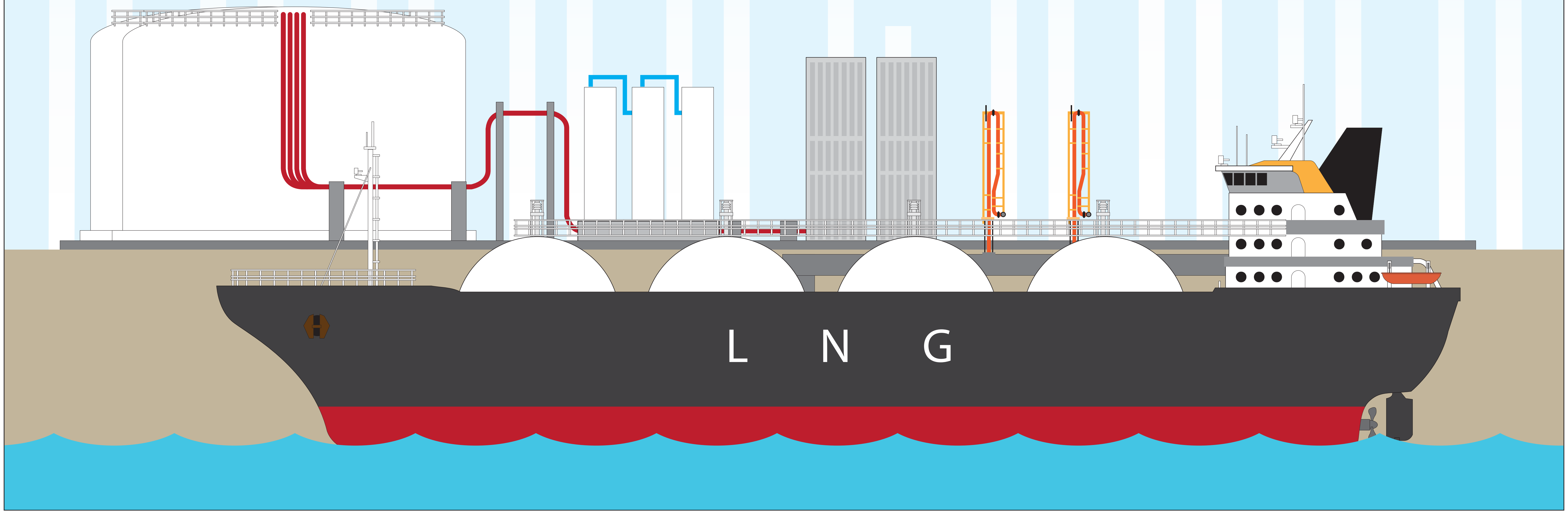
+9 new terminals in 2022

+3 expansion projects at existing terminals

China, Netherlands and Croatia expanded existing LNG regasification plants

4 New FSRUs[2] **El Salvador, Germany, Netherlands and Brazil**

238.1 MTPA of new regasification capacity under construction



[1] This report includes terminals with small-scale (<0.5 MTPA) regasification capacity adding large impact on import for the market.
[2] Note: Finland Inkoo FSRU commissioned by end-2022 and started commercial operation in 2023.

7. LNG Receiving Terminals

Global regasification capacity reached 970.6 MTPA across 48 markets as of April 2023. In 2022, 31.2 MTPA of regasification capacity was added with the start-up of nine new import terminals and the completion of three expansion projects at existing terminals. The largest capacity addition of the year was from Nong Fab LNG in Thailand with 7.5 MTPA.

Courtesy CNOOC

7.1 OVERVIEW

970.6 MTPA

Global LNG Regasification capacity as of April 2023

In 2022, Europe region witnessed the highest capacity additions at 14.5 MTPA, followed by Asia Pacific at 8.5 MTPA, Asia at 6 MTPA and Latin America at 2.2 MTPA. Out of the 31.2 MTPA regasification capacity additions in 2022, more than 80% came from new terminals. Nine new terminals were commissioned, with another three expansion projects brought online in the Netherlands, China and Croatia. Project-wise, the largest capacity addition in 2022 was from the 7.5 MTPA Nong Fab onshore LNG in Thailand, followed by the 5.9 MTPA Eemshaven FSRU in the Netherlands, and the 5.5 MTPA Wilhelmshaven FSRU in Germany. Wilhelmshaven FSRU became the first LNG terminal in Germany, with terminals at another three sites planned or under construction. Germany – the largest gas consumption market in Europe – accelerated regasification construction plans from last year, following the outbreak of Russia-Ukraine conflict. Last year also saw the first regasification facility installed in El Salvador, with the startup of the 2.2 MTPA BW Tatiana FSRU. Utilisation rates of global regasification facilities averaged 41% in 2022, remaining flat from a year earlier.

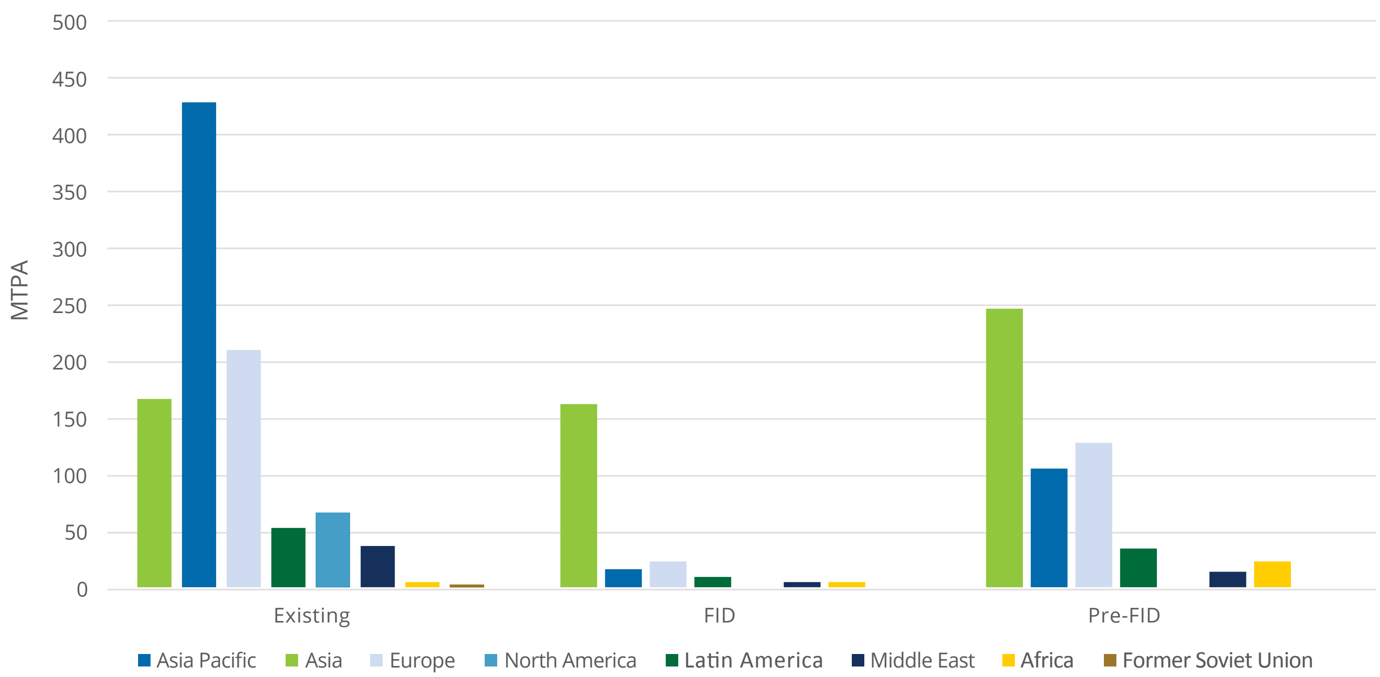
Besides Germany, many other European markets are planning new LNG import terminals in response to heightened geopolitical tensions, with the aim of reducing dependence on Russian pipeline gas and strengthening energy security.

Four regasification projects were commissioned in Europe in 2022, one in Germany, two in the Netherlands and one in Finland. Four terminals have come online in Europe so far in 2023, with another three new terminals and one expansion beginning construction and aiming to commission later in 2023. There has been a notable trend in Europe towards floating terminals which can be built faster than onshore terminals. Floating terminals also offer more flexibility as a shorter-term solution and require less fixed investment, which is viewed as an advantage corresponding with Europe's long-term plans to reduce gas demand as part of its energy transition goals.

More than 10 European markets, including Germany, Netherlands, Finland, France and Italy, have initiated construction plans since the Russia-Ukraine conflict broke out. This includes 26 projects with a combined regasification capacity of 104.5 MTPA. Nearly 70% of the new capacity will come from floating terminals, which can be brought online faster than onshore terminals. Of these 26 projects, six have been commissioned adding 25.5 MTPA to global capacity as of April 2023. Four projects are under construction with a combined capacity of 18.8 MTPA and the rest are still in the planning phase. Under EU taxonomy, gas-fired plants built through 2030 will be recognised as a transitional energy source, which contributes to the speed-up of terminal constructions in Europe.

By contrast, the Asia and Asia Pacific regions have shown a preference for onshore terminals, which are set to meet increasing short to long-term LNG demand and allow for further capacity expansions. Currently, the two regions account for the largest share of global regasification capacity, with ambitious plans and large projects under construction. Worth noting is that projects in South Asia have faced notable delays in recent years, due to the spot price spikes globally in 2022 and downward pressure on economic development, leading to a lack of incentives by investors and posing potential risks for the region's LNG demand outlook.

Figure 7.1: LNG regasification capacity by status and region, April 2023



Source: Rystad Energy

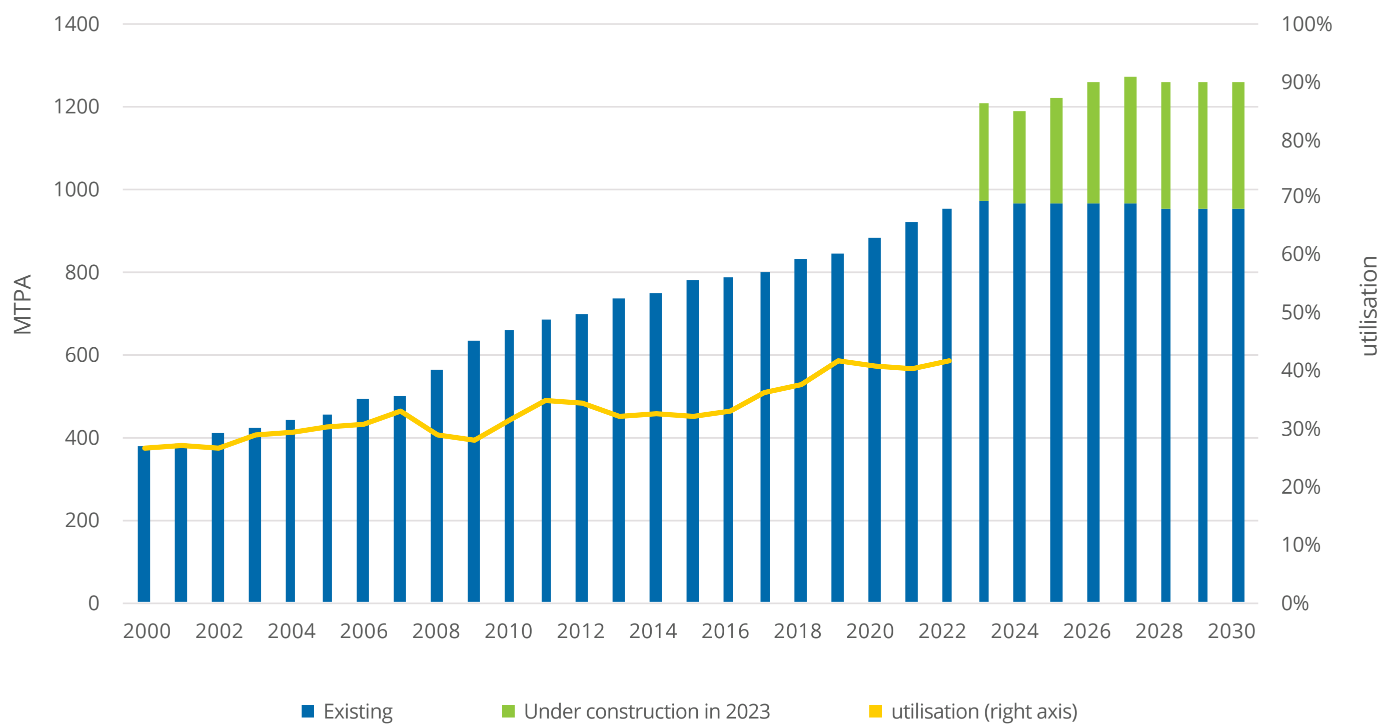
7.2 RECEIVING TERMINAL CAPACITY AND GLOBAL UTILISATION

A total of 31.2 MTPA of LNG import capacity was added globally in 2022, compared to the 62.3 MTPA of regasification capacity that had been expected to complete construction and be commissioned during the year. Sizable projects have delayed their startup from last year and failed to meet original timings. Most delays relate to FSRU-based projects and are due to tightness in the supply of FSRU vessels and slower LNG demand in smaller markets, which typically prefer floating-based terminals. Regasification capacity additions have slowed from the 36.8 MTPA and 39.6 MTPA added in 2021 and 2020, respectively, but were notably higher than the average of 20.8 MTPA additions over the ten-year period from 2010-2019. Two new markets emerged in 2022 as El Salvador and Germany commissioned their first regasification facilities after almost 10 months of work – both FSRU-based – in May and December 2022 respectively. Demand for FSRU-based terminals has trended upwards in recent years, especially in European markets, with the technology helping increase LNG import capability in a shorter timeframe to offset lower Russian piped gas volumes.

Last year saw the start-up of nine new import terminals, adding a total regasification capacity of 26.3 MTPA globally. Five were onshore terminals, located in Thailand (Nong Fab), China (Yancheng and Jiaxing), Japan (Niihama) and Finland (Hamina). The 7.5 MTPA Nong Fab terminal, located in Rayong, was PTT's second operational LNG import terminal in Thailand, adding to the group's 11.5 MTPA Map Ta Phut terminal which was commissioned in 2011. Nong Fab LNG received its first LNG commissioning cargo from Qatar in June 2022, delivered by LNG carrier Al Oraiq. The terminal has two 250,000 cubic metres LNG storage tanks, the largest in Thailand. China's 3 MTPA Jiangsu Yancheng Binhai LNG phase 1, owned by CNOOC, started commercial operation in September 2022, with the first cargo from Qatar unloaded from LNG carrier Al Ghashamiya. The facility currently has four 220,000 cubic metre LNG storage tanks, with another six 270,000 cubic metre tanks planning to complete construction by late 2023. This will bring the total regasification capacity to 6 MTPA. The project is one of the major projects enshrined in China's 14th five-year plan from 2021 to 2025.

Four new FSRU-based terminals came online in 2022. In addition to Germany's Wilhelmshaven FSRU, Brazil's Karmol LNGT Powership Asia and El Salvador FSRU, the Eemshaven FSRU in the Netherlands was commissioned during 2022 with regasification capacity of 5.9 MTPA and LNG storage of 196,000 cubic metres. The terminal is the second regasification facility in the Netherlands, following the start-up of the onshore Gate LNG terminal in 2011. Gasunie has chartered two FSRUs for the terminal – Eemshaven LNG from Exmar and the Golar Igloo from New Fortress Energy – both for a period of five years. The facility started commercial operations in September 2022, receiving its first LNG shipment from Sabine Pass LNG in the US. Gasunie plans to increase the Eemshaven FSRU's regasification capacity by 0.74 MTPA to 6.6 MTPA by end-2023.

Figure 7.2: Global receiving terminal capacity, 2000-2030



Source: Rystad Energy

Three expansion projects at existing terminals started up in 2022, with total regasification capacity of 5.5 MTPA. China's Qidong LNG terminal completed its phase four construction last October, lifting import capacity from 3 MTPA to 5 MTPA and adding 200,000 cubic metres of LNG storage capacity. In the Netherlands, Gate LNG terminal expanded its regasification capacity from 8.8 MTPA to 11.8 MTPA. The terminal received a permit to further lift import capacity by 2.9 MTPA, which is expected to be completed in 2025. Croatia added 0.2 MTPA to its Krk LNG terminal whose receiving capacity reached 2.1 MTPA in 2022.

As of April 2023, five new LNG import terminals have been commissioned, four of which are FSRU-based terminals in Europe: the 3.7 MTPA Inkoo FSRU in Finland, the 3.8 MTPA Lubmin FSRU and 3.7 MTPA Elbehafen FSRU in Germany, and the 5.6 MTPA Gulf of Saros FSRU in Turkey. This has increased total regasification capacity to 13 MTPA in Germany which is looking to further expand its LNG import capacity in the coming three years. The fifth one is Batangas Bay LNG terminal in the Philippines.

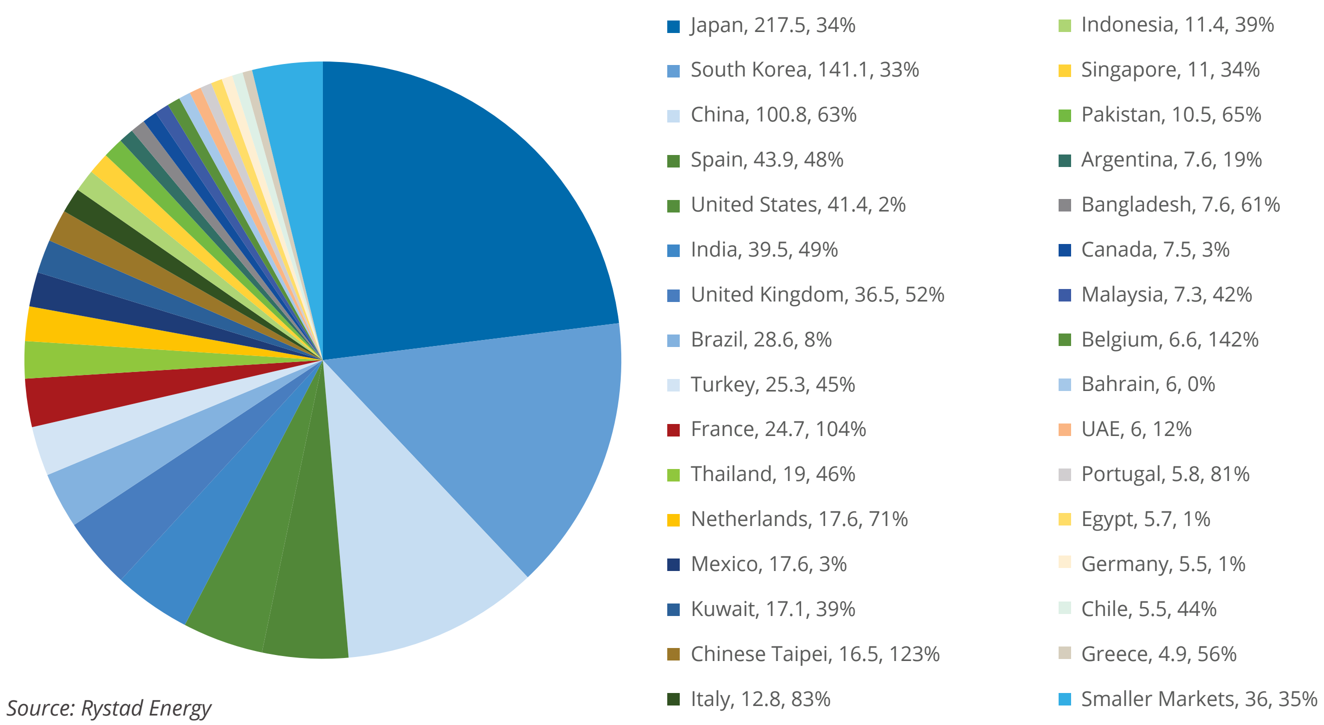
Also as of April 2023, 219.3 MTPA of new regasification capacity is under construction globally. This includes 26 new onshore terminals, 16 new floating-based terminals and 17 expansion projects at existing regasification facilities. Over 90% of regasification capacity under construction is being undertaken in Asia, Asia Pacific, and Europe. Market-wise, China and India lead the new builds, followed by the Philippines and Germany. China has 126.9 MTPA of capacity under construction, including 18 new onshore terminals, one FSRU-based terminal and 13 expansion projects at existing terminals. India has five new terminals and two expansion projects under construction with total capacity of 30 MTPA, all of which have postponed their start-up from previous years. Of the five new terminals, three are floating-based, reflecting the South Asian market's preference for floating terminals. Worth noting is that the floating terminals in India may face delays again this year due to the tight supply of FSRU vessels and increasing competition from European markets.

Five new markets, including Vietnam, Estonia, Senegal, Ghana and Nicaragua, are currently building their first LNG import terminals and planning to start importing LNG in 2023. The five new markets are expected to add 13.2 MTPA of regasification capacity through the construction of two onshore terminals and four floating terminals. Floating-based solutions are preferred in new markets, which are usually smaller. Construction is also underway in existing markets, including China, Chinese Taipei, India, Germany, Brazil, Turkey, Pakistan, Poland, Italy, Chile, South Korea, and Panama. Out of the 32 projects under construction in China, five were approved in 2022. China has continued to strengthen its LNG import capacity along its coastline with policy support. The third phase of the Zhoushan ENN LNG terminal in China's Zhejiang province was permitted in the first quarter of 2022 and began construction in early 2023. The project will add four LNG storage tanks with capacity of 220,000 cm each, lifting the terminal's regasification capacity from 5 MTPA at present to 10 MTPA by mid-2025. Another four new terminals currently under construction were also approved in China last year, including Jiangsu Ganyu Huadian LNG (3 MTPA), Shanghai LNG (3 MTPA), Huizhou LNG (6.1 MTPA) and Yingkou LNG (6.2 MTPA).

While average global regasification capacity utilisation remained unchanged at 41% in 2022, different trends were seen in major demand regions. Average utilisation in Europe during 2022 spiked to 65%, up from 41% in 2021, as Europe ramped up LNG imports to record-highs to offset the decline in Russian piped gas supplies. By contrast, regasification utilisation fell in Asia and Asia Pacific regions from 47% on average in 2021 to 43% in 2022 and fell in Latin America from 26% on average in 2021 to 17% in 2022, as LNG demand retreated or slowed in many markets on high spot LNG prices and impacts from the pandemic.

7.3 RECEIVING TERMINAL CAPACITY AND UTILISATION BY MARKET

Figure 7.3: LNG regasification capacity by market (MTPA) and annual regasification utilisation, 2022



Source: Rystad Energy

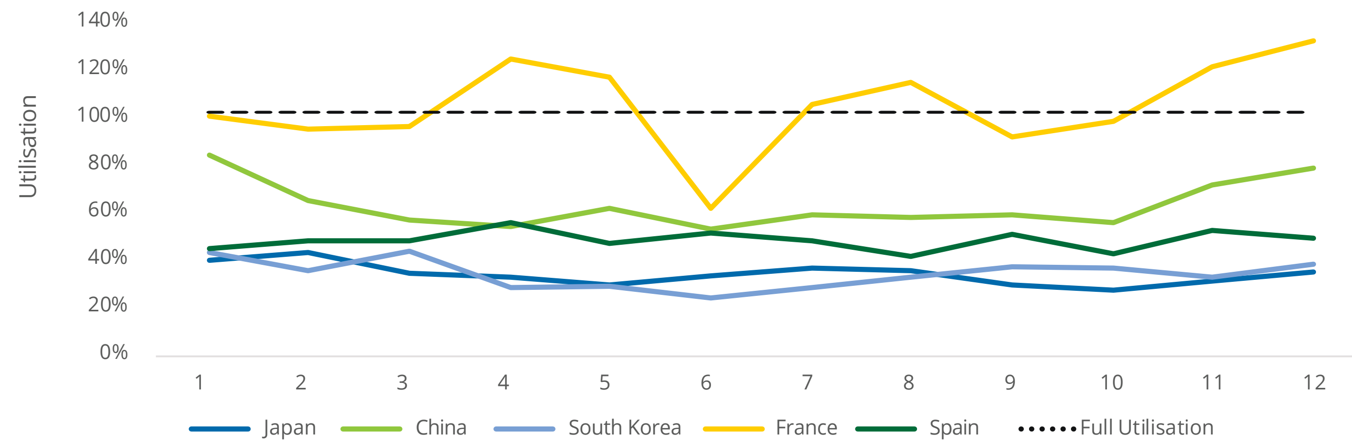
Japan was one of the first markets to build LNG import terminals, with its first regasification facility Negishi LNG starting operation in 1969. The market has remained the largest owner of regasification capacity, with 217.5 MTPA as of April 2023, representing more than 22% share of global capacity. New capacity was added in Japan over the past two years, with the 3.2 MTPA Hitachi LNG expansion project and the 1 MTPA Niihama LNG coming online in 2021 and 2022, respectively. Average utilisation of regasification facilities in Japan trended lower to 34% in 2022, down from nearly 35% in 2021, as high spot LNG prices and increased nuclear power generation limited Japan's gas demand and LNG buying.

South Korea is the second largest market for regasification capacity, with seven existing terminals with 138.6 MTPA in total. Among the world's top five import terminals by capacity, three are located in South Korea, namely Incheon LNG (54.9 MTPA), Pyeongtaek LNG (41.0 MTPA) and Tongyeong LNG (26.5 MTPA). South Korea started importing LNG in 1986 and in 2022 became one of the world's largest LNG importers, behind neighboring markets Japan and China. No new capacity was added in South Korea between 2020-2022, but one project started construction in early 2023. South Korean company POSCO will expand its Gwangyang LNG phase 1 terminal from the current regasification capacity of 3.1 MTPA to 5.2 MTPA by 2025, with the construction of two 200,000 cm LNG storage tanks. After denuclearisation policy of last presidency, South Korea is coming back to nuclear expansion. However, concern is growing about nuclear power due to difficulties in constructing repository of spent nuclear fuel. With planned fuel change of coal power to gas, this situation signals long-term importance of gas in this market's power mix.

Before 2022, China experienced high-speed growth in gas demand, supported by rapid urbanisation, industrialisation, and strong economic growth over the past two decades. Domestic gas production was China's only source of gas supply before 2006. But as production has seen a slower growth than demand, LNG imports have become an essential supply channel for meeting increasing demand across sectors. As a result, their share in China's total gas supplies reached 29% in 2021. In the same year, China overtook Japan to be the world's largest LNG importer. To support growth in LNG flows, huge regasification construction plans have been underway in China. Since the market's first LNG import terminal Guangdong Dapeng LNG commissioned in 2006, China's regasification capacity has reached 106.8 MTPA as of April 2023. New capacity has been added for seven consecutive years from 2016-2022, with the startup of 10 new terminals and 15 expansion projects at existing terminals, bringing a total regasification capacity to 61.5 MTPA. Three regasification projects were commissioned in 2022, including two new terminals Jiaxing Pinghu LNG and Jiangsu Yancheng Binhai LNG phase 1, as well as an expansion project Qidong LNG phase 4, adding 6 MTPA in total. With the construction of 19 new terminals and 13 expansion projects underway, another 126.9 MTPA of LNG import capacity is expected to be added in China by end-2026. Given the significant startups expected in the coming few years, China will likely surpass South Korea in terms of regasification capacity and narrow the gap to Japan in the near term.

In 2022, however, China experienced an unprecedented slowdown in gas demand and a retreat in LNG imports as activity in the industrial, commercial and transportation sectors were hit by the impacts of the pandemic. High spot LNG prices also hammered Chinese importers' buying interest and made them mainly rely on volumes from term contracts. This dragged down the market's average regasification utilisation rate to 63% last year from over 83% in 2021. Apart from January, November, and December 2022, when China's regasification utilisation reached above 70% to meet winter heating demand, the rest of the year saw utilisation rates below 65%. As China has now relaxed COVID-19-related control measures, the market's LNG imports are expected to regain growth momentum in 2023, with an expected recovery in economic activity. Meanwhile, China's LNG import sector still face challenges. Regasification utilisation is unlikely to rebound to the record high levels of 80-90% seen in 2020 and 2021 and are expected to keep rangebound at 40-50%, due to slower growth in LNG demand compared to growth in regasification capacity. In addition, LNG imports are seeing rising competition from piped gas imports, as China works on building more cross-border gas pipelines from neighbouring markets.

Figure 7.4: Monthly regasification utilisation by top five LNG importers, 2022



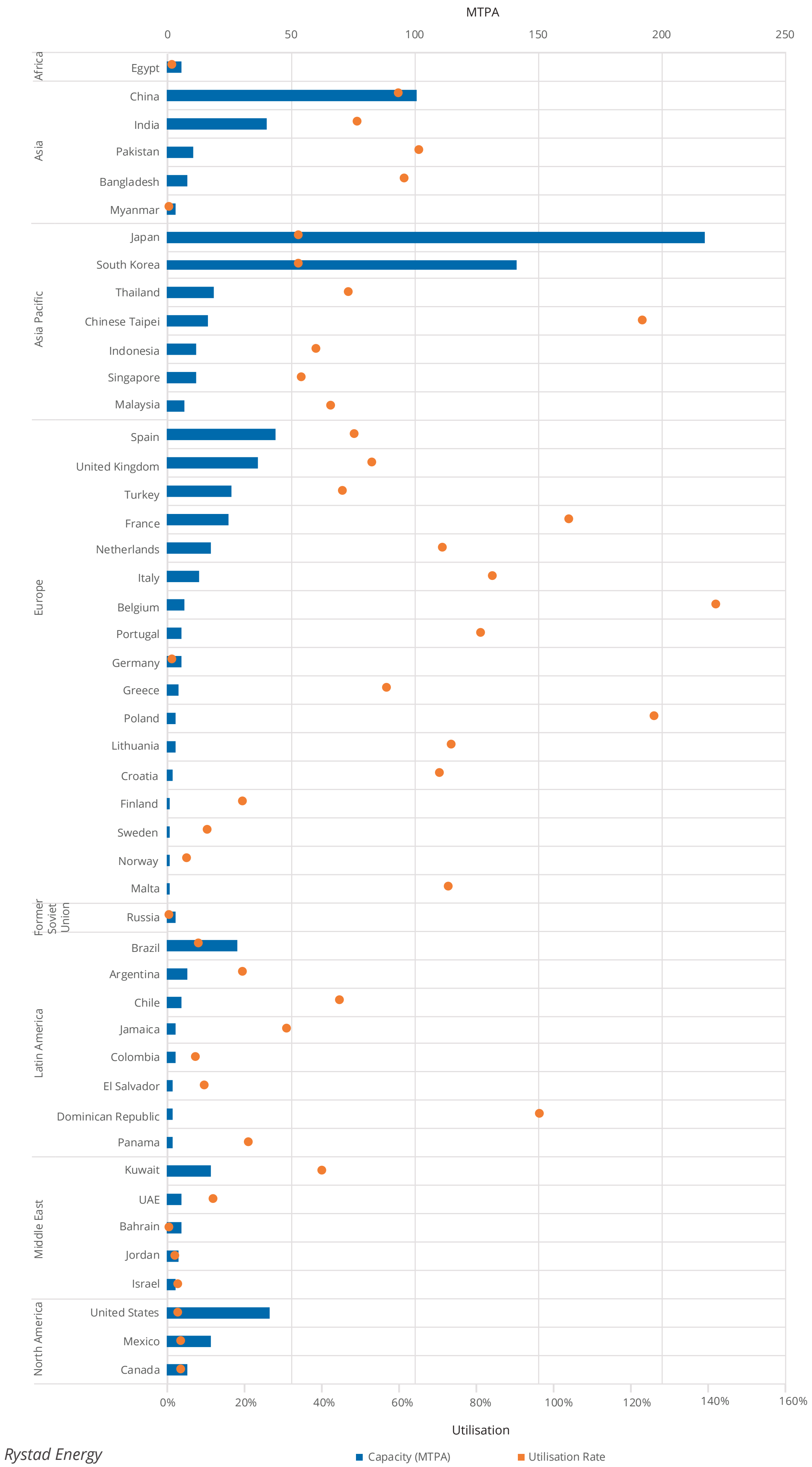
Source: Rystad Energy

France replaced India and emerged as the fourth-largest LNG importer in 2022, with LNG imports reaching a record-high of nearly 27 MT and almost doubling from 2021 levels. The outbreak of Russia-Ukraine conflict in February 2022 has pushed European markets to import LNG at maximum capacity to reduce their dependency on Russian gas supplies. In France, average regasification utilisation spiked to 104% in 2022, up from just 50% in 2021. Utilisation rates in April and May 2022, following the onset of the Russia-Ukraine conflict, rose to 128% and 121% respectively. Rates in November and December 2022 increased to 125% and 136% respectively to meet peak demand over winter. The regasification utilisation above 100% was driven by the import volumes exceeding the nameplate capacity. Bottlenecks in regasification capacity have prompted France to consider deploying more LNG import terminals. TotalEnergies is planning to install an FSRU-based terminal with regasification capacity of 3.1 MTPA in the port of Le Havre in northwest France.

Spain was fifth-largest LNG importer last year, with LNG imports growing over 40% year-on-year to more than 21 MT in 2022. Average regasification utilisation in Spain increased from 31% in 2021 to 48% in 2022. The market has the world's fourth-highest regasification capacity at 43.9 MTPA as of April 2023. To strengthen its LNG import capacity, Spain is planning to reactivate the idled El Musel onshore terminal in 2023, with import capacity of 5.9 MTPA and 300,000 cm of LNG storage.

As the world's sixth-largest market by regasification capacity, India has six LNG import terminals totaling 39.5 MTPA as of April 2023. Its 17.5 MTPA Dahej LNG ranks as the fifth-largest terminal by import capacity. India's LNG imports saw rapid growth over the period 2010-2020 transforming it into one of the top importing markets. To bring in more LNG, India has a large number of import terminals planned. Five new terminals and two expansion projects are currently under construction, with total regasification capacity of 30 MTPA. All five projects have postponed their commissioning in recent years. Average regasification utilisation in India has dropped to 49% in 2022 from 60% in the prior year, due to high spot LNG prices and a switch to coal-fired generation, which is more cost competitive. This curbed India's LNG imports in 2022. India's sensitivity to gas prices may limit investor interest and create further uncertainty for India's regasification construction plans which could be further delayed.

