IGU
INTERNATIONAL GAS UNION
UNION INTERNATIONALE DU GAZ

2022 WORLD LNG REPORT

Knowledge Partner

RYSTAD ENERGY

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MESSAGE FROM THE SECRETARY GENERAL OF THE INTERNATIONAL GAS UNION

Dear Colleagues,

This 13th edition of the IGU World LNG Report has become one of the most anticipated, in light of another, even more eventful year for the LNG sector.

The 2022 report is out at a time when LNG is more vital than ever to secure and reliable functioning of energy systems around the world. It is also a vital tool for controlling emissions, particularly as the crisis in energy supply is forcing even the most climate-conscious economies to turn back to coal, wiping out emissions reductions achieved in recent years.

The worst global energy crisis on memory is unfolding in the context of a fragile recovery from the global pandemic and compounding impacts of a broader commodity, inflation, and food supply crises. All while the planet is warming and the need to reverse growing emissions trends is urgent.

Even if it is becoming increasingly challenging in the current environment, the world must stay the course of energy transition, and natural gas, together with a growing portfolio of decarbonised, low and zero carbon gases, will be key to making that possible. Gas is the fastest available and sustainable long-term vehicle to get the world back onto the energy transition path, and the inherent flexibility of LNG allows to deliver it to almost anywhere in the world.

As of April 2022, LNG connected 40 importing with 19 exporting markets. We also saw global liquefaction capacity reach another high of 459.9 MTPA in 2021, after adding 6.9 MTPA, compared to the 20 MTPA the year prior. The great potential for LNG in Africa is very important to the region's development, with its 123.9 MTPA of proposed liquefaction waiting for FID. Global regasification capacity has reached 901.9 MTPA as of April 2022, following capacity additions of 49.8 MTPA in 2021, and 4.3 MTPA in the first four months of 2022. Floating storage and regasification (FSR) has proven to be essential in the ongoing efforts to rapidly diversify supply, and as of April 2022, FSR capacity worldwide stood at 142.6 MTPA with 32 operational terminals around the world. Finally, we are all too aware of the price rally that started after a rapid post-COVID-19 demand recovery and less rapid additions of supply and continued to get worse as the Russia-Ukraine conflict added more stress to the already fully subscribed market. Spot LNG prices surged to historic highs, and European benchmarks exceeded Asia. Addressing supply constraints is going to be critical to energy security and economic stability in the world.

The global gas industry welcomes the opportunity to demonstrate how it can maximise gas benefits to stregthen its role in sustainable, secure, affordable, and reliable energy of the future.

I welcome opportunities to demonstrate the immense contribution that liquefied natural gas today, and progressively decarbonised, low and zero- carbon gases, will make to sustainable energy – now and in the future. It is so, because gas itself is a major decarbonisation vehicle, and the only hydrocarbon that can be decarbonised at scale, while continuing to provide flexibility and reliability to energy consumers and feedstock to vital indusial sectors. Gas and renewables will be the two major pillars of decarbonisation.

However, clarity of policy and direction from the public sector is imperative to provide consistent signals to the industry and the financial community needed to guide industry investment decisions.

LNG plays a critical role in global energy security and economic stability, and this role has never been greater than now. As the world considers its options for navigating through the unprecedented times, policymakers should consider the options that are available and the time that is required to bring new supply online. Policy clarity, beyond the short-term, is absolutely essential to achieve a successful and secure energy transition and to solve the climate problem.

Sincerely,

Milton Catelin
Secretary General Of The International Gas Union

1. State of the Industry

LNG Trade

372.3 MT

Global LNG Trade in 2021

Global LNG trade grew by 4.5% from 2020 to 2021, reaching an all-time high of 372.3 million tonnes (MT), as the strong post-pandemic recovery resulted in a surge in LNG imports. The growth in exports from 2020 to 2021 was mainly driven by the United States (+22.3 MT, +49.8%), Egypt (+5.2 MT, +390.5%) and Algeria (+1.2 MT, +11.3%). Australia retained its position as the largest LNG exporter in 2021, exporting 78.5 MT last year versus 77.8 MT in 2020. The largest exporting region continued to be Asia Pacific with total exports of 131.2 MT, in line with 2020 numbers. The Asia Pacific region also continued to be the largest importing region with net imports of 155.7 MT last year, marking an 8.6 MT increase compared to 2020. China overtook Japan as the largest LNG importer, increasing its net imports from 68.9 MT in 2020 to 79.3 MT in 2021.

As of April 2022, the global LNG trade connects 19 exporting markets with 40 markets with importing capabilities.

Price Trends

Nearly

50 MT

of the contracts signed in 2021 were on FOB basis, versus 12 MT in 2020.

Global LNG markets had an eventful year in 2021, with the market transitioning away from oversupplied conditions amid the COVID-19 lockdowns and into a period of rapidly tightening market conditions, with resurgent demand rate exceeding supply additions. As a result, 2021 saw an almost complete reversal of the pricing trends witnessed in 2019 and 2020, with spot LNG prices surging to historic highs and staying above long-term contract formulas that use either Brent or Henry Hub as their basis.

In the first four months of 2022, the JKM/TTF relationship demonstrated both Europe's new-found role in the global LNG market and the emergence of Asian demand elasticity amid the Russia-Ukraine conflict. Market expectations, expressed via the forward curve, indicated that the JKM may price below the TTF well into 2023.

In the Atlantic basin, LNG markets grew in importance throughout 2021, with depleted gas storage in Europe and lower-than-average Russian pipeline deliveries driving Europe's evolution from the market of last resort to a premium LNG buyer.

US gas prices, represented by Henry Hub front month, traded in a relatively narrow range through 2021, although they peaked at $6.312/MMBtu on 4 October 2021. They were disconnected from the TTF and JKM, as liquefaction capacity proved to be a bottleneck, with the correlation between Henry Hub and international LNG prices (represented by the JKM) remaining weak during 2021-2022.

Nearly 50 million tonnes (MT) of the contracts signed in 2021 were on an FOB basis, versus just 12 MT the year prior. North American projects accounted for nearly 30 MT of the contracts signed, whereas in 2020 when Henry Hub-linked long-term contract formulas were uneconomic against LNG prices, just 3.5 MT of contracts were signed.

Liquefaction Plants

459.9 MTPA

Global Liquefaction capacity, End of 2021

Global liquefaction capacity grew in 2021, yet at a significantly slower pace than the year before, adding 6.9 MTPA of capacity to reach 459.9 MTPA by the end of the year. The liquefaction projects that came online in 2021 were PFLNG Dua (1.5 MTPA), Corpus Christi T3 (4.5 MTPA) and Yamal LNG T4 (0.9 MTPA). An additional 12.5 MTPA of liquefaction capacity was brought online during the first four months of 2022, bringing the total global liquefaction capacity to 472.4 MTPA. This included the Sabine Pass T6 (5.0 MTPA) and the Calcasieu Pass LNG T1-T12 (7.5 MTPA) projects located in the United States. With these new capacity additions, the United States became the market with the second largest operational capacity globally as of April 2022 with 86.1 MTPA of liquefaction capacity. This puts the Unites States behind Australia (87.6 MTPA) and ahead of Qatar (77.1 MTPA). The average global utilisation rate was 80.4% in 2021, compared to 74.6% in 2020. The increased utilisation was largely due to economic recovery following the lifting of stringent COVID-19 regulations, a prolonged European winter and drought in Brazil, which accelerated demand for LNG.

We expect LNG demand to grow further in 2022 as the ongoing Russia-Ukraine conflict continues to impact global gas supply, reinforcing LNG's critical role in global energy security. In 2021, Russia contributed to 8.0% of global LNG exports, out of which, 43.9% were to Europe, while the remaining 56.1% were to Asia Pacific and Asia. With the European Union committing to eliminate Russia energy imports by 2027, growth in existing LNG exporting markets, such as the United States and Qatar, and developing new ones like growing Africa, are important avenues to diversify its energy sources and support European energy security.

As of April 2022, 136.2 MTPA of liquefaction capacity was under construction or approved for development, but only 7.7 MTPA of that overall capacity increase is expected to come online in the second half of 2022, with the rest gradually coming in between 2023 and 2027.

In 2021, we witnessed one of the highest volumes of capacity being approved in a single year, with 50.0 MTPA worth of liquefaction capacity reaching a final investment decision (FID). This was mainly contributed by the QatarGas North Field East (NFE) project, which added 32.0 MTPA to global approved liquefaction capacity. The remaining approved capacity was contributed by the Baltic LNG T1–T2 (13.0 MTPA) and Pluto T2 Expansion (5.0 MTPA).

Proposed New Liquefaction Plants

1034.5 MTPA

Proposed aspirational liquefaction capacity in pre-FID stage, April 2022

Currently, 1,034.5 MTPA of aspirational liquefaction capacity is in the pre-FID stage, the majority of which is in the United States, Canada and Russia. There is high uncertainty surrounding future LNG capacity additions in Russia, as international sanctions and the exit of key LNG players have impacted the conditions for pre-FID project development in Russia. Russia had 136.7 MTPA of proposed liquefaction capacity as of April 2022. Africa has 123.9 MTPA of proposed liquefaction capacity and could emerge as a key LNG export region if these projects materialise. In the Middle East, Qatar Energy has taken FID on the North Field East (NFE), the world's largest LNG project, which will raise Qatar's LNG production capacity from 77.0 MTPA to 110.0 MTPA by 2025. The project involves the construction of four new LNG mega-trains with a capacity of 8.0 MTPA each. With the NFE project progressing, this will reposition Qatar as the world leader in terms of liquefaction capacity.

The current geopolitical situation has re-invigorated appetite for new liquefaction project development, with several project developers hoping to leverage strong demand and high LNG prices to progress to an FID. However, challenges such as access to financing remain, as financial institutions are reducing their exposure to fossil fuel investments, focusing developments on clean energy instead. As such, it is crucial for new liquefaction plants to be increasingly innovative in a decarbonising landscape, leveraging on solutions to continue driving down emissions in the liquefaction process and the rest of the LNG value chain. It is also important to have clarity and consistency in the policy environment, which impacts financial risk and liquidity provision.

Regasification Terminals

901.9 MTPA

Global nominal regasification capacity, April 2022

Global regasification capacity has reached 901.9 MTPA as of April 2022, following capacity additions of 49.8 MTPA in 2021, and 4.3 MTPA in the first four months of 2022. Five new regasification terminals started commercial operations, and five expansion projects at existing terminals were successfully completed last year.

New terminals started operations in Indonesia, Croatia, Turkey, Kuwait and Mexico, adding 23.6 MTPA of regasification capacity in 2021, while China and Japan expanded regasification capacity at existing facilities. In China, some terminals that faced COVID-19-related delays in 2020 became operational in 2021. As of April 2022, 40 markets are equipped with LNG receiving capabilities.

Regasification capacity additions can be anticipated in established markets as well as new import markets. The only new market that joined the ranks of LNG importers in 2021 was Croatia, with operations starting at the Krk LNG terminal. As of April 2022, 164.8 MTPA of new regasification capacity is under construction, including 19 new onshore terminals, 12 floating storage and regasification units (FSRUs) and 13 expansion projects at existing terminals. By year-end 2022, 80.4 MTPA of additional capacity is set to come online through newbuild terminals and expansion projects at existing terminals. This includes new importers such as Ghana, Senegal and the Philippines.

Floating and Offshore Regasification

142.6 MTPA

Global floating and offshore regasification capacity, April 2022

As of April 2022, floating and offshore regasification capacity worldwide stands at 142.6 MTPA with 32 operational terminals. In 2021, FSRUs were commissioned at new terminals in Croatia, Indonesia and Turkey, while FSRUs restarted operations at existing terminals in Brazil and Argentina. Another 12 floating and offshore regasification terminals are currently under construction, representing a further 44.6 MTPA once commissioned. Ten offshore/floating terminals are scheduled to enter service by end-2022, including new importers such as Ghana and the Philippines. Established markets have also been expanding their regasification capabilities through chartering FSRUs in 2021. After pandemic and weather-related delays, India is expected to bring its first FSRU-based terminal into service in 2022, equipping the market with both onshore and floating regasification capabilities. After the onset of the Russia-Ukraine conflict, several European markets have announced plans for new FSRUs to reduce dependence on Russian gas imports. Six countries are planning to operate new FSRUs within the next three years.

LNG Shipping

641 Vessels

LNG fleet, April 2022

There were 641 active LNG vessels as of end-April 2022, including 45 FSRUs and five floating storage units (FSUs). The global fleet grew by 9.9% with the delivery of 57 carriers and four FSRUs in 2021. Most vessels delivered last year are 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 gas admission (ME-GA) propulsion systems have gained popularity with 138 X-DF systems across both generations and 41 ME-GA systems on the order book, making up a large share of a total of 217 vessels on order.

Demand recovery from the COVID-19 pandemic, alongside stronger Asian demand catalysed by a colder winter at the start of the year, Chinese coal shortage and stronger industrial demand towards year-end drove a 11.8% growth in the number of LNG voyages. This is in contrast to 2020 which saw limited growth from the previous year. Charter rates were volatile through 2021, starting at a peak of US$190,000/day for steam turbine vessels, US$255,000/day for TFDE/DFDE vessels and US$290,000/day for X-DF/ME-GI vessels. This reversed rapidly as winter demand eased, before climbing as the Ever Given container ship blocked the Suez Canal and Europe and Asia competed for cargoes. With gas pricing hitting record levels by October 2021, rates spiked again, reaching US$140,000/day for steam turbine vessels, US$210,000/day for TFDE/DFDE vessels and US$250,000/day for X-DF/ME-GI vessels in December 2021.

LNG Bunkering Vessels and Terminals

16 Units

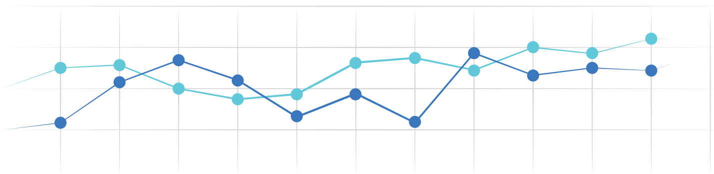
Global LNG Bunkering Vessel Order Book, End-of-April 2022

As the global shipping fleet turns to LNG to decarbonise and adhere to stricter environmental regulations, LNG bunkering demand and supply is growing. Bunkering of LNG-fuelled vessels can take place through different methods, including tank-to-ship, truck-to-ship and ship-to-ship transfers. There are currently 84 LNG bunkering facilities at terminals and ports globally, with 49 in Europe, 24 in Asia, six in North America, four in Australia and one in South America. Providing ship-to-ship transfers, the LNG bunkering fleet grew by nine vessels in 2021 and two vessels in the first four months of 2022, bringing the global fleet total to 30. There are an additional 16 vessels on the order book, to be delivered across the globe. The typical size of these vessels is increasing over time – average capacity of the active fleet is 7,200 cm, while the average capacity of vessels on the orderbook is 9,200 cm.

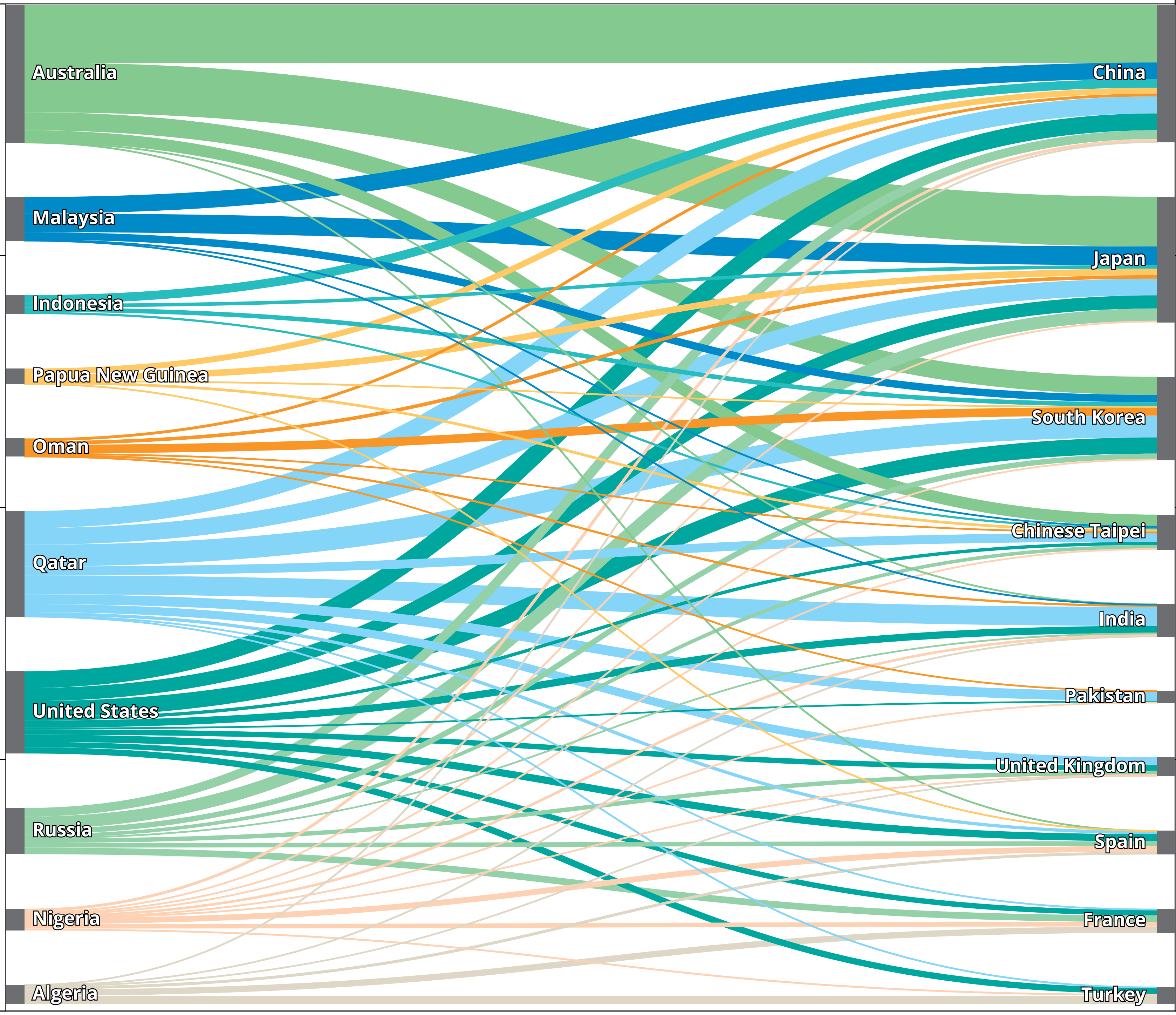
Energy Endeavour – Courtesy of Alpha Gas

2 LNG Trade

Global LNG trade increased to **372.3 MT**[1] in 2021, an increase of **16.2 MT**.



China became the largest importer with a total of
79.3 MT
of import
(+10.4 MT vs. 2020)



1st Australia retained its position as the largest exporter in 2020 with a total of
78.5 MT
of exports

2nd Qatar was the second largest exporter, exporting
77.0 MT

3rd The USA exported
67.0 MT,
22 MT more than in 2020

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

Japan imported
74.3 MT
(-0.1 MT vs. 2020)

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

India imported 2.6 MT less than in 2020
24.0 MT

European imports dropped to
75.1 MT
(-6.5 MT)

[1] Source: GIIGNL

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

2. LNG Trade

Global LNG trade grew by 4.5% from 2020 to 2021, reaching an all-time high of 372.3 MT. A strong post-pandemic recovery resulted in a surge in LNG imports, even though the annual growth rate of 4.5% remains far from pre-COVID-19 levels of 13.0% in 2019.

LNG ROSENROT – Courtesy of MOL

2.1 OVERVIEW

The growth in exports from 2020 to 2021 was mainly driven by the United States (+22.3 MT), Egypt (+5.2 MT) and Algeria (+1.2 MT). Australia retained its position as the largest LNG exporter in the world in 2021, exporting 78.5 MT last year versus 77.8 MT in 2020. Qatar, the second-largest exporter in 2021, exported 77.0 MT in 2021, compared to 77.1 MT in 2020. In 2021, the US remained the third-largest exporter of LNG at 67.0 MT, and Russia retained its spot as the fourth-largest exporter with 29.6 MT of exports in 2021. The largest exporting region continued to be Asia Pacific with a total of 131.2 MT of exports in 2021, in line with what was exported in 2020. Some markets exported less volume in 2021 than in 2020 as a result of technical issues, declining feed gas production, and a lack of commercial progress on backfill projects. The most significant drops in export levels were seen in Nigeria (-4.1 MT), Trinidad & Tobago (-3.9 MT), Norway (-2.9 MT) and Peru (-1.2 MT). In 2021, Asia Pacific also continued to be the largest net importing region in 2021 at 155.7 MT, marking an 8.6 MT increase compared to 2020. Asia was the second largest net importing region at 116.8 MT in 2021, an increase of 9.5 MT compared to 2020. This growth was driven by the increase in net imports into China (+10.4 MT) and Bangladesh (+0.9 MT). The only new importing market in 2021 was Croatia, which imported 1.2 MT of LNG in 2021.

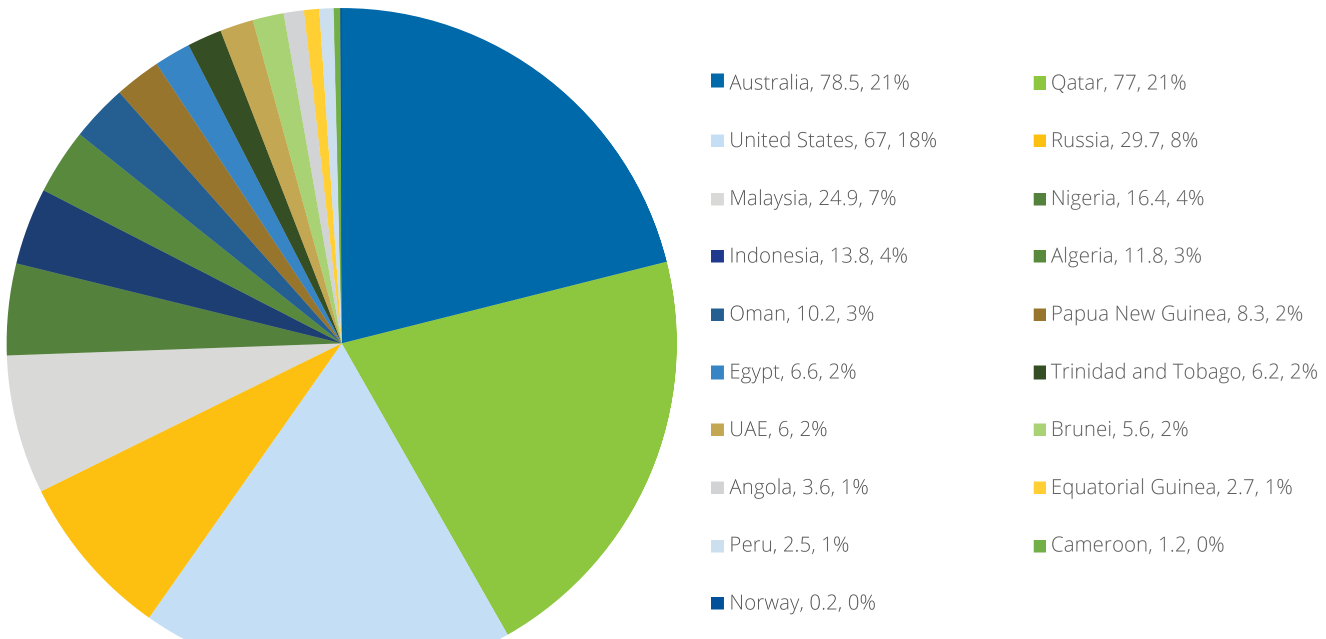
Global LNG Trade	LNG Exporters & Importers	LNG Re-Exports
+16.2 MT Growth of global LNG trade	Croatia commenced LNG imports in 2021, making it the 39th[1] importing market	+0.9 MT Re-exported volumes increased by 34.5% YOY in 2021.
Global LNG trade reached an all-time high of 372.3 MT in 2021, 4.5% growth from 2020.	China, Kuwait, Indonesia and Brazil increased net imports through expansion of import capacity.	Re-export activity increased to 3.5 MT in 2021 (2.6 MT in 2020).
China provided 10.4 MT in increased net imports, and Asia increased net imports by 9.5 MT.	Growth in exports came from the United States (+22.3 MT), Egypt (+5.2 MT) and Algeria (+1.2 MT).	Asia received the largest volume of re-exports (1.6 MT), while Europe re-exported the largest volumes (2.3 MT).
Contractions were greatest in India (-2.6 MT) and the United Kingdom (-2.4 MT).		

Source : GIIGNL

[1] This report excludes those with only small-scale (<0.5 MTPA) regasification capacity but includes markets with large regasification capacity that only consume domestically produced cargoes, such as Indonesia.

2.2 LNG EXPORTS BY MARKET

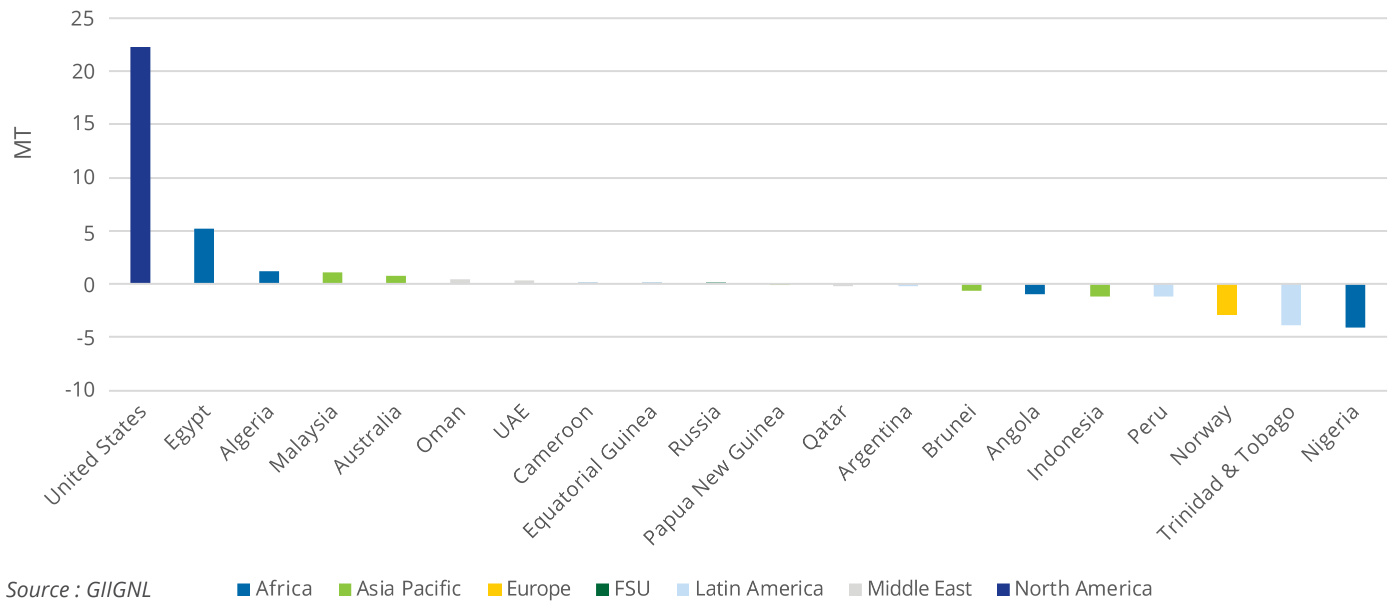
Figure 2.1: 2021 LNG Exports and Market Share by Export Market (in MT)



Source : GIIGNL

In 2021, 6.9 MTPA of liquefaction capacity came online, and no new markets started exporting. Australia remained the largest exporter in 2021, exporting 78.5 MT, an increase of 0.7 MT from 2020, while Qatar exported 77.0 MT, capturing a 21% exports market share. Australia's increase can be attributed to the restart of Prelude FLNG, which was shut down from February 2020 to January 2021 after an electrical problem. Another notable export market is the US, which exported 67.0 MT in 2021. This marks a 50% increase (+22.3 MT) in exports from 2020 (44.8 MT). This growth was driven by increased utilisation at five large liquefaction trains that started commercial operations in 2020 (Cameron LNG T2–T3, Corpus Christi T3, Freeport LNG T2–T3). Egypt saw a five-fold increase in its exports from 1.3 MT in 2020 to 6.6 MT in 2021, owing to the restart of the Damietta LNG plant in early 2021. Russia remained at fourth place, exporting a total of 29.6 MT in 2021, almost unchanged from 2020. Malaysia benefitted from the commissioning of the PFLNG Dua with an increase in export of 1.1 MT compared to 2020.

Figure 2.2: 2021 Incremental LNG Exports by Market Relative to 2020 (in MT)



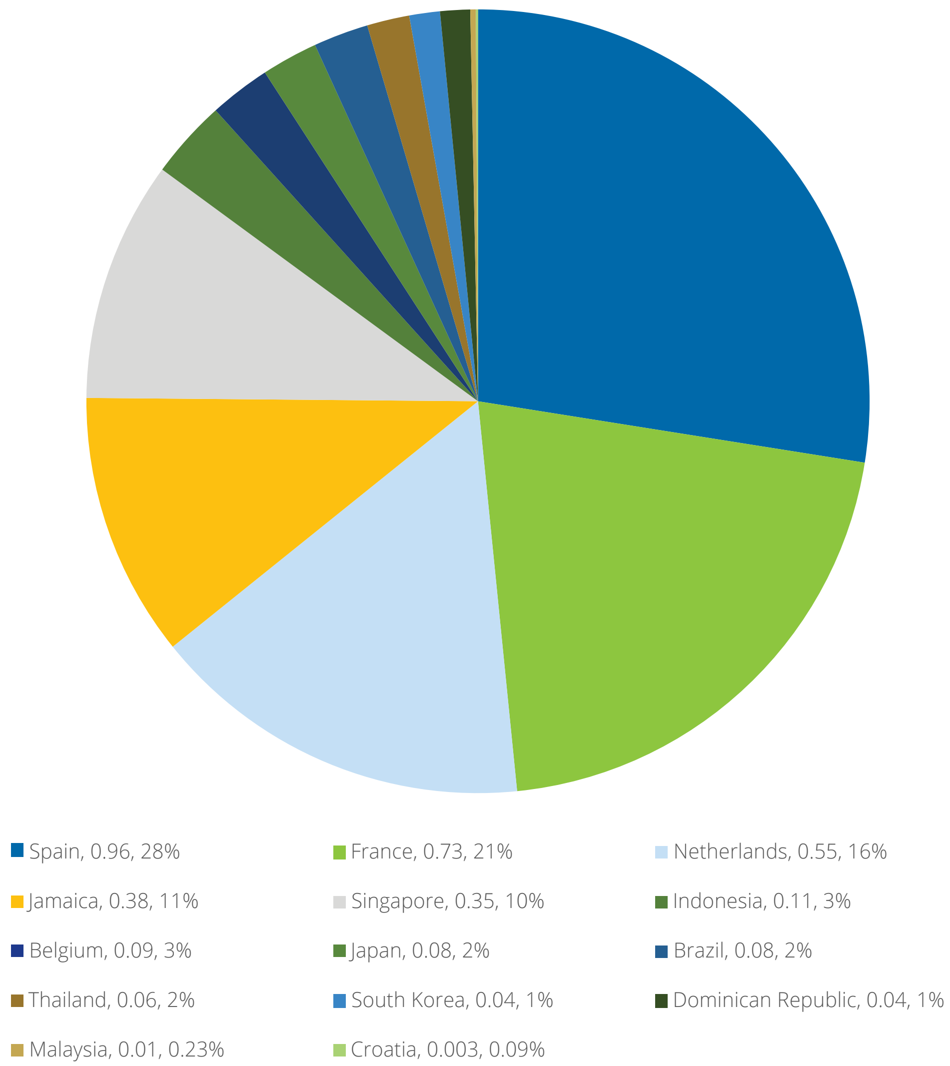
Source : GIIGNL

Large reductions in LNG exports were recorded in Nigeria (-4.1 MT) due to low feedstock availability and maintenance issues at its NLNG T1–6 liquefaction facility, Trinidad and Tobago (-3.9 MT) due to the depletion of feed gas and lack of backfill projects and Norway (-2.9 MT) due to the delays in the restart of operations at the Snøhvit LNG facility after a fire in 2020. Smaller reductions were seen in Angola (1.0 MT), Indonesia (1.2 MT) and Peru (1.2 MT). Exports decreased in 10 markets between 2020 and 2021, representing 15.4 MT in reduced exports.

Asia Pacific remained the largest export region, exporting a total of 131.2 MT in 2021, in line with total exports in 2020. Even though Indonesia (-1.2 MT) and Brunei (-0.6 MT) saw an overall reduction in exports, this was offset by an increase in exports from Malaysia (+1.1 MT) and Australia (+0.7 MT). The largest regional increase in exports came from North America, contributed by the US (+22.3 MT). The largest decrease in regional exports was seen in Latin America, which saw both of its two exporting markets, Trinidad and Tobago and Peru, reduce exports by 3.9 MT and 1.2 MT, respectively. Trinidad and Tobago has continued on a downtrend in LNG exports owing to domestic gas shortages, while Peru has been struggling with operational issues at its Peru LNG T1 facility being shut down for over 80 days during the first nine months of 2021.

Re-exported trade increased by 35% in 2021, from 2.6 MT to 3.5 MT, representing roughly 1% of global LNG trade in 2021. Spain (1.0 MT) and France (0.7 MT) topped the list of re-exporters in 2021 while Singapore, which has been at the top of the list over the last two years, ended up in fifth place. In fact, re-exported trade in Singapore decreased by 68.1%, from 1.1 MT in 2020 to 0.35 MT in 2021. Natural gas is one of four options in Singapore's energy transition. Around 95% of Singapore's electricity is generated from natural gas, with increasing reliance on LNG for a diversified supply portfolio. Re-exports were loaded in 14 markets, up from 10 in 2020. The four markets that re-exported volumes in 2021, but not in 2020 were Japan, Brazil, Thailand and Croatia. Conversely, the US re-exported volumes in 2020, but not in 2021. Europe loaded 67% of all re-exported volumes, followed by Asia Pacific at 19%.

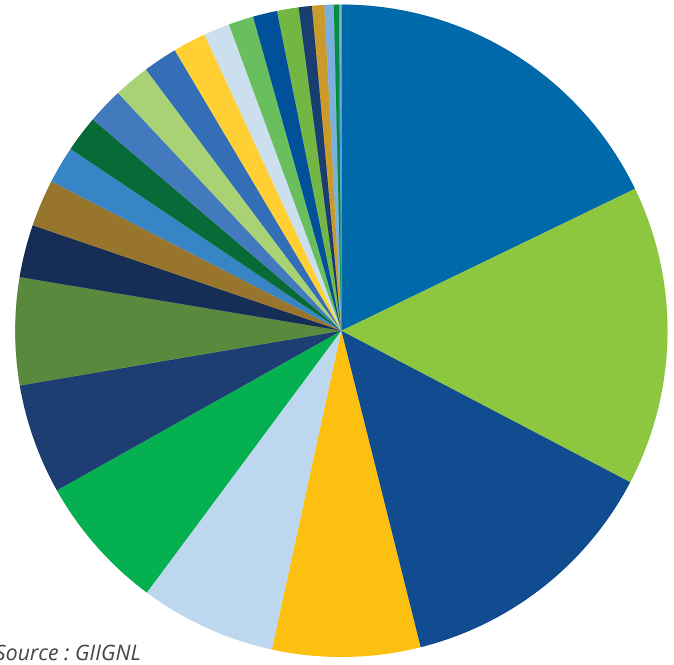
Figure 2.3: Re-exports loaded by Re-loading Market in 2021 (in MT)



Source : GIIGNL

In 2021, 26 markets received re-exported volumes compared to 22 markets in 2020. Markets that received re-exported volumes in 2021, but did not do so in 2020, were Brazil, Croatia, Turkey, the United Kingdom, Belgium, the Dominican Republic, Pakistan, and Thailand. Conversely, markets that received re-exported volumes in 2020, but did not do so in 2021 were Argentina, Greece, Singapore, and Chinese Taipei.

Figure 2.4: Re-Exports Received in 2021 by Receiving Market (in MT)



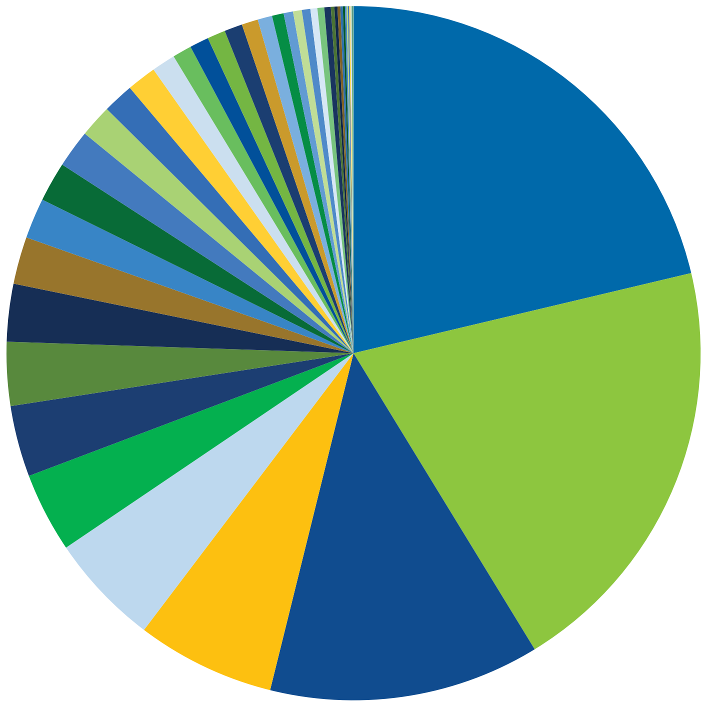
Source : GIIGNL

Ship to Ship Operation – Courtesy of SPEC LNG

2.3 NET LNG IMPORTS BY MARKET

Last year, 39 markets[2] imported LNG volumes from 19 exporting markets. Croatia was a new addition to the list of LNG importers in 2021, importing 1.2 MT. Its first receiving terminal, the FSRU LNG Croatia, started commercial operations in January 2021. The Asia Pacific region continues to be the leading importing region, with a 41.8% share of global LNG imports last year, up from 41.3% in 2020. Imports increased in all markets within Asia Pacific except for Japan (-0.1 MT), Malaysia (-0.6 MT) and Singapore (-0.1 MT). Asia is the second-largest importing region, with a 31.4% share of global LNG imports. India was the only market with lower imports in 2021 compared to 2020 (26.6 MT in 2020, 24.0 MT in 2021). The 9.8% decline in imports can be attributed to increased domestic gas production and high LNG spot prices, which led Indian consumers to import less LNG after the first quarter of 2021.

Figure 2.5: 2021 LNG Imports and Market Share by Market (in MT)



Source : GIIGNL

[2] This report excludes those with only small-scale (<0.5 MTPA) regasification capacity but includes markets with large regasification capacity that only consume domestically produced cargoes, such as Indonesia.

China overtook Japan as the largest LNG importer in 2021 after experiencing the largest growth in imported volumes, from 68.9 MT in 2020 to 79.3 MT in 2021, representing a 15% increase. This was driven by a strong economic recovery as well as growth in demand for gas in the power generation sector. Chinese buyers purchased LNG cargoes ahead of the winter season in 2021 to meet storage requirements and anticipated high demand. LNG imports into Japan remain relatively stable compared to 2020, with only a slight decline of 0.1 MT (74.4 MT in 2020 compared to 74.3 MT in 2021). The stagnation can be attributed to continued stringent COVID-19 restrictions, as well as a decrease in gas-fired power generation due to increased generation from nuclear and renewables. South Korea (+6.1 MT, +15%) and Chinese Taipei (+1.7 MT, +9.5%) also experienced strong growth in LNG imports, due to increased gas demand in the power generation sector and extended periods of cold weather. Other Asia Pacific markets such as Indonesia (+0.6 MT) and Thailand (+0.9 MT) also increased LNG imports due to lower domestic gas production and increased demand as COVID-19 restrictions eased. India experienced one of the greatest declines in LNG imports (-2.6 MT or -9.8%) as a result of high spot LNG prices and an increase in domestic gas production which led to a reduction in LNG imports through the first nine months of the year.

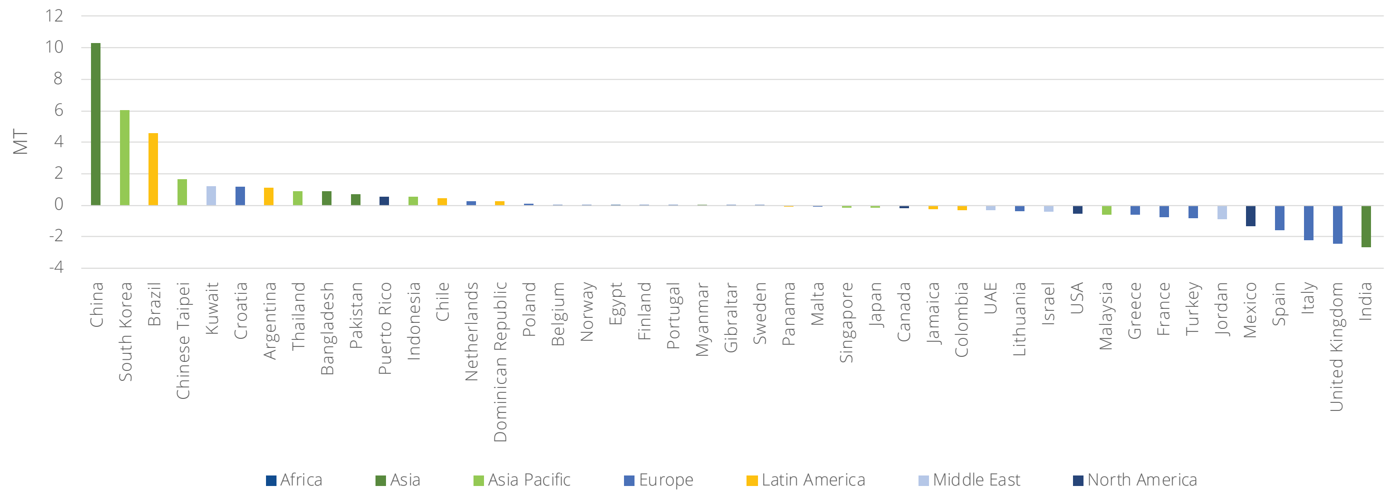
Europe experienced an 8.0% decrease in LNG imports from 81.6 MT in 2020 to 75.1 MT in 2021. Decreasing domestic gas production coupled with a colder winter and lower-than-expected pipeline gas deliveries from Russia brought storage levels to record lows. In addition, high JKM/TTF price differentials attracted flexible LNG volumes to Asia instead of Europe, which exacerbated the situation. This forced Europe to adjust its demand through a series of reductions in industrial consumption and gas-to-coal switching, leading to growth in emissions. The United Kingdom experienced the largest decline in LNG imports among all European markets, from 13.4 MT in 2020 to 11.0 MT in 2021, followed by Italy (9.1 MT in 2020 to 6.9 MT in 2021) and Spain (15.4 MT in 2020 to 13.8 MT in 2021).

Latin America experienced a 68.7% increase in LNG imports, from 8.8 MT in 2020 to 14.9 MT in 2021, mainly driven by Brazil and Argentina. Brazil experienced one of the worst droughts in the country's history, which reduced its hydropower output. This was exacerbated by limited growth in domestic natural gas production to meet its growing demand, which led to a 193% increase in LNG imports from 2020 (2.4 MT) to 2021 (7.0 MT), following the start-up of two LNG-to-power projects in Sergipe and Port Açu. Argentina's LNG imports grew by 84.9% from 1.4 MT in 2020 to 2.5 MT in 2021, due to reduced imports from Bolivia and lower domestic gas production. Chile (+16.7%, +0.5 MT) and the Dominican Republic (+26.1%, +0.3 MT) also saw LNG imports rise due to increased use of natural gas in the power generation sector.

Imports into North America fell by 29.7% from 4.3 MT in 2020 to 3.1 MT in 2021. Mexican imports recorded the largest decline of -67.5%, -1.3 MT, as the market moved towards being less reliant on LNG imports. Other markets in North America also recorded a decline in LNG imports. This included the US, which reduced LNG imports by 52.6%, from 0.9 MT in 2020 to 0.4 MT in 2021.

The Middle East saw a 5.4% decline in LNG imports, from 17.6 MT in 2020 to 16.7 MT in 2021. Israel experienced the largest decline, from 0.6 MT in 2020 to 0.2 MT in 2021, while Jordan did not import any LNG cargoes in 2021. Kuwait saw the largest increase in LNG imports, +31.3% from 4.1 MT in 2020 to 5.3 MT in 2021 with the commissioning of the Al-Zour LNG terminal in 2021.

Figure 2.6: Incremental 2021 LNG Imports by Market & Incremental Change Relative to 2020 (in MT)



Source : GIIGNL

2.4 LNG INTERREGIONAL TRADE

The largest global LNG trade route continues to be intra-Asia Pacific trade (81.9 MT), driven mainly by continued growth in exports from Australia to Japan (26.8 MT), South Korea (9.7 MT) and Chinese Taipei (6.3 MT). Most of the remaining supply out of the Asia Pacific region ended up in Asia in 2021, as was the case in 2020. The region saw the second-largest LNG trade flow in 2021 (49.0 MT), with 31.0 MT going from Australia to China alone.

The third-largest trade flow is from the Middle East to Asia Pacific, with 37.1 MT traded in 2021, most of which was exported from Qatar (28.2 MT). There were also significant flows from the Middle East to Asia (34.5 MT), mostly driven by volumes from Qatar and the UAE to India, China and Pakistan. African exports mostly flowed to Europe and Asia (23.6 MT and 11.3 MT respectively) where exports increased by +1.2 MT and +1.7 MT respectively, due to increased exports from Egypt, Algeria, Cameroon and Equatorial Guinea. European imports from Africa had to compete with imports from the US, which meant a reduction in flows. While India continued to be a large customer of African LNG in 2021, flows from Africa to India decreased by 2.4 MT compared to 2020, with India taking more volumes from Qatar instead. Imports into Asia Pacific from Africa increased, however, to 5.4 MT in 2021 from 3.7 MT in 2020, mostly driven by an increase in flows from Egypt into Japan (+0.1MT), South Korea (+0.1 MT), Chinese Taipei (+0.1 MT) and Singapore (+0.3 MT). This coincided with the restart of the Damietta LNG plant in Egypt in March 2021, which led to an increase in export volumes from Egypt to Asia Pacific.

Imports to Latin America increased significantly last year, with Brazil being the key driver. The largest increase in LNG flows into Latin America came from North America (+126.8%, +6.5 MT) and the Middle East (+159.2%, +1.0 MT). Flows from North America mostly went into Europe (21.5 MT, up from 18.5 MT in 2020) and Asia Pacific (18.2 MT, up from 12.7 MT in 2020). A large share of US exports into Europe went to Spain (3.8 MT), the Netherlands (3.2 MT), the UK (2.9 MT) and France (2.9 MT). Most of the additional exports from the US into Asia Pacific went into South Korea (8.7 MT) and Japan (7.1 MT) due to favourable netbacks in the winter months of 2021. Asia Pacific (12.7 MT in 2020 to 18.2 MT in 2021) became the largest importer of North American LNG last year, overtaking Europe (18.5 MT in 2020 to 21.5 MT in 2021).

The majority of Russian exports were shipped to Europe (13.0 MT in 2021, an increase from 12.6 MT in 2020) and Asia Pacific (11.5 MT, up from 10.7 MT in 2020). The top three largest offtakers of Russian LNG in 2021 were Japan (6.6 MT), China (4.7 MT) and France (3.6 MT). Moving forward, export from Russia to Europe are expected to decrease as the European Union's Repower Europe plan seeks to cut dependency on Russian gas by two-thirds this year and end all fossil fuel imports by 2027. Europe is poised to diversify its LNG imports, increasing flows from the Middle East, North America and Africa.

Table 2.1: LNG Trade Between Regions, 2021 (in 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	81.9	37.1	18.2	5.4	11.5	1.8	-	0.5	0.7	**155.7**
Asia	49.0	34.5	14.5	11.3	5.2	0.9	-	1.6	-	**116.8**
Europe	0.1	16.0	21.5	23.6	13.0	2.5	0.2	0.5	2.3	**75.1**
Latin America	0.0	1.6	11.7	0.5	-	1.4	-	0.2	0.5	**14.9**
Middle East	-	4.1	0.8	1.5	-	0.1	-	0.2	-	**6.7**
North America	0.2	-	0.3	-	-	2.0	-	0.5	-	**3.1**
Africa	-	-	-	0.1	-	-	-	-	-	**0.1**
Total	**131.2**	**93.2**	**67.0**	**42.3**	**29.6**	**8.7**	**0.2**	**3.5**	**3.5**	**372.3**

Source : GIIGNL

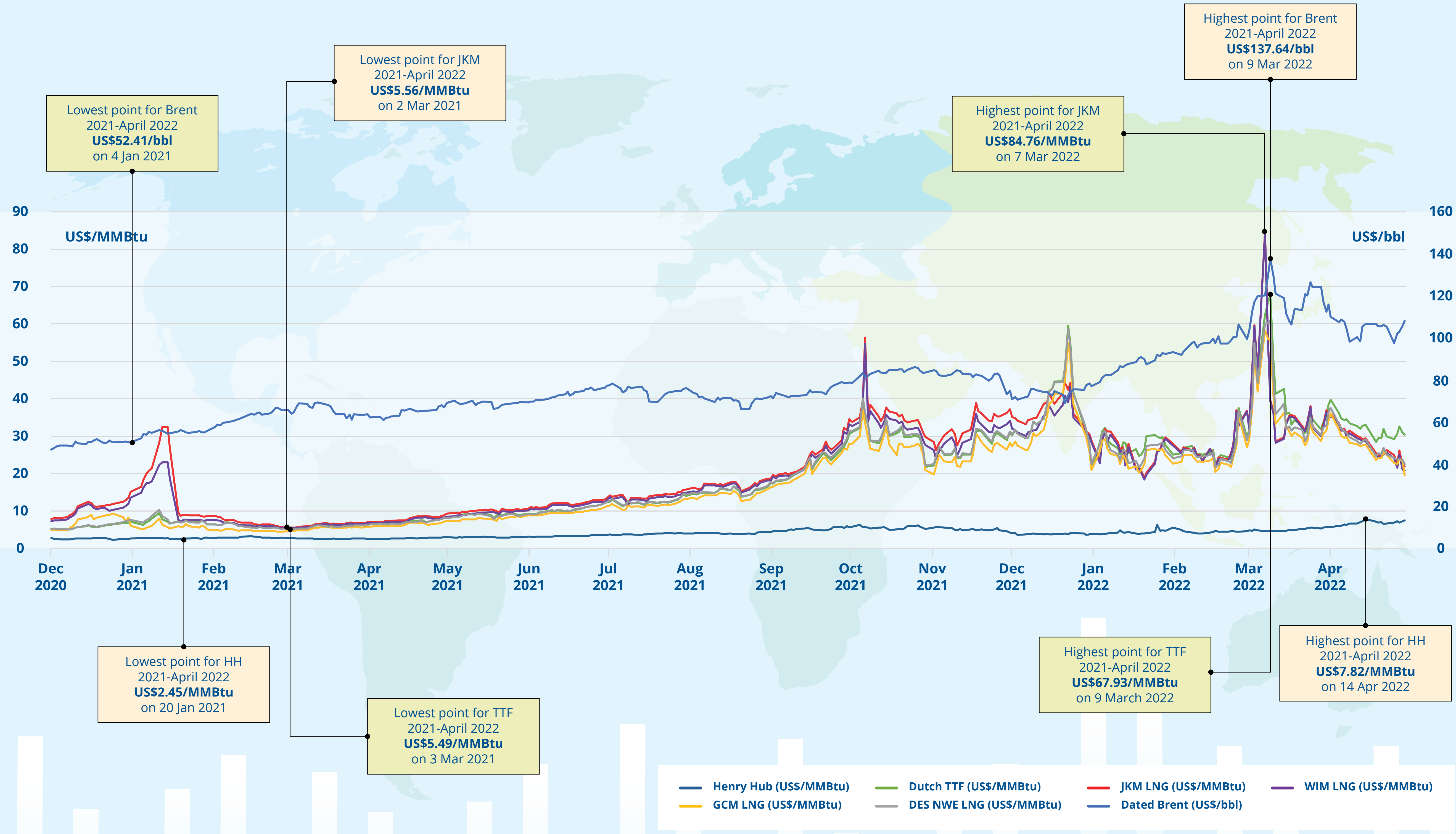
FSRU Based LNG Terminal – Courtesy of SPEC LNG

Table 2.2: LNG Trade Volumes between Markets, 2021 (in MT)

Markets	Algeria	Angola	Australia	Brunei	Cameroon	Egypt	Equatorial Guinea	Indonesia	Malaysia	Nigeria	Norway	Oman	Papua New Guinea	Peru	Qatar	Russia	Trinidad & Tobago	UAE	USA	Re-exports Received	Re-exports Loaded	2021 NET IMPORTS	2020 NET IMPORTS
China	0.24	0.57	30.97	0.67	0.62	1.19	0.45	4.72	8.85	1.53	-	1.52	3.16	0.14	9.17	4.68	0.44	0.71	9.03	0.62	-	79.27	68.91
India	0.07	1.11	0.28	-	0.19	1.04	0.33	-	0.06	1.39	-	1.16	-	-	10.20	0.41	0.28	3.17	3.86	0.47	-	24.02	26.63
Pakistan	-	0.59	-	-	-	0.83	0.06	-	-	0.12	-	0.06	-	-	5.24	-	-	0.26	0.85	0.19	-	8.19	7.42
Bangladesh	0.13	0.07	-	-	-	0.45	0.13	0.06	-	0.19	-	-	-	-	2.98	0.07	-	-	0.77	0.26	-	5.10	4.18
Myanmar	-	-	-	-	-	-	-	0.03	0.14	-	-	-	-	-	-	-	-	-	-	0.05	-	0.22	0.18
ASIA	0.43	2.34	31.26	0.67	0.80	3.51	0.97	4.81	9.05	3.23	-	2.73	3.16	0.14	27.59	5.16	0.72	4.14	14.51	1.58	-	116.80	107.31
Japan	-	-	26.77	4.29	-	0.20	0.26	1.89	10.05	0.81	-	1.90	3.50	0.53	8.97	6.63	-	1.33	7.07	0.24	(0.08)	74.35	74.43
South Korea	-	0.12	9.69	0.20	0.14	0.19	0.13	2.41	4.00	0.65	-	4.62	0.19	0.86	11.72	2.87	0.06	0.24	8.70	0.19	(0.04)	46.92	40.81
Chinese Taipei	-	-	6.27	0.06	0.20	0.18	-	1.17	0.50	0.58	-	0.47	1.43	-	4.77	1.89	0.10	0.06	1.76	-	-	19.44	17.76
Thailand	-	0.13	0.74	0.19	-	-	0.20	-	1.07	0.78	-	0.26	-	-	2.59	-	0.24	-	0.35	0.06	(0.06)	6.55	5.61
Indonesia	-	0.07	0.04	-	-	0.02	-	3.24	-	0.002	-	-	-	-	-	0.03	-	-	0.04	-	(0.11)	3.31	2.75
Singapore	-	0.13	2.14	-	-	0.31	0.15	0.06	0.06	0.08	-	-	-	-	0.17	0.04	-	-	0.32	-	(0.35)	3.12	3.19
Malaysia	-	-	1.55	0.18	-	-	-	-	0.23	0.06	-	-	-	-	-	-	-	-	-	-	(0.01)	2.02	2.57
ASIA PACIFIC	-	0.46	47.19	4.92	0.34	0.89	0.74	8.77	15.90	2.97	-	7.26	5.13	1.39	28.21	11.46	0.40	1.63	18.23	0.48	(0.65)	155.71	147.12
Spain	1.55	0.27	0.06	-	-	0.25	0.58	-	-	3.13	-	-	0.01	0.09	1.72	2.46	0.80	-	3.85	0.02	(0.96)	13.82	15.37
France	3.39	-	-	-	-	0.17	-	-	-	2.41	-	-	-	0.07	0.52	3.59	-	-	2.87	0.04	(0.73)	12.34	13.06
United Kingdom	0.62	-	-	-	-	-	-	-	-	0.06	-	-	-	0.62	4.36	2.35	0.11	-	2.91	0.01	-	11.04	13.43
Turkey	4.31	-	-	-	-	0.95	-	-	-	0.99	-	-	-	-	0.21	-	0.13	-	3.38	0.02	-	9.99	10.72
Italy	0.94	-	-	-	-	0.19	-	-	-	0.19	-	-	-	-	4.71	-	0.11	-	0.66	0.08	-	6.88	9.07
Netherlands	0.06	0.27	-	-	-	-	0.07	-	-	0.13	-	-	-	0.18	0.09	2.08	0.07	-	3.18	0.06	(0.55)	5.64	5.33
Portugal	-	-	-	-	-	-	-	-	-	2.16	-	-	-	-	0.24	0.57	-	-	1.14	-	-	4.11	4.07
Belgium	0.06	-	-	-	-	0.06	-	-	-	-	-	-	-	-	1.96	1.21	-	-	0.11	0.00	(0.09)	3.32	3.21
Poland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.75	-	-	-	1.09	-	-	2.83	2.71
Greece	0.36	0.06	-	-	-	0.07	-	-	-	-	-	-	-	-	0.31	-	-	-	0.83	-	-	1.64	2.20
Croatia	-	-	-	-	-	0.07	-	-	-	0.13	-	-	-	-	0.12	0.06	0.06	-	0.72	0.06	(0.00)	1.20	-
Lithuania	-	-	-	-	-	0.07	0.07	-	-	-	-	-	-	-	-	0.23	0.11	-	0.65	-	-	1.12	1.44
Sweden	-	-	-	-	-	-	-	-	-	-	0.10	-	-	-	-	0.17	-	-	-	0.09	-	0.36	0.36
Malta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19	-	0.10	-	-	0.29	0.32
Norway	-	-	-	-	-	-	-	-	-	-	0.13	-	-	-	-	0.08	-	-	-	0.02	-	0.22	0.12
Finland	-	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-	0.19	-	-	-	-	-	0.20	0.15
Gibraltar	-	-	-	-	-	-	-	-	-	-	-	-				-	-	-	-	0.06	-	0.06	0.05
EUROPE	11.29	0.60	0.06	-	-	1.83	0.71	-	-	9.19	0.24	-	0.01	0.97	15.99	12.99	1.58	-	21.47	0.47	(2.33)	75.05	81.59
Brazil	-	0.10	-	-	-	-	-	-	-	0.04	-	-	-	-	0.63	-	0.18	-	6.07	0.06	(0.08)	7.01	2.39
Chile	-	-	0.02	-	-	-	0.30	-	-	-	-	-	-	-	-	-	0.43	-	2.39	-	-	3.14	2.69
Argentina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.97	-	0.04	-	1.52	-	-	2.52	1.37
Dominican Republic	-	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	0.45	-	0.99	0.06	(0.04)	1.47	1.17
Jamaica	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	0.01	-	0.34	-	0.51	0.04	(0.38)	0.52	0.72
Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.16	0.04	-	0.21	0.22
Colombia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	0.04	0.30
LATIN AMERICA	-	0.10	0.02	-	-	0.02	0.30	-	-	0.05	-	-	-	-	1.60	-	1.44	-	11.68	0.20	(0.50)	14.92	8.84
Puerto Rico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00		-	0.52	-	1.52	0.93
Mexico	-	-	-	-	-	-	-	0.24	-	-	-	-	-	-	-	-	0.08	-	0.30	0.003	-	0.61	1.88
Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	0.44	-	-	-	-	0.50	0.63
United States	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.42	-	-	-	-	0.42	0.89
NORTH AMERICA	-	-	-	-	-	-	-	0.24	-	-	-	-	-	0.06	-	-	1.94	-	0.30	0.52	-	3.05	4.34
Kuwait	0.06	0.07	-	-	0.07	0.26	-	-	-	0.84	-	0.23	-	-	2.64	-	0.11	0.19	0.66	0.23	-	5.34	4.07
UAE	-	0.07	-	-	-	-	-	-	-	0.13	-	-	-	-	0.92	-	-	0.07	-	-	-	1.19	1.46
Israel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.18	-	-	0.18	0.57
Jordan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.82
MIDDLE EAST	0.06	0.13	-	-	0.07	0.26	-	-	-	0.98	-	0.23	-	-	3.57	-	0.11	0.25	0.83	0.23	-	6.71	6.92
Egypt	-	-	-	-	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-
AFRICA	-	-	-	-	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-
2021 EXPORTS	11.78	3.63	78.52	5.59	1.20	6.56	2.72	13.82	24.94	16.42	0.24	10.22	8.30	2.55	76.96	29.61	6.19	6.02	67.03	3.48	(3.48)	372.29	-
2020 EXPORTS	10.58	4.64	77.77	6.22	1.10	1.34	2.61	14.99	23.85	20.55	3.15	9.76	8.33	3.76	77.13	29.60	10.08	5.71	44.76	2.59	(2.59)	-	356.12

Source : GIIGNL

3 Price Trends



Source: S&P Global Commodity Insights

3. Price Trends

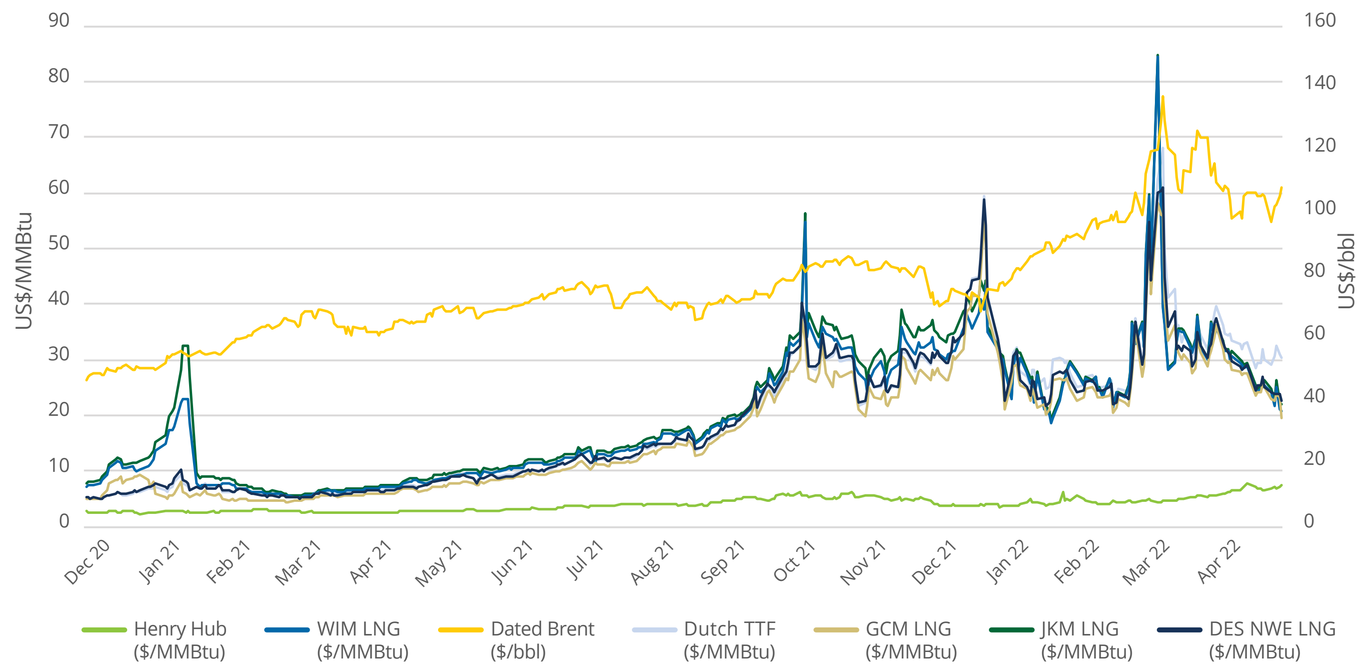
Global LNG markets had an eventful year in 2021, with the market transitioning away from the conditions where supply exceeded COVID-19 lockdown demand and into a period of rapidly tightening market conditions, with resurgent demand rate exceeding supply additions. As a result, 2021 saw an almost complete reversal of many of the pricing trends seen over 2019-2020, with spot LNG prices surging to historic highs and staying above the long-term contract formulas that use either Brent or Henry Hub as their basis.

