IGU
INTERNATIONAL GAS UNION
UNION INTERNATIONALE DU GAZ

2021 WORLD LNG REPORT

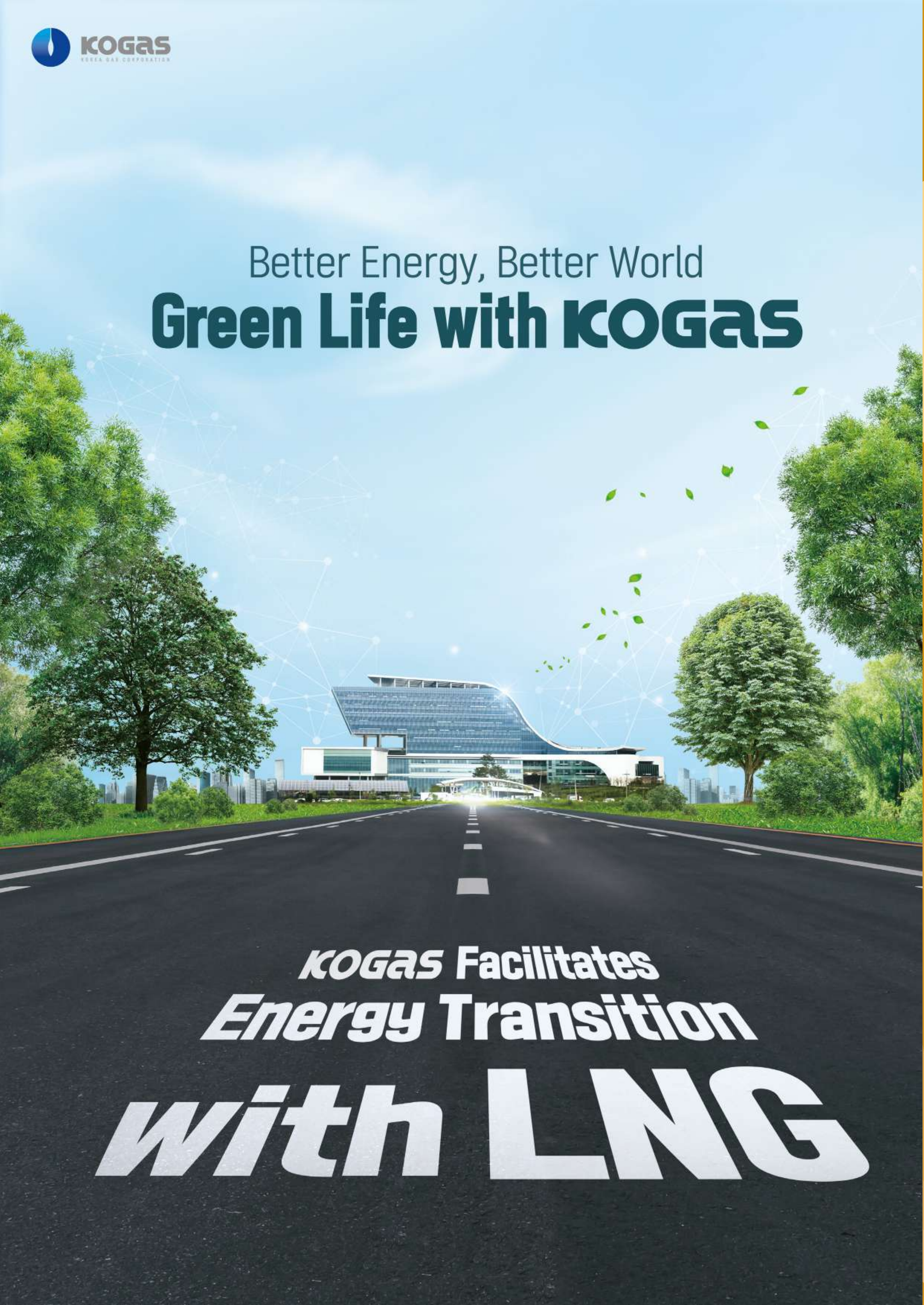
Sponsored by

KOGAS KOREA GAS CORPORATION

AGA American Gas Association

Knowledge Partner

RYSTAD ENERGY



RYSTAD ENERGY

GAS MARKET SOLUTIONS

Comprehensive suite of products and advisory services covering global gas and LNG markets

DATA

Granular data providing a comprehensive overview of production assets, country and sector specific demand, international pipeline gas and LNG trade, economic and financial field and infrastructure data, contract data, company asset ownership, LNG vessels, as well as long-term price forecasts for the main global trading hubs.