Figure 7.5: Receiving terminal import capacity and regasification utilisation by market, 2022



Source: Rystad Energy

After a slow-growth period from 2018 to 2021, Europe accelerated regasification capacity additions in 2022 by bringing 14.5 MTPA online, about 47% of global capacity additions last year. The escalation of regional geopolitical tensions has spurred regasification construction by European markets to reduce dependency on Russian gas and enhance energy security. Most of Europe's new capacity in 2022 was in the Netherlands, which added 8.8 MTPA in total. This includes the 2.9 MTPA expansion of the Gate onshore LNG terminal and the installation of the 5.9 MTPA Eemshaven FSRU, which were commissioned in July and September respectively. Finland brought a small-scale onshore terminal Hamina LNG online last year with capacity of 0.1 MTPA. Europe's largest gas consumer Germany became a new LNG importer in 2022, with its first LNG terminal the 5.5 MTPA Wilhelmshaven FSRU starting operation in December. The floating terminal is planning an expansion in 2023 by installing another FSRU Excelsior, which will add regasification capacity by 3.7 MTPA. This year, 16.8 MTPA of LNG import capacity has been commissioned in Europe as of April 2023 from four new terminals – Finland's Inkoo FSRU, Germany's Lubmin FSRU and Elbehafen FSRU, and Turkey's Gulf of Saros FSRU. Another four projects in Europe with combined capacity of 9.78 MTPA are underway and aim to start up in 2023.

Utilisation of European regasification facilities spiked to a record-high of 65% in 2022 from 41% in the previous year, with LNG imports growing significantly by over 66% year-on-year. Many European markets imported LNG at maximum capacity last year to meet gas demand, amid heightened geopolitical tension between Russia and Ukraine and reduced pipeline flows from Russia. France ran its LNG import terminals at full capacity for most of 2022 with Belgium's utilisation rate averaging 142% last year. In the past, Europe has typically only imported LNG when winter was approaching to meet peak demand, instead mainly relying on stable piped gas for the rest of the year. Spiking LNG demand from Europe and a lack of growth in global LNG supplies resulted in a tight market in 2022 and soaring gas prices. TTF prices reached a record high of around $100/mmBtu last August, following a major decline in Russian piped gas. The main gas pipeline to Germany from Russia, Nord Stream 1, ceased transmissions to Europe in late August 2022 and one month later an act of sabotage took this pipeline out of service via an explosion. More than 70% of Europe's LNG inflows last year were from the US, Qatar and Russia. The share of US LNG was 42% in 2022, up from 28% in 2021, as the US switched its LNG export focus from Asia and Asia Pacific to Europe. despite the plunge in Russian piped gas flows.

To mitigate the persistent impacts on reduced Russian gas supplies and import more LNG into the region, Europe has launched plans for new regasification capacity, including new terminals and the reactivation of idled projects. More than 10 European markets, such as Germany, Netherlands, Finland, France and Italy, have initiated construction plans since the Russia-Ukraine conflict broke out. This includes 26 projects with a combined regasification capacity of 104.5 MTPA. Nearly 70% of the new capacity will come from floating terminals, which can be brought online faster than onshore terminals. Of these 26 projects, six have been commissioned adding 25.5 MTPA to global capacity as of April 2023. Four projects are under construction with a combined capacity of 18.8 MTPA and the rest are still in the planning phase. Under EU taxonomy, gas-fired plants built through 2030 will be recognised as a transitional energy source, which contributes to the speed-up of terminal constructions in Europe.

Germany has plans to add the highest amount of regasification capacity among European markets, at a projected 41.54 MTPA. This involves building terminals at four sites, namely Wilhelmshaven, Lubmin, Brunsbuettel and Stade, each with two-phase construction and with the startup timeline ranging from 2022 to 2026. Germany's regasification capacity is expected to meet over 60% of its gas demand once all terminals have started operating. Since December 2022, three projects with a combined capacity of 13 MTPA have been commissioned as of April 2023. German energy firm Uniper launched the market's first LNG terminal Wilhelmshaven FSRU phase 1 with regasification capacity of 5.5 MTPA in mid-December 2022, following the arrival of the FSRU vessel Hoegh Esperanza. The 3.8 MTPA Lubmin FSRU phase 1, owned by private company Deutsche Regas, started operating in January 2023 after the arrival of the Neptune FSRU. The 3.7 MTPA Elbehafen LNG terminal, owned by RWE received its commissioning cargo in February 2023, following the arrival of the third Hoegh FSRU Hoegh Gannet in January.

As of April 2023, the US remains the fifth-largest market for regasification capacity, at 41.4 MTPA in total. However, due to its developed network of natural gas pipelines, relatively low natural gas prices and sufficient domestic natural gas supply, US demand for LNG imports remains low. Average utilisation of LNG import terminals was only around 3.6% in 2022, down from 5% in the previous year. More than three quarters of US LNG imports were imported by terminals in Puerto Rico, though utilisation dropped to only 28% in 2022 from 49% in 2021 and compared to 59% on average from 2015 to 2019. The San Juan FSRU with import capacity of 1.1 MTPA started operations in 2020, easing the pressure on the existing terminal EcoElectrica and partly causing Puerto Rico's overall regasification utilisation to drop. Average regasification utilisation in the North America region, including the US, Mexico, and Canada, was just 3% in 2022, down from 5% in 2021. The region has tended to prioritise LNG exports in recent years and is expected to bring online the highest liquefaction capacity additions in the future.

Latin America saw just two LNG import terminal commissioned in 2022. El Salvador launched its first terminal by installing the BW Tatiana FSRU with regasification capacity of 2.2 MTPA and LNG storage capacity of 137,000 cubic metres. The Karmol LNGT Powership Asia FSRU has arrived in Brazil. This brings the region's total import capacity to 53.8 MTPA. Five new floating terminals are currently under construction with a combined capacity of 12.5 MTPA. GNL Talcahuano FSRU in Chile, Sinolam LNG in Panama, and Puerto Sandino FSRU have all delayed their startups from 2022. Another two FSRU-based terminals are located in Brazil – Sao Paulo LNG and Terminal Gas Sul LNG – both of which are aiming to commission in 2023. Brazil's operational regasification capacity is currently 28.6 MTPA from six FSRU-based terminals, making up more than half of Latin America's capacity as of April 2023. With impacts from high spot LNG prices, Brazil's LNG imports plunged to 2.2 MT in 2022 from 7.8 MT in 2021, dragging down its regasification utilisation to just 8% from over 27% in 2021. Low utilisation of import facilities and sensitivity to prices creates uncertainty over the start-up of new terminals in Brazil.

Courtesy Excelerate Energy

Table 7.1: LNG regasification terminals, January 2022 to April 2023

Receiving Capacity	New LNG onshore import terminals	Number of regasification markets
+53.0 MTPA Net growth of global receiving capacity	**+5** Number of new onshore regasification terminals	**+3** New market with regasification capacity as of April 2023
Net nameplate regasification capacity grew by 53 MTPA from end-2021, reaching 970.6 MTPA by April 2023. Capacity at new terminals was 48.2 MTPA while expansion projects amounted to 5.3 MTPA.	New onshore regasification terminals were added in Japan (Niihama), Thailand (Nong Fab), China (Binhai and Jiaxing) and Finland (Hamina). Two expansion projects at existing onshore terminals were completed in the Netherlands (Gate LNG) and China (Qidong).	The number of markets with regasification capacity increased to 47 by end-2022 with the addition of two new market: El Salvador and Germany. As of April 2023, one new market emerged – the Philippines.

Source: Rystad Energy

7.4 RECEIVING TERMINAL LNG STORAGE CAPACITY

77.11 mmcm

of global storage capacity as of April 2023

Global LNG storage capacity has seen a steady uptick in recent years and reached 77.11 million cubic metres (mmcm) as of April 2023, alongside new import terminal construction and expansion projects at existing terminals. Last year, 2.68 mmcm of LNG storage was added at nine new terminals and three expansion projects. Four new terminals in Europe, all FSRU-based, added a combined 0.8 mmcm of storage of from January to April 2023. LNG storage capacity for existing terminals (aggregated) in the global market averaged 432 thousand cubic metres (mcm) in 2022, edging lower from 438 mcm in 2021.

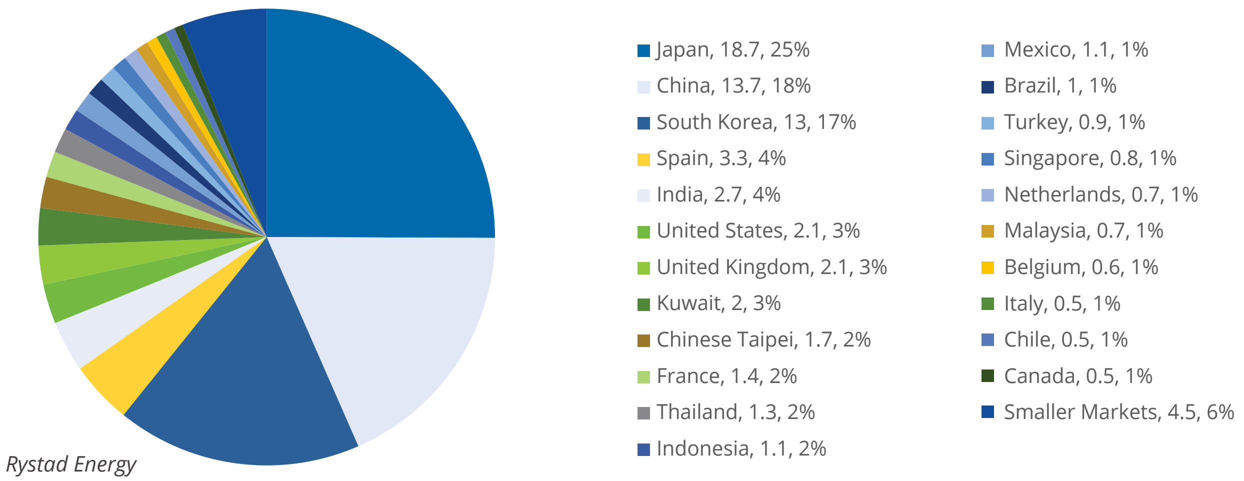
China, Japan, and South Korea – the three largest markets for regasification capacity – have the highest share of existing global LNG storage capacity at over 60% as of April 2023. Asia and Asia Pacific have the highest share of global LNG storage capacity, a crucial way of ensuring regional gas supplies and energy security. Among the world's terminals, South Korea's Pyeongtaek LNG has the largest storage capacity per terminal at 3.36 mmcm. The facility, which commissioned in 1986 and is owned by KOGAS, has regasification capacity of 40.6 MTPA, making it the world's second-largest regasification facility by import capacity.

In 2022, 2.68 mmcm of LNG storage capacity was added to global capacity, down from 5.47 mmcm in 2021. China added 1.28 mmcm of storage capacity last year following the startup of two new terminals in Zhejiang province (Jiaxing Pinghu LNG) and Jiangsu province (Yancheng Binhai LNG phase 1), and an expansion project in Jiangsu province (Qidong LNG phase 4), accounting for half of the world's capacity additions. The largest increase in storage capacity at a single terminal last year was at Jiangsu Yancheng Binhai LNG, where four 220,000 cm storage tanks were installed. The terminal plans to install another six 270,000 cm storage tanks by end-2023. Last year, 2.04 mmcm capacity was added by onshore terminals in China, Japan, Thailand and Finland. Four FSRU-based terminals – Eemshaven FSRU in the Netherlands, Wilhelmshaven FSRU in Germany, BW Tatiana FSRU in El Salvador and Inkoo FSRU in Finland– added 0.20 mmcm, 0.17 mmcm, 0.14 mmcm and 0.15 mmcm of capacity, respectively.

Newer markets, such as Germany and El Salvador, typically show a preference for floating terminals which have lower LNG storage capacity per terminal compared to onshore facilities. In established markets such as China and Japan, storage capacity growth is mainly from onshore terminals. As of 2022, onshore terminals accounted for 92% of global LNG storage capacity, while the remaining 8% from floating terminals.

China has been expanding its LNG storage capacity rapidly with the startup of new terminals and expansion projects. The market has 22 mmcm of storage capacity under construction which will lift its total storage capacity to 37.05 mmcm by 2026. Of the capacity currently under construction, five projects with a combined storage capacity of 3.82 mmcm were approved in 2022. This comprises Jiangsu Ganyu Huadian LNG with three 220,000 cm storage tanks, Zhoushan ENN LNG phase 3 with four 220,000 cm storage tanks, Shanghai LNG phase 1 with four 220,000 cm storage tanks, Huizhou LNG phase 1 with three 200,000 cm storage tanks and four 200,000 cm storage tanks.

Figure 7.6: LNG storage tank capacity by market (mmcm) and percentage of total, 2022



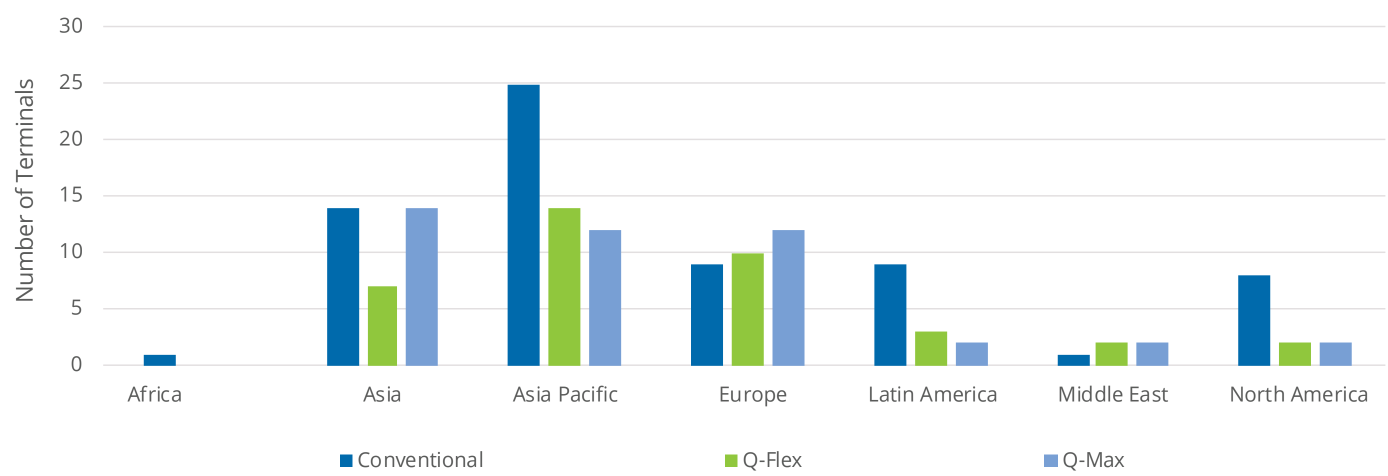
Source: Rystad Energy

7.5 RECEIVING TERMINAL BERTHING CAPACITY

The berthing capacity of receiving terminals determines the size and type of LNG carriers that can discharge at the terminal. There are generally three types of LNG carriers categorised by size, including conventional vessels typically with a capacity between 125,000 and 175,000 cm, Q-Flex carriers at about 210,000 cm, and Q-Max carriers at about 260,000 cm. As of 2022, 67 terminals can handle conventional carriers, equal to a 45% share of the world's regasification facilities. With growing storage capacity and the rising use of Q-Class carriers, which currently have the largest capacity, berthing capacity for receiving terminals has also grown to allow for flexibility on LNG shipping.

As of 2022, Q-Max carriers can berth at 44 terminals worldwide, 26 of which are located in Asia and Asia Pacific, 12 in Europe, and two each in Latin America, the Middle East and North America. In total, 38 import terminals have maximum capacity to accommodate Q-Flex vessels, with 55% of the terminals in Asia and Asia Pacific. A total of 67 terminals can handle conventional carriers at their maximum capacity with 82% of onshore terminals capable of accommodating Q-Max and Q-Flex carriers. Floating and offshore terminals are mostly designed to handle conventional carriers, although 44% of these terminals can berth Q-Class vessels. Last year, two new onshore terminals were commissioned with berthing capacity to handle Q-Max carriers. The 3 MTPA Jiangsu Yancheng Binhai LNG phase 1 in China has a berth to handle vessels with capacity ranging from 80,000 to 266,000 cm. The terminal received its first LNG cargo of 210,000 cm in September 2022 from LNG carrier Al Ghashamiya. In Thailand, the 7.5 MTPA Nong Fab LNG's jetty is capable of handling LNG carriers with capacities of between 125,000 and 266,000 cm.

Figure 7.7: Number of LNG receiving terminals with berthing capacity by vessel type and region, 2022



Source: Rystad Energy

7.6 FLOATING AND OFFSHORE REGASIFICATION

58.3 MTPA

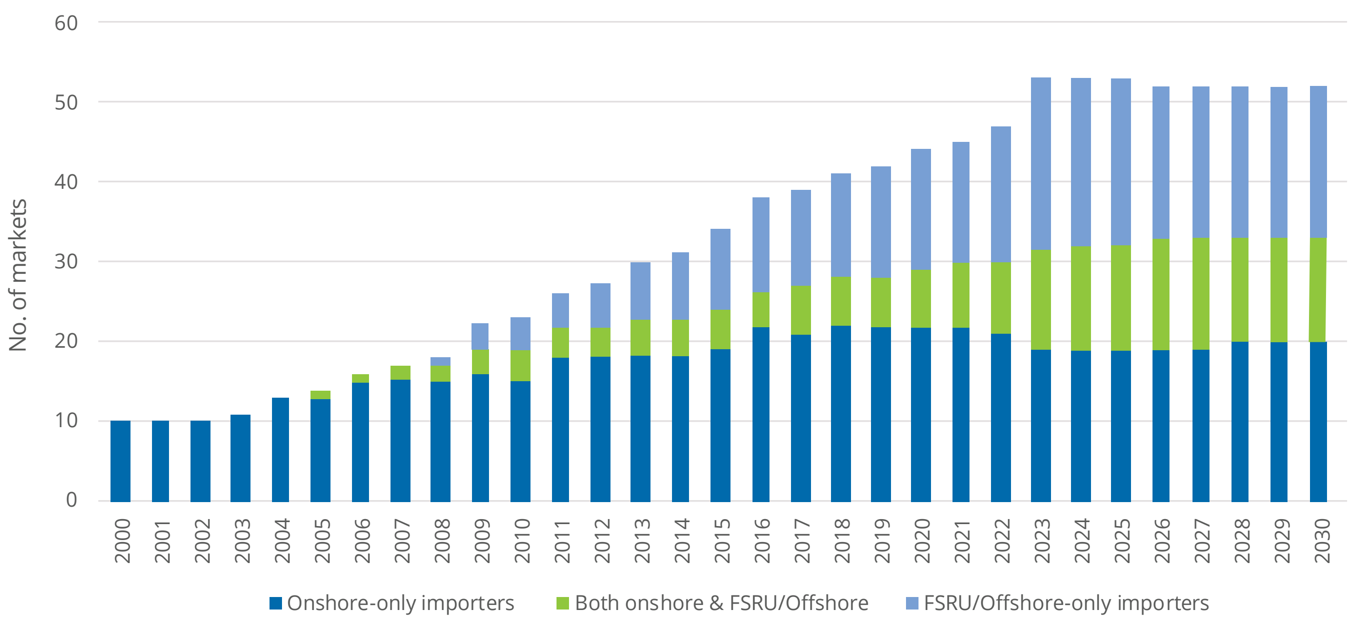
of floating and offshore terminals under construction, as of April 2023

Since the world's first FSRU-based terminal started operating in the US in 2005, floating and offshore regasification developments have seen steady growth, with sizable FSRU-based terminals commissioned and new markets beginning LNG imports. As of April 2023, there are 44 floating and offshore terminals around the world with total import capacity of 177.2 MTPA, accounting for about 18% of global capacity.

Although onshore terminals still dominate global regasification capacity, FSRU-based terminals have become more appealing to new markets. As of April 2023, there are 16 floating and offshore terminals under construction with total regasification capacity of 58.3 MTPA. Most terminals are expected to be commissioned in 2023. Five new markets, including Vietnam, Estonia, Senegal, Ghana, and Nicaragua, are expected to emerge this year if floating terminals progress as planned. In the past two years, four new markets started importing LNG following the commissioning of FSRU-based terminals, including Croatia in 2021, El Salvador and Germany in 2022, and the Philippines in 2023.

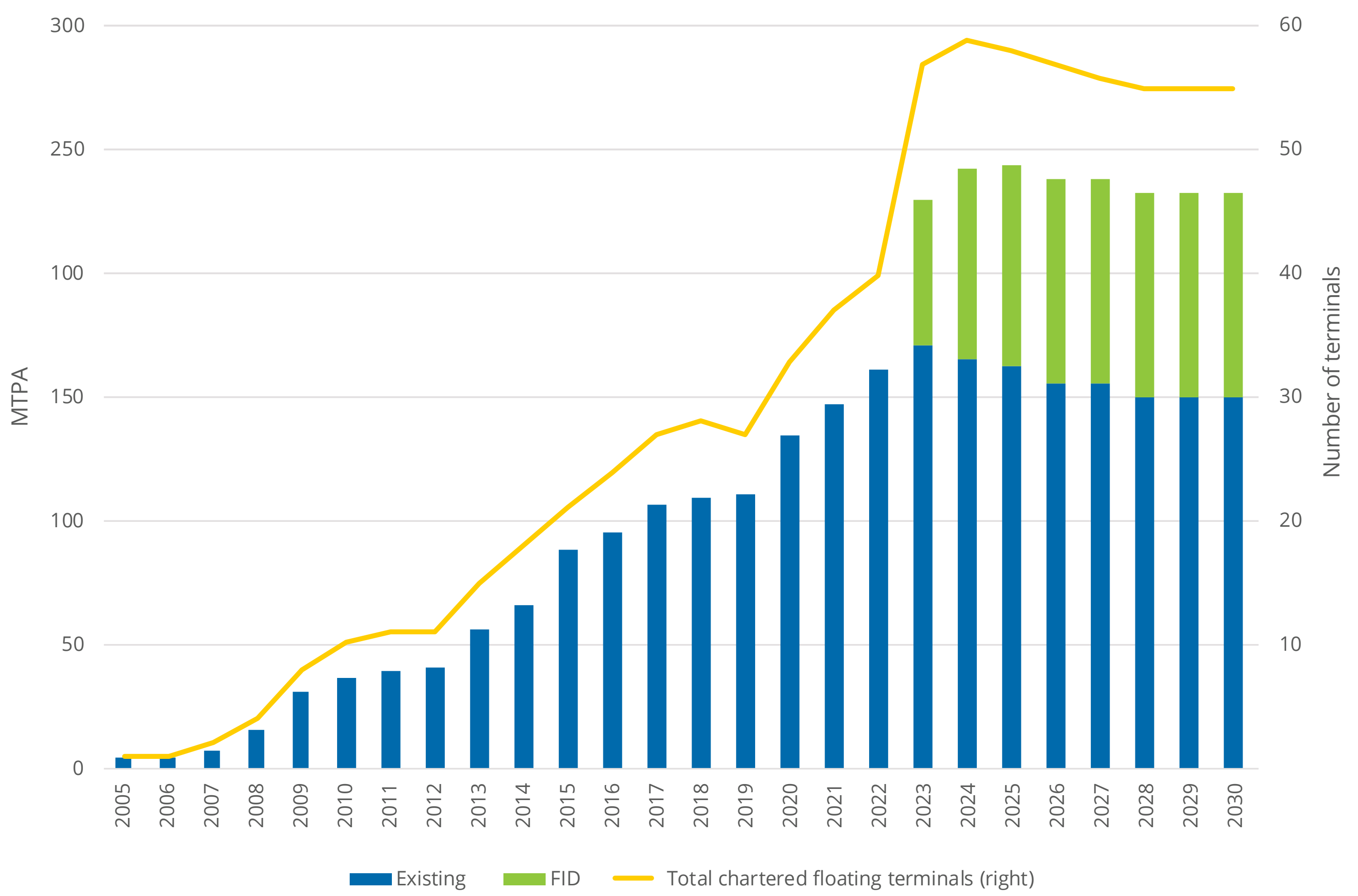
As of April 2023, five new FSRU-based terminals have been commissioned so far this year, including Lubmin FSRU and Elbehafen FSRU in Germany, Batangas Bay FSU in the Philippines, Gulf of Saros of FSRU in Turkey, and Inkoo FSRU in Finland, adding a combined 21.8 MTPA of regasification capacity. Another 12 floating terminals are under construction and planning to start up in 2023, with a combined capacity of 40.2 MTPA. Of this capacity, 40% will be in Asia and Asia Pacific, with India, the Philippines and China leading the new builds. India's 5 MTPA Jafrabad FSRU and 6 MTPA H-Gas LNG Gateway have postponed their startups from previous years and may see further delays due to the tight supply of FSRU vessels globally and tepid local LNG demand. The Hong Kong FSRU which was previously planned to be completed and to come online in 2022 has yet to be commissioned in April 2023.

Figure 7.8: Number of regasification markets by type, 2000-2030



Source: Rystad Energy

Figure 7.9: Floating and offshore regasification capacity by status and number of terminals, 2005-2030



Source: Rystad Energy

Most new markets emerging in the past 10 years have entered the LNG import sector by installing FSRUs. Among the 48 existing LNG import markets as of April 2023, 18 were floating and offshore-only importers, with another 10 importing LNG via both floating-based and onshore terminals. In contrast, only seven markets purely relied on floating-based terminals 10 years ago. FSRU's shorter construction timeline and the fact that they are less capital intensive can help new markets to meet emerging demand more quickly in the short term. The energy crisis in 2022 has prompted European markets to deploy large numbers of LNG import terminals which are mainly FSRU-based, due to the urgency of expanding regasification capacity. It took just a few months in 2022 to bring online the Eemshaven FSRU in the Netherlands and the Wilhelmshaven FSRU in Germany.

With increasing numbers of FSRUs being chartered by European markets, global FSRU supply has become tight which may pose problems for the floating terminal construction plans in cost-sensitive markets and lead to start-up delays or even project cancellations. The Netherlands has chartered two FSRUs – Exmar 188 from Exmar and Golar Igloo from New Fortress Energy – for Eemshaven FSRU. Italy has purchased three FSRU vessels, with Golar Tundra and BW Singapore to be installed at Piombino and Ravenna respectively. LNG carrier Golar Arctic is being converted to install at Portovesme in Sardinia.

Established gas markets still prefer onshore terminals which typically require larger regasification capacity and LNG storage tanks to meet demand. China, the third largest market by regasification capacity, currently has 24 LNG import terminals and all of them are onshore terminals which can provide plenty of room for capacity settings and expansions. Compared to floating-based terminals, they can also reduce exposure to risks from weather conditions, vessel performance and chartering renewal.

7.7 RECEIVING TERMINALS WITH RELOADING AND TRANS-SHIPMENT CAPABILITIES

Highest re-exports in 2022: Spain,

1.69 MTPA

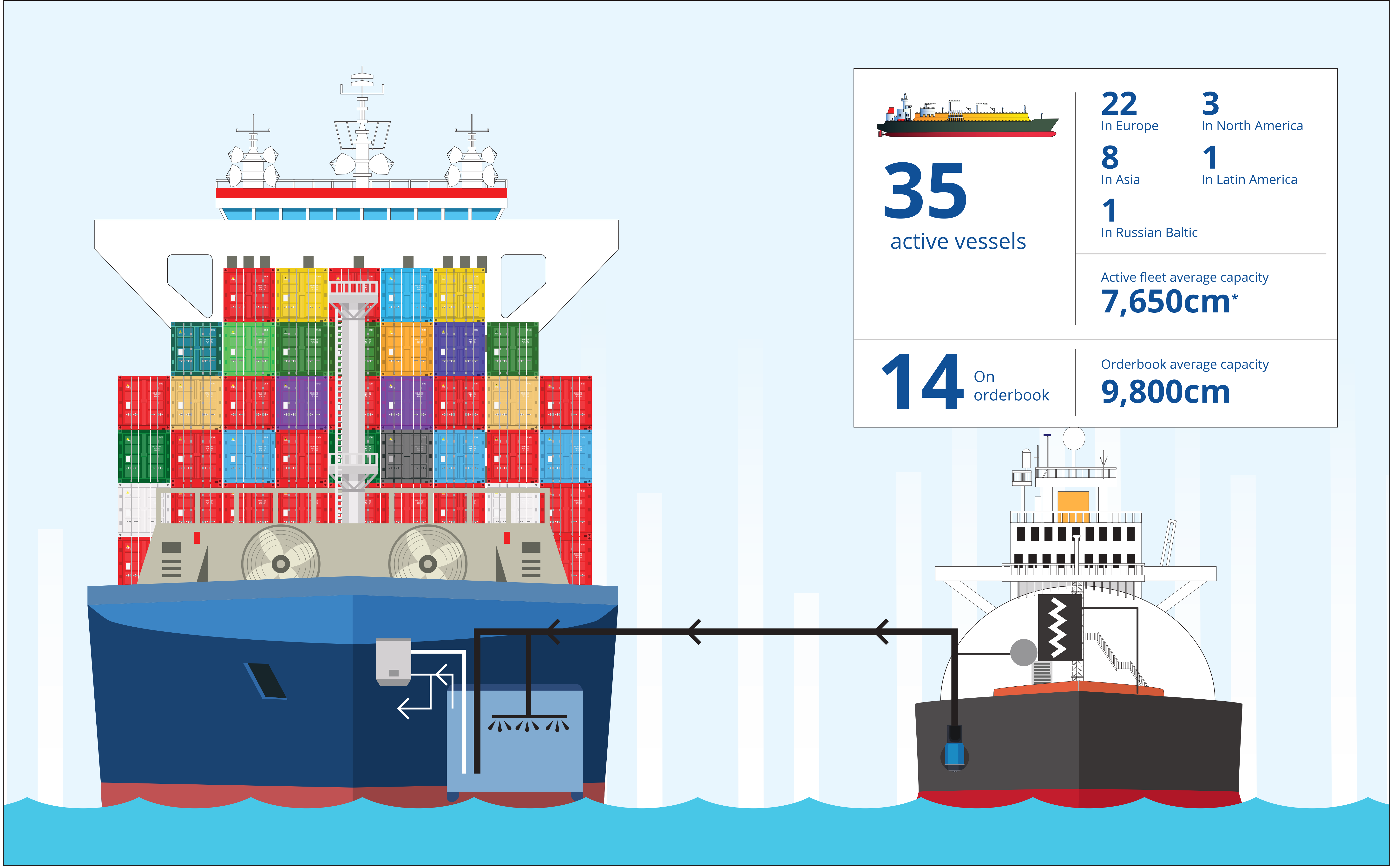
In recent years, some LNG import terminals have diversified their service portfolio from only traditional regasification service to other services, such as reloading, trans-shipment, small-scale LNG bunkering and truck-loading. An integrated LNG hub can help importers expand their trading business by leveraging price differentials between different regional markets and their LNG portfolio by holding term contracts. Terminals have enhanced their facilities with reloading and trans-shipment capabilities, aiming to better address the needs of the evolving market. Re-exported LNG volumes trended higher from 3.92 MTPA in 2021 to 4.68 MTPA in 2022, with 13 markets re-exporting cargoes, up from 12 in the previous year. Spain continued to be the largest re-exporter in 2022 with a volume of 1.69 MTPA, making up 36% of global re-exports and growing nearly 70% year-on-year. Most of Spain's re-exports were destined for other European markets, such as Italy, the Netherlands and France. As Spain has the highest regasification capacity in Europe, it has become a main regional LNG hub and further redistributed LNG cargoes to other markets in Europe. This was especially noticeable in 2022 when European markets snapped up LNG cargoes to ensure energy security. Infrastructure has been enhanced at several Iberian regasification terminals to provide reloading, bunkering, trans-shipment, and truck-loading capabilities. The Cartagena LNG import terminal completed its first direct bunkering to an LNG-fueled tanker in 2017, utilising the facility's tank-to-jetty pipeline and a dedicated jetty. The Bilbao terminal adapted its marine jetty to accommodate small-scale vessels in 2017 and carried out its first LNG bunkering operation through truck-to-ship transfer the same year. In 2022, Repsol started up a bunkering facility at Bilbao with storage capacity of 1,000 cm.

France, one of Europe's largest gas consuming markets, accounted for the second-highest LNG re-exports in 2022 at 0.73 MTPA, a slight drop from a year earlier, with domestic demand prioritised in the context of the energy crisis. Turkey, China, and Spain were the main destinations of France's LNG re-exports. France re-exported most cargoes via its Montoir-de-Bretagne, Fos Cavaou and Dunkirk terminals. The Montoir-de-Bretagne terminal has multiple jetties, helping it provide value-adding services for trans-shipment and bunkering in addition to regasification. The Dunkirk terminal launched its truck-loading service with a loading capacity of 3,000 slots per year after its newly built loading bay entered service in mid-2020. Additionally, the Dunkirk terminal has adapted its existing jetty to accommodate the berthing of small-scale LNG carriers and bunker vessels with capacity of 5,000 cm or more.

China re-exported 0.45 MTPA of LNG in 2022, accounting for 10% of global volumes, a record high since China performed its first LNG re-export in 2015 and mainly driven by arbitrage opportunities. Slowed domestic demand in China also caused the market to resell from its abundant LNG inventories. The main destinations included neighboring markets South Korea and Japan, as well as European markets Spain and Italy. China's LNG re-exports were mainly from PipeChina's Hainan Yangpu LNG terminal, one China's few terminals with reloading and trans-shipment capabilities. The terminal's geographical proximity to Southeast Asia helped it expand re-exports services there. Besides re-exports, the terminal delivers LNG to the nearby small-scale import terminal Fangchenggang LNG. Rising numbers of Chinese terminals, especially new builds, are designing their facilities with reloading, trans-shipment and bunkering functions. Zhoushan ENN LNG terminal in Zhejiang province equipped its second berth with reloading and bunkering capabilities in 2022. Another two regasification terminals in Zhejiang province – Sinopec Liuheng LNG and Zhejiang Energy Liuheng LNG – are planning to launch reloading services for smaller LNG carriers, helping deliver LNG to the inland market via the Yangtze River. They may also expand their services to include re-exports, depending on market conditions. Wuhu LNG terminal, the first inland river terminal to be approved and which is under construction, has been designed with reloading capacity. After its expected startup in 2024, it will help strengthen LNG supplies to the Yangtze River Delta, a major gas consuming region in China.