While true of many commodity markets in 2021, price volatility in global LNG and European gas markets also increased significantly year-on-year. In the winter season, prices became so high and volatile that the number of market participants trading LNG dwindled and market activity in key demand regions declined. This was in part down to the higher outright price of the commodity making it difficult for market participants to trade the same volume of cargoes as before, because more of their credit lines were used up per cargo.

2022 largely showed the same dynamic in Q1, although exchanges also hiked margin requirements for derivatives contracts, making it more difficult to manage price risk as well as tying up more credit and further reducing trading opportunities.

3.1
ASIA-PACIFIC LNG MARKET PRICE TRENDS

Figure 3.1: Comparison of major LNG, pipeline gas and oil benchmarks (December 2020 - April 2022)



Source: S&P Global Commodity Insights

US$56.33/MMBtu

November JKM Price at annual 2021 high on 6 October, 2021

The Platts Japan-Korea Marker (JKM) benchmark, reflecting cargoes delivered into Northeast Asia, began 2021 at $16.474 per million British thermal units (MMBtu). It hit a low for the year on 2 March 2021 at $5.563/MMBtu and reached an annual high of $56.326/MMBtu on 6 October 2021.

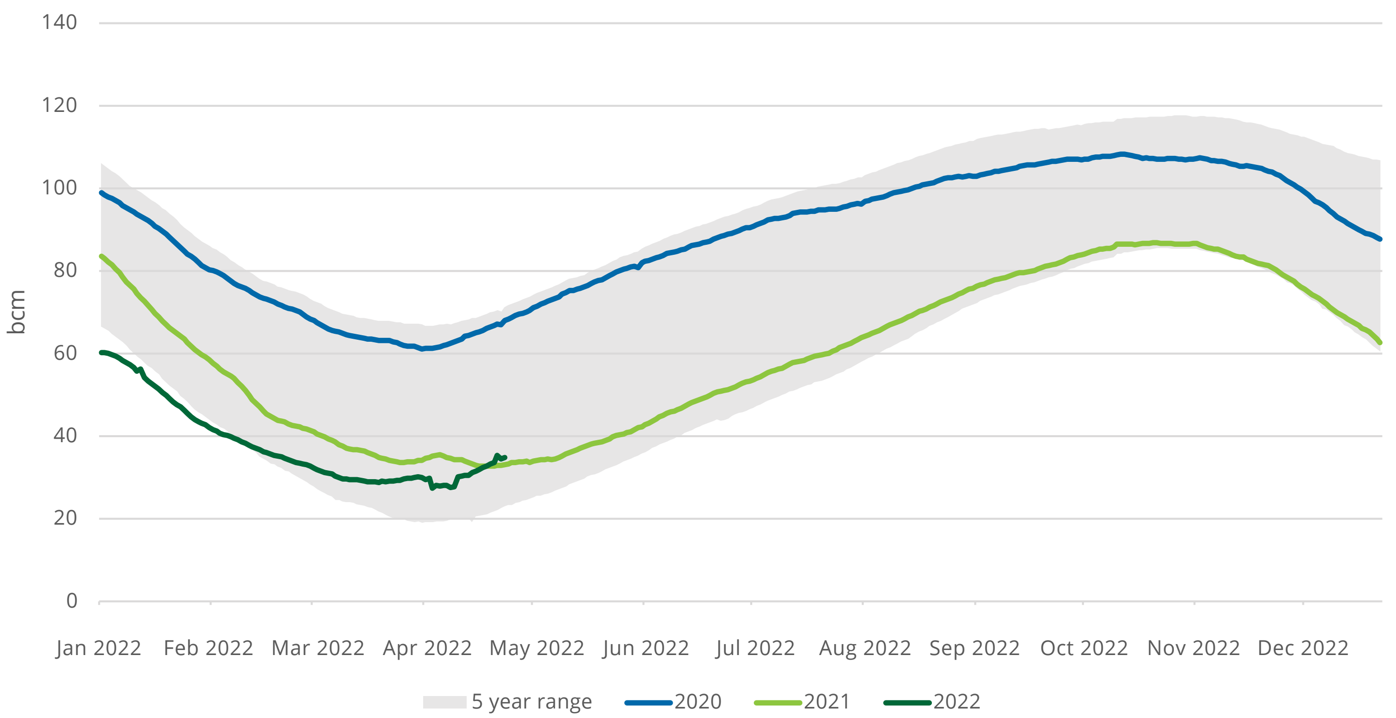
Tightening global gas balances were driven by multiple factors. Outages at many global liquefaction projects led to low-capacity utilisation on the supply side, due to unplanned shutdowns at plants and extended maintenance periods due to the COVID-19 pandemic. Output was notably lower year-on-year in Nigeria, Trinidad and Tobago, while LNG exports from Norway were offline for the entire year.

On the demand side, Brazil faced a drought that left its hydro reserves depleted and in turn boosted spot LNG demand by 193%. China meanwhile continued its policy of emissions and pollution reduction via coal-to-gas switching at pace, boosting its LNG demand by 15.0%.

In Asia Pacific, several other countries and regions also significantly increased LNG imports in 2021, including, South Korea (+15.0%) and Chinese Taipei (+9.5%).

In Europe, the tightening of global LNG balances and subsequent fall in LNG arrivals, alongside reduced Russian pipeline deliveries and strong downstream demand, led to a drawdown of the storage stock buffer over summer relative to the five-year average. Consequently, heading into winter 2021, Europe was forced to forgo its role as global gas balancer and price higher to compete with Asia for flexible, spot LNG cargoes.

Figure 3.2: Europe underground storage levels



Source: Gas Infrastructure Europe

Prompted by lower spot LNG prices versus traditional long-term contract price formulas, many importers had over 2019 and 2020 begun to rely on greater volumes of spot cargo supplies. However, this left some importers competing with spot-reliant buyers in the Atlantic basin for a limited supply of cargoes over the winter season, with Asian demand side elasticity emerging at previously untested price levels. Subsequently, while China's LNG demand grew exceptionally in the first nine months of 2021, growth slowed significantly in Q4 2021. This caused a dislocation between trucked LNG prices and spot LNG cargo prices. Trucked LNG prices tracked lower versus spot LNG cargo prices, as China started to step back from spot imports.

India was another buyer that had relied on spot cargoes to satisfy its growing appetite for LNG over the previous two years. However, as prices soared in 2021, India's imports fell by around 10%, with year-on-year declines seen from June 2021 onwards. High spot LNG prices disincentivised imports, with industrial users turning to cheaper fuels than spot LNG such as fuel oil.

Demand elasticity in Asia, driven by Europe's increased reliance on LNG due to a reduction in Russian pipeline supply and depleted storage stocks, led to an 'inversion' between JKM prices and those on the European gas hub the Title Transfer Facility (TTF). The JKM forward curve began to price below the TTF forward curve in mid-December 2021. The price relationship briefly returned to JKM being a premium to TTF in Q1 2022, as mild temperatures in Europe eased concerns of shortages. However, since the outbreak of the Russia - Ukraine conflict in late February 2022, the JKM has been pricing at a sustained discount to the TTF, at times up to 30% below.

In 2022, the JKM/TTF relationship demonstrates both Europe's new-found role in the global LNG market and the emergence of Asian demand elasticity, predominantly in the world's two most populous nations, which have significantly decreased their LNG imports year-on-year so far (China -17.6%, India -23.8%) in January-April. Market expectation, expressed via the forward curve, indicated that the JKM may price below the TTF into 2023.

During 2021, Platts published 795 bids, offers and trades in its Asia Pacific LNG Market on Close (MOC) process, compared to 1,031 bids, offers and trades the year prior. Trade volume reported via the process increased to nearly 5 million tonnes of LNG, a doubling compared to 2020. The MOC is the principal price assessment process used to determine JKM. Companies began reporting named, firm bids, offers and trades via the MOC in mid-2018.

3.2 ATLANTIC LNG MARKET PRICE TRENDS

The Platts delivered ex-ship Northwest Europe (DES NWE) LNG benchmark, which reflects spot LNG cargoes delivered into key terminals in the UK, Belgium, the Netherlands and France's Atlantic coast, started 2021 at $7.043/MMBtu, hit an annual low of $5.111/MMBtu on 3 March and touched an all-time-high on 22 December 2021 at $58.638/MMBtu. In the 12 years since Platts launched the price assessment, this has been the most eventful period for European LNG imports.

Atlantic Basin LNG markets grew in importance as the year progressed, with depleted gas storage in Europe and lower-than-average Russian pipeline deliveries driving Europe's evolution from the market of last resort to a premium LNG buyer. However, even before this, outages at Atlantic basin liquefaction plants and the growing role of Brazil as an importer of spot LNG cargoes drove tightness in the market that contributed to Europe's inability to refill stocks via LNG imports.

Brazil imported 7.644 million tonnes of LNG in 2021, compared to just 2.404 million tonnes the year before. Nearly all this increase was short-term or spot cargoes, and during Q3 Brazil became the largest importer of US-sourced LNG. Brazil's need was such, due to acute hydro reserve shortages caused by drought, that importers were regularly paying a premium to Europe's TTF price to secure cargoes.

The effect of this was for European LNG spot imports to price above the TTF, which had a significant downward pressure on import volumes. This was because the cargo would be lossmaking before it was sold onto the grid. Throughout Q3, European LNG import volumes remained below 5 million tonnes/month. As Europe is 60% or more dependent on short-term or spot LNG volumes for its import, this direct competition with Brazil, as well as surging imports to China, came at an unwelcome moment to ensure sufficient supply arrived at Europe's shores.

Indeed, Platts DES NWE LNG price remained above the TTF for the majority of 2021. But Q4 saw dramatic changes to relative values and Platts DES NWE began to price at a discount to the TTF once more. In 2022, the discount reached record levels: for April 2022 the discount for Platts DES NWE averaged minus $4.73/MMBtu compared to the TTF. The reason for this reversal was Europe's pivot from Russian piped gas to huge increases in LNG imports. As a result, the cost to regasify LNG into key European terminals rose significantly, pressuring the LNG import price. A disparity between those countries with spare regasification capacity and those with high dependence on Russian pipeline gas led to an atypical easterly flow of gas in Europe. Large dislocations emerged between European gas hubs, with the TTF detaching from international LNG prices as regasification capacity into continental Northwest Europe emerged as a bottleneck. Sellers were unable to monetise their gas into premium European markets, and thus were forced to discount their cargoes in a bid to incentivise demand in alternative markets. However, with spot procurement in North Asia limited, the price difference between Asian LNG and European gas widened to historic levels.

US gas prices, represented by Henry Hub front month, traded in a relatively narrow range through 2021, although they peaked at $6.312/MMBtu on 4 October 2021. They were disconnected from the TTF and JKM, as liquefaction capacity proved to be a bottleneck, with the correlation between Henry Hub and international LNG prices (represented by the JKM) remaining weak during 2021-2022.

The Platts Gulf Coast Marker (GCM), which represents US LNG spot cargoes on a free on board (FOB) US Gulf Coast basis, demonstrated the margins available to companies with offtake volumes from the US. The average premium for FOB spot cargoes against Henry Hub-linked term offtake volumes from US LNG producers was $20.985/MMBtu in winter 2021. Given that the GCM averaged below Henry Hub-linked term offtake in 2020, when around 170 LNG cargoes were cancelled from the US, this was quite a turnaround.

So far, 2022 has been a different story for Henry Hub, with prices more than doubling from January to the end of April, reaching $7.475/MMBtu as the US continues to ramp up its LNG export capacity and gas stock levels are below historical averages.

During 2021, Platts published a record 269 bids and offers for cargoes in its Atlantic LNG MOC process. This was a significant increase relative to the 22 cargoes reported in the process the year prior.

While LNG prices have been higher than Henry Hub-linked long-term contract formulas, they have also been higher than historical Brent-linked long-term contract formulas. This helped bring buyers back to the table with project developers. In 2021 around 78 million tonnes of LNG contracts were signed, versus just 38 million tonnes the year before.

Nearly 50 million tonnes of the contracts signed in 2021 were on an FOB basis, versus just 12 the year prior. North American projects accounted for nearly 30 million tonnes of the contracts signed, whereas in 2020 when Henry Hub-linked long-term contract formulas were uneconomic against LNG prices, just 3.5 million tonnes of contracts were signed.

Market-based LNG pricing accounted for around 10 million tonnes of the contracts signed in 2021, versus under 2 million tonnes the year prior.

4 LNG Liquefaction Plants

Global liquefaction capacity reached **459.9 MTPA** in 2021.

Capacity Additions for 2021

6.9MTPA of liquefaction capacity brought online

1.5% year-on-year growth vs 2020

Australia 87.6MTPA Market with the highest liquefaction capacity

USA 86.1MTPA Market with the second highest liquefaction capacity

Qatar 77.1MTPA

Pre-FID

1034.5MTPA of liquefaction capacity currently in pre-FID stage

387.6MTPA from USA

136.7MTPA from Russia

45.5 MTPA from Australia

210.4MTPA from Canada

52.2MTPA from Mozambique

FIDs and Under Construction

FID in 2022 **50.0MTPA**

QatarGas **32MTPA**

138.5MTPA of liquefaction capacity under construction or approved for development as of April 2022

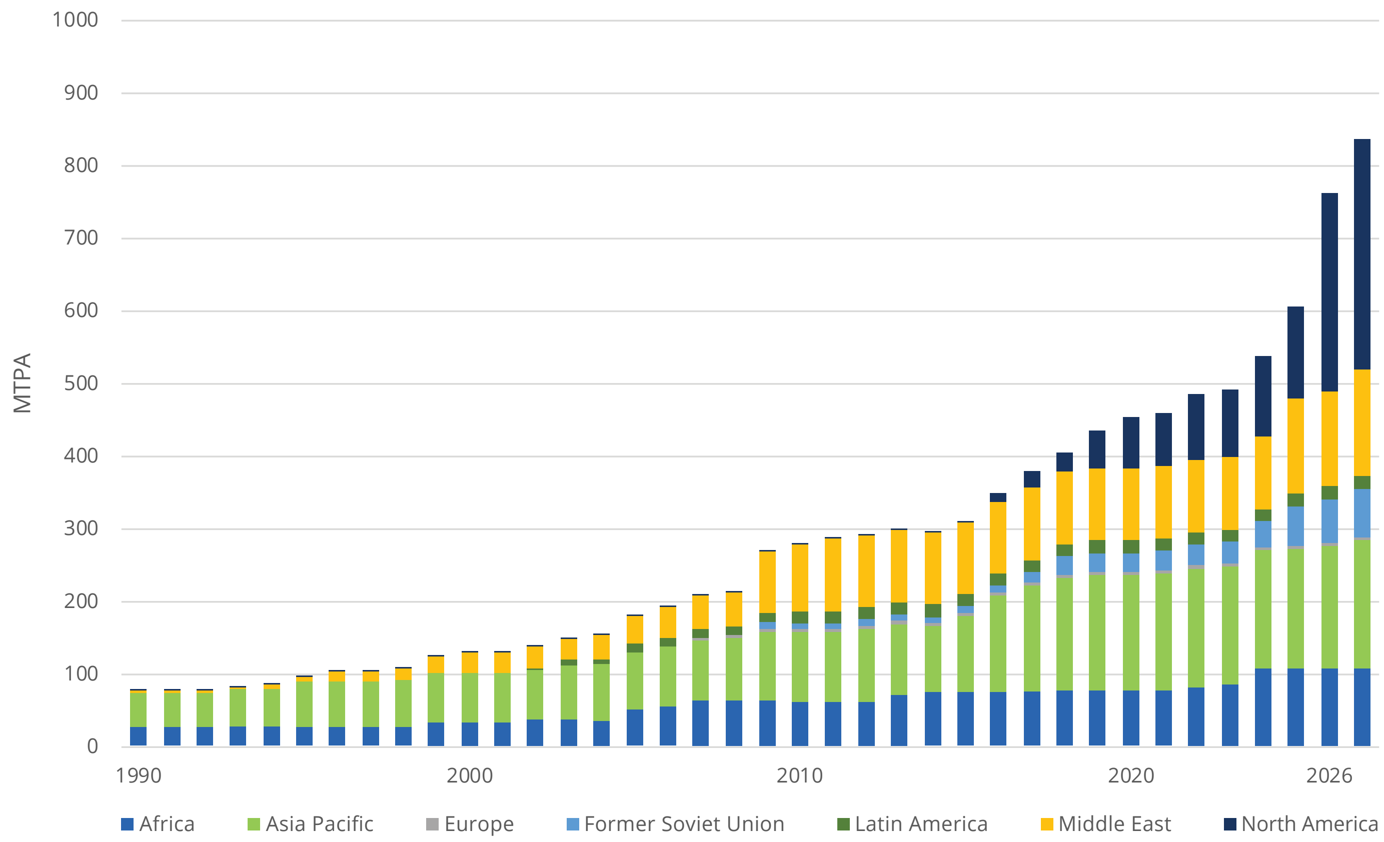
4. LNG Liquefaction Plants

About 6.9 million tonnes per annum (MTPA) of liquefaction capacity was brought online in 2021, increasing global liquefaction capacity to 459.9 MTPA[1] at the end of the year. The average global utilisation rate in 2021 was 80.4%, compared to 74.6% in 2020. In the first four months of 2022, an additional 12.5 MTPA of liquefaction capacity was brought online, bringing the total global liquefaction capacity to 472.4 MTPA as of April 2022.

[1] This number includes the liquefaction capacity of Marsa El Brega LNG, Yemen LNG and Tango FLNG, which have currently suspended operations. This number excludes the liquefaction capacity of Kenai LNG, which has announced plans to be converted to an import terminal.

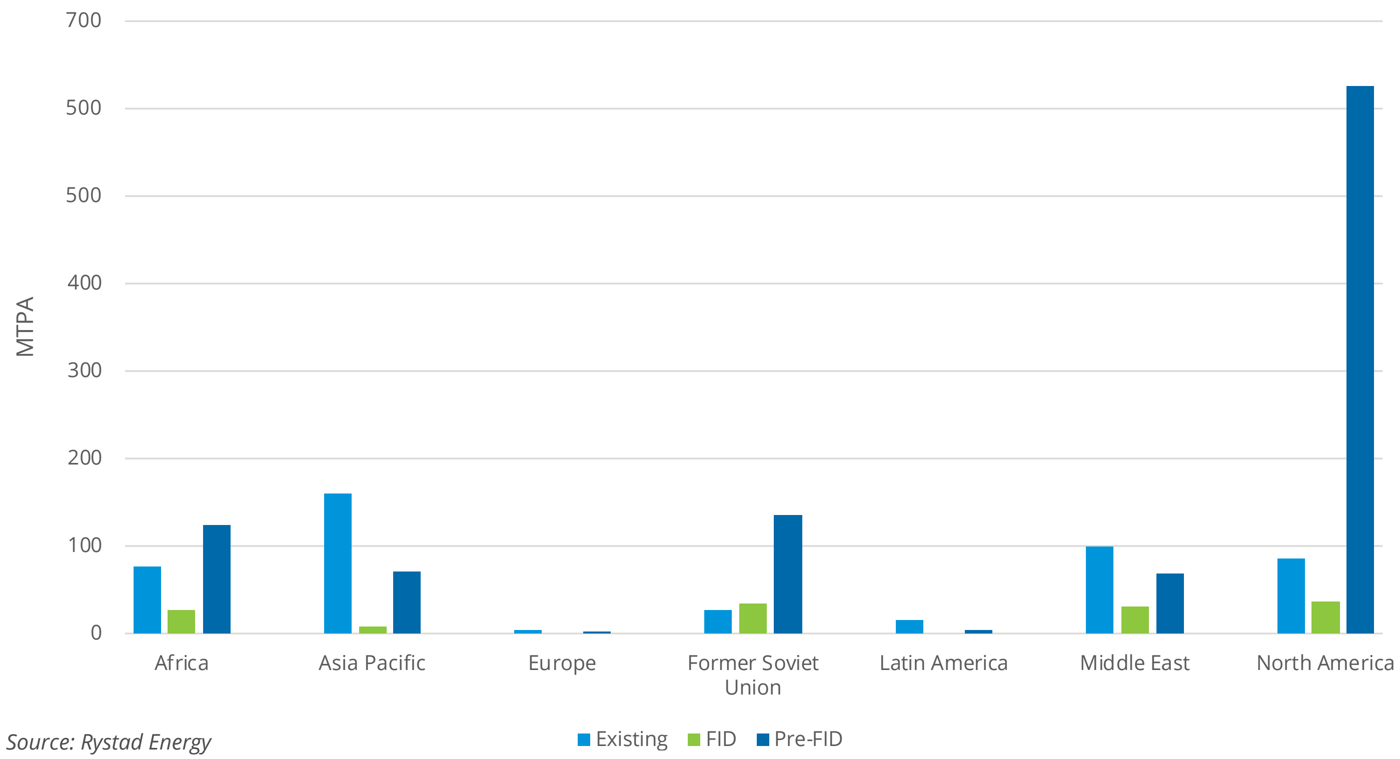
4.1 OVERVIEW

Figure 4.1: Global liquefaction capacity growth by region, 1990 – 2027



Source: Rystad Energy

Figure 4.2: Global liquefaction capacity by region and status, as of end-of-April 2022



Source: Rystad Energy

The Petronas PFLNG Dua (1.5 MTPA) and Corpus Christi T3 (4.5 MTPA) liquefaction plants began commercial operations in February and March 2021, respectively, while Yamal LNG T4 (0.95 MTPA) began commercial operations in June 2021. The start-up of Yamal LNG T4 marks the full commercial operation of the four-train facility in the Yamal peninsula, Russia. Over the first four months of 2022, the Sabine Pass LNG T6 (5.0 MTPA) and first twelve trains of the Calcasieu Pass LNG T1-T12 (7.5 MTPA) started commercial operations, making the US the market with the second largest operational liquefaction capacity in the world, overtaking Qatar.

Commercial operation for Tangguh LNG T3 (3.8 MTPA) and Coral-Sul FLNG (3.4 MTPA) is expected in the second half of 2022. The Portovaya LNG T1-T2 (1.5 MTPA) was initially set to come online in 2022, but because of the ongoing Russia–Ukraine conflict, it is uncertain whether proposed and under-construction Russian LNG projects will eventually start operations. International sanctions have also led to several key players exiting the market. Major international players, BP, Shell, Equinor and ExxonMobil have announced their exit from all investments and joint ventures in Russia. TotalEnergies, a major LNG player in Russia, announced it will not be making new investments in Russia but will keep its stakes in companies and hydrocarbon projects in the country. Another notable LNG player is Linde, a primary liquefaction technology provider. Linde played an important role in the Russian LNG sector as a partner underpinning the multi-billion-dollar EPC contract for the Arctic LNG 2 (19.8 MTPA) export project, Portovaya LNG T1-T2 (1.5 MTPA) and the Ust Luga T1-T2 (13.0 MTPA).

The volume of approved liquefaction capacity in 2021 increased to one of the highest levels historically, totalling 50.0 MTPA, recovering after the COVID-19 lockdowns stalling in 2020. This is driven by the QatarGas North Field Expansion (NFE) Phase 1 project (32.0 MTPA), which is expected to increase total production capacity in Qatar by 43% from 77 MTPA to 110 MTPA. A final investment decision (FID) was announced in February 2021, with first LNG production anticipated in 2025. Another Linde licensed project that reached FID is the Ust Luga LNG T1-T2 (13.0 MTPA), formerly known as Baltic LNG. However, there is a lot of uncertainty surrounding the continuation of the project due to the Russia-Ukraine conflict. The final project that reached FID in 2021 is Pluto LNG T2 Expansion (5.0 MTPA) . The expanded capacity allows for processing of third-party gas resources through the Pluto LNG facilities, including the Scarborough gas project.

Several factors led to the increase in approved liquefaction capacity in 2021. A faster-than-expected global economic recovery from the COVID-19 pandemic coupled with increasing LNG demand spurred LNG liquefaction investments as investors placed greater emphasis on fulfilling growing energy needs. This trend may continue in 2022, with the Russia–Ukraine crisis reinforcing LNG's role in ensuring energy security. Russia is one of the most significant gas sources for the European market through its vast pipeline network. Coupled with its historically low gas storage levels in early 2022, Europe is particularly vulnerable to short-term movements in supply and demand. As such, in the current geopolitical and energy crisis, alternative sources of LNG are critical for ensuring a stable and diversified supply of energy. In addition, decarbonisation and the energy transition remain imperative to meeting the Paris Agreement and goals and avoiding irreversible climate change implications. LNG has a key role to play – not only as the lowest emission hydrocarbon to replace coal and oil and to enable access to modern energy where it still lacks, but also to integrate large quantities of renewable generation. Only gas can provide at sufficient scale the flexibility and backup that renewable generation needs, particularly as its share in the energy mix rapidly grows (and should grow more rapidly still to meet decarbonisation goals).

Importantly, the aim of decarbonisation has transcended well into the liquefaction sector. Over the past year, we have seen an increased focus on decarbonisation among liquefaction facilities. For example, several proposed projects such as the Cedar LNG 1 (3.0 MTPA), Kitimat LNG (18.0 MTPA) and Woodfibre LNG (2.1 MTPA) in Canada will be powered by clean, renewable hydroelectricity. In the US, Venture Global is currently developing CCS at its LNG facilities (Plaquemines LNG and Calcasieu Pass LNG). Through this undertaking, Venture Global will capture and sequester an estimated 500,000 tonnes of carbon per year from its Calcasieu Pass and Plaquemines liquefaction sites. Low-carbon LNG is expected to play a key role in the global energy system. LNG offtakers will be more cautious about the environmental and emissions performance of procured cargoes as the urgency to meet decarbonisation targets intensifies.

Currently, 1,034.5 MTPA of aspirational liquefaction capacity is in the pre-FID stage. Global liquefaction capacity would increase threefold if all these projects materialise, although this is unlikely. Most of the proposed capacity is in North America (627.2 MTPA), with 387.6 MTPA located in the United States, 210.4 MTPA in Canada, and 29.3 MTPA in Mexico. This is followed by Russia (136.7 MTPA), Africa (123.9 MTPA), Asia Pacific (70.4 MTPA) and the Middle East (69.9 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 is likely to stimulate investments into additional liquefaction facilities as investors put more emphasis on increasing energy security while at the same time, balance decarbonisation goals in this fast-changing landscape.

4.2 GLOBAL LIQUEFACTION CAPACITY AND UTILISATION

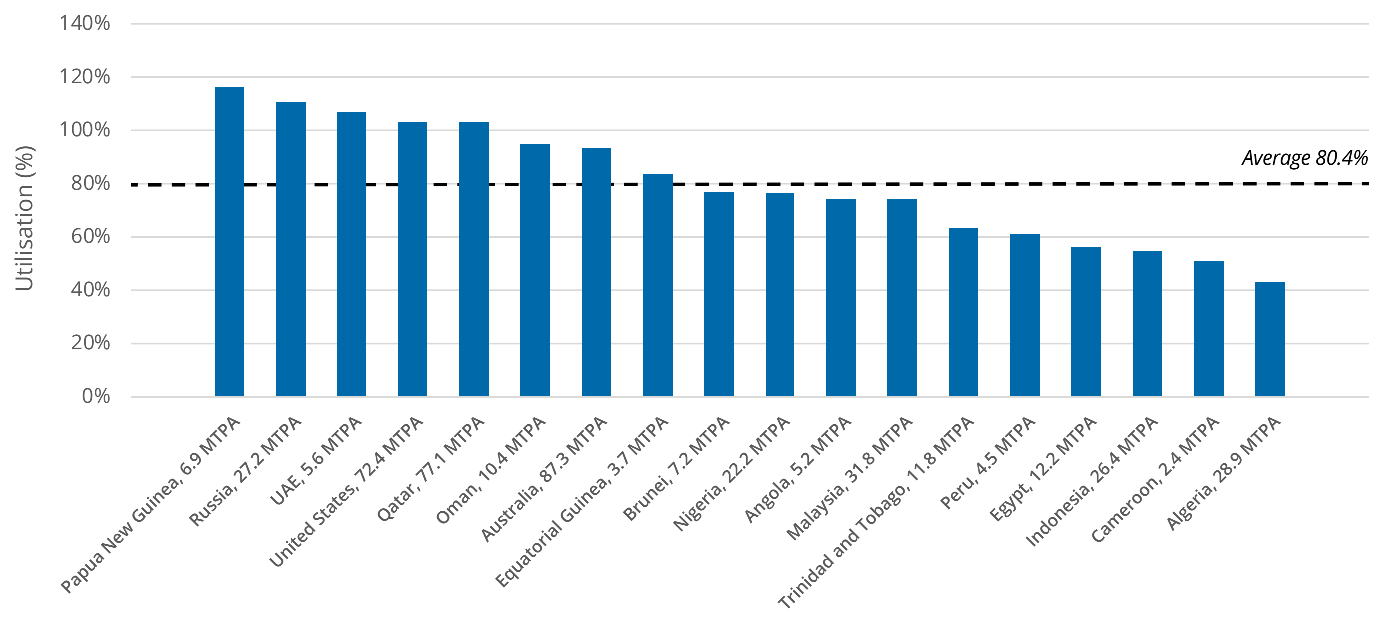
459.9 MTPA
Global liquefaction capacity, End of 2021

Global liquefaction capacity reached 459.9 MTPA at the end of 2021 and the utilisation rate was 80.4%[2] on average, compared to 74.6% in 2020.

Seven out of 21 LNG exporting markets[3] achieved utilisation rates of more than 90% in 2021, namely Papua New Guinea, Russia, United Arab Emirates, United States, Qatar, Oman, and Australia.

[2] Utilisation is calculated on a prorated basis, depending on when the plants are commissioned. Only operational facilities are considered.
[3] The 21 markets include Yemen, Libya, and Norway, although Yemen LNG and Marsa El Brega LNG have suspended operations while Norway's Hammerfest LNG have shut down for repair works after a fire since September 2020. Argentina's Tango FLNG has been uncontracted since its dispute in early 2020, hence, have not been added as an operational export market

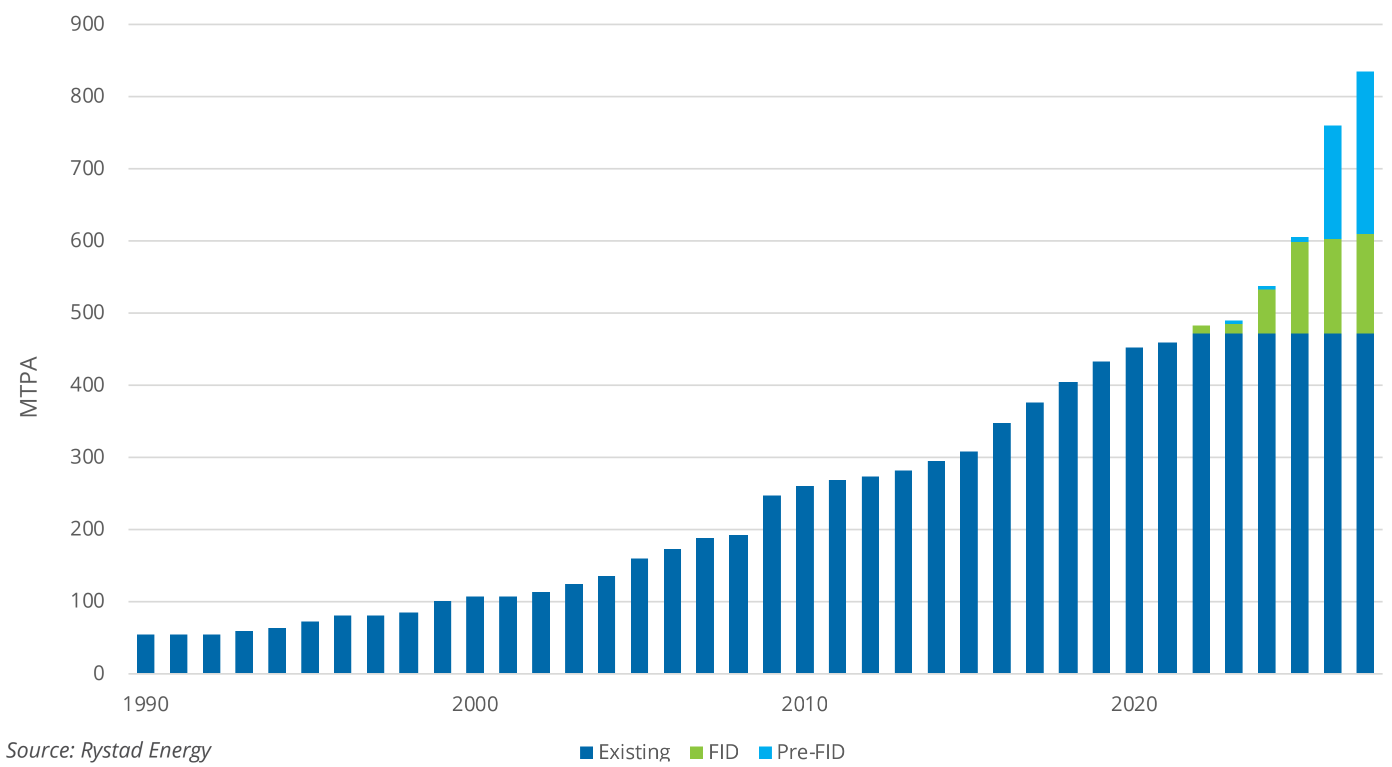
Figure 4.3: Global liquefaction capacity utilisation in 2021 (Capacity is pro-rated)



Source: Rystad Energy

The increase in utilisation was largely due to the global economic recovery following the lifting of COVID-19 regulations, a prolonged European winter, and drought in Brazil, which accelerated the demand for LNG.

Figure 4.4: Global liquefaction capacity development, 1990-2027



Source: Rystad Energy

The US was one of the main beneficiaries of the strong demand for LNG last year. Utilisation in the US increased from 76.5% in 2020 to 103.4% in 2021, representing a 50% increase in US LNG exports. This was primarily driven by strong netbacks due to high prices in end-user markets in Europe, Asia, and Asia Pacific, which incentivised full dispatch from US LNG export terminals in 2021. In the last quarter of 2021, US LNG exports to Europe increased due to low natural gas storage inventories in Europe, sending spot prices for natural gas soaring. As Europe continues to struggle to implement the policy to replace Russian gas following the Russia-Ukraine conflict, more attention has been placed on US LNG to fill the void. Similarly, liquefaction facilities in the Middle East have performed above nameplate capacity, with UAE and Qatar operating at a utilisation rate of 107.4% and 103.3%, respectively. Adgas has made investments to further boost output, while Qatar's facility remains tied up in long-term oil-linked contracts with Asian buyers, which have likely maximised contractual offtake to reduce exposure to the record-high prices in the spot market.

Not all plants enjoyed high utilisation in 2021. Some facilities in Asia Pacific, Latin America and Africa produced below capacity due to upstream or operational issues. Plants in Nigeria, Trinidad and Tobago, and Algeria have sustained low utilisation due to gas shortages. Algeria has had a utilisation rate of less than 50% over the past three years owing to a combination of reasons, including: declining gas production from maturing fields, lack of investments in secondary and tertiary recovery technologies to improve current recovery rates, and growing domestic consumption. In Asia Pacific, Indonesia's Bontang LNG (16.8 MTPA) has suffered sand production in the wells at the depleting Merakes gas field offshore Kalimantan, while Malaysia's MLNG plant (29.3 MTPA) also lost some gas supply due to mercury contaminants in the gas stream from the Pegaga field. Maintaining liquefaction production at a high level has brought value to some plant operators, such as those in the US and Qatar, enabling them to capitalise on high spot LNG prices.

Another factor that can affect utilisation of LNG export facilities is outages. In Norway, Hammerfest LNG (4.2 MTPA), also known as Snøhvit LNG, was offline throughout 2021 due to serious damage caused by a fire that broke out in one of the five power turbines in September 2020, resulting in an unplanned shutdown. Plans to bring it back online in January 2022 failed as there were still issues to be rectified. The facility has since restarted commercial operations in late May 2022. Prelude FLNG (3.6 MTPA) off Australia was troubled by a fire that occurred in December 2021, which resulted in a complete loss of power at the facility. It was shut down for five months until April 2022, when it resumed operations.

4.3 LIQUEFACTION CAPACITY BY MARKET

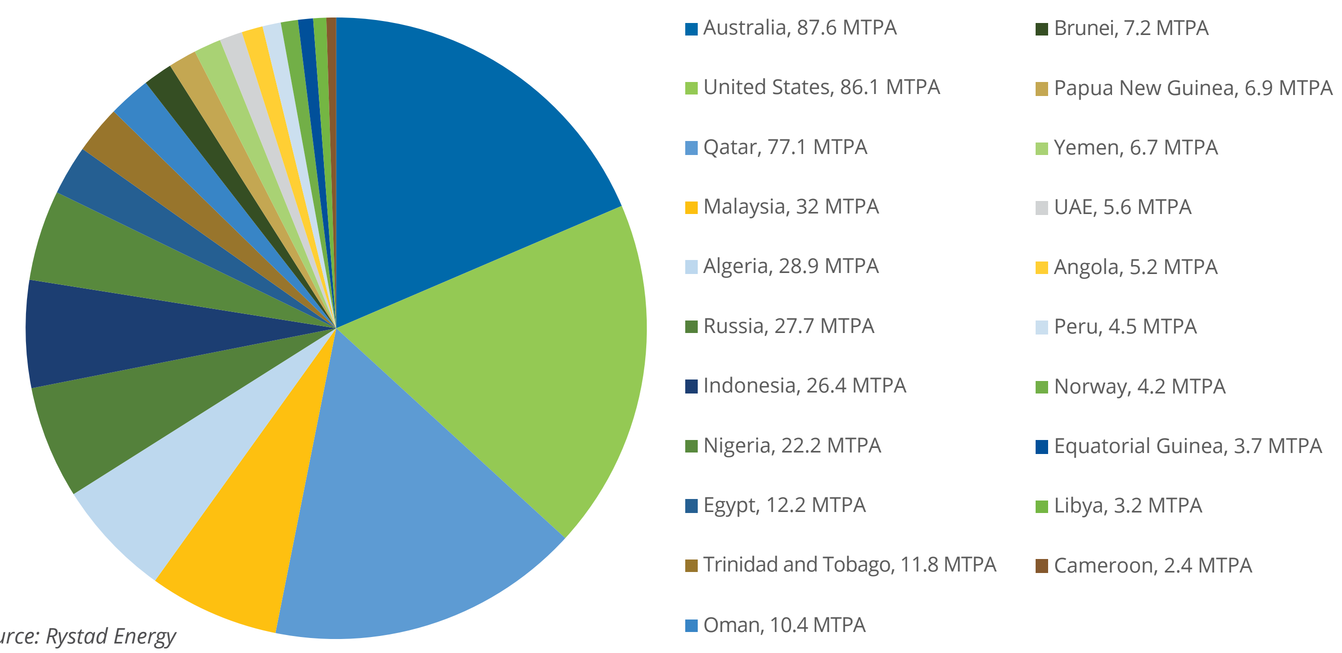
87.6 MTPA

Operational Liquefaction Capacity in Australia, as of end April 2022.

Operational

As of end-of-April 2022, there were 21 markets[4] with operational LNG export facilities. Australia continues to be the market with the largest operational capacity with 87.6 MTPA, followed by the United States, which overtook Qatar with an operational capacity of 86.1 MTPA. Qatar trails behind with 77.1 MTPA. The United States increased its total operational capacity by 25% from 69.1 MTPA at the end of 2020 to 86.1 MTPA in April 2022. This was mainly contributed by the start-up of Corpus Christi T3 (4.5 MTPA), Sabine Pass T6 (5.0 MTPA) and most recently in March 2022, part of the Calcasieu Pass LNG T1-T12 (7.5 MTPA). The remaining six trains of the Calcasieu Pass LNG T13-T18 (3.8 MTPA) is set to come online by the end of 2022, which will eventually make the United States the market with the largest operational liquefaction capacity. The top three LNG export markets currently represent more than half of the global liquefaction capacity.

Figure 4.5: Global operational liquefaction capacity by market as of end-of-April 2022



Source: Rystad Energy

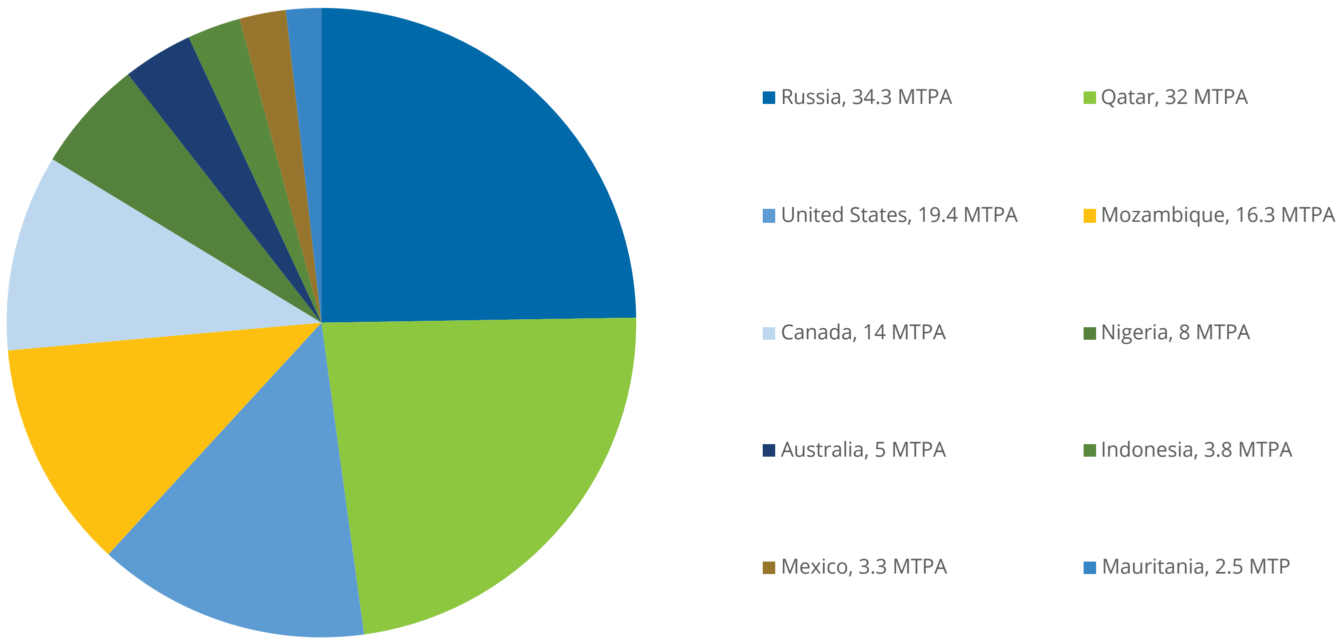
[4] Excludes Argentina as the Tango FLNG remains uncontracted after its charter with YPF was terminated

Under construction/FID

As of April 2022, 138.5 MTPA[5] of liquefaction capacity was under construction or approved for development, of which approximately 25% is located in Russia. In 2021, 50.0 MTPA of liquefaction capacity was approved. This was mainly contributed by the QatarGas North Field East (NFE) project that was approved in February 2021, adding 32.0 MTPA to global approved liquefaction capacity. The remaining approved capacity was contributed by the Ust Luga LNG T1-T2 (13.0 MTPA) and Pluto T2 Expansion (5.0 MTPA).

Several projects currently under construction and progressing towards completion in 2022. Projects that are expected to begin commercial operations this year include the Tangguh LNG T3 (3.8 MTPA) in Indonesia, Coral-Sul FLNG (3.4 MTPA) in Mozambique, the remaining trains of the Calcasieu Pass LNG T13-T18 (3.8 MTPA) and the Portovaya LNG T1-T2 (1.5 MTPA) in Russia. The Portovaya LNG T1-T2 (1.5 MTPA) was initially set to come online in the second half of 2022, however, international sanctions on Russia have challenged the commissioning of the project. Meanwhile, several projects are signalling FID in 2022. These include the eight-train Driftwood LNG Phase 1 (11.0 MTPA) in Louisiana, which has already begun construction before the FID was made. Similarly, Venture Global's Plaquemines LNG project (21.6 MTPA) and Woodfibre LNG (2.1 MTPA) have issued "Limited Notices to Proceed" to their respective EPC contractors, signalling an FID by the end of 2022. In early 2022, New Fortress Energy executed a Heads of Agreement (HoA) with Eni's subsidiary in the Republic of Congo for the deployment of a Fast LNG unit jack-up for a period of 20 years. This will provide a novel liquefaction facility for Eni's Congo-Brazzaville scheme (1.4 MTPA). The HoA provides a framework for negotiating a long-term tolling agreement between New Fortress Energy and Eni for the full capacity of the facility. Production is expected to start in mid-2023. Construction work for the Mozambique LNG Area 1 (12.8 MTPA) was halted in 2021 as TotalEnergies declared force majeure due to militant attacks close to its construction site. The initial plan was for the project to produce its first LNG cargo in 2024, which has now been delayed to at least 2025. Earlier in 2022, TotalEnergies indicated interest to resume work for the Mozambique LNG area 1 (12.8 MTPA) by the end of 2022.

Figure 4.6: Global approved liquefaction capacity by market as of end-of-April 2022



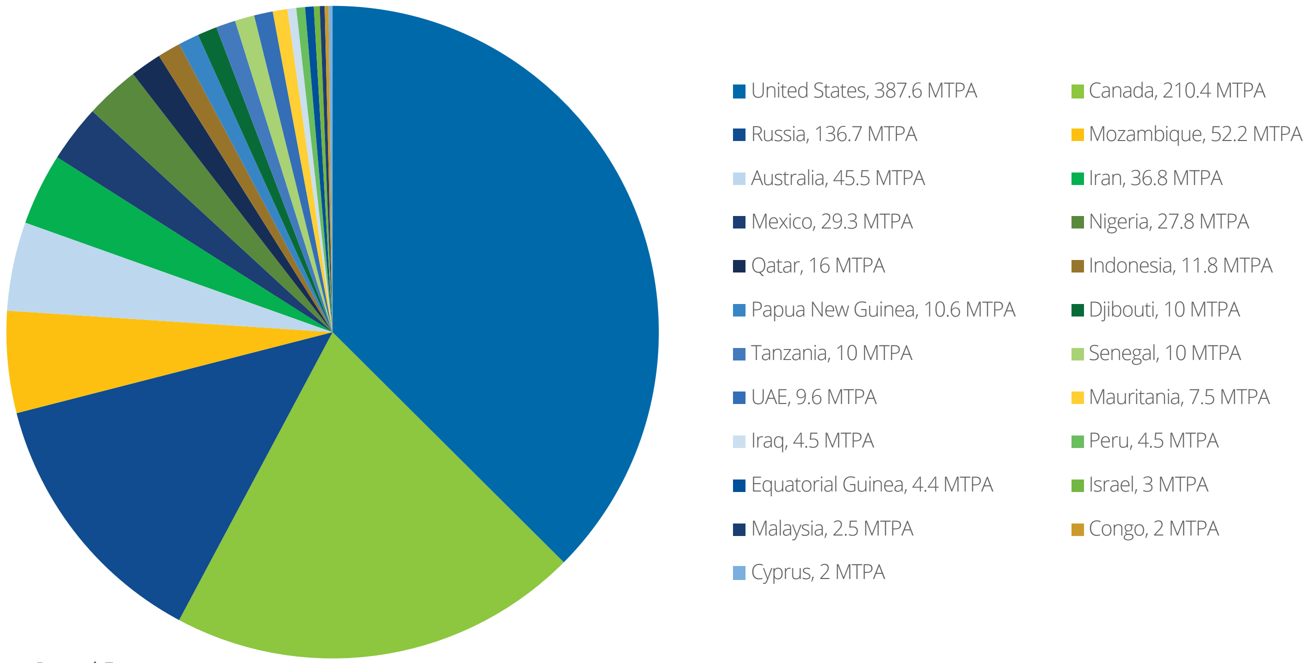
Source: Rystad Energy

[5] Does not include Sengkang LNG T1 (0.5 MTPA) as construction efforts have been stalled

Proposed

There is currently 1,034.5 MTPA of aspirational liquefaction capacity in pre-FID stage. 130.5 MTPA of this was proposed in 2022 alone. Given the geopolitical events in 2022 centred on the Russia–Ukraine conflict, global gas supply has been severely disrupted. This has spurred a wave of proposed liquefaction projects as operators attempt to seize high gas prices and growing LNG demand. However, a fair portion of the pre-FID projects are not likely to progress. With most developers still recovering from the economic backlash of the COVID-19 pandemic, developers have pushed back on capital-intensive pre-FID liquefaction projects and reinstated their strategies. This puts small-scale LNG in the spotlight as it remains a growing segment within the wider LNG sector with significant potential.

Figure 4.7: Global proposed liquefaction capacity by market, as of end-of-April 2022



Source: Rystad Energy

Out of the 1,034.5 MTPA of aspirational liquefaction capacity in pre-FID stage, the United States accounts for 37.5% (387.6 MTPA), followed by Canada at 20.3% (210.4 MTPA) and Russia at 13.2% (136.7 MTPA). The large inventory of proposed US projects is primarily driven by the growth in shale gas output in the US over the past few years. While most operational US LNG projects are brownfield conversion projects, the 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 off-takers and increases competitiveness in project economics through modular construction. One of the key examples of this is Plaquemines LNG (21.6 MTPA) in Louisiana, which plans to accommodate up to 36 liquefaction trains of 0.6 MTPA each, configured in 18 blocks. Venture Global, the developer of Plaquemines LNG, has announced that it will take FID by the end of 2022. The company has already sold 14.0 MTPA of its proposed 21.6 MTPA capacity at the time of writing. Another example is Driftwood LNG (27.6 MTPA), also in Louisiana, which consists of 20 liquefaction trains built in four phases. The facility will feed gas from the existing interstate pipeline system of the Columbia Gulf Transmission, which interconnects about 14 interstate pipelines.

Out of the 210.4 MTPA of liquefaction capacity proposed in Canada, 171.9 MTPA sits along the Pacific West Coast of British Columbia, which is closer to Asian markets than rival projects on the US Gulf Coast. This means that shipping costs from these projects to Asia are lower than for projects on the US Gulf Coast. This is a key driver for the increase in the number of proposed LNG export projects on the Canadian west coast, although most remain in early development stages. Due to strict environmental standards, these LNG export projects have adopted various strategies to reduce their 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, renewable hydroelectricity. Similarly, LNG Canada T3-T4 (14.0 MTPA) has selected high-efficiency aeroderivative gas turbines to minimise fuel use and will be powering a portion of its liquefaction plant with renewable energy as well. There are also three proposed projects on Canada's east coast totalling 38.5 MTPA of liquefaction capacity: Bear Head LNG (12.0 MTPA), Saguenay LNG (11.0 MTPA) and AC LNG (15.5 MTPA).