ANALYTICS

Comprehensive reports and commentaries covering gas market supply and demand, coal-to-gas competition, international gas and LNG trade, energy transition as well as macroeconomic analysis with price forecast.

ADVISORY

Extensive advisory services on gas and LNG markets, including gas market assessments, commodity pricing, gas infrastructure due diligence and benchmarking of gas assets.

ENERGY KNOWLEDGE HOUSE

Rystad Energy is an independent energy research and market intelligence company providing data, tools, analytics and consultancy services to the global energy industry. Our products and services cover energy fundamentals and the global and regional upstream, oilfield services and renewable energy industries, tailored to analysts, managers and executives alike.

www.rystadenergy.com

Table of Contents

Message from the President of the International Gas Union
7

1. State of the LNG Industry
9

2. Impact of COVID-19 on the LNG Industry
2.1 LNG trade
2.2 Liquefaction
2.3 Regasification
2.4 Shipping

12

3. LNG Trade
3.1 Overview
3.2 LNG Exports by Market
3.3 LNG Imports by Market
3.4 LNG Interregional Trade

18

4. LNG and Gas Pricing
4.1 Asia-Pacific LNG Market Price Trends
4.2 Atlantic LNG Market Price Trends
4.3 Crude Oil Market Price Trends

30

5. Liquefaction Plants
5.1 Overview
5.2 Global Liquefaction Capacity and Utilisation
5.3 Liquefaction Capacity by Market
5.4 Liquefaction Technologies
5.5 Floating Liquefaction (LNG-FPSOS)
5.6 Risks to Project Development
5.7 Update on New Liquefaction Plays

38

6. LNG Shipping
6.1 Overview
6.2 LNG Carriers
6.3 Floating Storage and Regasification Unit Ownership (FSRUs)
6.4 2020 LNG Orderbook
6.5 Vessel Costs and Delivery Schedule
6.6 Charter Market
6.7 Fleet Voyages and Vessel Utilisation
6.8 Near Term Shipping Developments

58

7. LNG Receiving Terminals
7.1 Overview
7.2 Receiving Terminal Capacity and Global Utilisation
7.3 Receiving Terminal Capacity and Utilisation by Market
7.4 Receiving Terminal LNG Storage Capacity
7.5 Receiving Terminal Berthing Capacity
7.6 Floating and Offshore Regasification
7.7 Receiving Terminals with Reloading and Transshipment Capabilities

78

8. Natural Gas (LNG & CNG) as Fuel for Marine and Road Transportation
8.1 Marine LNG Bunkering Infrastructure
8.2 Onshore LNG & CNG Fueling Infrastructure
8.3 LNG & CNG Demand as a Transportation Fuel

94

9. References used in 2021 Edition
9.1 Data Collection
9.2 Definitions
9.3 Regions and Basins
9.4 Acronyms
9.5 Units
9.6 Conversion Factors
9.7 Discrepancies in Data vs. Previous IGU LNG Reports

104

Appendices
1. Table of Global Liquefaction Plants
2. Table of Liquefaction Plants Sanctioned or Under Construction
3. Table of Global Active LNG Fleet, Year-End 2019
4. Table of Global LNG Vessel Orderbook, Year-End 2019
5. Table of Global LNG Receiving Terminals
6. Table of LNG Receiving Terminals Under Construction

106

MESSAGE FROM THE PRESIDENT OF THE INTERNATIONAL GAS UNION

Dear colleagues,

Last year I wrote my message amidst great challenges, as the initial implications of the COVID-19 pandemic started to surface. It was hard to imagine then that a year later, the pandemic would still be raging and continuing to impact all aspects of our daily lives, including LNG and the wider global gas markets. Yet that is where we are.