Courtesy KOGAS

8 LNG Bunkering Vessels and Terminals



35 active vessels

22 In Europe
3 In North America
8 In Asia
1 In Latin America
1 In Russian Baltic

Active fleet average capacity
7,650cm*

14 On orderbook

Orderbook average capacity
9,800cm

* Rounded to lowest 50cm for Active fleet average capacity

8. LNG Bunkering Vessels and Terminals

Stricter environmental legislation at a regional and global level is putting pressure on marine vessel owners to consider the use of cleaner alternatives to bunker fuels. With effect from January 2020, the International Maritime Organization (IMO) enforced a new global limit of 0.5% on the sulphur content of fuel oil for vessels. It also identified a range of geographical areas as Emission Control Areas (ECAs), such as in Europe (North Sea) and North America (US and Canada), where the use of fuels with a sulphur content over 0.1% is forbidden. Moreover, the Mediterranean Sea will also become an ECA from 2025 following the last discussions by the IMO in 2022. The imposition of a stricter sulphur content cap on marine bunker fuel has spurred the switch to LNG-fueled vessels which have near-zero SOx emissions. This is done through the installation of new systems or conversions where possible, alongside the construction of related bunkering infrastructure.

Courtesy Knutsen OAS

35 units

Global Operational LNG Bunkering Vessel Fleet, End-of-April 2023

In 2022, global LNG bunkering activity declined as oil-based fuels traded at significant discounts to global LNG prices. Any dual-fuel vessels that could switch to fuel oil did so. However, as of early 2023, LNG prices have once again become competitive with fuel oil, while the longer-term fundamentals of a rapidly expanding LNG-fueled orderbook and accelerating decarbonisation measures remain robust. As a result, 2023 is widely expected to be revival year for the LNG bunkering market.

Dramatic changes in regulations are stimulating a rapid increase in LNG-fueled vessel orders across different vessel classes. According to the IMO's Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations, since 1 January 2023, ships of 400 GT and above are required to calculate their attained EEXI to measure their energy efficiency. Ships of 5000 GT and above are also required to report their annual operational CII and CII rating. This has created a self-reinforcing feedback loop in which the development of an efficient, secure, and competitive LNG supply chain and related bunkering infrastructure is driving further construction of LNG-powered vessels. The IMO is also aiming for a 50% reduction in greenhouse gas (GHG) emissions in the shipping sector by 2050, compared to 2008 levels, which strengthens the case for LNG bunker fuel as means of immediate decarbonisation. Fossil fuel-origin LNG is also chemically identical to net-zero emissions bio-LNG and synthetic LNG, which provides a pathway for further emission reductions until zero-carbon fuels such as hydrogen and ammonia are developed to commercial scale. In addition, a preliminary agreement in the European Union (EU) will subject shipping companies that are compliant with EU Monitoring, Reporting and Verification (MRV) to adopt carbon taxation via the Emissions Trading System (ETS). This will be gradually phased in, with 40% of verified emissions requiring EU Allowances (EUAs) in 2024, 70% in 2025, and 100% in 2026. Another EU regulation FuelEU, which aims to accelerate the marine industry's decarbonisation through the adoption of renewable and low carbon fuels, has also been provisionally agreed in March 2023.
Multiple options exist for supplying LNG to vessels. The three most common methods have been terminal tank-to-ship, truck-to-ship, and ship-to-ship (STS) transfers. LNG-powered ships can be refuelled in a more timely and efficient manner through STS transfers from bunkering vessels than from jetty-side truck-to-ship LNG transfers. In 2023, two boxships in China completed voyages using a new containerised bunker tank system.

Over the past decade, the LNG bunkering market has developed steadily with the addition of bunkering vessels and terminals equipped with bunkering facilities, although this growth so far been concentrated around ports with substantial LNG infrastructure, such as in Western Europe.

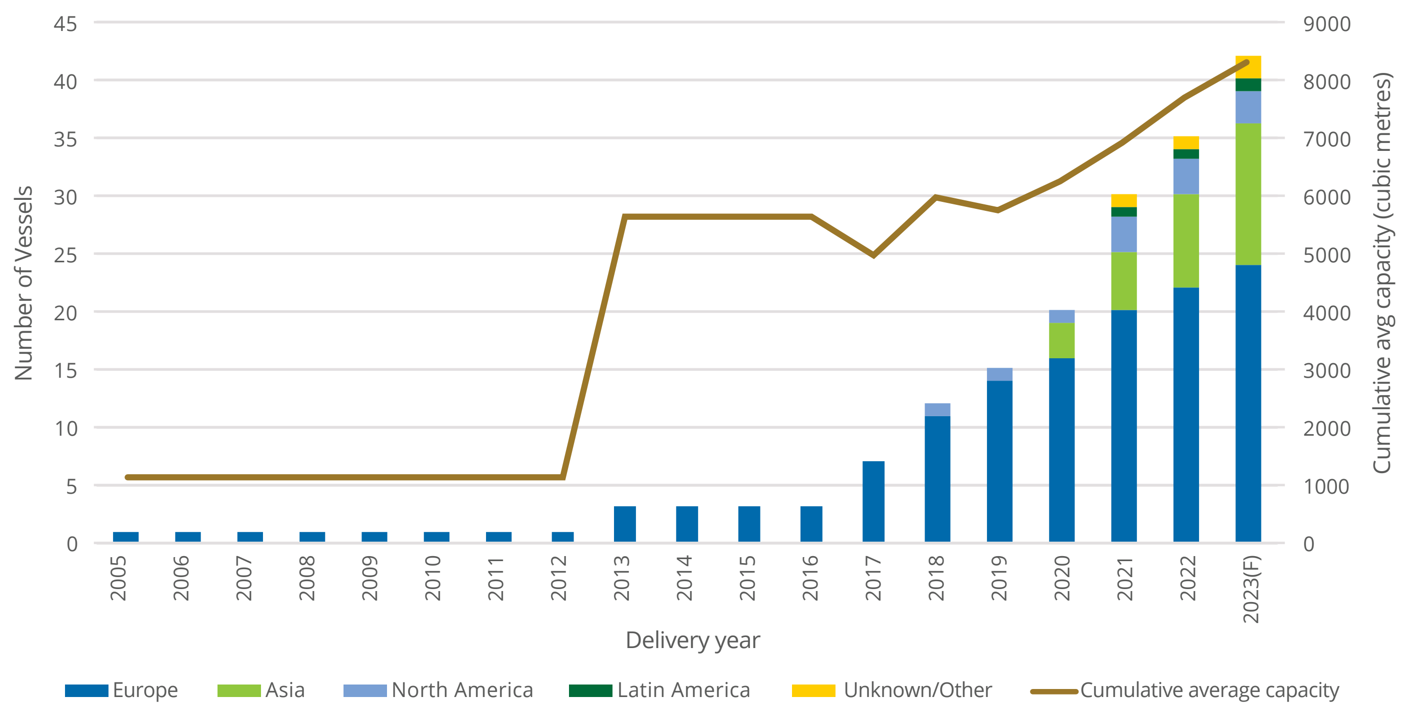
In the early years of LNG bunkering, small-scale LNG carriers performed few STS LNG bunkering services in addition to small-scale LNG deliveries. These carriers, with capacities of between 1,000 and 20,000 cubic metres (cm), entered service in the early 1990s, but were not specifically designed and built for STS LNG bunkering operations. The Pioneer Knutsen, launched in 2004, is one of the smallest LNG carriers in the world with a capacity of 1,100 cm. It has a long track record of STS transfers, although not specifically for bunkering, as well as small-scale LNG deliveries along the Norwegian coast, with approximately 200 cargo deliveries per year.

The first dedicated LNG bunkering barge to enter operations was the Seagas in 2013 in the Port of Stockholm. The 187 cm Seagas, converted from a small Norwegian ferry, delivers around 70 tonnes of LNG to the large Viking Grace ferry almost every round trip. LNG is loaded onto the Seagas by trucks from the small-scale Nynashamn LNG terminal in Sweden, located almost 60 kilometres south of Stockholm.

The Seagas remained the sole dedicated STS bunkering barge for some years until some small inland LNG barges were developed in China between 2014 and 2016 for bunkering purposes. In 2017, three purpose-built LNG bunkering vessels with much larger capacities entered operations: the Green Zeebrugge (5,000 cm), the Coralius (5,800 cm), and the New Frontier1 (6,500 cm, ex-Cardissa). Green Zeebrugge operates primarily near the Zeebrugge region, while Coralius and New Frontier1 serve the North Sea/Baltic Sea region, sailing from the Risavika and Rotterdam bases, respectively, to load and perform bunkering operations. The business case for these pioneering projects was supported by their proximity to LNG terminals as well as the ability to modify the regasification facilities to accommodate small-scale ships, such as at the GATE terminal in Rotterdam. In less than a year, the Kairos, another 7,500 cm LNG bunker vessel, began operations at the Klaipeda LNG terminal in Lithuania.

Conversions and vessel upgrades have also enabled the expansion of LNG bunkering infrastructure. The world's sixth LNG bunkering vessel, the Oizmendi, was a converted heavy fuel oil/marine diesel oil bunkering tanker with a capacity of 660 cm of LNG in two type C tanks on deck. As Spain's first LNG bunkering vessel, it performed its first STS bunkering operation in the Port of Bilbao in early 2018 and currently serves the Iberian Peninsula. The Coral Methane (7,500 cm) was a modified small-scale tanker that was upgraded with STS LNG bunkering capabilities in 2018. The highly mobile vessel performs bunkering operations across multiple ports, including Barcelona, Rotterdam, Marseille Fos and Tenerife. The TotalEnergies-chartered Gas Agility performed the first STS bunkering in the Port of Rotterdam in November 2020. It is equipped with membrane tanks with a total capacity of 18,600 cm. This pioneering bunkering operation, to CMA CGM's vessel Jacques Saade, also involved a 13% blend of biomethane. The LNG bunkering fleet has experienced rapid growth since many regions received their first LNG bunkering vessel in 2021. Russia's first vessel, the Dmitry Mendeleev (5,800 cm with icebreaking capabilities), was delivered to Gazprom. Estonia received its first 6,000 cm vessel, the Optimus, while Italy and France both received their first LNG bunker vessels, the 7,500 cm Avenir Aspiration and the 18,600 cm Gas Vitality (sister ship of the Gas Agility), respectively. The 5,000 cm Haugesund Knutsen performed its first LNG bunkering operation in March 2023 at the Port of Barcelona. Titan LNG has recently acquired two small-scale LNG vessels, the Seapeak Unikum (12,000 cm) and

Figure 8.1: Cumulative number of operational LNG bunkering vessels by region and average vessel capacity, 2005 to end-2023



Source: Rystad Energy

Seapeak Vision (12,000 cm), to be converted for the bunkering and transportation of LNG, biomethane and hydrogen derived e-methane. The maiden LNG bunker barge in the US, the Clean Jacksonville, has a capacity of 2,200 cm and is the first with a membrane cargo tank. It is stationed at the Port of Jacksonville in Florida and was built to supply LNG bunker to TOTE containerships from 2018 onwards. The Q-LNG 4000 was delivered in early 2021 as the market's first bunker and supply articulated tug barge (ATB) unit and was the second operational LNG bunker barge in the US after the Clean Jacksonville. In less than a year, the Clean Canaveral became the third operational bunker barge, operating as an articulated tug barge (ATB) unit along the southeastern coast of the US, with a capacity of 5,000 cm. Latin America's first LNG bunkering vessel, the Avenir Accolade (7,500 cm), was also delivered to Brazil in 2021.

The Asia Pacific region started to add bunkering vessels in 2020. The first two operational bunkering vessels were the Kaguya in Japan and the Avenir Advantage in Malaysia. Japan conducted its first STS LNG bunkering operation with the 3,500 cm Kaguya in October 2020. This vessel is based at the Kawagoe Thermal Power Station and supplies LNG to other ships in the Chubu region. Similarly, in October 2020, Malaysia launched STS LNG bunkering operations, chartering the 7,500 cm Avenir Advantage from Future Horizon, a joint venture between MISC Berhad and Avenir LNG. The vessel provides STS bunkering operations in the region and transports LNG to small-scale customers. The third operational LNG bunkering vessel in the Asia Pacific, which is also Singapore's first LNG bunkering vessel, the FueLNG Bellina, was successfully delivered in early 2021 to FueLNG and will provide STS LNG bunkering in Singapore. FueLNG is a joint venture between Keppel Offshore & Marine Ltd (Keppel O&M) and Shell Eastern Petroleum (Pte) Ltd.

The Avenir Allegiance (20,000 cm), after being sold to Shanghai SIPG Energy Service in early 2022, became China's first active LNG bunker vessel and was renamed the Hai Gang Wei Lai.

2022 saw two newbuild LNG bunkering vessels in Asia Pacific. The Xin Ao Pu Tuo Hao (8,500 cm) was delivered to ENN in 2022 and will provide LNG bunkering services to the domestic market in the eastern China's coastal region. The K LNG Dream (500 cm) became the first LNG bunkering vessel for coastal ships in South Korea.

China has also rapidly developed inland LNG bunkering stations that can perform truck-to-ship bunkering operations, to increase the utilisation of LNG on river vessels as part of its 14th Five Year Plan (2021-2025). CNOOC already has six inland bunkering stations in Southern China, the most recent one in Zhongshan Shenwan port, completing its first LNG bunkering in March 2023.

Outside Asia, Korea Line took delivery of the 18,000 cm K. Lotus, due to operate under Shell's charter in the Port of Rotterdam.

As of end-April 2023, the global operational LNG bunkering and bunkering-capable small-scale vessel fleet has reached 35 units[1], including both self-propelled and tug-propelled vessels and barges. While the LNG bunkering fleet is growing in Asia and North America, over two-thirds of the vessels operate in Europe. The fleet is still young with most of the active bunkering vessels delivered over the past five years. While the bunkering needs of different ports and different types of vessels may vary widely, the typical size of LNG bunkering vessels has increased over time. The Hai Yang Shi You 301, which has a capacity of 30,000 cm, was converted from a small-scale LNG carrier in November 2022 and is the largest operational LNG bunkering vessel in the world.

[1] Not including multiple inland bunker barges operating in China

Ports and terminals have either added to or modified their facilities to offer LNG bunkering services in response to the expected increase in LNG bunkering demand. These shore-based facilities are often located in regions with tighter emissions control regulations and in proximity to LNG import terminals, enabling efficient distribution. Truck-to-ship is currently the most widely used configuration at terminals and ports due to its low capital investment and limited infrastructure requirements. This method is restrictive in terms of its flow rates, among other factors, which limits bunkering operations to smaller-sized LNG-fueled vessels. Alternative options such as STS and shore-to-ship (also known as terminal tank-to-ship) support larger storage capacities and higher flow rates. However, both ship-to-ship and shore-to-ship require significantly higher capital investment in the form of bunker vessels, storage tanks and specialised loading arms. Avenir LNG has performed the first ship-to-truck transfer in Mukran, Germany. The cargo was unloaded from a small-scale LNG vessel onto trucks in February 2023, where it serviced the German market for trucked LNG.

Most LNG bunkering facilities in the North Sea and the Baltic Sea are part of a network of small-scale LNG terminals and ports which expanded in the 2010s. This expansion was enabled by increasing small-scale LNG exports from Norway and reloading/trans-shipment services offered at large-scale LNG import terminals to small-scale LNG terminals and ports in the region. Several large-scale LNG terminals also offer truck-loading and bunkering services directly from the terminal, which supports the delivery of LNG to nearby ports to be loaded on vessels via truck-to-ship bunkering. Bunkering services are also available at small-scale export terminals. Shore-based LNG terminals capable of providing bunkering services are more prevalent in Europe. However, the market is witnessing progressive construction in other parts of the world, such as in Asia and North America. The Risavika plant, one of Norway's liquefaction facilities, commissioned a dedicated bunkering facility in 2015 for Fjord Line ferries. The bunkering facility is linked to the plant's 30,000 cm LNG storage tank and supports direct shore-to-ship transfers through the region's first loading arm dedicated solely to bunkering purposes. Finland's Pori terminal, a small-scale import terminal, was equipped with direct LNG bunkering (terminal-to-ship) and truck-loading capabilities when it was commissioned in 2016. In 2019, another new small-scale receiving terminal in Finland, Tornio Manga, bunkered its first vessel, the Polaris. The terminal offers both tank-to-ship and truck-to-ship bunkering.

Iberian terminals have also started to diversify into LNG bunkering services. With support from the 'CORE LNGas hive' initiative aimed at building an Iberian LNG bunkering network, several Spanish ports have rapidly added truck-to-ship bunkering infrastructure and are implementing additional terminal enhancements to accommodate small-scale carriers and develop direct jetty-to-ship services for LNG-fueled vessels. The Cartagena LNG regasification terminal completed its first direct bunkering to an LNG-fueled tanker with 370 cm of LNG in 2017, using the facility's tank-to-jetty pipeline and a dedicated jetty. The Bilbao terminal adapted its marine jetty to accommodate small-scale vessels with capacities larger than 600 cm in 2017 and carried out its first LNG bunkering operation through a five-hour truck-to-ship transfer in the same year. In a bid to encourage the development of LNG bunkering at Spanish regasification terminals, a large reduction in reloading fees, especially for small ships destined for ship-to-ship bunkering, was implemented in September 2020 and will be applied for the next six years. In 2022, Repsol started up a bunkering facility at Bilbao with a storage capacity of 1000 cm and plans to start up another one in Santander in 2023. Both terminals will fuel Brittany Ferries' LNG-powered ferries as part of deal signed in 2019. In France, Le Havre Port completed its first LNG bunkering in September 2021, while La Rochelle Port achieved this in September 2022.

Within the Asia Pacific region, a growing number of markets – such as Singapore, Japan, China, and South Korea – are building LNG bunkering infrastructure, signifying an increased demand for LNG as a marine fuel in the region. Singapore's port has been modified and equipped with truck-to-ship bunkering capabilities since 2017. Over 400 truck-based fueling operations and 24 STS bunkering operations were completed by FueLNG in 2021. The STS bunkering operations were performed by Singapore's first LNG bunker vessel, FueLNG Bellina. The FueLNG Venosa (18,000cm) will be Singapore's second LNG bunker vessel and will be delivered in 2023. In Japan, the Port of Yokohama introduced truck-to-ship bunkering services in 2018 and has plans to offer STS bunkering using the vessel Ecobunker Tokyo Bay. The Kaguya LNG bunkering vessel provides STS bunkering in the Chubu region. South Korea currently offers truck-to-ship bunkering at its Incheon Port and infrastructure for STS bunkering at Tongyeong. In China, ship-to-ship bunkering services are provided at Shanghai and Shenzhen. The first ship-to-ship transfer by CNPC was completed by the 8,500cm Xin Ao Pu Tuo in Shenzhen Yantian in November 2022. Likewise, the first ship-to-ship transfer completed by CNOOC was by the 30,000 cm Hai Yang Shi You 301 in January 2023. Hainan Yangpu and Shenzhen Diefu are the only ports capable of performing re-loading onto LNG vessels.

The US is also expected to become a significant player in the LNG bunkering market. Currently, its bunkering operations occur primarily at the Jacksonville and Canaveral ports in Florida and Port Fourchon in Los Angeles. Jacksonville has conducted truck-to-ship operations since 2016 for two containerships and added STS bunkering services to the facility with the delivery of the Clean Jacksonville bunker barge in 2018. Port Fourchon completed the bunkering of its first LNG-fueled vessel in 2016 and has plans to become a central LNG bunkering terminal in North America. With the arrival of the 4,000 cm Q-LNG 4000 ATB unit and its dedicated tug Q-Ocean Service in early 2021, Port Canaveral in Florida is on track to be the first LNG cruise port in the US. Q-LNG 4000 vessel will operate from Port Canaveral to provide LNG fuel to cruise ships after loading LNG from a fuel distribution facility on Elba Island, Georgia. Norwegian firm Kanfer is also exploring several LNG bunkering projects, namely in Brazil, the Suez Canal and the Panama Canal, which are key waterways for the shipping industry.

The development of small-scale infrastructure in the southern US is also supporting the maritime decarbonisation in Latin America and the Caribbean. In June 2022, Eagle LNG announced they will introduce multiple bunkering and small-scale vessels to facilitate LNG fueling and delivery throughout the Caribbean. Eagle LNG's expansion at the Jacksonville facility is expected to increase supply to the Caribbean when it is operational in 2026. Shipping firm Zim completed its first LNG bunkering operation in late March 2023 at Jamaica's Kingston Freeport terminal.

Table 8.1: Table of global LNG bunkering vessels[2]

Reference number	Market	Vessel Name	Start year	LNG Tank Capacity (cm)	Concept
1	North Europe	Pioneer Knutsen	2004	1,100	Small-scale/bunkerable
2	Sweden	Seagas	2013	187	Bunkering vessel
3	Europe	Coral Energy	2013	15,600	Small-scale/bunkerable
4	Belgium	Green Zeebrugge	2017	5,000	Bunkering vessel
5	North Europe	Coralius	2017	5,800	Bunkering vessel
6	Netherlands	New Frontier 1 (ex-Cardissa)	2017	6,500	Bunkering vessel
7	Spain	Oizmendi	2017	660	Bunkering vessel
8	Spain	Bunker Breeze	2018	1,200	FO/DO bunker vessel/ LNG Bunker designed
9	US	Clean Jacksonville	2018	2,200	Bunker barge (by tug)
10	Europe	Coral Methane	2018	7,500	Small-scale/bunkerable
11	North Europe	Coral EnergICE	2018	18,000	Small-scale/bunkerable
12	North Europe	Kairos	2018	7,500	Bunkering vessel
13	Netherlands	LNG London	2019	3,000	Bunkering vessel
14	North Europe	Coral Fraseri	2019	10,000	Small-scale/bunkerable
15	Netherlands	FlexFueler 001	2019	1,480	Bunker barge (by tug)
16	Belgium	FlexFueler 002	2020	1,480	Bunker barge (by tug)
17	Malaysia	Avenir Advantage	2020	7,500	Bunkering vessel
18	South Korea	SM Jeju LNG2	2020	7,500	Bunkering vessel
19	Netherlands	Gas Agility	2020	18,600	Bunkering vessel
22	Japan	Kaguya	2020	3,500	Bunkering vessel
20	US	Q-LNG ATB 4000	2021	4,000	Bunker barge (by tug)
21	Norway	Bergen LNG	2021	850	Bunkering vessel
23	US	Clean Canaveral	2021	5,000	Bunkering vessel
24	Russian Baltic	Dmitry Mendeleev	2021	5,800	Bunkering vessel
25	North Europe	LNG Optimus	2021	6,000	Bunkering vessel
26	Brazil	Avenir Accolade	2021	7,500	Bunkering vessel
27	North Europe	Avenir Aspiration	2021	7,500	Bunkering vessel
28	Singapore	FueLNG Bellina	2021	7,500	Bunkering vessel
29	France	Gas Vitality	2021	18,600	Bunkering vessel
30	South Korea	K LNG Dream	2022	500	Bunkering vessel
31	Spain	Haugesund Knutsen	2022	5,000	Bunkering vessel
32	China	Xin Ao Pu Tuo Hao	2022	8,500	Bunkering vessel
33	Netherlands	K. Lotus	2022	18,000	Bunkering vessel
34	China	Hai Gang Wei Lai (ex-Avenir Allegiance)	2021	20,000	Bunkering vessel
35	China	Hai Yang Shi You 301	2022	30,000	Small-scale/bunkerable

Source: Rystad Energy

[2] In addition to these, there are several inland bunkering barges in China of capacity 200-500 cm

Table 8.2: Table of global LNG bunkering vessels order book

Reference number	Market	Vessel Name	Start year	LNG Tank Capacity (cm)	Concept
1	Japan	Ecobunker Tokyo Bay	2023	2,500	Bunkering vessel
2	South Korea	Blue Whale	2023	7,500	Bunkering vessel
3	Singapore	FueLNG Venosa	2023	18,000	Bunkering vessel
4	Unknown	Shell LNG BV	2023	18,000	Bunkering vessel
5	Europe	Fratelli Cosulich Small-Scale-1	2023	8,200	Small-scale/bunkerable
6	Spain	Scale Gas BV	2023	12,500	Bunkering vessel
7	Asia	LNG Brassavola	2023	12,000	Bunkering vessel
8	Asia	Fratelli Cosulich Small-Scale-2	2024	8,200	Small-scale/bunkerable

Table 8.2: Table of global LNG bunkering vessels order book (continued)

Reference number	Market	Vessel Name	Start year	LNG Tank Capacity (cm)	Concept
9	North America	Seaspan-1	2024	7,600	Bunkering vessel
10	North America	Seaspan-2	2024	7,600	Bunkering vessel
11	Asia	Mitsubishi Bunkering Tanker	2024	3,500	Bunkering vessel
12	China	Anhui Changjiang LNG	2024	14,000	Bunkering vessel
13	China	CNOOC BV	2024	10,000	Bunkering vessel
14	North America	Seaspan-3	2025	7,600	Bunkering vessel

Source: Rystad Energy

Courtesy CNOOC

9. References Used in the 2023 Edition

9.1 Data Collection

Data in Chapters 1, 2, 5, 6, 7, 8 and 9 of the 2023 IGU World LNG Report is sourced from a range of public and private domains, including Rystad Energy, the BP Statistical Review of World Energy, the International Energy Agency (IEA), the Oxford Institute for Energy Studies (OIES), the US Energy Information Administration (EIA), the US Department of Energy (DOE), Argus, the International Group of Liquefied Natural Gas Importers (GIIGNL), Refinitiv Eikon, DNV GL, Barry Rogliano Salles (BRS), company reports and announcements. Any private data obtained from third-party organisations is cited as a source at the point of reference (i.e. charts and tables). No representations or warranties, express or implied, are made by the sponsors concerning the accuracy or completeness of the data and forecasts supplied under the report.

9.2 Data Collection for Chapter 3

Data in Chapter 3 of the 2023 IGU World LNG Report is sourced from Rystad Energy. No representations or warranties, express or implied, are made by the sponsors concerning the accuracy or completeness of the data and forecasts supplied under the report.

9.3 Data Collection for Chapter 4

Data in Chapter 4 of the 2023 IGU World LNG Report is sourced from S&P Global Commodities Insights. No representations or warranties, express or implied, are made by the sponsors concerning the accuracy or completeness of the data and forecasts supplied under the report.

9.4 Preparation and Publication of the 2023 IGU World LNG Report

The IGU wishes to thank the following organisations and Task Force members entrusted to oversee the preparation and publication of this report

- Energy Institute Hrvoje Pozar, Croatia: Daniel Golja
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- Osaka Gas Co., Ltd., Japan: Ryota Amemoto
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- Qatargas Operating Company Limited, Qatar: Amine Yacef
- Bureau Veritas, France: Carlos Guerrero Pozuelo
- GIIGNL, France: Ekaterina Dukhanina
- S&P Global, Singapore: Ciaran Roe
- International Gas Union, United Kingdom: Tatiana Khanberg
- Korea Gas Corporation, Republic of Korea: Jeongwook Khang, Nak-Gyun Kim
- CNOOC EEI, China: Kai Wang, Dong Liang, Meini Zou, Wei Li, Yun Shi, Yinghao Kong, Yumeng Zhang, Chuyu Sun, Sixing Zhao
- Rystad Energy, Norway: Xi Nan, Kaushal Ramesh, Lu Ming Pang, Zongqiang Luo, Sindre Knutsson, Wei Xiong, Yi Cui

9.5 Definitions

Brownfield Liquefaction Project: A land-based LNG project at a site with existing LNG infrastructure, such as: jetties, storage tanks, liquefaction facilities or regasification facilities.

Commercial Operations: For LNG liquefaction plants, commercial operations start when the plants deliver commercial cargos under the supply contracts with their customers.

East and West of Suez: The terms East and West of Suez refer to the location in which an LNG tanker fixture begins. For these purposes, marine locations to the west of the Suez Canal, Cape of Good Hope, or Novaya Zemlya, but to the east of Tierra del Fuego, the Panama Canal, or Lancaster Sound, are considered to lie west of Suez. Other points are considered to lie east of Suez.

Forecast Data: Forecast liquefaction and regasification capacity data only considers existing and approved capacity (criteria being FID taken) and is based on company announced start dates.

Greenfield Liquefaction Project: A land-based LNG project at a site where no previous LNG infrastructure has been developed.

Home Market: The market in which a company is based.

Laid-Up Vessel: A vessel is considered laid-up when it is inactive and temporarily out of commercial operation. This can be due to low freight demand or when running costs exceed ongoing freight rates. Laid-up LNG vessels can return to commercial operation, undergo FSU/FSRU conversion or proceed to be sold for scrap.

Liquefaction and Regasification Capacity: Unless otherwise noted, liquefaction and regasification capacity throughout the document refers to nominal capacity. It must be noted that re-loading and storage activity can significantly reduce the effective capacity available for regasification.

LNG Carriers: For the purposes of this report, only Q-Class and conventional LNG vessels with a capacity greater than 30,000 cm are considered part of the global fleet discussed in the 'LNG Carriers' chapter (Chapter 6). Vessels with a capacity of 30,000 cm or less are considered small-scale LNG carriers.

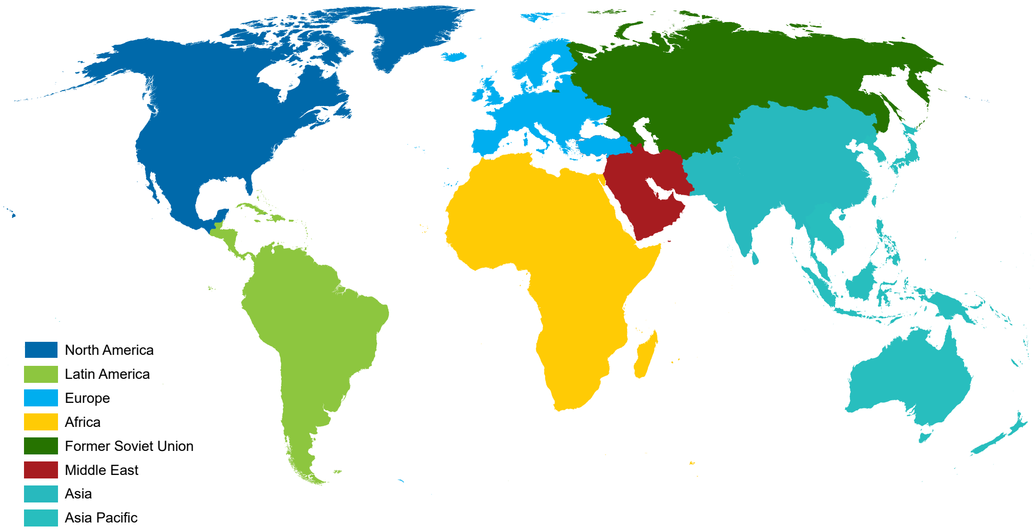
Scale of LNG Trains:
- **Small-scale:** 0-0.5 MTPA capacity per train
- **Mid-scale:** >0.5-1.5 MTPA capacity per train
- **Large-scale:** More than 1.5 MTPA capacity per train

Spot Charter Rates: Spot charter rates refer to fixtures beginning between five days after the date of assessment and the end of the following calendar month.

9.6 Regions and Basins

The IGU regions referred to throughout the report are defined as per the colour-coded areas in the map below. The report also refers to three basins: Atlantic, Pacific and Middle East. The Atlantic Basin encompasses all markets that border the Atlantic Ocean or Mediterranean Sea, while the Pacific Basin refers to all markets bordering the Pacific and Indian Oceans. However, these two categories do not include the following markets, which have been differentiated to compose the Middle East Basin: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Oman, Qatar, UAE and Yemen. IGU has also considered markets with liquefaction or regasification activities in multiple basins and has adjusted the data accordingly.