Russia has 136.7 MTPA of proposed liquefaction capacity, in addition to the Ust Luga LNG T1-T2 (13.0 MTPA), which was approved in 2021 and is currently under construction. 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 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 feed gas sources since plans to purchase feed gas from Sakhalin-1 gas fields were abandoned and the developed gas reserves in the Sakhalin-2 region are not yet sufficient. In addition, there are the proposed developments of Arctic LNG 1 (19.8 MTPA) and Obsky LNG (5.0 MTPA) in the Arctic region. The latter is the third LNG project proposed by Novatek, after Novatek's successful start-up of Yamal LNG (17.4 MTPA) and FID on Arctic LNG 2 (19.8 MTPA). Another proposed project, Yakutsk LNG (17.7 MTPA), is situated in the Far East of the Russian Federation and targets exports to the Asian and Asia Pacific markets. The project involves a gas pipeline from Yakutia to the Sea of Okhotsk, and a condensate pipeline with a capacity of 1.5 MTPA. Given the current geopolitical situation because of the Russia–Ukraine conflict, international sanctions have jeopardised the commercialisation of these proposed projects, as prominent players in the LNG industry have exited the Russian market with the likes of Shell, BP, ExxonMobil, Equinor and Linde signalling their withdrawal from Russian investments.

Recent gas discoveries in Africa have increased the proposed liquefaction capacity to 123.9 MTPA for the continent. Mozambique has the largest pipeline of proposed projects, with a combined capacity of 52.2 MTPA. Rovuma LNG (15.2 MTPA), which is 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. Operator ExxonMobil has also been exploring the feasibility of decarbonising the Rovuma LNG facility via carbon capture and storage technology to lower emissions intensity of the project. In West Africa, 55.3 MTPA of liquefaction capacity has long been proposed but has been met with challenges. Brass LNG (10.0 MTPA) in Nigeria was proposed in 2003 and has been subject to numerous attempts to reach an 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 for the NLNG project is underway. NLNG T8 (4.0 MTPA) is said to be different from the existing ones, with a focus on reducing carbon emissions. In Mauritania, plans for the Phase 2 of the Greater Tortue Ahmeyim project is being re-evaluated, with FID expected in late 2022 or early 2023. Phase 2 is expected to add another 2.5 MTPA. Situated in north-eastern Africa, Djibouti LNG is expected to bring 10.0 MTPA of liquefaction capacity online if the project progresses further. Tanzania is also planning its long-delayed first LNG plant, Tanzania LNG (10.0 MTPA), with FID targeted for 2025 and planned start-up in 2030. Though Tanzania is well situated as a point of supply to Asian markets, the project is expected to face strong competition from projects under construction in the US, Mozambique, Canada, and Qatar. Nevertheless, if the proposed liquefaction projects materialise, East Africa could emerge as a key LNG producing region in the future.

In Asia Pacific, Australia has the largest aspirational capacity of 45.5 MTPA. The Ichthys expansion T1, T2 has made some progress as INPEX announced its plans to boost LNG production capacity at its operated Ichthys project from its current capacity of 8.9 MTPA to 9.3 MTPA by 2024. Other proposed projects such as the Abott LNG T1-T4 (2.0 MTPA), Darwin LNG T2 (3.5 MTPA), Gorgon LNG T4 (5.2 MTPA) and the Wheatstone LNG T3-T5 (15.9 MTPA) have yet to progress, with most of them still in feasibility stages. In Papua New Guinea, TotalEnergies has been progressing the Papua LNG project (5.4 MTPA). FEED work is expected to take place in June 2022, with expected FID in 2023. In Southeast Asia, Indonesia has proposed 11.8 MTPA of liquefaction capacity, mainly from Abadi LNG (9.5 MTPA), which will be supplied by the Abadi gas and condensate field in the Masela PSC.

Decommissioned and idle

There were no announcements of LNG plants being decommissioned in 2021.

The Kenai LNG plant in Alaska, which has been dormant since the autumn of 2015, garnered approval in December 2020 from the Federal Energy Regulatory Commission (FERC) to bring the plant back online as a limited-use import facility. The Marsa El Brega LNG plant in Libya halted production in 2011, and there are currently no plans to bring it back online.

The Damietta LNG (5.0 MTPA) plant in Egypt restarted commercial operations in March 2021. Damietta LNG was idled in 2012 after feed gas to the plant was diverted for use in the domestic market. Efforts to restart it were further complicated by a lawsuit filed against Egypt in 2014 by Union Fenosa, which was subsequently resolved in December 2020.

There is currently 46.7 MTPA[6] of capacity at operational LNG liquefaction trains that are more than 35 years old, including trains at Brunei LNG, ADGAS LNG in the UAE, Arzew LNG in Algeria, and MLNG in Malaysia. There have been no major upgrading plans announced for these plants in 2021.

4.4 LIQUEFACTION TECHNOLOGIES

Air Products Technologies Account For

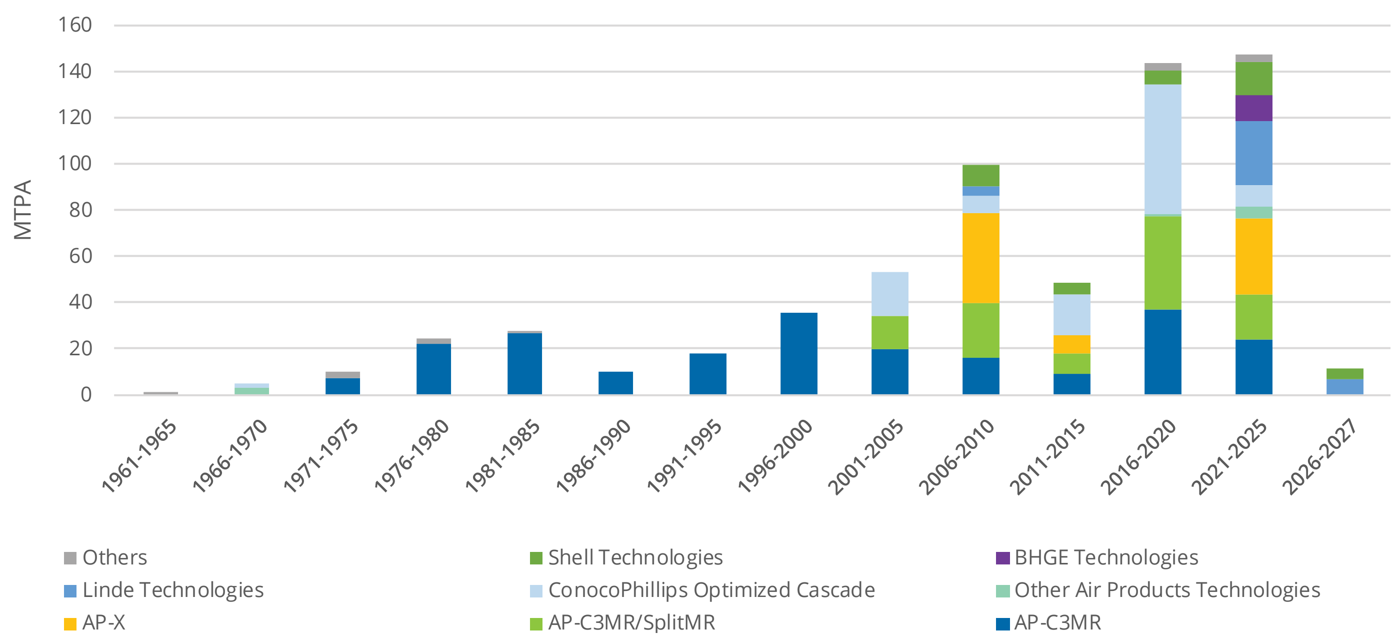
68% of Global Operational Capacity

The liquefaction trains that began operations in 2021 and the first four months of 2022 use a variety of liquefaction technologies. BHGE's Single Mixed Refrigerant is used in Calcasieu Pass LNG. Both Corpus Christi T3 and Sabine Pass T6 use the ConocoPhillips Optimized Cascade, while the Petronas FLNG Dua uses the Air Products AP-N technology. Yamal LNG T4 adopts Novatek's Arctic Cascade technology. Globally, Air Products' liquefaction technologies account for around 68% of operational capacity. Recent liquefaction projects such as the Cameron LNG T1-T3 and Freeport LNG T1-T3 employ the Air Products AP-C3MR process, which currently makes up over 38.4% of operational capacity globally (excluding the SplitMR variation). ConocoPhillips's Optimized Cascade is the runner-up, making up 23.0%.

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

[6] This does not include Kenai LNG as plans to convert it to an import facility were approved in December 2020. Does not include Sengkang LNG T1 as plans to bring it online have been stalled.

Figure 4.8: Installed and approved liquefaction capacity by technology and start-up year, 1961-2027



Source: Rystad Energy

The AP-C3MR has attained the dominant position among liquefaction technologies since it was first introduced at Brunei LNG in 1972, representing close to 56.7% of operational capacity globally as of April 2022 (including the SplitMR variation). The growing share of the AP-C3MR technology was primarily driven by QatarGas, totalling 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 in 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 that was recently approved, which consists of four mega-trains, each with 8.0 MTPA 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. Its 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 the Petronas PFLNG Satu and PFLNG Dua, while the Coral South FLNG will have the AP-DMR process installed. 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 be using the Black & Veatch PRICO technology.

The share of the added capacity using Air Products' liquefaction technologies fell from more than 90% in the 1980s and 1990s to 67.8% as of April 2022. Competition increased in the 2000s, mainly due to ConocoPhillips's Optimized Cascade Process, which now comprises 109.3 MTPA of operational capacity, or 23.0%, making it the second leading liquefaction technology. ConocoPhillips's Optimized Cascade Process was first used in Kenai LNG in the late 1960s and reappeared on the market in 1999 with the successful start-up of Atlantic LNG T1. With the Rio Grande T1-3, Lake Charles LNG T1-T3, Port Arthur LNG T1-T2, and Freeport LNG T4 signalling FID in 2022, Air Products' dominance might be reinforced again with 48.6 MTPA of liquefaction capacity approved.

As the LNG industry moves towards 2022-2027, a growing number of new entrants are expected in the liquefaction technology market, mainly due to the notable growth in small- and mid-scale LNG trains. As the interest to explore for smaller volumes of stranded gas grows and access to LNG project financing and off-takers becomes increasingly competitive, small- to mid-scale LNG trains could emerge as lower-risk alternatives. Owing to the smaller size of LNG trains and simpler configurations, the ease of standardisation and modularisation can also offer cost and execution time savings. In early 2022, Venture Global LNG started operations at its Calcasieu Pass LNG using BHGE's Single Mixed Refrigerant (SMR) liquefaction technology, with each liquefaction module having a capacity of 0.56 MTPA. Tortue Ahmeyim FLNG will also come online with Black & Veatch's PRICO technology (0.6 MTPA per train, four trains), which is already used in Tango FLNG. In large-scale LNG, although the liquefaction technology market is concentrated on a few players, there are some new technologies that have entered the market recently. One of these is Linde's MFC4 process, which will be used in the three-train Arctic 2 LNG project, with a capacity of 6.6 MTPA per train.

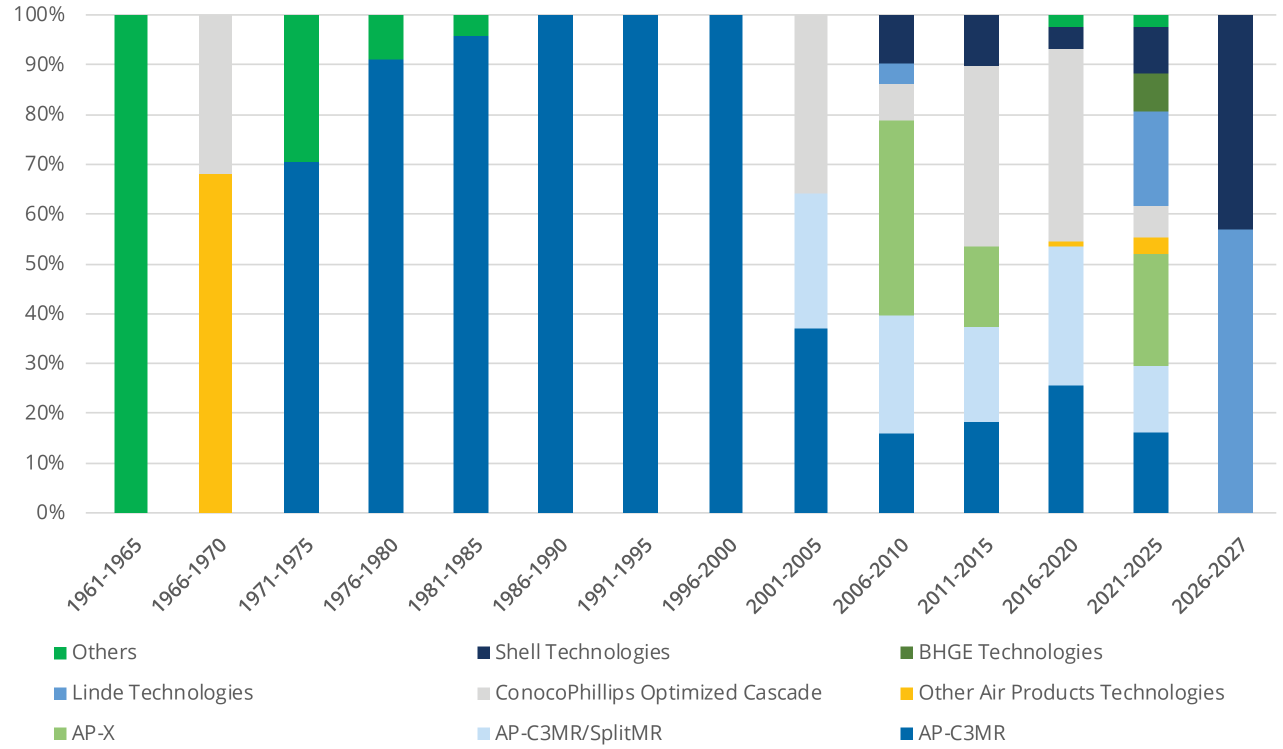
There has also been a growing focus on operator-based technologies. The Shell DMR technology will be used at LNG Canada (scheduled for start-up in 2025), after its application at Sakhalin 2 LNG and Prelude FLNG. Novatek's Arctic Cascade process, designed for the Arctic climate, is used for Yamal LNG T4 (0.9 MTPA).

Small FLNGs mostly use relatively simple liquefaction technologies for safety reasons (minimising highly flammable refrigerants) and space limitations with 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 was successfully applied in 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 bigger capacity, such as Coral South FLNG (3.4 MTPA) using Air Products AP-DMR technology and Prelude FLNG (3.6 MTPA) using Shell DMR technology.

Another key area of focus is lowering emissions in the liquefaction process. Currently, carbon emissions at an LNG liquefaction facility can be categorised into 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 the all-electric concept, which was also applied for Freeport LNG featuring electric motors installed to drive their liquefaction compressors. It 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 the installation of an acid gas removal unit (AGRU), which absorbs CO2 from the feed along with several sulphur-bearing gases and eventually emits the CO2 to the atmosphere. Carbon capture and storage (CCS) is also another solution that is widely discussed in the LNG industry. CCS deployment mainly targets two areas: capturing CO2 from the reservoir (demonstrated in Hammerfest LNG) and capturing post-combustion CO2. Capturing post-combustion CO2 is more expensive, however, cost benefits can potentially be reaped when this is added to a newbuild liquefaction facility due to design and location synergies. Venture Global is currently developing CCS at its LNG facilities (Plaquemines LNG and Calcasieu Pass LNG), aiming to capture and sequester an estimated 500,000 tonnes of carbon per year from these liquefaction sites.

As global liquefied natural gas trade continues to expand rapidly, the challenge of liquefaction process selection – a key element of an LNG project – becomes increasingly important. Selecting more versatile and cost-effective liquefaction technologies that meet stringent emissions standards will be a key focus area for new projects as governments and companies commit to decarbonisation efforts.

Figure 4.9: Share of installed and future approved liquefaction capacity by technology and start-up year, 1961-2027



Source: Rystad Energy

4.5 FLOATING LIQUEFACTION (LNG-FPSOS)

8.7 MTPA

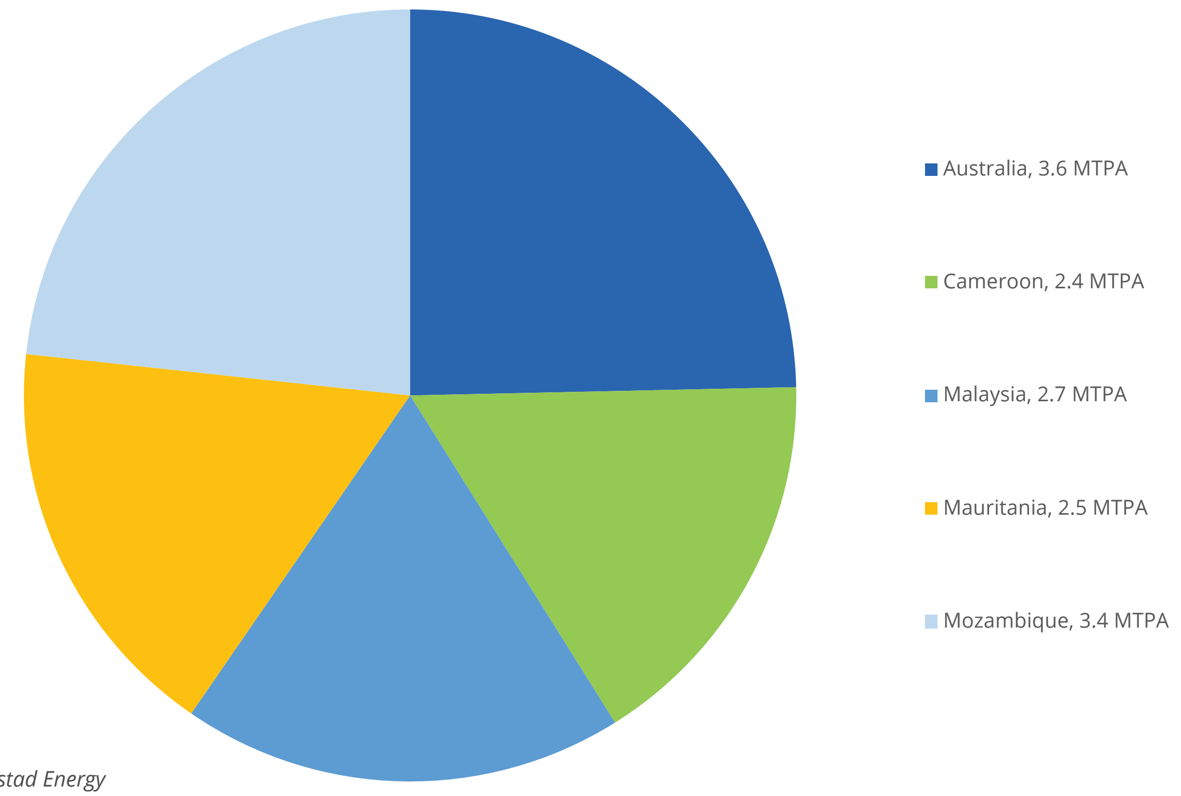
Operational Floating Liquefaction Capacity Worldwide as of end April 2022

At the end of April 2022, there were four operational[7] FLNG units globally. The latest addition to the global FLNG fleet is the PFLNG Dua (1.5 MTPA), Petronas' second FLNG unit. It is currently located at the Rotan gas field, 140 kilometres off Kota Kinabalu. In collaboration with its upstream production sharing contract partner PTT Exploration and Production, it successfully achieved first gas on 6 February 2021. PFLNG Dua is the second operational FLNG unit in Malaysia, following the start-up of FLNG Satu (1.2 MTPA), which began operations in 2016. Of the existing units, Prelude FLNG (3.6 MTPA), deployed in the Browse Basin off Western Australia, suffered from a fire and power outage in December 2021, which led to a temporary cease of production until operations were resumed in April 2022. By the end of 2022, the Coral-Sul FLNG (3.4 MTPA) is expected to begin commercial operations. It is currently moored at its operating site in the Rovuma Basin of Mozambique, where it will produce gas from the Coral offshore gas field in Area 4. The project will be the world's deepest FLNG project, extending to a water depth of around 2,000 metres. As of April 2022, there is a total of 8.7 MTPA operational floating liquefaction worldwide. This is expected to grow to 12.1 MTPA after Coral-Sul FLNG (3.4 MTPA) comes on stream.

Delivery of the Tortue Ahmeyim FLNG (2.5 MTPA) (also known as the Golar Gimi FLNG) project off Mauritania and Senegal has been delayed by more than 12 months, postponing start-up of the facility to late 2023. The vessel was originally due to come on stream in 2022, but the COVID-19 pandemic forced the operator to declare force majeure in 2021, pushing back start-up to early 2023, with further delays being announced since then. In March 2022, Golar LNG stated that the FLNG unit, which is under conversion at Singapore's Keppel Offshore and Marine shipyard, is now technically 80% complete. With 20% of the work remaining, sail-away has been scheduled for the first quarter of 2023. After some months in operation in Argentina under a charter with YPF, the Tango FLNG (0.5 MTPA) is currently available for other projects further to the charter party settlement in October 2021.

The FLNG sector remains in the early stages of development, with challenges related to financing and project overruns exacerbated by the COVID-19 pandemic. There have been several planned and proposed FLNG projects, only a quarter of which have been realised. Among those that have materialised, the Golar Hilli Episeyo FLNG, located at Perenco's SNH project offshore Cameroon, secured around 80% of conversion financing from China State Shipbuilding Corp., which will ultimately transition into a sale and leaseback structure. PFLNG Satu, PFLNG Dua, Tango FLNG and Prelude FLNG were financed by balance sheet funding from their respective owners, while the Coral Sul FLNG was financed with project financing.

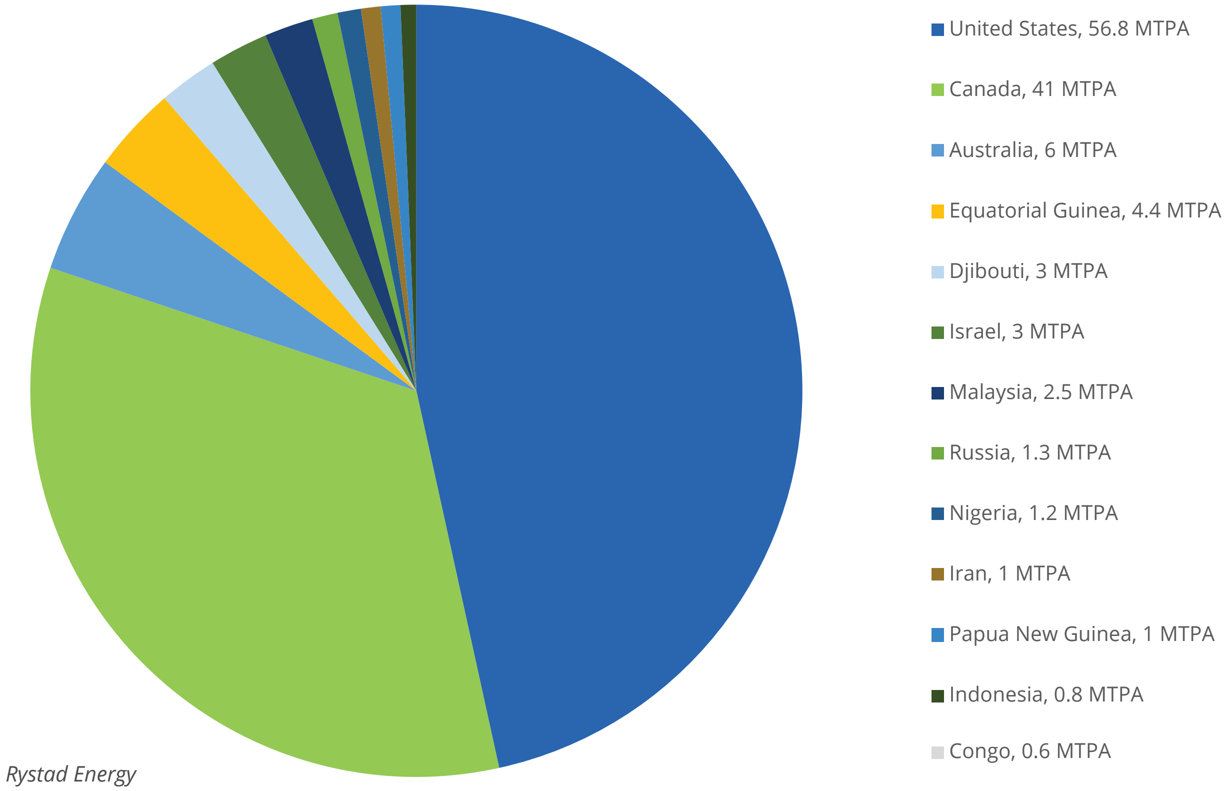
Figure 4.10: Global operational and approved FLNG liquefaction capacity as of end-of-April 2022



Source: Rystad Energy

[7] Tango FLNG is not included as it remains uncontracted and non-operational since June 2020

Figure 4.11: Global proposed FLNG liquefaction capacity as of end-of-April 2022



Source: Rystad Energy

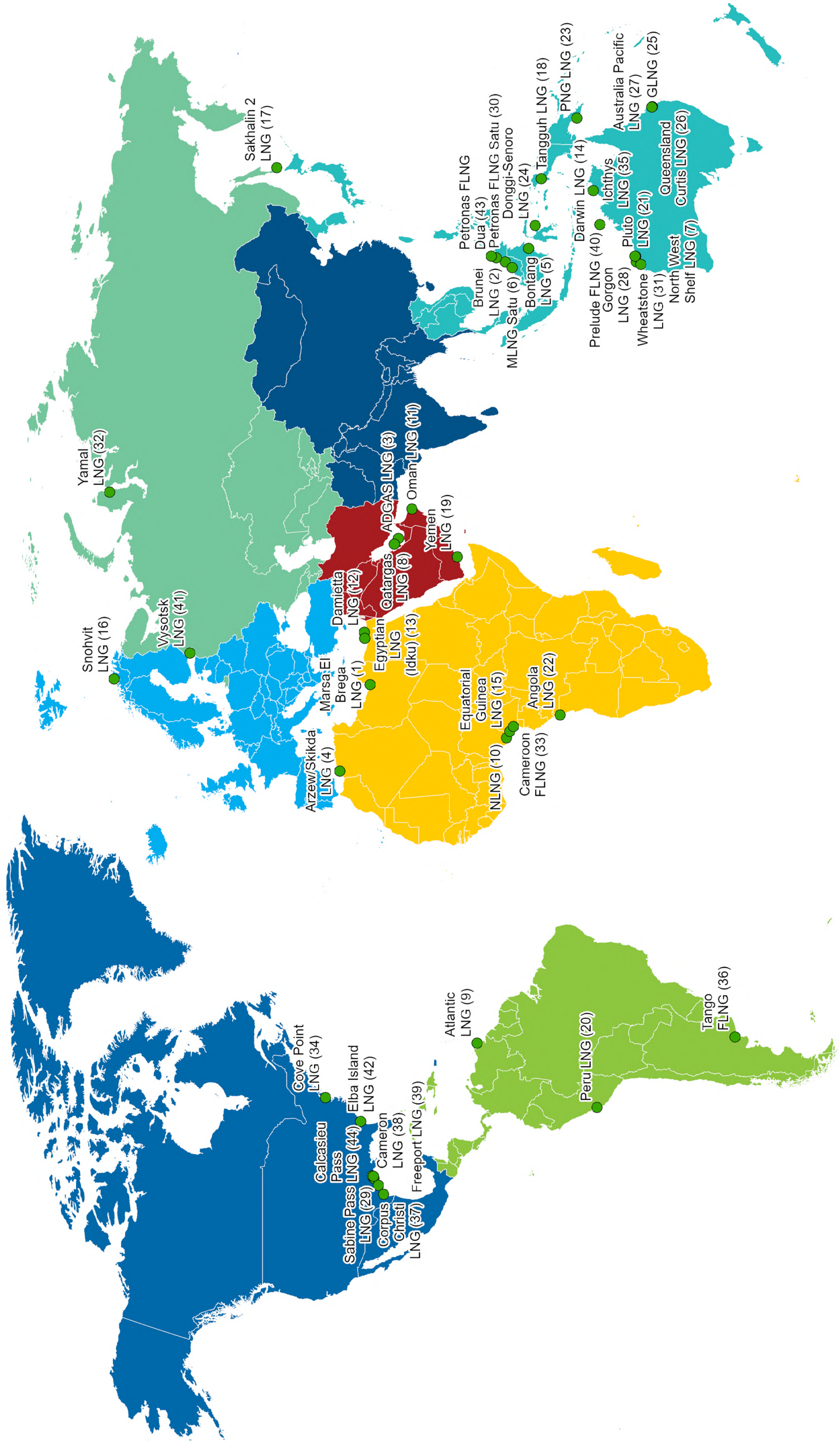
There is currently 122.6 MTPA of aspirational liquefaction capacity proposed as FLNG developments. Of the proposed capacity, 97.8 MTPA is located in North America. Delfin FLNG completed its FEED in October 2020, which was carried out in partnership with Samsung Heavy Industries and Black & Veatch. Instead of using FLNG vessels to liquefy gas from remote offshore fields, Delfin FLNG will be integrated with both onshore and offshore pipeline networks. Such a development concept aims to save both construction time and cost compared to onshore LNG plants. There is also greater flexibility for the vessel to be redeployed when onshore gas fields reach their end of life or are no longer commercially viable. Interest in FLNGs has also grown in Africa in recent years, with a total proposed capacity of 9.2 MTPA. This includes an aspirational FLNG project offshore Equatorial Guinea, where Golar LNG and New Fortress Energy have teamed up to explore the opportunity of installing an FLNG unit off the west coast of Bioko Island in Block R. The license hosts about 2.6 trillion cubic feet of resources held in multiple discoveries, with Fortuna being the largest.

In Asia Pacific, Petronas awarded two FEED contracts in late 2021 to the JGC Corporation-Samsung Heavy Industries consortium and Saipem for its proposed third FLNG vessel, which will be deployed offshore Sabah, East Malaysia. Dubbed "ZLNG", the project is targeted to reach FID by the end of 2022. This will be Petronas's third FLNG vessel, following the PFLNG Satu (1.2 MTPA) and PFLNG Dua (1.5 MPTA).

There have been significant developments in floating liquefaction technologies in recent years, primarily related to the design of the FLNG units. The "Fast LNG" liquefaction technology by New Fortress Energy is one such example. The design is said to combine the latest advances in modular, mid-size liquefaction technologies with jack-up rigs or similar floating infrastructure to achieve lower cost and faster deployment. A permanently moored floating storage unit (FSU) will operate as an LNG storage facility alongside the floating liquefaction facility. The first Fast LNG 1 will likely be commissioned in 2023 as part of Eni's LNG plans in Congo-Brazzaville. Both Eni and New Fortress Energy were engaged in a head of agreement (HoA) in early 2022 as part of the Congo-Brazzaville FLNG scheme (1.4 MTPA). In late 2021, New Fortress Energy signed a memorandum of understanding (MOU) with Mauritania for the development of an Energy Hub. Under the MOU, New Fortress Energy will deploy its Fast LNG liquefaction technology to produce LNG in the Atlantic coastal basin off Mauritania for local gas and power markets as well as international exports. New Fortress Energy will supply natural gas to both the existing 180-MW Somolec Power Plant and a new 120-MW combined-cycle power plant that will be developed.

A new generation of FLNG vessels, often referred to as standardised FLNGs, is emerging as the preferred option for new developments. The main benefit of standardised FLNGs is that they provide a cost-effective alternative to the highly bespoke FLNGs that have been built in the past. Keppel Shipyard and Black & Veatch first introduced this concept to the floating liquefaction industry by converting the Moss-design LNG carrier Hilli into an FLNG retrofitted with the B&V PRICO liquefaction technology. Over the years, SBM Offshore has also patented its FLNG conversion solution, the TwinHull FLNG. This concept maximises efficiency and cost savings to optimise offshore gas fields. This design is comprised of two LNG tankers converted into a single integrated hull, which allows for greater storage capacity and optimisation of deck space. While these newer vessels are typically not as customised for the targeted field, they have greater flexibility in deployment and reduced lead times, combined with significant cost savings. In addition to their suitability for smaller, remote, offshore gas fields, FLNGs can offer advantages over onshore projects in terms of land constraints and environmental challenges. They can also serve as a stopgap solution for larger fields until onshore liquefaction trains come online. With the IMO MARPOL environmental regulations EEXI and CII entering into force and the fleet aging it may be expected that some additional steam turbine MOSS type LNG carriers will be converted to FLNGs.

Figure 4.12: Global Liquefaction Plants, April 2022



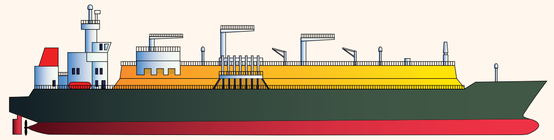
Note: Numbers in parentheses behind project names refer to Appendix 1: Table of Global Liquefaction Plants.
Source: Rystad Energy

5 LNG Shipping

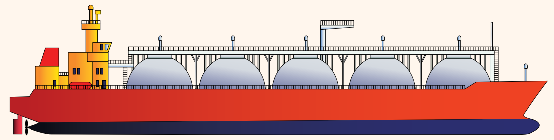
The global LNG fleet grew by **10% year-on-year** in 2021.

6.708
trade voyages, an increase of
12% year-on-year

641 active vessels / **64** new vessels[1]

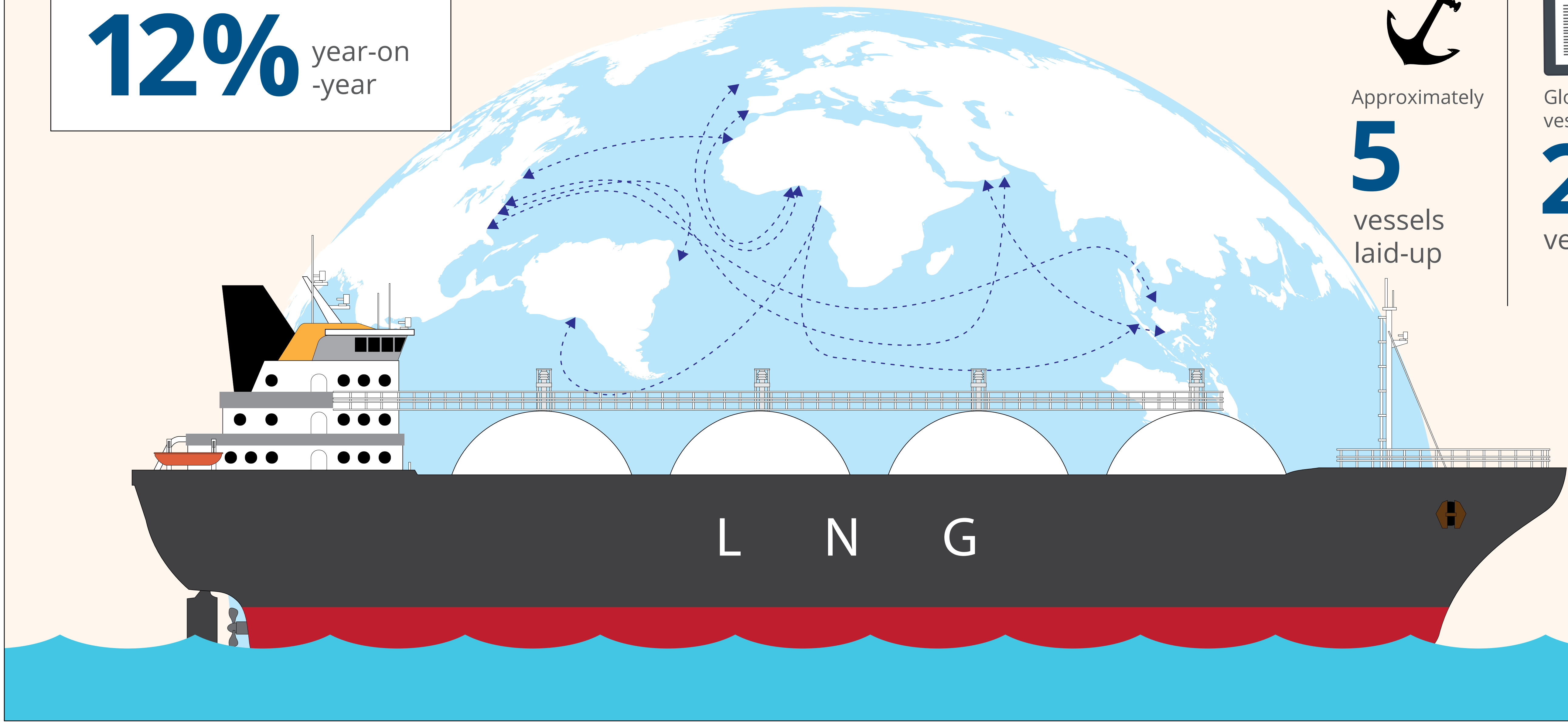


Including **45** FSRUs / **5** FSUs



Approximately **5** vessels laid-up

Global LNG vessel orderbook: **216** vessels



[1] During 2021 and the first four months of 2022

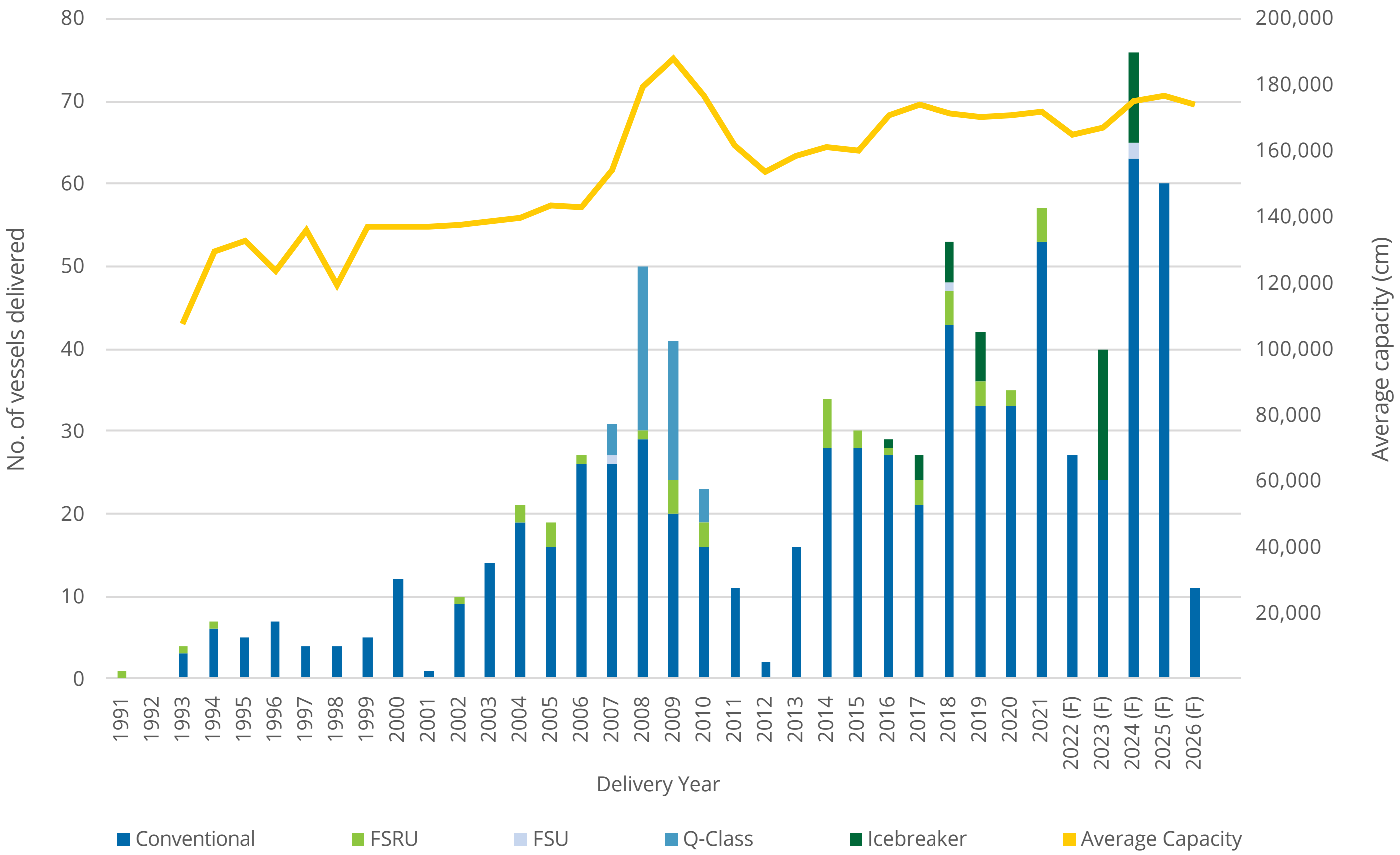
5. LNG Shipping

With the delivery of 57 vessels[1] in 2021 and seven in the first four months of 2022, the global LNG carrier fleet consisted of 641 active vessels[1] as of end-of-April 2022, including 45 floating storage and regasification units (FSRUs) and five floating storage units (FSUs). This represents a 10% growth in the fleet size from 2020 to 2021, comparable to a 12% growth in the number of LNG voyages as trade recovered from COVID-19-induced demand reductions.

[1] Only LNG carriers with a capacity of 30,000 cm and greater are included in this report.

5.1 OVERVIEW

Figure 5.1: Global active LNG fleet and orderbook by delivery year and average capacity, 1991-2026



Source: Rystad Energy

216 LNG Vessels

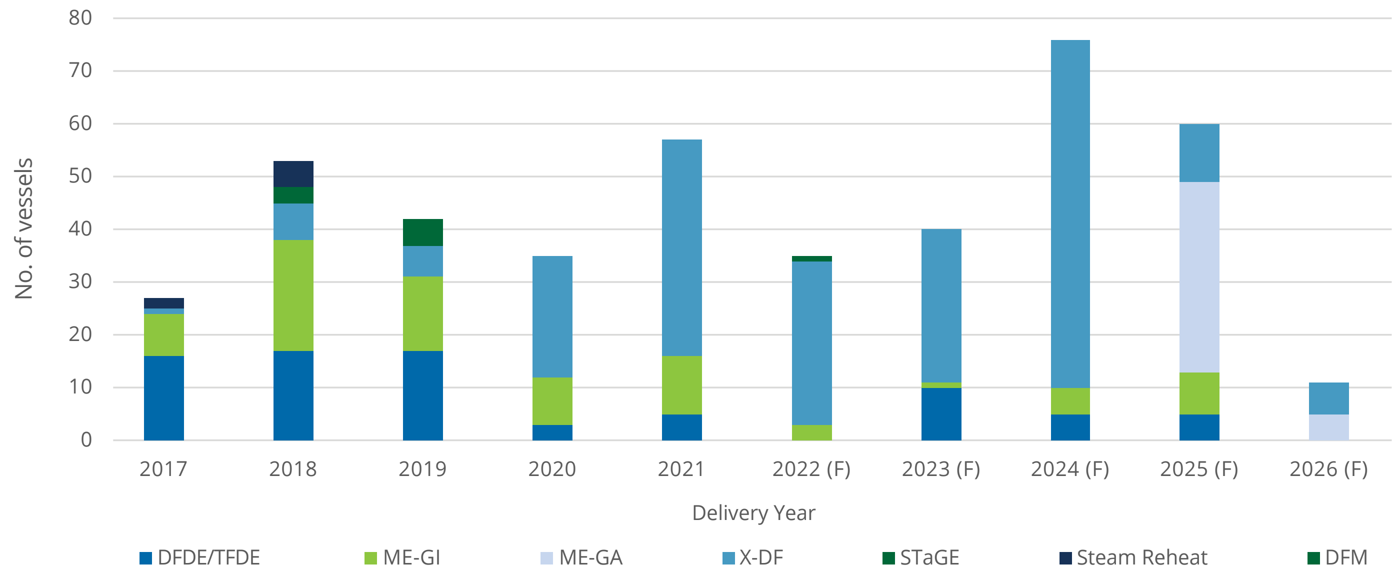
Under Construction as of End-of-April 2022

Of the 57 newbuilds delivered in 2021, all except one have a capacity of between 170,000 cubic metres (cm) and 180,000 cm. Vessels of this size remain within the upper limit of the Panama Canal's capacity after its 2016 expansion, while still benefiting from economies of scale. Although larger vessels have become more common over time, this is a departure from the trend seen in the 2007-2010 period, when 45 Qatari Q-Class newbuilds larger than 200,000 cm were delivered. However, moving forward, with a shift to the latest generation of propulsion systems, 200,000 cm vessels could make a return, depending on economies of scale, flexibility and terminal compatibility.

The global LNG fleet is relatively young due to the rapid increase in LNG trade over the past two decades. Vessels under 20 years of age make up 90% of the active fleet with newer vessels being larger and more efficient and with far superior project economics over their operational lifetime. Only 13 active vessels are 30 years or older, including six that have been converted into FSRUs or FSUs. There were approximately five laid-up LNG carriers at end-of-April 2022, a reduction of two-thirds from end-2020 due to several vessels being scrapped

The global LNG orderbook had 216 vessels[1] under construction as of end-of-April 2022, equivalent to a third of the current active fleet. This illustrates shipowners' expectations that LNG trade will continue to grow in line with scheduled increases in liquefaction capacity. An expected 28 additional carriers will be delivered by the end of 2022 and 40 in 2023. The orderbook includes 21 Icebreaker-class vessels which are highly innovative and capex-intensive ships with the capabilities required to traverse the Arctic region.

Figure 5.2: Historical and future vessel deliveries by propulsion type, 2017-2026



Source: Rystad Energy

2020 was the first year in which more low-pressure slow-speed dual-fuel Winterthur Gas & Diesel engine (X-DF) systems were delivered than any other type. Capitalising on improved fuel efficiencies and lower emissions, two generations of X-DF systems will dominate in the years 2021-2024 as well, with 138 systems on order as of end-of-April 2022. There are 16 competing M-type, electronically controlled (ME-GI) system vessels under construction, together representing a major shift from the popular propulsion systems of the past – steam turbine and dual-fuel diesel-electric (DFDE) engines. The more efficient new generation M-type, electronically controlled gas admission (ME-GA) system might become the propulsion choice for newbuilds further out in time, with 41 orders representing a large proportion of deliveries in 2025 and 2026. South Korean shipbuilders Hyundai Heavy Industries Group, Samsung Heavy Industries and Daewoo Shipbuilding & Marine Engineering remain the top three LNG carrier builders on the market.

The 2021 LNG charter market was characterised by extreme volatility, with charter rates recording new all-time highs and all-time lows. A winter spike in charter rates was quickly reversed as weather eased, causing rates to reach historic lows in early March. The rates quickly ticked upwards again as the Ever Given container ship blocked the Suez Canal and Europe and Asia competed for LNG cargoes to increase storage filling levels. By October 2021, gas prices hit new record highs due to demand growth from the industrial sector and a coal shortage in China. This resulted in a large spike in charter rates which reached US$140,000/day for steam turbine vessels, US$210,000/day for TFDE/DFDE vessels and US$250,000/day for X-DF/ME-GI vessels in mid-December 2021.

6,708 LNG trade voyages were undertaken in 2021, a 12% increase from 5,757 in 2020. This is in line with growth in global liquefaction capacity and increased competition for LNG cargoes between Asia and Europe. While Asia remains the dominant demand centre, European trade voyages have grown 11% to 1,435 so far this year in the face of the Russia-Ukraine conflict.

GAIL BHUWAN – Courtesy of MOL

5.2
LNG CARRIERS

Containment systems

LNG containment systems are designed to store LNG at a cryogenic temperature of approximately -162°C (-260°F). This has been a key element in designing containment systems for LNG carriers, which 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. Due to the advantages highlighted below, modern newbuilds have for the most part adopted the membrane type.

Table 5.1: Overview of containment systems

	Membrane	Self-supporting
Current Fleet Count	518	123
Current Fleet proportion (%)	81%	19%
Systems	GTT-designed: Mark III, Mark III Flex, Mark III Flex+, NO96, NO96 Super+ CS1 Kogas-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 is referred to as boil-off gas, 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 total volume per day. This contrasts with older self-supporting carriers, which average about 0.15% of total volume 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 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. The KC1, a new membrane system designed by KOGAS, has also entered the market in recent years. GTT states a boil-off-rate of 0.07% for its Mark III Flex+ and 0.085% for the new NO96 Super+, the new system of choice for several recent orders.

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. It is possible for considerable liquid movement to take place, creating 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: lower than a level corresponding to 10% of the height of the tank, or higher than a level corresponding to normally 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 partial fillings being restricted. The new generation of 200,000 cm vessels have four-tank membrane vessels, contrasting with five-tank Q-flex ships.

Celebrating almost 50 years in operation, the Moss Rosenberg system was first delivered in 1973. LNG carriers of this design feature several self-supporting aluminium spherical tanks, each storing LNG 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 catch LNG should there be a leak. Independent self-supporting spherical tanks allow for partial loading during a voyage. Owing 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, is a further improvement on the Saeyndo 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 during 2018 and 2019.

The IHI-designed SPB self-supporting prismatic type was first implemented in a pair of 89,900 cm LNG carriers in 1993, Polar Spirit and Arctic Spirit. Since then, it has been used in several LPG and small-scale LNG FSRU vessels before Tokyo Gas commissioned four 165,000 cm vessels with the design. These ships are used for exporting LNG from the new Cove Point LNG liquefaction plant in the United States. The design involves tanks subdivided into four by a liquid-tight centreline, allowing for partial loading during the voyage. The result eliminates 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.

While Moss Rosenberg and IHI SPB tank types represent just under 20% of the fleet in service, there are currently only two small LNG vessels under construction 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. 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 40,000 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. Hence, it is crucial to select an appropriate type for each newbuild. 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 created a need for more efficient engines, giving rise to alternatives such as the dual-fuel diesel electric (DFDE), triple-fuel diesel electric 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 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-pressured MAN B&W M-type electronically controlled, gas injection (ME-GI) system, 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 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 these 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. The success has led to a new order of ABB Azipod units for the additional icebreakers required for the Arctic LNG 2 project developed by Novatek.

As propulsion systems are manufactured by third parties such as WinGD and MAN B&W, different shipbuilders generally offer a variety of propulsion systems. As a result, shipowners are not restricted to specific shipbuilders or geographies when choosing newbuild specifications that best match their purpose. Additional systems in place to reduce fuel consumption on board are air lubrication systems and PTO-Shaft generators in the propulsion lines. These technologies are being implemented in many vessels currently on order.

Steam turbine

The use of steam turbines for ship propulsion is 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 as an alternative should the former prove 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 compared to the steam, respectively. There are currently 225 active steam turbine propulsion vessels, making up 35% of the total active fleet. There are no steam turbine vessels being built currently, showing the high adoption rates of newer technologies.

An improvement of the steam turbine was introduced in 2015, involving reheating of 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.

The new IMO MARPOL regulations to enter into force in January 2023, in particular the EEXI, will lead to a shaft power limitation and reduced speed for steam turbine LNG carriers, which in some cases may be in the range of 4-5 knots.

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 and gas mode, powering electrical generators which then turn electric motors. Auxiliary power is also delivered through these generators, and a gas combustion unit (GCU) is in place should there be excess boil-off gas. The 2008 arrival of TFDE vessels has improved the adaptability of this type of vessel, allowing the burning of 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 the vessels under a dynamic load, such as during adverse weather conditions, is considered to be 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 total cylinders. Eventually in gas mode, knocking and misfiring could 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 could be detrimental to regular engine operation. There are 194 active TFDE/DFDE vessels as of end-of-April 2022, representing 30% of the current fleet. There are currently 20 newbuild vessels with TFDE/DFDE systems to be delivered.

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

The SSDR was introduced alongside 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 minimisation of LNG wastage and being able 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. One additional Q-Max vessel previously ran an SSDR engine before being converted to a ME-GI-type vessel. Due to 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 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.

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 reflect the apparent advantages of the ME-GI propulsion system. A total of 70 vessels fitted with ME-GI systems have been delivered since 2015, with 16 additional newbuilds with the system under construction.

MAN B&W has developed a new engine based on the ME-GI make, the M-type electronically controlled, gas admission system (ME-GA) which is specifically designed for the LNG carrier segment. This system allows for a low gas supply pressure, 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 over 50%. There are 41 ME-GA vessels currently on order, 36 of which will be delivered in 2025 and five in 2026.

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 a South Korean newbuild in 2017. The X-DF burns fuel and air, mixed at a high air-to-fuel ratio, injected at a low pressure. 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 makes up 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 3-5% through exhaust recycling systems. Overall efficiency has improved to over 50% as operations and maintenance requirements have remained excellent. The second-generation X-DF is to compete with ME-GA systems. There are currently 84 vessels with the X-DF system in service. The orderbook for LNG carriers contains 138 X-DF vessels across both generations, representing 64% of total newbuilds to be delivered.

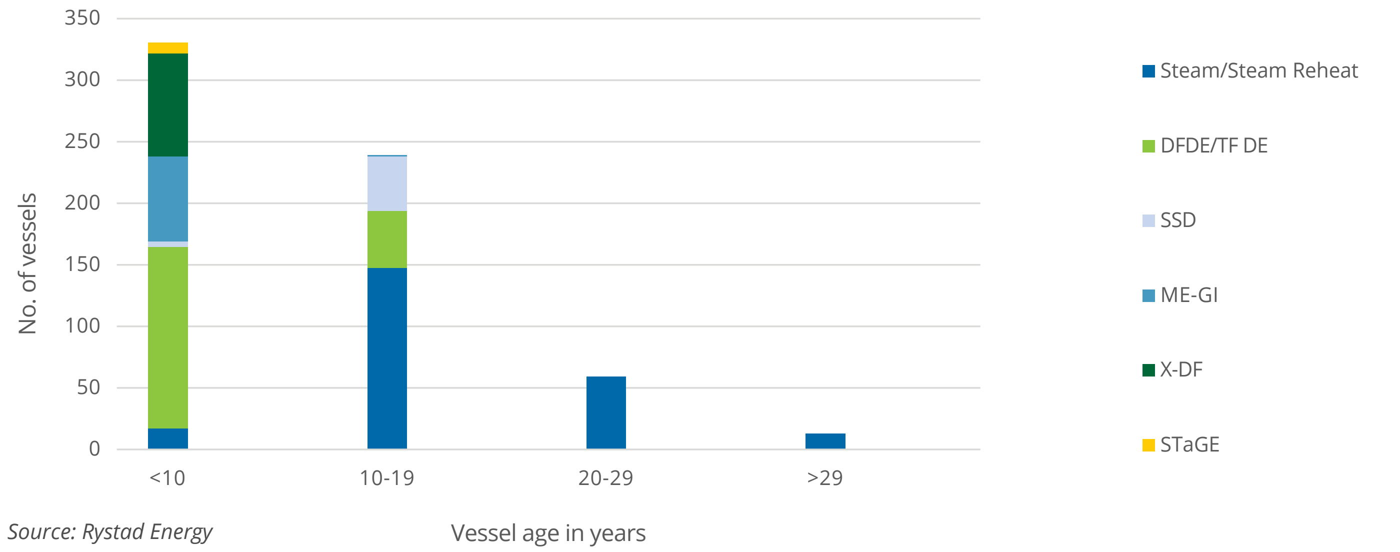
Steam turbine and gas engine (STaGE)

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

Looking at the active fleet today, 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, 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, when they will compete with ME-GA systems as the first newbuilds equipped with that propulsion system are delivered.