I also wrote about hope for a stronger and more united future, and my optimism today is stronger than ever. Not in the least because the world has shown remarkable resilience and comradery. Together, we found light amid darkness – thanks to the tireless efforts, courage, and steadfast dedication of those who continued to work throughout this crisis on the front lines, risking their lives to save others'. It is hard to find the right words to express the depth of my gratitude to them.

The gas industry too has held its own. Despite having to overcome many challenges in supply chain management, maintenance and commercial matters, reliable supply of gas continued uninterrupted. This demonstrates the incredible resilience, flexibility and reliability of the gas sector in bringing secure, clean, and modern energy whenever and wherever it is needed, even with significant parts of the world affected by lockdowns or restrictions.

It is because of our industry's frontline – those who run the production plants and terminals, sail ships, manage pipelines and ports - that the lights stayed on, buildings were heated or cooled, families were able to prepare meals, medical professionals were able to treat patients, and the world was able to switch to working remotely, seamlessly.

I am very proud of our industry for navigating through this crisis and for offering a sustainable pathway to recovery.

However, we shouldn't forget that the pandemic has come at a great cost to economies, societies and the industry at large. Unfortunately, the greatest costs befell the world's most vulnerable, including those who still lack access to clean and modern energy.

Gas, including LNG, is an abundant, clean, accessible and versatile energy form that is not only a substitute to more polluting energy sources, but also a fuel that can deliver access to modern energy to those who lack it.

Coal-to-gas switching has already saved over 600 MT of CO_2 over the last decade[1], more than the annual emissions of all but the seven largest global economies, and further fuel switching has the potential to remove almost tenfold more.[2] The natural gas industry is also ready to accommodate more decarbonisation, renewable gas, and hydrogen in the coming decade, enabling further reductions in emissions. This will be essential to maintaining energy security and meeting the world's growing energy and sustainable economic development needs, without compromising on the goals of the Paris Agreement.

IGU members continue to work diligently to minimise methane emissions, a key priority for the sector. We are a supporting organisation to the Methane Guiding Principles, and we encourage all our members and representatives of the global gas industry to measure, document, report, and reduce methane emissions. It is a safety requirement; it makes good commercial sense, but beyond that, it is an opportunity to enable gas to play a role in the energy transition as a cleaner and reliable energy source.

Turning back to the LNG markets and the findings we present to you in this report. This year's global LNG trade increased to 356.1 MT[3], a small increase of 1.4 MT versus 2019, but another year of consecutive growth in LNG trade despite COVID-19 related impacts on the supply and demand sides. This was mostly supported by increased exports from the USA and Australia, together adding 13.4 MT of exports. Asia Pacific and Asia again imported the most volumes in 2020, together accounting for more than 70% of global LNG imports. Asia also accounted for the largest growth in imports in 2020 – adding 9.5 MT of net LNG imports versus 2019.

Global LNG market pricing experienced a turbulent year. Spot prices of cargoes trading in the Atlantic and Asia Pacific basins plummeted to record lows in the first six months, before reaching record highs at the start of 2021. Pricing responded to COVID-19 impacts on demand, an initially well-supply market, and high storage levels in some markets, followed by a cold winter and shipping constraints.

While 20 MTPA in liquefaction capacity was brought onstream in 2020, all in the United States, start-up of several liquefaction trains in Russia, Indonesia, the United States and Malaysia were delayed as a result of the pandemic. The only project that was sanctioned in 2020 was the 3.25 MTPA Energia Costa Azul facility in Mexico, and early 2021 Qatar took FID on four expansion trains totalling 32 MTPA. With additional new projects proposed, global pre-FID volumes stand at 892.4 MTPA, most of which are in North America.