Figure 9.1: Grouping of markets into regions



9.7 Acronyms

CAPEX = Capital Expenditure
CCS = Carbon Capture and Storage
CCUS = Carbon Capture, Utilisation and Storage
CII = Carbon Intensity Indicator
CO2 = Carbon Dioxide
CSG = Coal Seam Gas
CNG = Compressed Natural Gas
DES = Delivered Ex-Ship
DFDE = Dual-Fuel Diesel Electric
DMR = Dual Mixed Refrigerant
EEXI = Energy Efficiency Existing Ship Index
EPC = Engineering, Procurement and Construction
EU = European Union
FEED = Front-End Engineering and Design
FERC = Federal Energy Regulatory Commission
FID = Final Investment Decision
FLNG = Floating Liquefied Natural Gas
FOB = Free On-Board
FPSO = Floating Production, Storage and Offloading
FSRU = Floating Storage and Regasification Unit
FSU = Floating Storage Unit
FSU = Former Soviet Union
GCU = Gas Combustion Unit
GHG = Greenhouse Gas
GTT = Gaztransport & Technigaz
IHI = Ishikawajima-Harima Heavy Industries
IMO = International Maritime Organization
ISO = International Organization for Standardization
JKM = Platts Japan-Korea Marker
LPG = Liquefied Petroleum Gas
MARPOL = International Convention for the Prevention of Pollution from Ships
MEGA = M-type, Electronically Controlled, Gas Admission
MEGI = M-type, Electronically Controlled, Gas Injection
MEPC = Marine Environment Protection Committee
MMLS = Moveable Modular Liquefaction System
NGV = Natural Gas Vehicle
OPEX = Operating Expenditure
PSC = Production Sharing Contract
SOx = Sulfur Oxides
SPA = Sales and Purchase Agreement
STaGE = Steam Turbine and Gas Engine
SSDR = Slow Speed Diesel with Re-liquefaction Plant
STS = Ship-to-Ship
TFDE = Triple-Fuel Diesel Electric
TTF = Title Transfer Facility
UAE = United Arab Emirates
UK = United Kingdom
US = United States
YOY = Year-on-Year

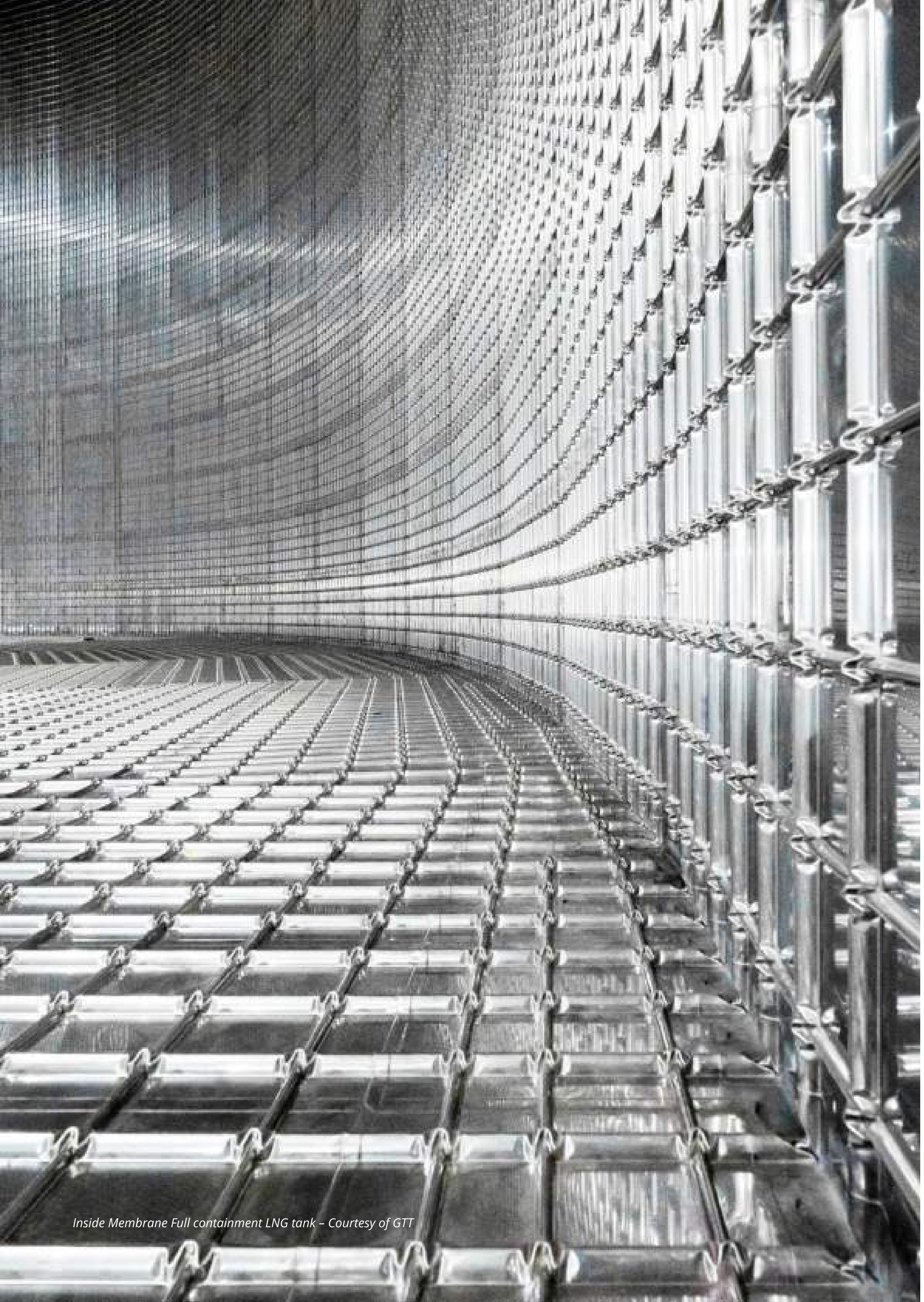
9.8 Units

bbl = barrel
bcfd = billion cubic feet per day
bcm = billion cubic metres
cm = cubic metres
GT = gigatonnes
KTPA = thousand tonnes per annum
mcm = thousand cubic metres
mmcfd = million cubic feet per day
mmcm = million cubic metres
mmBtu = million British thermal units
MT = million tonnes
MTPA = million tonnes per annum
nm = nautical miles
tcf = trillion cubic feet

9.9 Conversion Factors

Table 9.1: Overview of Conversion Factors

	Tonnes LNG	cm LNG	mmcm gas	mmcf gas	mmBtu	boe
Tonnes LNG	-	2.222	0.0013	0.0459	53.38	9.203
cm LNG	0.45	-	5.85 x 10-4	0.0207	24.02	4.141
mmcm gas	769.2	1,700	-	35.31	41,100	7,100
mmcf gas	21.78	48	0.0283	-	1,200	200.5
mmBtu	0.0187	0.0416	2.44 x 10-5	8.601 x 10-4	-	0.1724
boe	0.1087	0.2415	1.41 x 10-4	0.00499	5.8	-


Inside Membrane Full containment LNG tank – Courtesy of GTT

Appendix 1: Table of Global Liquefaction Plants

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
1	Libya	Marsa El Brega LNG	AP-SMR	1970	3.20	NOC (Libya)* (100%)
2	Brunei	Brunei LNG T1-T2	AP-C3MR	1972	2.88	Shell* (25%); Brunei Government (50%); Mitsubishi Corp (25%)
2	Brunei	Brunei LNG T3-T4	AP-C3MR	1973	2.88	Shell* (25%); Brunei Government (50%); Mitsubishi Corp (25%)
2	Brunei	Brunei LNG T5	AP-C3MR	1974	1.44	Shell* (25%); Brunei Government (50%); Mitsubishi Corp (25%)
3	UAE	Adgas LNG T1	AP-C3MR	1977	1.15	ADNOC LNG* (0%); Abu Dhabi NOC (70%); Mitsui (15%); BP (10%); TotalEnergies (5%)
3	UAE	Adgas LNG T2	AP-C3MR	1977	1.15	ADNOC LNG* (0%); Abu Dhabi NOC (70%); Mitsui (15%); BP (10%); TotalEnergies (5%)
4	Algeria	Arzew GL1Z T1-T6	AP-C3MR	1978	7.90	Sonatrach* (100%)
5	Algeria	Arzew GL2Z T1-T6	AP-C3MR	1981	8.40	Sonatrach* (100%)
6	Malaysia	MLNG Satu T1-T3	AP-C3MR	1982	8.40	Petronas* (90%); Mitsubishi Corp (5%); Sarawak State (5%)
7	Indonesia	Bontang LNG TC-TD	AP-C3MR	1983	5.60	Pertamina* (55%); Japan Indonesia LNG Co. (JILCO) (20%); PT VICO Indonesia (15%); TotalEnergies (10%)
7	Indonesia	Bontang LNG TE	AP-C3MR	1989	2.80	Pertamina* (55%); Japan Indonesia LNG Co. (JILCO) (20%); PT VICO Indonesia (15%); TotalEnergies (10%)
8	Australia	North West Shelf LNG T1	AP-C3MR	1989	2.50	Woodside* (16.67%); BHP (16.67%); BP (16.67%); Chevron (16.67%); Shell (16.67%); Mitsubishi Corp (8.33%); Mitsui (8.33%)
8	Australia	North West Shelf LNG T2	AP-C3MR	1989	2.50	Woodside* (16.67%); BHP (16.67%); BP (16.67%); Chevron (16.67%); Shell (16.67%); Mitsubishi Corp (8.33%); Mitsui (8.33%)
7	Indonesia	Bontang LNG TF	AP-C3MR	1993	2.80	Pertamina* (55%); Japan Indonesia LNG Co. (JILCO) (20%); PT VICO In-donesia (15%); TotalEnergies (10%)
8	Australia	North West Shelf LNG T3	AP-C3MR	1993	2.50	Woodside* (16.67%); BHP (16.67%); BP (16.67%); Chevron (16.67%); Shell (16.67%); Mitsubishi Corp (8.33%); Mitsui (8.33%)
3	UAE	Adgas LNG T3	AP-C3MR	1994	3.00	ADNOC LNG* (0%); Abu Dhabi NOC (70%); Mitsui (15%); BP (10%); TotalEnergies (5%)
6	Malaysia	MLNG Dua T4-T6	AP-C3MR	1995	9.60	Petronas* (80%); Mitsubishi Corp (10%); Sarawak State (10%)
9	Qatar	Qatargas 1 T1	AP-C3MR	1996	3.20	Qatargas* (0%); Qatar Energy (100%)
9	Qatar	Qatargas 1 T2	AP-C3MR	1996	3.20	Qatargas* (0%); Qatar Energy (100%)
9	Qatar	Qatargas 1 T3	AP-C3MR	1996	3.20	Qatargas* (0%); Qatar Energy (100%)
7	Indonesia	Bontang LNG TG	AP-C3MR	1998	2.80	Pertamina* (55%); Japan Indonesia LNG Co. (JILCO) (20%); PT VICO Indonesia (15%); TotalEnergies (10%)
7	Indonesia	Bontang LNG TH	AP-C3MR	1999	2.95	Pertamina* (55%); Japan Indonesia LNG Co. (JILCO) (20%); PT VICO Indonesia (15%); TotalEnergies (10%)

Note:
1. Reference number is sorted by infrastructure start year and liquefaction plant project.

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
9	Qatar	Rasgas 1 T1	AP-C3MR	1999	3.30	Qatargas* (0%); Qatar Energy (63%); ExxonMobil (25%); ITOCHU (4%); Korea Gas (3%); Sojitz (1.5%); Sumitomo (1.5%); Samsung (0.5%); Hyundai (0.4%); SK Innovation (0.4%); LG International (0.28%); Daesung (0.27%); Hanwha Energy (0.15%)
9	Qatar	Rasgas 1 T2	AP-C3MR	1999	3.30	Qatargas* (0%); Qatar Energy (63%); ExxonMobil (25%); ITOCHU (4%); Korea Gas (3%); Sojitz (1.5%); Sumitomo (1.5%); Samsung (0.5%); Hyundai (0.4%); SK Innovation (0.4%); LG International (0.28%); Daesung (0.27%); Hanwha Energy (0.15%)
10	Trinidad and Tobago	Atlantic LNG T1	ConocoPhil-lips Optimized Cascade	1999	3.00	Atlantic LNG* (0%); Shell (46%); BP (34%); China Investment Corporation (10%); NGC (10%)
11	Nigeria	NLNG T1	AP-C3MR	1999	3.30	NNPC (Nigeria)* (49%); Shell (25.6%); TotalEnergies (15%); Eni (10.4%)
11	Nigeria	NLNG T2	AP-C3MR	1999	3.30	NNPC (Nigeria)* (49%); Shell (25.6%); TotalEnergies (15%); Eni (10.4%)
12	Oman	Oman LNG T1	AP-C3MR	2000	3.55	Oman LNG* (0%); Omani Government (51%); Shell (30%); TotalEnergies (5.54%); Korea LNG (5%); Mitsubishi Corp (2.77%); Mitsui (2.77%); PTTEP (Thailand) (2%); ITOCHU (0.92%)
12	Oman	Oman LNG T2	AP-C3MR	2000	3.55	Oman LNG* (0%); Omani Government (51%); Shell (30%); TotalEnergies (5.54%); Korea LNG (5%); Mitsubishi Corp (2.77%); Mitsui (2.77%); PTTEP (Thailand) (2%); ITOCHU (0.92%)
10	Trinidad and Tobago	Atlantic LNG T2	ConocoPhil-lips Optimized Cascade	2002	3.30	Atlantic LNG* (0%); Shell (57.5%); BP (42.5%)
11	Nigeria	NLNG T3	AP-C3MR	2002	3.30	NNPC (Nigeria)* (49%); Shell (25.6%); TotalEnergies (15%); Eni (10.4%)
6	Malaysia	MLNG Tiga T7-T8	AP-C3MR	2003	7.70	Petronas* (60%); Sarawak State (25%); JX Nippon Oil and Gas (10%); Mitsubishi Corp (5%)
10	Trinidad and Tobago	Atlantic LNG T3	ConocoPhil-lips Optimized Cascade	2003	3.30	Atlantic LNG* (0%); Shell (57.5%); BP (42.5%)
8	Australia	North West Shelf LNG T4	AP-C3MR	2004	4.60	Woodside* (16.67%); BHP (16.67%); BP (16.67%); Chevron (16.67%); Shell (16.67%); Mitsubishi Corp (8.33%); Mitsui (8.33%)
9	Qatar	Rasgas 2 T3	AP-C3MR/ SplitMR	2004	4.70	Qatargas* (0%); Qatar Energy (70%); ExxonMobil (30%)
9	Qatar	Rasgas 2 T4	AP-C3MR/ SplitMR	2005	4.70	Qatargas* (0%); Qatar Energy (70%); ExxonMobil (30%)
10	Trinidad and Tobago	Atlantic LNG T4	ConocoPhil-lips Optimized Cascade	2005	5.20	Atlantic LNG* (0%); Shell (51.1%); BP (37.8%); NGC (11.1%)

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
11	Nigeria	NLNG T4	AP-C3MR	2005	4.10	NNPC (Nigeria)* (49%); Shell (25.6%); TotalEnergies (15%); Eni (10.4%)
13	Egypt	Damietta LNG T1	AP-C3MR/ SplitMR	2005	5.00	SEGAS* (0%); Eni (50%); EGAS (40%); EGPC (Egypt) (10%)
14	Egypt	Egyptian LNG (Idku) T1	ConocoPhil-lips Optimized Cascade	2005	3.60	Shell* (35.5%); Petronas (35.5%); EGPC (Egypt) (24%); TotalEnergies (5%)
14	Egypt	Egyptian LNG (Idku) T2	ConocoPhil-lips Optimized Cascade	2005	3.60	Shell* (38%); Petronas (38%); EGPC (Egypt) (24%)
11	Nigeria	NLNG T5	AP-C3MR	2006	4.10	NNPC (Nigeria)* (49%); Shell (25.6%); TotalEnergies (15%); Eni (10.4%)
12	Oman	Oman LNG T3 (Qalhat)	AP-C3MR	2006	3.30	Oman LNG* (0%); Omani Government (65.6%); Shell (11.04%); Mitsubishi Corp (4.02%); Eni (3.68%); Naturgy (3.68%); ITOCHU (3.34%); Osaka Gas (3%); TotalEnergies (2.04%); Korea LNG (1.84%); Mitsui (1.02%); PTTEP (Thailand) (0.74%)
15	Australia	Darwin LNG T1	ConocoPhil-lips Optimized Cascade	2006	3.70	Santos* (43.44%); SK E&S (25%); Inpex (11.38%); Eni (10.98%); JERA (6.13%); Tokyo Gas (3.07%)
9	Qatar	Rasgas 2 T5	AP-C3MR/ SplitMR	2007	4.70	Qatargas* (0%); Qatar Energy (70%); ExxonMobil (30%)
11	Nigeria	NLNG T6	AP-C3MR	2007	4.10	NNPC (Nigeria)* (49%); Shell (25.6%); TotalEnergies (15%); Eni (10.4%)
16	Equatorial Guinea	EG LNG T1	ConocoPhil-lips Optimized Cascade	2007	3.70	Marathon Oil* (56%); Sonagas G.E. (25%); Mitsui (8.5%); Marubeni (6.5%); Equatorial Guinea Govern-ment (4%)
17	Norway	Snøhvit LNG T1	Linde MFC	2007	4.30	Equinor* (36.79%); Petoro (30%); TotalEnergies (18.4%); Neptune Energy (12%); Wintershall Dea (2.81%)
8	Australia	North West Shelf LNG T5	AP-C3MR	2008	4.60	Woodside* (16.67%); BHP (16.67%); BP (16.67%); Chevron (16.67%); Shell (16.67%); Mitsubishi Corp (8.33%); Mitsui (8.33%)
9	Qatar	Qatargas 2 T4	AP-X	2009	7.80	Qatargas* (0%); Qatar Energy (67.5%); ExxonMobil (24.15%); TotalEnergies (8.35%)
9	Qatar	Qatargas 2 T5	AP-X	2009	7.80	Qatargas* (0%); Qatar Energy (67.5%); ExxonMobil (24.15%); TotalEnergies (8.35%)
9	Qatar	Rasgas 3 T6	AP-X	2009	7.80	Qatargas* (0%); Qatar Energy (70%); ExxonMobil (30%)
9	Qatar	Rasgas 3 T7	AP-X	2009	7.80	Qatargas* (0%); Qatar Energy (70%); ExxonMobil (30%)
18	Yemen	Yemen LNG (T1+T2)	AP-C3MR/ SplitMR	2009	6.70	TotalEnergies* (39.62%); Yemen General Oil and Gas (21.73%); Hunt Oil (17.22%); Korea Gas (8.88%); SK Innovation (8.49%); Hyundai (3%); KNOC (S.Korea) (1.06%)

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
19	Indonesia	Tangguh LNG T1	AP-C3MR/ SplitMR	2009	3.80	BP* (40.22%); CNOOC (13.9%); JOGMEC (11.07%); Mitsubishi Corp (9.92%); Inpex (7.79%); JX Nippon Oil and Gas (7.46%); Sojitz (3.67%); Sumitomo (3.67%); Mitsui (2.3%)
19	Indonesia	Tangguh LNG T2	AP-C3MR/ SplitMR	2009	3.80	BP* (40.22%); CNOOC (13.9%); JOGMEC (11.07%); Mitsubishi Corp (9.92%); Inpex (7.79%); JX Nippon Oil and Gas (7.46%); Sojitz (3.67%); Sumitomo (3.67%); Mitsui (2.3%)
20	Russia	Sakhalin 2 T1	Shell DMR	2009	4.80	Sakhalin Energy Investment Company* (0%); Gazprom (50%); Shell (27.5%); Mitsui (12.5%); Mitsubishi Corp (10%)
20	Russia	Sakhalin 2 T2	Shell DMR	2009	4.80	Sakhalin Energy Investment Company* (0%); Gazprom (50%); Shell (27.5%); Mitsui (12.5%); Mitsubishi Corp (10%)
9	Qatar	Qatargas 3 T6	AP-X	2010	7.80	Qatargas* (0%); Qatar Energy (68.5%); ConocoPhillips (30%); Mitsui (1.5%)
21	Peru	Peru LNG T1	AP-C3MR/ SplitMR	2010	4.45	Hunt Oil* (50%); Shell (20%); SK Innovation (20%); Marubeni (10%)
9	Qatar	Qatargas 4 T7	AP-X	2011	7.80	Qatargas* (0%); Qatar Energy (70%); Shell (30%)
22	Australia	Pluto LNG T1	Shell Propane Precooled Mixed Refrig-erant	2012	4.90	Woodside* (90%); Kansai Electric (5%); Tokyo Gas (5%)
23	Angola	Angola LNG T1	ConocoPhil-lips Optimized Cascade	2013	5.20	Angola LNG* (0%); Chevron (36.4%); Sonangol (22.8%); BP (13.6%); Eni (13.6%); TotalEnergies (13.6%)
24	Algeria	Skikda GL1K T1 (rebuild)	AP-C3MR/ SplitMR	2013	4.50	Sonatrach* (100%)
25	Papua New Guinea	PNG LNG T1	AP-C3MR	2014	3.45	ExxonMobil* (33.2%); Santos (42.5%); Kumul Petroleum Holdings Limited (16.8%); JX Nippon Oil and Gas (3.72%); Mineral Resources Development (2.8%); Marubeni (0.98%)
25	Papua New Guinea	PNG LNG T2	AP-C3MR	2014	3.45	ExxonMobil* (33.2%); Santos (42.5%); Kumul Petroleum Holdings Limited (16.8%); JX Nippon Oil and Gas (3.72%); Mineral Resources Development (2.8%); Marubeni (0.98%)
26	Algeria	Arzew GL3Z (Gas-si Touil) T1	AP-C3MR/ SplitMR	2014	4.70	Sonatrach* (100%)
27	Indonesia	Donggi-Senoro LNG T1	AP-C3MR	2015	2.00	Donggi-Senoro LNG (DSLNG)* (0%); Mitsubishi Corp (44.92%); Pertamina (29%); Korea Gas (14.98%); MedcoEnergi (11.1%)
28	Australia	GLNG T1	ConocoPhil-lips Optimized Cascade	2015	3.90	Santos* (30%); Petronas (27.5%); TotalEnergies (27.5%); Korea Gas (15%)
29	Australia	Queensland Curtis LNG T1	ConocoPhil-lips Optimized Cascade	2015	4.25	Shell* (50%); CNOOC (50%)

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
29	Australia	Queensland Curtis LNG T2	ConocoPhil-lips Optimized Cascade	2015	4.25	Shell* (97.5%); Tokyo Gas (2.5%)
28	Australia	GLNG T2	ConocoPhil-lips Optimized Cascade	2016	3.90	Santos* (30%); Petronas (27.5%); TotalEnergies (27.5%); Korea Gas (15%)
30	Australia	Gorgon LNG T1	AP-C3MR/ SplitMR	2016	5.20	Chevron* (47.33%); ExxonMobil (25%); Shell (25%); Osaka Gas (1.25%); Tokyo Gas (1%); JERA (0.42%)
30	Australia	Gorgon LNG T2	AP-C3MR/ SplitMR	2016	5.20	Chevron* (47.33%); ExxonMobil (25%); Shell (25%); Osaka Gas (1.25%); Tokyo Gas (1%); JERA (0.42%)
30	Australia	Gorgon LNG T3	AP-C3MR/ SplitMR	2016	5.20	Chevron* (47.33%); ExxonMobil (25%); Shell (25%); Osaka Gas (1.25%); Tokyo Gas (1%); JERA (0.42%)
31	Australia	Australia Pacific LNG T1	ConocoPhil-lips Optimized Cascade	2016	4.50	Origin Energy* (27.5%); ConocoPhillips (47.5%); Sinopec Group (parent) (25%)
31	Australia	Australia Pacific LNG T2	ConocoPhil-lips Optimized Cascade	2016	4.50	Origin Energy* (27.5%); ConocoPhillips (47.5%); Sinopec Group (parent) (25%)
32	United States	Sabine Pass T1-T2	ConocoPhil-lips Optimized Cascade	2016	9.00	Cheniere Energy* (100%)
6	Malaysia	MLNG T9	AP-C3MR/ SplitMR	2017	3.60	Petronas* (80%); JX Nippon Oil and Gas (10%); Sarawak State (10%)
32	United States	Sabine Pass T3-T4	ConocoPhil-lips Optimized Cascade	2017	9.00	Cheniere Energy* (100%)
33	Malaysia	Petronas FLNG Satu (PFLNG1)	AP-N	2017	1.20	Petronas* (100%)
34	Australia	Wheatstone LNG T1	ConocoPhil-lips Optimized Cascade	2017	4.45	Chevron* (64.14%); Kuwait Petroleum Corp (KPC) (13.4%); Woodside (13%); JOGMEC (3.36%); Mitsubishi Corp (3.18%); Kyushu Electric (1.46%); Nippon Yusen Kabushiki Kaisha (NYK Line) (0.82%); JERA (0.64%)
34	Australia	Wheatstone LNG T2	ConocoPhil-lips Optimized Cascade	2017	4.45	Chevron* (64.14%); Kuwait Petro-leum Corp (KPC) (13.4%); Woodside (13%); JOGMEC (3.36%); Mitsubi-shi Corp (3.18%); Kyushu Electric (1.46%); Nippon Yusen Kabushiki Kaisha (NYK Line) (0.82%); JERA (0.64%)
35	Russia	Yamal LNG T1	AP-C3MR	2017	5.50	OOO Yamal LNG* (0%); Novatek (50.1%); CNPC (parent) (20%); TotalEnergies (20%); Silk Road Fund (9.9%)
35	Russia	Yamal LNG T2	AP-C3MR	2018	5.50	OOO Yamal LNG* (0%); Novatek (50.1%); CNPC (parent) (20%); TotalEnergies (20%); Silk Road Fund (9.9%)
35	Russia	Yamal LNG T3	AP-C3MR	2018	5.50	OOO Yamal LNG* (0%); Novatek (50.1%); CNPC (parent) (20%); TotalEnergies (20%); Silk Road Fund (9.9%)

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
36	Australia	Ichthys LNG T1	AP-C3MR/ SplitMR	2018	4.45	Inpex* (66.25%); TotalEnergies (26%); CPC (Chinese Taipei) (2.63%); Tokyo Gas (1.58%); Kansai Electric (1.2%); Osaka Gas (1.2%); JERA (0.73%); Toho Gas (0.41%)
36	Australia	Ichthys LNG T2	AP-C3MR/ SplitMR	2018	4.45	Inpex* (66.25%); TotalEnergies (26%); CPC (Chinese Taipei) (2.63%); Tokyo Gas (1.58%); Kansai Electric (1.2%); Osaka Gas (1.2%); JERA (0.73%); Toho Gas (0.41%)
37	United States	Cove Point LNG T1	AP-C3MR	2018	5.25	Berkshire Hathaway Energy* (25%); Dominion Cove Point LNG LP (50%); Brookfield Asset Management (25%)
38	Cameroon	Cameroon FLNG	Black and Veatch PRICO	2018	2.40	Perenco* (75%); SNH (Cameroon) (25%)
32	United States	Sabine Pass T5	ConocoPhillips Optimized Cascade	2019	5.00	Cheniere Energy* (100%)
39	Australia	Prelude FLNG	Shell DMR	2019	3.60	Shell* (67.5%); Inpex (17.5%); Korea Gas (10%); CPC (Chinese Taipei) (5%)
40	United States	Cameron LNG T1	AP-C3MR/ SplitMR	2019	4.50	Cameron LNG* (0%); Sempra (50.2%); Mitsui (16.6%); TotalEnergies (16.6%); Mitsubishi Corp (11.62%); Nippon Yusen Kabushiki Kaisha (NYK Line) (4.98%)
41	United States	Elba Island T1	Shell MMLS	2019	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T2	Shell MMLS	2019	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T3	Shell MMLS	2019	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T4	Shell MMLS	2019	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
42	Russia	Vysotsk LNG T1	Air Liquide Smartfin	2019	0.66	Novatek* (51%); Gazprom (49%)
43	United States	Corpus Christi T1	ConocoPhillips Optimized Cascade	2019	4.52	Cheniere Energy* (100%)
43	United States	Corpus Christi T2	ConocoPhillips Optimized Cascade	2019	4.52	Cheniere Energy* (100%)
44	United States	Freeport LNG T1	AP-C3MR	2019	5.10	Freeport LNG* (50%); JERA (25%); Osaka Gas (25%)
40	United States	Cameron LNG T2	AP-C3MR/ SplitMR	2020	4.50	Cameron LNG* (0%); Sempra (50.2%); Mitsui (16.6%); TotalEnergies (16.6%); Mitsubishi Corp (11.62%); Nippon Yusen Kabushiki Kaisha (NYK Line) (4.98%)
40	United States	Cameron LNG T3	AP-C3MR/ SplitMR	2020	4.50	Cameron LNG* (0%); Sempra (50.2%); Mitsui (16.6%); TotalEnergies (16.6%); Mitsubishi Corp (11.62%); Nippon Yusen Kabushiki Kaisha (NYK Line) (4.98%)

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
41	United States	Elba Island T10	Shell MMLS	2020	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T5	Shell MMLS	2020	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T6	Shell MMLS	2020	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T7	Shell MMLS	2020	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T8	Shell MMLS	2020	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
41	United States	Elba Island T9	Shell MMLS	2020	0.25	Southern LNG* (0%); Kinder Morgan (51%); EIG Partners (49%)
44	United States	Freeport LNG T2	AP-C3MR	2020	5.10	Freeport LNG* (57.5%); Global Infrastructure Partners (GIP) (25%); Osaka Gas (10%); Dow Chemical Company (7.5%)
44	United States	Freeport LNG T3	AP-C3MR	2020	5.10	Freeport LNG* (57.5%); Global Infrastructure Partners (GIP) (25%); Osaka Gas (10%); Dow Chemical Company (7.5%)
35	Russia	Yamal LNG T4	Novatek Arctic Cascade	2021	0.90	OOO Yamal LNG* (0%); Novatek (50.1%); CNPC (parent) (20%); TotalEnergies (20%); Silk Road Fund (9.9%)
43	United States	Corpus Christi T3	ConocoPhillips Optimized Cascade	2021	4.52	Cheniere Energy* (100%)
45	Malaysia	Petronas FLNG Rotan (PFLNG2)	AP-N	2021	1.50	Petronas* (100%)
32	United States	Sabine Pass T6	ConocoPhillips Optimized Cascade	2022	5.00	Cheniere Energy* (100%)
46	Mozambique	Coral South FLNG	AP-DMR	2022	3.40	Eni* (25%); ExxonMobil (25%); CNPC (parent) (20%); ENH (Mozambique) (10%); Galp Energia SA (10%); Korea Gas (10%)
47	United States	Calcasieu Pass LNG T1	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T10	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T11	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T12	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T13	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T14	BHGE SMR	2022	0.56	Venture Global LNG* (100%)

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
47	United States	Calcasieu Pass LNG T15	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T16	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T17	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T18	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T2	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T3	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T4	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T5	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T6	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T7	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T8	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
47	United States	Calcasieu Pass LNG T9	BHGE SMR	2022	0.56	Venture Global LNG* (100%)
48	Russia	Portovaya LNG T1	Linde LIMUM	2022	1.50	Gazprom* (100%)

Note:
1. In the ownership column, companies with "*" refer to plant operators. If a company doesn't have any ownership stake in the LNG plant, it will be marked with "(0%)".
2. Marsa El Bregas LNG in Libya has not been operational since 2011. It is included for reference only.
3. Yemen LNG has not exported since 2015 due to an ongoing civil war.

Appendix 2: Table of Liquefaction Plants Sanctioned or Under Construction

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
19	Indonesia	Tangguh LNG T3	AP-C3MR/ SplitMR	2023	3.80	BP* (40.22%); CNOOC (13.9%); JOGMEC (11.07%); Mitsubishi Corp (9.92%); Inpex (7.79%); JX Nippon Oil and Gas (7.46%); Sojitz (3.67%); Sumitomo (3.67%); Mitsui (2.3%)
49	Congo	Tango FLNG	Black and Veatch PRICO	2023	0.60	Eni* (100%)
50	Mexico	Altamira FLNG 1	Fast LNG	2023	1.40	New Fortress Energy*(100%)
11	Nigeria	NLNG T7	AP-C3MR	2024	8.00	NNPC (Nigeria)* (49%); Shell (25.6%); TotalEnergies (15%); Eni (10.4%)
50	Mexico	Altamira FLNG 2	Fast LNG	2024	1.40	New Fortress Energy*(100%)
51	United States	Golden Pass LNG T1	AP-C3MR/ SplitMR	2024	5.20	Golden Pass Products* (0%); Qatar Energy (70%); ExxonMobil (30%)
51	United States	Golden Pass LNG T2	AP-C3MR/ SplitMR	2024	5.20	Golden Pass Products* (0%); Qatar Energy (70%); ExxonMobil (30%)
52	Mauritania	Tortue/Ahmeyim FLNG T1	Black and Veatch PRICO	2024	2.50	BP* (56.29%); Kosmos Energy (26.71%); Petrosen (10%); Societe Mauritanienne des Hydrocarbures (7%)
53	United States	Plaquemines LNG T1	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T10	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T11	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T12	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T13	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T14	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T15	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T16	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T17	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T18	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T2	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T3	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T4	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T5	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T6	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T7	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T8	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T9	BHGE SCMR	2024	0.56	Venture Global LNG* (100%)

Appendix 2: Table of Liquefaction Plants Sanctioned or Under Construction (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
54	Russia	Arctic LNG 2 T1	Linde MFC	2024	6.60	OOO Arctic LNG-2* (0%); Novatek (60%); CNOOC (10%); CNPC (parent) (10%); TotalEnergies (10%); JOGMEC (7.5%); Mitsui (2.5%)
51	United States	Golden Pass LNG T3	AP-C3MR/ SplitMR	2025	5.20	Golden Pass Products* (0%); Qatar Energy (70%); ExxonMobil (30%)
55	Mexico	Energía Costa Azul LNG T1	AP-DMR	2025	3.25	Sempra* (83.4%); TotalEnergies (16.6%)
56	Canada	LNG Canada T1	Shell DMR	2025	7.00	Shell* (40%); Petronas (25%); Mitsubishi Corp (15%); PetroChina (15%); Korea Gas (5%)
56	Canada	LNG Canada T2	Shell DMR	2025	7.00	Shell* (40%); Petronas (25%); Mitsubishi Corp (15%); PetroChina (15%); Korea Gas (5%)
9	Qatar	QatarGas LNG T8	AP-X	2026	7.80	Qatargas* (0%); Qatar Energy (100%)
9	Qatar	QatarGas LNG T9	AP-X	2026	7.80	Qatargas* (0%); Qatar Energy (100%)
22	Australia	Pluto LNG T2 (expansion)	ConocoPhillips Optimized Cascade	2026	5.00	Woodside* (51%); Global Infrastructure Partners (GIP) (49%)
43	United States	Corpus Christi Stage 3 T1	ConocoPhillips Optimized Cascade	2026	1.42	Cheniere Energy* (100%)
43	United States	Corpus Christi Stage 3 T2	ConocoPhillips Optimized Cascade	2026	1.42	Cheniere Energy* (100%)
43	United States	Corpus Christi Stage 3 T3	ConocoPhillips Optimized Cascade	2026	1.42	Cheniere Energy* (100%)
43	United States	Corpus Christi Stage 3 T4	ConocoPhillips Optimized Cascade	2026	1.42	Cheniere Energy* (100%)
43	United States	Corpus Christi Stage 3 T5	ConocoPhillips Optimized Cascade	2026	1.42	Cheniere Energy* (100%)
43	United States	Corpus Christi Stage 3 T6	ConocoPhillips Optimized Cascade	2026	1.42	Cheniere Energy* (100%)
43	United States	Corpus Christi Stage 3 T7	ConocoPhillips Optimized Cascade	2026	1.42	Cheniere Energy* (100%)
53	United States	Plaquemines LNG T19	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T20	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T21	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T22	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T23	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T24	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T25	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)

Appendix 2: Table of Liquefaction Plants Sanctioned or Under Construction (continued)

Reference number	Market	Liquefaction Plant Train	Liquefaction technology	Infrastructure start year	Liquefaction capacity (MTPA)	Ownership
53	United States	Plaquemines LNG T26	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T27	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T28	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T29	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T30	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T31	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T32	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T33	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T34	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T35	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
53	United States	Plaquemines LNG T36	BHGE SCMR	2026	0.56	Venture Global LNG* (100%)
9	Qatar	QatarGas LNG T10	AP-X	2027	7.80	Qatargas* (0%); Qatar Energy (100%)
9	Qatar	QatarGas LNG T11	AP-X	2027	7.80	Qatargas* (0%); Qatar Energy (100%)
57	Congo	Eni Congo FLNG II		2027	2.40	Eni* (100%)
58	Mozambique	Mozambique LNG (Area 1) T1	AP-C3MR	2028	6.44	TotalEnergies* (26.5%); Mitsui (20%); ONGC (India) (16%); ENH (Mozambique) (15%); Bharat Petroleum Corp (BPCL) (10%); PTTEP (Thailand) (8.5%); Oil India (4%)
58	Mozambique	Mozambique LNG (Area 1) T2	AP-C3MR	2028	6.44	TotalEnergies* (26.5%); Mitsui (20%); ONGC (India) (16%); ENH (Mozambique) (15%); Bharat Petroleum Corp (BPCL) (10%); PTTEP (Thailand) (8.5%); Oil India (4%)
59	United States	Port Arthur LNG T1	C3MR	2028	6.75	Sempra* (100%)
59	United States	Port Arthur LNG T2	C3MR	2028	6.75	Sempra* (100%)

Note:
1. In the ownership column, companies with "*" refer to plant operators. If a company doesn't have any ownership stake in the LNG plant, it will be marked with "(0%)".
2. Sengkang LNG T1 is not included in the table as construction progress has been stalled.