Figure 5.3: Fleet propulsion type by vessel age as of end-of-April 2022



Source: Rystad Energy

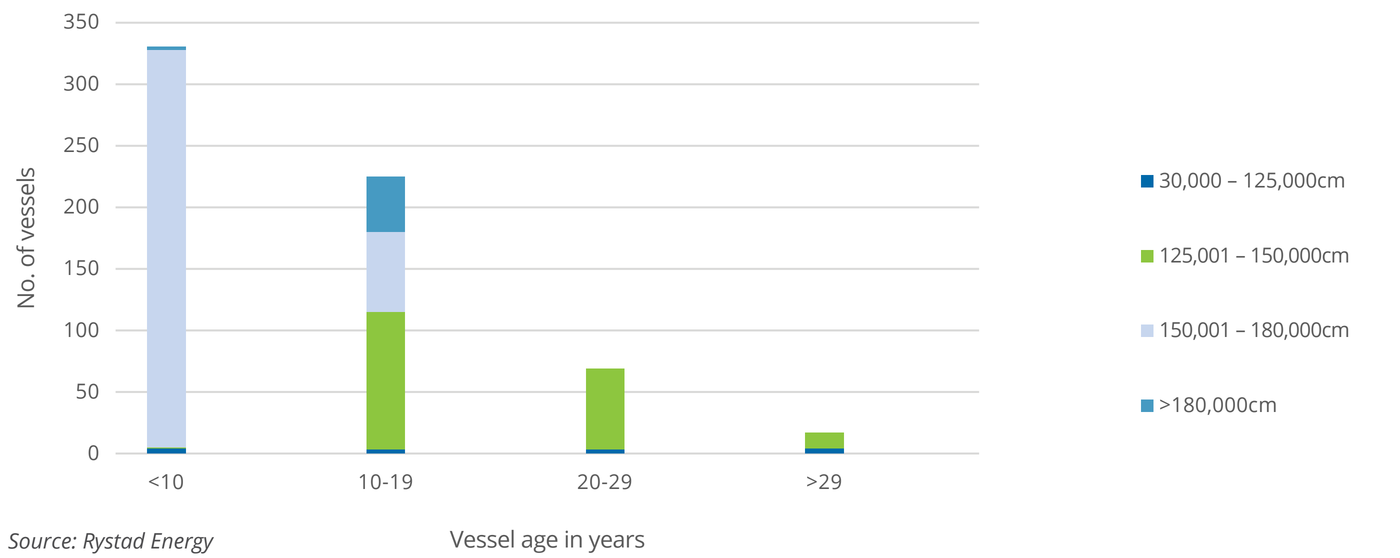
Vessel age and capacity

The current global LNG fleet is relatively young, considering the oldest LNG carrier operating was constructed in 1977. Vessels under 20 years of age comprise approximately 90% of the fleet, consistent with liquefaction capacity growing rapidly from the turn of the century. In addition, newer vessels are larger and more efficient, with far superior project economics over their operational lifetime. This is a result of improvements in technology and an increase in global LNG trade. This trend is slated to continue as capacity and global LNG demand continue to grow with each passing year.

With financial and safety concerns in mind, shipowners plan to operate a vessel for 35 to 40 years before it is laid-up. A decision can then be made on whether to scrap the carrier, convert it to an FSU/ FSRU, or return it to operation should the market pick up. A total of ten vessels were scrapped in 2021, bringing the tally of laid-up LNG carriers to approximately five. Of these laid-up carriers, Sinokor Merchant Marine vessels Grace Energy and Adriatic Energy are reported to be undergoing reactivation work and may possibly re-enter service as LNG carriers if they find a suitable charter.

When commissioning a newbuild, a shipowner determines vessel capacity based on individual needs, ongoing market trends and technologies available at the time with a view on future environmental regulations. Liquefaction and regasification plants also have berthing capacity limits, which is an important consideration regarding ship dimensions and compatibility. Individual shipowner needs 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 5.4.

Figure 5.4: Fleet capacity by vessel age as of end-of-April 2022



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 engines. The LNG carrier landscape changed dramatically when Nakilat, the Qatari shipping line, 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 settled at a size between 150,000 and 180,000 cm. This capacity range now makes up 39% of the current fleet. The technological developments that steered adoption of this size are the two-stroke propulsion systems, such as the ME-GI, X-DF and STaGE 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 12 200,000 cm vessels currently on order, nine at Hyundai Heavy Industries Group and three at Daewoo Shipbuilding & Marine Engineering, with the first unit expected to be delivered in early May 2022. 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 have to be considered.

Additional LNG carrier developments

Additional developments in the LNG carrier space include the progress on International Maritime Organisation (IMO) environmental regulations, re-liquefaction/subcooling system development, wind-assisted propulsion, and onboard carbon capture solutions.

The IMO's Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) is expected to come into force in January 2023. The EEXI is a one-off measurement to ensure a ship is energy efficient relative to its type, propulsion system and capacity. Any ship in service must attain EEXI approval from January 2023 to be considered compliant, which could result in LNG carriers having to reduce maximum speed to attain certification, impacting voyage durations and flexibility. The CII is an ongoing measure of carbon emission intensity of the ship in operation over a period of one year where the requirements will become more stringent over time. The rating levels will become stricter towards 2030 and might prove challenging to meet for a large proportion of LNG vessels. Depending on the operational efficiency during the measured year, some vessels will be at risk of attaining a 'D' rating, having to improve carbon efficiency if the rating is not improved in maximum three years, or an 'E' rating, having to do carbon intensity improvements immediately. This ruling could cause a wave of vessels to be scrapped or converted, reducing the size of the active LNG carrier fleet in the subsequent few years.

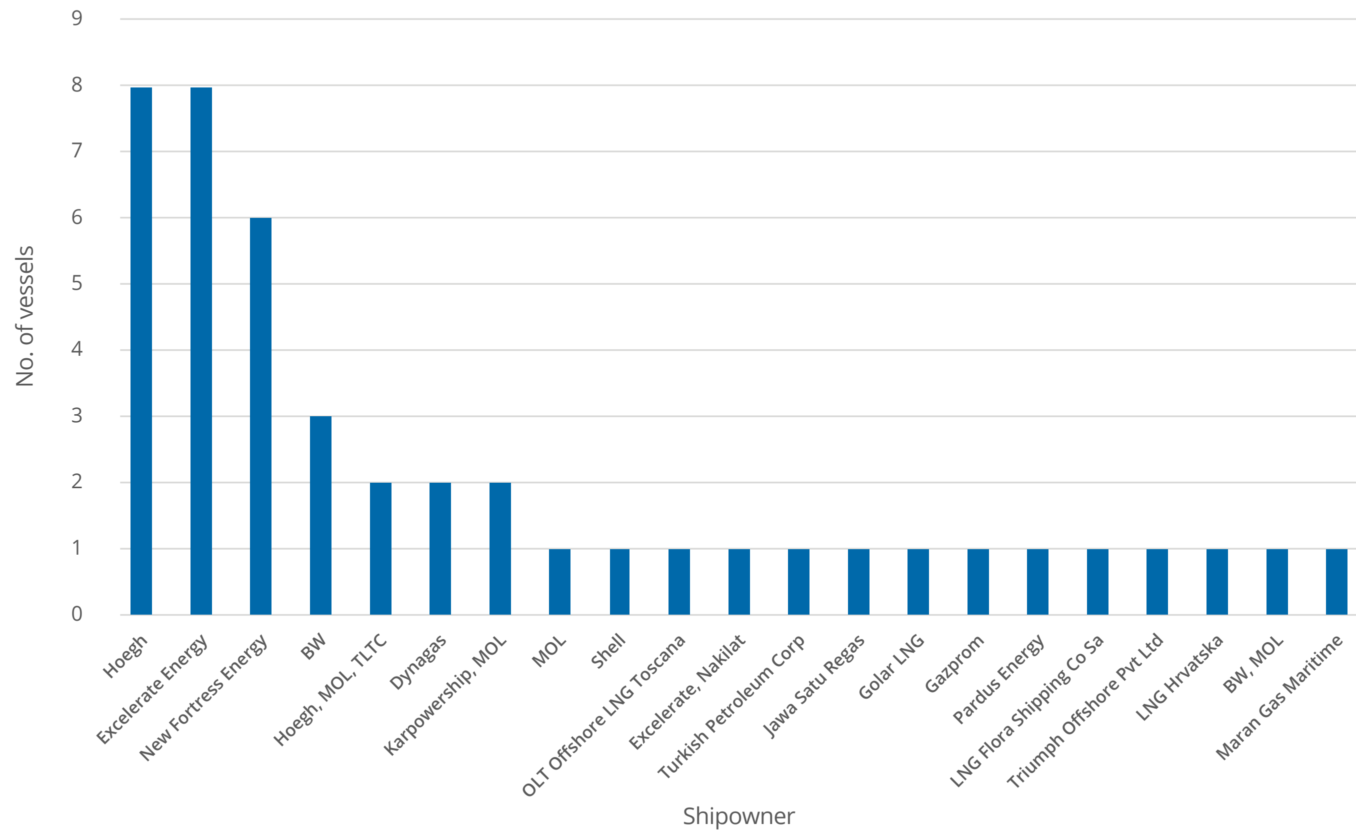
Newer generations of LNG carriers are delivered with re-liquefaction or subcooling systems to minimise boil-off gas consumption during sailing. Re-liquefaction systems return unused boil-off gas to the LNG tank. Due to the large upfront investment and power requirements for such systems, partial liquefaction systems are usually preferred. Installation of a subcooling system is another alternative for reducing boil-off gas. This alternative may be simpler than traditional liquefaction systems and is an emerging and popular solution.

Wind-assisted propulsion is a solution that has gained traction recently. By attaching rotors or rigid, flexible or inflatable sails to the vessel, this solution can lead to reduced fuel consumption, reduced emissions and cost savings. With pilot programs in progress, LNG players are examining the potential of applying wind-assisted propulsion to newbuilds as well as retrofitting the active fleet. An example is TotalEnergies working with Hyundai Heavy Industries Group, Daewoo Shipbuilding & Marine Engineering and Samsung Heavy Industries on assessing both possibilities for LNG carriers.

Capturing carbon dioxide from vessel exhaust gas is another method of decarbonising shipping that has gained interest recently. Installing carbon capture solutions on LNG carriers is less complicated relative to other vessel types, due to high exhaust gas heat and low-impurity fuel. Samsung Heavy Industries has announced the successful development of an onboard carbon capture system for LNG-fuelled vessels and is in the process of commercialising the technology with the aim of having it widely available by 2024.

5.3 FLOATING STORAGE AND REGASIFICATION UNIT OWNERSHIP (FSRUs)

Figure 5.5: FSRU fleet by shipowner as of end-of-April 2022



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 FRU barges. Compared to traditional onshore regasification plants, FSRUs offer better flexibility, lower capital outlay and a faster means of exploiting LNG-sourced natural gas. In 2021, four FSRUs were delivered: Transgas Force, Transgas Power, Ertugrul Gazi and Jawa Satu. In 2022, a total of 45 FSRUs make up 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 has entered the market through the acquisition of Golar units.

With the ability to import LNG with 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 in order 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.

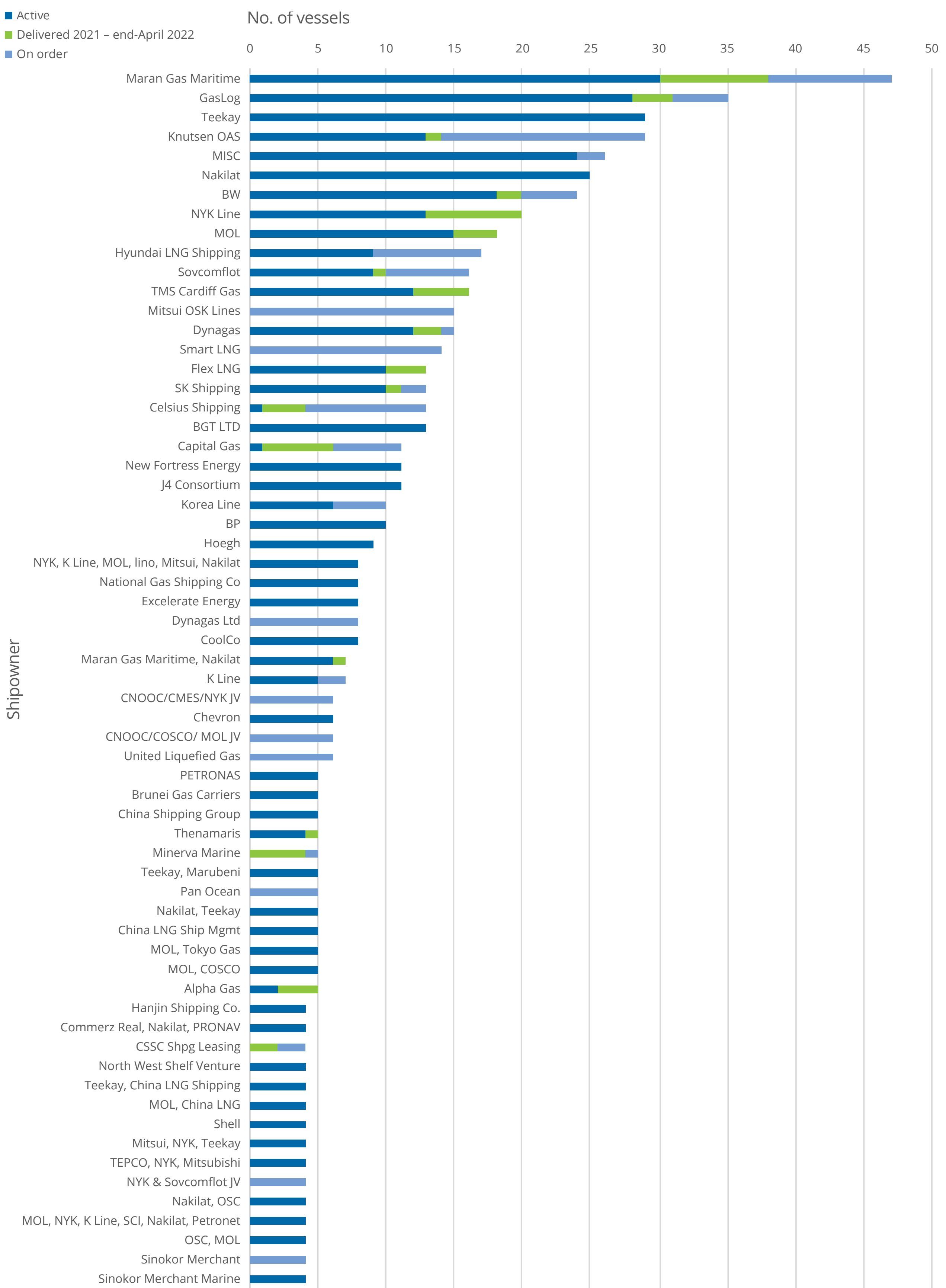
Capital expenditure and construction duration of an FSRU can be as little as half that of an onshore terminal, but this is offset by higher operating expenditure. FSRUs can either be built with a newbuild hull or converted from an existing LNG carrier. Newbuild FSRUs offer design flexibility and a wider range of outfitting options but are higher in cost and take longer to build.

However, 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. In 2021, 19 out of 45 FSRUs were used as LNG carriers instead of being deployed solely as regasification units, illustrating the extent to which operators are capitalising on their adaptability.

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 shipowners receiving numerous queries about the possibility of deployment to ease the supply crunch and reduce dependence on Russian piped gas. As of end-of-April, Germany has announced intentions to deploy three FSRUs along its coast, following goals to cut Russian gas imports towards 2024. Italy will deploy two, one due in 2023 and one in 2024. The Netherlands has chartered one FSRU in response to the conflict, aiming for deployment in late 2022. Greece expects two FSRU deployments between 2023 and 2025, the United Kingdom has plans for one due in 2023 while France also will deploy one by 2024. There are five FSRUs due for delivery in 2022, currently undergoing conversion.

5.4 2022 LNG ORDERBOOK

Figure 5.6: Global fleet and orderbook by shipowner as of end-of-April 2022[1] *Source: Rystad Energy*



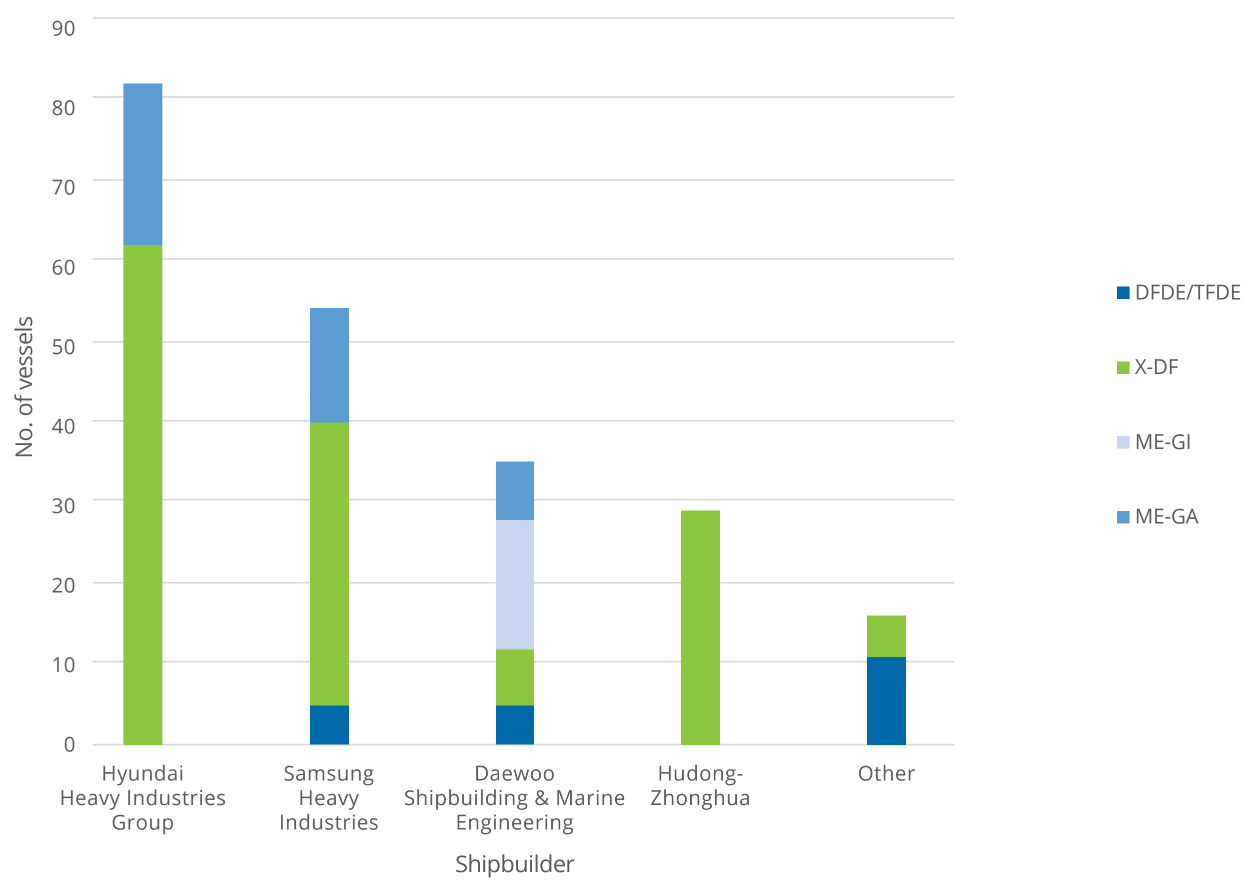
[1] Shipowners or consortiums with four or more total vessels included.

28 Additional

LNG Vessels Scheduled for Delivery in 2022

There were 216 LNG carriers under construction as of end-of-April 2022, of which 150 were ordered between 2021 and the end of April 2022. Notable vessel recipients include Mitsui OSK Lines and Knutsen OAS, both with 15 vessels on order, while Celsius Tankers and Maran Gas Maritime have nine each. Of the 216 vessels, 28 are scheduled for delivery in the remainder of 2022, 40 in 2023, 76 in 2024, 60 in 2025, 11 in 2026 and the last one in 2027. We may see a slight slippage from 2024 to 2025 due to the significant levels of deliveries foreseen in 2024 compared to average yearly numbers. The past year has been a record year in terms of orders with Korean and Chinese shipbuilders expected to continue accommodating orders driven by large projects under discussion, such as with Qatar Energy and Petronas.

Figure 5.7: Newbuild orderbook by propulsion type and shipbuilder as of end-of-April 2022



Source: Rystad Energy

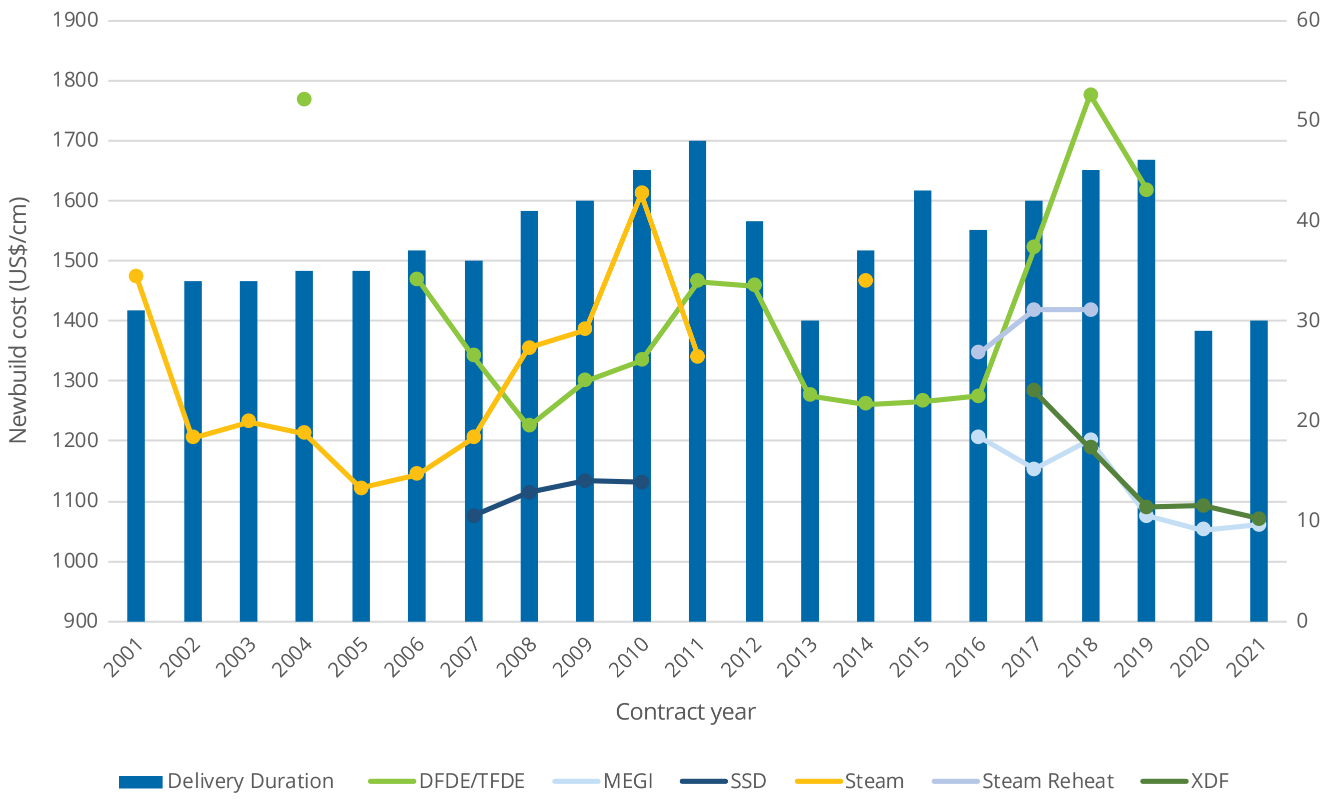
Capitalising on better fuel efficiencies and lower emissions, both generations of X-DF are currently the main propulsion systems of choice, with 138 currently on order. The competing ME-GI system has 16 orders, and the new generation of ME-GA system has 41. ME-GA engines are expected to capture market share moving forward. TFDE/DFDE systems account for 20 vessels. Some 97% of the vessels on order are above 170,000 cm in size, showing a clear trend towards larger vessels that the new Panama Canal locks can now accommodate. 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. 12 such vessels are currently on order, nine of which will belong to Dynagas. The first 200,000 cm delivery of Dynagas vessel Clean Cajun is due as early as May 2022.

South Korean shipbuilders Hyundai Heavy Industries Group, Samsung Heavy Industries and Daewoo Shipbuilding & Marine Engineering are the top three shipbuilders for LNG vessels, with 82, 54 and 35 units on order, respectively. 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 2025 onwards. Chinese builder Hudong-Zhonghua is currently working on 29 vessels, all of which are equipped with X-DF propulsion systems.

The Russia-Ukraine conflict has impacted the LNG shipbuilding sector with about 35 vessels on the order book due for Russian customers. Both 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. For example, Gaztransport & Technigaz (GTT), a crucial supplier of containment systems, has publicly acknowledged that sanctions might become a material barrier to fulfilling existing orders for Russian newbuilds.

5.5 VESSEL COSTS AND DELIVERY SCHEDULE

Figure 5.8: Vessel delivery schedule and newbuild cost, 2001-2021



Source: Barry Rogliano Salles

30-50 Months

Average Delivery Time for New LNG Vessels

The cost of constructing an LNG carrier is highly dependent on characteristics such as propulsion systems 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 US$1,700/cm for 15 ice-breaker class vessels ordered to service Yamal LNG. These vessels, contracted from 2017, were priced at about US$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 5.8 shows how the cost for X-DF and ME-GI vessels have trended in line, and have come down from an initial US$1,200–US$1,300/cm to around US$1,100/cm. This comes amidst stiff competition between South Korean, Japanese and Chinese shipbuilders, with aggressive pricing that is keeping newbuild costs relatively low.

Barring unusual delays, most new LNG vessels have been delivered between 30 to 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 introduction of DFDE/TFDE systems.

2021 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 US$180 million to US$220 million by end-of-year and more recently to US$230 million, with the orderbook remaining strong for subsequent years. Similarly, the lead time is expected to increase, with some ship owners expected to wait three or more years for new carrier deliveries.

5.6 CHARTER MARKET

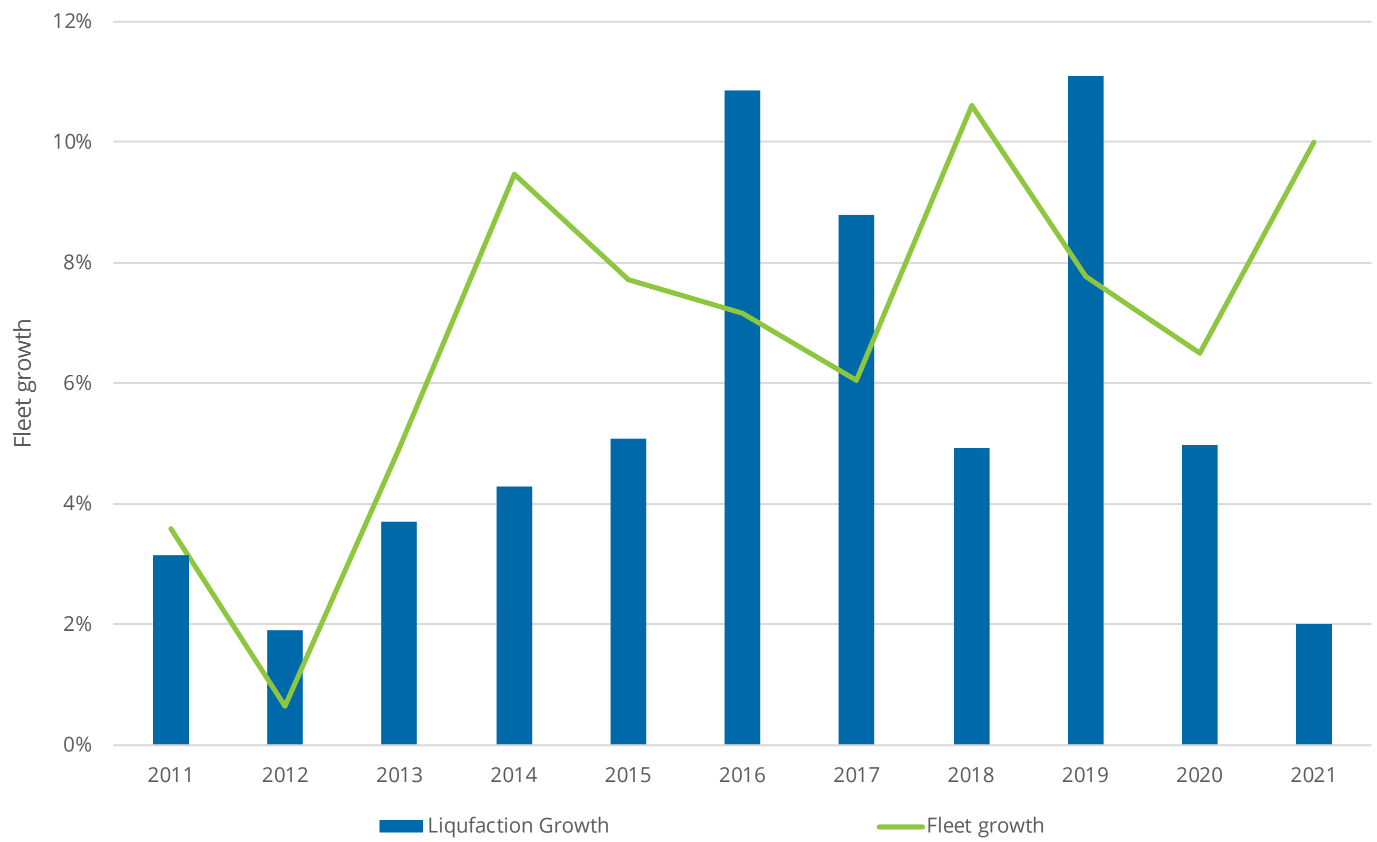
US$195,000

for steam turbine, US$255,000 for TFDE and US$290,000 for X-DF/ME-GI vessels Peak Charter Dayrates in 2021

Shipping costs constitute a high 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 are now 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 mismatch between supply and demand.

The price differentials between vessels with X-DF/ME-GI, TFDE/DFDE and steam turbine engines can be explained by efficiency gains from using newer propulsion systems. Steam turbine engines 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 turbine engines tend to be smaller in size, lowering demand as spot cargoes tend to be at least 150,000 cm. Finally, charterers, conscious about carrier emissions, are demanding newer technologies, widening the price differential further. Market participants must balance fuel efficiencies, boil-off gas savings and higher costs when choosing their carriers and associated propulsion system.

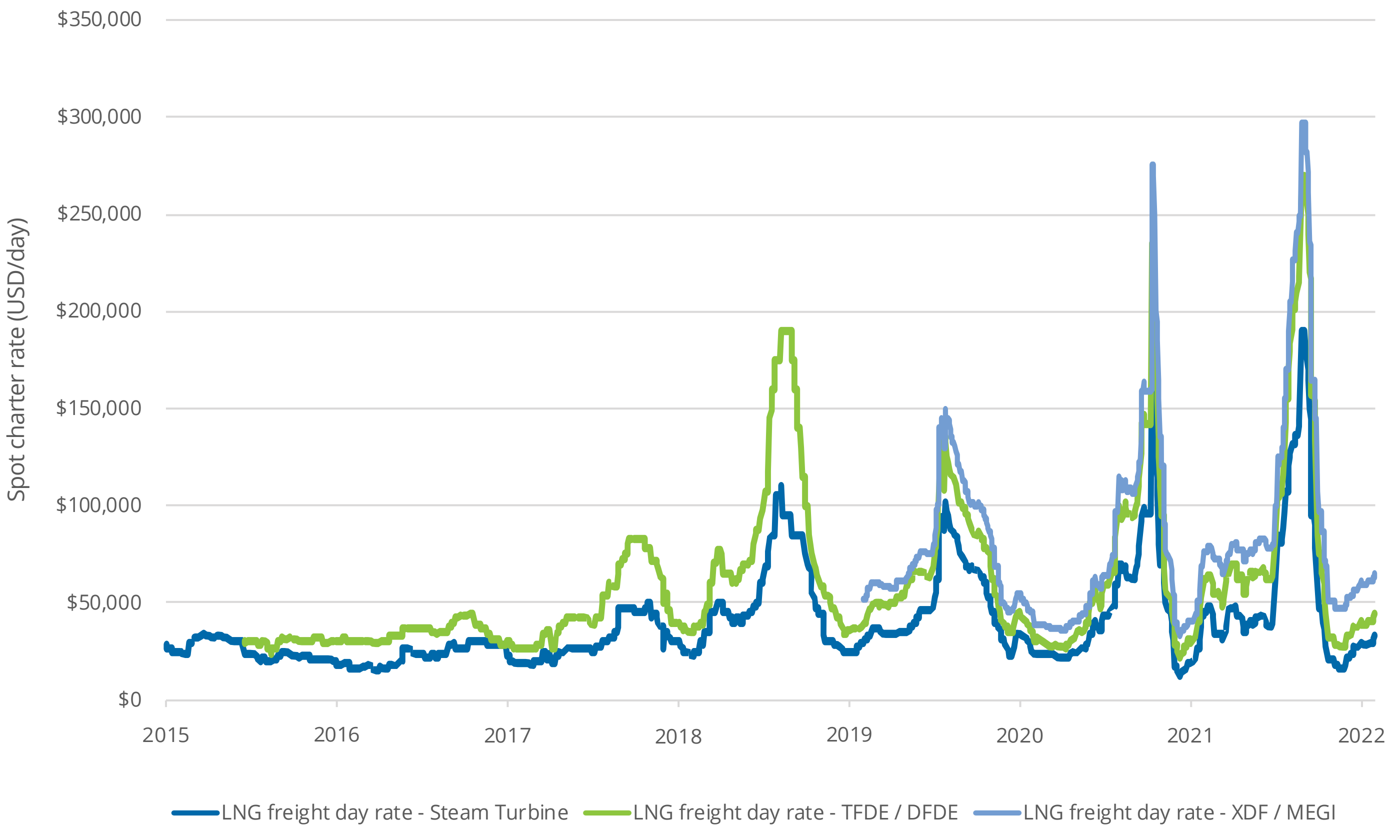
Figure 5.9: Liquefaction capacity growth vs LNG global fleet count growth, 2011-2021



Source: Rystad Energy

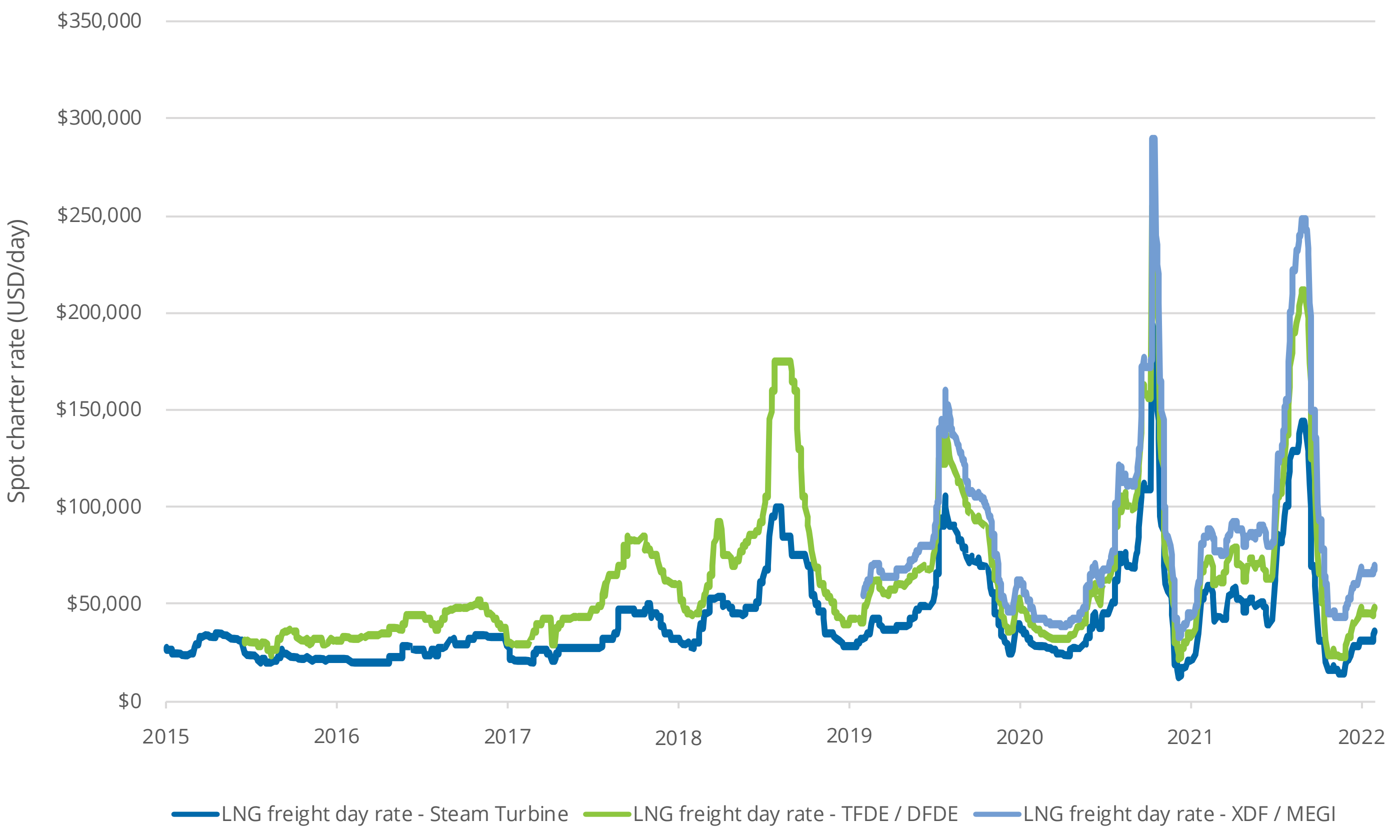
In the early 2010s, fleet growth was well balanced with additional liquefaction capacity coming online, resulting in a stable charter market. However, the rate of vessel deliveries far outweighed that of liquefaction capacity growth from 2013 onwards, resulting in a glut of LNG shipping capacity and a steady decline in charter rates. This continued until 2015, after which they remained between US$15,000/day and US$50,000/day (for steam turbine engines) 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 an unprecedented spike in charter prices with TFDE day rates reaching US$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 5.10: Spot charter rates East of Suez, 2015 to end-of-April 2022



Source: Rystad Energy, Argus Direct

Figure 5.11: Spot charter rates West of Suez, 2015 to end-of-April 2022



Source: Rystad Energy, Argus Direct

Following the peak in 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 US$105,000/day for steam turbine vessels, US$145,000/day for TFDE/DFDE vessels and US$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 inter-basin arbitrage closed, slower American 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 shipowners were operating at a financial loss at such charter rates.

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 US$190,000/day for steam turbine vessels, US$255,000/day for TFDE/DFDE vessels and US$290,000/day for X-DF/ME-GI vessels at the beginning of 2021.

2021 proved to be the most turbulent year in the history of gas and LNG freight markets with the charter spike quickly reversed as winter demand eased, with rates falling to historic 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. This once again caused a large spike in charter rates, reaching US$140,000/day for steam turbine vessels, US$210,000/day for TFDE/DFDE vessels and US$250,000/day for X-DF/ME-GI vessels in mid-December.

As the northern hemisphere winter volumes became accounted for, freight rates eased briefly before ticking upwards as the Russia-Ukraine conflict starting in February 2022 caused an LNG demand hike in Europe. Nations relying on Russian gas imports are now looking to increase their LNG imports, while aiming to build out regasification capacity, placing a slight upward pressure on freight rates. Rates reached US$35,000/day for steam turbine vessels, US$48,000/day for TFDE/DFDE vessels and US$70,000/day for X-DF/ME-GI vessels by end-of-April 2022.

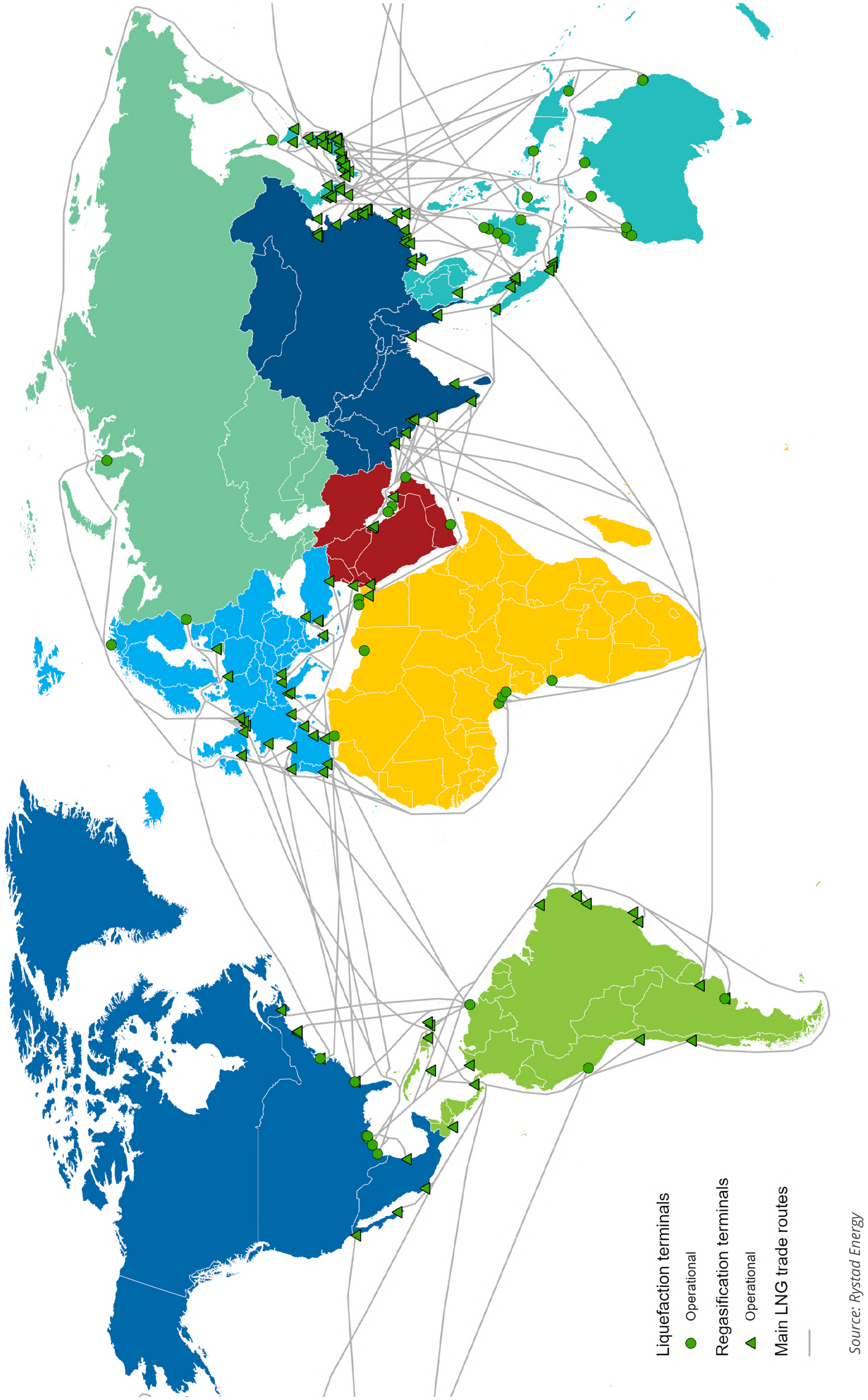


Figure 5.12: Major LNG Shipping Routes, 2021

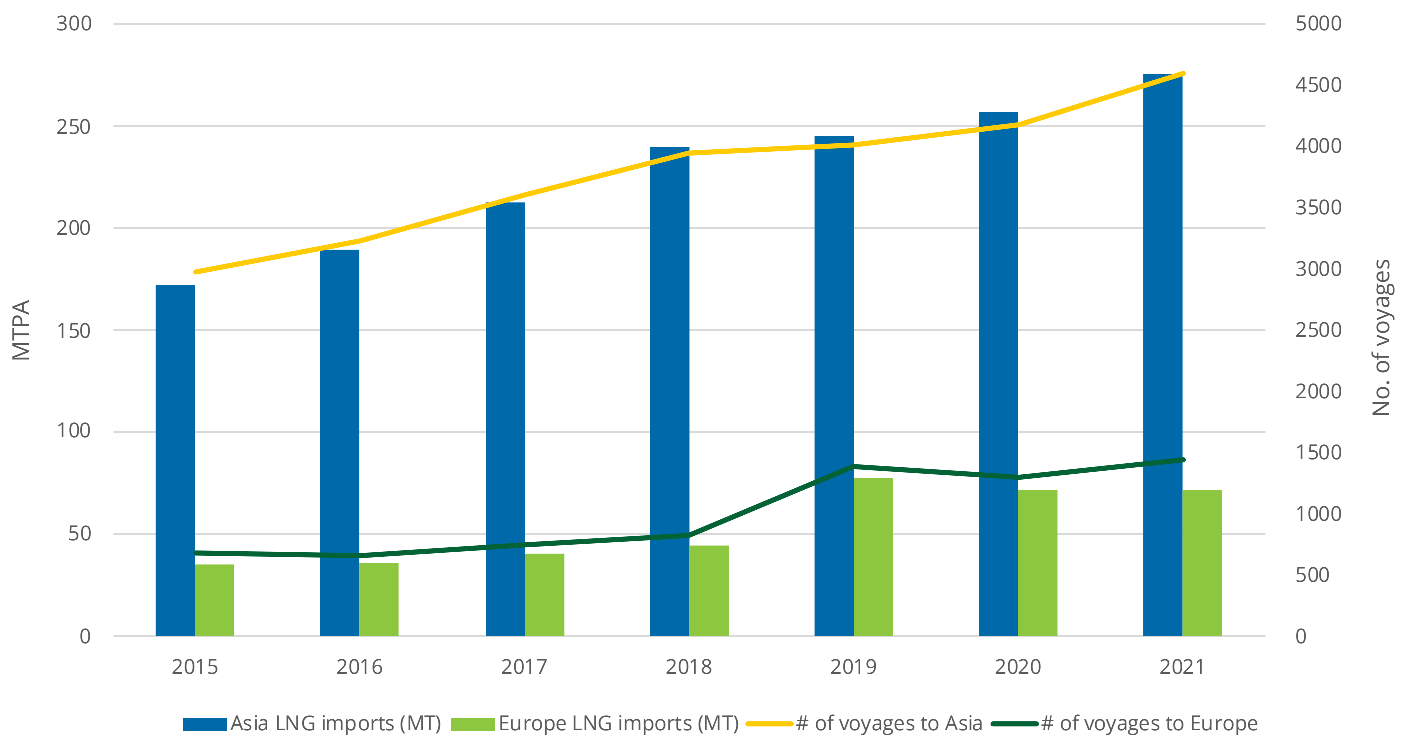
5.7
FLEET VOYAGES AND VESSEL UTILISATION

6,708 LNG Trade Voyages
in 2021

With additional liquefaction capacity, 2021 was characterised by a resumption of growth in the number of voyages and vessel utilisation, after COVID-19 demand reduction in 2020. A total of 6,708 LNG trade voyages departed in 2021, up 12% from 2020, which in contrast saw little growth from the previous year. Global growth in LNG trade voyages is in line with growth in liquefaction capacity, alongside growing competition between Asia and Europe as LNG demand centres.

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. The resulting voyage distance and time from the United States' Sabine Pass terminal to Japan's Kawasaki LNG site 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.

Figure 5.13: LNG imports and number of voyages to Asia and Europe, 2015-2021



Source: Rystad Energy, Refinitiv

LNG carriers reduce speed and increase the amount of LNG afloat in a quasi-floating storage as a short-term bridge before winter to meet larger end-of-year demand. High charter rates and boil-off usually lead to storing LNG earlier in the year or for longer periods being uneconomical. COVID-19 led to low LNG shipping charter rates, port closures and excess liquefaction, an environment that allowed for use of LNG carriers at reduced speed or eventually for storage as early as February 2020. This dampened the effect that demand destruction otherwise would have had on vessel utilisation in 2020.

In March 2021, the Ever Given container ship ran aground in the Suez Canal, blocking the passage for a week. 16 LNG carriers intended to transit through the Suez Canal at this time, some of which made the decision to sail around the Cape of Good Hope instead. There were 4,598 voyages to Asia in 2021, a 10% increase from 2020 driven by stronger Chinese demand amidst a colder winter at the beginning of the year, coupled with a coal shortage and stronger industrial demand towards year-end. European trade voyages grew 11% to 1,435, competing head-to-head with Asia for LNG supply.

The most common voyage globally in 2021 was from Australia to Japan, with 452 voyages. This was closely matched with the voyage count from Australia to China, at 447 journeys. The most common voyage to Europe in 2021 was from Qatar to Italy, with 76 shipments. Japan, China and South Korea took the highest number of cargoes globally, receiving 1,523, 1,192 and 715 cargoes, respectively. The average number of voyages completed per vessel was 10.6 in 2021, a similar level to the year before.

5.8 NEAR-TERM SHIPPING DEVELOPMENTS

The shipping industry will soon face an additional wave of environmental regulations both regionally and globally to limit air pollution and advance decarbonisation. In addition, institutions are increasing their focus on green projects – access to financing and insurance will progressively become easier for companies that are taking steps towards reducing greenhouse gas (GHG) emissions.

As a reminder, IMO introduced in the MARPOL regulation the Energy Efficiency Design Index (EEDI) for new ships in 2013, followed by an emission control areas (ECA) regulation for NOx and SOx, and finally a global cap of 0.5% sulphur content in marine fuels or 0.1% in ECA in 2020. Going forward, IMO regulations will include two more stringent requirements for new and existing ships from January 2023, the Energy Efficiency eXisting ship Index (EEXI) and the Carbon Intensity Index (CII). These new regulations have the objective of progressively limiting GHG emissions within the maritime industry. In addition, the European Union is currently discussing two more regulations which will drive the shipping community to limit and reduce CO2 emissions, the FuelEU directive and the application of the ETS to shipping. This is being done as part of the Fit for 55 initiative, the EU's 2030 ambition of cutting GHG emissions by 55%.

Among the solutions available for a progressive decarbonisation, LNG as a maritime fuel has become one of the best options in the short term because of the environmental benefits compared to traditional fuels such as heavy fuel oil or marine diesel oil. With a long track record, supported globally by regulations, infrastructure and technology, LNG is being implemented in many projects, both newbuilds and conversions. In addition, another advantage of LNG as a fuel is that the use of bio or synthetic LNG is possible without any system modifications. Another trend to highlight is that in some cases shipping companies are also looking into flexible solutions to prepare for the energy transition, i.e. LNG fuel installations with possibility for a retrofit to ammonia. While it is difficult to predict the utilisation of LNG as a fuel in the horizon of 2050 for the global shipping fleet, it seems likely that this fuel will play an important role for the years to come.

The gas carrier segment is at the forefront of clean fuels distribution, with a growing fleet of LNG carriers and other type of projects such as floating LNG, LNG bunkering vessels and other gas carrier types such as liquid petroleum gas (LPG) and liquid ethylene gas (LEG). All these ships will be affected by the aforementioned regulations from the IMO and EU, but the new ships are already well optimised and will generally use their cargo as fuel (LNG, LPG or LEG) which helps reducing their greenhouse gas emissions as well. Almost all the LPG and LEG ships ordered last year are equipped with dual fuel engines capable of burning the cargo as fuel, which can lead to a 15-20% reduction in CO2 emissions. Many new projects are also exploring technologies with a relatively acceptable Technology Readiness Level (TRL) such as air lubrication or wind assisted propulsion systems for instance to reduce carbon emissions.

One of the main impacts of the EEXI for existing ships which were not properly optimised is the need for speed reduction. This is particularly important for steam turbine LNG carriers, which still represent around one third of the active fleet, for which a reduction of up to four knots will likely be needed. As a consequence, we may see the need for a higher utilisation of the existing fleet, a potential further increase of fleet demand to cover the growing energy demand alongside possible scrapping of a significant proportion of the fleet.

In the frame of energy transportation, LNG carriers will further develop with highly optimised designs, the use of LNG as a fuel in more efficient propulsion systems, reduced boil-off rate cargo containment systems, re-liquefaction and sub-cooling systems for full flexibility in terms of fuel utilisation and reduced cost of freight. The reduction in methane emissions is also being assessed properly on board the ships, including the progressive reduction of methane slip for internal combustion engines. It remains to be seen if the new design of 200,000 cubic metres (cm) LNG carriers becomes popular or not, since flexibility for charterers is still very important.

With industry developments in new fuels and decarbonisation there will be additional development of the LNG carrier fleet and others such as LPG, mainly driven by a potential new trade of blue or green ammonia for power generation. Transportation of grey ammonia, mainly for the fertiliser industry on board LPG carriers is a mature industry, covered by international regulations for many years. Recently, various Very Large Ammonia Carriers (VLAC) have been designed. If green or blue Ammonia is to develop further as a decarbonisation solution, a brand-new fleet of these large ammonia carriers, possibly with a cargo capacity above 100,000 cm, will have to be built in the coming years. For these ships, ammonia as fuel would be a natural option, provided the technology and regulations are in place for the use of this new fuel. Classification societies and engine manufacturers are developing rules and engines respectively for the purpose, but IMO will also have to cover the international regulations for the use of ammonia as a fuel.

Another interesting development linked to decarbonisation is the potential for a new fleet of liquid carbon dioxide (LCO2) carriers. The industry requires additional carbon capture and storage (CCS) projects in order to cut carbon emissions to acceptable levels. Depending on several factors such as capture and storage locations, commercial-scale liquefaction, and shipping of the CO2 might become a reality. Several large companies involved in the oil and gas industry are exploring the potential and some LCO2 carriers have recently been contracted at Chinese and Japanese yards. In the evaluation of the projects, small size carriers with a capacity of around 7,500 cm is the starting point with progressive increase to 12,000 cm, 20,000 cm or more being expected in the coming years. Similar to ammonia carriers, ship designers and yards have started to make their own designs with a wide range of pressures and temperatures for the transportation depending on the cargo volume.

In addition, somewhat linked to the carbon capture industry, the shipping industry is paying attention to the installation of such systems on board ships. Although for the time being the benefits are not included in the IMO regulations mentioned above, the technology seems to be ready for deployment in ships and possibly more interestingly on board of LNG fuel ships which could use the LNG as cooling media for the CO2 liquefaction. Some pilot projects have been already developed and some others are being assessed at this moment by different stakeholders.

Another energy carrier which might see further development is liquid hydrogen (LH2) vessels, although regulations and technologies need to be developed further. The first seagoing LH2 carrier, Suiso Frontier, entered operations in the beginning of 2022 and other designs and cargo tank technologies are currently being proposed.

Returning to the LNG shipping segment, the boom in LNG bunkering vessels continues with several small-scale LNG carriers in the range of 20,000 to 30,000 cm being built for potential retrofit to ship-to-ship bunkering operations and other smaller units still being specifically built for the purpose of LNG bunkering.

Following the recent Russia-Ukraine conflict, Europe is working hard to try to secure energy supplies, and LNG has been one of the topics widely discussed. New FSRU projects have been approved in The Netherlands, Greece, Finland, Germany, etc. and additional flows of LNG will come to Europe from different locations. Units in service available in the market by Exmar, Hoegh, Excelerate or Dynagas for instance will be deployed as soon as possible in key locations and other projects are being discussed in other European countries.

Carbon-offset LNG

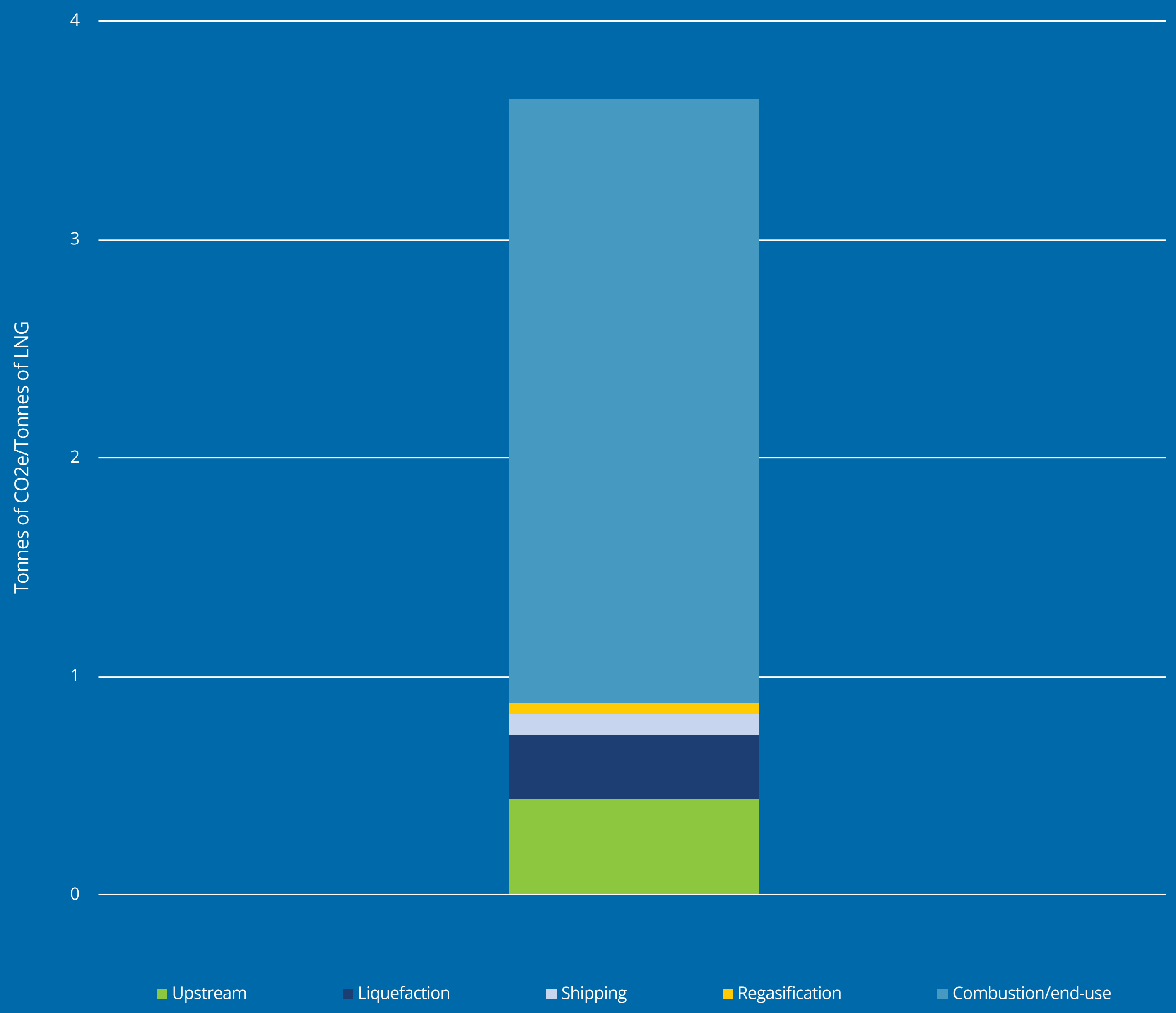
A detailed description of greenhouse gas emission reduction activities within the LNG industry is outside of the scope of this report. However, we recognise the importance of the work toward lower greenhouse gas emissions, and as such we have included an introductory piece on some of the work that is being done in this space.