With 35 new vessels added to the LNG shipping fleet in 2020, the total number of active vessels reached 572 at the end 2020, including 37 FSRUs and 4 FSUs. Notably, with the exception of one, all new vessels are equipped with membrane containment systems, and 23 of them feature X-DF propulsion systems. Membrane containment systems capitalise on improved fuel efficiencies and lower emissions. The number of LNG voyages, however, only increased by 1%, largely due to demand impact of COVID-19.

Global regasification capacity increased by 19 MTPA in 2020, bringing the total to 850.1 MTPA as of February 2021. Four new terminals and four expansion projects at existing terminals started importing cargoes – with the majority in the Asia Pacific region. There are now 39 markets that are equipped with LNG receiving capabilities[4]. As of February 2021 there was 147.3 MTPA of regasification capacity under construction, of which 72.3 MTPA have communicated start-up dates in 2021, some of which is in new importing markets such as Ghana, El Salvador, Vietnam and Nicaragua. Offshore regasification capacity increased by 5.6 MTPA, bringing the global floating and offshore regasification capacity to 115.5 MTPA as of February 2021.

In conclusion, the ongoing global health and economic crisis reminded us that access to energy is critical to keeping people safe and societies functioning: from hospitals and intensive care units, to vaccine manufacture and delivery, and remote work.

LNG and gas are key to unlocking access to secure, clean, and modern energy. Today, it can immediately reduce emissions, improve quality of life, health, and clean air by replacing coal, oil, and conventional biomass; and tomorrow, it will be the key pathway to decarbonisation as we add more renewable gas, hydrogen, and CCS.

As the world leaders plan for recovery from COVID-19 and realign their investments in energy transition plans to a path consistent with the Paris Agreement and Sustainable Development Goals, the gas industry stands ready to support them in this challenge.

LNG will continue to play a key role by bringing affordable, clean energy to the world.