Appendix 3: Table of global active LNG fleet as of end-of-April 2023

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9443401	Aamira	Nakilat	Samsung	266000	Membrane	Q-Max	SSDR	2010
9210828	Abadi	Brunei Gas Carriers	Mitsubishi	137000	Spherical	Conventional	Steam	2002
9501186	Adam LNG	OSC	Hyundai	162000	Membrane	Conventional	DFDE	2014
9879698	Adamastos	Capital Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9831220	Adriano Knutsen	Knutsen OAS	Hyundai	180000	Membrane	Conventional	ME-GI	2019
9338266	Al Aamriya	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Daewoo	216200	Membrane	Q-Flex	SSDR	2008
9325697	Al Areesh	Seapeak	Daewoo	151700	Membrane	Conventional	Steam	2007
9431147	Al Bahiya	Nakilat	Daewoo	210100	Membrane	Q-Flex	SSDR	2010
9132741	Al Bidda	J4 Consortium	Kawasaki	137300	Spherical	Conventional	Steam	1999
9325702	Al Daayen	Seapeak	Daewoo	151700	Membrane	Conventional	Steam	2007
9443683	Al Dafna	Nakilat	Samsung	266400	Membrane	Q-Max	SSDR	2009
9307176	Al Deebel	MOL, NYK, K Line	Samsung	145700	Membrane	Conventional	Steam	2005
9337705	Al Gattara	Nakilat, OSC	Hyundai	216200	Membrane	Q-Flex	SSDR	2007
9337987	Al Ghariya	Commerz Real, Nakilat, PRONAV	Daewoo	210200	Membrane	Q-Flex	SSDR	2008
9337717	Al Gharrafa	Nakilat, OSC	Hyundai	216200	Membrane	Q-Flex	SSDR	2008
9397286	Al Ghashamiya	Nakilat	Samsung	217600	Membrane	Q-Flex	SSDR	2009
9372743	Al Ghuwairiya	Nakilat	Daewoo	263300	Membrane	Q-Max	SSDR	2008
9337743	Al Hamla	Nakilat, OSC	Samsung	216200	Membrane	Q-Flex	SSDR	2008
9074640	Al Hamra	National Gas Shipping Co	Kvaerner Masa	135000	Spherical	Conventional	Steam	1997
9360879	Al Huwaila	Nakilat, Seapeak	Samsung	217000	Membrane	Q-Flex	SSDR	2008
9132791	Al Jasra	J4 Consortium	Mitsubishi	137200	Spherical	Conventional	Steam	2000
9324435	Al Jassasiya	Maran Gas Maritime, Nakilat	Daewoo	145700	Membrane	Conventional	Steam	2007
9431123	Al Karaana	Nakilat	Daewoo	210100	Membrane	Q-Flex	SSDR	2009
9397327	Al Kharaitiyat	Nakilat	Hyundai	216300	Membrane	Q-Flex	SSDR	2009
9360881	Al Kharsaah	Nakilat, Seapeak	Samsung	217000	Membrane	Q-Flex	SSDR	2008
9431111	Al Khattiya	Nakilat	Daewoo	210200	Membrane	Q-Flex	SSDR	2009
9038440	Al Khaznah	National Gas Shipping Co	Mitsui	135000	Spherical	Conventional	Steam	1994
9085613	Al Khor	J4 Consortium	Mitsubishi	137400	Spherical	Conventional	Steam	1996
9360908	Al Khuwair	Nakilat, Seapeak	Samsung	217000	Membrane	Q-Flex	SSDR	2008
9397315	Al Mafyar	Nakilat	Samsung	266400	Membrane	Q-Max	SSDR	2009
9325685	Al Marrouna	Nakilat, Seapeak	Daewoo	152600	Membrane	Conventional	Steam	2006
9397298	Al Mayeda	Nakilat	Samsung	266000	Membrane	Q-Max	SSDR	2009
9431135	Al Nuaman	Nakilat	Daewoo	210100	Membrane	Q-Flex	SSDR	2009
9360790	Al Oraiq	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Daewoo	210200	Membrane	Q-Flex	SSDR	2008
9086734	Al Rayyan	J4 Consortium	Kawasaki	137400	Spherical	Conventional	Steam	1997
9397339	Al Rekayyat	Nakilat	Hyundai	216300	Membrane	Q-Flex	SSDR	2009
9337951	Al Ruwais	Commerz Real, Nakilat, PRONAV	Daewoo	210200	Membrane	Q-Flex	SSDR	2007
9397341	Al Sadd	Nakilat	Daewoo	210200	Membrane	Q-Flex	SSDR	2009

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9337963	Al Safliya	Commerz Real, Nakilat, PRONAV	Daewoo	210200	Membrane	Q-Flex	SSDR	2007
9360855	Al Sahla	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Hyundai	216200	Membrane	Q-Flex	SSDR	2008
9388821	Al Samriya	Nakilat	Daewoo	263300	Membrane	Q-Max	SSDR	2009
9360893	Al Shamal	Nakilat, Seapeak	Samsung	217000	Membrane	Q-Flex	SSDR	2008
9360831	Al Sheehaniya	Nakilat	Daewoo	210200	Membrane	Q-Flex	SSDR	2009
9298399	Al Thakhira	K Line, Qatar Shpg.	Samsung	145700	Membrane	Conventional	Steam	2005
9360843	Al Thumama	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Hyundai	216200	Membrane	Q-Flex	SSDR	2008
9360867	Al Utouriya	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Hyundai	215000	Membrane	Q-Flex	SSDR	2008
9085625	Al Wajbah	J4 Consortium	Mitsubishi	137300	Spherical	Conventional	Steam	1997
9086746	Al Wakrah	J4 Consortium	Kawasaki	137600	Spherical	Conventional	Steam	1998
9085649	Al Zubarah	J4 Consortium	Mitsui	137600	Spherical	Conventional	Steam	1996
9343106	Alto Acrux	TEPCO, NYK, Mitsubishi	Mitsubishi	147800	Spherical	Conventional	Steam	2008
9682552	Amadi	Brunei Gas Carriers	Hyundai	154800	Membrane	Conventional	TFDE	2015
9496317	Amali	Brunei Gas Carriers	Daewoo	147000	Membrane	Conventional	TFDE	2011
9661869	Amani	Brunei Gas Carriers	Hyundai	154800	Membrane	Conventional	TFDE	2014
9845776	Amberjack LNG	TMS Cardiff Gas	Hyundai	174000	Membrane	Conventional	X-DF	2020
9317999	Amur River	Dynagas	Hyundai	149700	Membrane	Conventional	Steam	2008
9645970	Arctic Aurora	Dynagas	Hyundai	155000	Membrane	Conventional	TFDE	2013
9276389	Arctic Discoverer	K Line, Equinor, Mitsui, Iino	Mitsui	142600	Spherical	Conventional	Steam	2006
9284192	Arctic Lady	Hoegh	Mitsubishi	148000	Spherical	Conventional	Steam	2006
9915911	Kun Lun	COSCO	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2023
9918145	El Ferrol Knutsen	Knutsen OAS	Hyundai	174000	Membrane	Conventional	X-DF	2023
9918157	Extremadura Knutsen	Knutsen OAS	Hyundai	174000	Membrane	Conventional	X-DF	2023
9271248	Arctic Princess	Hoegh, MOL, Equinor	Mitsubishi	148000	Spherical	Conventional	Steam	2006
9275335	Arctic Voyager	K Line, Equinor, Mitsui, Iino	Kawasaki	142800	Spherical	Conventional	Steam	2006
9862918	Aristarchos	Capital Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9862906	Aristidis I	Capital Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9862891	Aristos I	Capital Gas	Hyundai	174000	Membrane	Conventional	X-DF	2020
9496305	Arkat	Brunei Gas Carriers	Daewoo	147000	Membrane	Conventional	TFDE	2011
8125868	Armada LNG Mediterrana	Bumi Armada Berhad	Mitsui	127209	Spherical	FSU	Steam	1985
9339260	Seapeak Arwa	Seapeak, Marubeni	Samsung	168900	Membrane	Conventional	DFDE	2008
9377547	Aseem	MOL, NYK, K Line, SCI, Nakilat, Petronet	Samsung	155000	Membrane	Conventional	DFDE	2009

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9610779	Asia Endeavour	Chevron	Samsung	160000	Membrane	Conventional	DFDE	2015
9606950	Asia Energy	Chevron	Samsung	160000	Membrane	Conventional	DFDE	2014
9610767	Asia Excellence	Chevron	Samsung	160000	Membrane	Conventional	DFDE	2015
9680188	Asia Integrity	Chevron	Samsung	160000	Membrane	Conventional	DFDE	2017
9680190	Asia Venture	Chevron	Samsung	160000	Membrane	Conventional	TFDE	2017
9606948	Asia Vision	Chevron	Samsung	160000	Membrane	Conventional	TFDE	2014
9884021	Asklipios	Capital Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9892298	Asterix I	Capital Gas	Hyundai	174000	Membrane	Conventional	X-DF	2023
9862920	Attalos	Capital Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9771080	Seapeak Bahrain	Seapeak	Daewoo	173400	Membrane	FSU	ME-GI	2018
9401295	Barcelona Knutsen	Knutsen OAS	Daewoo	173400	Membrane	Conventional	TFDE	2009
9613159	Beidou Star	MOL, China LNG	Hudong-Zhonghua	171800	Membrane	Conventional	SSDR	2015
9256597	Berge Arzew	BW	Daewoo	138000	Membrane	Conventional	Steam	2004
9236432	Bilbao Knutsen	Knutsen OAS	IZAR	138000	Membrane	Conventional	Steam	2004
9691137	Bishu Maru	Trans Pacific Shipping	Kawasaki	164700	Spherical	Conventional	Steam reheat	2017
9845788	Bonito LNG	TMS Cardiff Gas	Hyundai	174000	Membrane	Conventional	X-DF	2020
9768394	Boris Davydov	Sovcomflot	Daewoo	172000	Membrane	Icebreaker	TFDE	2018
9768368	Boris Vilkitsky	Sovcomflot	Daewoo	172000	Membrane	Icebreaker	TFDE	2017
9766542	British Achiever	BP	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9766554	British Contributor	BP	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9333620	British Diamond	BP	Hyundai	155000	Membrane	Conventional	DFDE	2008
9333591	British Emerald	BP	Hyundai	155000	Membrane	Conventional	DFDE	2007
9766566	British Listener	BP	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9766578	British Mentor	BP	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9766530	British Partner	BP	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9333606	British Ruby	BP	Hyundai	155000	Membrane	Conventional	DFDE	2008
9333618	British Sapphire	BP	Hyundai	155000	Membrane	Conventional	DFDE	2008
9766580	British Sponsor	BP	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9085651	Broog	J4 Consortium	Mitsui	137500	Spherical	Conventional	Steam	1998
9388833	Bu Samra	Nakilat	Samsung	266000	Membrane	Q-Max	SSDR	2008
9796793	Bushu Maru	NYK, JERA	Mitsubishi	180000	Spherical	Conventional	STaGE	2019
9230062	BW Boston	BW, Total	Daewoo	138000	Membrane	Conventional	Steam	2003
9368314	BW Brussels	BW	Daewoo	162500	Membrane	Conventional	DFDE	2009
9243148	BW Everett	BW	Daewoo	138000	Membrane	Conventional	Steam	2003
9873852	BW Helios	BW	Daewoo	174000	Membrane	Conventional	ME-GI	2021
9724946	BW Integrity	BW, MOL	Samsung	173400	Membrane	FSRU	TFDE	2017
9873840	BW Lesmes	BW	Daewoo	174000	Membrane	Conventional	ME-GI	2021
9758076	BW Lilac	BW	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9792591	BW Magna	BW	Daewoo	173400	Membrane	FSRU	TFDE	2019
9850666	BW Magnolia	BW	Daewoo	173400	Membrane	Conventional	ME-GI	2020
9368302	BW Paris	BW	Daewoo	162400	Membrane	FSRU	TFDE	2009
9792606	BW Pavilion Aranda	BW, Pavilion LNG	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9850678	Bw Pavilion Aranthera	BW	Daewoo	170800	Membrane	Conventional	ME-GI	2020
9640645	BW Pavilion Leeara	BW, Pavilion LNG	Hyundai	162000	Membrane	Conventional	TFDE	2015
9640437	BW Pavilion Vanda	BW, Pavilion LNG	Hyundai	162000	Membrane	Conventional	TFDE	2015

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9684495	BW Singapore	BW	Samsung	170200	Membrane	FSRU	TFDE	2015
9236626	BW Tatiana (ex-Gallina)	Shell	Mitsubishi	136600	Spherical	FSRU	Steam	2002
9758064	BW Tulip	BW	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9246578	Cadiz Knutsen	Knutsen OAS	IZAR	138000	Membrane	Conventional	Steam	2004
9390680	Cape Ann	Hoegh, MOL, TLTC	Samsung	145000	Membrane	FSRU	DFDE	2010
9742819	Castillo De Caldelas	Elcano	Imabari	178800	Membrane	Conventional	ME-GI	2018
9742807	Castillo De Merida	Elcano	Imabari	178800	Membrane	Conventional	ME-GI	2018
9433717	Castillo De Santisteban	Elcano	STX	173600	Membrane	Conventional	TFDE	2010
9236418	Castillo De Villalba	Elcano	IZAR	138200	Membrane	Conventional	Steam	2003
9236420	Seapeak Catalunya	Seapeak	IZAR	138200	Membrane	Conventional	Steam	2003
9864796	Celsius Canberra	Celsius Shipping	Samsung	180000	Membrane	Conventional	X-DF	2021
9878711	Celsius Charlotte	Celsius Shipping	Samsung	180000	Membrane	Conventional	X-DF	2021
9864784	Celsius Copenhagen	Celsius Shipping	Samsung	180000	Membrane	Conventional	X-DF	2020
9672844	Cesi Beihai	China Shipping Group	Hudong-Zhonghua	174100	Membrane	Conventional	TFDE	2017
9672820	Cesi Gladstone	Chuo Kaiun/ Shinwa Chem.	Hudong-Zhonghua	174100	Membrane	Conventional	DFDE	2016
9672818	Cesi Lianyungang	China Shipping Group	Hudong-Zhonghua	174100	Membrane	Conventional	DFDE	2018
9672832	Cesi Qingdao	China Shipping Group	Hudong-Zhonghua	174100	Membrane	Conventional	DFDE	2017
9694749	Cesi Tianjin	China Shipping Group	Hudong-Zhonghua	174100	Membrane	Conventional	DFDE	2017
9694751	Cesi Wenzhou	China Shipping Group	Hudong-Zhonghua	174100	Membrane	Conventional	TFDE	2018
9324344	Cheikh Bouamama	HYPROC, Sonatrach, Itochu, MOL	Universal	75500	Membrane	Conventional	Steam	2008
9324332	Cheikh El Mokrani	HYPROC, Sonatrach, Itochu, MOL	Universal	75500	Membrane	Conventional	Steam	2007
9737187	Christophe De Margerie	Sovcomflot	Daewoo	172000	Membrane	Icebreaker	TFDE	2016
9886732	Clean Cajun	Dynagas	Hyundai	200000	Membrane	Conventional	X-DF	2022
9886744	Clean Copano	Dynagas	Hyundai	200000	Membrane	Conventional	X-DF	2022
9323687	Clean Energy	Dynagas	Hyundai	149700	Membrane	Conventional	Steam	2007
9655444	Clean Horizon	Dynagas	Hyundai	162000	Membrane	Conventional	TFDE	2015
9637492	Clean Ocean	Dynagas	Hyundai	162000	Membrane	Conventional	TFDE	2014
9637507	Clean Planet	Dynagas	Hyundai	162000	Membrane	Conventional	TFDE	2014
9655456	Clean Vision	Dynagas	Hyundai	162000	Membrane	Conventional	TFDE	2016
9540089	Energy Fidelity (ex-Jules Verne)	Alpha Gas	Hyundai	174000	Membrane	Conventional	X-DF	2023
9869306	Cobia LNG	TMS Cardiff Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9861031	Cool Discoverer	Thenamaris	Hyundai	174000	Membrane	Conventional	X-DF	2020
9640023	Cool Explorer	Thenamaris	Samsung	160000	Membrane	Conventional	TFDE	2015
9869265	Cool Racer	Thenamaris	Hyundai	174000	Membrane	Conventional	ME-GI	2021
9636797	Cool Runner	Thenamaris	Samsung	160000	Membrane	Conventional	TFDE	2014
9636785	Cool Voyager	Thenamaris	Samsung	160000	Membrane	Conventional	TFDE	2013

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9693719	Coral Encanto	Anthony Veder	Ningbo Xinle Shipbuilding Co Ltd	30000	Type C	Small-scale	DFDE	2020
9636711	Corcovado LNG	TMS Cardiff Gas	Daewoo	160100	Membrane	Conventional	TFDE	2014
9681687	Creole Spirit	Seapeak	Daewoo	173400	Membrane	Conventional	ME-GI	2016
9491812	Cubal	Mitsui, NYK, Seapeak	Samsung	160000	Membrane	Conventional	TFDE	2012
9376294	Cygnus Passage	TEPCO, NYK, Mitsubishi	Mitsubishi	147000	Spherical	Conventional	Steam	2009
9883742	Maran Gas Kalymnos	Maran Gas Maritime	Daewoo	174000	Membrane	Conventional	X-DF	2021
9887217	Maran Gas Amorgos	Maran Gas Maritime	Daewoo	174000	Membrane	Conventional	X-DF	2021
9896921	BW ENN Snow Lotus	BW	Daewoo	174000	Membrane	Conventional	ME-GI	2022
9896933	BW Cassia	BW	Daewoo	174000	Membrane	Conventional	ME-GI	2022
9308481	Dapeng Moon	China LNG Ship Mgmt	Hudong-Zhonghua	147200	Membrane	Conventional	Steam	2008
9369473	Dapeng Star	China LNG Ship Mgmt	Hudong-Zhonghua	147600	Membrane	Conventional	Steam	2009
9308479	Dapeng Sun	China LNG Ship Mgmt	Hudong-Zhonghua	147200	Membrane	Conventional	Steam	2008
9874454	Diamond Gas Crystal	NYK Line	Hyundai	174000	Membrane	Conventional	X-DF	2021
9862487	Diamond Gas Metropolis	NYK Line	Hyundai	174000	Membrane	Conventional	X-DF	2020
9779226	Diamond Gas Orchid	NYK Line	Mitsubishi	165000	Spherical	Conventional	STaGE	2018
9779238	Diamond Gas Rose	NYK Line	Mitsubishi	165000	Spherical	Conventional	STaGE	2018
9810020	Diamond Gas Sakura	NYK Line	Mitsubishi	165000	Spherical	Conventional	STaGE	2019
9874466	Diamond Gas Victoria	NYK Line	Hyundai	174000	Membrane	Conventional	X-DF	2021
9250713	Disha	MOL, NYK, K Line, SCI, Nakilat, Petronet	Daewoo	138100	Membrane	Conventional	Steam	2004
9085637	Doha	J4 Consortium	Mitsubishi	137300	Spherical	Conventional	Steam	1999
9863182	Dorado LNG	TMS Cardiff Gas	Samsung	174000	Membrane	Conventional	X-DF	2020
9337975	Duhail	Commerz Real, Nakilat, PRONAV	Daewoo	210200	Membrane	Q-Flex	SSDR	2008
9265500	Dukhan	J4 Consortium	Mitsui	137500	Spherical	Conventional	Steam	2004
9750696	Eduard Toll	Seapeak	Daewoo	172000	Membrane	Icebreaker	TFDE	2017
9334076	Ejnan	K Line, MOL, NYK, Mitsui, Nakilat	Samsung	145000	Membrane	Conventional	Steam	2007
8706155	Ekaputra 1	P.T. Humpuss Trans	Mitsubishi	137000	Spherical	Conventional	Steam	1990
9884473	Elisa Aquila	NYK Line	Hyundai	174000	Membrane	Conventional	X-DF	2022
9852975	Elisa Larus	GazOcean	Hyundai	174000	Membrane	Conventional	X-DF	2020
9269180	Energy Advance	Tokyo Gas	Kawasaki	147000	Spherical	Conventional	Steam	2005
9649328	Energy Atlantic	Alpha Gas	STX	159700	Membrane	Conventional	TFDE	2015
9405588	Energy Confidence	NYK, Tokyo Gas	Kawasaki	155000	Spherical	Conventional	Steam	2009
9854624	Energy Endeavour	Alpha Gas	Daewoo	173400	Membrane	Conventional	ME-GI	2021

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9245720	Energy Frontier	Tokyo Gas	Kawasaki	147000	Spherical	Conventional	Steam	2003
9752565	Energy Glory	NYK, Tokyo Gas	Japan Marine	165000	Self-Supporting Prismatic	Conventional	TFDE	2019
9483877	Energy Horizon	NYK, TLTC	Kawasaki	177000	Spherical	Conventional	Steam	2011
9758832	Energy Innovator	MOL, Tokyo Gas	Japan Marine	165000	Self-Supporting Prismatic	Conventional	TFDE	2019
9859739	Energy Integrity	Alpha Gas	Daewoo	173400	Membrane	Conventional	ME-GI	2021
9881201	Energy Intelligence	Alpha Gas	Daewoo	173400	Membrane	Conventional	ME-GI	2021
9736092	Energy Liberty	MOL, Tokyo Gas	Japan Marine	165000	Self-Supporting Prismatic	Conventional	TFDE	2018
9355264	Energy Navigator	MOL, Tokyo Gas	Kawasaki	147000	Spherical	Conventional	Steam	2008
9854612	Energy Pacific	Alpha Gas	Daewoo	173400	Membrane	Conventional	ME-GI	2020
9274226	Energy Progress	MOL	Kawasaki	147000	Spherical	Conventional	Steam	2006
9758844	Energy Universe	MOL, Tokyo Gas	Japan Marine	165000	Self-Supporting Prismatic	Conventional	TFDE	2019
9749609	Enshu Maru	K Line	Kawasaki	164700	Spherical	Conventional	Steam reheat	2018
9859820	Ertugrul Gazi	Turkish Petroleum Corp	Hyundai	170000	Membrane	FSRU	DFDE	2021
9666560	Esshu Maru	MOL, Tokyo Gas	Mitsubishi	153000	Spherical	Conventional	Steam	2014
9230050	Excalibur	Exmar	Daewoo	138000	Membrane	Conventional	Steam	2002
9820843	Excelerate Sequoia	Maran Gas Maritime	Daewoo	173400	Membrane	FSRU	TFDE	2020
9252539	Excellence	Excelerate Energy	Daewoo	138000	Membrane	FSRU	Steam	2005
9239616	Excelsior	Excelerate Energy	Daewoo	138000	Membrane	FSRU	Steam	2005
9444649	Exemplar	Excelerate Energy	Daewoo	150900	Membrane	FSRU	Steam	2010
9389643	Expedient	Excelerate Energy	Daewoo	150900	Membrane	FSRU	Steam	2010
9638525	Experience	Excelerate Energy	Daewoo	173400	Membrane	FSRU	TFDE	2014
9361079	Explorer	Excelerate Energy	Daewoo	150900	Membrane	FSRU	Steam	2008
9361445	Express	Excelerate Energy	Daewoo	150900	Membrane	FSRU	Steam	2009
9381134	Exquisite	Excelerate Energy, Nakilat	Daewoo	150900	Membrane	FSRU	Steam	2009
9768370	Fedor Litke	LITKE	Daewoo	172000	Membrane	Icebreaker	TFDE	2017
9857377	Flex Amber	Flex LNG	Hyundai	174000	Membrane	Conventional	X-DF	2020
9851634	Flex Artemis	Flex LNG	Daewoo	173400	Membrane	Conventional	ME-GI	2020
9857365	Flex Aurora	Flex LNG	Hyundai	174000	Membrane	Conventional	X-DF	2020
9825427	Flex Constellation	Flex LNG	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9825439	Flex Courageous	Flex LNG	Daewoo	173400	Spherical	Conventional	ME-GI	2019
9762261	Flex Endeavour	Flex LNG	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9762273	Flex Enterprise	Flex LNG	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9862308	Flex Freedom	Flex LNG	Daewoo	173400	Membrane	Conventional	ME-GI	2021
9709037	Flex Rainbow	Flex LNG	Samsung	174000	Membrane	Conventional	ME-GI	2018
9709025	Flex Ranger	Flex LNG	Samsung	174000	Membrane	Conventional	ME-GI	2018

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9851646	Flex Resolute	Flex LNG	Daewoo	173400	Membrane	Conventional	ME-GI	2020
9862475	Flex Vigilant	Flex LNG	Hyundai	174000	Membrane	Conventional	X-DF	2021
9862463	Flex Volunteer	Flex LNG	Hyundai	174000	Membrane	Conventional	X-DF	2021
9360817	Fraiha	NYK, K Line, MOL, lino, Mitsui, Nakilat	Daewoo	210100	Membrane	Q-Flex	SSDR	2008
9253284	FSRU Toscana	OLT Offshore LNG Toscana	Hyundai	137100	Spherical	FSRU	Steam	2004
9275359	Fuji LNG	TMS Cardiff Gas	Kawasaki	147900	Spherical	Conventional	Steam	2004
9256200	Fuwairit	MOL	Samsung	138300	Membrane	Conventional	Steam	2004
9877145	Gail Bhuwan	MOL	Daewoo	176500	Membrane	Conventional	X-DF	2021
9247364	Galicia Spirit	Seapeak	Daewoo	140500	Membrane	Conventional	Steam	2004
9864928	Gaslog Galveston	GasLog	Samsung	174000	Membrane	Conventional	X-DF	2021
9707508	Gaslog Geneva	GasLog	Samsung	174000	Membrane	Conventional	TFDE	2016
9744013	Gaslog Genoa	GasLog	Samsung	174000	Membrane	Conventional	X-DF	2018
9864916	Gaslog Georgetown	GasLog	Samsung	174000	Membrane	Conventional	X-DF	2020
9707510	Gaslog Gibraltar	GasLog	Samsung	174000	Membrane	Conventional	TFDE	2016
9744025	Gaslog Gladstone	GasLog	Samsung	174000	Membrane	Conventional	X-DF	2019
9687021	Gaslog Glasgow	GasLog	Samsung	174000	Membrane	Conventional	TFDE	2016
9687019	Gaslog Greece	GasLog	Samsung	174000	Membrane	Conventional	TFDE	2016
9748904	Gaslog Hongkong	GasLog	Hyundai	174000	Membrane	Conventional	X-DF	2018
9748899	Gaslog Houston	GasLog	Hyundai	174000	Membrane	Conventional	X-DF	2018
9638915	Gaslog Salem	CDB Leasing	Samsung	155000	Membrane	Conventional	TFDE	2015
9600530	Gaslog Santiago	GasLog	Samsung	155000	Membrane	Conventional	TFDE	2013
9638903	Gaslog Saratoga	CDB Leasing	Samsung	155000	Membrane	Conventional	TFDE	2014
9352860	Gaslog Savannah	GasLog	Samsung	155000	Membrane	Conventional	TFDE	2010
9634086	Gaslog Seattle	GasLog	Samsung	155000	Membrane	Conventional	TFDE	2013
9600528	Gaslog Shanghai	CDB Leasing	Samsung	155000	Membrane	Conventional	TFDE	2013
9355604	Gaslog Singapore	GasLog	Samsung	155000	Membrane	FSU	TFDE	2010
9626285	Gaslog Skagen	CDB Leasing	Samsung	155000	Membrane	Conventional	TFDE	2013
9626273	Gaslog Sydney	CDB Leasing	Samsung	155000	Membrane	Conventional	TFDE	2013
9853137	Gaslog Wales	GasLog	Samsung	180000	Membrane	Conventional	X-DF	2020
9816763	Gaslog Warsaw	GasLog	Samsung	180000	Membrane	Conventional	X-DF	2019
9876660	Gaslog Wellington	GasLog	Samsung	180000	Membrane	Conventional	X-DF	2021
9855812	Gaslog Westminster	GasLog	Samsung	180000	Membrane	Conventional	X-DF	2020
9876737	Gaslog Winchester	GasLog	Samsung	180000	Membrane	Conventional	X-DF	2021
9819650	Gaslog Windsor	GasLog	Samsung	180000	Membrane	Conventional	X-DF	2020
9253222	Gemmata	Shell	Mitsubishi	135000	Spherical	Conventional	Steam	2004
9768382	Georgiy Brusilov	Dynagas	Daewoo	172600	Membrane	Icebreaker	TFDE	2018
9750749	Georgiy Ushakov	Seapeak, China LNG Shipping	Daewoo	172000	Membrane	Icebreaker	TFDE	2019
9038452	Ghasha	National Gas Shipping Co	Mitsui	135000	Spherical	Conventional	Steam	1995
9360922	Gigira Laitebo	MOL, Itochu	Hyundai	155000	Membrane	Conventional	TFDE	2010
9269207	Energy Spirit	Jovo Group	Chantiers de l'Atlantique	74500	Membrane	Conventional	Steam	2006
9845013	Global Energy	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2020
9880465	Global Sea Spirit	Maran Gas Maritime	Daewoo	174000	Membrane	Conventional	X-DF	2021

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9880477	Global Sealine	Maran Gas Maritime	Daewoo	174000	Membrane	Conventional	X-DF	2022
9859741	Global Star	Maran Gas Maritime, Nakilat	Daewoo	173400	Membrane	Conventional	ME-GI	2021
9626039	Golar Bear	CoolCo	Samsung	160000	Membrane	Conventional	TFDE	2014
9626027	Golar Celsius	New Fortress Energy	Samsung	160000	Membrane	Conventional	TFDE	2013
9624926	Golar Crystal	CoolCo	Samsung	160000	Membrane	Conventional	TFDE	2014
9624940	Golar Eskimo	New Fortress Energy	Samsung	160000	Membrane	FSRU	TFDE	2014
7361922	Golar Freeze	New Fortress Energy	HDW	125000	Spherical	FSRU	Steam	1977
9655042	Golar Frost	CoolCo	Samsung	160000	Membrane	Conventional	TFDE	2014
9654696	Golar Glacier	CoolCo	Hyundai	162000	Membrane	Conventional	TFDE	2014
9303560	Golar Grand	New Fortress Energy	Daewoo	145000	Membrane	Conventional	Steam	2005
9637325	Golar Ice	CoolCo	Samsung	160000	Membrane	Conventional	TFDE	2015
9633991	Golar Igloo	New Fortress Energy	Samsung	170000	Membrane	FSRU	TFDE	2014
9654701	Golar Kelvin	CoolCo	Hyundai	162000	Membrane	Conventional	TFDE	2015
9320374	Golar Maria	New Fortress Energy	Daewoo	145000	Membrane	Conventional	Steam	2006
9165011	Golar Mazo	New Fortress Energy	Mitsubishi	135000	Spherical	Conventional	Steam	2000
9785500	Golar Nanook	New Fortress Energy	Samsung	170000	Membrane	FSRU	DFDE	2018
9624938	Golar Penguin	New Fortress Energy	Samsung	160000	Membrane	Conventional	TFDE	2014
9624914	Golar Seal	Hoegh	Samsung	160000	Membrane	Conventional	TFDE	2013
9635315	Golar Snow	CoolCo	Samsung	160000	Membrane	Conventional	TFDE	2015
9655808	Golar Tundra	Snam	Samsung	170000	Membrane	FSRU	TFDE	2015
9256614	Golar Winter	New Fortress Energy	Daewoo	138000	Membrane	FSRU	Steam	2004
9315707	Grace Acacia	NYK Line	Hyundai	150000	Membrane	Conventional	Steam	2007
9315719	Grace Barleria	NYK Line	Hyundai	150000	Membrane	Conventional	Steam	2007
9323675	Grace Cosmos	MOL, NYK	Hyundai	150000	Membrane	Conventional	Steam	2008
9540716	Grace Dahlia	NYK Line	Kawasaki	177400	Spherical	Conventional	Steam	2013
9884174	Grace Emelia	NYK Line	Hyundai	174000	Membrane	Conventional	X-DF	2021
9903920	Grace Freesia	NYK Line	Hyundai	174000	Membrane	Conventional	X-DF	2022
9338955	Grand Aniva	NYK, Sovcomflot	Mitsubishi	147000	Spherical	Conventional	Steam	2008
9332054	Grand Elena	NYK, Sovcomflot	Mitsubishi	147000	Spherical	Conventional	Steam	2007
9338929	Grand Mereya	MOL, K Line, Primorsk	Mitsui	147600	Spherical	Conventional	Steam	2008
9878888	Gui Ying	CSSC Shpg Leasing	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2021
9696266	Hai Yang Shi You 301	CNOOC	Jiangnan	30000	Membrane	Bunkering vessel	DFDE	2015
9872999	Hellas Athina	Latsco (London)	Hyundai	174000	Membrane	Conventional	X-DF	2021
9872987	Hellas Diana	Latsco (London)	Hyundai	174000	Membrane	Conventional	X-DF	2021
9230048	Hispania Spirit	Seapeak	Daewoo	140500	Membrane	Conventional	Steam	2002