Following the conclusion of COP26, more than 120 countries have set targets to reduce greenhouse gas (GHG) emissions to net zero (by 2050 for most). Natural gas is a key component of this proposed energy transition.

Since 2019, there has been a growing interest in the use of carbon offsets to compensate for residual emissions that cannot be reduced. This involves the offsetting of carbon emissions resulting from the production, liquefaction, transportation, regasification and combustion of LNG through the purchase of carbon credits.

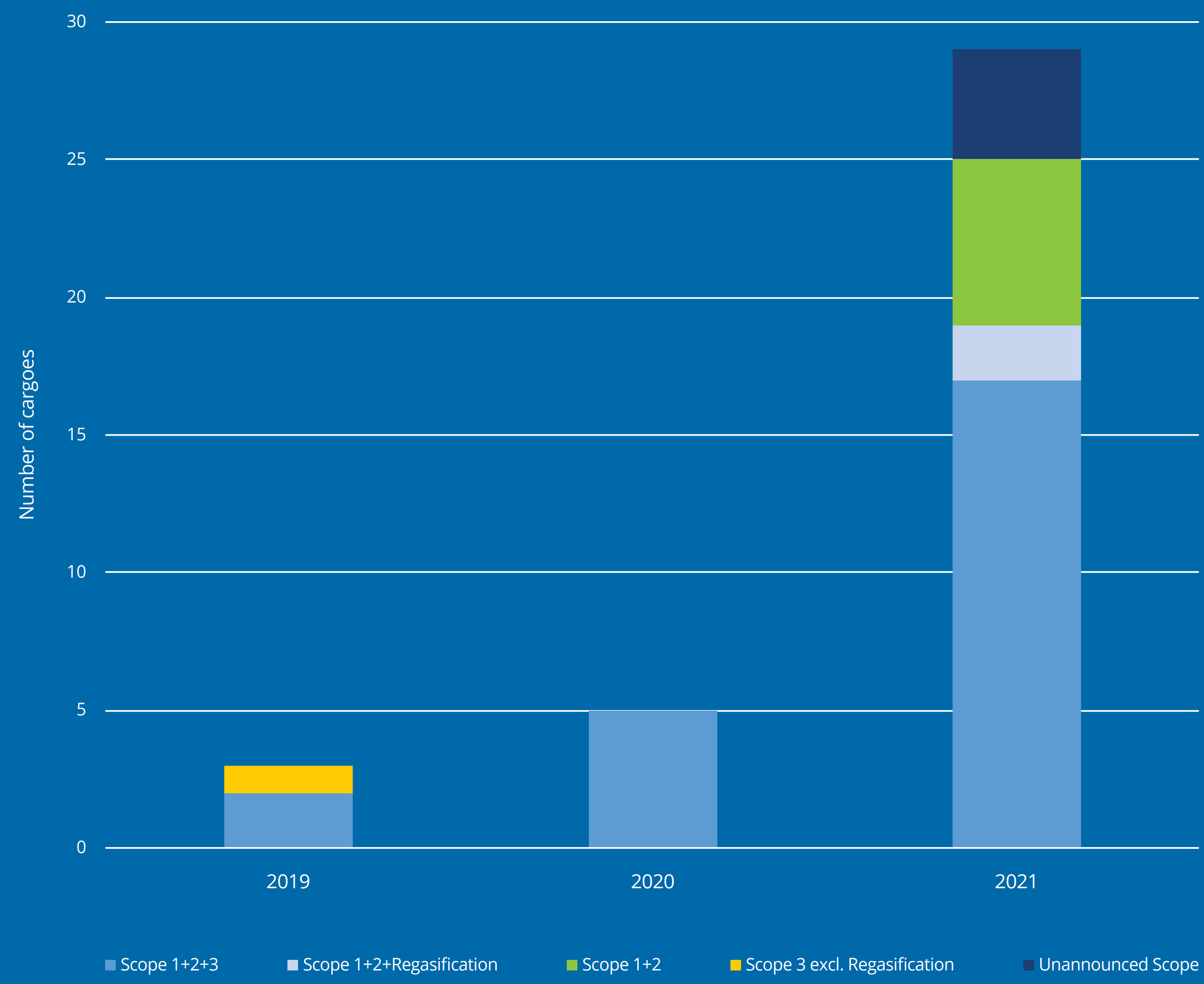
From 2019 to 2021, 24 transactions have offset emissions from Scope 1 to Scope 3 (upstream to combustion end use), six have covered Scope 1 and Scope 2 (upstream to shipping) and one has covered Scope 1, Scope 2 and regasification. The remaining transaction accounted for Scope 3 only (combustion end-use). These transactions have differed in terms of which GHG emissions were offset. For example, some only accounted for CO2 instead of CO2 equivalents (including other greenhouse gases such as methane and nitrogen oxide). Most of the carbon offset LNG cargoes have been quantified from an emissions standpoint by using the companies' own methodologies or generic conversion factors from the United Kingdom's Department of Environment, Food, and Rural Affairs (DEFRA) to estimate the CO2 intensity. However, several major industry players have invested a lot of work in the monitoring, reporting, and verification of GHG, paving the way to more deliveries of carbon-offset LNG cargoes on the spot market and under long-term agreements.

Figure 5.14: Estimated lifecycle GHG Intensity of LNG



Source: UK DEFRA

Figure 5.15: Carbon offset LNG transactions by emissions coverage



Source: Rystad Energy

In November 2021, QatarEnergy, Chevron Corp and Pavilion Energy Trading jointly published a GHG quantification methodology to produce a statement of greenhouse gas emissions (SGE) from wellhead-to-discharge terminal for every LNG cargo. The SGE methodology will be applied to SPAs concluded by Pavilion Energy to be supplied by the two other parties starting from 2023.

Moreover, the International Group of Liquefied Natural Gas Importers (GIIGNL) published the first comprehensive industry framework for the Monitoring, Reporting and Verification (MRV) of greenhouse gas emissions and for the declaration of GHG offset cargoes. Based on existing international standards, it includes best practice principles for accounting and offsetting as well a Cargo Statement to be used for reporting. The Framework promotes transparency and emissions reduction along the full value chain, from the wellhead to end-use.

In 2021, global trade in carbon-offset LNG reached more than 1 million tonnes, which makes up less than 0.5% of all traded LNG cargo. Global trade in carbon-offset LNG is growing in momentum, driven by LNG industry participants looking to decarbonise their existing portfolios alongside deploying other emission-reduction technologies at their production sites.

Northeast Asia remains the key destination hub for carbon-offset trade, comprising 68% of the 37 known carbon-offset cargoes in from 2019 to 2021. These include buyers from China, Japan, Chinese Taipei and South Korea. The popularity of carbon-offset LNG can be attributed to the increasing policy requirements across these countries to decarbonise quickly.

In the case of Japan, whose power system decarbonisation plan depends on renewables and nuclear, carbon-offset LNG provides optionality for governments and corporations to minimise their emissions in times of power supply shortages from other sources. Moreover, Japan's Ministry of Economy, Trade and Industry (METI) has included carbon-offset LNG as a decarbonisation option. This has provided sufficient signal to the industry to purchase more carbon-offset LNG. Tokyo Gas and 14 of its customers have established the Carbon Neutral LNG Buyers Alliance, while multiple city gas distributors (such as Toho Gas, Joestu Gas and Water Bureau, Nihonkai Gas and Kiryu Gas) have signed agreements to either offtake or supply carbon-offset gas to their customers.

6 LNG Receiving Terminals

49.8 MTPA of receiving capacity was added in 2021.

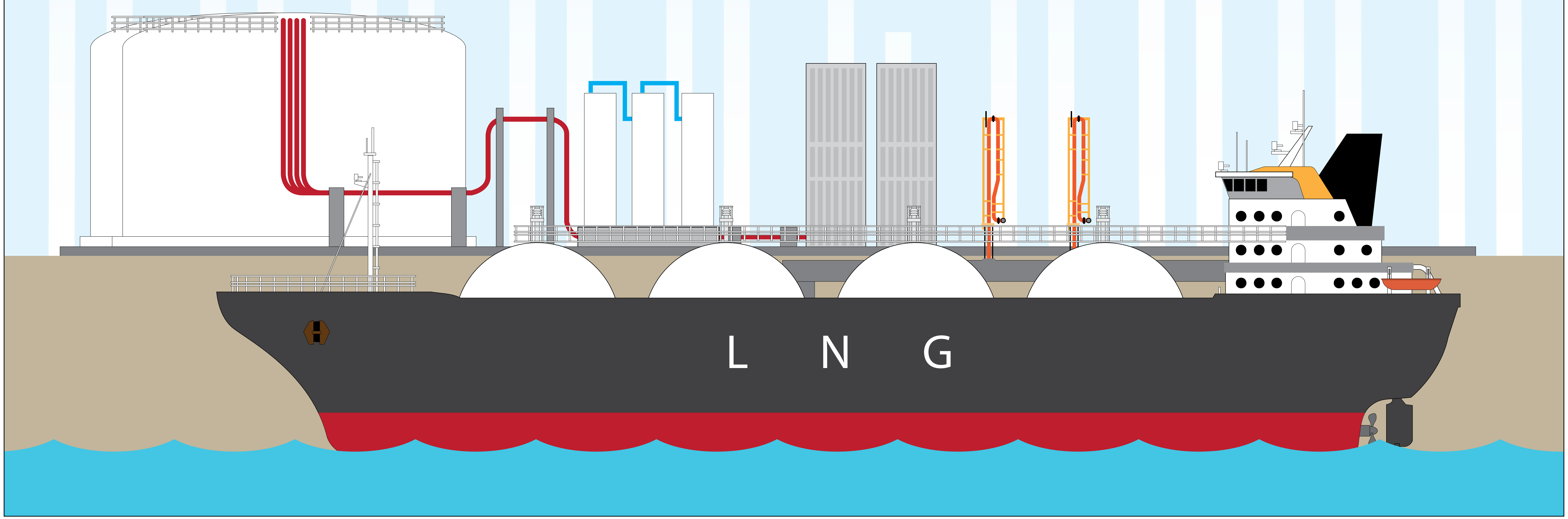
+5 new terminals in 2021

+5 expansion projects at existing terminals

China and Japan
expanded existing LNG regasification plants

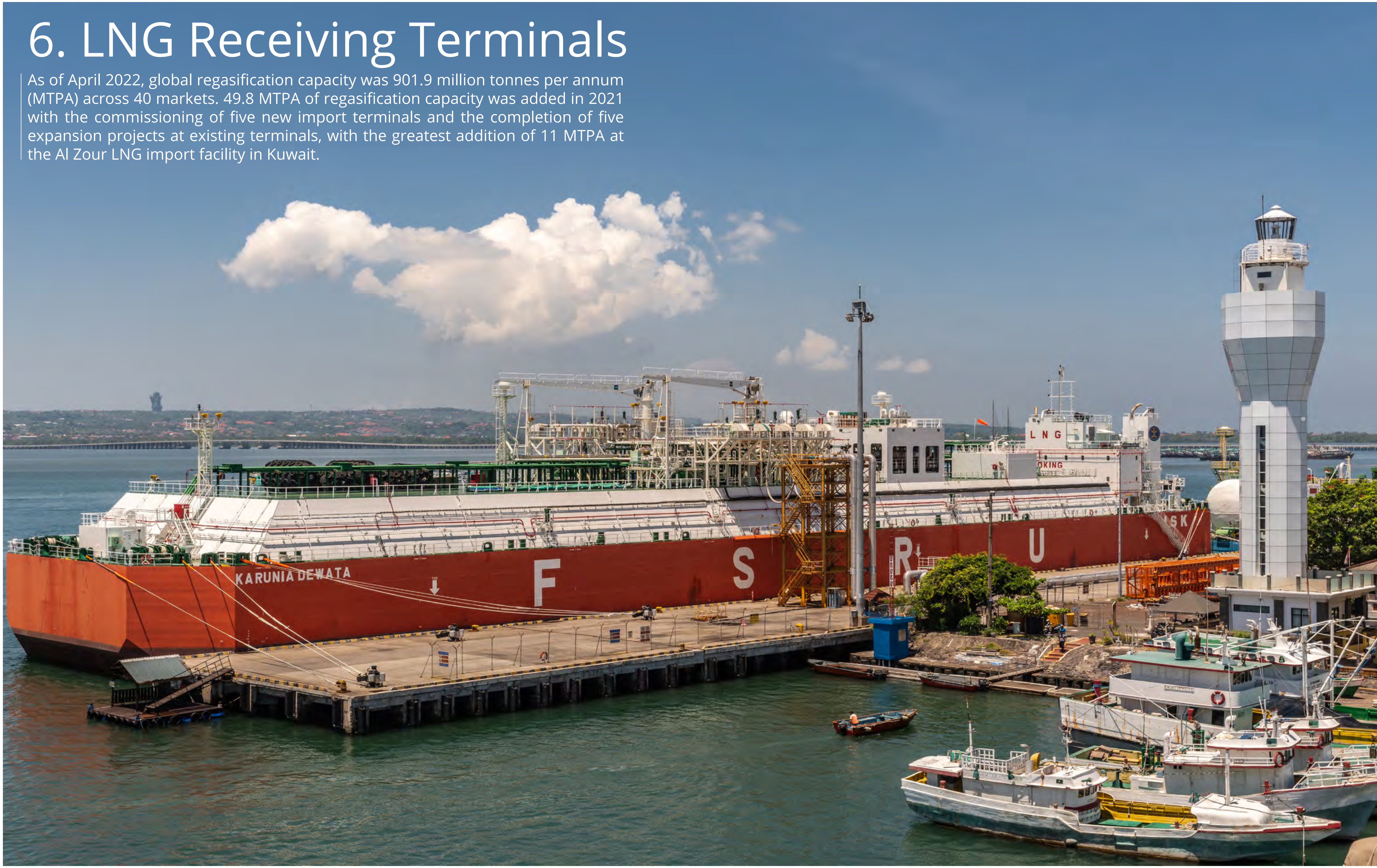
4 New FSRUs
Croatia, El Salvador, Indonesia and Turkey

164.8 MTPA
of new regasification capacity under construction



6. LNG Receiving Terminals

As of April 2022, global regasification capacity was 901.9 million tonnes per annum (MTPA) across 40 markets. 49.8 MTPA of regasification capacity was added in 2021 with the commissioning of five new import terminals and the completion of five expansion projects at existing terminals, with the greatest addition of 11 MTPA at the Al Zour LNG import facility in Kuwait.



6.1 OVERVIEW

901.9 MTPA

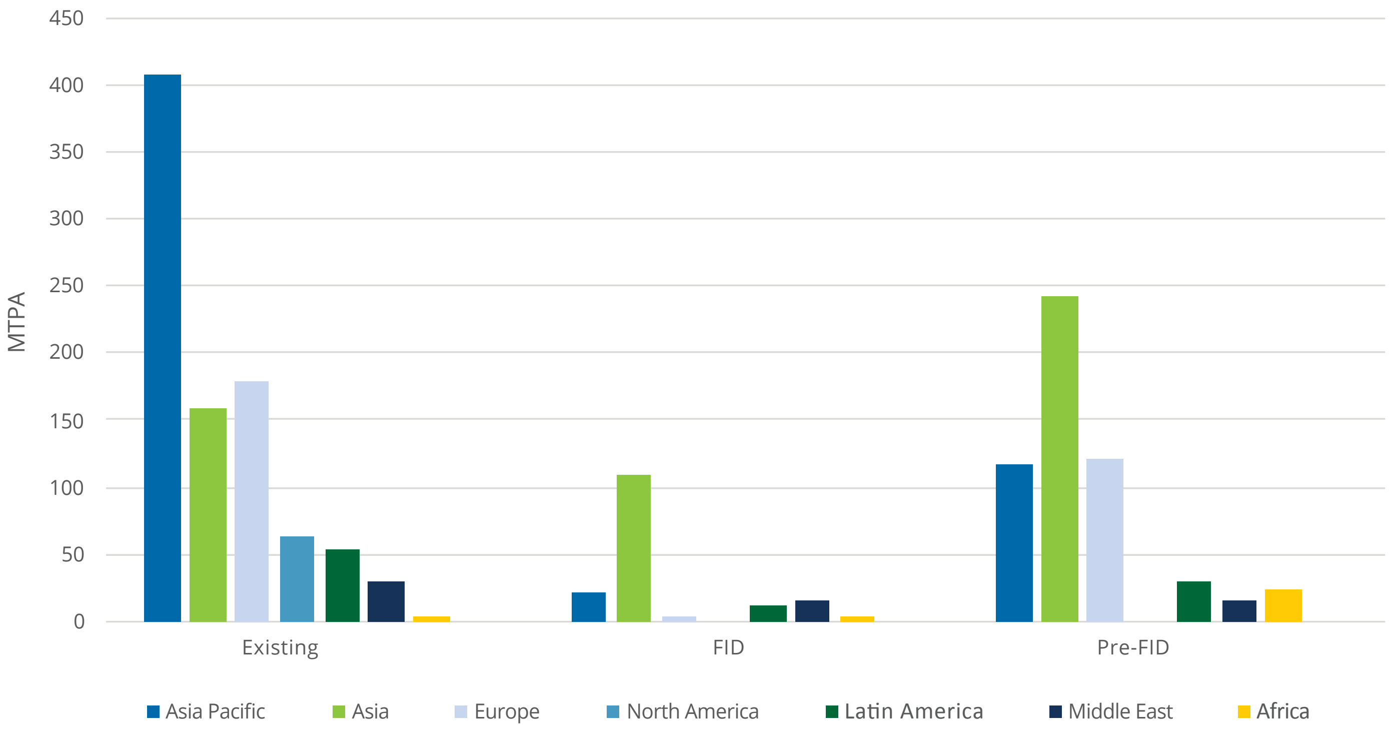
Global LNG Regasification Capacity as of April 2022

Among the existing LNG markets, new terminals started operations in Indonesia, Kuwait and Mexico, while China and Japan contributed to growth in regasification and storage capacity by expanding five existing terminals. 2021 was also marked by the debut of the first LNG import terminal in Croatia, with the start-up of the Krk (1.9 MTPA) regasification terminal. A total of 24.8 MTPA of floating regasification capacity was added in 2021, with the 7.5 MTPA Ertugrul Gazi floating storage and regasification unit (FSRU) in Turkey being the largest floating regasification terminal to start up last year. Utilisation rates at regasification terminals remained at 43%, the same as in 2020. Last year saw a continuation of the trend seen in 2020, when onshore regasification projects added slightly more capacity than floating regasification facilities. Notably, the majority of prospective new markets, such as Senegal and the Philippines, where facilities are currently under construction, have shown a preference for floating-based solutions through the charter of an FSRU or floating storage unit (FSU) as their first LNG regasification terminals.

The Asia and Asia Pacific regions currently account for the largest share of operational LNG regasification capacity globally and are anticipated to grow through capacity expansions in both existing and new markets. The expansion of regasification capacity in North America has been limited as domestic gas production has accelerated in recent years and the US has become a major LNG exporter. In addition to the Sabine Pass and Cove Point facilities that have been operating notionally as bi-directional import/export facilities, several other North American import terminals have been converted to or are being converted to liquefaction export facilities, including Golden Pass.

Croatia imported its first commercial LNG cargoes through the FSRU deployed at the Krk terminal in early 2021. FSRUs have helped new markets to access global LNG trade quickly, with their shorter construction times and lower capital expenditure, proving advantageous for smaller importers. In comparison, established LNG importers such as China and Japan have chosen to expand regasification capacities with the construction of onshore terminals, which allow for long-term use and potential regasification and storage expansion.

Figure 6.1: LNG regasification capacity by status and region, as of end-of-April 2022



Source: Rystad Energy

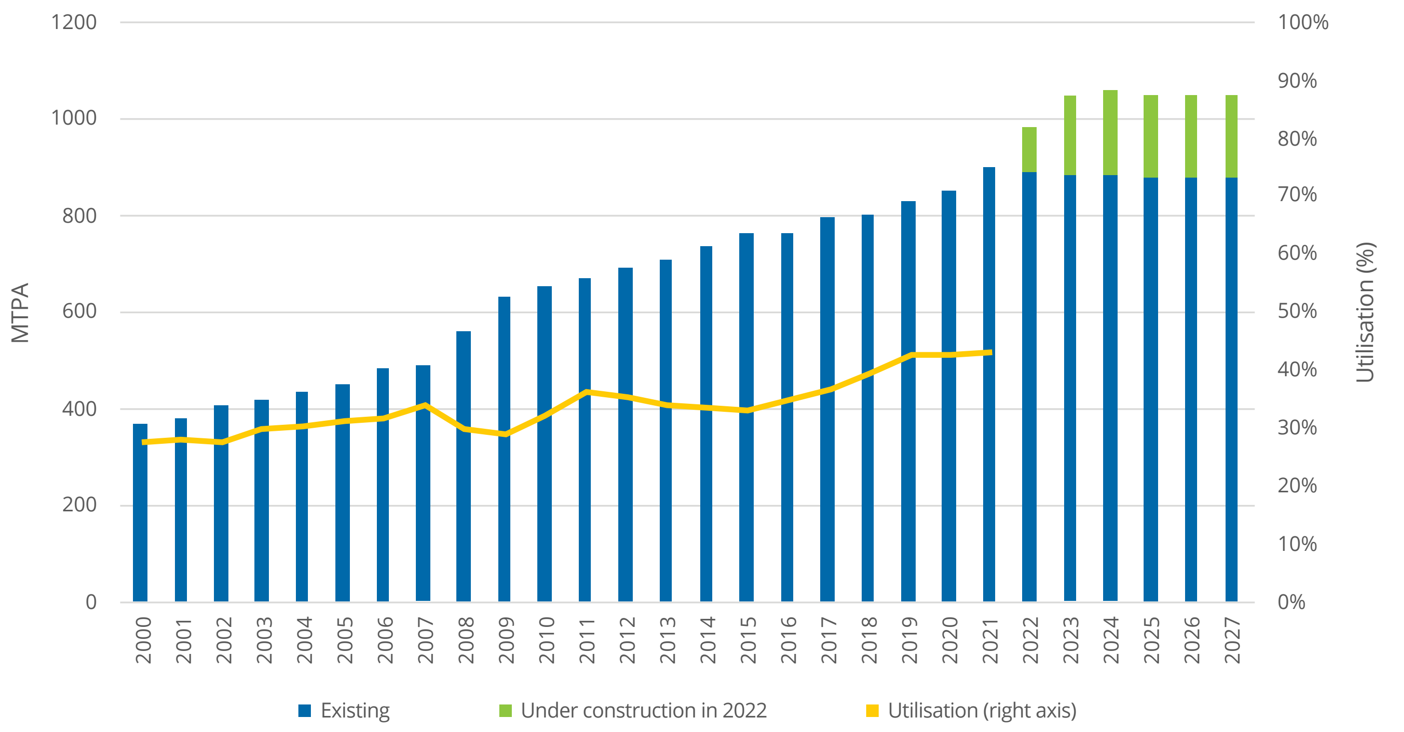
6.2 RECEIVING TERMINAL CAPACITY AND GLOBAL UTILISATION

49.8 MTPA of net regasification capacity was added globally in 2021, compared to 19 MTPA added in the previous year. At the beginning of 2021, we expected 81 MTPA of import capacity under construction to be commissioned by the end of the year. A large share of this included terminals that faced COVID-19-induced disruptions to construction schedules. Quite a few terminals in China were eventually able to start operations in 2021. Net capacity addition during the year was considerably higher than the average net addition of 26 MTPA in the last five years. The number of global LNG importers has increased consistently over the past decade, and a similar trend was observed in 2021, as Croatia commissioned its first LNG import terminal on Krk Island, with the deployment of an FSRU in January 2021. The FSRU market has seen significant growth over the last few years, as they involve a relatively lower capital expenditure and construction time. It is expected that FSRUs will increasingly be used to meet gas demand in smaller markets.

Five new import terminals started operations in 2021, with a combined regasification capacity of 23.6 MTPA. Two of these are onshore regasification facilities in Kuwait (Al-Zour) and Mexico (Pichilingue). The Al-Zour LNG import facility, the first of its kind in Kuwait, faced delays in construction due to the COVID-19 pandemic. It received its first cargo from Qatar in July 2021, delivered by Nakilat's Al Kharsaah LNG carrier. The terminal, operated by Kuwait Integrated Petroleum Industries Company (KIPIC), is designed to import 22 MTPA of LNG, making it the largest of its kind in the Middle East. Four 225,000 cubic metre storage tanks and 11 MTPA of regasification capacity became operational as part of the first phase of the terminal. It is expected that four more tanks of the same size will come online in 2022 as part of the second phase of the project, doubling the terminal's regasification capacity.

FSRUs started operations in Turkey in June and in Brazil in December of 2021, respectively. The Ertugrul Gazi, built by Hyundai Heavy Industries and chartered by Botas, started operations at the Dortyol LNG terminal in Turkey. It is one of the FSRUs with the highest send-out capacities in the world, with a regasification capacity of 7.5 MTPA. At the Bahia regasification terminal in Brazil, Excelerate Energy started operations using the Excelerate Sequoia, with a regasification capacity of 5.4 MTPA, and 173,400 cubic metres of LNG storage. Petrobras, which was originally operating the terminal, signed a contract to lease it to Excelerate through a competitive international tender process. Brazil's regasification capacity is comprised entirely of FSRUs, with only one planned onshore facility which is expected to come online in 2025.

Figure 6.2: Global receiving terminal capacity, 2000-2027



Source: Rystad Energy

Five expansion projects were completed at existing regasification terminals in 2021, adding 13.2 MTPA of regasification capacity. Several projects that faced pandemic-induced delays came online in China. The third phase of expansion at the Caofeidian LNG terminal was completed in August, increasing capacity from 6.5 MTPA to 10 MTPA. A 3.5 MTPA increase in capacity was recorded at the Jiangsu Rudong LNG terminal later in the year, with 400,000 cubic metres of storage capacity being added. Expansion was also undertaken at the Shandong (Qingdao) and Zhoushan ENN LNG terminals. The second phase of expansion was completed at the Hitachi LNG terminal in Japan, with operations starting in March 2021. Combining the 13.2 MTPA added via expansion projects and the 36.6 MTPA added by new terminals and FSRUs at existing terminals, total regasification capacity additions in 2021 amounted to 49.8 MTPA.

Three new terminals have come online in 2022 as of end of April – the Jiaxing terminal in China (1 MTPA), the Niihama terminal in Japan (1 MTPA), and the Acajutla FSRU in El Salvador (2.3 MTPA) which started operations in January, March and April, respectively.

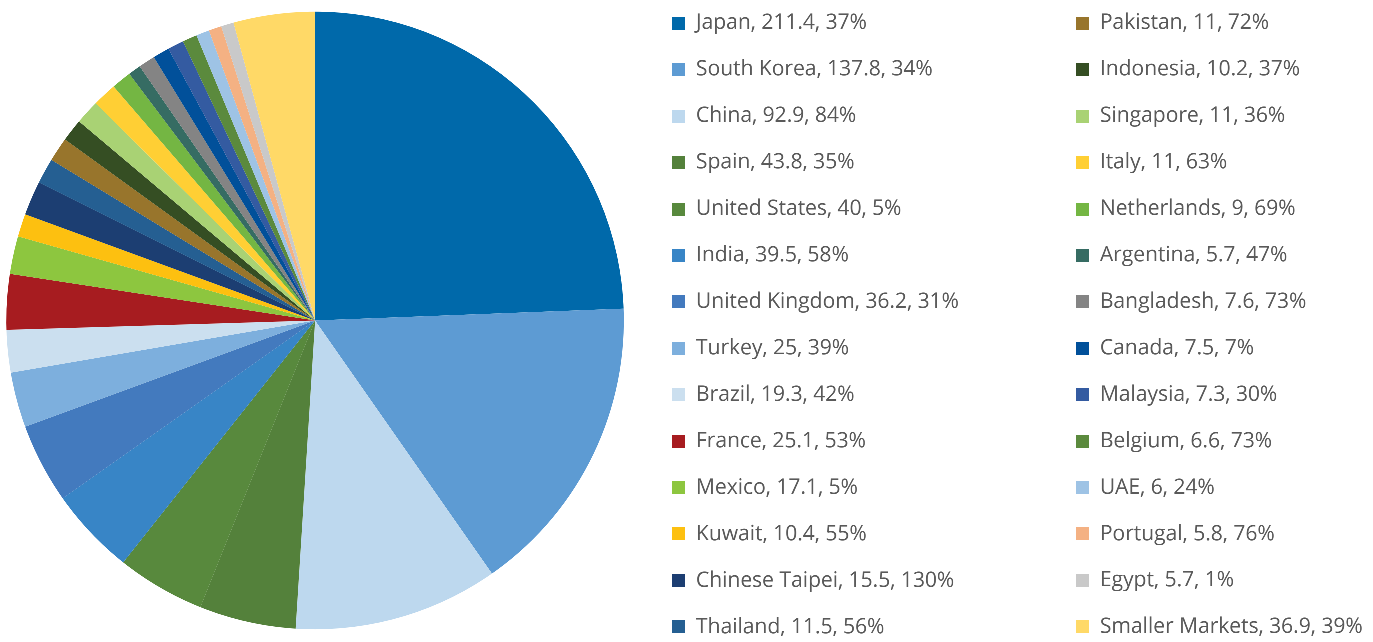
As of April 2022, 164.8 MTPA of new regasification capacity is under construction. This includes 19 new onshore terminals, 12 FSRUs and 13 expansion projects at existing receiving terminals. Nearly 80% of the regasification capacity under construction is being carried out at new and existing LNG terminals in Asia and Asia Pacific, with China and India leading. China has 10 new onshore terminals under construction in addition to eight expansion projects at existing terminals. India, on the other hand, is building five new terminals and carrying out expansion projects at one onshore terminal. The country is showing a preference for floating terminals, and three out of five new terminals under construction are FSRUs, all of which are set to become operational in 2022. Six new markets without existing regasification capacity are looking to start LNG imports over the next three years, with construction of their first LNG terminals underway. This includes markets such as Finland, Ghana, Nicaragua, Senegal, Vietnam and the Philippines. Thailand's Nong Fab LNG terminal, currently under construction for PTT LNG, features two 250,000 cubic metre storage tanks, and 7.5 MTPA of regasification capacity. The facility will have the longest jetty for LNG in the world, one of the largest LNG tanks and the world's longest subsea tunnel. It is expected to start operations in 2023.

Through the construction of four onshore and four floating terminals, these six new markets are expected to add 18.4 MTPA of regasification capacity to the global LNG market. Additional terminal construction and regasification expansion projects in existing markets are underway in Chinese Taipei, India, China, Brazil, Chile, Kuwait, Pakistan, Poland and Thailand. China's state-backed Sinopec received government approval to expand its LNG receiving terminal in the northern coastal city of Tianjin in December 2021. The third phase expansion project will increase regasification capacity to 11.65 MTPA from 10.8 MTPA, and includes five new LNG storage tanks, with a capacity of 270,000 cubic metres each.

Average global regasification utilisation remained at 43% in 2021, the same level as the year before. Natural gas demand increased significantly in 2021, with a corresponding increase in regasification capacity. To ensure sufficient supply in the market to meet peak seasonal demand, regasification terminal capacity generally exceeds liquefaction capacity. Utilisation rates across regasification terminals have fluctuated on a monthly basis, with the highest utilisation during the Northern Hemisphere's late-autumn/early-winter months from November to January. This cyclical fluctuation in utilisation rates is driven by the seasonality of LNG demand, which varies with the geographical distribution of the LNG importing markets. Winter months in the Northern Hemisphere drive the greatest demand for LNG regasification.

6.3 RECEIVING TERMINAL CAPACITY AND UTILISATION BY MARKET

Figure 6.3: LNG regasification capacity by market (MTPA) and annual regasification utilisation, 2021



Source: Rystad Energy

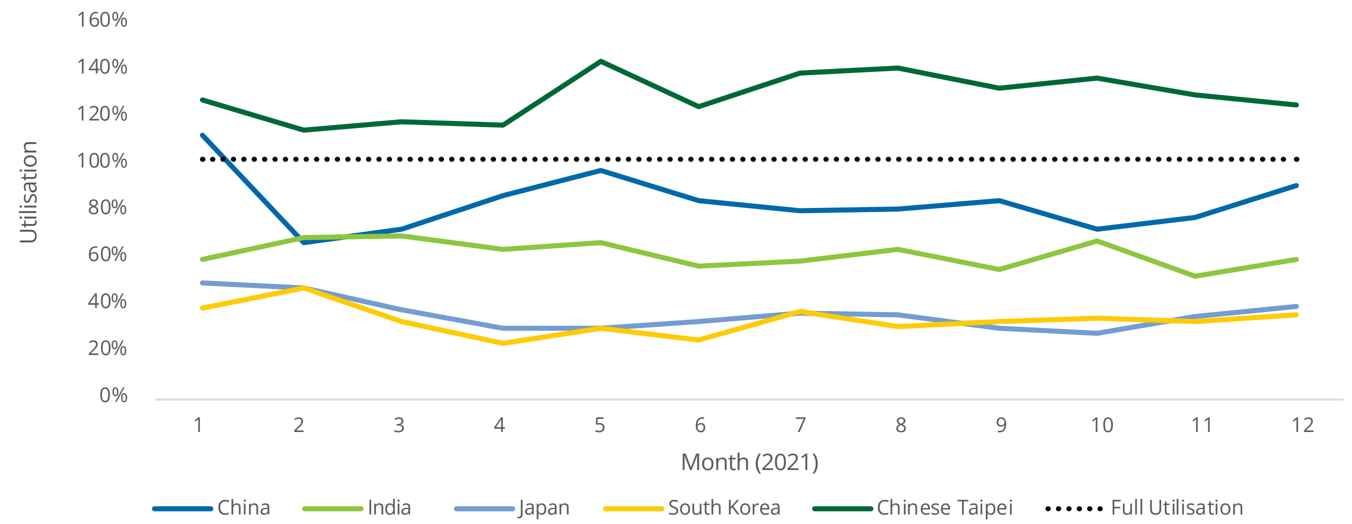
As of April 2022, Japan had the highest regasification capacity with 213.2 MTPA, representing about 24% of the global capacity. New capacity was added in Japan for the first time since 2018, with the Hitachi and Niihama LNG terminals becoming operational. At present, three of the country's largest terminals – Sodegaura, Senboku and Futtsu LNG – have a combined regasification capacity of 60.7 MTPA. Japan's regasification utilisation increased to 36.6% in 2021, up from 35% in 2020.

With seven existing import terminals contributing 137.8 MTPA of regasification capacity, South Korea retained its position as the second-largest market by capacity in 2021. It is currently the third-largest LNG importer globally, behind China and Japan. Natural gas is expected to continue to play a pivotal role in power generation to maintain energy security and fulfil the growing energy demand in South Korea, which has resulted in additional LNG imports. It is expected that coal-fired power plants will gradually be phased out in South Korea, offset by increased use of gas and renewables. There are currently no terminals under construction in South Korea, although there is a proposed project at Dangjin, in the South Chungcheong Province. The onshore receiving terminal, with a planned capacity of close to 12 MTPA and 2 million cubic metres of storage, is expected to be commissioned in two phases, in 2025 and 2031. South Korea's utilisation rate increased from 30% in 2020, to 34.2% in 2021.

China's natural gas demand increased significantly in 2021, with strong growth in the power and industrial sectors. Underperforming hydropower in southwest China and high coal prices, coupled with high summer temperatures led to a boost in gas-fired power generation. It is expected that as the Chinese market focuses more on decarbonisation and implementation of clean energy policies, natural gas demand will increase further. China has experienced very rapid growth in terms of regasification capacity. The market's LNG imports exceeded both Japanese and South Korean imports for the first time in 2021, making it the largest importer globally. Since 2017, China has expanded its total regasification capacity from 51.3 MTPA before 2017 to 100.9 MTPA as of April 2022. This expansion involved the commissioning of ten new terminals and 11 expansion projects at existing terminals between 2017 and 2022, adding a total of 49.6 MTPA of import capacity. Expansion projects were successfully completed at four existing regasification terminals in 2021 – Jiangsu Rudong, Caofeidian (Tangshan), Shandong (Qingdao) and Zhoushan ENN, accounting for 10 MTPA of combined capacity. With new onshore terminals under construction and seven existing terminals undergoing expansion, China is expected to add another 74.9 MTPA of regasification capacity by the end of 2024. Once these projects become operational, China will have expanded its regasification capacity by almost 73%. A significant volume of projects that were expected to come online in 2020 deferred their start-up to 2021 due to COVID-19-related construction delays and financial difficulties. This included both new terminal construction and expansion plans at existing facilities. It is expected that China will experience a strong growth in regasification capacity the near term and close the gap to South Korea and Japan. 2021 saw the country's regasification utilisation at a record high 84.4%, up from 83% in 2020.

After a relatively quick recovery from the initial COVID-19 lockdown measures, China boosted its natural gas imports, with demand outstripping regasification terminal capacity expansion. At its peak, utilisation rates have consistently exceeded 100% in recent years, with the highest monthly utilisation rate observed to be above 110% in January 2022. The import value chain has seen tightness despite new capacity becoming operational in 2021, driven by the increase in China's LNG imports. It is also necessary to ensure that newly built terminals are connected to the local grid, to support send-outs. Despite a high-price environment, LNG demand in China is expected to increase in the short to medium term, as governmental support for cleaner fuels becomes more prominent. This will translate to development of additional regasification capacity.

Figure 6.4: Monthly 2021 regasification utilisation by top five LNG importers

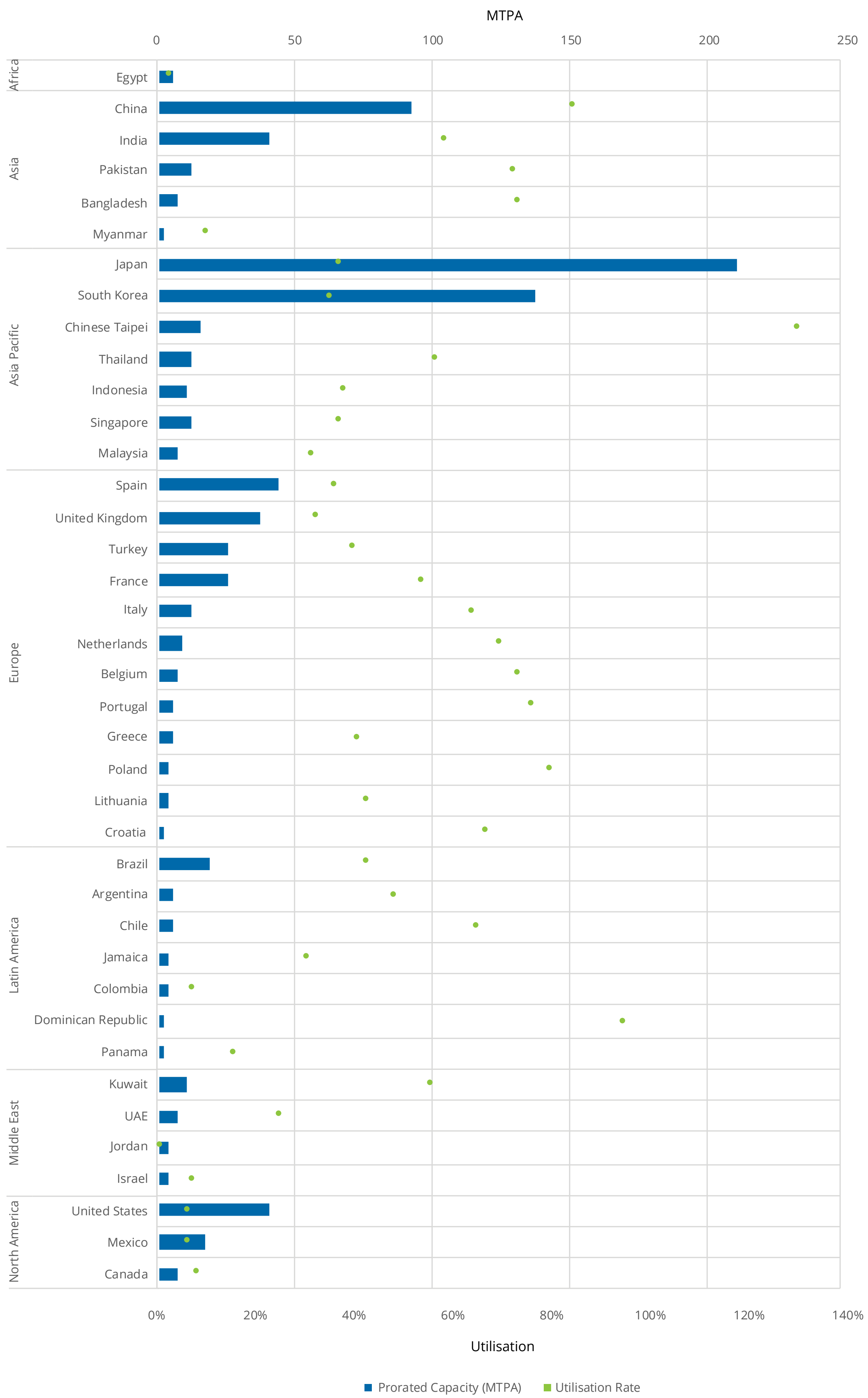


Source: Rystad Energy

As the world's fourth-largest LNG importer, India has experienced exceptionally strong growth over the past decade, increasing its import capacity by more than 160%. Despite accounting for only 39.5 MTPA of regasification capacity by the end of 2020, India has another 30 MTPA of capacity under construction as of April 2022. India currently has a total of six operational import terminals. No new LNG import terminals were commissioned in 2021, with Mundra LNG being the last one coming into operation in 2020, adding 5 MTPA of regasification capacity. India's first FSRU-based terminals, which were initially due to be commissioned in early 2021, are likely to see operations starting up in the second half of 2022. The Hoegh Giant FSRU, with a storage capacity of 170,000 cubic metres and regasification capacity of 6 MTPA, arrived at H-Energy's Jaigarh terminal in Maharashtra in March 2022. The FSRU will deliver re-gasified LNG to the 56-kilometer-long Jaigarh-Dabhol LNG natural gas pipeline, connecting the LNG terminal to the national gas grid. A 5 MTPA FSRU, located at Jafrabad in Gujarat, was initially expected to be commissioned in early 2020. However, two cyclones and the pandemic delayed the construction of a breakwater required to ensure that it is an all-weather facility. The facility, which is partially owned by Swan Energy, is expected to come online in the second quarter of 2022. India's utilisation rate dropped to 58% in 2021 from 65% 2020. The relatively low utilisation rate reflects the availability of spare capacity to support growth in India's LNG demand. This growth is driven primarily by growth in demand for city gas.

Despite a relatively low import capacity of 15.5 MTPA as of April 2022, Chinese Taipei is among the top 10 importers of LNG, driven largely by its clean energy plan, as it targets to phase out coal and nuclear in electricity generation. The market recorded one of the highest annual regasification utilisation rates globally in 2021, reaching a monthly average high of 141% in May. Both its operational terminals were utilised above their nameplate capacities the whole year. Chinese Taipei successfully expanded its Taichung terminal in 2020, by increasing regasification capacity to 6 MTPA. To support further growth, Chinese Taipei is also adding capacity through the construction of a third LNG import terminal (Taoyuan), which is expected to come online in 2023. Another facility in Taichung, owned by Taipower, is scheduled to start operating in 2025. A significant amount of backlash from environmental groups has caused delays, as operators have had to tackle these concerns. Chinese Taipei's regasification utilisation rate is likely to remain elevated in the near term.

Figure 6.5: Receiving terminal import capacity and regasification utilisation rate by market in 2021



Source: Rystad Energy

In the past five years, European markets have been slow in adding regasification capacity despite accounting for almost 20% of the global regasification capacity. Croatia became a new LNG importer in 2021, as operations started at the Krk LNG terminal with the arrival of a 1.9 MTPA FSRU. Significant capacity has also been added in Turkey since 2018. With the increase in gas consumption during the winter months of 2021, the throughput increased at the import facilities in the country. Usage of gas in the power generation sector increased, to compensate for lower output from a drought that impacted hydropower plants. Turkey continues to rely heavily on Russian gas. Imports to Turkey via the Marmara Ereglisi terminal, operated by Botas, started in 1994. The year 2006 also saw operations starting at the EgeGaz LNG-owned Aliaga Izmir LNG terminal. Three FSRUs are currently operational in Turkey – the Ertugrul Gazi FSRU in the Iskenderun Bay, the Etki LNG terminal in Izmir, Aliaga, and the MOL FSRU Challenger in the Port of Dortyol. Collectively, they account for over 19 MTPA of capacity. Two more floating facilities are expected to become operational by 2025 - the Yalova and Iskenderun FSRUs - which will increase Turkey's regasification capacity by 9.8 MTPA.

European terminals had a utilisation rate of 45% in 2021. More than 70% of LNG volumes imported during the year were supplied by the US, Qatar and Russia. After a pandemic-driven demand reduction in 2020, economic activity picked up in 2021. Lower domestic production, decreased LNG inflow, along with reduced pipeline deliveries from Russia resulted in a tight market leading to record high gas prices. The Dutch Title Transfer Facility (TTF) prices rose to a new high at the end of 2021, with intense competition emerging between Europe and Asia for LNG cargoes. In December, several vessels carrying US LNG destined for Asia were directed to change course mid-voyage, as demand in Europe spiked. Some African LNG cargoes en route from Nigeria and Equatorial Guinea to Asia were redirected to Europe as well. A slight increase in LNG import levels propped up utilisation rates at import terminals across the region. Import terminals in Poland, Portugal, Belgium and the Netherlands experienced some of the highest utilisation rates, averaging around 73%. Portugal's utilisation rate increased by 6 percentage points compared to 2020. Utilisation rates at regasification terminals are less uniform across the European markets, ranging from 31% in the UK to 79% in Poland. With the largest regasification capacities among European markets, regasification terminals in UK, Spain and Turkey experienced low utilisation rates of 31%, 35% and 39% respectively, despite receiving some of the highest volume of LNG in the region. This can be attributed to LNG volumes being reloaded to meet demand in Asian markets over the course of the year.

After the onset of the Russia-Ukraine conflict starting in February 2022, European governments pledged to drastically reduce dependence on Russian gas, which constituted about 30% to 40% of the region's total gas supply. To facilitate LNG imports, a number of regasification terminals have been planned across Europe. This involves the construction of new terminals, as well as reactivation of dormant facilities. Since the start of the conflict, at least 10 new projects have been announced, adding a combined 43.5 MTPA by 2025. Some of these projects have substantial governmental support, ensuring financial support and greater certainty of completion. France, Germany, Greece, Italy, the Netherlands and the UK are planning for deployment of FSRUs, accounting for about 75% of the total new capacity that is expected to become operational.

Among the European markets with potential additional import capability, Germany has plans to add the most regasification capacity, at a projected 13.2 MTPA. The country revealed plans to build two LNG terminals in Brunsbuttel and Wilhelmshaven in February 2022, in an effort to reduce its dependence on Russian gas. German energy major Uniper will build and operate the LNG terminal at Wilhelmshaven. The FSRU, with a capacity of 7.3 MTPA, is expected to cover around 8% of Germany's gas demand in the future. The project is expected to be completed in two phases – by the end of 2022 and 2025, respectively. The Brunsbuttel floating LNG terminal, expected to begin operations in the beginning of 2023, will have two onshore tanks of 165,000 cubic metres each and a send-out capacity of 5.9 MTPA. In May 2021, Dow signed an agreement to take a minority stake in Hanseatic Energy Hub, which plans to build a zero-emissions LNG import terminal in Stade. The terminal may start operations in 2026. Two FSRUs to be deployed in the Tyrrhenian Sea and the Adriatic Sea, respectively, are currently being considered in Italy, to boost the country's regasification capacity by 7.4 MTPA.

The US is the fifth-largest market in terms of total operational regasification capacity, with a combined capacity of 40 MTPA as of April 2022. However, overall utilisation rates of most terminals were very low in 2021, averaging only 5%. The US sometimes re-exports LNG that it originally imports. However, in 2021, it did not re-export any LNG. Imports to Puerto Rico accounted for 75% of US imports in 2021. The Penuelas regasification terminal received large volumes of LNG in recent years, reaching a utilisation rate of 119% in 2019. Operations started up at the FSRU-based terminal at San Juan in 2019, which somewhat eased the pressure on the Penuelas facility and reduced utilisation rates to 60%. Except for Puerto Rico's terminals, very few LNG import terminals in the US received cargoes in the last three years. The received cargoes were mostly used as tank cooling supplies in relation to the addition of liquefaction capabilities to existing regasification terminals. Given the US' large-scale domestic production of shale and tight gas resources, it is likely to further reduce LNG imports and prioritise the construction of LNG export over import terminals. The US has started converting existing import terminals into exporting facilities, such as Cheniere's Sabine Pass which exported its first cargo in 2016. Golden Pass LNG, which started as an LNG import terminal, expects the first of three liquefaction trains to come online in 2024, and reach full operations in 2025.

Latin America has seen its regasification capacity increase significantly in the past five years. In June 2021, Excelerate's FSRU Exemplar, with a regasification capacity of 3.8 MTPA and storage capacity of 151,000 cubic metres, restarted operations at the Bahia Blanca Gas port. In Brazil, Petrobras signed a lease agreement with Excelerate Energy, for operations at Bahia's LNG Import terminal. This agreement allows for relocation of its 138,000 cubic metre FSRU Golar Winter FSRU back to the Pecem terminal, which was idle while the FSRU was being utilised at Bahia. Some 18 MTPA of regasification capacity is expected to be added in Latin America by 2025, with FSRUs starting operations in new markets including Cuba and Ecuador.

Table 6.1: LNG regasification terminals, January 2021 - April 2022

Receiving Capacity	New LNG onshore import terminals	Number of regasification markets
+54.1 MTPA Net growth of global receiving capacity	**+4** Number of new onshore regasification terminals	**+1** New market with regasification capacity as of April 2022
Net nameplate regasification capacity grew by 54.1 MTPA from end 2020 and reached 901.9 MTPA by April 2022. Capacity at new terminals was 40.9 MTPA while expansion projects amounted to 13.2 MTPA.	New onshore regasification terminals were added in Kuwait (Al Zour), Mexico (Pichilingue), Japan (Niihama) and China (Jiaxing). Five expansion projects at existing onshore terminals were completed in China (Jiangsu Rudong, Caofeidian, Shandong Qingdao and Zhoushan) and Japan (Hitachi).	The number of markets with regasification capacity increased to 39 by year-end 2021 with the addition of one new market – Croatia. This has increased to 40 following the addition of El Salvador in April 2022.

6.4
RECEIVING TERMINAL LNG STORAGE CAPACITY

70.75 mmcm
Global Storage Capacity

With the construction of new LNG terminals and expansion of existing facilities, storage capacity has increased steadily in recent years. Global LNG storage capacity was 70.75 million cubic metres (mmcm) as of April 2022 after the addition of 4.5 mmcm at eight new terminals, five expansion projects and three FSRUs during 2021 and the first four months of 2022. The average storage capacity for existing terminals in the global market was 404 thousand cubic metres in 2021, a slight reduction from 419 thousand cubic metres in 2020.

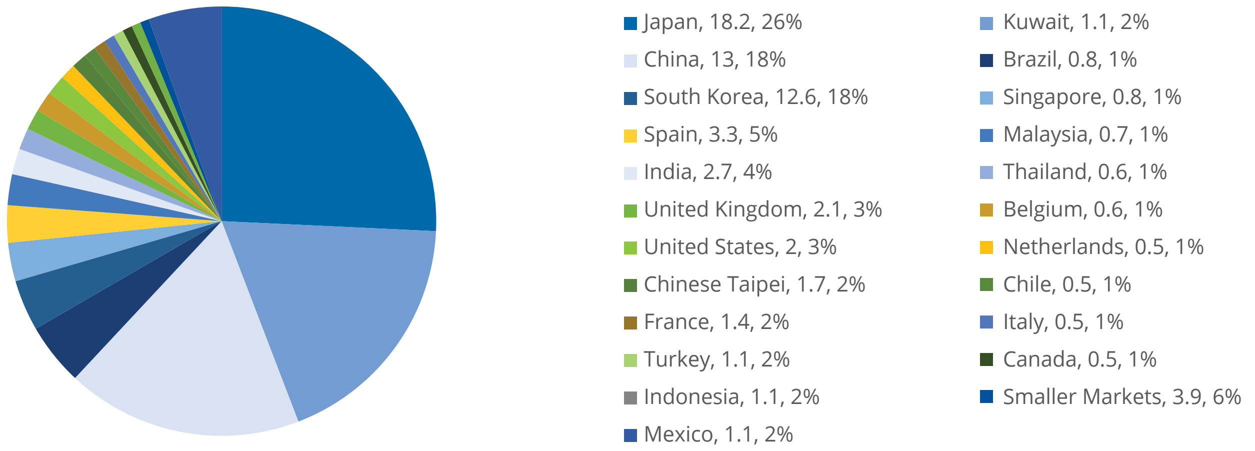
Similar to the geographical distribution of regasification capacity, over 60% of existing LNG storage capacity is in China, Japan and South Korea, with storage capacity per terminal ranging from 0.01 to 3.36 mmcm. Markets in the Asia and Asia Pacific regions have the highest share of global storage capacity, since it is imperative to ensure that the region has security of gas supply and flexibility. In addition, Japan, China and South Korea have limited gas storage options available outside of LNG terminals.

New terminals and project expansions increased LNG storage capacity by 3.47 mmcm in 2021, compared to 2.7 mmcm additions in 2020. China accounted for 46% of last year's storage capacity additions (1.68 mmcm) through the successful completion of four capacity expansions at existing terminals in Jiangsu, Tangshan, Qingdao and Zhejiang. The largest increase in storage capacity at a single terminal was at the Al Zour LNG import facility in Kuwait, where eight tanks were constructed, each with a capacity of 225,000 cubic metres. The second phase of expansion at the Caofeidian terminal at Tangshan, in China, was completed in August 2021, with four 160,000 cubic metre storage tanks. A sizeable onshore addition was made at the Hitachi LNG terminal in Japan, with 0.23 mmcm coming online. In terms of offshore facilities, the installation of new FSRUs at the Bahia and Pecem LNG terminals in Brazil added 0.17 and 0.14 mmcm of storage, respectively.

Notably, the development of storage capacity has shown signs of divergence. In established LNG markets, the construction of new onshore terminals supports the growth of storage capacity. In newer markets, however, the increasing popularity of FSRUs translates to substantially lower storage capacity per terminal. As of 2021, the operational storage capacity at onshore terminals (65.4 mmcm) is observed to be much higher than that at offshore or floating terminals (5.2 mmcm).

With China's increasing dependence on LNG imports, storage capacity is being expanded in parallel with the expansion of regasification capacity. CNOOC announced plans to expand the Binhai terminal with six new LNG tanks in June 2021, each with a capacity of 270,000 cm. It is expected to start operations by the end of 2023. Sinopec announced that it has started construction of the world's largest LNG storage tank at the Qingdao terminal in China's Shandong province in March 2022, with a capacity of 270,000 cm.

Figure 6.6: LNG storage tank capacity by market (mmcm) and % of total, 2021



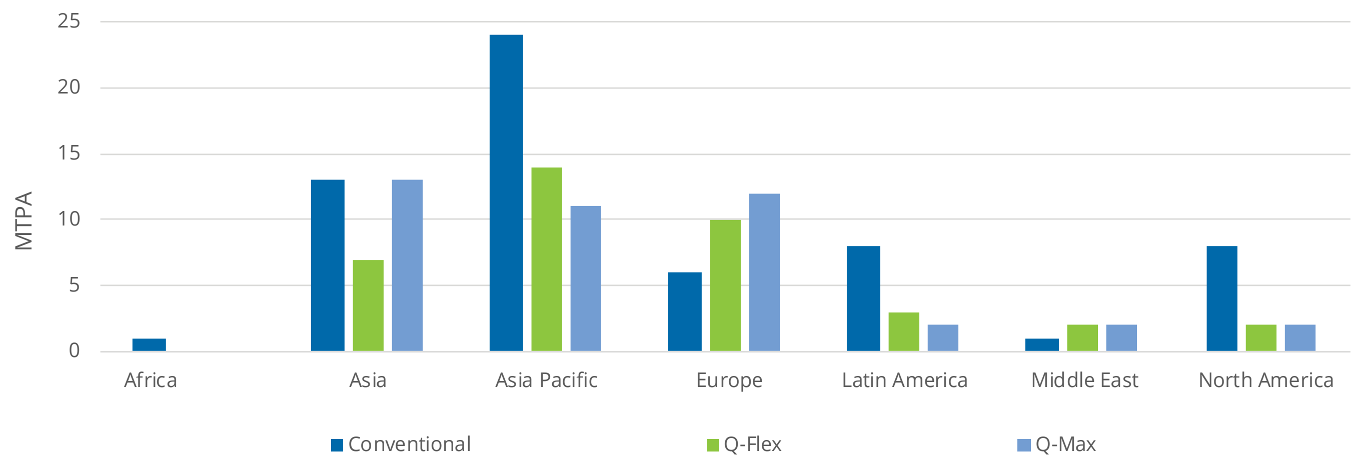
Source: Rystad Energy

6.5
RECEIVING TERMINAL BERTHING CAPACITY

The berthing capacity at a regasification terminal determines the types of LNG carriers it can accommodate. Traditionally, regasification terminals are designed to handle conventional-sized carriers, which predominantly have a capacity between 125,000 and 175,000 cm. With the increased utilisation of Q-Class carriers and the global increase in storage capacities, maximum berthing capacity at many existing and new terminals is increased to allow for a larger variety of vessels. This ranges from Q-Class carriers to small-scale vessels below 10,000 cm. However, in new markets which typically deploy FSRUs or small-scale regasification terminals, berthing capacities are smaller.