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9155078	HL Muscat	Hanjin Shipping Co.	Hanjin H.I.	138000	Membrane	Conventional	Steam	1999
9061928	HL Pyeongtaek	Hanjin Shipping Co.	Hanjin H.I.	130100	Membrane	Conventional	Steam	1995
9176008	HL Ras Laffan	Hanjin Shipping Co.	Hanjin H.I.	138000	Membrane	Conventional	Steam	2000
9176010	HL Sur	Hanjin Shipping Co.	Hanjin H.I.	138300	Membrane	Conventional	Steam	2000
9780354	Hoegh Esperanza	Hoegh	Hyundai	170000	Membrane	FSRU	DFDE	2018
9653678	Hoegh Gallant	Hoegh	Hyundai	170100	Membrane	FSRU	DFDE	2014
9820013	Hoegh Galleon	Hoegh	Samsung	170000	Membrane	FSRU	TFDE	2019
9822451	Hoegh Gannet	Hoegh	Hyundai	170000	Membrane	FSRU	DFDE	2018
9762962	Hoegh Giant	Hoegh	Hyundai	170000	Membrane	FSRU	DFDE	2017
9674907	Hoegh Grace	Hoegh	Hyundai	170000	Membrane	FSRU	DFDE	2016
9250725	Hongkong Energy	Sinokor Merchant Marine	Daewoo	140500	Membrane	Conventional	Steam	2004
9861811	Transgas Force	Dynagas	Hudong-Zhonghua	174000	Membrane	FSRU	DFDE	2021
9179581	Hyundai Aquapia	Hyundai LNG Shipping	Hyundai	135000	Spherical	Conventional	Steam	2000
9155157	Hyundai Cosmopia	Hyundai LNG Shipping	Hyundai	135000	Spherical	Conventional	Steam	2000
9372999	Hyundai Ecopia	Hyundai LNG Shipping	Hyundai	150000	Membrane	Conventional	Steam	2008
9075333	Hyundai Greenpia	Hyundai LNG Shipping	Hyundai	125000	Spherical	Conventional	Steam	1996
9892456	Tenergy	Tsakos	Hyundai	174000	Membrane	Conventional	X-DF	2022
9888481	Prism Courage	SK Shipping	Hyundai	174000	Membrane	Conventional	X-DF	2021
9183269	Hyundai Oceanpia	Hyundai LNG Shipping	Hyundai	135000	Spherical	Conventional	Steam	2000
9761853	Hyundai Peacepia	Hyundai LNG Shipping	Daewoo	174000	Membrane	Conventional	ME-GI	2017
9761841	Hyundai Princepia	Hyundai LNG Shipping	Daewoo	174000	Membrane	Conventional	ME-GI	2017
9904170	Santander Knutsen	Knutsen OAS	Hyundai	174000	Membrane	Conventional	X-DF	2022
9904182	Malaga Knutsen	Knutsen OAS	Hyundai	174000	Membrane	Conventional	X-DF	2022
9904194	Alicante Knutsen	Knutsen OAS	Hyundai	174000	Membrane	Conventional	X-DF	2022
9904209	Huelva Knutsen	Knutsen OAS	Hyundai	174000	Membrane	Conventional	X-DF	2022
9155145	Hyundai Technopia	Hyundai LNG Shipping	Hyundai	135000	Spherical	Conventional	Steam	1999
9902902	SM Albatross	Korea Line	Hyundai	174000	Membrane	Conventional	X-DF	2022
9902914	SM Bluebird	Korea Line	Hyundai	174000	Membrane	Conventional	X-DF	2022
9902926	Orion Bohemia	Global Meridian	Hyundai	174000	Membrane	Conventional	X-DF	2022
9902938	LNG Prosperity	Global Meridian	Hyundai	174000	Membrane	Conventional	X-DF	2023
9018555	Hyundai Utopia	Hyundai LNG Shipping	Hyundai	125200	Spherical	Conventional	Steam	1994
9326603	Iberica Knutsen	Knutsen OAS	Daewoo	138000	Membrane	Conventional	Steam	2006
9326689	Ibra LNG	OSC, MOL	Samsung	147600	Membrane	Conventional	Steam	2006
9317315	Ibri LNG	OSC, MOL, Mitsubishi	Mitsubishi	147600	Spherical	Conventional	Steam	2006
9629536	Independence	Hoegh	Hyundai	170100	Membrane	FSRU	DFDE	2014
9035864	Ish	National Gas Shipping Co	Mitsubishi	137300	Spherical	FSU	Steam	1995

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9854935	Jawa Satu	Jawa Satu Regas	Samsung	170000	Membrane	FSRU	DFDE	2021
9157636	K. Acacia	Korea Line	Daewoo	138000	Membrane	Conventional	Steam	2000
9186584	K. Freesia	Korea Line	Daewoo	138000	Membrane	Conventional	Steam	2000
9373008	K. Jasmine	Korea Line	Daewoo	145700	Membrane	Conventional	Steam	2008
9373010	K. Mugungwha	Korea Line	Daewoo	151700	Membrane	Conventional	Steam	2008
9043677	Karmol LNGT Powership Africa	Karpowership, MOL	Mitsubishi	127386	Spherical	FSRU	Steam	1994
8608705	Karmol LNGT Powership Asia	Karpowership, MOL	Kawasaki	127000	Spherical	FSRU	Steam	1991
9785158	Kinisis	Chandris Group	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9636723	Kita LNG	TMS Cardiff Gas	Daewoo	160100	Membrane	Conventional	TFDE	2014
9613161	Kumul	MOL, China LNG	Hudong-Zhonghua	172000	Membrane	Conventional	SSDR	2016
9721724	La Mancha Knutsen	Knutsen OAS	Hyundai	176000	Membrane	Conventional	ME-GI	2016
9845764	La Seine	TMS Cardiff Gas	Hyundai	174000	Membrane	Conventional	X-DF	2020
9275347	Lalla Fatma N'soumer	HYPROC	Kawasaki	147300	Spherical	Conventional	Steam	2004
9629598	Lena River	Dynagas	Hyundai	155000	Membrane	Conventional	DFDE	2013
9064085	Lerici	MISC	Sestri	65000	Membrane	Conventional	Steam	1998
9388819	Lijmiliya	Nakilat	Daewoo	263300	Membrane	Q-Max	SSDR	2009
9690171	LNG Abalamabie	BGT LTD	Samsung	175000	Membrane	Conventional	DFDE	2016
9690169	LNG Abuja II	BGT LTD	Samsung	175000	Membrane	Conventional	DFDE	2016
9262211	LNG Adamawa	BGT LTD	Hyundai	141000	Spherical	Conventional	Steam	2005
9870159	LNG Adventure	France LNG Shipping	Samsung	174000	Membrane	Conventional	X-DF	2021
9262209	LNG Akwa Ibom	BGT LTD	Hyundai	141000	Spherical	Conventional	Steam	2004
9320075	LNG Alliance	GazOcean	Chantiers de l'Atlantique	154500	Membrane	Conventional	DFDE	2007
7390181	LNG Aquarius	Hanochem	General Dynamics	126300	Spherical	Conventional	Steam	1977
9341299	LNG Barka	OSC, Osaka Gas, NYK, K Line	Kawasaki	153600	Spherical	Conventional	Steam	2008
9241267	LNG Bayelsa	BGT LTD	Hyundai	137000	Spherical	Conventional	Steam	2003
9267015	LNG Benue	BW	Daewoo	145700	Membrane	Conventional	Steam	2006
9692002	LNG Bonny II	BGT LTD	Hyundai	177000	Membrane	Conventional	DFDE	2015
9322803	LNG Borno	NYK Line	Samsung	149600	Membrane	Conventional	Steam	2007
9256767	LNG Croatia	LNG Croatia	Hyundai	138000	Membrane	FSRU	Steam	2005
9262223	LNG Cross River	BGT LTD	Hyundai	141000	Spherical	Conventional	Steam	2005
9277620	LNG Dream	NYK Line	Kawasaki	145300	Spherical	Conventional	Steam	2006
9834296	LNG Dubhe	MOL, COSCO	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2019
9329291	LNG Ebisu	MOL, KEPCO	Kawasaki	147500	Spherical	Conventional	Steam	2008
9266994	LNG Enugu	BW	Daewoo	145000	Membrane	Conventional	Steam	2005
9690145	LNG Finima II	BGT LTD	Samsung	175000	Membrane	Conventional	DFDE	2015
9006681	LNG Flora	LNG Flora Shipping Co Sa	Kawasaki	127700	Spherical	FSRU	Steam	1993
9666986	LNG Fukurokuju	MOL, KEPCO	Kawasaki	165100	Spherical	Conventional	Steam reheat	2016
9311581	LNG Imo	BW	Daewoo	148500	Membrane	Conventional	Steam	2008

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9200316	LNG Jamal	NYK, Osaka Gas	Mitsubishi	137000	Spherical	Conventional	Steam	2000
9774628	LNG Juno	MOL	Mitsubishi	177300	Spherical	Conventional	STaGE	2018
9341689	LNG Jupiter	NYK, Osaka Gas	Kawasaki	156000	Spherical	Conventional	Steam	2009
9666998	LNG Jurojin	MOL, KEPCO	Mitsubishi	155300	Spherical	Conventional	Steam reheat	2015
9311567	LNG Kano	BW	Daewoo	148300	Membrane	Conventional	Steam	2007
9372963	LNG Kolt	Pan Ocean	Hanjin H.I.	153000	Membrane	Conventional	Steam	2008
9692014	LNG Lagos II	BGT LTD	Hyundai	177000	Membrane	Conventional	DFDE	2016
9269960	LNG Lokoja	BW	Daewoo	148300	Membrane	Conventional	Steam	2006
8701791	LNG Maleo	MOL, NYK, K Line	Mitsui	127700	Spherical	Conventional	Steam	1989
9645748	LNG Mars	MOL, Osaka Gas	Mitsubishi	155000	Spherical	Conventional	Steam reheat	2016
9834325	LNG Megrez	MOL, COSCO	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2020
9834301	LNG Merak	MOL, COSCO	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2020
9322815	LNG Ogun	NYK Line	Samsung	149600	Membrane	Conventional	Steam	2007
9311579	LNG Ondo	BW	Daewoo	148300	Membrane	Conventional	Steam	2007
9267003	LNG Oyo	BW	Daewoo	145800	Membrane	Conventional	Steam	2005
9834313	LNG Phecda	MOL, COSCO	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2020
9256602	LNG Pioneer	Jovo Group	Daewoo	138000	Membrane	Conventional	Steam	2005
9690157	LNG Port-Harcourt II	BGT LTD	Samsung	175000	Membrane	Conventional	DFDE	2015
9262235	LNG River Niger	BGT LTD	Hyundai	141000	Spherical	Conventional	Steam	2006
9266982	LNG River Orashi	BW	Daewoo	145900	Membrane	Conventional	Steam	2004
9216298	LNG Rivers	BGT LTD	Hyundai	137000	Spherical	Conventional	Steam	2002
9877133	LNG Rosenrot	MOL	Daewoo	174000	Membrane	Conventional	X-DF	2021
9774135	LNG Sakura	NYK, KEPCO	Kawasaki	177000	Spherical	Conventional	TFDE	2018
9696149	LNG Saturn	MOL	Mitsubishi	155700	Spherical	Conventional	Steam reheat	2016
9771913	LNG Schneeweisschen	MOL	Daewoo	180000	Membrane	Conventional	X-DF	2018
9872949	LNGships Athena	TMS Cardiff Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9875800	LNGships Empress	TMS Cardiff Gas	Samsung	174000	Membrane	Conventional	X-DF	2021
9872901	LNGships Manhatten	TMS Cardiff Gas	Hyundai	174000	Membrane	Conventional	X-DF	2021
9216303	LNG Sokoto	BGT LTD	Hyundai	137000	Spherical	Conventional	Steam	2002
9306495	LNG Unity	Karpowership	Chantiers de l'Atlantique	154472	Membrane	Conventional	DFDE	2006
9645736	LNG Venus	MOL, Osaka Gas	Mitsubishi	155000	Spherical	Conventional	Steam	2014
9490961	Lobito	Mitsui, NYK, Seapeak	Samsung	160400	Membrane	Conventional	TFDE	2011
9285952	Lusail	K Line, MOL, NYK, Nakilat	Samsung	145700	Membrane	Conventional	Steam	2005
9705653	Macoma	Seapeak	Daewoo	173000	Membrane	Conventional	ME-GI	2017
9259276	Madrid Spirit	Seapeak	IZAR	138000	Membrane	Conventional	Steam	2004
9770921	Magdala	Seapeak	Daewoo	173000	Membrane	Conventional	ME-GI	2018
9342487	Magellan Spirit	Seapeak, Marubeni	Samsung	165500	Membrane	Conventional	DFDE	2009

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9490959	Malanje	Mitsui, NYK, Seapeak	Samsung	160400	Membrane	Conventional	DFDE	2011
9682588	Maran Gas Achilles	Maran Gas Maritime	Hyundai	174000	Membrane	Conventional	DFDE	2015
9682590	Maran Gas Agamemnon	Maran Gas Maritime	Hyundai	174000	Membrane	Conventional	ME-GI	2016
9650054	Maran Gas Alexandria	Maran Gas Maritime	Hyundai	161900	Membrane	Conventional	DFDE	2015
9701217	Maran Gas Amphipolis	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	DFDE	2016
9810379	Maran Gas Andros	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9633422	Maran Gas Apollonia	Maran Gas Maritime	Hyundai	161900	Membrane	Conventional	DFDE	2014
9302499	Maran Gas Asclepius	Maran Gas Maritime, Nakilat	Daewoo	145800	Membrane	Conventional	Steam	2005
9753014	Maran Gas Chios	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9331048	Maran Gas Coronis	Maran Gas Maritime, Nakilat	Daewoo	145700	Membrane	Conventional	Steam	2007
9633173	Maran Gas Delphi	Maran Gas Maritime	Daewoo	159800	Membrane	Conventional	TFDE	2014
9627497	Maran Gas Efessos	Maran Gas Maritime	Daewoo	159800	Membrane	Conventional	DFDE	2014
9682605	Maran Gas Hector	Maran Gas Maritime	Hyundai	174000	Membrane	Conventional	DFDE	2016
9767962	Maran Gas Hydra	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9874820	Maran Gas Isabella	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	X-DF	2021
9892717	Maran Gas Ithaca	Maran Gas Maritime	Daewoo	174000	Membrane	Conventional	X-DF	2021
9901350	John A Angelicoussis	Maran Gas Maritime	Daewoo	174000	Membrane	Conventional	ME-GI	2022
9682576	Maran Gas Leto	Maran Gas Maritime	Hyundai	174000	Membrane	Conventional	DFDE	2016
9627502	Maran Gas Lindos	Maran Gas Maritime	Daewoo	159800	Membrane	Conventional	DFDE	2015
9658238	Maran Gas Mystras	Maran Gas Maritime	Daewoo	159800	Membrane	Conventional	DFDE	2015
9732371	Maran Gas Olympias	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	TFDE	2017
9709489	Maran Gas Pericles	Maran Gas Maritime	Hyundai	174000	Membrane	Conventional	DFDE	2016
9633434	Maran Gas Posidonia	Maran Gas Maritime	Hyundai	161900	Membrane	Conventional	DFDE	2014
9844863	Maran Gas Psara	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2020
9701229	Maran Gas Roxana	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	TFDE	2017
9650042	Maran Gas Sparta	Maran Gas Maritime	Hyundai	161900	Membrane	Conventional	TFDE	2015
9767950	Maran Gas Spetses	Maran Gas Maritime, Nakilat	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9658240	Maran Gas Troy	Maran Gas Maritime	Daewoo	159800	Membrane	Conventional	TFDE	2015

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9709491	Maran Gas Ulysses	Maran Gas Maritime	Hyundai	174000	Membrane	Conventional	TFDE	2017
9732369	Maran Gas Vergina	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	TFDE	2016
9659725	Maria Energy	Tsakos	Hyundai	174000	Membrane	Conventional	TFDE	2016
9336749	Marib Spirit	Seapeak	Samsung	165500	Membrane	Conventional	DFDE	2008
9778313	Marshal Vasilevskiy	Gazprom	Hyundai	174000	Membrane	FSRU	TFDE	2018
9770438	Marvel Crane	NYK Line	Mitsubishi	177000	Spherical	Conventional	STaGE	2019
9759240	Marvel Eagle	MOL	Kawasaki	155000	Spherical	Conventional	TFDE	2018
9760768	Marvel Falcon	MOL	Samsung	174000	Membrane	Conventional	X-DF	2018
9760770	Marvel Hawk	MOL	Samsung	174000	Membrane	Conventional	X-DF	2018
9770440	Marvel Heron	MOL	Mitsubishi	177000	Spherical	Conventional	STaGE	2019
9760782	Marvel Kite	Meiji Shipping	Samsung	174000	Membrane	Conventional	X-DF	2019
9759252	Marvel Pelican	MOL	Kawasaki	155985	Spherical	Conventional	TFDE	2019
9880192	Marvel Swan	Navigare Capital Partners	Samsung	174000	Membrane	Conventional	DFDE	2021
9770945	Megara	Seapeak	Daewoo	173000	Membrane	Conventional	ME-GI	2018
9397303	Mekaines	Nakilat	Samsung	266500	Membrane	Q-Max	SSDR	2009
9250191	Merchant	Sinokor Merchant Marine	Samsung	138200	Membrane	Conventional	Steam	2003
9369904	Meridian Spirit	Seapeak, Marubeni	Samsung	165500	Membrane	Conventional	DFDE	2010
9337729	Mesaimeer	Nakilat	Hyundai	216300	Membrane	Q-Flex	SSDR	2009
9321768	Methane Alison Victoria	CNTIC Vpower Energy	Samsung	145000	Membrane	FSU	Steam	2007
9516129	Methane Becki Anne	GasLog	Samsung	170000	Membrane	Conventional	TFDE	2010
9321744	Methane Heather Sally	Huaxia Financial Leasing	Samsung	145000	Membrane	Conventional	Steam	2007
9307190	Methane Jane Elizabeth	GasLog	Samsung	145000	Membrane	Conventional	Steam	2006
9412880	Methane Julia Louise	MOL	Samsung	170000	Membrane	Conventional	TFDE	2010
9256793	Methane Kari Elin	Shell	Samsung	138000	Membrane	Conventional	Steam	2004
9307205	Methane Lydon Volney	TMS Cardiff Gas	Samsung	145000	Membrane	Conventional	Steam	2006
9520376	Methane Mickie Harper	Meiji Shipping	Samsung	170000	Membrane	Conventional	TFDE	2010
9321770	Methane Nile Eagle	Shell, Gaslog	Samsung	145000	Membrane	Conventional	Steam	2007
9425277	Methane Patricia Camila	Meiji Shipping	Samsung	170000	Membrane	Conventional	TFDE	2010
9253715	Methane Princess	New Fortress Energy	Daewoo	138000	Membrane	Conventional	Steam	2003
9307188	Methane Rita Andrea	Shell, Gaslog	Samsung	145000	Membrane	Conventional	Steam	2006
9321756	Methane Shirley Elisabeth	Shell, Gaslog	Samsung	145000	Membrane	Conventional	Steam	2007
9336737	Methane Spirit	Seapeak, Marubeni	Samsung	165500	Membrane	Conventional	TFDE	2008
9321732	Milaha Qatar	Nakilat, Qatar Shpg., SocGen	Samsung	145600	Membrane	Conventional	Steam	2006

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9255854	Milaha Ras Laffan	Nakilat, Qatar Shpg., SocGen	Samsung	138300	Membrane	Conventional	Steam	2004
9305128	Min Lu	China LNG Ship Mgmt	Hudong-Zhonghua	147200	Membrane	Conventional	Steam	2009
9305116	Min Rong	China LNG Ship Mgmt	Hudong-Zhonghua	147600	Membrane	Conventional	Steam	2009
9885855	Minerva Amorgos	Minerva Marine	Samsung	174000	Membrane	Conventional	X-DF	2022
9877341	Minerva Chios	Minerva Marine	Samsung	174000	Membrane	Conventional	X-DF	2021
9869942	Minerva Kalymnos	Minerva Marine	Samsung	174000	Membrane	Conventional	X-DF	2021
9854375	Minerva Limnos	Minerva Marine	Daewoo	173400	Membrane	Conventional	ME-GI	2021
9854363	Minerva Psara	Minerva Marine	Daewoo	173400	Membrane	Conventional	ME-GI	2021
9713105	Bauhinia Spirit	MOL	Daewoo	263000	Membrane	FSRU	TFDE	2017
9885996	MOL Hestia	MOL	Daewoo	173400	Membrane	Conventional	X-DF	2021
9337755	Mozah	Nakilat	Samsung	266300	Membrane	Q-Max	SSDR	2008
9074638	Mraweh	National Gas Shipping Co	Kvaerner Masa	135000	Spherical	Conventional	Steam	1996
9878876	Mu Lan	CSSC Shpg Leasing	Hudong-Zhonghua	178000	Membrane	Conventional	X-DF	2021
9074626	Mubaraz	National Gas Shipping Co	Kvaerner Masa	135000	Spherical	Conventional	Steam	1996
9705641	Murex	Seapeak	Daewoo	173000	Membrane	Conventional	ME-GI	2017
9360805	Murwab	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Daewoo	210100	Membrane	Q-Flex	SSDR	2008
9770933	Myrina	Seapeak	Daewoo	173000	Membrane	Conventional	ME-GI	2018
9324277	Neo Energy	Tsakos	Hyundai	150000	Spherical	Conventional	Steam	2007
9385673	Neptune	Hoegh, MOL, TLTC	Samsung	145000	Membrane	FSRU	DFDE	2009
9750660	Nikolay Urvantsev	MOL, COSCO	Daewoo	172000	Membrane	Icebreaker	TFDE	2019
9750725	Nikolay Yevgenov	Seapeak, China LNG Shipping	Daewoo	172000	Membrane	Icebreaker	TFDE	2019
9768526	Nikolay Zubov	Dynagas	Daewoo	172000	Membrane	Icebreaker	TFDE	2019
9294264	Nizwa LNG	OSC, MOL	Kawasaki	147700	Spherical	Conventional	Steam	2005
9796781	Nohshu Maru	MOL, JERA	Mitsubishi	177300	Spherical	Conventional	STaGE	2019
8608872	Northwest Sanderling	North West Shelf Venture	Mitsubishi	126700	Spherical	Conventional	Steam	1989
8913150	Northwest Sandpiper	North West Shelf Venture	Mitsui	127000	Spherical	Conventional	Steam	1993
8608884	Northwest Snipe	North West Shelf Venture	Mitsui	126900	Spherical	Conventional	Steam	1990
9045132	Northwest Stormpetrel	North West Shelf Venture	Mitsubishi	126800	Spherical	Conventional	Steam	1994
7382744	Nusantara Regas Satu	New Fortress Energy	Rosenberg Verft	125000	Spherical	FSRU	Steam	1977
9681699	Oak Spirit	Seapeak	Daewoo	173400	Membrane	Conventional	ME-GI	2016
9315692	Ob River	Dynagas	Hyundai	149700	Membrane	Conventional	Steam	2007
9698111	Oceanic Breeze	K Line, Inpex	Mitsubishi	155300	Spherical	Conventional	Steam reheat	2018
9397353	Onaiza	Nakilat	Daewoo	210200	Membrane	Q-Flex	SSDR	2009
9761267	Ougarta	HYPROC	Hyundai	171800	Membrane	Conventional	TFDE	2017
9621077	Pacific Arcadia	NYK Line	Mitsubishi	145400	Spherical	Conventional	Steam	2014

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9698123	Pacific Breeze	K Line	Kawasaki	182000	Spherical	Conventional	TFDE	2018
9351971	Pacific Enlighten	Kyushu Electric, TEPCO, Mitsubishi, Mitsui, NYK, MOK	Mitsubishi	145000	Spherical	Conventional	Steam	2009
9264910	Pacific Eurus	TEPCO, NYK, Mitsubishi	Mitsubishi	137000	Spherical	Conventional	Steam	2006
9743875	Pacific Mimosa	NYK Line	Mitsubishi	155300	Membrane	Conventional	Steam reheat	2018
9247962	Pacific Notus	TEPCO, NYK, Mitsubishi	Mitsubishi	137000	Spherical	Conventional	Steam	2003
9636735	Palu LNG	TMS Cardiff Gas	Daewoo	160000	Membrane	Conventional	TFDE	2014
9750256	Pan Africa	Seapeak, China LNG Shipping, CETS Investment Management, BW	Hudong-Zhonghua	174000	Membrane	Conventional	DFDE	2019
9750232	Pan Americas	Seapeak	Hudong-Zhonghua	174000	Membrane	Conventional	DFDE	2018
9750220	Pan Asia	Seapeak	Hudong-Zhonghua	174000	Membrane	Conventional	DFDE	2017
9750244	Pan Europe	Seapeak	Hudong-Zhonghua	174000	Membrane	Conventional	DFDE	2018
9929106	New Apex	Pan Ocean	Samsung	174000	Membrane	Conventional	X-DF	2023
9613135	Papua	MOL, China LNG	Hudong-Zhonghua	172000	Membrane	Conventional	SSDR	2015
9766889	Patris	Chandris Group	Daewoo	173400	Membrane	Conventional	ME-GI	2018
9862346	Pearl LNG	TMS Cardiff Gas	Samsung	174000	Membrane	Conventional	X-DF	2020
9905978	Lagenda Suria	K Line	Hudong-Zhonghua	80000	Membrane	Mid-scale	X-DF	2022
9905980	Lagenda Serenity	K Line	Hudong-Zhonghua	80000	Membrane	Mid-scale	X-DF	2022
9629524	PGN FSRU Lampung	Hoegh	Hyundai	170000	Membrane	FSRU	DFDE	2014
9375721	Point Fortin	MOL, Sumitomo, LNG JAPAN	Imabari	154200	Membrane	Conventional	Steam	2010
9001772	Polar Spirit	Seapeak	I.H.I.	88900	Self-Supporting Prismatic	Mid-scale	Steam	1993
9064073	Portovenere	MISC	Sestri	65000	Membrane	Conventional	Steam	1996
9246621	Portovyy	Gazprom	Daewoo	138100	Membrane	FSU	Steam	2003
9723801	Prachi	MOL, NYK, K Line, SCI, Nakilat, Petronet	Hyundai	173000	Membrane	Conventional	TFDE	2016
9810549	Prism Agility	SK Shipping	Hyundai	180000	Membrane	Conventional	X-DF	2019
9810551	Prism Brilliance	SK Shipping	Hyundai	180000	Membrane	Conventional	X-DF	2019
9904651	Prism Diversity	SK Shipping	Hyundai	180000	Membrane	Conventional	X-DF	2022
9630028	Pskov	Sovcomflot	STX	170200	Membrane	Conventional	DFDE	2014
9030814	Puteri Delima	MISC	Chantiers de l'Atlantique	130000	Membrane	Conventional	Steam	1995
9211872	Puteri Delima Satu	MISC	Mitsui	137500	Membrane	Conventional	Steam	2002
9248502	Puteri Firus Satu	MISC	Mitsubishi	137500	Membrane	Conventional	Steam	2004

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9030802	Puteri Intan	MISC	Chantiers de l'Atlantique	130000	Membrane	Conventional	Steam	1994
9213416	Puteri Intan Satu	MISC	Mitsubishi	137500	Membrane	Conventional	Steam	2002
9261205	Puteri Mutiara Satu	MISC	Mitsui	137000	Membrane	Conventional	Steam	2005
9030826	Puteri Nilam	MISC	Chantiers de l'Atlantique	130000	Membrane	Conventional	Steam	1995
9229647	Puteri Nilam Satu	MISC	Mitsubishi	137500	Membrane	Conventional	Steam	2003
9030838	Puteri Zamrud	MISC	Chantiers de l'Atlantique	130000	Membrane	Conventional	Steam	1996
9245031	Puteri Zamrud Satu	MISC	Mitsui	137500	Membrane	Conventional	Steam	2004
9851787	Qogir	TMS Cardiff Gas	Samsung	174000	Membrane	Conventional	X-DF	2020
9253703	Raahi	MOL, NYK, K Line, SCI, Nakilat, Petronet	Daewoo	138100	Membrane	Conventional	Steam	2004
9443413	Rasheeda	Nakilat	Samsung	266300	Membrane	Q-Max	ME-GI	2010
9874040	Ravenna Knutsen	Knutsen OAS	Hyundai	30000	Type C	Small-scale	X-DF	2021
9825568	Rias Baixas Knutsen	Knutsen OAS	Hyundai	180000	Membrane	Conventional	ME-GI	2019
9477593	Ribera Duero Knutsen	Knutsen OAS	Daewoo	173400	Membrane	Conventional	DFDE	2010
9721736	Rioja Knutsen	Knutsen OAS	Hyundai	176000	Membrane	Conventional	ME-GI	2016
9750713	Rudolf Samoylovich	Seapeak	Daewoo	172000	Membrane	Icebreaker	TFDE	2018
9769855	Saga Dawn	Landmark Capital	Xiamen Shipbuilding Industry	45000	Self-Supporting Prismatic	Small-scale	DFDE	2019
9300817	Salalah LNG	OSC, MOL	Samsung	147000	Membrane	Conventional	Steam	2005
9888766	Orion Star	Global Meridian	Samsung	174000	Membrane	Conventional	X-DF	2022
9874480	LNG Enterprise	NYK Line	Samsung	174000	Membrane	Conventional	X-DF	2021
9874492	LNG Endurance	NYK Line	Samsung	174000	Membrane	Conventional	X-DF	2021
9889904	Orion Sea	Global Meridian	Samsung	174000	Membrane	Conventional	X-DF	2022
9889916	Orion Sun	Global Meridian	Samsung	174000	Membrane	Conventional	X-DF	2022
9893606	LNG Endeavour	NYK Line	Samsung	174000	Membrane	Conventional	X-DF	2021
9896440	Seri Damai	MISC	Samsung	174000	Membrane	Conventional	X-DF	2023
9896452	Seri Daya	MISC	Samsung	174000	Membrane	Conventional	X-DF	2023
9878723	Celsius Carolina	Celsius Shipping	Samsung	180000	Membrane	Conventional	X-DF	2021
9864746	Scf Barents	Sovcomflot	Hyundai	174000	Membrane	Conventional	X-DF	2020
9849887	Scf La Perouse	Sovcomflot	Hyundai	174000	Membrane	Conventional	X-DF	2020
9654878	SCF Melampus	Sovcomflot	STX	170200	Membrane	Conventional	TFDE	2015
9654880	SCF Mitre	Sovcomflot	STX	170200	Membrane	Conventional	TFDE	2015
9870525	SCF Timmerman	Sovcomflot	Hyundai	174000	Membrane	Conventional	X-DF	2021
9781918	Sean Spirit	Seapeak	Hyundai	174000	Membrane	Conventional	ME-GI	2018
9666558	Seishu Maru	Mitsubishi, NYK, Chubu Electric	Mitsubishi	153000	Membrane	Conventional	Steam	2014
9293832	Seri Alam	MISC	Samsung	145700	Membrane	Conventional	Steam	2005
9293844	Seri Amanah	MISC	Samsung	145700	Membrane	Conventional	Steam	2006
9321653	Seri Anggun	MISC	Samsung	145700	Membrane	Conventional	Steam	2006