Q-Flex and Q-Max carriers, which currently have the largest capacity, can carry about 210,000 cm and 260,000 cm of LNG, respectively. As of 2021, 42 terminals have the capacity to accommodate Q-Max vessels. Of these 42 terminals, almost 58% of them are in the Asia or Asia Pacific regions, while the Middle East and Latin America have two such terminals each. Q-Flex vessels, which have a slightly smaller capacity, can be berthed at 38 additional terminals, which are also primarily located in the Asia or Asia Pacific regions. The remaining 61 terminals are equipped with sufficient berthing capacity to handle most modern LNG vessels, which are generally below 200,000 cm. Onshore terminals account for 82% of the terminals capable of handling Q-Max and Q-Flex sized vessels. In comparison, offshore terminals are better equipped to accommodate conventional sized LNG carriers, though around 42% of FSRU-based terminals are able to berth Q-Class vessels. An LNG vessel carrying 69,000 tonnes of LNG successfully docked at the second berth of Sinopec's Tianjin LNG terminal in the Nangang Industrial Park in December 2021, marking the official commissioning of the "Double Berth" LNG terminal. Plans for expansion of berthing capacity are currently under consideration for the Swinoujscie terminal in Poland.

Figure 6.7: Maximum berthing capacity of LNG receiving terminal by region, 2021



Source: Rystad Energy

6.6 FLOATING AND OFFSHORE REGASIFICATION

44.6 MTPA

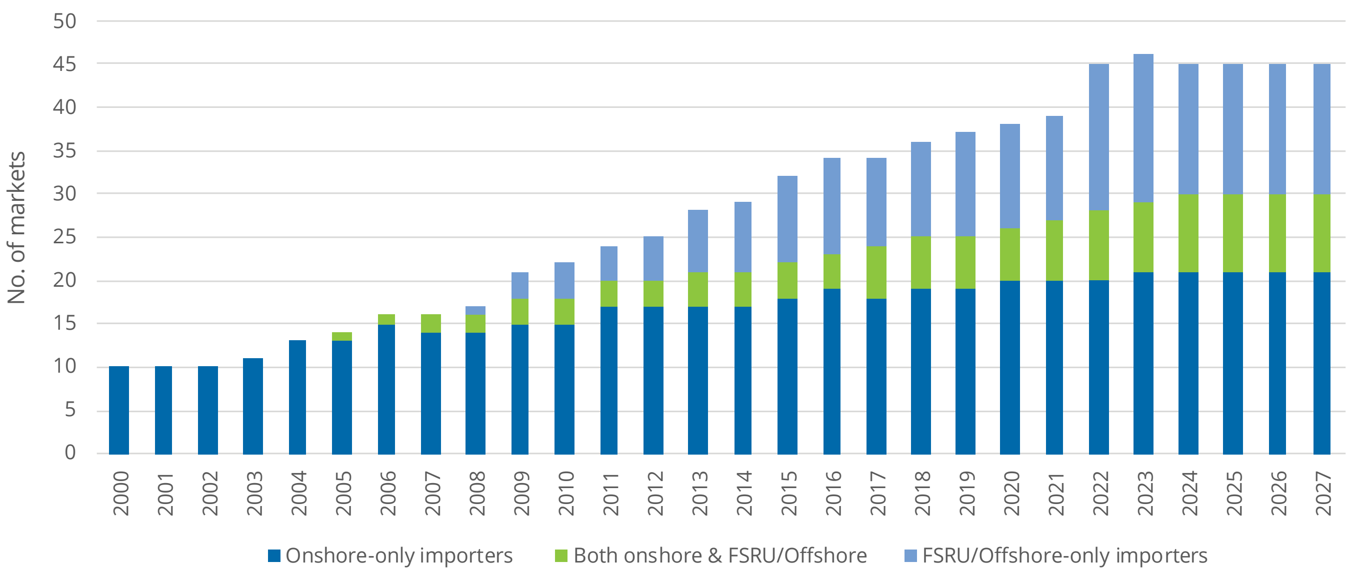
of Floating and Offshore Terminals Under Construction, April 2022

Floating and offshore regasification developments have been growing steadily in the past decade, with a large number of FSRU-based projects coming online. Starting from a single terminal in 2005, the market has 32 operating terminals at present, with a combined regasification capacity of 142.6 MTPA. Despite most regasification terminals currently being located onshore, the relatively low capital expenditure and construction time of FSRU-based projects has made FSRUs an attractive option, especially in smaller markets with less infrastructure. As of April 2022, there are 12 floating and offshore terminals under construction, with a combined regasification capacity of 44.6 MTPA. The majority of these terminals have announced plans for commissioning in 2022 and 2023. If successful, four new LNG importing markets will emerge – Ghana, Nicaragua, Senegal and the Philippines. Through the addition of FSRU-based or offshore terminals in the past few years, several markets have entered the global LNG import market, including Jamaica in 2016, Bangladesh in 2018, and Croatia in 2021.

Two FSRU-based projects in the Latin American region are starting operations in 2022. The BW Tatiana FSRU, deployed in El Salvador, performed its first ship-to-ship LNG transfer in April 2022, transferring about 125,000 cm of LNG. The vessel, at the Acajutla terminal, has a regasification capacity of 2.3 MTPA and is exclusively used by Energia del Pacifico. The import terminal is expected to provide 30% of the country's electricity needs once fully operational. Separately, New Fortress Energy is developing the Puerto Sandrino FSRU in Nicaragua. It was expected to come online in 2021 but faced delays due to permitting and construction issues. As of April 2022, the project is still under construction.

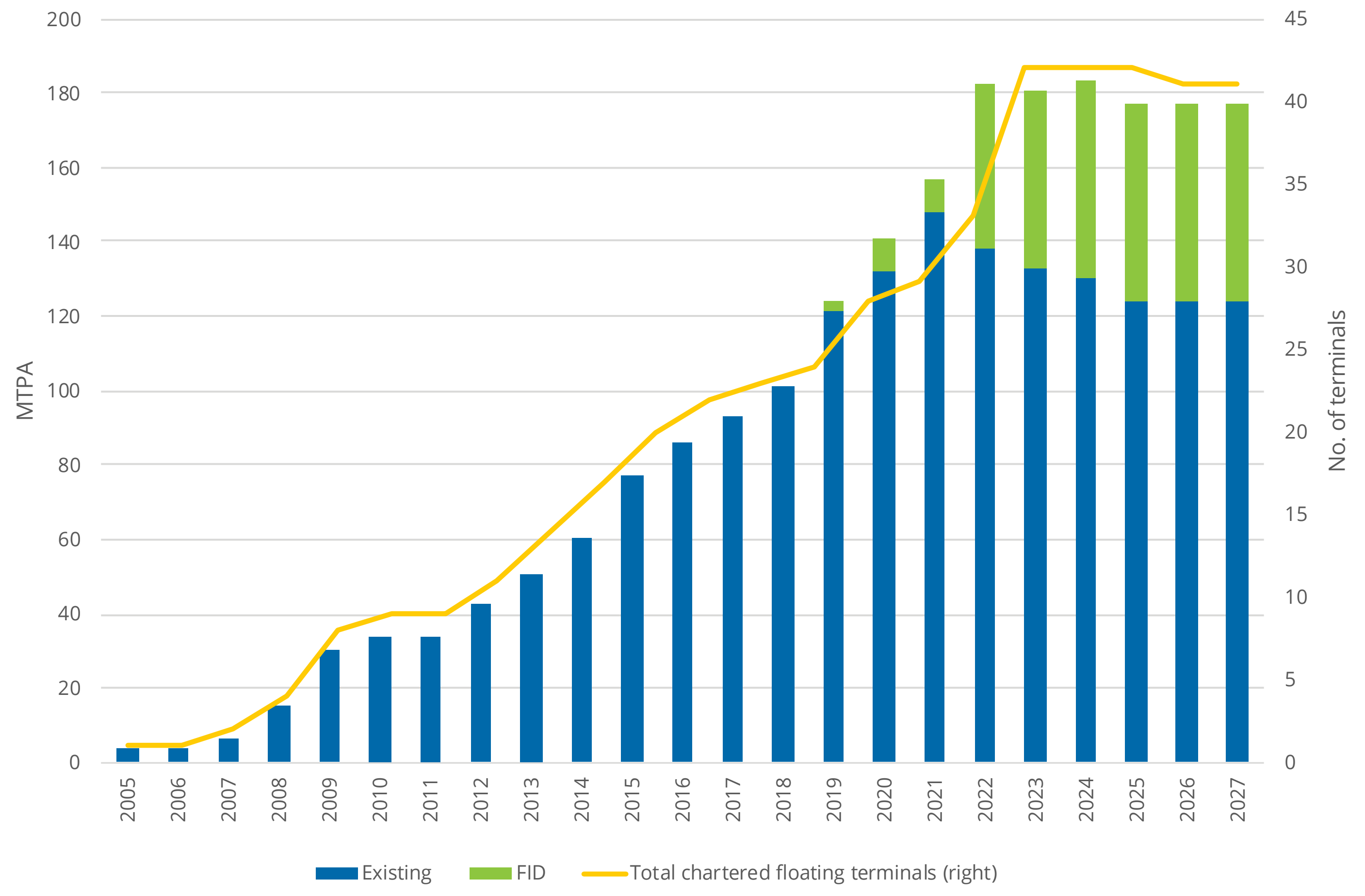
Of the 40 existing LNG import markets as of April 2022, 20 imported LNG through FSRUs (or other offshore terminals). Seven of these have onshore terminals as well. In India, two FSRU-based terminals, at Jaigarh and Jafrabad, are currently under development and are expected to start operations in 2022 after pandemic and weather-related delays. The Hoegh Giant FSRU at the Jaigarh terminal in Maharashtra, and the Jafrabad FSRU in Gujarat, are expected to add a combined regasification capacity of 11 MTPA. Mitsui OSK Lines (MOL) and Royal Vopak came to an agreement to jointly own and operate the MOL FSRU Challenger, the world's largest FSRU, in December 2021. The FSRU, to be renamed Bauhinia Spirit, is expected to have a regasification capacity of 6.1 MTPA and storage capacity of 263,000 cm. The new joint venture has signed a long-term contract with Hong Kong LNG Terminal and is expected to provide jetty operations as well as maintenance and port services along with the FSRU. The terminal, located 25 kilometers offshore southwest of Hong Kong island, is currently under construction and expected to become operational in the middle of 2022.

Figure 6.8: Number of regasification markets by type, 2000-2027



Source: Rystad Energy

Figure 6.9: Floating and offshore regasification capacity by status and number of terminals, 2005-2027



Source: Rystad Energy

The increased use of FSRUs as a storage and regasification solution has demonstrated the potential to deliver a range of benefits, often distinct from the onshore alternative. In selecting the concept of a newbuild terminal, it is critical for markets to weigh the benefits and drawbacks of each option (FSRUs and onshore terminals) against specific market requirements, conditions and constraints. In recent years, several new markets have been able to receive their first LNG cargoes in a relatively short time span, with the implementation of FSRUs. This includes Bangladesh, Jordan, Pakistan and, most recently, Croatia and El Salvador. FSRUs' shorter construction and delivery time coupled with the ease of relocation compared to an onshore terminal can meet potential near-term gas demand surges in a time-efficient manner. FSRUs can complement domestic production or help to accelerate a market's fuel-switching process. Due to the common practice of chartering FSRUs from third parties, they are less capital-intensive than onshore terminals. FSRUs are an especially attractive option in markets that have limited land and port availability since they take up minimal onshore space during the construction phase.

Onshore terminals provide a different set of advantages compared to FSRUs. Markets that have substantial storage and regasification capacity requirements can benefit from developing an onshore terminal, which typically supports the installation of larger storage tanks and regasification capacities. Onshore projects are less exposed to certain location-dependent risk factors including vessel performance, and weather conditions that may potentially cause longer downtime. The permanence of onshore assets also allows for easier on-site storage and regasification capacity expansions if required.

As of April 2022, there are 5 FSRUs due for delivery in 2022 that are currently undergoing conversion. The number of proposed import projects (including pre-FID terminals) utilising FSRUs has grown significantly in recent years, but over half have yet to sign any charter agreements to secure their vessels.

With European markets looking to deploy more FSRUs to reduce Russian gas imports, the FSRU market is expected to tighten in the longer term. The European Union's REpowerEU plan envisages replacing Russian gas with non-Russian pipeline imports and LNG.

6.7 RECEIVING TERMINALS WITH RELOADING AND TRANSSHIPMENT CAPABILITIES

Highest Re-Exports in 2021 – Spain,

1.0 MTPA

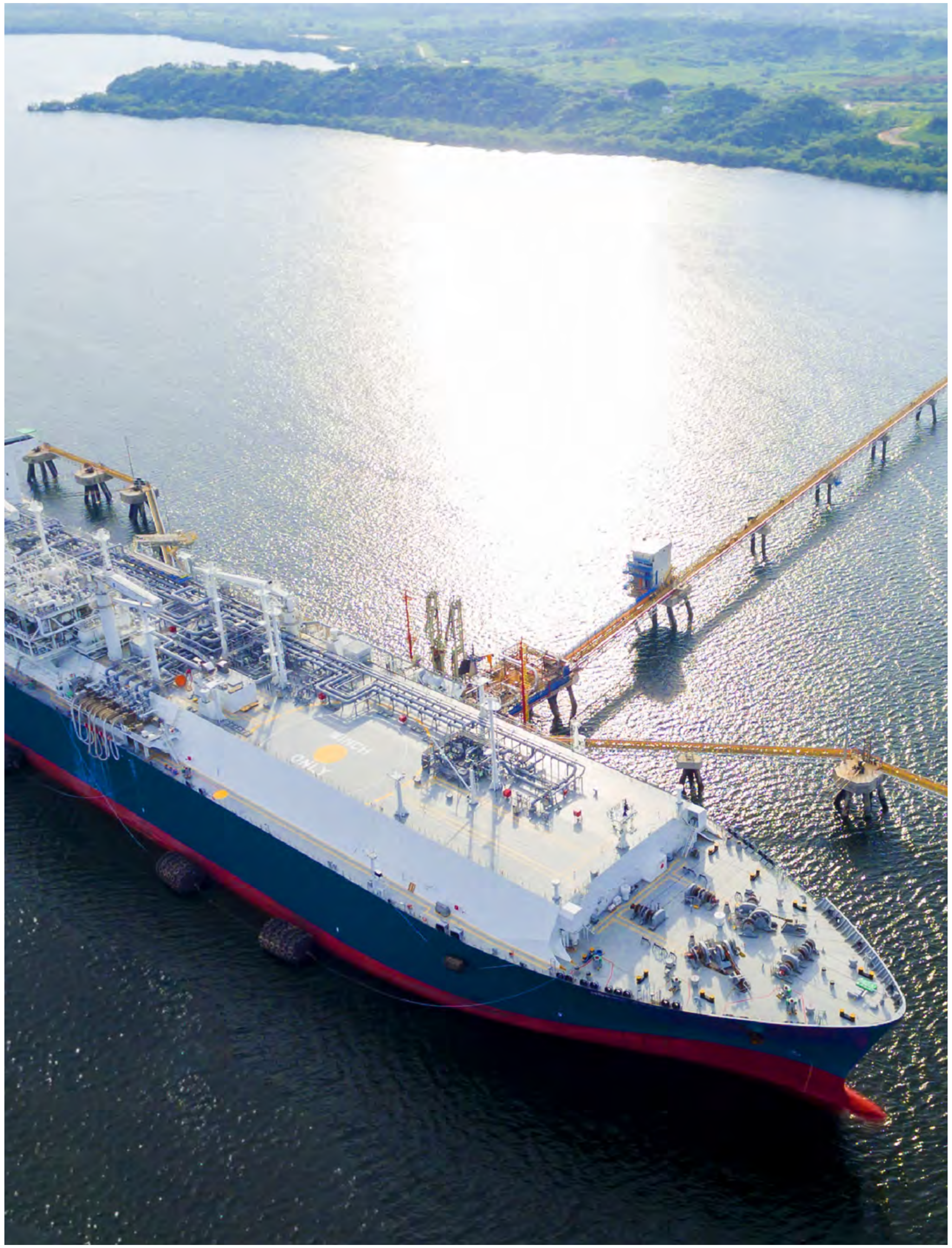
Several LNG import markets have transformed their terminals into LNG hubs that provide diversified service offerings beyond traditional regasification operations in recent years. These services include reloading, transshipment, small-scale LNG bunkering and truck-loading. Re-exporting activities can enable increased profitability for traders by taking advantage of arbitrage opportunities between regional markets, as well as logistical factors within certain markets. In order to address the needs of the evolving LNG market better, terminals have enhanced their reloading and transshipment capabilities. This has resulted in a steady increase in re-export volumes from markets with reloading terminals. In 2021, volumes of re-exported LNG increased, with 14 markets re-exporting cargoes. Spain and France re-exported the most cargoes globally at 1.69 MTPA collectively, accounting for over 48% of the global re-exported volumes. Both Indonesia and Thailand completed LNG re-exports for the first time in January 2021. In Indonesia, the Arun terminal, which was converted to a regasification plant from an export terminal in 2014, sent its first reloaded cargo to China. At the Map Ta Phut facility in Thailand, the first re-exported LNG shipment made its way to the Tokyo Bay area of Japan. As part of the Thai government's plans to turn the market into an international LNG trading hub, it has been developing LNG reloading infrastructure. Record volumes of reloaded cargoes were also delivered from Singapore to China in 2021. Superior reloading capabilities has enabled Southeast Asian markets to take advantage of high spot LNG prices during winter months in the Northern Hemisphere. It has also helped to ease fuel shortages in the event of unexpected cold spells in northern Asia.

Terminals with multiple jetties, such as the Montoir-de-Bretagne terminal in France, can perform value-adding services including transshipment and bunkering services. Established markets, especially in Europe, have terminals such as the Zeebrugge in Belgium, Fos Cavaou in France, and Cartagena in Spain, that have both bunkering and transshipment facilities. Infrastructure has been enhanced at several regasification facilities as well to provide ship loading and truck loading capabilities.

The Zeebrugge LNG terminal in Belgium experienced considerable activity over the course of last year. In June 2021, the Dutch marine fuel supplier Titan LNG commissioned a short-term truck loading facility at the Port of Zeebrugge, to supply LNG as marine fuel during a four-week maintenance period at the Gate terminal in the Netherlands. The Green Zeebrugge LNG bunkering vessel was used as an interim solution to serve bunkering in Zeebrugge and surrounding areas. In December 2021, Fluxys LNG announced that they would organise a subscription window for long-term bio-LNG liquefaction services at the terminal, such that biomethane could be converted into bio-LNG for trucks and bunkering ships. The first small-scale LNG reloading operation was successfully carried out at the Krk LNG terminal in Croatia in May 2021, making it a leader in the region for the provision of reloading services. LNG was reloaded from the FSRU LNG Croatia to the smaller vessel Avenir Accolade, headed towards an LNG terminal in Sardinia, Italy. LNG Croatia also started offering LNG reloading services from the FSRU to LNG transport trucks in April 2022. India's first FSRU-based LNG terminal at Jaigarh, which is expected to start operations in 2022, will be capable of reloading LNG onto other LNG vessels to supply other terminals as well as for bunkering services. The facility is also expected to have ship-to-truck loading facilities to enable onshore retail distribution in the near future. Singapore's first LNG bunkering vessel, the FueLNG Bellina, made its first reloading operation in March 2021 at the Jurong import terminal. The vessel will provide LNG bunkering services to LNG-fuelled vessels that stop at the Port of Singapore. The vessel participated in Singapore's first ship-to-ship LNG transfer in March 2022.

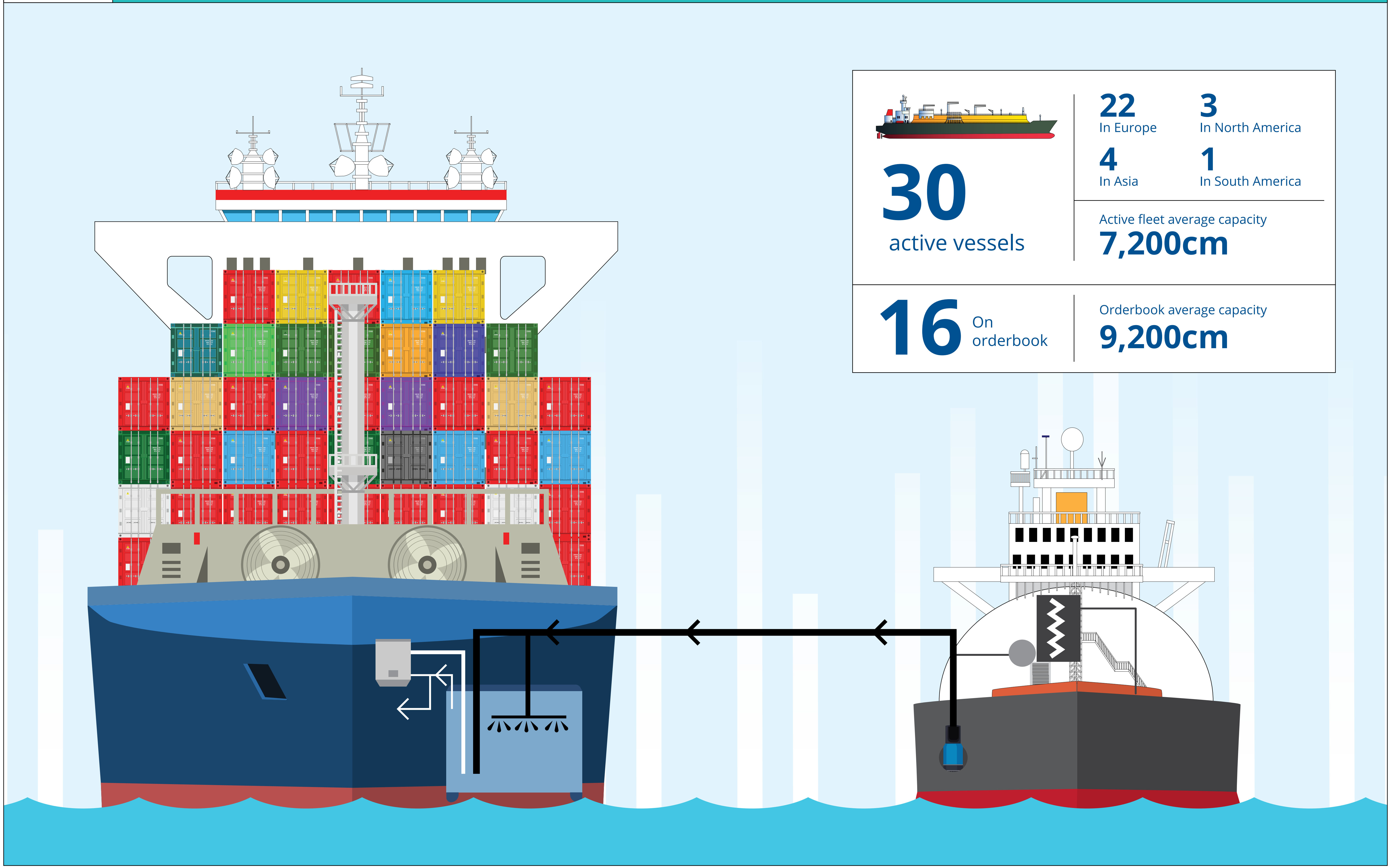
Bunkering projects are also currently under development at several terminals globally. In Japan, a ship-to-ship LNG bunkering project is being developed in Tokyo Bay using the multi-bunker vessel EcoBunker Tokyo Bay, which is capable of both LNG and VLSFO bunkering. At the Kochi LNG terminal in India, operator Petronet LNG has plans to start bunkering services to ocean-going vessels.

LNG cargo reloads in Spain reached a new high in 2021, mainly driven by the attractive price arbitrage between Asia and Europe. However, as gas demand in Europe remains strong and lower volumes flow into Europe from Russia, it is expected that Spain will see limited reloading in 2022. As of April 2022, 45 terminals in 23 different markets have reloading capabilities.



FSRU Based - LNG Terminal - Courtesy of SPEC LNG

7 LNG Bunkering Vessels and Terminals



7. LNG Bunkering Vessels and Terminals

With the implementation of stricter environmental legislation to reduce emissions at both the local and international levels, a growing number of marine vessel owners are considering the use of cleaner alternative bunker fuels to achieve compliance. With effect from January 2020, the International Maritime Organization (IMO) enforced a new global limit of 0.5% on the sulphur content of ships' fuel oil. The imposition of a stricter sulphur content cap on marine bunker fuel has spurred the switch to LNG-fuelled vessels through the installation of new systems or conversion where possible, alongside the construction of related bunkering infrastructure.

LNG Bergen - Courtesy of Bergen Tankers

30 units

Global Operational LNG Bunkering Vessel Fleet, End-of-April 2022

The IMOs Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations, which are expected to go into force in January 2023, have put further pressure on shipowners to turn to LNG to comply with regulations. This has created a self-reinforcing feedback loop where the development of an efficient, secure and competitive LNG supply chain and related bunkering infrastructure is driving further construction of LNG-powered vessels. The extent to which this is happening is evident in the rapid increase in LNG-fuelled vessel orders across different vessel classes.

Multiple options exist for supplying LNG to vessels, with the three most common methods being 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 jetty-side truck-to-ship LNG transfers. Over the past decade, the LNG bunkering market has developed steadily with the addition of bunkering vessels and terminals equipped with bunkering facilities.

The early LNG bunkering market involved the use of small-scale LNG carriers to perform STS LNG bunkering services in addition to small-scale LNG deliveries. These small-scale LNG 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, in addition to 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 bunkering vessel by trucks from the small-scale Nynashamn LNG terminal located almost 60 kilometres south of Stockholm.

Although some small inland LNG barges were developed in China between 2014 and 2016 for bunkering purposes, the Seagas remained the sole dedicated STS bunkering barge for some years. This changed in 2017, when three purpose-built LNG bunkering vessels with much larger capacities entered operations: the Green Zeebrugge (5,100 cm); the Coralius (5,600 cm); and the Cardissa (6,500 cm, renamed New Frontier1 after its sale to Pan Ocean). 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 made sense due to 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, was launched in northern Europe, based at the Klaipeda LNG terminal in Lithuania.

The expansion of marine LNG bunkering infrastructure has also been enabled by conversion and ship upgrading. The world's sixth LNG bunkering vessel, the Oizmendi, was converted from a heavy fuel oil/marine diesel oil bunkering tanker into a multifuel bunkering vessel with a capacity of 660 cm. It performed its first STS bunkering operation in the Port of Bilbao in early 2018 and serves the Iberian Peninsula. The Coral Methane (7,500 cm) is another vessel that was modified and 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. An LNG bunkering vessel that has entered operation recently is the Gas Agility. The vessel 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.

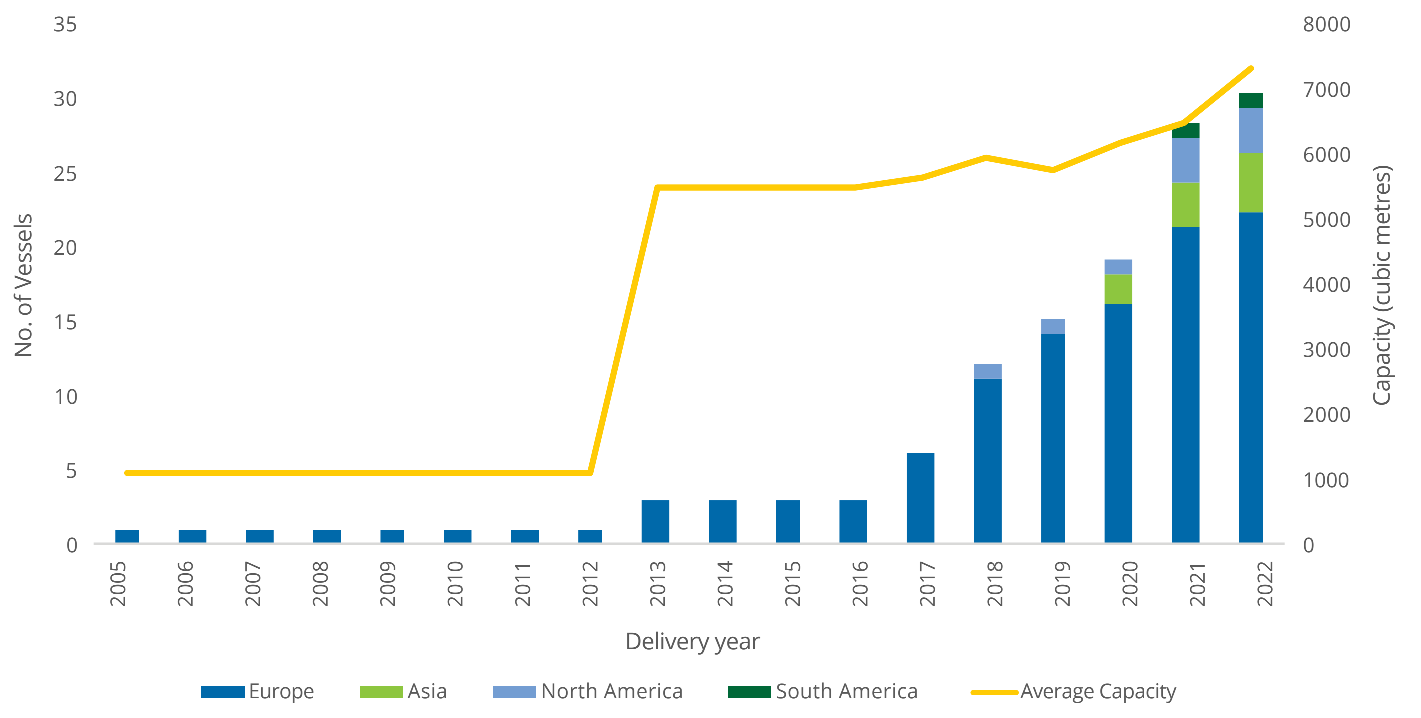
The maiden LNG bunker barge in the US, the Clean Jacksonville, has a capacity of 2,200 cm and is the first with a membrane cargo tank. It is stationed at the Port of Jacksonville in Florida and was built specifically to load LNG onto TOTE containerships from 2018 onwards. The Q-LNG 4000 was delivered in early 2021 as the country's first bunker and supply articulated tug barge (ATB) unit and is the second operational LNG bunker barge after the Clean Jacksonville.

The Asia Pacific region added two bunkering vessels in 2020 – 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.

Nine new LNG bunkering vessels started operations in 2021, making it a record year in terms of the number of new LNG bunkering vessels, with many regions receiving their first LNG bunkering vessel. Singapore's first LNG bunkering vessel, the FueLNG Bellina, was successfully delivered to FueLNG in early 2021 and serves the Port of Singapore with STS LNG bunkering services. South America's first LNG bunkering vessel, the Avenir Accolade (7,500 cm), was also delivered to Brazil. 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. Norway took delivery of a second LNG bunker vessel, the converted Bergen LNG (850 cm). Finally, in addition to the Q-LNG 4000, the US took delivery of the Jones Act-compliant 5,400 cm Clean Canaveral.

The first quarter of 2022 saw the world's largest LNG bunker vessel, the 20,000 cm Avenir Allegiance, being sold to Shanghai SIPG Energy Service. With a name change to Hai Gang Wei Lai, it has become China's first active LNG bunker vessel. Korea Line also took delivery of the 18,000 cm K. Lotus, due to operate in the Port of Rotterdam.

Figure 7.1: Cumulative number of operational LNG bunkering vessels by region and average vessel capacity, 2005 to end-of-April 2022



Source: Rystad Energy

As of the end of April 2022, the global operational LNG bunkering vessel fleet has reached 30 units, including both self-propelled and tug-propelled vessels. While Asia and North America's fleet share has started to grow, 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. The typical size of LNG bunkering vessels has increased over time, with the first two 2022-delivered newbuilds having a capacity of close to 20,000 cm.

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 as well as 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 the limited infrastructure required. This method is, however, restrictive in terms of its flow rates, among other factors, which limits bunkering operations to smaller-sized LNG-fuelled vessels. Alternative options like 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.

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/transshipment 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 European markets. However, the market is witnessing progressive construction in other parts of the world, such as in Asia and North America. Of the 84 LNG terminals and ports offering LNG bunkering services, 49 are in Europe, another 24 are in Asia, six are in North America, four are in Australia and the last is in South 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, one of the small-scale import terminals, 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. Ships at the terminal can be filled via truck or directly from the terminal tanks via pipelines.

As some of the first few terminals to offer road tanker loading and cargo reloading, 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 added truck-to-ship bunkering infrastructure. They are also implementing additional terminal enhancements to accommodate small-scale carriers and develop direct jetty-to-ship services for LNG-fuelled vessels. The Cartagena LNG regasification terminal completed its first direct bunkering to an LNG-fuelled tanker with 370 cm of LNG in 2017, utilising the facility's tank-to-jetty pipeline and a dedicated jetty. Cartagena completed three direct pipe-to-ship bunkering operations in 2021. The Bilbao terminal adapted its marine jetty to accommodate small-scale vessels ranging from 600 to 270,000 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.

Within the Asia Pacific region, a growing number of markets – such as Singapore, Japan, 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 fuelling 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, the FueLNG Bellina. In Japan, the Port of Yokohama introduced truck-to-ship bunkering services in 2018 and has plans to offer STS bunkering. 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.

The US is expected to become a significant player in the LNG bunkering market. Its bunkering operations currently take place primarily at the Port of Jacksonville 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. The Clean Canaveral, a 5,500 cm bunker barge, was also delivered to Jacksonville in late 2021. Port Fourchon completed the bunkering of its first LNG-fuelled vessel in 2016 and has plans to become a central LNG 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 become the US' first LNG cruise port. The 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.

Table 7.1: Table of global LNG bunkering vessels

Operational as of April 2022					
Reference number	**Market**	**Vessel Name**	**Start year**	**LNG Tank Capacity (cm)**	**Concept**
1	Norway	Pioneer Knutsen	2004	1,100	Small Scale LNG / Bunker able
2	Europe	Coral Energy	2013	15,000	Small Scale LNG / Bunker able
3	Sweden	Seagas	2013	187	Bunker vessel
4	Belgium	Green Zeebrugge	2017	5,100	Bunker vessel
5	Norway	Coralius	2017	5,600	Bunker vessel
6	Netherlands	New Frontier1	2017	6,500	Bunker vessel
7	Netherlands	Coral Methane	2018	7,500	Bunker vessel
8	Spain	Oizmendi	2018	600	Bunker vessel
9	Spain	Bunker Breeze	2018	1,200	FO/DO bunker vessel / LNG Bunker designed
10	US	Clean Jacksonville	2018	2,200	Bunker barge (by tug)
11	Lithuania	Kairos	2018	7,500	Bunker vessel
12	Europe	Coral EnergICE	2018	18,000	Small Scale LNG / Bunker able
13	Netherlands	FlexFueler 001	2019	1,480	Bunker barge (by tug)
14	Netherlands	LNG London	2019	3,000	Bunker vessel
15	Europe	Coral Fraseri	2019	10,000	Small Scale LNG / Bunker able
16	Malaysia	Avenir Advantage	2020	7,500	Bunker vessel
17	Belgium	FlexFueler 002	2020	1,480	Bunker barge (by tug)
18	The Netherlands	Gas Agility	2020	18,600	Bunker vessel
19	Japan	Kaguya	2020	3,500	Bunker vessel
20	United States	Q-LNG ATB Bunker Barge 4000	2021	4,000	Bunker barge (by tug)
21	Singapore	FueLNG Bellina	2021	7,500	Bunker vessel
22	Norway	Bergen LNG	2021	850	Bunker vessel
23	Brazil	Avenir Accolade	2021	7,500	Bunker vessel
24	Russia	Dmitry Mendeleev	2021	5,800	Bunker vessel
25	Estonia	Optimus	2021	6,000	Bunker vessel
26	Italy	Avenir Aspiration	2021	7,500	Bunker vessel
27	France	Gas Vitality	2021	18,600	Bunker vessel
28	United States	Clean Canaveral	2021	5,500	Bunker vessel
29	China	Hai Gang Wei Lai	2022	20,000	Bunker vessel
30	The Netherlands	K. Lotus	2022	18,000	Bunker vessel

Source: Rystad Energy

Table 7.2: Table of global LNG bunkering vessel order book

Reference number	Vessel Name	Start year	LNG Tank Capacity (cm)	Concept
1	Xin Ao Pu Tuo Hao	2022	8,500	Bunker vessel
2	N/B EK Heavy Industries Goseong 010	2022	500	Bunker vessel
3	Ecobunker Tokyo Bay	2022	2,500	Bunker vessel
4	Brassavola	2022	12,000	Bunker vessel
5	Rosetti	2022	4,000	Bunker vessel
6	Haugesund Knutsen	2022	5,000	Bunker vessel
7	N/B CIMC SOE	2022	12,000	Bunker vessel
8	N/B CIMC SOE	2022	20,000	Small Scale LNG / Bunker able
9	N/B Hyundai HI (Ulsan)	2023	7,500	Bunker vessel
10	N/B CIMC SOE	2023	7,600	Bunker vessel
11	N/B Hyundai Mipo Ulsan 8370	2023	12,500	Bunker vessel
12	N/B Hyundai Mipo Ulsan 8299	2023	18,000	Bunker vessel
13	N/B Hyundai Mipo Ulsan 8300	2023	18,000	Bunker vessel
14	N/B CIMC SOE	2024	7,600	Bunker vessel
15	N/B CIMC SOE	2024	8,200	Bunker vessel
16	N/B MHI Shimonoseki	2024	3,500	Bunker vessel

Source: Rystad Energy

8. References Used in the 2022 Edition

8.1 Data Collection

Data in Chapters 1, 4, 5, 6, 7 and 8 of the 2022 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.

8.2 Data Collection for Chapter 2

Data in Chapter 2 of the 2022 IGU World LNG Report is sourced from the International Group of Liquefied Natural Gas Importers (GIIGNL). 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.

8.3 Data Collection for Chapter 3

Data in Chapter 3 of the 2022 IGU World LNG Report is sourced from S&P Global Commodity 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.

8.4 Preparation and Publication of the 2022 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:

- Bureau Veritas, France: Carlos Guerrero
- Chevron, USA: Kevin Maxian
- Promigas, Colombia: Ketty Rodríguez Mendoza
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- International Gas Union, United Kingdom: Tatiana Khanberg
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8.5 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 cargoes 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 5). 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.

8.6 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 8.1: Grouping of markets into regions

8.7 ACRONYMS

CAPEX = Capital Expenditure
CSG = Coal Seam Gas
CNG = Compressed Natural Gas
DFDE = Dual-Fuel Diesel Electric
DMR = Dual Mixed Refrigerant
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
FPSO = Floating Production, Storage and Offloading
FSRU = Floating Storage and Regasification Unit
FSU = Floating Storage Unit
FSU = Former Soviet Union
GCU = Gas Combustion Unit
GTT = Gaztransport & Technigaz
IHI = Ishikawajima-Harima Heavy Industries
ISO = International Organization for Standardization
LPG = Liquefied Petroleum Gas
MEGI = M-type, Electronically Controlled, Gas Injection
MMLS = Moveable Modular Liquefaction System
NGV = Natural Gas Vehicle
OPEX = Operating Expenditure
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
UAE = United Arab Emirates
UK = United Kingdom
US = United States
YOY = Year-on-Year

8.8 UNITS

bbl = barrel
bcfd = billion cubic feet per day
bcm = billion cubic metres
cm = cubic metres
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

8.9 Conversion Factors

Table 8.1: 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	-

Appendix 1: Table of Global Liquefaction Plants

Reference Number	Market	Liquefaction Plant Train	Infrastructure Start Year	Liquefaction Capacity (MTPA)	Owners	Liquefaction Technology
1	Libya	Marsa El Brega LNG T1-4[1]	1970	3.20	LNOC	AP-SMR
2	Brunei	Brunei LNG T1-T2	1972	2.88	Shell*; Brunei Government; Mitsubishi Corp	AP-C3MR
2	Brunei	Brunei LNG T3-T4	1973	2.88	Shell*; Brunei Government; Mitsubishi Corp	AP-C3MR
2	Brunei	Brunei LNG T5	1974	1.44	Shell*; Brunei Government; Mitsubishi Corp	AP-C3MR
3	UAE	ADGAS LNG T1-2	1977	2.60	ADNOC LNG* (0%); Abu Dhabi NOC; Mitsui; BP; TotalEnergies;	AP-C3MR
4	Algeria	Arzew GL1Z T1-T6	1978	7.90	Sonatrach*	AP-C3MR
4	Algeria	Arzew GL2Z T1-T6	1981	8.40	Sonatrach*	AP-C3MR
5	Indonesia	Bontang LNG TC-TD	1983	5.60	Pertamina*; PT VICO Indonesia; Total	AP-C3MR
6	Malaysia	MLNG Satu T1-T3	1983	8.40	Petronas*; Mitsubishi Corp; Sarawak State	AP-C3MR
5	Indonesia	Bontang LNG TE	1989	2.80	Pertamina*; PT VICO Indonesia; Total	AP-C3MR
7	Australia	North West Shelf LNG T1-T2	1989	5.00	Woodside*; BHP; BP; Chevron; Shell; Mitsubishi Corp; Mitsui	AP-C3MR
7	Australia	North West Shelf LNG T3	1992	2.50	Woodside*; BHP; BP; Chevron; Shell; Mitsubishi Corp; Mitsui	AP-C3MR
5	Indonesia	Bontang LNG TF	1993	2.80	Pertamina*; PT VICO Indonesia; Total	AP-C3MR
3	UAE	ADGAS LNG T3	1994	3.20	ADNOC LNG* (0%); Abu Dhabi NOC; Mitsui; BP; Total	AP-C3MR
6	Malaysia	MLNG Dua T4-T5	1995	6.40	Petronas*; Mitsubishi Corp; Sarawak State	AP-C3MR
6	Malaysia	MLNG Dua T6	1995	3.20	Petronas*; Mitsubishi Corp; Sarawak State	AP-C3MR
8	Qatar	Qatargas 1 T1	1996	3.20	Qatargas* (0%); QatarEnergy; Exxon-Mobil; TotalEnergies; Marubeni; Mitsui	AP-C3MR
5	Indonesia	Bontang LNG TG	1997	2.80	Pertamina*; PT VICO Indonesia; Total	AP-C3MR
8	Qatar	Qatargas 1 T2	1997	3.20	Qatargas* (0%); QatarEnergy; Exxon-Mobil; TotalEnergies; Marubeni; Mitsui	AP-C3MR
8	Qatar	Qatargas 1 T3	1998	3.20	Qatargas* (0%); QatarEnergy; Exxon-Mobil; TotalEnergies; Marubeni; Mitsui	AP-C3MR
5	Indonesia	Bontang LNG TH	1999	2.95	Pertamina*; PT VICO Indonesia; Total	AP-C3MR
8	Qatar	Rasgas 1 T1	1999	3.30	Qatargas* (0%); QatarEnergy; Exx-onMobil; ITOCHU; Korea Gas; Sojitz; Sumitomo; Samsung; Hyundai; SK Energy; LG International; Daesung; Hanwha Energy	AP-C3MR
9	Trinidad and Tobago	Atlantic LNG T1	1999	3.00	Atlantic LNG* (0%); Shell; BP; China Investment Corporation; NGC	Cono-coPhillips Optimized Cascade
10	Nigeria	NLNG T1-T2	1999	6.60	NNPC (Nigeria)*; Shell; TotalEnergies; Eni	AP-C3MR
8	Qatar	Rasgas 1 T2	2000	3.30	Qatargas* (0%); QatarEnergy; Exx-onMobil; ITOCHU; Korea Gas; Sojitz; Sumitomo; Samsung; Hyundai; SK Energy; LG International; Daesung; Hanwha Energy	AP-C3MR

[1] Marsa El Bregas LNG in Libya has not been operational since 2011. It is included for reference only.

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference Number	Market	Liquefaction Plant Train	Infrastructure Start Year	Liquefaction Capacity (MTPA)	Owners	Liquefaction Technology
11	Oman	Oman LNG T1-T2	2000	7.10	Oman LNG* (0%); Omani Government; Shell; TotalEnergies; Korea LNG; Mitsubishi Corp; Mitsui; Partex (Gulbenkian Foundation); ITOCHU	AP-C3MR
9	Trinidad and Tobago	Atlantic LNG T2	2002	3.30	Atlantic LNG* (0%); Shell; BP	ConocoPhillips Optimized Cascade
10	Nigeria	NLNG T3	2002	3.30	NNPC (Nigeria)*; Shell; TotalEnergies; Eni	AP-C3MR
6	Malaysia	MLNG Tiga T7-T8	2003	7.70	Petronas*; Sarawak State; JX Nippon Oil and Gas; Mitsubishi Corp	AP-C3MR
9	Trinidad and Tobago	Atlantic LNG T3	2003	3.30	Atlantic LNG*; Shell; BP	ConocoPhillips Optimized Cascade
7	Australia	North West Shelf LNG T4	2004	4.60	Woodside*; BHP; BP; Chevron; Shell; Mitsubishi Corp; Mitsui	AP-C3MR
8	Qatar	Rasgas 2 T3	2004	4.70	Qatargas* (0%); QatarEnergy; ExxonMobil	AP-C3MR/ SplitMR
8	Qatar	Rasgas 2 T4	2005	4.70	Qatargas* (0%); QatarEnergy; ExxonMobil	AP-C3MR/ SplitMR
9	Trinidad and Tobago	Atlantic LNG T4	2005	5.20	Atlantic LNG* (0%); Shell; BP; NGC	ConocoPhillips Optimized Cascade
10	Nigeria	NLNG T4	2005	4.10	NNPC (Nigeria)*; Shell; TotalEnergies; Eni	AP-C3MR
12	Egypt	Damietta LNG T1	2005	5.00	Union Fenosa*; Eni; EGPC (Egypt)	AP-C3MR/ SplitMR
13	Egypt	Egyptian LNG (Idku) T1-T2	2005	7.20	Shell*; Petronas; EGPC (Egypt); EGAS; Total	ConocoPhillips Optimized Cascade
10	Nigeria	NLNG T5	2006	4.10	NNPC (Nigeria)*; Shell; TotalEnergies; Eni	AP-C3MR
11	Oman	Oman LNG T3 (Qalhat)	2006	3.30	Oman LNG* (0%); Omani Government; Shell; Mitsubishi Corp; Eni; Gas Natural SDG; ITOCHU; Osaka Gas; TotalEnergies; Korea LNG; Mitsui; Partex (Gulbenkian Foundation)	AP-C3MR
14	Australia	Darwin LNG T1	2006	3.70	Santos*; Inpex; Eni; Tokyo Electric; Tokyo Gas	ConocoPhillips Optimized Cascade
8	Qatar	Rasgas 2 T5	2007	4.70	Qatargas* (0%); QatarEnergy; ExxonMobil	AP-C3MR/ SplitMR
10	Nigeria	NLNG T6	2007	4.10	NNPC (Nigeria)*; Shell; TotalEnergies; Eni	AP-C3MR
15	Equatorial Guinea	EG LNG T1	2007	3.70	Marathon Oil*; Sonagas G.E.; Mitsui; Marubeni	ConocoPhillips Optimized Cascade
16	Norway	Hammerfest LNG T1	2007	4.20	Equinor*; Petoro; TotalEnergies; Neptune Energy; Wintershall Dea	Linde MFC
7	Australia	North West Shelf LNG T5	2008	4.60	Woodside*; BHP; BP; Chevron; Shell; Mitsubishi Corp; Mitsui	AP-C3MR
8	Qatar	Qatargas 2 T4-T5	2009	15.60	Qatargas* (0%); QatarEnergy; ExxonMobil; Total	AP-X
8	Qatar	Rasgas 3 T6-T7	2009	15.60	Qatargas* (0%); QatarEnergy; ExxonMobil	AP-X

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference Number	Market	Liquefaction Plant Train	Infrastructure Start Year	Liquefaction Capacity (MTPA)	Owners	Liquefaction Technology
17	Russia	Sakhalin 2 T1-T2	2009	9.60	Sakhalin Energy Investment Company* (0%); Gazprom; Shell; Mitsui; Mitsubishi Corp	Shell DMR
18	Indonesia	Tangguh LNG T1	2009	3.80	BP*; CNOOC; JOGMEC; Mitsubishi Corp; Inpex; JX Nippon Oil and Gas; Sojitz; Sumitomo; Mitsui	AP-C3MR/ SplitMR
19	Yemen	Yemen LNG T1-T2[1]	2009	6.70	Total*; Yemen Gas Company; Hunt Oil; Korea Gas; SK Energy; Hyundai; Social Security and Pensions (GASSP)	AP-C3MR/ SplitMR
8	Qatar	Qatargas 3 T6	2010	7.80	Qatargas* (0%); QatarEnergy; ConocoPhillips; Mitsui	AP-X
18	Indonesia	Tangguh LNG T2	2010	3.80	BP*; CNOOC; JOGMEC; Mitsubishi Corp; Inpex; JX Nippon Oil and Gas; Sojitz; Sumitomo; Mitsui	AP-C3MR/ SplitMR
20	Peru	Peru LNG T1	2010	4.45	Hunt Oil*; Repsol; SK Energy; Marubeni	AP-C3MR/ SplitMR
8	Qatar	Qatargas 4 T7	2011	7.80	Qatargas* (0%); QatarEnergy; Shell	AP-X
21	Australia	Pluto LNG T1	2012	4.90	Woodside*; Kansai Electric; Tokyo Gas	Shell Propane Pre-cooled Mixed Refrigerant
4	Algeria	Skikda GL1K T1 (rebuild)	2013	4.50	Sonatrach*	AP-C3MR/ SplitMR
22	Angola	Angola LNG T1	2013	5.20	Angola LNG* (0%); Chevron; Sonangol; BP; Eni; Total	ConocoPhillips Optimized Cascade
4	Algeria	Arzew GL3Z (Gassi Touil) T1	2014	4.70	Sonatrach*	AP-C3MR/ SplitMR
23	Papua New Guinea	PNG LNG T1-T2	2014	6.90	ExxonMobil*; Oil Search; PNG Government; Santos; JX Nippon Oil and Gas; Mineral Resources Development; Marubeni	AP-C3MR
24	Indonesia	Donggi-Senoro LNG T1	2015	2.00	Donggi-Senoro LNG (DSLNG)* (0%); Mitsubishi Corp; Pertamina; Korea Gas; MedcoEnergi	AP-C3MR
25	Australia	GLNG T1	2015	3.90	Santos*; Petronas; TotalEnergies; Korea Gas	ConocoPhillips Optimized Cascade
26	Australia	Queensland Curtis LNG T1-T2	2015	8.50	Shell*; CNOOC	ConocoPhillips Optimized Cascade
25	Australia	GLNG T2	2016	3.90	Santos*; Petronas; TotalEnergies; Korea Gas	ConocoPhillips Optimized Cascade
27	Australia	Australia Pacific LNG T1-T2	2016	9.00	Origin Energy*; ConocoPhillips; Sinopec Group	ConocoPhillips Optimized Cascade
28	Australia	Gorgon LNG T1-T2	2016	10.40	Chevron*; ExxonMobil; Shell; Osaka Gas; Tokyo Gas; Chubu Electric	AP-C3MR/ SplitMR
29	United States	Sabine Pass T1-T2	2016	10.00	Cheniere Energy*	ConocoPhillips Optimized Cascade
6	Malaysia	MLNG T9	2017	3.60	Petronas*; JX Nippon Oil and Gas; Sarawak State	AP-C3MR/ SplitMR

[1] Yemen LNG has not exported since 2015 due to an ongoing civil war.