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9321665	Seri Angkasa	MISC	Samsung	145700	Membrane	Conventional	Steam	2006
9329679	Seri Ayu	MISC	Samsung	145700	Membrane	Conventional	Steam	2007
9331634	Seri Bakti	MISC	Mitsubishi	152300	Membrane	Conventional	Steam	2007
9331660	Seri Balhaf	MISC	Mitsubishi	157000	Membrane	Conventional	TFDE	2009
9331672	Seri Balqis	MISC	Mitsubishi	152000	Membrane	Conventional	TFDE	2009
9331646	Seri Begawan	MISC	Mitsubishi	152300	Membrane	Conventional	Steam	2007
9331658	Seri Bijaksana	MISC	Mitsubishi	152300	Membrane	Conventional	Steam	2008
9714305	Seri Camar	PETRONAS	Hyundai	150200	Membrane	Conventional	Steam reheat	2018
9714276	Seri Camellia	PETRONAS	Hyundai	150200	Membrane	Conventional	Steam reheat	2016
9756389	Seri Cemara	PETRONAS	Hyundai	150200	Spherical	Conventional	Steam reheat	2018
9714290	Seri Cempaka	PETRONAS	Hyundai	150200	Spherical	Conventional	ME-GI	2017
9714288	Seri Cenderawasih	PETRONAS	Hyundai	150200	Spherical	Conventional	Steam reheat	2017
9338797	Sestao Knutsen	Knutsen OAS	IZAR	138000	Membrane	Conventional	Steam	2007
9414632	Sevilla Knutsen	Knutsen OAS	Daewoo	173400	Membrane	Conventional	DFDE	2010
9418365	Shagra	Nakilat	Samsung	266300	Membrane	Q-Max	SSDR	2009
9035852	Shahamah	National Gas Shipping Co	Kawasaki	135000	Spherical	Conventional	Steam	1994
9583677	Shen Hai	China LNG, CNOOC, Shanghai LNG	Hudong-Zhonghua	147600	Membrane	Conventional	Steam	2012
9937907	Dapeng Princess	Shenzhen Gas	Hudong-Zhonghua	80000	Membrane	Mid-scale	X-DF	2023
9791200	Shinshu Maru	MOL	Kawasaki	177000	Spherical	Conventional	DFDE	2019
9320386	Simaisma	Maran Gas Maritime, Nakilat	Daewoo	145700	Membrane	Conventional	Steam	2006
9238040	Singapore Energy	Sinokor Merchant Marine	Samsung	138000	Membrane	Conventional	Steam	2003
9693161	SK Audace	SK Shipping, Marubeni	Samsung	180000	Membrane	Conventional	X-DF	2017
9693173	SK Resolute	SK Shipping, Marubeni	Samsung	180000	Membrane	Conventional	X-DF	2018
9761803	SK Serenity	SK Shipping	Samsung	174000	Membrane	Conventional	ME-GI	2018
9761815	SK Spica	SK Shipping	Samsung	174000	Membrane	Conventional	ME-GI	2018
9180231	SK Splendor	SK Shipping	Samsung	138200	Membrane	Conventional	Steam	2000
9180243	SK Stellar	SK Shipping	Samsung	138200	Membrane	Conventional	Steam	2000
9157624	SK Summit	SK Shipping	Daewoo	138000	Membrane	Conventional	Steam	1999
9247194	SK Sunrise	SK Shipping	Samsung	138200	Membrane	Conventional	Steam	2003
9157739	SK Supreme	SK Shipping	Samsung	138200	Membrane	Conventional	Steam	2000
9761827	SM Eagle	Korea Line	Daewoo	174000	Membrane	Conventional	ME-GI	2017
9761839	SM Seahawk	Korea Line	Daewoo	174000	Membrane	Conventional	ME-GI	2017
9210816	Sohar LNG	OSC, MOL	Mitsubishi	137200	Spherical	Conventional	Steam	2001
9791212	Sohshu Maru	MOL, JERA	Kawasaki	177300	Spherical	Conventional	DFDE	2019
9634098	Solaris	GasLog	Samsung	155000	Membrane	Conventional	TFDE	2014
9482304	Sonangol Benguela	Mitsui, Sonangol, Sojlitz	Daewoo	160000	Membrane	Conventional	Steam	2011
9482299	Sonangol Etosha	Mitsui, Sonangol, Sojlitz	Daewoo	160000	Membrane	Conventional	Steam	2011

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9475600	Sonangol Sambizanga	Mitsui, Sonangol, Sojlitz	Daewoo	160000	Membrane	Conventional	Steam	2011
9613147	Southern Cross	MOL, China LNG	Hudong-Zhonghua	168400	Membrane	Conventional	SSDR	2015
9475208	Soyo	Mitsui, NYK, Seapeak	Samsung	160400	Membrane	Conventional	DFDE	2011
9361639	Spirit Of Hela	MOL, Itochu	Hyundai	177000	Membrane	Conventional	DFDE	2009
9315393	Stena Blue Sky	Stena Bulk	Daewoo	145700	Membrane	Conventional	Steam	2006
9413327	Stena Clear Sky	Stena Bulk	Daewoo	173000	Membrane	Conventional	TFDE	2011
9383900	Stena Crystal Sky	Stena Bulk	Daewoo	173000	Membrane	Conventional	TFDE	2011
9322255	Summit LNG	Excelerate Energy	Daewoo	138000	Membrane	FSRU	Steam	2006
9330745	Symphonic Breeze	K Line	Kawasaki	147600	Spherical	Conventional	Steam	2007
9403669	Taitar No.1	CPC, Mitsui, NYK Line	Mitsubishi	145300	Spherical	Conventional	Steam	2009
9403645	Taitar No.2	MOL, NYK	Kawasaki	145300	Spherical	Conventional	Steam	2009
9403671	Taitar No.3	MOL, NYK	Mitsubishi	145300	Spherical	Conventional	Steam	2010
9403657	Taitar No.4	CPC, Mitsui, NYK Line	Kawasaki	145300	Spherical	Conventional	Steam	2010
9334284	Tangguh Batur	NYK, Sovcomflot	Daewoo	145700	Membrane	Conventional	Steam	2008
9349007	Tangguh Foja	K Line, PT Meratus	Samsung	154800	Membrane	Conventional	DFDE	2008
9333632	Tangguh Hiri	Seapeak	Hyundai	155000	Membrane	Conventional	DFDE	2008
9349019	Tangguh Jaya	K Line, PT Meratus	Samsung	155000	Membrane	Conventional	DFDE	2008
9355379	Tangguh Palung	K Line, PT Meratus	Samsung	155000	Membrane	Conventional	DFDE	2009
9361990	Tangguh Sago	Seapeak	Hyundai	155000	Membrane	Conventional	DFDE	2009
9325893	Tangguh Towuti	NYK, PT Samudera, Sovcomflot	Daewoo	145700	Membrane	Conventional	Steam	2008
9337731	Tembek	Nakilat, OSC	Samsung	216200	Membrane	Q-Flex	SSDR	2007
7428433	Tenaga Empat	MISC	CNIM	130000	Membrane	FSU	Steam	1981
7428457	Tenaga Satu	MISC	Dunkerque Chantiers	130000	Membrane	FSU	Steam	1982
9761243	Tessala	HYPROC	Hyundai	171800	Membrane	Conventional	TFDE	2016
9721401	Torben Spirit	Seapeak	Daewoo	173000	Membrane	Conventional	ME-GI	2017
9238038	Trader	Sinokor Merchant Marine	Samsung	138000	Membrane	Conventional	Steam	2002
9854765	Traiano Knutsen	Knutsen OAS	Hyundai	180000	Membrane	Conventional	ME-GI	2020
9861809	Transgas Power	Dynagas	Hudong-Zhonghua	174000	Membrane	FSRU	DFDE	2021
9319404	Trinity Arrow	K Line	Imabari	155000	Membrane	Conventional	Steam	2008
9350927	Trinity Glory	K Line	Imabari	155000	Membrane	Conventional	Steam	2009
9823883	Turquoise P	Pardus Energy	Hyundai	170000	Membrane	FSRU	DFDE	2019
9360829	Umm Al Amad	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Daewoo	210200	Membrane	Q-Flex	SSDR	2008
9074652	Umm Al Ashtan	National Gas Shipping Co	Kvaerner Masa	135000	Spherical	Conventional	Steam	1997
9308431	Umm Bab	Maran Gas Maritime, Nakilat	Daewoo	145700	Membrane	Conventional	Steam	2005

Appendix 3: Table of Global Active LNG Fleet (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9372731	Umm Slal	Nakilat	Samsung	266000	Membrane	Q-Max	SSDR	2008
9915909	Wu Dang	COSCO	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2022
9915894	Shaolin	COSCO	Hudong-Zhonghua	174000	Membrane	Conventional	X-DF	2022
9434266	Valencia Knutsen	Knutsen OAS	Daewoo	173400	Membrane	Conventional	DFDE	2010
9837066	Vasant 1	Triumph Offshore Pvt Ltd	Hyundai	180000	Membrane	FSRU	DFDE	2020
9630004	Velikiy Novgorod	Sovcomflot	STX	170200	Membrane	Conventional	DFDE	2014
9864667	Vivit Americas LNG	TMS Cardiff Gas	Hyundai	170520	Membrane	Conventional	X-DF	2020
9902756	Vivit Arabia	H-Line Shipping	Hyundai	174000	Membrane	Conventional	X-DF	2022
9895238	Vivirt City	H-Line Shipping	Hyundai	174000	Membrane	Conventional	X-DF	2021
9750701	Vladimir Rusanov	MOL	Daewoo	172000	Membrane	Icebreaker	TFDE	2018
9750658	Vladimir Vize	MOL	Daewoo	172000	Membrane	Icebreaker	TFDE	2018
9750737	Vladimir Voronin	Seapeak, China LNG Shipping	Daewoo	172000	Membrane	Icebreaker	TFDE	2019
9627954	Wilforce	Seapeak	Daewoo	160000	Membrane	Conventional	TFDE	2013
9627966	Wilpride	Seapeak	Daewoo	160000	Membrane	Conventional	TFDE	2013
9753026	Woodside Chaney	Maran Gas Maritime	Hyundai	174000	Membrane	Conventional	ME-GI	2019
9859753	Woodside Charles Allen	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2020
9369899	Woodside Donaldson	Seapeak, Marubeni	Samsung	165500	Membrane	Conventional	DFDE	2009
9633161	Woodside Goode	Maran Gas Maritime	Daewoo	159800	Membrane	Conventional	DFDE	2013
9810367	Woodside Rees Wither	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9627485	Woodside Rogers	Maran Gas Maritime	Daewoo	159800	Membrane	Conventional	DFDE	2013
9750672	Yakov Gakkel	Seapeak, China LNG Shipping	Daewoo	172000	Membrane	Icebreaker	TFDE	2019
9781920	Yamal Spirit	Seapeak	Hyundai	174000	Membrane	Conventional	ME-GI	2019
9636747	Yari LNG	TMS Cardiff Gas	Daewoo	160000	Membrane	Conventional	TFDE	2014
9629586	Yenisei River	Dynagas	Hyundai	155000	Membrane	Conventional	DFDE	2013
9879674	Yiannis	Maran Gas Maritime	Daewoo	174000	Membrane	Conventional	ME-GI	2021
9038816	YK Sovereign	SK Shipping	Hyundai	127100	Spherical	Conventional	Steam	1994
9431214	Zarga	Nakilat	Samsung	266000	Membrane	Q-Max	SSDR	2010
9132818	Zekreet	J4 Consortium	Mitsui	137500	Spherical	Conventional	Steam	1998
9922976	Lech Kaczynski	Knutsen OAS	Hyundai	174000	Membrane	Conventional	X-DF	2023
9919890	Coral Nordic	Anthony Veder	Jiangnan	30000	Type C	Small-scale	X-DF	2022

Appendix 4: Table of global LNG vessel orderbook, end-of-April 2023

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9903425	Hull 2315	Sinokor Merchant Marine	Samsung	174000	X-DF	2023
9917543	Orion Jessica	Global Meridian	Hyundai	174000	X-DF	2023
9946350	Hull 8101	Knutsen OAS	Hyundai	174000	X-DF	2024
9904546	Hull 041	Sovcomflot	Samsung	172600	DFDE	2024
9904675	Hull 042	Smart LNG	Samsung	172600	DFDE	2024
9904687	Hull 043	Smart LNG	Samsung	172600	DFDE	2024
9904699	Hull 044	Smart LNG	Samsung	172600	DFDE	2024
9904704	Hull 045	Smart LNG	Samsung	172600	DFDE	2024
9903451	Hull 2318	Sinokor Merchant Marine	Samsung	174000	X-DF	2024
9917555	Hull 3190	Global Meridian	Hyundai	174000	X-DF	2023
9946374	Hull 8139	Knutsen OAS	Hyundai	174000	X-DF	2023
9949027	Hull 2520	MOL	Daewoo	174000	ME-GA	2023
9924869	Hull 2425	Maran Gas Maritime	Samsung	174000	ME-GA	2023
9955521	Hull 8354	Anthony Veder	Hyundai	30000	X-DF	2023
9953509	Hull 2580	NYK Line	Samsung	174000	X-DF	2023
9953511	Hull 2581	NYK Line	Samsung	174000	X-DF	2023
9953523	Hull 2582	NYK Line	Samsung	174000	X-DF	2024
9918004	Hull 2514	Daewoo	Daewoo	172600	DFDE	2023
9918016	Hull 2515	Daewoo	Daewoo	172600	DFDE	2023
9918028	Hull 2516	Daewoo	Daewoo	172600	DFDE	2023
9922988	Grazyna Gesicka	Knutsen OAS	Hyundai	174000	X-DF	2023
9943853	Axios II	Capital Gas	Hyundai	174000	ME-GA	2024
9943475	Clean Resolution	Dynagas	Hyundai	200000	ME-GA	2023
9943487	Clean Destiny	Dynagas	Hyundai	200000	ME-GA	2023
9917579	SM Kestrel	Korea Line	Hyundai	174000	ME-GA	2023
9918030	Hull 2517	MOL	Daewoo	172600	DFDE	2023
9918042	Hull 2518	MOL	Daewoo	172600	DFDE	2023
9918054	Hull 2519	MOL	Daewoo	172600	DFDE	2023
9943841	Amore Mio I	Capital Gas	Hyundai	174000	ME-GA	2023
9945435	Hull 2459	Celsius Shipping	Samsung	180000	ME-GA	2023
9945447	Hull 2460	Celsius Shipping	Samsung	180000	ME-GA	2024
9945459	Hull 2461	Celsius Shipping	Samsung	180000	ME-GA	2024
9952816	Hull H1838A	K Line	Hudong-Zhonghua	79960	X-DF	2023
Unknown	Unknown Hull No.	Unknown	Hudong-Zhonghua	174000	X-DF	2024
Unknown	Unknown Hull No.	Unknown	Hudong-Zhonghua	174000	X-DF	2024
9950105	Hull 8147	H-Line Shipping	Hyundai	174000	X-DF	2023
9864837	Mulan Spirit	Jovo Group	Jiangnan	79800	X-DF	2023
9946386	Hull 8148	Knutsen OAS	Hyundai	174000	X-DF	2025
9941013	Hull 2521	Hyundai LNG Shipping	Daewoo	174000	ME-GI	2023
9917567	SM Golden Eagle	Korea Line	Hyundai	174000	ME-GA	2023

Appendix 4: Table of Global LNG Vessel Orderbook (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
Unknown	Hull 3224	Pan Ocean	Hyundai	174000	X-DF	2024
9948695	Hull 8106	Alpha Gas	Hyundai	174000	X-DF	2024
9948700	Hull 8107	Alpha Gas	Hyundai	174000	X-DF	2024
Unknown	Unknown Hull No.	Unknown	Hyundai	174000	X-DF	2024
9988700	Hull 2651	Celsius Shipping	Samsung	180000	ME-GA	2025
9948724	Hull 2584	Celsius Shipping	Samsung	180000	ME-GA	2024
9958286	Aktoras	Capital Gas	Hyundai	174000	ME-GA	2024
Unknown	Hull 3292	Dynagas	Hyundai	200000	ME-GA	2024
Unknown	Hull 3293	Dynagas	Hyundai	200000	ME-GA	2024
9972672	Hull 2635	TMS Cardiff Gas	Samsung	174000	ME-GA	2026
9964182	Hull 8173	SK Shipping	Hyundai	174000	X-DF	2024
9937945	Hull 3294	Hyundai LNG Shipping	Hyundai	174000	X-DF	2024
9892133	Hull H1830A	CSSC Leasing	Hudong-Zhonghua	174000	X-DF	2024
9892121	Wen Cheng	CSSC Leasing	Hudong-Zhonghua	174000	X-DF	2023
9928061	Hull 2393	Unknown	Samsung	174000	X-DF	2024
9928073	Hull 2394	Unknown	Samsung	174000	X-DF	2024
9928085	Hull 2395	Unknown	Samsung	174000	X-DF	2024
9928097	Hull 2396	Unknown	Samsung	174000	X-DF	2024
9957737	Apostolos	Capital Gas	Hyundai	174000	ME-GA	2024
9926714	Hull 8100	Knutsen OAS	Hyundai	174000	ME-GA	2024
9926922	Hull 3223	Global Meridian	Hyundai	174000	ME-GA	2024
Unknown	Unknown Hull No.	Global Meridian	Hyundai	174000	X-DF	2024
9947627	Hull 3320	Global Meridian	Hyundai	174000	X-DF	2025
Unknown	Unknown Hull No.	Global Meridian	Hyundai	174000	X-DF	2024
9926908	Hull 3221	Pan Ocean	Hyundai	174000	ME-GA	2024
9946398	Hull 8149	Knutsen OAS	Hyundai	174000	X-DF	2025
9926910	Hull 3222	Pan Ocean	Hyundai	174000	ME-GA	2024
9918810	Hull 050	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2025
9918846	Hull 053	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2025
9918858	Hull 054	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2025
9918860	Hull 055	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2025
9918822	Hull 051	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2026
9918834	Hull 052	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2026
9918793	Hull 048	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2024
9918808	Hull 049	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2024
9957725	Assos	Capital Gas	Hyundai	174000	ME-GA	2024
Unknown	Unknown Hull No.	United LNG Transportation	Hudong-Zhonghua	174000	X-DF	2026
9941518	Hull 2473	Maran Gas Maritime	Samsung	174000	ME-GA	2024
9941520	Hull 2474	Maran Gas Maritime	Samsung	174000	ME-GA	2024
9937957	Hull 3295	Hyundai LNG Shipping	Hyundai	174000	X-DF	2024
9903437	Hull 2316	Sinokor Merchant Marine	Samsung	174000	X-DF	2024

Appendix 4: Table of Global LNG Vessel Orderbook (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9903449	Hull 2317	Sinokor Merchant Marine	Samsung	174000	X-DF	2023
9947639	Orion Gaugin	Global Meridian	Hyundai	174000	X-DF	2025
Unknown	Unknown Hull No.	Unknown	Hyundai	174000	X-DF	2024
Unknown	Unknown Hull No.	Knutsen OAS	Hyundai	174000	X-DF	2024
Unknown	Unknown Hull No.	Knutsen OAS	Hyundai	174000	X-DF	2024
Unknown	Unknown Hull No.	Unknown	Samsung	174000	X-DF	2024
Unknown	Unknown Hull No.	Global Meridian	Hyundai	174000	X-DF	2024
9958298	Hull 2523	MOL	Daewoo	174000	ME-GA	2024
9958303	Hull 2524	MOL	Daewoo	174000	ME-GA	2024
9956953	Hull 2527	MOL	Daewoo	174000	ME-GA	2024
9958315	Hull 2525	MOL	Daewoo	174000	ME-GA	2024
9953535	Hull 2583	NYK Line	Samsung	174000	X-DF	2024
9963853	Hull 2604	NYK Line	Samsung	174000	X-DF	2024
9937969	Hull 3296	Hyundai LNG Shipping	Hyundai	174000	X-DF	2024
9962407	Hull 2532	GasLog	Daewoo	174000	ME-GI	2024
9962419	Hull 2533	GasLog	Daewoo	174000	ME-GI	2024
9946829	Hull 2579	Celsius Shipping	Samsung	180000	ME-GA	2024
9947691	Hull 2522	Hyundai LNG Shipping	Daewoo	174000	ME-GI	2024
Unknown	Unknown Hull No.	United LNG Transportation	Hudong-Zhonghua	174000	X-DF	2026
9947598	Hull 3297	Hyundai LNG Shipping	Hyundai	174000	X-DF	2024
9953248	Hull H1790A	MOL & CSLNG JV	Hudong-Zhonghua	174000	X-DF	2024
9980851	Hull 2639	Oceonix Services Ltd	Samsung	174000	ME-GA	2025
9981049	Hull 2640	Oceonix Services Ltd	Samsung	174000	ME-GA	2025
9977323	Hull 2646	Oceonix Services Ltd	Samsung	174000	ME-GA	2026
9977335	Hull 2647	Oceonix Services Ltd	Samsung	174000	ME-GA	2026
9976903	Hull 2546	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2024
Unknown	Unknown Hull No.	NYK K Line MISC CLNG	Hudong-Zhonghua	174000	X-DF	2026
9953250	Hull H1791A	MOL & CSLNG JV	Hudong-Zhonghua	174000	X-DF	2024
9953262	Hull H1792A	MOL & CSLNG JV	Hudong-Zhonghua	174000	X-DF	2025
Unknown	Hull 2566	Meiji Shipping	Daewoo	174000	X-DF	2026
9991939	Hull 2572	TMS Cardiff Gas	Daewoo	174000	X-DF	2026
9991941	Hull 2573	TMS Cardiff Gas	Daewoo	174000	X-DF	2026
9947512	Hull 3225	Pan Ocean	Hyundai	174000	X-DF	2024
9994008	Hull 3433	Dynagas	Hyundai	200000	ME-GA	2025
9994034	Hull 3434	Dynagas	Hyundai	200000	ME-GA	2025
9968451	Hull 8177	Unknown	Hyundai	174000	ME-GA	2025
9968463	Hull 8178	Unknown	Hyundai	174000	ME-GA	2025
9976135	Hull 8196	Eastern Pacific Shpg	Hyundai	174000	ME-GA	2025
9976147	Hull 8197	Eastern Pacific Shpg	Hyundai	174000	ME-GA	2025
9977220	Hull 2596	Oceonix Services Ltd	Samsung	174000	ME-GA	2024
Unknown	Hull 8170	Hyundai Glovis	Hyundai	174000	ME-GA	2024

Appendix 4: Table of Global LNG Vessel Orderbook (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9958999	Hull 2598	Celsius Shipping	Samsung	180000	ME-GA	2025
9959008	Hull 2599	Celsius Shipping	Samsung	180000	ME-GA	2025
9948736	Hull 2585	Celsius Shipping	Samsung	180000	ME-GA	2024
9947603	Hull 3298	Hyundai LNG Shipping	Hyundai	174000	X-DF	2024
9975507	Hull 3380	Knutsen OAS	Hyundai	174000	X-DF	2025
9975519	Hull 3381	Knutsen OAS	Hyundai	174000	X-DF	2025
9981374	Hull 3382	Knutsen OAS	Hyundai	174000	X-DF	2025
9918779	Hull 046	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2024
9918781	Hull 047	Smart LNG	Zvezda Shipbuilding	172600	DFDE	2024
Unknown	Unknown Hull No.	United LNG Transportation	Hudong-Zhonghua	174000	X-DF	2026
9947615	Hull 3299	Hyundai LNG Shipping	Hyundai	174000	X-DF	2025
Unknown	Unknown Hull No.	H-Line/Pan Ocean/SK	Samsung	174000	ME-GA	2024
Unknown	Unknown Hull No.	H-Line/Pan Ocean/SK	Samsung	174000	ME-GA	2024
9956599	Hull 2593	Global Meridian	Samsung	174000	ME-GA	2024
9958846	Hull 2600	Global Meridian	Samsung	174000	ME-GA	2024
9956604	Hull 2594	Global Meridian	Samsung	174000	ME-GA	2024
9958858	Hull 2601	Global Meridian	Samsung	174000	ME-GA	2025
9977244	Hull 2634	Oceonix Services Ltd	Samsung	174000	ME-GA	2025
9977256	Hull 2637	Oceonix Services Ltd	Samsung	174000	ME-GA	2025
9977268	Hull 2638	Oceonix Services Ltd	Samsung	174000	ME-GA	2025
9977270	Hull 2641	Oceonix Services Ltd	Samsung	174000	ME-GA	2025
9977282	Hull 2642	Oceonix Services Ltd	Samsung	174000	ME-GA	2026
9977294	Hull 2643	Oceonix Services Ltd	Samsung	174000	ME-GA	2026
9977309	Hull 2644	Oceonix Services Ltd	Samsung	174000	ME-GA	2026
9977311	Hull 2645	Oceonix Services Ltd	Samsung	174000	ME-GA	2026
9953274	Hull H1793A	MOL & CSLNG JV	Hudong-Zhonghua	174000	X-DF	2025
9986609	Hull H1797A	NYK K Line MISC CLNG	Hudong-Zhonghua	174000	X-DF	2025
9958640	Hull H1834A	United Liquefied Gas	Hudong-Zhonghua	174199	X-DF	2024
9958652	Hull H1835A	United Liquefied Gas	Hudong-Zhonghua	174199	X-DF	2024
9958664	Hull H1836A	United Liquefied Gas	Hudong-Zhonghua	174199	X-DF	2025
9977232	Hull 2597	Oceonix Services Ltd	Samsung	174000	ME-GA	2024
9956587	Hull 2592	Global Meridian	Samsung	174000	ME-GA	2024
9982677	Hull 2611	H-Line Shipping	Samsung	174000	X-DF	2025
9972359	Hull 2607	H-Line Shipping	Samsung	174000	ME-GA	2025
Unknown	Hull H1894A	CMES/K Line/CMC JV	Hudong-Zhonghua	174000	X-DF	2025
Unknown	Hull H1895A	CMES/K Line/CMC JV	Hudong-Zhonghua	174000	X-DF	2026
Unknown	Hull H1896A	CMES/K Line/CMC JV	Hudong-Zhonghua	174000	X-DF	2027
9980540	Hull 8049	NYK Line	Hyundai	174000	X-DF	2025
9963449	Hull 2536	MOL	Daewoo	174000	ME-GA	2024
Unknown	Unknown Hull No.	Unknown	Hudong-Zhonghua	174000	X-DF	2025
9975521	Hull 3370	SK Shipping	Hyundai	174000	X-DF	2025

Appendix 4: Table of Global LNG Vessel Orderbook (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9982689	Hull 2612	H-Line Shipping	Samsung	174000	ME-GA	2025
9972361	Hull 2608	H-Line Shipping	Samsung	174000	ME-GA	2025
9972373	Hull 2609	H-Line Shipping	Samsung	174000	ME-GA	2025
9974149	Hull 2631	H-Line Shipping	Samsung	174000	X-DF	2025
9965423	Hull H2700	ADNOC Logistics	Jiangnan	175000	X-DF	2025
9965435	Hull H2701	ADNOC Logistics	Jiangnan	175000	X-DF	2025
9972945	Hull H2702	ADNOC Logistics	Jiangnan	175000	X-DF	2026
9972957	Hull H2703	ADNOC Logistics	Jiangnan	175000	X-DF	2026
9970686	Hull 2551	MOL	Daewoo	174000	ME-GA	2026
9970650	Hull G175K-1	China Merchants Shpg	Dalian Shipbuilding	175000	X-DF	2025
Unknown	Hull G175K-3	China Merchants Shpg	Dalian Shipbuilding	175000	X-DF	2026
9970662	Hull G175K-2	China Merchants Shpg	Dalian Shipbuilding	175000	X-DF	2026
Unknown	Hull G175K-4	China Merchants Shpg	Dalian Shipbuilding	175000	X-DF	2026
Unknown	Hull G175K-5	China Merchants Shpg	Dalian Shipbuilding	175000	X-DF	2026
9962421	Hull 2534	GasLog	Daewoo	174000	ME-GI	2025
9962433	Hull 2535	GasLog	Daewoo	174000	ME-GI	2025
9960588	Hull 2530	BW	Daewoo	174000	ME-GI	2025
9960590	Hull 2531	BW	Daewoo	174000	ME-GI	2025
9969388	Hull 8180	Knutsen OAS	Hyundai	174000	ME-GA	2025
9946362	Hull 8102	Knutsen OAS	Hyundai	174000	X-DF	2024
Unknown	Unknown Hull No.	NYK K Line MISC CLNG	Hudong-Zhonghua	174000	X-DF	2025
Unknown	Unknown Hull No.	NYK K Line MISC CLNG	Hudong-Zhonghua	174000	X-DF	2025
Unknown	Unknown Hull No.	NYK K Line MISC CLNG	Hudong-Zhonghua	174000	X-DF	2025
9976915	Hull 2547	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2024
9976927	Hull 2548	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9976939	Hull 2549	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9986051	Hull 2559	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9986087	Hull 2560	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9986116	Hull 2564	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9986075	Hull 2565	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2026
9986104	Hull 2651	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9986063	Hull 2652	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9986099	Hull 2653	H-Line/Pan Ocean/SK	Daewoo	174000	ME-GA	2025
9991915	Hull 2570	MISC	Daewoo	174000	X-DF	2026
9991927	Hull 2571	MISC	Daewoo	174000	X-DF	2026
Unknown	Hull 2567	Meiji Shipping	Daewoo	174000	X-DF	2026
Unknown	Unknown Hull No.	Unknown	Daewoo	174000	X-DF	2026
Unknown	Unknown Hull No.	Unknown	Daewoo	174000	X-DF	2026
Unknown	Unknown Hull No.	NYK K Line MISC CLNG	Hudong-Zhonghua	174000	X-DF	2026
9987445	Hull 2579	Maran Gas Maritime	Daewoo	174000	ME-GA	2026
9991874	Hull 2568	Meiji Shipping	Daewoo	174000	X-DF	2026

Appendix 4: Table of Global LNG Vessel Orderbook (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9991903	Hull 2569	Meiji Shipping	Daewoo	174000	X-DF	2026
Unknown	Unknown Hull No.	MISC	Samsung	174000	X-DF	2026
Unknown	Unknown Hull No.	MISC	Samsung	174000	X-DF	2026
9961398	Hull 2537	Maran Gas Maritime	Daewoo	174000	ME-GI	2025
9961403	Hull 2538	Maran Gas Maritime	Daewoo	174000	ME-GI	2025
9970569	Hull 2541	Venture Global LNG	Daewoo	200000	ME-GA	2025
9970571	Hull 2542	Venture Global LNG	Daewoo	200000	ME-GA	2025
9970583	Hull 2543	Venture Global LNG	Daewoo	200000	ME-GA	2025
9968932	Hull 2544	BW	Daewoo	174000	ME-GI	2025
9968944	Hull 2545	BW	Daewoo	174000	ME-GI	2025
9967328	Hull 3356	Dynagas	Hyundai	200000	ME-GA	2025
9967330	Hull 3357	Dynagas	Hyundai	200000	ME-GA	2025
9967342	Hull 3358	Dynagas	Hyundai	200000	ME-GA	2025
9972218	Hull 8181	Knutsen OAS	Hyundai	174000	ME-GA	2025
9969376	Hull 8179	Knutsen OAS	Hyundai	174000	ME-GA	2025
9969223	Hull 2619	Celsius Shipping	Samsung	180000	ME-GA	2025
Unknown	Unknown Hull No.	OSC	Hyundai	174000	ME-GA	2026
Unknown	Unknown Hull No.	OSC	Hyundai	174000	ME-GA	2026
Unknown	Unknown Hull No.	Unknown	Yangzi Xinfu SB	175000	ME-GA	2025
Unknown	Unknown Hull No.	Unknown	Yangzi Xinfu SB	175000	ME-GA	2025
Unknown	Unknown Hull No.	Celsius Shipping	CMHI	180000	ME-GI	2026
Unknown	Unknown Hull No.	Celsius Shipping	CMHI	180000	ME-GI	2026
Unknown	Unknown Hull No.	Celsius Shipping	CMHI	180000	ME-GI	2026
Unknown	Unknown Hull No.	Celsius Shipping	CMHI	180000	ME-GI	2026
9972684	Hull 2636	TMS Cardiff Gas	Samsung	174000	ME-GA	2026
9992232	Hull 8200	TMS Cardiff Gas	Hyundai	174000	X-DF	2026
9981386	Hull 3383	Knutsen OAS	Hyundai	174000	X-DF	2025
9981398	Hull 3384	Knutsen OAS	Hyundai	174000	X-DF	2025
9981491	Hull 3395	NYK K Line MISC CLNG	Hyundai	174000	X-DF	2025
9981506	Hull 3396	NYK K Line MISC CLNG	Hyundai	174000	X-DF	2025
9981518	Hull 3397	NYK K Line MISC CLNG	Hyundai	174000	X-DF	2025
9981520	Hull 3398	NYK K Line MISC CLNG	Hyundai	174000	X-DF	2025
9981532	Hull 3399	NYK K Line MISC CLNG	Hyundai	174000	X-DF	2026
9981544	Hull 3400	NYK K Line MISC CLNG	Hyundai	174000	X-DF	2026
9981556	Hull 3401	NYK K Line MISC CLNG	Hyundai	174000	X-DF	2026
9981403	Hull 3385	Knutsen OAS	Hyundai	174000	X-DF	2026
9981415	Hull 3386	Knutsen OAS	Hyundai	174000	X-DF	2026
9981427	Hull 3387	Knutsen OAS	Hyundai	174000	X-DF	2026
9981439	Hull 3393	Knutsen OAS	Hyundai	174000	X-DF	2026
9981441	Hull 3394	Knutsen OAS	Hyundai	174000	X-DF	2026
9975325	Hull 8198	Capital Gas	Hyundai	174000	ME-GA	2026

Appendix 4: Table of Global LNG Vessel Orderbook (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9975533	Hull 3371	SK Shipping	Hyundai	174000	X-DF	2025
Unknown	Unknown Hull No.	SK Shipping	Hyundai	174000	ME-GA	2026
Unknown	Unknown Hull No.	SK Shipping	Hyundai	174000	X-DF	2026
Unknown	Unknown Hull No.	SK Shipping	Hyundai	174000	X-DF	2026
9961489	Hull H1881A	CNOOC/CSLNG/MOL JV	Hudong-Zhonghua	174000	X-DF	2025
9961491	Hull H1882A	CNOOC/CSLNG/MOL JV	Hudong-Zhonghua	174000	X-DF	2025
9961506	Hull H1883A	CNOOC/CSLNG/MOL JV	Hudong-Zhonghua	174000	X-DF	2026
9961518	Hull H1884A	CNOOC/CSLNG/MOL JV	Hudong-Zhonghua	174000	X-DF	2026
9961520	Hull H1885A	CNOOC/CSLNG/MOL JV	Hudong-Zhonghua	174000	X-DF	2026
Unknown	Unknown Hull No.	MOL	Hudong-Zhonghua	174000	X-DF	2027
9963815	Hull 2539	Maran Gas Maritime	Daewoo	174000	ME-GI	2025
9963827	Hull 2540	Maran Gas Maritime	Daewoo	174000	ME-GI	2025
9972969	Hull H2704	ADNOC Logistics	Jiangnan	175000	X-DF	2026
9972971	Hull H2705	ADNOC Logistics	Jiangnan	175000	X-DF	2027
9972385	Hull 2610	H-Line Shipping	Samsung	174000	ME-GA	2025
Unknown	Hull H1897A	CMES/K Line/CMC JV	Hudong-Zhonghua	174000	X-DF	2027
Unknown	Unknown Hull No.	NYK Line	Hudong-Zhonghua	174000	X-DF	2027
Unknown	Unknown Hull No.	NYK Line	Hudong-Zhonghua	174000	X-DF	2027
Unknown	Unknown Hull No.	NYK Line	Hudong-Zhonghua	174000	X-DF	2026
9975337	Hull 8199	Capital Gas	Hyundai	174000	ME-GA	2026
9974606	Hull 2552	Maran Gas Maritime	Daewoo	174000	ME-GI	2026
9974618	Hull 2553	Maran Gas Maritime	Daewoo	174000	ME-GI	2026
Unknown	Unknown Hull No.	Meiji Shipping	Samsung	174000	X-DF	2026
Unknown	Unknown Hull No.	Meiji Shipping	Samsung	174000	X-DF	2026
9988023	Hull 2652	Minerva Marine	Samsung	174000	X-DF	2026
9988035	Hull 2653	Minerva Marine	Samsung	174000	X-DF	2026
9974163	Hull 2633	H-Line Shipping	Samsung	174000	X-DF	2026
Unknown	Unknown Hull No.	Excelerate Energy	Hyundai	170000	DFDE	2026
9970674	Hull 2550	MOL	Daewoo	174000	ME-GA	2026
9983176	Hull 2558	Knutsen OAS	Daewoo	174000	ME-GA	2026
Unknown	Hull G175K-6	China Merchants Shpg	Dalian Shipbuilding	175000	X-DF	2026
Unknown	Unknown Hull No.	CMES	Dalian Shipbuilding	175000	X-DF	2026
Unknown	Unknown Hull No.	CMES	Dalian Shipbuilding	175000	X-DF	2026
Unknown	Unknown Hull No.	Capital Gas	Hyundai	174000	ME-GA	2026
Unknown	Unknown Hull No.	Capital Gas	Hyundai	174000	ME-GA	2026
9992244	Hull 8201	TMS Cardiff Gas	Hyundai	174000	X-DF	2026
9989429	Hull 2576	MOL	Daewoo	174000	ME-GI	2026
Unknown	Unknown Hull No.	Venture Global LNG	Daewoo	200000	ME-GA	2026
Unknown	Unknown Hull No.	Venture Global LNG	Daewoo	200000	ME-GA	2026
9986570	Hull H1794A	MOL & CSLNG JV	Hudong-Zhonghua	174000	X-DF	2027
9986582	Hull H1795A	MOL & CSLNG JV	Hudong-Zhonghua	174000	X-DF	2027

Appendix 4: Table of Global LNG Vessel Orderbook (continued)

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9986594	Hull H1796A	MOL & CSLNG JV	Hudong-Zhonghua	174000	X-DF	2027
Unknown	Unknown Hull No.	MOL	Daewoo	174000	ME-GA	2027
Unknown	Unknown Hull No.	MOL	Samsung	174000	ME-GA	2027
Unknown	Unknown Hull No.	MOL	Samsung	174000	ME-GA	2027
9992103	Hull 2656	Seapeak	Samsung	174000	ME-GA	2027
9992115	Hull 2657	Seapeak	Samsung	174000	ME-GA	2027
9992127	Hull 2658	Seapeak	Samsung	174000	ME-GA	2027
9992139	Hull 2659	Seapeak	Samsung	174000	ME-GA	2027
9992141	Hull 2660	Seapeak	Samsung	174000	ME-GA	2027
Unknown	Unknown Hull No.	Unknown	Daewoo	174000	ME-GI	2026
Unknown	Hull H1898A	MOL	Hudong-Zhonghua	174000	X-DF	2027
Unknown	Hull H1899A	MOL	Hudong-Zhonghua	174000	X-DF	2027
Unknown	Hull H1900A	MOL	Hudong-Zhonghua	174000	X-DF	2028
Unknown	Unknown Hull No.	NYK Line	Hyundai	174000	X-DF	2027
Unknown	Unknown Hull No.	NYK Line	Hyundai	174000	ME-GA	2027
Unknown	Unknown Hull No.	NYK Line	Hyundai	174000	ME-GA	2027
Unknown	Unknown Hull No.	Maran Gas Maritime	Daewoo	174000	ME-GA	2027
Unknown	Unknown Hull No.	Maran Gas Maritime	Daewoo	174000	ME-GA	2027
Unknown	Unknown Hull No.	Capital Gas	Hyundai	174000	ME-GA	2027
Unknown	Unknown Hull No.	Capital Gas	Hyundai	174000	ME-GA	2027
Unknown	Unknown Hull No.	China Taiping Insurance Holdings	Jiangnan	175000	X-DF	2027
Unknown	Unknown Hull No.	China Taiping Insurance Holdings	Jiangnan	175000	X-DF	2027
Unknown	Unknown Hull No.	K Line	Samsung	174000	ME-GA	2026
Unknown	Unknown Hull No.	K Line	Samsung	174000	ME-GA	2026
Unknown	Unknown Hull No.	MOL	Daewoo	174000	ME-GA	2027
9994046	Hull 3435	Dynagas	Hyundai	200000	ME-GA	2026

Appendix 5: Table of Global LNG Receiving Terminals

Reference Number	Market	Terminal Name	Start Year	Regasification Capacity (MTPA)	Owners	Concept
1	Argentina	Bahia Blanca GasPort - Excelerate Exemplar	2021	3.8	YPF (50%); Stream JV (50%);	Floating
2	Argentina	GNL Escobar - Excelerate Expedient	2011	3.8	YPF (50%); Enarsa (50%);	Floating
3	Bahrain	Bahrain LNG	2020	6	NOGA (30%); Teekay Corporation (30%); Gulf Investment Corporation (20%); Samsung (20%);	Floating
4	Bangladesh	Moheshkhali - Excelerate Excellence	2018	3.8	PetroBangla (100%);	Floating
5	Bangladesh	Summit FSRU	2019	3.8	Summit Group (75%); Mitsubishi (25%);	Floating
6	Belgium	Zeebrugge	1987	6.6	Fluxys LNG SA (100%);	Onshore
7	Brazil	Acu Port LNG	2020	5.6	Prumo Logistica (46.9%); Siemens (33%); BP (20.1%);	Floating
8	Brazil	Bahia LNG	2021	5.4	Petrobras (100%);	Floating
9	Brazil	Guanabara LNG	2020	8.1	Petrobras (100%);	Floating
10	Brazil	Pecem LNG	2021	3.8	Petrobras (100%);	Floating
11	Brazil	Sergipe LNG	2020	5.6	Eneva (100%);	Floating
12	Canada	Saint John LNG	2009	7.5	Repsol (100%);	Onshore
13	Chile	GNL Mejillones	2014	1.5	ENGIE (63%); Ameris Capital (37%);	Onshore
14	Chile	GNL Quintero	2009	4	Fluxys (40%); EIG (40%); ENAP (20%);	Onshore
15	China	Caofeidian (Tangshan) LNG	2013	10	CNPC (51%); Beijing Enterprises Group Company (29%); Hebei Natural Gas (20%);	Onshore
16	China	Dalian LNG	2011	6	PipeChina (75%); Dalian Port (20%); Dalian Construction Investment Corporation (5%);	Onshore
17	China	Diefu LNG (Shenzhen)	2018	4	PipeChina (70%); Shenzhen Energy Group (30%);	Onshore
18	China	Fangchenggang LNG	2019	0.6	PipeChina (51%); Guangxi Beibu Gulf Port Group (49%)	Onshore
19	China	Fujian LNG	2009	6.3	CNOOC (60%); Fujian Investment and Development Co (40%);	Onshore
20	China	Guangdong Dapeng LNG	2006	6.8	CNOOC (33%); Guangdong Province Consortium (31%); BP (30%); HK & China Gas (3%); Hong Kong Electric (3%);	Onshore
21	China	Guangxi Beihai LNG	2016	6	PipeChina (80%); Guangxi Beibu Gulf Port Group (20%)	Onshore
22	China	Hainan Yangpu LNG	2014	3	PipeChina (65%); China Energy Group Haikong New Energy (35%);	Onshore
23	China	Jiangsu Rudong LNG	2011	10	CNPC (55%); Pacific Oil and Gas (35%); Jiangsu Guoxin (10%);	Onshore
24	China	Jiangsu Yancheng Binhai LNG	2022	3	CNOOC (100%);	Onshore
25	China	Jiaxing Pinghu LNG	2022	1	Jiaxing Gas Group (51%); Hangzhou Gas (49%);	Onshore
26	China	Jieyang (Yuedong) LNG	2018	2	PipeChina (100%);	Onshore
27	China	Jovo Dongguan	2012	1	Jovo Group (100%);	Onshore
28	China	Qidong LNG (1-3)	2017	3	Xinjiang Guanghui Petroleum (100%);	Onshore
29	China	Qidong LNG 4	2022	2	Xinjiang Guanghui Petroleum (100%);	Onshore
30	China	Shandong (Qingdao) LNG	2014	7	Sinopec (99%); Qingdao Port(1%);	Onshore

Appendix 5: Table of Global LNG Receiving Terminals (continued)

Reference Number	Market	Terminal Name	Start Year	Regasification Capacity (MTPA)	Owners	Concept
31	China	Shanghai Wuhaogou LNG	2008	1.5	Shenergy (100%);	Onshore
32	China	Shanghai Yangshan LNG	2009	6	Shenergy Group (55%); CNOOC (45%);	Onshore
33	China	Shenzhen Gas LNG	2019	0.8	Shenzhen Gas (100%);	Onshore
34	China	Tianjin PipeChina LNG	2013	6	PipeChina (100%);	Onshore
35	China	Tianjin Sinopec LNG	2018	6	Sinopec (98%); Tianjin Nangang Industrial Zone Developemnt Co (2%);	Onshore
36	China	Zhejiang Ningbo LNG (1-2)	2012	6	CNOOC (51%); Zhejiang Energy Company (29%); Ningbo Power (20%);	Onshore
37	China	Zhoushan ENN LNG	2018	5	ENN (90%); Prism Energy (10%);	Onshore
38	China	Zhuhai LNG	2013	3.5	CNOOC (30%); Guangdong Energy (25%); Guangzhou Gas Group (25%); Local companies (20%);	Onshore
39	Chinese Taipei	Taichung LNG	2009	6	CPC (100%);	Onshore
40	Chinese Taipei	Yung-An	1990	10.5	CPC (100%);	Onshore
41	Colombia	SPEC FSRU	2016	3	Promigas (51%); Royal Vopak (49%);	Floating
42	Croatia	Krk LNG Terminal	2021	2.1	HEP (85%); Plinacro (15%);	Floating
43	Dominican Republic	AES Andres LNG	2003	1.9	AES (100%);	Onshore
44	Egypt	Sumed - BW Singapore	2017	5.7	EGAS (100%);	Floating
45	El Salvador	El Salvador FSRU	2022	2.1	Energía del Pacífico (100%);	Floating
46	Finland	Inkoo FSRU	2023	3.7	Gasgrid Finland (100%);	Floating
47	France	Dunkirk LNG	2017	9.6	Fluxys and AXA Investment Managers & Crédit Agricole Assurances (60.76%); IPM Group and Samsung Asset Management (39.24%);	Onshore
48	France	Fos Cavaou	2010	6	ENGIE (100%);	Onshore
49	France	Fos Tonkin	1972	1.1	ENGIE (100%);	Onshore
50	France	Montoir-de-Bretagne	1980	8	ENGIE (100%);	Onshore
51	Germany	Elbehafen LNG Terminal	2023	3.7	RWE (100%);	Floating
52	Germany	Lubmin LNG	2023	3.8	Deutsche Regas (100%);	Floating
53	Germany	Wilhelmshaven LNG	2022	5.5	Uniper (100%);	Floating
54	Greece	Revithoussa	2000	4.9	DEPA (100%);	Onshore
55	India	Dabhol LNG	2013	2	Gail (31.52%); NTPC (31.52%); Indian Financial Institutions (20.28%); MSEB Holding Co. (16.68%);	Onshore
56	India	Dahej LNG	2004	17.5	Petronet LNG (100%);	Onshore
57	India	Ennore LNG	2019	5	Indian Oil Corporation (95%); Tamil Nadu Industrial Development Corporation (5%);	Onshore
58	India	Hazira LNG	2005	5	Shell (100%);	Onshore
59	India	Kochi LNG	2013	5	Petronet LNG (100%);	Onshore
60	India	Mundra LNG	2020	5	GSPC (50%); Adani Group (50%);	Onshore

Appendix 5: Table of Global LNG Receiving Terminals (continued)

Reference Number	Market	Terminal Name	Start Year	Regasification Capacity (MTPA)	Owners	Concept
61	Indonesia	Arun LNG	2015	3	Pertamina (70%); Aceh Regional Government (30%);	Onshore
62	Indonesia	Cilamaya - Jawa 1 FSRU	2021	2.4	Pertamina (26%); Humpuss (25%); Marubeni (20%); MOL (19%); Sojitz (10%);	Floating
63	Indonesia	Lampung LNG - PGN FSRU Lampung	2014	1.8	LNG Indonesia (100%);	Floating
64	Indonesia	Nusantara Regas Satu - FSRU Jawa Barat	2012	3.8	Pertamina (60%); PGN (40%);	Floating
65	Israel	Hadera Deepwater LNG - Excelerate Expedient	2013	3	INGL (100%);	Floating
66	Italy	Adriatic LNG	2009	6.6	ExxonMobil (70.7%); Qatar Petroleum (22%); Snam (7.3%);	Offshore
67	Italy	Panigaglia LNG	1971	2.5	GNL Italia (100%);	Onshore
68	Italy	Ravenna LNG	2021	0.7	Petrolifera Italo Rumena (51%); Edison S.p.A. (30%); Scale Gas Solutions (19%);	Onshore
69	Italy	Toscana - Toscana FSRU	2013	2.7	Snam (49.07%); First State Investments (48.24%); Golar LNG (2.69%);	Floating
70	Jamaica	Old Harbour FSRU	2019	3.6	New Fortress Energy (100%);	Floating
71	Japan	Akita LNG Terminal	2015	0.6	Tobu Gas (100%);	Onshore
72	Japan	Chita LNG	1983	10.9	Chubu Electric (50%); Toho Gas (50%);	Onshore
73	Japan	Chita LNG	1977	7.5	JERA (50%); Toho Gas (50%);	Onshore
74	Japan	Chita Midorihama Works	2001	8.3	Toho Gas (100%);	Onshore
75	Japan	Futtsu LNG	1985	16	JERA (100%);	Onshore
76	Japan	Hachinohe	2015	1.5	JX Nippon Oil & Energy (100%);	Onshore
77	Japan	Hatsukaichi	1996	0.9	Hiroshima Gas (100%);	Onshore
78	Japan	Hibiki LNG	2014	2.4	Saibu Gas (90%); Kyushu Electric (10%);	Onshore
79	Japan	Higashi-Niigata	1984	8.9	Nihonkai LNG (58.1%); Tohuko Electric (41.9%);	Onshore
80	Japan	Higashi-Ohgishima	1984	14.7	JERA (100%);	Onshore
81	Japan	Himeji LNG Kansai	1979	14	Osaka Gas (100%);	Onshore
82	Japan	Hitachi LNG	2016	6.4	Tokyo Gas (100%);	Onshore
83	Japan	Ishikari LNG	2012	2.7	Hokkaido Gas (100%);	Onshore
84	Japan	Joetsu	2012	2.3	JERA (100%);	Onshore
85	Japan	Kawagoe	1997	7.7	JERA (100%);	Onshore
86	Japan	Kushiro LNG	2015	0.5	Nippon Oil (100%);	Onshore
87	Japan	Mizushima	2006	4.3	Chugoku Electric (50%); JX Nippon Oil & Energy (50%);	Onshore
88	Japan	Naoetsu LNG	2013	1.5	INPEX (100%);	Onshore
89	Japan	Negishi	1969	12	JERA (50%); Tokyo Gas (50%);	Onshore
90	Japan	Niihama LNG	2022	1	Tokyo Gas (50.1%); Shikoku Electric Power (30.1%); Other Japanese Partneers (19.8%);	Onshore

Appendix 5: Table of Global LNG Receiving Terminals (continued)

Reference Number	Market	Terminal Name	Start Year	Regasification Capacity (MTPA)	Owners	Concept
91	Japan	Ohgishima	1998	9.9	Tokyo Gas (100%);	Onshore
92	Japan	Oita LNG	1990	5.1	Kyushu Electric (100%);	Onshore
93	Japan	Sakai LNG	2006	6.4	Kansai Electric (70%); Cosmo Oil (12.5%); Iwatani (12.5%); Ube Industries (5%);	Onshore
94	Japan	Sakaide LNG	2010	1.2	Shikoku Electric Power Co. (70%); Cosmo Oil Co. Ltd (20%); Shikoku Gas Co. (10%);	Onshore
95	Japan	Senboku I & II	1972	15.3	Osaka Gas (100%);	Onshore
96	Japan	Shin-Sendai	2015	1.5	Tohoku Electric (100%);	Onshore
97	Japan	Sodegaura	1973	29.4	JERA (50%); Tokyo Gas (50%);	Onshore
98	Japan	Sodeshi	1996	2.9	Shizuoka Gas (65%); ENEOS Corporation (35%);	Onshore
99	Japan	Soma LNG	2018	1.5	JAPEX (100%);	Onshore
100	Japan	Tobata	1977	6.8	Kitakyushu LNG (100%);	Onshore
101	Japan	Yanai	1990	2.4	Chugoku Electric (100%);	Onshore
102	Japan	Yokkaichi LNG Center	1987	6.4	JERA (100%);	Onshore
103	Japan	Yokkaichi Works	1991	2.1	Toho Gas (100%);	Onshore
104	Jordan	Jordan LNG - Golar Eskimo	2015	3.8	Jordan MEMR (100%);	Floating
105	Kuwait	Al-Zour LNG Import Facility	2021	11.3	Kuwait Petroleum Corporation (100%);	Onshore
106	Kuwait	Mina Al Ahmadi	2014	5.8	Kuwait Petroleum Corporation (100%);	Floating
107	Lithuania	Klaipeda LNG	2014	3	Klaipedos Nafta (100%);	Floating
108	Malaysia	Melaka LNG	2013	3.8	Petronas (100%);	Floating
109	Malaysia	Pengerang LNG	2017	3.5	PETRONAS (65%); Dialog Group (25%); Johor Government (10%);	Onshore
110	Mexico	Energia Costa Azul	2008	7.6	Sempra Energy (100%);	Onshore
111	Mexico	Pichilingue LNG	2021	0.8	New Fortress Energy (100%);	Onshore
112	Mexico	Terminal de LNG Altamira	2006	5.4	Vopak (60%); ENAGAS (40%);	Onshore
113	Mexico	Terminal KMS	2012	3.8	Samsung (37.5%); Mitsui (37.5%); KOGAS (25%);	Onshore
114	Myanmar	Thilawa LNG	2020	1.5	CNTIC VPower (100%);	Onshore
115	Netherlands	Gate LNG terminal (LNG Rotterdam) expansion 1	2022	2.94	Gasunie (50%); Vopak (50%);	Onshore
116	Netherlands	Eemshaven FSRU	2022	5.9	Gasunie (100%);	Floating
117	Netherlands	Gate LNG terminal (LNG Rotterdam)	2011	8.86	Gasunie (50%); Vopak (50%);	Onshore
118	Pakistan	Port Qasim GasPort - BW Integrity	2017	5.7	Pakistan LNG Terminals Limited (100%);	Floating
119	Pakistan	Port Qasim Karachi LNG	2015	4.8	Elengy Terminal Pakistan Ltd. (100%);	Floating
120	Panama	Costa Norte LNG	2018	1.5	AES (100%);	Onshore
121	Philippines	Batangas Bay LNG Terminal	2023	5	AG&P (100%);	Floating
122	Poland	Swinoujscie LNG	2016	3.7	Gaz-System (100%);	Onshore

Appendix 5: Table of Global LNG Receiving Terminals (continued)

Reference Number	Market	Terminal Name	Start Year	Regasification Capacity (MTPA)	Owners	Concept
123	Portugal	Sines LNG Terminal	2004	5.8	REN (100%);	Onshore
124	Russia	Kaliningrad FSRU	2019	2.7	Gazprom (100%);	Floating
125	Singapore	Jurong LNG	2013	11	SLNG (100%);	Onshore
126	South Korea	Boryeong LNG	2017	3	GS Caltex (50%); SK E&S (50%);	Onshore
127	South Korea	Gwangyang LNG	2005	3.1	POSCO (100%);	Onshore
128	South Korea	Incheon	1996	54.9	KOGAS (100%);	Onshore
129	South Korea	Jeju LNG	2019	1	KOGAS (100%);	Onshore
130	South Korea	Pyeongtaek LNG	1986	41	KOGAS (100%);	Onshore
131	South Korea	Samcheok LNG	2014	11.6	KOGAS (100%);	Onshore
132	South Korea	Tongyeong LNG	2002	26.5	KOGAS (100%);	Onshore
133	Spain	Bahía de Bizkaia Gas	2003	5.1	ENAGAS (50%); EVE (50%);	Onshore
134	Spain	Barcelona LNG	1969	12.6	Enagas (100%);	Onshore
135	Spain	Cartagena	1989	8.6	Enagas (100%);	Onshore
136	Spain	Huelva	1988	8.6	Enagas (100%);	Onshore
137	Spain	Mugardos LNG	2007	2.6	Tojeiro Group (51%); Sojitz (15%); Sonatrach (10%); the Government of Galicia (24%);	Onshore
138	Spain	Sagunto	2006	6.4	ENAGAS (72.5%); Osaka Gas (20%); Oman Oil (7.5%);	Onshore
139	Thailand	Map Ta Phut	2011	11.5	PTT LNG (100%);	Onshore
140	Thailand	Nong Fab LNG	2022	7.5	PTT LNG (100%);	Onshore
141	Turkey	Aliaga Izmir LNG	2006	4.4	EgeGaz (100%);	Onshore
142	Turkey	Dortyol LNG terminal	2021	7.5	Botas (100%);	Floating
143	Turkey	Etki LNG terminal	2019	7.5	Etki Liman (100%);	Floating
144	Turkey	Marmara Ereglisi	1994	5.9	Botas (100%);	Onshore
145	Turkey	Gulf of Saros FSRU	2023	5.6	Botas (100%);	Floating
146	UAE	Dubai Jebel Ali	2015	6	DUSUP (100%);	Floating
147	United Kingdom	Dragon LNG	2009	5.6	Shell (50%); Ancala (50%);	Onshore
148	United Kingdom	Grain LNG	2005	15	National Grid Transco (100%);	Onshore
149	United Kingdom	South Hook LNG	2009	15.6	Qatar Petroleum (67.5%); Exxon Mobil (24.25%); ELF Petroleum (8.35%);	Onshore
150	United States	EcoElectrica	2000	2	Gas natural Fenosa (47.5%); ENGIE (35%); Mitsui (15%); GE Capital (2.5%);	Onshore
151	United States	San Juan - New Fortress LNG	2020	1.1	New Fortress Energy (100%);	Floating
152	United States	Cove Point LNG	2003	11	Dominion Cove Point LNG (100%);	Onshore
153	United States	Elba Island LNG	1978	12	Kinder Morgan (100%);	Onshore
154	United States	Everett	1971	5.4	Exelon Generation (100%);	Onshore

Appendix 5: Table of Global LNG Receiving Terminals (continued)

Reference Number	Market	Terminal Name	Start Year	Regasification Capacity (MTPA)	Owners	Concept
155	United States	Neptune Deepwater LNG Port	2010	5.4	Northeast Gateway Energy Bridge LLC (100%);	Onshore
156	United States	Northeast Gateway	2008	4.5	Excelerate Energy (100%);	Floating
157	Brazil	KARMOL LNGT Powership Aisa	2022	0.1	Kapowership;Mitsui OSK Lines;	Floating
158	China	Hainan Shennan LNG	2014	0.3	Hainan CNPC Shennan Petroleum Technology Development (90%); Hainan Fushan Oil and Gas Chemical (10%);	Onshore
159	Finland	Hamina LNG-terminal	2022	0.1	Hamina LNG Oy (100%);	Onshore
160	Finland	Pori LNG	2016	0.2	Gasum (100%);	Onshore
161	Finland	Tornio Manga LNG	2018	0.4	Wärtsilä (100%);	Onshore
162	Indonesia	Benoa LNG (Bali)	2016	0.3	PT Pelindo (50%); JSK Group (50%);	Floating
163	Indonesia	Powership Zeynep Sultan Amurang - Hua Xiang 8 FSRU	2020	0.1	PLT(50%); PT Humpuss (50%);	Floating
164	Italy	HIGAS LNG terminal	2021	0.2	Avenir LNG (80%); Gas and Heat (10%); CPL Concordia (10%);	Onshore
165	Japan	Chikko Terminal	2003	0.2	Okayama Gas (100%);	Onshore
166	Japan	Hakodate-Minato Terminal	2006	0.2	Hokkaido Gas (100%);	Onshore
167	Japan	Kagoshima	1996	0.2	Nippon Gas (100%);	Onshore
168	Japan	Matsuyama Terminal	2008	0.4	Shikoku Gas (100%);	Onshore
169	Japan	Nagasaki	2003	0.2	Saibu Gas (100%);	Onshore
170	Japan	Shin-Minato	1997	0.3	Gas Bureau (100%);	Onshore
171	Japan	Takamatsu Terminal	2003	0.4	Shikoku Gas (100%);	Onshore
172	Japan	Tokushima LNG Terminal	2019	0.18	Shikoku Gas (100%);	Onshore
173	Japan	Toyama Shinko	2018	0.38	Hokuriku Electric (100%);	Onshore
174	Japan	Yufutsu Terminal	2011	0.14	JAPEX (100%);	Onshore
175	Malta	Electrogas Malta	2017	0.4	Reganosa (100%);	Floating
176	Norway	Fredrikstad LNG terminal	2011	0.1	Gasum (100%);	Onshore
177	Norway	Mosjøen LNG terminal	2007	0.4	Gasnor (100%);	Onshore
178	Sweden	Lysekil LNG	2014	0.2	Skangas (100%);	Onshore
179	Sweden	Nynäshamn LNG	2011	0.4	AGA (100%);	Onshore
180	United Kingdom	Mowi LNG terminal	2021	0.2	Mowi (100%);	Onshore

Note:
1. 157–180 are terminals with small-scale (<0.5 MTPA) regasification capacity but add large impact on import for the market.
2. Croatia's Krk LNG Terminal expanded its receiving capacity from 1.9 Mtpa to 2.1 Mtpa at the existing facility.
3. Tianjin PipeChina LNG FSRU left berth in March 2023 and becomes an onshore terminal with 4 completed storage tanks.

Appendix 6: Table of LNG Receiving Terminals Under Construction

Reference Number	Market	Terminal Name	Start Year	Nameplate Receiving Capacity (Mtpa)	Ownership	Concept
181	Brazil	Sao Paulo LNG	2023	3.78	Cosan (100%);	Floating
182	Brazil	Terminal Gas Sul (TGS) LNG	2023	4	New Fortress Energy (100%);	Floating
183	Chile	GNL Talcahuano	2023	2.3	EOS LNG (100%);	Floating
184	China	Chaozhou Huafeng LNG	2023	1	Sinoenergy (55%); Chaozhou Huafeng Group (45%);	Onshore
185	China	Chaozhou Huaying LNG	2023	6	Huaying Investment Holding Group (50%); Sinopec Natural Gas Co Ltd (50%);	Onshore
186	China	Hong Kong Offshore LNG	2023	6.1	Castle Peak Power Company Limited (70%); Hongkong Electric Co., Ltd. (30%);	Floating
187	China	Huizhou LNG	2023	6.1	Guangdong Energy Group (100%);	Onshore
188	China	Jiangsu Ganyu (Huadian) LNG	2026	3	China Huadian (51%); Lianyungang Port Group (20%); SK (14%); BP (10%); JERA (5%);	Onshore
189	China	Jiangsu Guoxin Rudong LNG	2023	3	Jiangsu Guoxin (95%); Jiangsu Yangkou Port (5%);	Onshore
190	China	Jieyang (Yuedong) LNG 2	2023	2	PipeChina (100%);	Onshore
191	China	Jiangsu Yancheng Binhai LNG 1 expansion	2023	3	CNOOC (100%);	Onshore
192	China	Qidong LNG 5	2025	5	Xinjiang Guanhui Petroleum (100%);	Onshore
193	China	PipeChina Longkou Nanshan LNG	2024	5	PipeChina (60%); Nanshan Group (40%);	Onshore
194	China	Tianjin PipeChina LNG 2	2024	6	PipeChina (100%);	Onshore
195	China	Tianjian PipeChina LNG 3	2025	6.5	PipeChina (100%);	Onshore
196	China	Shandong (Qingdao) LNG 3	2023	4	Sinopec (99%); Qingdao Port(1%);	Onshore
197	China	Shanghai LNG	2025	3	Shenergy Group (60%); Zhejiang Energy (20%); CNOOC (20%);	Onshore
198	China	Sinopec Longkou LNG	2023	6.5	Sinopec Gas (50%); Hengtong Logistics (32%); Longkou port (18%);	Onshore
199	China	Tangshan LNG 1	2023	5	Suntien Green Energy (100%);	Onshore
200	China	Zhejiang ningbo LNG 3	2025	6	CNOOC (51%); Zhejiang Energy Company (29%); Ningbo Power (20%);	Onshore
201	China	Tianjin Nangang LNG 1	2023	1.9	Beijing Gas (100%);	Onshore
202	China	Tianjin Nangang LNG 2	2024	2.0	Beijing Gas (100%);	Onshore
203	China	Tianjin Nangang LNG 3	2025	1.0	Beijing Gas (100%);	Onshore
204	China	Tianjin Sinopec LNG 2	2023	4.8	Sinopec (98%); Tianjin Nangang Industrial Zone Developemnt Co (2%);	Onshore
205	China	Wenzhou Huagang LNG	2023	3	Huafeng Grop (100%);	Onshore
206	China	Wenzhou LNG	2023	3	Sinopec (41%); Zhejiang Energy Group (51%); Local firms (8%);	Onshore
207	China	Wuhu LNG terminal	2024	1.5	Huaihe Energy (100%);	Onshore
208	China	Xiexin Huidong Jiangsu Rudong LNG	2025	3	Pacific Energy (49%); Xiexin Oil and Gas (26%); Huidon Investment (25%);	Onshore
209	China	Yangjiang LNG	2024	2.8	Guangdong Yudean Power (100%);	Onshore
210	China	Yantai LNG	2023	5.9	Shandong Poly-GCL Pan-Asia International Energy Co., Ltd. (100%);	Onshore

Appendix 6: Table of LNG Receiving Terminals Under Construction (continued)

Reference Number	Market	Terminal Name	Start Year	Nameplate Receiving Capacity (Mtpa)	Ownership	Concept
211	China	Yingkou LNG terminal	2025	6.2	China Urban Rural Energy (75%); Hebei Shenneng Industry Group (25%);	Onshore
212	China	Zhangzhou LNG 1	2023	3	PipeChina (60%); Fujian Investment and Development Co (40%);	Onshore
213	China	Zhangzhou LNG 2	2024	3	PipeChina (60%); Fujian Investment and Development Co (40%);	Onshore
214	China	Zhoushan ENN LNG 3	2025	5	ENN (90%); Prism Energy (10%);	Onshore
215	China	Zhuhai LNG 2	2023	3.5	CNOOC (30%); Guangdong Energy (25%); Guangzhou Gas Group (25%); Local companies (20%);	Onshore
216	Chinese Taipei	Taoyuan LNG	2023	3	CPC (100%);	Onshore
217	Estonia	Paldiski LNG	2023	3.7	Alexela (100%);	Floating
218	Germany	Brunsbuettel LNG Terminal	2026	5.88	Kreditanstalt für Wiederaufbau (50%); Gasunie (40%); RWE (10%);	Onshore
219	Germany	Stade LNG	2024	5.51	Hanseatic Energy Hub (50%); Uniper (50%);	Floating
220	Ghana	Tema LNG terminal	2023	1.7	GNPC (50%); Helios (50%);	Floating
221	India	Chhara LNG	2023	5	HPCL (50%); Shapoorji Pallonji (50%);	Onshore
222	India	Dabhol LNG Breakwater Completition	2023	3	Gail (31.52%); NTPC (31.52%); Indian Financial Institutions (20.28%); MSEB Holding Co. (16.68%);	Onshore
223	India	Dabhol KNG 2	2023	5	Gail (31.52%); NTPC (31.52%); Indian Financial Institutions (20.28%); MSEB Holding Co. (16.68%);	Onshore
224	India	Dhamra LNG	2023	5	Adani Group (50%); Total (50%);	Onshore
225	India	H-Gas LNG Gateway	2025	6	H-Energy Gateway Private limited (100%);	Floating
226	India	Jafrabad FSRU	2023	5	Swan Energy Limited (32.12%); Indian Farmers Fertiliser Cooperative Limited (30.87%); Mitsui Group (11%); Gujarat Maritime Board (15%); Gujarat State Petronet Ltd (11%);	Floating
227	India	Karaikal LNG	2024	1	AG&P (100%);	Floating
228	Italy	Piombino FSRU	2023	3.7	Snam (100%);	Floating
229	Nicaragua	Puerto Sandino FSRU	2023	1.3	New Fortress Energy (100%);	Floating
230	Pakistan	Energas Terminal	2024	5.6	Energas (50%); Yunus Group (50%);	Floating
231	Panama	Sinolam LNG (Gaslog Singapore)	2023	1.1	Sinolam Smarter Energy LNG Power Co. (100%);	Floating
232	Philippines	First Gen LNG	2023	5	First Gen LNG (80%); Tokyo Gas (20%);	Floating
233	Philippines	Pagbilao LNG	2024	3	Energy World Corporation (100%);	Onshore
234	Poland	Swinoujscie LNG 1 Expansion	2023	2.43	Gaz-System (100%);	Onshore
235	Poland	Swinoujscie LNG 2	2024	1.9	Gaz-System (100%);	Onshore
236	Senegal	Sengal FSRU	2023	2.5	Karadeniz Energy Group (100%);	Floating
237	South Korea	Gwangyang LNG 2	2025	2.1	POSCO (100%);	Onshore
238	Vietnam	Hai Linh LNG	2023	3	Hai Linh Co Ltd (100%);	Onshore
239	Vietnam	Thi Vai LNG	2023	1	PetroVietnam Gas (100%);	Onshore

Note:
1. Another two storage tanks in Tianjin PipeChina LNG 2 are under construction as of April 2023.

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