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference Number	Market	Liquefaction Plant Train	Infrastructure Start Year	Liquefaction Capacity (MTPA)	Owners	Liquefaction Technology
28	Australia	Gorgon LNG T3	2017	5.20	Chevron*; ExxonMobil; Shell; Osaka Gas; Tokyo Gas; Chubu Electric	AP-C3MR/ SplitMR
29	United States	Sabine Pass T3-T4	2017	10.00	Cheniere Energy*	Cono-coPhillips Optimized Cascade
30	Malaysia	Petronas FLNG Satu	2017	1.20	Petronas*	AP-N
31	Australia	Wheatstone LNG T1	2017	4.45	Chevron*; Kuwait Petroleum Corp (KPC); Woodside; JOGMEC; Mitsubishi Corp; Kyushu Electric; Nippon Yusen; Chubu Electric; Tokyo Electric	Cono-coPhillips Optimized Cascade
32	Russia	Yamal LNG T1	2017	5.50	Yamal LNG* (0%), Novatek; CNPC; TotalEnergies; Silk Road Fund	AP-C3MR
31	Australia	Wheatstone LNG T2	2018	4.45	Chevron*; Kuwait Petroleum Corp (KPC); Woodside; JOGMEC; Mitsubishi Corp; Kyushu Electric; Nippon Yusen; Chubu Electric; Tokyo Electric	Cono-coPhillips Optimized Cascade
32	Russia	Yamal LNG T2	2018	5.50	Yamal LNG* (0%), Novatek; CNPC; TotalEnergies; Silk Road Fund	AP-C3MR
33	Cameroon	Cameroon FLNG	2018	2.40	Golar*	Black and Ve-atch PRICO
34	United States	Cove Point LNG T1	2018	5.25	Dominion Cove Point LNG LP*	AP-C3MR
29	United States	Sabine Pass T5	2019	5.00	Cheniere Energy*	Cono-coPhillips Optimized Cascade
32	Russia	Yamal LNG T3	2019	5.50	Yamal LNG* (0%), Novatek; CNPC; TotalEnergies; Silk Road Fund	AP-C3MR
35	Australia	Ichthys LNG T1-T2	2019	8.90	Inpex*; TotalEnergies; CPC ; Tokyo Gas; Kansai Electric; Osaka Gas; Chubu Electric; Toho Gas	AP-C3MR/ SplitMR
36	Argentina	Tango FLNG	2019	0.50	Exmar*	Black and Ve-atch PRICO
37	United States	Corpus Christi T1	2019	4.50	Cheniere Energy*	Cono-coPhillips Optimized Cascade
38	United States	Cameron LNG T1	2019	4.00	Cameron LNG* (0%); Sempra; Mitsui; TotalEnergies; Mitsubishi Corp; Nippon Yusen Kabushiki Kaisha	AP-C3MR/ SplitMR
37	United States	Corpus Christi T2	2019	4.50	Cheniere Energy*	Cono-coPhillips Optimized Cascade
39	United States	Freeport LNG T1	2019	5.10	Freeport LNG*; Zachry Hastings; Osaka Gas; Dow Chemical Company; Global Infrastructure Partners	AP-C3MR
40	Australia	Prelude FLNG	2019	3.60	Shell*	Shell DMR
41	Russia	Vysotsk LNG T1	2019	0.66	Novatek*, Gazprombank	Air Liquide Smartfin
42	United States	Elba Island T1-T3	2019	0.75	Southern LNG* (0%); Kinder Morgan; EIG Partners	Shell MMLS
39	United States	Freeport LNG T2-T3	2020	10.20	Freeport LNG*; Zachry Hastings; Osaka Gas; Dow Chemical Company; Global Infrastructure Partners	AP-C3MR
38	United States	Cameron T2-T3	2020	8.00	Cameron LNG* (0%); Sempra; Mitsui; TotalEnergies; Mitsubishi Corp; Nippon Yusen Kabushiki Kaisha	AP-C3MR/ SplitMR

Appendix 1: Table of Global Liquefaction Plants (continued)

Reference Number	Market	Liquefaction Plant Train	Infrastructure Start Year	Liquefaction Capacity (MTPA)	Owners	Liquefaction Technology
42	United States	Elba Island T4-T10	2020	1.75	Southern LNG* (0%); Kinder Morgan; EIG Partners	Shell MMLS
43	Malaysia	Petronas FLNG Dua	2021	1.50	Petronas*	AP-N
37	United States	Corpus Christi T3	2021	4.50	Cheniere Energy*	Cono-coPhillips Optimized Cascade
32	Russia	Yamal LNG T4	2021	0.90	Yamal LNG* (0%), Novatek; CNPC; TotalEnergies; Silk Road Fund	Novatek Arc-tic Cascade
29	United States	Sabine Pass T6	2022	5.00	Cheniere Energy*	Cono-coPhillips Optimized Cascade
44	United States	Calcasieu Pass LNG (T1 – T12)	2022	7.51	Venture Global LNG*	BHGE SMR

Appendix 2: Table of Liquefaction Plants Sanctioned or Under Construction

Reference Number	Market	Liquefaction Plant Train	Infrastructure Start Year	Liquefaction Capacity (MTPA)	Owners	Liquefaction Technology
44	United States	Calcasieu Pass LNG (T13 – T18)	2022	3.76	Venture Global LNG*	BHGE SMR
45	Russia	Portovaya LNG T1-T2	2021	1.50	Gazprom*	Linde LIM-UM3
18	Indonesia	Tangguh LNG T3	2022	3.80	BP*; CNOOC; JOGMEC; Mitsubishi Corp; Inpex; JX Nippon Oil and Gas; Sojitz; Sumitomo; Mitsui	AP-C3MR/ SplitMR
46	Mozambique	Coral-Sul FLNG	2022	3.40	Eni*; ExxonMobil; CNPC; ENH (Mozambique); Galp Energia SA; Korea Gas	AP-DMR
47	Russia	Arctic LNG 2 T1	2022	6.60	Novatek*; CNOOC; CNPC; TotalEnergies; JOGMEC; Mitsui	Linde MFC4
48	Mauritania	Tortue/Ahmeyim FLNG T1	2023	2.50	BP*; Kosmos Energy; Petrosen; Société Mauritanienne des Hydrocarbures	Black and Veatch PRICO
47	Russia	Arctic LNG 2 T2	2024	6.60	Novatek*; CNOOC; CNPC; TotalEnergies; JOGMEC; Mitsui	Linde MFC4
49	Mexico	Energía Costa Azul T1	2024	3.25	Sempra*	AP-C3MR
10	Nigeria	NLNG T7	2024	8.00	NNPC (Nigeria)*; Shell; TotalEnergies; Eni	AP-C3MR
50	United States	Golden Pass LNG T1-T2	2024	10.40	Golden Pass Products*; QatarEnergy; ExxonMobil	AP-C3MR/ SplitMR
51	Canada	LNG Canada T1-T2	2025	14.00	Shell*; Petronas; Mitsubishi Corp; PetroChina; Korea Gas	Shell DMR
52	Mozambique	Mozambique LNG (Area 1) T1-T2	2025	12.88	Total*; Mitsui; ONGC (India); ENH (Mozambique); Bharat Petroleum Corp (BPCL); PTTEP (Thailand); Oil India	AP-C3MR
50	United States	Golden Pass LNG T3	2025	5.20	Golden Pass Products*; QatarEnergy; ExxonMobil	AP-C3MR/ SplitMR
47	Russia	Arctic LNG 2 T3	2026	6.60	Novatek*; CNOOC; CNPC; TotalEnergies; JOGMEC; Mitsui	Linde MFC4
8	Qatar	QatarGas North Field East Expansion (T1 – 4)	2025	32.00	Qatargas* (0%); QatarEnergy	AP-X
53	Russia	Ust Luga LNG T1 – T2	2025	13.00	Gazprom* (90%); RusGazDobycha (10%)	Linde MFC2
21	Australia	Pluto LNG T2 (Expansion)	2026	5.00	Woodside* (51%); Global Infrastructure Partners (GIP) (49%)	Shell Propane Precooled Mixed Refrigerant

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 2022

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9443401	Aamira	Nakilat	Samsung	266,000	Membrane	Q-Max	SSDR	2010
9210828	Abadi	Brunei Gas Carriers	Mitsubishi	137,000	Spherical	Conventional	Steam	2002
9501186	Adam LNG	Oman Shipping Co (OSC)	Hyundai	162,000	Membrane	Conventional	DFDE	2014
9831220	Adriano Knutsen	Knutsen OAS	Hyundai	180,000	Membrane	Conventional	ME-GI	2019
9338266	Al Aamriya	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Daewoo	216,200	Membrane	Q-Flex	SSDR	2008
9325697	Al Areesh	Teekay	Daewoo	151,700	Membrane	Conventional	Steam	2007
9431147	Al Bahiya	Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSDR	2010
9132741	Al Bidda	J4 Consortium	Kawasaki	137,300	Spherical	Conventional	Steam	1999
9325702	Al Daayen	Teekay	Daewoo	151,700	Membrane	Conventional	Steam	2007
9443683	Al Dafna	Nakilat	Samsung	266,400	Membrane	Q-Max	SSDR	2009
9307176	Al Deebel	MOL, NYK, K Line	Samsung	145,700	Membrane	Conventional	Steam	2005
9337705	Al Gattara	Nakilat, OSC	Hyundai	216,200	Membrane	Q-Flex	SSDR	2007
9337987	Al Ghariya	Commerz Real, Nakilat, PRONAV	Daewoo	210,200	Membrane	Q-Flex	SSDR	2008
9337717	Al Gharrafa	Nakilat, OSC	Hyundai	216,200	Membrane	Q-Flex	SSDR	2008
9397286	Al Ghashamiya	Nakilat	Samsung	217,600	Membrane	Q-Flex	SSDR	2009
9372743	Al Ghuwairiya	Nakilat	Daewoo	263,300	Membrane	Q-Max	SSDR	2008
9337743	Al Hamla	Nakilat, OSC	Samsung	216,200	Membrane	Q-Flex	SSDR	2008
9074640	Al Hamra	National Gas Shipping Co	Kvaerner Masa	135,000	Spherical	Conventional	Steam	1997
9360879	Al Huwaila	Nakilat, Teekay	Samsung	217,000	Membrane	Q-Flex	SSDR	2008
9132791	Al Jasra	J4 Consortium	Mitsubishi	137,200	Spherical	Conventional	Steam	2000
9324435	Al Jassasiya	Maran Gas Maritime, Nakilat	Daewoo	145,700	Membrane	Conventional	Steam	2007
9431123	Al Karaana	Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSDR	2009
9397327	Al Kharaitiyat	Nakilat	Hyundai	216,300	Membrane	Q-Flex	SSDR	2009
9360881	Al Kharsaah	Nakilat, Teekay	Samsung	217,000	Membrane	Q-Flex	SSDR	2008
9431111	Al Khattiya	Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSDR	2009
9038440	Al Khaznah	National Gas Shipping Co	Mitsui	135,000	Spherical	Conventional	Steam	1994
9085613	Al Khor	J4 Consortium	Mitsubishi	137,400	Spherical	Conventional	Steam	1996
9360908	Al Khuwair	Nakilat, Teekay	Samsung	217,000	Membrane	Q-Flex	SSDR	2008
9397315	Al Mafyar	Nakilat	Samsung	266,400	Membrane	Q-Max	SSDR	2009
9325685	Al Marrouna	Nakilat, Teekay	Daewoo	152,600	Membrane	Conventional	Steam	2006
9397298	Al Mayeda	Nakilat	Samsung	266,000	Membrane	Q-Max	SSDR	2009
9431135	Al Nuaman	Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSDR	2009
9360790	Al Oraiq	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSDR	2008
9086734	Al Rayyan	J4 Consortium	Kawasaki	137,400	Spherical	Conventional	Steam	1997
9397339	Al Rekayyat	Nakilat	Hyundai	216,300	Membrane	Q-Flex	SSDR	2009
9337951	Al Ruwais	Commerz Real, Nakilat, PRONAV	Daewoo	210,200	Membrane	Q-Flex	SSDR	2007
9397341	Al Sadd	Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSDR	2009
9337963	Al Safliya	Commerz Real, Nakilat, PRONAV	Daewoo	210,200	Membrane	Q-Flex	SSDR	2007

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
9360855	Al Sahla	NYK, K Line, MOL, lino, Mitsui, Nakilat	Hyundai	216,200	Membrane	Q-Flex	SSDR	2008
9388821	Al Samriya	Nakilat	Daewoo	263,300	Membrane	Q-Max	SSDR	2009
9360893	Al Shamal	Nakilat, Teekay	Samsung	217,000	Membrane	Q-Flex	SSDR	2008
9360831	Al Sheehaniya	Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSDR	2009
9298399	Al Thakhira	K Line, Qatar Shpg.	Samsung	145,700	Membrane	Conventional	Steam	2005
9360843	Al Thumama	NYK, K Line, MOL, lino, Mitsui, Nakilat	Hyundai	216,200	Membrane	Q-Flex	SSDR	2008
9360867	Al Utouriya	NYK, K Line, MOL, lino, Mitsui, Nakilat	Hyundai	215,000	Membrane	Q-Flex	SSDR	2008
9085625	Al Wajbah	J4 Consortium	Mitsubishi	137,300	Spherical	Conventional	Steam	1997
9086746	Al Wakrah	J4 Consortium	Kawasaki	137,600	Spherical	Conventional	Steam	1998
9085649	Al Zubarah	J4 Consortium	Mitsui	137,600	Spherical	Conventional	Steam	1996
9343106	Alto Acrux	TEPCO, NYK, Mitsubishi	Mitsubishi	147,800	Spherical	Conventional	Steam	2008
9682552	Amadi	Brunei Gas Carriers	Hyundai	154,800	Membrane	Conventional	TFDE	2015
9496317	Amali	Brunei Gas Carriers	Daewoo	147,000	Membrane	Conventional	TFDE	2011
9661869	Amani	Brunei Gas Carriers	Hyundai	154,800	Membrane	Conventional	TFDE	2014
9845776	Amberjack LNG	TMS Cardiff Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9317999	Amur River	Dynagas	Hyundai	149,700	Membrane	Conventional	Steam	2008
9645970	Arctic Aurora	Dynagas	Hyundai	155,000	Membrane	Conventional	TFDE	2013
9276389	Arctic Discoverer	K Line, Statoil, Mitsui, lino	Mitsui	142,600	Spherical	Conventional	Steam	2006
9284192	Arctic Lady	Hoegh	Mitsubishi	148,000	Spherical	Conventional	Steam	2006
9271248	Arctic Princess	Hoegh, MOL, Statoil	Mitsubishi	148,000	Spherical	Conventional	Steam	2006
9001784	Arctic Spirit	Teekay	I.H.I.	88,900	Self-Supporting Prismatic	Conventional	Steam	1993
9275335	Arctic Voyager	K Line, Statoil, Mitsui, lino	Kawasaki	142,800	Spherical	Conventional	Steam	2006
9862891	Aristos I	Capital Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9496305	Arkat	Brunei Gas Carriers	Daewoo	147,000	Membrane	Conventional	TFDE	2011
8125868	Armada LNG Mediterrana	Bumi Armada Berhad	Mitsui	127,209	Spherical	FSU	Steam	1985
9339260	Arwa Spirit	Teekay, Marubeni	Samsung	168,900	Membrane	Conventional	DFDE	2008
9377547	Aseem	MOL, NYK, K Line, SCI, Nakilat, Petronet	Samsung	155,000	Membrane	Conventional	DFDE	2009
9610779	Asia Endeavour	Chevron	Samsung	160,000	Membrane	Conventional	DFDE	2015
9606950	Asia Energy	Chevron	Samsung	160,000	Membrane	Conventional	DFDE	2014
9610767	Asia Excellence	Chevron	Samsung	160,000	Membrane	Conventional	DFDE	2015
9680188	Asia Integrity	Chevron	Samsung	160,000	Membrane	Conventional	DFDE	2017
9680190	Asia Venture	Chevron	Samsung	160,000	Membrane	Conventional	TFDE	2017
9606948	Asia Vision	Chevron	Samsung	160,000	Membrane	Conventional	TFDE	2014
9771080	Bahrain Spirit	Teekay	Daewoo	173,400	Membrane	FSU	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
9401295	Barcelona Knutsen	Knutsen OAS	Daewoo	173,400	Membrane	Conventional	TFDE	2009
9613159	Beidou Star	MOL, China LNG	Hudong-Zhonghua	171,800	Membrane	Conventional	SSDR	2015
9256597	Berge Arzew	BW	Daewoo	138,000	Membrane	Conventional	Steam	2004
9236432	Bilbao Knutsen	Knutsen OAS	IZAR	138,000	Membrane	Conventional	Steam	2004
9691137	Bishu Maru	Trans Pacific Shipping	Kawasaki	164,700	Spherical	Conventional	Steam reheat	2017
9845788	Bonito LNG	TMS Cardiff Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9768394	Boris Davydov	Sovcomflot	Daewoo	172,000	Membrane	Icebreaker	TFDE	2018
9768368	Boris Vilkitsky	Sovcomflot	Daewoo	172,000	Membrane	Icebreaker	TFDE	2017
9766542	British Achiever	BP	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9766554	British Contributor	BP	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9333620	British Diamond	BP	Hyundai	155,000	Membrane	Conventional	DFDE	2008
9333591	British Emerald	BP	Hyundai	155,000	Membrane	Conventional	DFDE	2007
9766566	British Listener	BP	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9766578	British Mentor	BP	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9766530	British Partner	BP	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9333606	British Ruby	BP	Hyundai	155,000	Membrane	Conventional	DFDE	2008
9333618	British Sapphire	BP	Hyundai	155,000	Membrane	Conventional	DFDE	2008
9766580	British Sponsor	BP	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9085651	Broog	J4 Consortium	Mitsui	137,500	Spherical	Conventional	Steam	1998
9388833	Bu Samra	Nakilat	Samsung	266,000	Membrane	Q-Max	SSDR	2008
9796793	Bushu Maru	NYK, JERA	Mitsubishi	180,000	Spherical	Conventional	STaGE	2019
9230062	BW Boston	BW, Total	Daewoo	138,000	Membrane	Conventional	Steam	2003
9368314	BW Brussels	BW	Daewoo	162,500	Membrane	Conventional	DFDE	2009
9243148	BW Everett	BW	Daewoo	138,000	Membrane	Conventional	Steam	2003
9724946	BW Integrity	BW, MOL	Samsung	173,400	Membrane	FSRU	TFDE	2017
9758076	BW Lilac	BW	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9792591	BW Magna	BW	Daewoo	173,400	Membrane	FSRU	TFDE	2019
9850666	BW Magnolia	BW	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9368302	BW Paris	BW	Daewoo	162,400	Membrane	FSRU	TFDE	2009
9792606	BW Pavilion Aranda	BW, Pavilion LNG	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9850678	Bw Pavilion Aranthera	BW	Daewoo	170,800	Membrane	Conventional	ME-GI	2020
9640645	BW Pavilion Leeara	BW, Pavilion LNG	Hyundai	162,000	Membrane	Conventional	TFDE	2015
9640437	BW Pavilion Vanda	BW, Pavilion LNG	Hyundai	162,000	Membrane	Conventional	TFDE	2015
9684495	BW Singapore	BW	Samsung	170,200	Membrane	FSRU	TFDE	2015
9758064	BW Tulip	BW	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9246578	Cadiz Knutsen	Knutsen OAS	IZAR	138,000	Membrane	Conventional	Steam	2004
9390680	Cape Ann	Hoegh, MOL, TLTC	Samsung	145,000	Membrane	FSRU	DFDE	2010
9742819	Castillo De Caldelas	Caldelas LNG Shipping LTD	Imabari	178,800	Membrane	Conventional	ME-GI	2018
9742807	Castillo De Merida	Merida LNG Shipping LTD	Imabari	178,800	Membrane	Conventional	ME-GI	2018
9433717	Castillo De Santisteban	Jofre Shipping LTD	STX	173,600	Membrane	Conventional	TFDE	2010
9236418	Castillo De Villalba	Elcano Gas Transport, S.A.U.	IZAR	138,200	Membrane	Conventional	Steam	2003

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
9236420	Catalunya Spirit	Teekay	IZAR	138,200	Membrane	Conventional	Steam	2003
9864784	Celsius Copenhagen	Celsius Shipping	Samsung	180,000	Membrane	Conventional	X-DF	2020
9672844	Cesi Beihai	China Shipping Group	Hudong-Zhonghua	174,100	Membrane	Conventional	TFDE	2017
9672820	Cesi Gladstone	Chuo Kaiun/ Shinwa Chem.	Hudong-Zhonghua	174,100	Membrane	Conventional	DFDE	2016
9672818	Cesi Lianyungang	China Shipping Group	Hudong-Zhonghua	174,100	Membrane	Conventional	DFDE	2018
9672832	Cesi Qingdao	China Shipping Group	Hudong-Zhonghua	174,100	Membrane	Conventional	DFDE	2017
9694749	Cesi Tianjin	China Shipping Group	Hudong-Zhonghua	174,100	Membrane	Conventional	DFDE	2017
9694751	Cesi Wenzhou	China Shipping Group	Hudong-Zhonghua	174,100	Membrane	Conventional	TFDE	2018
9324344	Cheikh Bouamama	HYPROC, Sonatrach, Itochu, MOL	Universal	75,500	Membrane	Conventional	Steam	2008
9324332	Cheikh El Mokrani	HYPROC, Sonatrach, Itochu, MOL	Universal	75,500	Membrane	Conventional	Steam	2007
9737187	Christophe De Margerie	Sovcomflot	Daewoo	172,000	Membrane	Icebreaker	TFDE	2016
9323687	Clean Energy	Dynagas	Hyundai	149,700	Membrane	Conventional	Steam	2007
9655444	Clean Horizon	Dynagas	Hyundai	162,000	Membrane	Conventional	TFDE	2015
9637492	Clean Ocean	Dynagas	Hyundai	162,000	Membrane	Conventional	TFDE	2014
9637507	Clean Planet	Dynagas	Hyundai	162,000	Membrane	Conventional	TFDE	2014
9655456	Clean Vision	Dynagas	Hyundai	162,000	Membrane	Conventional	TFDE	2016
9861031	Cool Discoverer	Thenamaris	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9640023	Cool Explorer	Thenamaris	Samsung	160,000	Membrane	Conventional	TFDE	2015
9636797	Cool Runner	Thenamaris	Samsung	160,000	Membrane	Conventional	TFDE	2014
9636785	Cool Voyager	Thenamaris	Samsung	160,000	Membrane	Conventional	TFDE	2013
9693719	Coral Encanto	Anthony Veder	Ningbo Xinle Shipbuilding Co Ltd	30,000	Type C	Conventional	DFDE	2020
9636711	Corcovado LNG	TMS Cardiff Gas	Daewoo	160,100	Membrane	Conventional	TFDE	2014
9681687	Creole Spirit	Teekay	Daewoo	173,400	Membrane	Conventional	ME-GI	2016
9491812	Cubal	Mitsui, NYK, Teekay	Samsung	160,000	Membrane	Conventional	TFDE	2012
9376294	Cygnus Passage	TEPCO, NYK, Mitsubishi	Mitsubishi	147,000	Spherical	Conventional	Steam	2009
9308481	Dapeng Moon	China LNG Ship Mgmt	Hudong-Zhonghua	147,200	Membrane	Conventional	Steam	2008
9369473	Dapeng Star	China LNG Ship Mgmt	Hudong-Zhonghua	147,600	Membrane	Conventional	Steam	2009
9308479	Dapeng Sun	China LNG Ship Mgmt	Hudong-Zhonghua	147,200	Membrane	Conventional	Steam	2008
9862487	Diamond Gas Metropolis	NYK Line	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9779226	Diamond Gas Orchid	NYK Line	Mitsubishi	165,000	Spherical	Conventional	STaGE	2018
9779238	Diamond Gas Rose	NYK Line	Mitsubishi	165,000	Spherical	Conventional	STaGE	2018
9810020	Diamond Gas Sakura	NYK Line	Mitsubishi	165,000	Spherical	Conventional	STaGE	2019

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
9250713	Disha	MOL, NYK, K Line, SCI, Nakilat, Petronet	Daewoo	138,100	Membrane	Conventional	Steam	2004
9085637	Doha	J4 Consortium	Mitsubishi	137,300	Spherical	Conventional	Steam	1999
9863182	Dorado LNG	TMS Cardiff Gas	Samsung	174,000	Membrane	Conventional	X-DF	2020
9337975	Duhail	Commerz Real, Nakilat, PRONAV	Daewoo	210,200	Membrane	Q-Flex	SSDR	2008
9265500	Dukhan	J4 Consortium	Mitsui	137,500	Spherical	Conventional	Steam	2004
9750696	Eduard Toll	Teekay	Daewoo	172,000	Membrane	Icebreaker	TFDE	2017
9334076	Ejnan	K Line, MOL, NYK, Mitsui, Nakilat	Samsung	145,000	Membrane	Conventional	Steam	2007
8706155	Ekaputra 1	P.T. Humpuss Trans	Mitsubishi	137,000	Spherical	Conventional	Steam	1990
9852975	Elisa Larus	GazOcean	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9269180	Energy Advance	Tokyo Gas	Kawasaki	147,000	Spherical	Conventional	Steam	2005
9649328	Energy Atlantic	Alpha Gas	STX	159,700	Membrane	Conventional	TFDE	2015
9405588	Energy Confidence	NYK, Tokyo Gas	Kawasaki	155,000	Spherical	Conventional	Steam	2009
9245720	Energy Frontier	Tokyo Gas	Kawasaki	147,000	Spherical	Conventional	Steam	2003
9752565	Energy Glory	NYK, Tokyo Gas	Japan Marine	165,000	Self-Supporting Prismatic	Conventional	TFDE	2019
9483877	Energy Horizon	NYK, TLTC	Kawasaki	177,000	Spherical	Conventional	Steam	2011
9758832	Energy Innovator	MOL, Tokyo Gas	Japan Marine	165,000	Self-Supporting Prismatic	Conventional	TFDE	2019
9736092	Energy Liberty	MOL, Tokyo Gas	Japan Marine	165,000	Self-Supporting Prismatic	Conventional	TFDE	2018
9355264	Energy Navigator	MOL, Tokyo Gas	Kawasaki	147,000	Spherical	Conventional	Steam	2008
9854612	Energy Pacific	Alpha Gas	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9274226	Energy Progress	MOL	Kawasaki	147,000	Spherical	Conventional	Steam	2006
9758844	Energy Universe	MOL, Tokyo Gas	Japan Marine	165,000	Self-Supporting Prismatic	Conventional	TFDE	2019
9749609	Enshu Maru	K Line	Kawasaki	164,700	Spherical	Conventional	Steam reheat	2018
9666560	Esshu Maru	MOL, Tokyo Gas	Mitsubishi	153,000	Spherical	Conventional	Steam	2014
9230050	Excalibur	Exmar	Daewoo	138,000	Membrane	Conventional	Steam	2002
9820843	Excelerate Sequoia	Maran Gas Maritime	Daewoo	173,400	Membrane	FSRU	TFDE	2020
9252539	Excellence	Excelerate Energy	Daewoo	138,000	Membrane	FSRU	Steam	2005
9239616	Excelsior	Excelerate Energy	Daewoo	138,000	Membrane	FSRU	Steam	2005
9444649	Exemplar	Excelerate Energy	Daewoo	150,900	Membrane	FSRU	Steam	2010
9389643	Expedient	Excelerate Energy	Daewoo	150,900	Membrane	FSRU	Steam	2010
9638525	Experience	Excelerate Energy	Daewoo	173,400	Membrane	FSRU	TFDE	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
9361079	Explorer	Excelerate Energy	Daewoo	150,900	Membrane	FSRU	Steam	2008
9361445	Express	Excelerate Energy	Daewoo	150,900	Membrane	FSRU	Steam	2009
9381134	Exquisite	Excelerate, Nakilat	Daewoo	150,900	Membrane	FSRU	Steam	2009
9768370	Fedor Litke	LITKE	Daewoo	172,000	Membrane	Icebreaker	TFDE	2017
9857377	Flex Amber	Flex LNG	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9851634	Flex Artemis	Flex LNG	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9857365	Flex Aurora	Flex LNG	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9825427	Flex Constellation	Flex LNG	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9825439	Flex Courageous	Flex LNG	Daewoo	173,400	Spherical	Conventional	ME-GI	2019
9762261	Flex Endeavour	Flex LNG	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9762273	Flex Enterprise	Flex LNG	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9709037	Flex Rainbow	Flex LNG	Samsung	174,000	Membrane	Conventional	ME-GI	2018
9709025	Flex Ranger	Flex LNG	Samsung	174,000	Membrane	Conventional	ME-GI	2018
9851646	Flex Resolute	Flex LNG	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9360817	Fraiha	NYK, K Line, MOL, Iino, Mitsui, Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSDR	2008
9253284	FSRU Toscana	OLT Offshore LNG Toscana	Hyundai	137,100	Spherical	FSRU	Steam	2004
9275359	Fuji LNG	TMS Cardiff Gas	Kawasaki	147,900	Spherical	Conventional	Steam	2004
9256200	Fuwairit	MOL	Samsung	138,300	Membrane	Conventional	Steam	2004
9236614	Galea	Shell	Mitsubishi	136,600	Spherical	Conventional	Steam	2002
9247364	Galicia Spirit	Teekay	Daewoo	140,500	Membrane	Conventional	Steam	2004
9390185	Gaslog Chelsea	GasLog	Hanjin H.I.	153,600	Membrane	Conventional	TFDE	2010
9707508	Gaslog Geneva	GasLog	Samsung	174,000	Membrane	Conventional	TFDE	2016
9744013	Gaslog Genoa	GasLog	Samsung	174,000	Membrane	Conventional	X-DF	2018
9864916	Gaslog Georgetown	GasLog	Samsung	174,000	Membrane	Conventional	X-DF	2020
9707510	Gaslog Gibraltar	GasLog	Samsung	174,000	Membrane	Conventional	TFDE	2016
9744025	Gaslog Gladstone	GasLog	Samsung	174,000	Membrane	Conventional	X-DF	2019
9687021	Gaslog Glasgow	GasLog	Samsung	174,000	Membrane	Conventional	TFDE	2016
9687019	Gaslog Greece	GasLog	Samsung	174,000	Membrane	Conventional	TFDE	2016
9748904	Gaslog Hongkong	GasLog	Hyundai	174,000	Membrane	Conventional	X-DF	2018
9748899	Gaslog Houston	GasLog	Hyundai	174,000	Membrane	Conventional	X-DF	2018
9638915	Gaslog Salem	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2015
9600530	Gaslog Santiago	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2013
9638903	Gaslog Saratoga	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2014
9352860	Gaslog Savannah	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2010
9634086	Gaslog Seattle	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2013
9600528	Gaslog Shanghai	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2013
9355604	Gaslog Singapore	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2010
9626285	Gaslog Skagen	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2013
9626273	Gaslog Sydney	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2013
9853137	Gaslog Wales	GasLog	Samsung	180,000	Membrane	Conventional	X-DF	2020
9816763	Gaslog Warsaw	GasLog	Samsung	180,000	Membrane	Conventional	X-DF	2019
9855812	Gaslog Westminster	GasLog	Samsung	180,000	Membrane	Conventional	X-DF	2020
9819650	Gaslog Windsor	GasLog	Samsung	180,000	Membrane	Conventional	X-DF	2020

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
9253222	Gemmata	Shell	Mitsubishi	135,000	Spherical	Conventional	Steam	2004
9768382	Georgiy Brusilov	Dynagas	Daewoo	172,600	Membrane	Icebreaker	TFDE	2018
9750749	Georgiy Ushakov	Teekay, China LNG Shipping	Daewoo	172,000	Membrane	Icebreaker	TFDE	2019
9038452	Ghasha	National Gas Shipping Co	Mitsui	135,000	Spherical	Conventional	Steam	1995
9360922	Gigira Laitebo	MOL, Itochu	Hyundai	155,000	Membrane	Conventional	TFDE	2010
9845013	Global Energy	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9269207	Global Energy	Jovo Group	Chantiers de l'Atlantique	74,500	Membrane	Conventional	Steam	2006
9253105	Golar Arctic	Golar LNG	Daewoo	140,000	Membrane	Conventional	Steam	2003
9626039	Golar Bear	CoolCo	Samsung	160,000	Membrane	Conventional	TFDE	2014
9626027	Golar Celsius	New Fortress Energy	Samsung	160,000	Membrane	Conventional	TFDE	2013
9624926	Golar Crystal	CoolCo	Samsung	160,000	Membrane	Conventional	TFDE	2014
9624940	Golar Eskimo	New Fortress Energy	Samsung	160,000	Membrane	FSRU	TFDE	2014
7361922	Golar Freeze	New Fortress Energy	HDW	125,000	Spherical	FSRU	Steam	1977
9655042	Golar Frost	CoolCo	Samsung	160,000	Membrane	Conventional	TFDE	2014
9654696	Golar Glacier	CoolCo	Hyundai	162,000	Membrane	Conventional	TFDE	2014
9303560	Golar Grand	New Fortress Energy	Daewoo	145,000	Membrane	Conventional	Steam	2005
9637325	Golar Ice	CoolCo	Samsung	160,000	Membrane	Conventional	TFDE	2015
9633991	Golar Igloo	New Fortress Energy	Samsung	170,000	Membrane	FSRU	TFDE	2014
9654701	Golar Kelvin	CoolCo	Hyundai	162,000	Membrane	Conventional	TFDE	2015
9320374	Golar Maria	New Fortress Energy	Daewoo	145,000	Membrane	Conventional	Steam	2006
9785500	Golar Nanook	New Fortress Energy	Samsung	170,000	Membrane	FSRU	DFDE	2018
9624938	Golar Penguin	New Fortress Energy	Samsung	160,000	Membrane	Conventional	TFDE	2014
9624914	Golar Seal	CoolCo	Samsung	160,000	Membrane	Conventional	TFDE	2013
9635315	Golar Snow	CoolCo	Samsung	160,000	Membrane	Conventional	TFDE	2015
9655808	Golar Tundra	Golar LNG	Samsung	170,000	Membrane	FSRU	TFDE	2015
9256614	Golar Winter	New Fortress Energy	Daewoo	138,000	Membrane	FSRU	Steam	2004
9315707	Grace Acacia	NYK Line	Hyundai	150,000	Membrane	Conventional	Steam	2007
9315719	Grace Barleria	NYK Line	Hyundai	150,000	Membrane	Conventional	Steam	2007
9323675	Grace Cosmos	MOL, NYK	Hyundai	150,000	Membrane	Conventional	Steam	2008
9540716	Grace Dahlia	NYK Line	Kawasaki	177,400	Spherical	Conventional	Steam	2013
9338955	Grand Aniva	NYK, Sovcomflot	Mitsubishi	147,000	Spherical	Conventional	Steam	2008
9332054	Grand Elena	NYK, Sovcomflot	Mitsubishi	147,000	Spherical	Conventional	Steam	2007
9338929	Grand Mereya	MOL, K Line, Primorsk	Mitsui	147,600	Spherical	Conventional	Steam	2008
9696266	Hai Yang Shi You 301	CNOOC	Jiangnan	30,000	Membrane	Conventional	DFDE	2015
9230048	Hispania Spirit	Teekay	Daewoo	140,500	Membrane	Conventional	Steam	2002
9155078	HL Muscat	Hanjin Shipping Co.	Hanjin H.I.	138,000	Membrane	Conventional	Steam	1999

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
9061928	HL Pyeongtaek	Hanjin Shipping Co.	Hanjin H.I.	130,100	Membrane	Conventional	Steam	1995
9176008	HL Ras Laffan	Hanjin Shipping Co.	Hanjin H.I.	138,000	Membrane	Conventional	Steam	2000
9176010	HL Sur	Hanjin Shipping Co.	Hanjin H.I.	138,300	Membrane	Conventional	Steam	2000
9780354	Hoegh Esperanza	Hoegh	Hyundai	170,000	Membrane	FSRU	DFDE	2018
9653678	Hoegh Gallant	Hoegh	Hyundai	170,100	Membrane	FSRU	DFDE	2014
9820013	Hoegh Galleon	Hoegh	Samsung	170,000	Membrane	FSRU	TFDE	2019
9822451	Hoegh Gannet	Hoegh	Hyundai	170,000	Membrane	FSRU	DFDE	2018
9762962	Hoegh Giant	Hoegh	Hyundai	170,000	Membrane	FSRU	DFDE	2017
9674907	Hoegh Grace	Hoegh	Hyundai	170,000	Membrane	FSRU	DFDE	2016
9250725	Hongkong Energy	Sinokor Merchant Marine	Daewoo	140,500	Membrane	Conventional	Steam	2004
9179581	Hyundai Aquapia	Hyundai LNG Shipping	Hyundai	135,000	Spherical	Conventional	Steam	2000
9155157	Hyundai Cosmopia	Hyundai LNG Shipping	Hyundai	135,000	Spherical	Conventional	Steam	2000
9372999	Hyundai Ecopia	Hyundai LNG Shipping	Hyundai	150,000	Membrane	Conventional	Steam	2008
9075333	Hyundai Greenpia	Hyundai LNG Shipping	Hyundai	125,000	Spherical	Conventional	Steam	1996
9183269	Hyundai Oceanpia	Hyundai LNG Shipping	Hyundai	135,000	Spherical	Conventional	Steam	2000
9761853	Hyundai Peacepia	Hyundai LNG Shipping	Daewoo	174,000	Membrane	Conventional	ME-GI	2017
9761841	Hyundai Princepia	Hyundai LNG Shipping	Daewoo	174,000	Membrane	Conventional	ME-GI	2017
9155145	Hyundai Technopia	Hyundai LNG Shipping	Hyundai	135,000	Spherical	Conventional	Steam	1999
9018555	Hyundai Utopia	Hyundai LNG Shipping	Hyundai	125,200	Spherical	Conventional	Steam	1994
9326603	Iberica Knutsen	Knutsen OAS	Daewoo	138,000	Membrane	Conventional	Steam	2006
9326689	Ibra LNG	OSC, MOL	Samsung	147,600	Membrane	Conventional	Steam	2006
9317315	Ibri LNG	OSC, MOL, Mitsubishi	Mitsubishi	147,600	Spherical	Conventional	Steam	2006
9629536	Independence	Hoegh	Hyundai	170,100	Membrane	FSRU	DFDE	2014
9035864	Ish	National Gas Shipping Co	Mitsubishi	137,300	Spherical	Conventional	Steam	1995
9157636	K. Acacia	Korea Line	Daewoo	138,000	Membrane	Conventional	Steam	2000
9186584	K. Freesia	Korea Line	Daewoo	138,000	Membrane	Conventional	Steam	2000
9373008	K. Jasmine	Korea Line	Daewoo	145,700	Membrane	Conventional	Steam	2008
9373010	K. Mugungwha	Korea Line	Daewoo	151,700	Membrane	Conventional	Steam	2008
9785158	Kinisis	Chandris Group	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9636723	Kita LNG	TMS Cardiff Gas	Daewoo	160,100	Membrane	Conventional	TFDE	2014
9613161	Kumul	MOL, China LNG	Hudong-Zhonghua	172,000	Membrane	Conventional	SSDR	2016
9721724	La Mancha Knutsen	Knutsen OAS	Hyundai	176,000	Membrane	Conventional	ME-GI	2016
9845764	La Seine	TMS Cardiff Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9275347	Lalla Fatma N'soumer	HYPROC	Kawasaki	147,300	Spherical	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
9629598	Lena River	Dynagas	Hyundai	155,000	Membrane	Conventional	DFDE	2013
9064085	Lerici	MISC	Sestri	65,000	Membrane	Conventional	Steam	1998
9388819	Lijmiliya	Nakilat	Daewoo	263,300	Membrane	Q-Max	SSDR	2009
9690171	LNG Abalamabie	BGT LTD	Samsung	175,000	Membrane	Conventional	DFDE	2016
9690169	LNG Abuja II	BGT LTD	Samsung	175,000	Membrane	Conventional	DFDE	2016
9262211	LNG Adamawa	BGT LTD	Hyundai	141,000	Spherical	Conventional	Steam	2005
9262209	LNG Akwa Ibom	BGT LTD	Hyundai	141,000	Spherical	Conventional	Steam	2004
9320075	LNG Alliance	GazOcean	Chantiers de l'Atlantique	154,500	Membrane	Conventional	DFDE	2007
7390181	LNG Aquarius	Hanochem	General Dynamics	126,300	Spherical	Conventional	Steam	1977
9341299	LNG Barka	OSC, OG, NYK, K Line	Kawasaki	153,600	Spherical	Conventional	Steam	2008
9241267	LNG Bayelsa	BGT LTD	Hyundai	137,000	Spherical	Conventional	Steam	2003
9267015	LNG Benue	BW	Daewoo	145,700	Membrane	Conventional	Steam	2006
9692002	LNG Bonny II	BGT LTD	Hyundai	177,000	Membrane	Conventional	DFDE	2015
9322803	LNG Borno	NYK Line	Samsung	149,600	Membrane	Conventional	Steam	2007
9256767	LNG Croatia	LNG Hrvatska	Huyndai	138,000	Membrane	FSRU	Steam	2005
9262223	LNG Cross River	BGT LTD	Hyundai	141,000	Spherical	Conventional	Steam	2005
9277620	LNG Dream	NYK Line	Kawasaki	145,300	Spherical	Conventional	Steam	2006
9834296	LNG Dubhe	MOL, COSCO	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2019
9329291	LNG Ebisu	MOL, KEPCO	Kawasaki	147,500	Spherical	Conventional	Steam	2008
9266994	LNG Enugu	BW	Daewoo	145,000	Membrane	Conventional	Steam	2005
9690145	LNG Finima II	BGT LTD	Samsung	175,000	Membrane	Conventional	DFDE	2015
9666986	LNG Fukurokuju	MOL, KEPCO	Kawasaki	165,100	Spherical	Conventional	Steam reheat	2016
9311581	LNG Imo	BW	Daewoo	148,500	Membrane	Conventional	Steam	2008
9200316	LNG Jamal	NYK, Osaka Gas	Mitsubishi	137,000	Spherical	Conventional	Steam	2000
9774628	LNG Juno	MOL	Mitsubishi	177,300	Spherical	Conventional	STaGE	2018
9341689	LNG Jupiter	NYK, Osaka Gas	Kawasaki	156,000	Spherical	Conventional	Steam	2009
9666998	LNG Jurojin	MOL, KEPCO	Mitsubishi	155,300	Spherical	Conventional	Steam reheat	2015
9311567	LNG Kano	BW	Daewoo	148,300	Membrane	Conventional	Steam	2007
9372963	LNG Kolt	STX Pan Ocean	Hanjin H.I.	153,000	Membrane	Conventional	Steam	2008
9692014	LNG Lagos II	BGT LTD	Hyundai	177,000	Membrane	Conventional	DFDE	2016
9269960	LNG Lokoja	BW	Daewoo	148,300	Membrane	Conventional	Steam	2006
8701791	LNG Maleo	MOL, NYK, K Line	Mitsui	127,700	Spherical	Conventional	Steam	1989
9645748	LNG Mars	MOL, Osaka Gas	Mitsubishi	155,000	Spherical	Conventional	Steam reheat	2016
9834325	LNG Megrez	MOL, COSCO	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2020
9834301	LNG Merak	MOL, COSCO	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2020
9322815	LNG Ogun	NYK Line	Samsung	149,600	Membrane	Conventional	Steam	2007
9311579	LNG Ondo	BW	Daewoo	148,300	Membrane	Conventional	Steam	2007
9267003	LNG Oyo	BW	Daewoo	145,800	Membrane	Conventional	Steam	2005
9834313	LNG Phecda	MOL, COSCO	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2020
9256602	LNG Pioneer	Jovo Group	Daewoo	138,000	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
9690157	LNG Port-Harcourt II	BGT LTD	Samsung	175,000	Membrane	Conventional	DFDE	2015
9262235	LNG River Niger	BGT LTD	Hyundai	141,000	Spherical	Conventional	Steam	2006
9266982	LNG River Orashi	BW	Daewoo	145,900	Membrane	Conventional	Steam	2004
9216298	LNG Rivers	BGT LTD	Hyundai	137,000	Spherical	Conventional	Steam	2002
9774135	LNG Sakura	NYK, KEPCO	Kawasaki	177,000	Spherical	Conventional	TFDE	2018
9696149	LNG Saturn	MOL	Mitsubishi	155,700	Spherical	Conventional	Steam reheat	2016
9771913	LNG Schneeweisschen	MOL	Daewoo	180,000	Membrane	Conventional	X-DF	2018
9216303	LNG Sokoto	BGT LTD	Hyundai	137,000	Spherical	Conventional	Steam	2002
9306495	LNG Unity	Karpowership	Chantiers de l'Atlantique	154,472	Membrane	Conventional	DFDE	2006
9645736	LNG Venus	MOL, Osaka Gas	Mitsubishi	155,000	Spherical	Conventional	Steam	2014
9490961	Lobito	Mitsui, NYK, Teekay	Samsung	160,400	Membrane	Conventional	TFDE	2011
9285952	Lusail	K Line, MOL, NYK, Nakilat	Samsung	145,700	Membrane	Conventional	Steam	2005
9705653	Macoma	Teekay	Daewoo	173,000	Membrane	Conventional	ME-GI	2017
9259276	Madrid Spirit	Teekay	IZAR	138,000	Membrane	Conventional	Steam	2004
9770921	Magdala	Teekay	Daewoo	173,000	Membrane	Conventional	ME-GI	2018
9342487	Magellan Spirit	Teekay, Marubeni	Samsung	165,500	Membrane	Conventional	DFDE	2009
9490959	Malanje	Mitsui, NYK, Teekay	Samsung	160,400	Membrane	Conventional	DFDE	2011
9682588	Maran Gas Achilles	Maran Gas Maritime	Hyundai	174,000	Membrane	Conventional	DFDE	2015
9682590	Maran Gas Agamemnon	Maran Gas Maritime	Hyundai	174,000	Membrane	Conventional	ME-GI	2016
9650054	Maran Gas Alexandria	Maran Gas Maritime	Hyundai	161,900	Membrane	Conventional	DFDE	2015
9701217	Maran Gas Amphipolis	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	DFDE	2016
9810379	Maran Gas Andros	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9633422	Maran Gas Apollonia	Maran Gas Maritime	Hyundai	161,900	Membrane	Conventional	DFDE	2014
9302499	Maran Gas Asclepius	Maran Gas Maritime, Nakilat	Daewoo	145,800	Membrane	Conventional	Steam	2005
9753014	Maran Gas Chios	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9331048	Maran Gas Coronis	Maran Gas Maritime, Nakilat	Daewoo	145,700	Membrane	Conventional	Steam	2007
9633173	Maran Gas Delphi	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	TFDE	2014
9627497	Maran Gas Efessos	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	DFDE	2014
9682605	Maran Gas Hector	Maran Gas Maritime	Hyundai	174,000	Membrane	Conventional	DFDE	2016
9767962	Maran Gas Hydra	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9682576	Maran Gas Leto	Maran Gas Maritime	Hyundai	174,000	Membrane	Conventional	DFDE	2016
9627502	Maran Gas Lindos	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	DFDE	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
9658238	Maran Gas Mystras	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	DFDE	2015
9732371	Maran Gas Olympias	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	TFDE	2017
9709489	Maran Gas Pericles	Maran Gas Maritime	Hyundai	174,000	Membrane	Conventional	DFDE	2016
9633434	Maran Gas Posidonia	Maran Gas Maritime	Hyundai	161,900	Membrane	Conventional	DFDE	2014
9844863	Maran Gas Psara	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9701229	Maran Gas Roxana	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	TFDE	2017
9650042	Maran Gas Sparta	Maran Gas Maritime	Hyundai	161,900	Membrane	Conventional	TFDE	2015
9767950	Maran Gas Spetses	Maran Gas Maritime, Nakilat	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9658240	Maran Gas Troy	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	TFDE	2015
9709491	Maran Gas Ulysses	Maran Gas Maritime	Hyundai	174,000	Membrane	Conventional	TFDE	2017
9732369	Maran Gas Vergina	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	TFDE	2016
9659725	Maria Energy	Tsakos	Hyundai	174,000	Membrane	Conventional	TFDE	2016
9336749	Marib Spirit	Teekay	Samsung	165,500	Membrane	Conventional	DFDE	2008
9778313	Marshal Vasilevskiy	Gazprom	Hyundai	174,000	Membrane	FSRU	TFDE	2018
9770438	Marvel Crane	NYK Line	Mitsubishi	177,000	Spherical	Conventional	STaGE	2019
9759240	Marvel Eagle	MOL	Kawasaki	155,000	Spherical	Conventional	TFDE	2018
9760768	Marvel Falcon	MOL	Samsung	174,000	Membrane	Conventional	X-DF	2018
9760770	Marvel Hawk	MOL	Samsung	174,000	Membrane	Conventional	X-DF	2018
9770440	Marvel Heron	MOL	Mitsubishi	177,000	Spherical	Conventional	STaGE	2019
9760782	Marvel Kite	Meiji Shipping	Samsung	174,000	Membrane	Conventional	X-DF	2019
9759252	Marvel Pelican	MOL	Kawasaki	155,985	Spherical	Conventional	TFDE	2019
9770945	Megara	Teekay	Daewoo	173,000	Membrane	Conventional	ME-GI	2018
9397303	Mekaines	Nakilat	Samsung	266,500	Membrane	Q-Max	SSDR	2009
9250191	Merchant	Sinokor Merchant Marine	Samsung	138,200	Membrane	Conventional	Steam	2003
9369904	Meridian Spirit	Teekay, Marubeni	Samsung	165,500	Membrane	Conventional	DFDE	2010
9337729	Mesaimeer	Nakilat	Hyundai	216,300	Membrane	Q-Flex	SSDR	2009
9321768	Methane Alison Victoria	CNTIC Vpower Energy	Samsung	145,000	Membrane	FSU	Steam	2007
9516129	Methane Becki Anne	GasLog	Samsung	170,000	Membrane	Conventional	TFDE	2010
9321744	Methane Heather Sally	GasLog	Samsung	145,000	Membrane	Conventional	Steam	2007
9307190	Methane Jane Elizabeth	GasLog	Samsung	145,000	Membrane	Conventional	Steam	2006
9412880	Methane Julia Louise	MOL	Samsung	170,000	Membrane	Conventional	TFDE	2010
9256793	Methane Kari Elin	Shell	Samsung	138,000	Membrane	Conventional	Steam	2004
9307205	Methane Lydon Volney	GasLog	Samsung	145,000	Membrane	Conventional	Steam	2006
9520376	Methane Mickie Harper	Meiji Shipping	Samsung	170,000	Membrane	Conventional	TFDE	2010

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
9321770	Methane Nile Eagle	Shell, Gaslog	Samsung	145,000	Membrane	Conventional	Steam	2007
9425277	Methane Patricia Camila	Meiji Shipping	Samsung	170,000	Membrane	Conventional	TFDE	2010
9253715	Methane Princess	New Fortress Energy	Daewoo	138,000	Membrane	Conventional	Steam	2003
9307188	Methane Rita Andrea	Shell, Gaslog	Samsung	145,000	Membrane	Conventional	Steam	2006
9321756	Methane Shirley Elisabeth	Shell, Gaslog	Samsung	145,000	Membrane	Conventional	Steam	2007
9336737	Methane Spirit	Teekay, Marubeni	Samsung	165,500	Membrane	Conventional	TFDE	2008
9321732	Milaha Qatar	Nakilat, Qatar Shpg., SocGen	Samsung	145,600	Membrane	Conventional	Steam	2006
9255854	Milaha Ras Laffan	Nakilat, Qatar Shpg., SocGen	Samsung	138,300	Membrane	Conventional	Steam	2004
9305128	Min Lu	China LNG Ship Mgmt	Hudong-Zhonghua	147,200	Membrane	Conventional	Steam	2009
9305116	Min Rong	China LNG Ship Mgmt	Hudong-Zhonghua	147,600	Membrane	Conventional	Steam	2009
9713105	MOL FSRU Challenger	MOL	Daewoo	263,000	Membrane	FSRU	TFDE	2017
9337755	Mozah	Nakilat	Samsung	266,300	Membrane	Q-Max	SSDR	2008
9074638	Mraweh	National Gas Shipping Co	Kvaerner Masa	135,000	Spherical	Conventional	Steam	1996
9074626	Mubaraz	National Gas Shipping Co	Kvaerner Masa	135,000	Spherical	Conventional	Steam	1996
9705641	Murex	Teekay	Daewoo	173,000	Membrane	Conventional	ME-GI	2017
9360805	Murwab	NYK, K Line, MOL, lino, Mitsui, Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSDR	2008
9770933	Myrina	Teekay	Daewoo	173,000	Membrane	Conventional	ME-GI	2018
9324277	Neo Energy	Tsakos	Hyundai	150,000	Spherical	Conventional	Steam	2007
9385673	Neptune	Hoegh, MOL, TLTC	Samsung	145,000	Membrane	FSRU	DFDE	2009
9750660	Nikolay Urvantsev	MOL, COSCO	Daewoo	172,000	Membrane	Icebreaker	TFDE	2019
9750725	Nikolay Yevgenov	Teekay, China LNG Shipping	Daewoo	172,000	Membrane	Icebreaker	TFDE	2019
9768526	Nikolay Zubov	Dynagas	Daewoo	172,000	Membrane	Icebreaker	TFDE	2019
9294264	Nizwa LNG	OSC, MOL	Kawasaki	147,700	Spherical	Conventional	Steam	2005
9796781	Nohshu Maru	MOL, JERA	Mitsubishi	177,300	Spherical	Conventional	STaGE	2019
8608872	Northwest Sanderling	North West Shelf Venture	Mitsubishi	126,700	Spherical	Conventional	Steam	1989
8913150	Northwest Sandpiper	North West Shelf Venture	Mitsui	127,000	Spherical	Conventional	Steam	1993
8608884	Northwest Snipe	North West Shelf Venture	Mitsui	126,900	Spherical	Conventional	Steam	1990
9045132	Northwest Stormpetrel	North West Shelf Venture	Mitsubishi	126,800	Spherical	Conventional	Steam	1994
7382744	Nusantara Regas Satu	New Fortress Energy	Rosenberg Verft	125,000	Spherical	FSRU	Steam	1977
9681699	Oak Spirit	Teekay	Daewoo	173,400	Membrane	Conventional	ME-GI	2016
9315692	Ob River	Dynagas	Hyundai	149,700	Membrane	Conventional	Steam	2007
9698111	Oceanic Breeze	K-Line, Inpex	Mitsubishi	155,300	Spherical	Conventional	Steam reheat	2018
9397353	Onaiza	Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSDR	2009
9761267	Ougarta	HYPROC	Hyundai	171,800	Membrane	Conventional	TFDE	2017

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
9621077	Pacific Arcadia	NYK Line	Mitsubishi	145,400	Spherical	Conventional	Steam	2014
9698123	Pacific Breeze	K Line	Kawasaki	182,000	Spherical	Conventional	TFDE	2018
9351971	Pacific Enlighten	Kyushu Electric, TEPCO, Mitsubishi, Mitsui, NYK, MOK	Mitsubishi	145,000	Spherical	Conventional	Steam	2009
9264910	Pacific Eurus	TEPCO, NYK, Mitsubishi	Mitsubishi	137,000	Spherical	Conventional	Steam	2006
9743875	Pacific Mimosa	NYK Line	Mitsubishi	155,300	Membrane	Conventional	Steam reheat	2018
9247962	Pacific Notus	TEPCO, NYK, Mitsubishi	Mitsubishi	137,000	Spherical	Conventional	Steam	2003
9636735	Palu LNG	TMS Cardiff Gas	Daewoo	160,000	Membrane	Conventional	TFDE	2014
9750256	Pan Africa	Teekay, China LNG Shipping, CETS Investment Management, BW	Hudong-Zhonghua	174,000	Membrane	Conventional	DFDE	2019
9750232	Pan Americas	Teekay	Hudong-Zhonghua	174,000	Membrane	Conventional	DFDE	2018
9750220	Pan Asia	Teekay	Hudong-Zhonghua	174,000	Membrane	Conventional	DFDE	2017
9750244	Pan Europe	Teekay	Hudong-Zhonghua	174,000	Membrane	Conventional	DFDE	2018
9613135	Papua	MOL, China LNG	Hudong-Zhonghua	172,000	Membrane	Conventional	SSDR	2015
9766889	Patris	Chandris Group	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9862346	Pearl LNG	TMS Cardiff Gas	Samsung	174,000	Membrane	Conventional	X-DF	2020
9629524	PGN FSRU Lampung	Hoegh	Hyundai	170,000	Membrane	FSRU	DFDE	2014
9375721	Point Fortin	MOL, Sumitomo, LNG JAPAN	Imabari	154,200	Membrane	Conventional	Steam	2010
9001772	Polar Spirit	Teekay	I.H.I.	88,900	Self-Supporting Prismatic	Conventional	Steam	1993
9064073	Portovenere	MISC	Sestri	65,000	Membrane	Conventional	Steam	1996
9246621	Portovyy	Gazprom	Daewoo	138,100	Membrane	Conventional	Steam	2003
9723801	Prachi	MOL, NYK, K Line, SCI, Nakilat, Petronet	Hyundai	173,000	Membrane	Conventional	TFDE	2016
9810549	Prism Agility	SK Shipping	Hyundai	180,000	Membrane	Conventional	X-DF	2019
9810551	Prism Brilliance	SK Shipping	Hyundai	180,000	Membrane	Conventional	X-DF	2019
9630028	Pskov	Sovcomflot	STX	170,200	Membrane	Conventional	DFDE	2014
9030814	Puteri Delima	MISC	Chantiers de l'Atlantique	130,000	Membrane	Conventional	Steam	1995
9211872	Puteri Delima Satu	MISC	Mitsui	137,500	Membrane	Conventional	Steam	2002
9248502	Puteri Firus Satu	MISC	Mitsubishi	137,500	Membrane	Conventional	Steam	2004
9030802	Puteri Intan	MISC	Chantiers de l'Atlantique	130,000	Membrane	Conventional	Steam	1994
9213416	Puteri Intan Satu	MISC	Mitsubishi	137,500	Membrane	Conventional	Steam	2002
9261205	Puteri Mutiara Satu	MISC	Mitsui	137,000	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
9030826	Puteri Nilam	MISC	Chantiers de l'Atlantique	130,000	Membrane	Conventional	Steam	1995
9229647	Puteri Nilam Satu	MISC	Mitsubishi	137,500	Membrane	Conventional	Steam	2003
9030838	Puteri Zamrud	MISC	Chantiers de l'Atlantique	130,000	Membrane	Conventional	Steam	1996
9245031	Puteri Zamrud Satu	MISC	Mitsui	137,500	Membrane	Conventional	Steam	2004
9851787	Qogir	TMS Cardiff Gas	Samsung	174,000	Membrane	Conventional	X-DF	2020
9253703	Raahi	MOL, NYK, K Line, SCI, Nakilat, Petronet	Daewoo	138,100	Membrane	Conventional	Steam	2004
7411961	Ramdane Abane	Sonatrach	Chantiers de l'Atlantique	126,000	Membrane	Conventional	Steam	1981
9443413	Rasheeda	Nakilat	Samsung	266,300	Membrane	Q-Max	ME-GI	2010
9825568	Rias Baixas Knutsen	Knutsen OAS	Hyundai	180,000	Membrane	Conventional	ME-GI	2019
9477593	Ribera Duero Knutsen	Knutsen OAS	Daewoo	173,400	Membrane	Conventional	DFDE	2010
9721736	Rioja Knutsen	Knutsen OAS	Hyundai	176,000	Membrane	Conventional	ME-GI	2016
9750713	Rudolf Samoylovich	Teekay	Daewoo	172,000	Membrane	Icebreaker	TFDE	2018
9769855	Saga Dawn	Landmark Capital	Xiamen Shipbuilding Industry	45,000	Self-Supporting Prismatic	Conventional	DFDE	2019
9300817	Salalah LNG	OSC, MOL	Samsung	147,000	Membrane	Conventional	Steam	2005
9864746	Scf Barents	Sovcomflot	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9849887	Scf La Perouse	Sovcomflot	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9654878	SCF Melampus	Sovcomflot	STX	170,200	Membrane	Conventional	TFDE	2015
9654880	SCF Mitre	Sovcomflot	STX	170,200	Membrane	Conventional	TFDE	2015
9781918	Sean Spirit	Teekay	Hyundai	174,000	Membrane	Conventional	ME-GI	2018
9666558	Seishu Maru	Mitsubishi, NYK, Chubu Electric	Mitsubishi	153,000	Membrane	Conventional	Steam	2014
9293832	Seri Alam	MISC	Samsung	145,700	Membrane	Conventional	Steam	2005
9293844	Seri Amanah	MISC	Samsung	145,700	Membrane	Conventional	Steam	2006
9321653	Seri Anggun	MISC	Samsung	145,700	Membrane	Conventional	Steam	2006
9321665	Seri Angkasa	MISC	Samsung	145,700	Membrane	Conventional	Steam	2006
9329679	Seri Ayu	MISC	Samsung	145,700	Membrane	Conventional	Steam	2007
9331634	Seri Bakti	MISC	Mitsubishi	152,300	Membrane	Conventional	Steam	2007
9331660	Seri Balhaf	MISC	Mitsubishi	157,000	Membrane	Conventional	TFDE	2009
9331672	Seri Balqis	MISC	Mitsubishi	152,000	Membrane	Conventional	TFDE	2009
9331646	Seri Begawan	MISC	Mitsubishi	152,300	Membrane	Conventional	Steam	2007
9331658	Seri Bijaksana	MISC	Mitsubishi	152,300	Membrane	Conventional	Steam	2008
9714305	Seri Camar	PETRONAS	Hyundai	150,200	Membrane	Conventional	Steam reheat	2018
9714276	Seri Camellia	PETRONAS	Hyundai	150,200	Membrane	Conventional	Steam reheat	2016
9756389	Seri Cemara	PETRONAS	Hyundai	150,200	Spherical	Conventional	Steam reheat	2018
9714290	Seri Cempaka	PETRONAS	Hyundai	150,200	Spherical	Conventional	ME-GI	2017
9714288	Seri Cenderawasih	PETRONAS	Hyundai	150,200	Spherical	Conventional	Steam reheat	2017
9338797	Sestao Knutsen	Knutsen OAS	IZAR	138,000	Membrane	Conventional	Steam	2007

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
9414632	Sevilla Knutsen	Knutsen OAS	Daewoo	173,400	Membrane	Conventional	DFDE	2010
9418365	Shagra	Nakilat	Samsung	266,300	Membrane	Q-Max	SSDR	2009
9035852	Shahamah	National Gas Shipping Co	Kawasaki	135,000	Spherical	Conventional	Steam	1994
9583677	Shen Hai	China LNG, CNOOC, Shanghai LNG	Hudong-Zhonghua	147,600	Membrane	Conventional	Steam	2012
9791200	Shinshu Maru	MOL	Kawasaki	177,000	Spherical	Conventional	DFDE	2019
9320386	Simaisma	Maran Gas Maritime, Nakilat	Daewoo	145,700	Membrane	Conventional	Steam	2006
9238040	Singapore Energy	Sinokor Merchant Marine	Samsung	138,000	Membrane	Conventional	Steam	2003
9693161	SK Audace	SK Shipping, Marubeni	Samsung	180,000	Membrane	Conventional	X-DF	2017
9693173	SK Resolute	SK Shipping, Marubeni	Samsung	180,000	Membrane	Conventional	X-DF	2018
9761803	SK Serenity	SK Shipping	Samsung	174,000	Membrane	Conventional	ME-GI	2018
9761815	SK Spica	SK Shipping	Samsung	174,000	Membrane	Conventional	ME-GI	2018
9180231	SK Splendor	SK Shipping	Samsung	138,200	Membrane	Conventional	Steam	2000
9180243	SK Stellar	SK Shipping	Samsung	138,200	Membrane	Conventional	Steam	2000
9157624	SK Summit	SK Shipping	Daewoo	138,000	Membrane	Conventional	Steam	1999
9247194	SK Sunrise	SK Shipping	Samsung	138,200	Membrane	Conventional	Steam	2003
9157739	SK Supreme	SK Shipping	Samsung	138,200	Membrane	Conventional	Steam	2000
9761827	SM Eagle	Korea Line	Daewoo	174,000	Membrane	Conventional	ME-GI	2017
9761839	SM Seahawk	Korea Line	Daewoo	174,000	Membrane	Conventional	ME-GI	2017
9210816	Sohar LNG	OSC, MOL	Mitsubishi	137,200	Spherical	Conventional	Steam	2001
9791212	Sohshu Maru	MOL, JERA	Kawasaki	177,300	Spherical	Conventional	DFDE	2019
9634098	Solaris	GasLog	Samsung	155,000	Membrane	Conventional	TFDE	2014
9482304	Sonangol Benguela	Mitsui, Sonangol, Sojlitz	Daewoo	160,000	Membrane	Conventional	Steam	2011
9482299	Sonangol Etosha	Mitsui, Sonangol, Sojlitz	Daewoo	160,000	Membrane	Conventional	Steam	2011
9475600	Sonangol Sambizanga	Mitsui, Sonangol, Sojlitz	Daewoo	160,000	Membrane	Conventional	Steam	2011
9613147	Southern Cross	MOL, China LNG	Hudong-Zhonghua	168,400	Membrane	Conventional	SSDR	2015
9475208	Soyo	Mitsui, NYK, Teekay	Samsung	160,400	Membrane	Conventional	DFDE	2011
9361639	Spirit Of Hela	MOL, Itochu	Hyundai	177,000	Membrane	Conventional	DFDE	2009
9315393	Stena Blue Sky	Stena Bulk	Daewoo	145,700	Membrane	Conventional	Steam	2006
9413327	Stena Clear Sky	Stena Bulk	Daewoo	173,000	Membrane	Conventional	TFDE	2011
9383900	Stena Crystal Sky	Stena Bulk	Daewoo	173,000	Membrane	Conventional	TFDE	2011
9322255	Summit LNG	Excelerate Energy	Daewoo	138,000	Membrane	FSRU	Steam	2006
9330745	Symphonic Breeze	K Line	Kawasaki	147,600	Spherical	Conventional	Steam	2007
9403669	Taitar No.1	CPC, Mitsui. NYK	Mitsubishi	145,300	Spherical	Conventional	Steam	2009
9403645	Taitar No.2	MOL, NYK	Kawasaki	145,300	Spherical	Conventional	Steam	2009
9403671	Taitar No.3	MOL, NYK	Mitsubishi	145,300	Spherical	Conventional	Steam	2010
9403657	Taitar No.4	CPC, Mitsui. NYK	Kawasaki	145,300	Spherical	Conventional	Steam	2010

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
9334284	Tangguh Batur	NYK, Sovcomflot	Daewoo	145,700	Membrane	Conventional	Steam	2008
9349007	Tangguh Foja	K Line, PT Meratus	Samsung	154,800	Membrane	Conventional	DFDE	2008
9333632	Tangguh Hiri	Teekay	Hyundai	155,000	Membrane	Conventional	DFDE	2008
9349019	Tangguh Jaya	K Line, PT Meratus	Samsung	155,000	Membrane	Conventional	DFDE	2008
9355379	Tangguh Palung	K Line, PT Meratus	Samsung	155,000	Membrane	Conventional	DFDE	2009
9361990	Tangguh Sago	Teekay	Hyundai	155,000	Membrane	Conventional	DFDE	2009
9325893	Tangguh Towuti	NYK, PT Samudera, Sovcomflot	Daewoo	145,700	Membrane	Conventional	Steam	2008
9337731	Tembek	Nakilat, OSC	Samsung	216,200	Membrane	Q-Flex	SSDR	2007
7428433	Tenaga Empat	MISC	CNIM	130,000	Membrane	FSU	Steam	1981
7428457	Tenaga Satu	MISC	Dunkerque Chantiers	130,000	Membrane	FSU	Steam	1982
9761243	Tessala	HYPROC	Hyundai	171,800	Membrane	Conventional	TFDE	2016
9721401	Torben Spirit	Teekay	Daewoo	173,000	Membrane	Conventional	ME-GI	2017
9238038	Trader	Sinokor Merchant Marine	Samsung	138,000	Membrane	Conventional	Steam	2002
9854765	Traiano Knutsen	Knutsen OAS	Hyundai	180,000	Membrane	Conventional	ME-GI	2020
9319404	Trinity Arrow	K Line	Imabari	155,000	Membrane	Conventional	Steam	2008
9350927	Trinity Glory	K Line	Imabari	155,000	Membrane	Conventional	Steam	2009
9823883	Turquoise P	Pardus Energy	Hyundai	170,000	Membrane	FSRU	DFDE	2019
9360829	Umm Al Amad	NYK, K Line, MOL, lino, Mitsui, Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSDR	2008
9074652	Umm Al Ashtan	National Gas Shipping Co	Kvaerner Masa	135,000	Spherical	Conventional	Steam	1997
9308431	Umm Bab	Maran Gas Maritime, Nakilat	Daewoo	145,700	Membrane	Conventional	Steam	2005
9372731	Umm Slal	Nakilat	Samsung	266,000	Membrane	Q-Max	SSDR	2008
9434266	Valencia Knutsen	Knutsen OAS	Daewoo	173,400	Membrane	Conventional	DFDE	2010
9837066	Vasant 1	Triumph Offshore Pvt Ltd	Huyndai	180,000	Membrane	FSRU	DFDE	2020
9630004	Velikiy Novgorod	Sovcomflot	STX	170,200	Membrane	Conventional	DFDE	2014
9864667	Vivit Americas LNG	TMS Cardiff Gas	Hyundai	170,520	Membrane	Conventional	X-DF	2020
9750701	Vladimir Rusanov	MOL	Daewoo	172,000	Membrane	Icebreaker	TFDE	2018
9750658	Vladimir Vize	MOL	Daewoo	172,000	Membrane	Icebreaker	TFDE	2018
9750737	Vladimir Voronin	Teekay, China LNG Shipping	Daewoo	172,000	Membrane	Icebreaker	TFDE	2019
9627954	Wilforce	Teekay	Daewoo	160,000	Membrane	Conventional	TFDE	2013
9627966	Wilpride	Teekay	Daewoo	160,000	Membrane	Conventional	TFDE	2013
9753026	Woodside Chaney	Maran Gas Maritime	Hyundai	174,000	Membrane	Conventional	ME-GI	2019
9859753	Woodside Charles Allen	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9369899	Woodside Donaldson	Teekay, Marubeni	Samsung	165,500	Membrane	Conventional	DFDE	2009
9633161	Woodside Goode	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	DFDE	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
9810367	Woodside Rees Wither	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2019
9627485	Woodside Rogers	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	DFDE	2013
9750672	Yakov Gakkel	Teekay, China LNG Shipping	Daewoo	172,000	Membrane	Icebreaker	TFDE	2019
9781920	Yamal Spirit	Teekay	Hyundai	174,000	Membrane	Conventional	ME-GI	2019
9636747	Yari LNG	TMS Cardiff Gas	Daewoo	160,000	Membrane	Conventional	TFDE	2014
9629586	Yenisei River	Dynagas	Hyundai	155,000	Membrane	Conventional	DFDE	2013
9038816	YK Sovereign	SK Shipping	Hyundai	127,100	Spherical	Conventional	Steam	1994
9431214	Zarga	Nakilat	Samsung	266,000	Membrane	Q-Max	SSDR	2010
9132818	Zekreet	J4 Consortium	Mitsui	137,500	Spherical	Conventional	Steam	1998
9879698	Adamastos	Capital Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9862918	Aristarchos	Capital Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9862906	Aristidis I	Capital Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9884021	Asklipios	Capital Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9862920	Attalos	Capital Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9873852	BW Helios	BW	Daewoo	174,000	Membrane	Conventional	ME-GI	2021
9873840	BW Lesmes	BW	Daewoo	174,000	Membrane	Conventional	ME-GI	2021
9236626	BW Tatiana (ex-Gallina)	Shell	Mitsubishi	136,600	Spherical	FSRU	Steam	2002
9864796	Celsius Canberra	Celsius Shipping	Samsung	180,000	Membrane	Conventional	X-DF	2021
9878711	Celsius Charlotte	Celsius Shipping	Samsung	180,000	Membrane	Conventional	X-DF	2021
9869306	Cobia LNG	TMS Cardiff Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9869265	Cool Racer	Thenamaris	Hyundai	174,000	Membrane	Conventional	ME-GI	2021
9883742	Maran Gas Kalymnos	Maran Gas Maritime	Daewoo	174,000	Membrane	Conventional	X-DF	2021
9887217	Maran Gas Amorgos	Maran Gas Maritime	Daewoo	174,000	Membrane	Conventional	X-DF	2021
9874454	Diamond Gas Crystal	NYK Line	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9874466	Diamond Gas Victoria	NYK Line	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9884473	Elisa Aquila	NYK Line	Hyundai	174,000	Membrane	Conventional	X-DF	2022
9854624	Energy Endeavour	Alpha Gas	Daewoo	173,400	Membrane	Conventional	ME-GI	2021
9859739	Energy Integrity	Alpha Gas	Daewoo	173,400	Membrane	Conventional	ME-GI	2021
9881201	Energy Intelligence	Alpha Gas	Daewoo	173,400	Membrane	Conventional	ME-GI	2021
9859820	Ertugrul Gazi	Turkish Petroleum Corp	Hyundai	170,000	Membrane	FSRU	DFDE	2021
9862308	Flex Freedom	Flex LNG	Daewoo	173,400	Membrane	Conventional	ME-GI	2021
9862475	Flex Vigilant	Flex LNG	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9862463	Flex Volunteer	Flex LNG	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9877145	Gail Bhuwan	MOL	Daewoo	176,500	Membrane	Conventional	X-DF	2021
9864928	Gaslog Galveston	GasLog	Samsung	174,000	Membrane	Conventional	X-DF	2021
9876660	Gaslog Wellington	GasLog	Samsung	180,000	Membrane	Conventional	X-DF	2021
9876737	Gaslog Winchester	GasLog	Samsung	180,000	Membrane	Conventional	X-DF	2021
9880465	Global Sea Spirit	Maran Gas Maritime	Daewoo	174,000	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	174,000	Membrane	Conventional	X-DF	2022
9859741	Global Star	Nakilat; Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	ME-GI	2021
9884174	Grace Emelia	NYK Line	Hyundai	174,000	Membrane	Conventional	X-DF	2022
9878888	Gui Ying	CSSC Shpg Leasing	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2021
9872999	Hellas Athina	Latsco (London)	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9872987	Hellas Diana	Latsco (London)	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9861811	Transgas Force	Dynagas	Hudong-Zhonghua	174,000	Membrane	FSRU	DFDE	2021
9892456	Tenergy	Tsakos	Hyundai	174,000	Membrane	Conventional	X-DF	2022
9888481	Prism Courage	SK Shipping	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9854935	Jawa Satu	Jawa Satu Regas	Samsung	170,000	Membrane	FSRU	DFDE	2021
9043677	Karmol LNGT Powership Africa	Karpowership, MOL	Mitsubishi	127,386	Spherical	FSRU	Steam	1994
8608705	Karmol LNGT Powership Asia	Karpowership, MOL	Kawasaki	127,000	Spherical	FSRU	Steam	1991
9870159	LNG Adventure	France LNG Shipping	Samsung	174,000	Membrane	Conventional	X-DF	2021
9006681	LNG Flora	LNG Flora Shipping Co Sa	Kawasaki	127,700	Spherical	FSRU	Steam	1993
9877133	LNG Rosenrot	MOL	Daewoo	174,000	Membrane	Conventional	X-DF	2021
9872949	LNGships Athena	TMS Cardiff Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9875800	LNGships Empress	TMS Cardiff Gas	Samsung	174,000	Membrane	Conventional	X-DF	2021
9872901	LNGships Manhatten	TMS Cardiff Gas	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9874820	Maran Gas Isabella	Maran Gas Maritime	Daewoo	173,400	Membrane	Conventional	X-DF	2021
9901350	John A Angelicoussis	Maran Gas Maritime	Daewoo	174,000	Membrane	Conventional	ME-GI	2022
9880192	Marvel Swan	Navigare Capital Partners	Samsung	174,000	Membrane	Conventional	DFDE	2021
9877341	Minerva Chios	Minerva Marine	Samsung	174,000	Membrane	Conventional	X-DF	2021
9869942	Minerva Kalymnos	Minerva Marine	Samsung	174,000	Membrane	Conventional	X-DF	2021
9854375	Minerva Limnos	Minerva Marine	Daewoo	173,400	Membrane	Conventional	ME-GI	2021
9854363	Minerva Psara	Minerva Marine	Daewoo	173,400	Membrane	Conventional	ME-GI	2021
9885996	MOL Hestia	MOL	Daewoo	173,400	Membrane	Conventional	X-DF	2021
9878876	Mu Lan	CSSC Shpg Leasing	Hudong-Zhonghua	178,000	Membrane	Conventional	X-DF	2021
7391214	Ocean Quest	Hong Kong LNG	Newport News Shipbuilding	128,000	Membrane	Conventional	Steam	1979
9874040	Ravenna Knutsen	Knutsen OAS	Hyundai	30,000	Type C	Conventional	X-DF	2021
9888766	Orion Star	J.P. Morgan	Samsung	174,000	Membrane	Conventional	X-DF	2022
9874480	LNG Enterprise	NYK Line	Samsung	174,000	Membrane	Conventional	X-DF	2021
9874492	LNG Endurance	NYK Line	Samsung	174,000	Membrane	Conventional	X-DF	2021
9889904	Orion Sea	J.P. Morgan	Samsung	174,000	Membrane	Conventional	X-DF	2022

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
9893606	LNG Endeavour	NYK Line	Samsung	174,000	Membrane	Conventional	X-DF	2021
9878723	Celsius Carolina	Celsius Shipping	Samsung	180,000	Membrane	Conventional	X-DF	2021
9870525	SCF Timmerman	Sovcomflot	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9861809	Transgas Power	Dynagas	Hudong-Zhonghua	174,000	Membrane	FSRU	DFDE	2021
9895238	Vivirt City	H-Line Shipping	Hyundai	174,000	Membrane	Conventional	X-DF	2021
9879674	Yiannis	Maran Gas Maritime	Daewoo	174,000	Membrane	Conventional	ME-GI	2021
9892717	Maran Gas Ithaca	Maran Gas Maritime	Daewoo	174,000	Membrane	Conventional	X-DF	2021

Appendix 4: Table of global LNG vessel orderbook, end-of-April 2022

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9948695	Alexandre Dumas	Sovcomflot	Hyundai	174,000	X-DF	2023
9904546	Alexey Kosygin	Sovcomflot	Samsung	172,600	DFDE	2023
9904194	Alicante Knutsen	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2022
9943841	Amore Mio I	Capital Gas	Hyundai	174,000	X-DF	2023
9892298	Asterix I	Capital Gas	Hyundai	174,000	X-DF	2022
9943853	Axios II	Capital Gas	Hyundai	174,000	X-DF	2023
9896933	BW Cassia	BW LNG	Daewoo	174,000	ME-GI	2022
9896921	BW Iris	BW LNG	Daewoo	174,000	ME-GI	2022
9886732	Clean Cajun	Dynagas Ltd	Hyundai	200,000	X-DF	2022
9886744	Clean Copano	Dynagas Ltd	Hyundai	200,000	X-DF	2022
9919890	Coral Nordic	Anthony Veder	Jiangnan	30,000	DFM	2022
9918145	El Ferrol Knutsen	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2023
9918157	Extremedura Knutsen	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2023
9903920	Grace Freesia	Nippon Yusen Kaisha	Hyundai	174,000	X-DF	2022
9922988	Grazyna Gesicka	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2023
9953248	HUDONG-ZHONGHUA H1790A	Mitsui OSK Lines	Hudong Zhonghua	174,000	X-DF	2024
9953250	HUDONG-ZHONGHUA H1791A	Mitsui OSK Lines	Hudong Zhonghua	174,000	X-DF	2024
9953262	HUDONG-ZHONGHUA H1792A	Mitsui OSK Lines	Hudong Zhonghua	174,000	X-DF	2025
9953274	HUDONG-ZHONGHUA H1793A	Mitsui OSK Lines	Hudong Zhonghua	174,000	X-DF	2025
9961477	HUDONG-ZHONGHUA H1880A	CNOOC/COSCO/ MOL JV	Hudong Zhonghua	174,000	X-DF	2024
9961489	HUDONG-ZHONGHUA H1881A	CNOOC/COSCO/ MOL JV	Hudong Zhonghua	174,000	X-DF	2024
9961491	HUDONG-ZHONGHUA H1882A	CNOOC/COSCO/ MOL JV	Hudong Zhonghua	174,000	X-DF	2025
9961506	HUDONG-ZHONGHUA H1883A	CNOOC/COSCO/ MOL JV	Hudong Zhonghua	174,000	X-DF	2025
9961518	HUDONG-ZHONGHUA H1884A	CNOOC/COSCO/ MOL JV	Hudong Zhonghua	174,000	X-DF	2025
9961520	HUDONG-ZHONGHUA H1885A	CNOOC/COSCO/ MOL JV	Hudong Zhonghua	174,000	X-DF	2026
9904209	Huelva Knutsen	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2022
9905980	Lagenda Serenity	K-Line	Hudong Zhonghua	80,000	X-DF	2022
9905978	Lagenda Suria	K-Line	Hudong Zhonghua	80,000	X-DF	2022
9922976	Lech Kaczynski	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2022
9904182	Malaga Knutsen	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2022
9885855	Minerva Amorgos	Minerva Marine	Samsung	174,000	X-DF	2022
9918028	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	172,600	DFDE	2023
9918030	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	172,600	DFDE	2023
9918042	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	172,600	DFDE	2023
9918054	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	X-DF	2023
Unknown	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	X-DF	2024
Unknown	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	X-DF	2024

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
Unknown	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	X-DF	2024
Unknown	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	X-DF	2024
Unknown	N/B Daewoo (DSME)	Unknown	Daewoo	174,000	X-DF	2024
Unknown	N/B Daewoo (DSME)	GasLog	Daewoo	174,000	ME-GI	2024
Unknown	N/B Daewoo (DSME)	GasLog	Daewoo	174,000	ME-GI	2024
Unknown	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	X-DF	2024
Unknown	N/B Daewoo (DSME)	BW LNG	Daewoo	174,000	ME-GI	2025
Unknown	N/B Daewoo (DSME)	BW LNG	Daewoo	174,000	ME-GI	2025
Unknown	N/B Daewoo (DSME)	GasLog	Daewoo	174,000	ME-GI	2025
Unknown	N/B Daewoo (DSME)	GasLog	Daewoo	174,000	ME-GI	2025
Unknown	N/B Daewoo (DSME)	Unknown	Daewoo	200,000	ME-GA	2025
Unknown	N/B Daewoo (DSME)	Unknown	Daewoo	200,000	ME-GA	2025
Unknown	N/B Daewoo (DSME)	Unknown	Daewoo	200,000	ME-GA	2025
Unknown	N/B Daewoo (DSME)	Unknown	Daewoo	174,000	ME-GA	2025
Unknown	N/B Daewoo (DSME)	Unknown	Daewoo	174,000	ME-GA	2025
Unknown	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	ME-GA	2026
Unknown	N/B Daewoo (DSME)	Mitsui OSK Lines	Daewoo	174,000	ME-GA	2026
9918004	N/B Daewoo (DSME) Geoje 2514	Sovcomflot	Daewoo	172,600	DFDE	2023
9918016	N/B Daewoo (DSME) Geoje 2515	Sovcomflot	Daewoo	172,600	DFDE	2023
9941013	N/B Daewoo (DSME) Geoje 2521	Hyundai LNG Shipping	Daewoo	174,000	ME-GI	2023
9947691	N/B Daewoo (DSME) Geoje 2522	Hyundai LNG Shipping	Daewoo	174,000	ME-GI	2024
9956393	N/B Daewoo (DSME) Geoje 2528	Maran Gas Maritime	Daewoo	174,000	ME-GI	2024
9956408	N/B Daewoo (DSME) Geoje 2529	Maran Gas Maritime	Daewoo	174,000	ME-GI	2024
9961398	N/B Daewoo (DSME) Geoje 2537	Maran Gas Maritime	Daewoo	174,000	ME-GI	2025
9961403	N/B Daewoo (DSME) Geoje 2538	Maran Gas Maritime	Daewoo	174,000	ME-GI	2025
9963815	N/B Daewoo (DSME) Geoje 2539	Maran Gas Maritime	Daewoo	174,000	ME-GI	2025
9963827	N/B Daewoo (DSME) Geoje 2540	Maran Gas Maritime	Daewoo	174,000	ME-GI	2025
Unknown	N/B Dalian Shipbuilding	China Merchants Shpg	Dalian	174,000	X-DF	2025
Unknown	N/B Dalian Shipbuilding	China Merchants Shpg	Dalian	174,000	X-DF	2026
9915894	N/B Hudong Zhonghua	United Liquefied Gas	Hudong Zhonghua	174,000	X-DF	2024
9915909	N/B Hudong Zhonghua	United Liquefied Gas	Hudong Zhonghua	174,000	X-DF	2024
9915911	N/B Hudong Zhonghua	United Liquefied Gas	Hudong Zhonghua	174,000	X-DF	2024
Unknown	N/B Hudong Zhonghua	CNOOC/CMES/NYK JV	Hudong Zhonghua	174,000	X-DF	2025
Unknown	N/B Hudong Zhonghua	COSCO Hong Kong LNG	Hudong Zhonghua	174,000	X-DF	2025
Unknown	N/B Hudong Zhonghua	CNOOC/CMES/NYK JV	Hudong Zhonghua	174,000	X-DF	2025
Unknown	N/B Hudong Zhonghua	CNOOC/CMES/NYK JV	Hudong Zhonghua	174,000	X-DF	2026
Unknown	N/B Hudong Zhonghua	CNOOC/CMES/NYK JV	Hudong Zhonghua	174,000	X-DF	2026

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
Unknown	N/B Hudong Zhonghua	CNOOC/CMES/NYK JV	Hudong Zhonghua	174,000	X-DF	2026
Unknown	N/B Hudong Zhonghua	COSCO Hong Kong LNG	Hudong Zhonghua	174,000	X-DF	2026
Unknown	N/B Hudong Zhonghua	CNOOC/CMES/NYK JV	Hudong Zhonghua	174,000	X-DF	2027
9892121	N/B Hudong Zhonghua Shanghai H1829A	CSSC Shpg Leasing	Hudong Zhonghua	174,000	X-DF	2024
9892133	N/B Hudong Zhonghua Shanghai H1830A	CSSC Shpg Leasing	Hudong Zhonghua	174,000	X-DF	2024
9915894	N/B Hudong Zhonghua Shanghai H1831A	United Liquefied Gas	Hudong Zhonghua	174,000	X-DF	2022
9915911	N/B Hudong Zhonghua Shanghai H1833A	United Liquefied Gas	Hudong Zhonghua	174,000	X-DF	2023
9937907	N/B Hudong Zhonghua Shanghai H1837A	Shenzhen Gas	Hudong Zhonghua	80,000	X-DF	2023
Unknown	N/B Hyundai HI (Ulsan)	Unknown	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai HI (Ulsan)	Unknown	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai HI (Ulsan)	Unknown	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai HI (Ulsan)	Unknown	Hyundai	174,000	ME-GA	2025
9902914	N/B Hyundai HI (Ulsan) Ulsan 3186	Korea Line LNG	Hyundai	174,000	X-DF	2022
9902926	N/B Hyundai HI (Ulsan) Ulsan 3187	Global Meridian	Hyundai	174,000	X-DF	2022
9902938	N/B Hyundai HI (Ulsan) Ulsan 3188	Global Meridian	Hyundai	174,000	X-DF	2022
9917543	N/B Hyundai HI (Ulsan) Ulsan 3189	Unknown	Hyundai	174,000	X-DF	2023
9917555	N/B Hyundai HI (Ulsan) Ulsan 3190	Unknown	Hyundai	174,000	X-DF	2023
9926908	N/B Hyundai HI (Ulsan) Ulsan 3221	Pan Ocean	Hyundai	174,000	X-DF	2024
9926910	N/B Hyundai HI (Ulsan) Ulsan 3222	Pan Ocean	Hyundai	174,000	X-DF	2024
9926922	N/B Hyundai HI (Ulsan) Ulsan 3223	Unknown	Hyundai	174,000	X-DF	2024
9947500	N/B Hyundai HI (Ulsan) Ulsan 3224	Pan Ocean	Hyundai	174,000	X-DF	2024
9947512	N/B Hyundai HI (Ulsan) Ulsan 3225	Pan Ocean	Hyundai	174,000	X-DF	2024
9943475	N/B Hyundai HI (Ulsan) Ulsan 3290	Dynagas Ltd	Hyundai	200,000	X-DF	2023
9943487	N/B Hyundai HI (Ulsan) Ulsan 3291	Dynagas Ltd	Hyundai	200,000	X-DF	2023
9943499	N/B Hyundai HI (Ulsan) Ulsan 3292	Dynagas Ltd	Hyundai	200,000	X-DF	2024
9943504	N/B Hyundai HI (Ulsan) Ulsan 3293	Dynagas Ltd	Hyundai	200,000	X-DF	2024
9937945	N/B Hyundai HI (Ulsan) Ulsan 3294	Hyundai LNG Shipping	Hyundai	174,000	X-DF	2024
9937957	N/B Hyundai HI (Ulsan) Ulsan 3295	Hyundai LNG Shipping	Hyundai	174,000	X-DF	2024
9937969	N/B Hyundai HI (Ulsan) Ulsan 3296	Hyundai LNG Shipping	Hyundai	174,000	X-DF	2024
9947598	N/B Hyundai HI (Ulsan) Ulsan 3297	Hyundai LNG Shipping	Hyundai	174,000	X-DF	2024
9947603	N/B Hyundai HI (Ulsan) Ulsan 3298	Hyundai LNG Shipping	Hyundai	174,000	X-DF	2024

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9947615	N/B Hyundai HI (Ulsan) Ulsan 3299	Hyundai LNG Shipping	Hyundai	174,000	ME-GA	2025
9957725	N/B Hyundai HI (Ulsan) Ulsan 3341	Capital Gas	Hyundai	174,000	X-DF	2024
9957737	N/B Hyundai HI (Ulsan) Ulsan 3342	Unknown	Hyundai	174,000	X-DF	2024
9967328	N/B Hyundai HI (Ulsan) Ulsan 3356	Dynagas Ltd	Hyundai	200,000	ME-GA	2025
9967330	N/B Hyundai HI (Ulsan) Ulsan 3357	Dynagas Ltd	Hyundai	200,000	ME-GA	2025
9967342	N/B Hyundai HI (Ulsan) Ulsan 3358	Dynagas Ltd	Hyundai	200,000	ME-GA	2025
9955521	N/B Hyundai Mipo Ulsan 8354	Anthony Veder	Hyundai	30,000	X-DF	2023
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2023
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2023
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2023
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2023
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2023
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI	Nippon Yusen Kaisha	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai Samho HI	Knutsen OAS Shipping	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai Samho HI	Nippon Yusen Kaisha	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	ME-GA	2025
Unknown	N/B Hyundai Samho HI	Unknown	Hyundai	174,000	ME-GA	2025
9926714	N/B Hyundai Samho HI Yeongam 8100	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2024
9946350	N/B Hyundai Samho HI Yeongam 8101	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2024
9946362	N/B Hyundai Samho HI Yeongam 8102	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI Yeongam 8106	Sovcomflot	Hyundai	174,000	X-DF	2024
Unknown	N/B Hyundai Samho HI Yeongam 8107	Sovcomflot	Hyundai	174,000	X-DF	2024
9946374	N/B Hyundai Samho HI Yeongam 8139	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2024
9958286	N/B Hyundai Samho HI Yeongam 8140	Capital Gas	Hyundai	174,000	X-DF	2024
9946386	N/B Hyundai Samho HI Yeongam 8148	Knutsen OAS Shipping	Hyundai	174,000	ME-GA	2025
9946398	N/B Hyundai Samho HI Yeongam 8149	Knutsen OAS Shipping	Hyundai	174,000	ME-GA	2025

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
Unknown	N/B Hyundai Samho HI Yeongam 8170	Hyundai Glovis	Hyundai	174,000	X-DF	2024
9964182	N/B Hyundai Samho HI Yeongam 8173	SK Shipping	Hyundai	174,000	X-DF	2024
9968451	N/B Hyundai Samho HI Yeongam 8177	Unknown	Hyundai	174,000	ME-GA	2025
9968463	N/B Hyundai Samho HI Yeongam 8178	Unknown	Hyundai	174,000	ME-GA	2025
9965423	N/B Jiangnan SY Group	ADNOC Logistics	Jiangnan	174,000	X-DF	2025
9965435	N/B Jiangnan SY Group	ADNOC Logistics	Jiangnan	174,000	X-DF	2025
9864837	N/B Jiangnan SY Group Shanghai H2637	Jovo Group	Jiangnan	80,000	X-DF	2023
Unknown	N/B Samsung HI	Pan Ocean	Samsung	174,000	X-DF	2023
Unknown	N/B Samsung HI	NYK & Sovcomflot JV	Samsung	174,000	X-DF	2023
Unknown	N/B Samsung HI	NYK & Sovcomflot JV	Samsung	174,000	X-DF	2023
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	NYK & Sovcomflot JV	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	NYK & Sovcomflot JV	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	X-DF	2024
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Celsius Tankers	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2025
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2026
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2026
Unknown	N/B Samsung HI	Unknown	Samsung	174,000	ME-GA	2026
9904675	N/B Samsung HI / Zvezda Shipbuilding 042	Smart LNG	Samsung	172,600	DFDE	2023

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9904687	N/B Samsung HI / Zvezda Shipbuilding 043	Smart LNG	Samsung	172,600	DFDE	2023
9904699	N/B Samsung HI / Zvezda Shipbuilding 044	Smart LNG	Samsung	172,600	DFDE	2023
9904704	N/B Samsung HI / Zvezda Shipbuilding 045	Smart LNG	Samsung	172,600	DFDE	2023
9903425	N/B Samsung HI Geoje 2315	Sinokor Merchant	Samsung	174,000	X-DF	2022
9903437	N/B Samsung HI Geoje 2316	Sinokor Merchant	Samsung	174,000	X-DF	2022
9903449	N/B Samsung HI Geoje 2317	Sinokor Merchant	Samsung	174,000	X-DF	2022
9903451	N/B Samsung HI Geoje 2318	Sinokor Merchant	Samsung	174,000	X-DF	2022
9896440	N/B Samsung HI Geoje 2364	MISC	Samsung	174,000	X-DF	2023
9896452	N/B Samsung HI Geoje 2365	MISC	Samsung	174,000	X-DF	2023
9924869	N/B Samsung HI Geoje 2425	Maran Gas Maritime	Samsung	174,000	X-DF	2023
9945435	N/B Samsung HI Geoje 2459	Celsius Tankers	Samsung	180,000	X-DF	2023
9945447	N/B Samsung HI Geoje 2460	Celsius Tankers	Samsung	180,000	X-DF	2024
9945459	N/B Samsung HI Geoje 2461	Celsius Tankers	Samsung	180,000	X-DF	2024
9941518	N/B Samsung HI Geoje 2473	Maran Gas Maritime	Samsung	174,000	X-DF	2024
9941520	N/B Samsung HI Geoje 2474	Maran Gas Maritime	Samsung	174,000	X-DF	2024
9946829	N/B Samsung HI Geoje 2579	Celsius Tankers	Samsung	180,000	X-DF	2024
9948724	N/B Samsung HI Geoje 2584	Celsius Tankers	Samsung	180,000	X-DF	2024
9948736	N/B Samsung HI Geoje 2585	Celsius Tankers	Samsung	180,000	X-DF	2024
9958999	N/B Samsung HI Geoje 2598	Celsius Tankers	Samsung	174,000	ME-GA	2025
9959008	N/B Samsung HI Geoje 2599	Celsius Tankers	Samsung	174,000	ME-GA	2025
9918779	N/B Zvezda Shipbuilding Bolshoy Kamen 046	Smart LNG	Zvezda	172,600	DFDE	2024
9918781	N/B Zvezda Shipbuilding Bolshoy Kamen 047	Smart LNG	Zvezda	172,600	DFDE	2024
9918793	N/B Zvezda Shipbuilding Bolshoy Kamen 048	Smart LNG	Zvezda	172,600	DFDE	2024
9918808	N/B Zvezda Shipbuilding Bolshoy Kamen 049	Smart LNG	Zvezda	172,600	DFDE	2024
9918810	N/B Zvezda Shipbuilding Bolshoy Kamen 050	Smart LNG	Zvezda	172,600	DFDE	2024
9918822	N/B Zvezda Shipbuilding Bolshoy Kamen 051	Smart LNG	Zvezda	172,600	DFDE	2025
9918834	N/B Zvezda Shipbuilding Bolshoy Kamen 052	Smart LNG	Zvezda	172,600	DFDE	2025
9918846	N/B Zvezda Shipbuilding Bolshoy Kamen 053	Smart LNG	Zvezda	172,600	DFDE	2025
9918858	N/B Zvezda Shipbuilding Bolshoy Kamen 054	Smart LNG	Zvezda	172,600	DFDE	2025

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9918860	N/B Zvezda Shipbuilding Bolshoy Kamen 055	Smart LNG	Zvezda	172,600	DFDE	2025
9889916	Orion Sun	Oceonix Services Ltd	Samsung	174,000	X-DF	2022
9904651	Prism Diversity	SK Shipping	Hyundai	174,000	X-DF	2022
9904170	Santander Knutsen	Knutsen OAS Shipping	Hyundai	174,000	X-DF	2022
9902902	SM Albatross	Korea Line LNG	Hyundai	174,000	X-DF	2022
9917567	SM Golden Eagle	Korea Line LNG	Hyundai	174,000	X-DF	2023
9917579	SM Kestrel	Korea Line LNG	Hyundai	174,000	X-DF	2023
9902756	Vivit Arabia LNG	H-Line Shipping	Hyundai	174,000	X-DF	2022
9915909	Wu Dang	United Liquefied Gas	Hudong Zhonghua	174,000	X-DF	2022

Appendix 5: Table of Global LNG Receiving Terminals

Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
1	Argentina	Bahia Blanca	2021	3.8	YPF (50%); Stream JV (50%);	Floating
2	Argentina	GNL Escobar - Excelerate Exemplar	2011	3.8	YPF (50%); Enarsa (50%);	Floating
3	Bangladesh	Moheshkha-li - Excelerate Excellence	2018	3.75	Terminal: PetroBangla (100%), FSRU: Excel-erate Energy (100%)	Floating
4	Bangladesh	Summit LNG	2019	3.8	Terminal: Summit Corp (75%); Mitsubishi (25%), FSRU: Excelerate Energy (100%)	Floating
5	Belgium	Zeebrugge	1987	6.6	Fluxys LNG SA (100%)	Onshore
6	Brazil	Acu Port LNG - BW Magna	2020	5.6	Prumo Logistica (46.9%); Siemens (33%); BP (20.1%)	Floating
7	Brazil	Bahia LNG	2021	5.37	Petrobras (100%);	Floating
8	Brazil	Guanabara LNG	2020	8.05	Petrobras (100%);	Floating
9	Brazil	Pecem LNG	2021	3.8	Petrobras (100%);	Floating
10	Brazil	Sergipe - Golar Nanook FSRU	2019	5.6	Elbrasil (50%); Golar Power (50%);	Floating
11	Canada	Saint John LNG	2009	7.5	Repsol (100%);	Onshore
12	Chile	GNL Mejillones 2 (onshore storage)	2014	1.5	ENGIE (63%); Ameris Capital AGF(37%);	Onshore
13	Chile	GNL Quintero	2009	4.0	ENAGAS (60.4%); ENAP (20%); Oman Oil (19.6%);	Onshore
14	China	Caofeidian (Tangshan) LNG	2013	10	CNPC (51%); Beijing Enterprises Group Company (29%); Hebei Natural Gas (20%);	Onshore
15	China	Dalian LNG	2011	6	PipeChina (75%); Dalian Port (20%); Dalian Construction Investment Corporation (5%);	Onshore
16	China	Diefu LNG (Shen-zhen)	2018	4	PipeChina (70%); Shenzhen Energy Group (30%)	Onshore
17	China	Fangchenggang LNG	2019	0.6	PipeChina (51%); Guangxi Beibu Gulf Port Group (49%)	Onshore
18	China	Fujian LNG	2009	6.3	CNOOC (60%); Fujian Investment and Development Co (40%);	Onshore
19	China	Guangdong Dapeng LNG	2006	6.8	Local Company (37%); CNOOC (33%); BP (30%)	Onshore
20	China	Guangxi (Beihai) LNG	2016	3	PipeChina (80%); Guangxi Beibu Gulf Port Group (20%)	Onshore
21	China	Hainan LNG	2014	4.32	PipeChina (65%); Hainan Developing Hold-ing (35%)	Onshore
22	China	Jiangsu Rudong LNG	2011	10	CNPC (55%); Pacific Oil and Gas (35%); Jiangsu Guoxin (10%);	Onshore
23	China	Jiaxing LNG	2022	1	Jiaxing Gas Group (51%); Hangzhou Gas (49%);	Onshore
24	China	Jieyang LNG (Yuedong)	2017	2	PipeChina (100%)	Onshore
25	China	Jovo Dongguan	2013	1.5	Jovo Group (100%);	Onshore
26	China	Qidong LNG	2017	3.05	Xinjiang Guanghui Petroleum (100%)	Onshore
27	China	Shandong (Qing-dao) LNG	2014	7	Sinopec (99%); Qingdao Port(1%);	Onshore
28	China	Shenzhen Gas LNG	2019	0.8	Shenzhen Gas (100%);	Onshore
29	China	Tianjin (CNOOC)	2018	3.5	CNOOC (100%);	Onshore
30	China	Tianjin (Sinopec)	2018	3	Sinopec (100%);	Onshore
31	China	Tianjin FSRU - Hoegh Esper-anza	2018	6	PipeChina (100%);	Floating

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

Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
32	China	Wuhaogou LNG	2008	1.5	Shenergy (100%)	Onshore
33	China	Yangshan LNG (Shanghai)	2009	6	Shenergy Group (55%); CNOOC (45%);	Onshore
34	China	Zhejiang Ningbo LNG	2012	6	CNOOC (51%); Zhejiang Energy Company (29%); Ningbo Power (20%)	Onshore
35	China	Zhoushan ENN LNG	2018	5	ENN Group (90%); SK E&S (10%);	Onshore
36	China	Zhuhai LNG	2013	3.5	CNOOC (30%); Guangdong Gas (25%); Guangdong Yuedian (25%); Local companies (20%);	Onshore
37	Chinese Taipei	Taichung LNG	2009	6	CPC (100%);	Onshore
38	Chinese Taipei	Yung-An	1990	9.5	CPC (100%);	Onshore
39	Colombia	SPEC FSRU (Hoegh Grace)	2016	3	Hoegh LNG (0%); Promigas (51%); Baru LNG (49%);	Floating
40	Croatia	Krk LNG	2021	1.9	Terminal: HEP (85%); Plinacro (15%), FSRU: Golar (100%)	Floating
41	Dominican Republic	AES Andres LNG	2003	1.9	AES (92%); Estrella-Linda (8%);	Onshore
42	Egypt	Sumed - BW Singapore	2017	5.7	Terminal: EGAS (100%), FSRU: BW (100%)	Floating
43	El Salvador	El Salvador FSRU	2022	2.3	Energía del Pacífico (100%);	Floating
44	France	Dunkerque LNG	2017	9.6	Consortium led by Fluxys with AXA Investment Managers & Crédit Agricole Assurances (60.76%); Korean investors consortium led by IPM Group in cooperation with Samsung Asset Management (39.24%)	Onshore
45	France	Fos Cavaou	2010	6	ENGIE (100%)	Onshore
46	France	Fos Tonkin	1972	2.2	ENGIE (100%)	Onshore
47	France	Montoir-de-Bretagne	1980	7.3	ENGIE (100%);	Onshore
48	Greece	Revithoussa	2000	4.6	DEPA (100%)	Onshore
49	India	Dabhol LNG	2013	2	Gail (31.52%); NTPC (31.52%); Indian Financial Institutions (20.28%); MSEB Holding Co. (16.68%);	Onshore
50	India	Dahej LNG	2004	17.5	Petronet LNG (100%);	Onshore
51	India	Ennore LNG	2019	5	Indian Oil Corporation (95%); Tamil Nadu Industrial Development Corporation (5%);	Onshore
52	India	Hazira LNG	2005	5	Shell (100%)	Onshore
53	India	Kochi LNG	2013	5	Petronet LNG (100%);	Onshore
54	India	Mundra LNG	2020	5	GSCP (50%); Adani Group (50%);	Onshore
55	Indonesia	Arun LNG	2015	3	Pertamina (70%); Aceh Regional Government (30%);	Onshore
56	Indonesia	Cilamaya - Jawa 1 FSRU	2021	2.4	Pertamina (26%); Humpuss (25%); Marubeni (20%); MOL (19%); Sojitz (10%)	Floating
57	Indonesia	Lampung LNG - PGN FSRU Lampung	2014	1.8	LNG Indonesia (100%);	Floating
58	Indonesia	Nusantara Regas Satu - FSRU Jawa Barat	2012	3.8	Pertamina (60%); PGN (40%);	Floating
59	Israel	Hadera Deepwater LNG - Excelerate Expedient	2013	3	INGL (100%);	Floating
60	Italy	Adriatic LNG	2009	5.8	ExxonMobil (70.7%); Qatar Petroleum (22%); Snam (7.3%);	Offshore
61	Italy	Panigaglia LNG	1971	2.5	GNL Italia (100%);	Onshore

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

Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
62	Italy	Toscana - Toscana FSRU	2013	2.7	IREN Group (49.07%); First State Investments (48.24%); Golar LNG (2.69%)	Floating
63	Jamaica	Old Harbour LNG	2019	3.6	New Fortress Energy (100%);	Floating
64	Japan	Akita LNG	2015	0.58	Tobu Gas (100%);	Onshore
65	Japan	Chita LNG	1983	18.4	JERA (50%); Toho Gas (50%);	Onshore
66	Japan	Chita Midorihama Works	2001	8.3	Toho Gas (100%);	Onshore
67	Japan	Futtsu LNG	1985	16	JERA (100%);	Onshore
68	Japan	Hachinohe	2015	1.5	JX Nippon Oil & Energy (100%);	Onshore
69	Japan	Hatsukaichi	1996	0.9	Hiroshima Gas (100%);	Onshore
70	Japan	Hibiki LNG	2014	2.4	Saibu Gas (90%); Kyushu Electric (10%);	Onshore
71	Japan	Higashi-Niigata	1984	8.9	Nihonkai LNG (58.1%); Tohuko Electric (41.9%);	Onshore
72	Japan	Higashi-Ohgishima	1984	14.7	JERA (100%);	Onshore
73	Japan	Himeji	1979	14	Osaka Gas (100%);	Onshore
74	Japan	Hitachi LNG	2016	6.4	Tokyo Gas (100%);	Onshore
75	Japan	Ishikari LNG	2012	2.7	Hokkaido Gas (100%);	Onshore
76	Japan	Joetsu	2012	2.3	JERA (100%);	Onshore
77	Japan	Kawagoe	1997	7.7	JERA (100%);	Onshore
78	Japan	Kushiro LNG	2015	0.5	Nippon Oil (100%);	Onshore
79	Japan	Mizushima	2006	4.3	Chugoku Electric (50%); JX Nippon Oil & Energy (50%);	Onshore
80	Japan	Naoetsu LNG	2013	FSU, JRU	INPEX (100%);	Onshore
81	Japan	Negishi	1969	12	JERA (50%); Tokyo Gas (50%);	Onshore
82	Japan	Niihama LNG	2022	1	Tokyo Gas (50.1%); Shikoku Electric Power (30.1%); Other Japanese Partneers (19.8%);	Onshore
83	Japan	Ohgishima	1998	9.9	Tokyo Gas (100%);	Onshore
84	Japan	Oita LNG	1990	5.1	Kyushu Electric (100%);	Onshore
85	Japan	Sakai LNG	2006	6.4	Kansai Electric (70%); Cosmo Oil (12.5%); Iwatani (12.5%); Ube Industries (5%);	Onshore
86	Japan	Sakaide LNG	2010	1.2	Shikoku Electric Power Co. (70%); Cosmo Oil Co. Ltd (20%); Shikoku Gas Co. (10%);	Onshore
87	Japan	Senboku	1972	15.3	Osaka Gas (100%);	Onshore
88	Japan	Shin-Minato	1997	0.3	Sendai Gas (0%); Gas Bureau (100%);	Onshore
89	Japan	Shin-Sendai	2015	1.5	Tohoku Electric (100%);	Onshore
90	Japan	Sodegaura	1973	29.4	JERA (50%); Tokyo Gas (50%);	Onshore
91	Japan	Sodeshi	1996	1.6	Shizuoka Gas (65%); TonenGeneral (35%);	Onshore
92	Japan	Soma LNG	2018	1.5	JAPEX (100%);	Onshore
93	Japan	Tobata	1977	6.8	Kitakyushu LNG (100%);	Onshore
94	Japan	Yanai	1990	2.4	Chugoku Electric (100%);	Onshore
95	Japan	Yokkaichi LNG Center	1987	7.1	JERA (100%);	Onshore
96	Japan	Yokkaichi Works	1991	2.1	Toho Gas (100%);	Onshore
97	Jordan	Jordan LNG - Golar Eskimo	2015	3.8	Golar LNG (0%); Jordan MEMR (100%);	Floating
98	Kuwait	Al-Zour LNG	2021	11	Kuwait Petroleum Corporation (100%);	Onshore

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

Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
99	Kuwait	Mina Al Ahmadi - Golar Igloo	2014	5.8	Golar LNG (0%); Kuwait Petroleum Corporation (100%);	Floating
100	Lithuania	Klaipeda LNG - Hoegh Independence	2014	3	Klaipedos Nafta (100%);	Floating
101	Malaysia	Melaka LNG	2013	3.8	Petronas (100%);	Offshore
102	Malaysia	Pengerang LNG	2017	3.5	PETRONAS (65%); Dialog Group (25%); Johor Government (10%);	Onshore
103	Mexico	Energia Costa Azul	2008	7.6	Sempra Energy (100%);	Onshore
104	Mexico	Pichilingue LNG	2021	0.8	New Fortress Energy (100%);	Onshore
105	Mexico	Terminal de LNG Altamira	2006	5.4	Vopak (60%); ENAGAS (40%);	Onshore
106	Mexico	Terminal KMS	2012	3.8	Samsung (37.5%); Mitsui (37.5%); KOGAS (25%);	Onshore
107	Myanmar	Thanlyin (Thilawa) LNG	2020	1.5	CNTIC VPower (100%);	Onshore
108	Netherlands	Gate LNG terminal (LNG Rotterdam)	2011	9	Gasuine (50%); Vopak (50%);	Onshore
109	Pakistan	Port Qasim GasPort - BW Integrity	2017	5.7	Pakistan LNG Terminals Limited (100%);	Floating
110	Pakistan	Port Qasim Karachi - Excelerate Sequioa	2020	5.3	Elengy Terminal Pakistan Ltd. (100%);	Floating
111	Panama	Costa Norte LNG	2018	1.5	AES Panama (50.1%); Inversiones Bahia (49.9%);	Onshore
112	Poland	Swinoujscie	2016	3.6	Gaz-System (100%);	Onshore
113	Portugal	Sines LNG Terminal	2004	5.8	REN (100%);	Onshore
114	Singapore	Jurong	2013	11	EMA (100%)	Onshore
115	South Korea	Boryeong LNG	2017	3	GS Caltex (50%); SK E&S (50%);	Onshore
116	South Korea	Gwangyang	2005	2.3	POSCO (100%);	Onshore
117	South Korea	Incheon	1996	52.7	KOGAS (100%);	Onshore
118	South Korea	Jeju LNG	2019	1	KOGAS (100%);	Onshore
119	South Korea	Pyeongtaek LNG	1986	40.6	KOGAS (100%);	Onshore
120	South Korea	Samcheok LNG	2014	11.6	KOGAS (100%);	Onshore
121	South Korea	Tongyeong LNG	2002	26.6	KOGAS (100%);	Onshore
122	Spain	Bahía de Bizkaia Gas	2003	5.1	ENAGAS (50%); EVE (50%);	Onshore
123	Spain	Barcelona LNG	1969	12.5	Enagas (100%);	Onshore
124	Spain	Cartagena	1989	8.6	Enagas (100%);	Onshore
125	Spain	Huelva	1988	8.6	Enagas (100%);	Onshore
126	Spain	Mugardos LNG	2007	2.6	Grupo Tojeiro (50.36%); Gobierno de Galicia (24.64%); First State Regasificadora (15%); Sonatrach (10%);	Onshore
127	Spain	Sagunto	2006	6.4	ENAGAS (72.5%); Osaka Gas (20%); Oman Oil (7.5%);	Onshore
128	Thailand	Map Ta Phut	2011	11.5	PTT LNG (100%);	Onshore
129	Turkey	Aliaga Izmir LNG	2006	4.4	EgeGaz (100%);	Onshore
130	Turkey	Dortyol - MOL FSRU Challenger	2018	4.1	Botas (100%);	Floating

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

Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
131	Turkey	Etki LNG terminal - Turquoise	2019	7.5	Terminal: Etki Liman (100%), FSRU: Kolin Construction (100%)	Floating
132	Turkey	Gulf of Saros terminal - Ertugrul Gazi	2021	7.5	Botas (100%);	Floating
133	Turkey	Marmara Ereglisi	1994	5.9	Botas (100%);	Onshore
134	UAE	Dubai Jebel Ali - Execelerate Explorer	2015	6	Terminal: DUSUP (100%), FSRU: Excelerate Energy (100%)	Floating
135	United Kingdom	Dragon LNG	2009	5.6	Shell (50%); Ancala (50%)	Onshore
136	United Kingdom	Grain LNG	2005	15	National Grid Transco (100%);	Onshore
137	United Kingdom	South Hook	2009	15.6	Qatar Petroleum (67.5%); Exxon Mobil (24.25%); TOTAL (8.35%);	Onshore
138	United States	Cove Point LNG	2003	11	Dominion Cove Point LNG (100%);	Onshore
139	United States	EcoElectrica	2000	1.2	Naturgy (47.5%); ENGIE (35%); Mitsui (15%); GE Capital (2.5%)	Onshore
140	United States	Elba Island LNG	1978	12	Kinder Morgan (100%);	Onshore
141	United States	Everett	1971	5.4	Exelon Generation (100%)	Onshore
142	United States	Neptune Deepwater LNG	2010	5.4	Northeast Gateway Energy Bridge LLC (100%);	Onshore
143	United States	Northeast Gateway	2008	4.5	Excelerate Energy (100%);	Floating
144	United States	San Juan - New Fortress LNG	2020	0.5	New Fortress Energy (100%)	Onshore

Appendix 6: Table of LNG Receiving Terminals Under Construction

Reference Number	IGU Market	Terminal Name (aggregated)	Start Year (IGU)	Nameplate Receiving Capacity (MTPA)	Ownership	Concept (IGU)
145	Bahrain	Bahrain LNG	2020	6	Bahrain LNG WLL (0%); NOGA (30%); Teekay Corporation (30%); Gulf Investment Corporation (20%); Samsung (20%);	Offshore
146	Brazil	Sao Paulo LNG	2023	3.78	Cosan (100%);	Floating
147	Brazil	Terminal Gas Sul LNG	2022	4	New Fortress Energy (100%);	Floating
148	Chile	GNL Talcahuano	2022	2.3	EOS LNG (100%);	Floating
149	China	Binhai LNG	2022	6	CNOOC (100%);	Onshore
150	China	Chaozhou Huafeng LNG	2021	1	Sinoenergy (55%); Chaozhou Huafeng Group (45%);	Onshore
151	China	Chaozhou Huaying LNG	2023	6	Huaying Natural Gas (100%);	Onshore
152	China	Guangxi (Beihai) LNG	2022	3.5	PipeChina (80%); Guangxi Beibu Gulf Port Group (20%)	Onshore
153	China	Hong Kong Offshore LNG	2022	6.1	CAPCO (70%), HK Electric (30%)	Floating
154	China	Longkou Nanshan LNG	2023	5	PipeChina (60%); Nanshan Group (40%)	Onshore
155	China	Qidong LNG	2022	1	Xinjiang Guanghui Petroleum (100%);	Onshore
156	China	Shandong (Qingdao) LNH	2023	7	Sinopec (99%); Qingdao Port(1%);	Onshore
157	China	Tianjin (CNOOC)	2022	3.8	CNOOC (100%);	Onshore
158	China	Tianjin (Sinopec)	2023	7.8	Sinopec (100%);	Onshore
159	China	Tianjin Nangang LNG	2023	5	Beijing Gas (100%)	Onshore
160	China	Wenzhou LNG	2022	3	Sinopec (41%); Zhejiang Group (51%); Local firms (8%);	Onshore
161	China	Yangjiang LNG	2024	2.8	Guangdong Yudean Power (100%);	Onshore
162	China	Yantai LNG	2023	5.9	Shandong Poly-GCL Pan-Asia International Energy Co., Ltd. (100%);	Onshore
163	China	Yueyang LNG	2022	1.5	Guanghui Energy (50%); China Huadian (50%);	Onshore
164	China	Zhangzhou LNG	2022	6	PipeChina (60%); Fujian Investment and Development Co (40%)	Onshore
165	China	Zhuhai LNG	2023	3.5	CNOOC (30%); Guangdong Gas (25%); Guangdong Yuedian (25%); Local companies (20%);	Onshore
166	Chinese Taipei	Taoyuan LNG	2023	3	CPC (100%);	Onshore
167	Finland	Hamina LNG	2022	0.6	Hamina LNG Oy (100%);	Onshore
168	Ghana	Ghana Tema	2022	2	GNPC (50%); Helios (50%)	Floating
169	India	Chhara LNG	2023	5	HPCL (50%); Shapoorji Pallonji (50%)	Onshore
170	India	Dabhol LNG	2022	8	Gail (31.52%); NTPC (31.52%); Indian Financial Institutions (20.28%); MSEB Holding Co. (16.68%);	Onshore
171	India	Dhamra LNG	2022	5	Adani Group (50%); Total (50%)	Onshore
172	India	H-Gas LNG Gateway (Jaigarh) - Hoegh Giant	2022	6	H-Energy Gateway Private limited (100%);	Floating
173	India	Jafrabad FSRU	2022	5	Swan Energy Limited (32.12%), Indian Farmers Fertilizers Cooperative (IFFCO) Limited (30.87%), Mitsui Group (11%), Gujarat Maritime Board with (15%), and Gujarat State Petronet Ltd (11%)	Floating
174	India	Karaikal LNG	2022	1	AG&P (100%);	Floating

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

Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
175	Kuwait	Al-Zour LNG	2022	11	Kuwait Petroleum Corporation (100%);	Onshore
176	Nicaragua	Puerto Sandino FSRU	2022	1.3	New Fortress Energy (100%);	Floating
177	Pakistan	Energas Terminal	2024	5.6	Energas (50%); Yunus Group (50%);	Floating
178	Philippines	Batangas Bay LNG	2022	5	AG&P (100%);	Floating
179	Philippines	Pagbilao LNG	2024	3	Energy World Corporation (100%);	Onshore
180	Poland	Swinoujscie LNG	2023	4.33	Gaz-System (100%);	Onshore
181	Russia	Kaliningrad FSRU	2019	2.7	Gazprom (100%);	Floating
182	Senegal	Senegal FSRU	2022	2.5	Karadeniz Energy Group (100%);	Floating
183	Thailand	Nong Fab LNG	2023	7.5	PTT LNG (100%);	Onshore
184	Vietnam	Hai Linh LNG	2023	3	Hai Linh Co Ltd (100%);	Onshore
185	Vietnam	Thi Vai LNG	2023	1	PetroVietnam Gas (100%);	Onshore

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