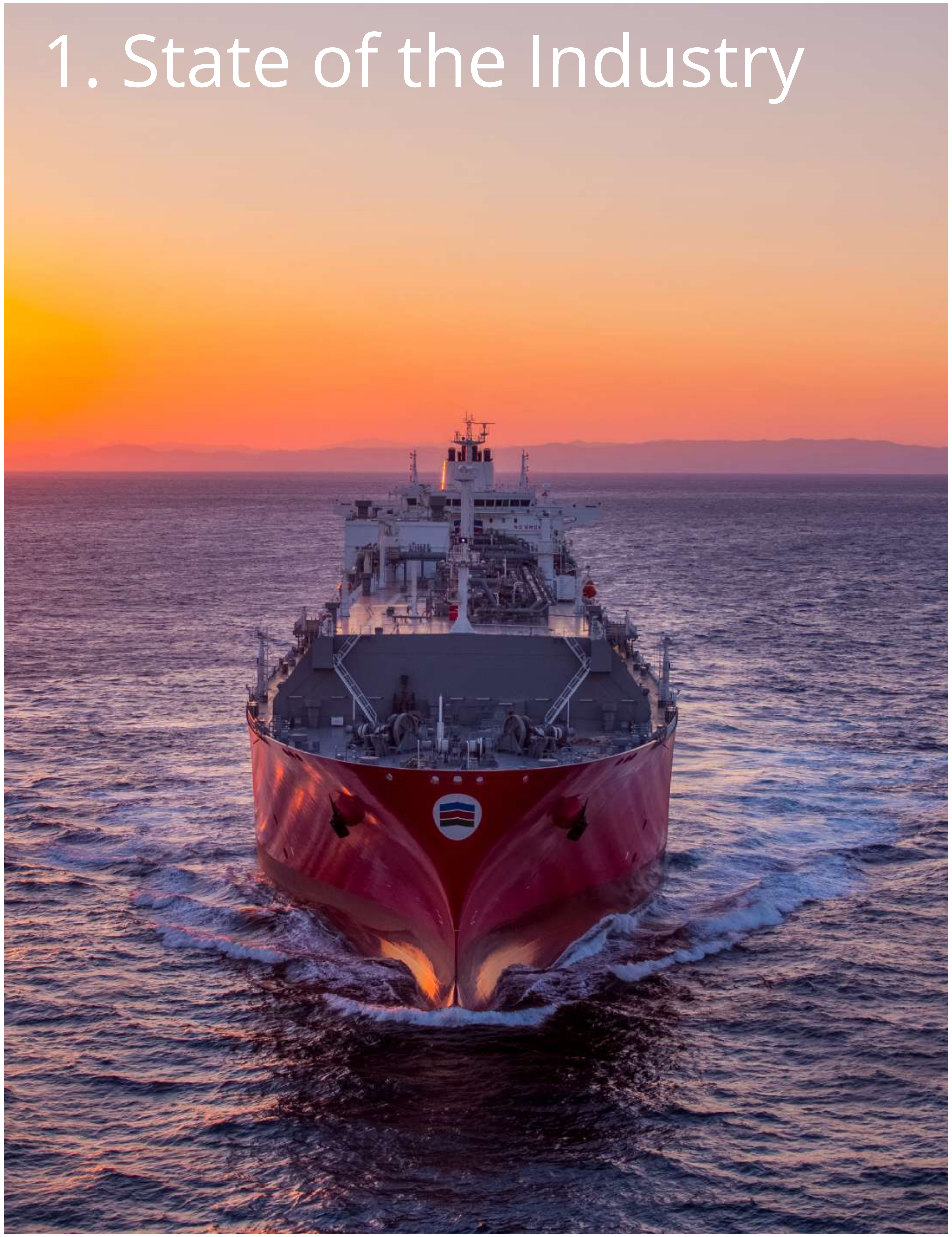
Yours faithfully,

Joe M. Kang
President of the International Gas Union

[1] IEA, The Role of Gas in Today's Energy Transition. 2019 (https://www.iea.org/reports/the-role-of-gas-in-todays-energy-transitions)
[2] IGU, BCG. Gas Technology and Innovation for a Sustainable Future. 2020 (https://www.igu.org/resources/gas-technology-and-innovation-for-a-sustainable-future/)
[3] GIIGNL
[4] The total number of markets excludes those with only small-scale (<0.5 MTPA) regasification capacity such as Finland, Malta, Norway, and Sweden. It includes markets with large regasification capacity that only consume domestically produced cargoes, such as Indonesia.

The Task Force dedicates this edition of the IGU World LNG Report to Geoff Hunter in recognition of his tireless work and support for the IGU World LNG Report. The recent loss of Geoff has been well felt across the efforts of the Task Force.

1. State of the Industry



LNG carrier ARISTOS I - Courtesy of Capital Gas

Trade

356.1 MT[1]

Global LNG Trade in 2020

Global LNG trade increased to 356.1 MT, a small increase of 1.4 MT versus 2019, but another year of consecutive growth in LNG trade despite COVID-19 related impacts on the supply and demand sides. This was mostly supported by increased exports from the USA and Australia, together adding 13.4 MT of exports. Asia Pacific and Asia again imported the most volumes in 2020, together accounting for more than 70% of global LNG imports. Asia also accounted for the largest growth in imports in 2020 – adding 9.5 MT of net LNG imports versus 2019.

Liquefaction Plants

452.9 MTPA

Global liquefaction capacity, End of 2020

Global liquefaction capacity continued to grow in 2020, adding 20.0 MTPA of capacity last year to reach 452.9 MTPA. The liquefaction projects that came online in 2020 were Freeport LNG T2-T3 (10.2 MTPA), Cameron LNG T2-T3 (8.0 MTPA) and Elba Island T4-T10 (1.75 MTPA), all of which are located in the United States. Several projects with planned start-up of commercial operations in 2020 were delayed to 2021 amid the COVID-19 pandemic. These include Yamal LNG T4 (0.9 MTPA), Sengkang LNG T1 (0.5 MTPA), Portovaya LNG T1 (1.5 MTPA), Corpus Christi LNG T3 (4.5 MTPA) and Petronas PFLNG Dua (1.5 MTPA). The average global utilisation rate in 2020 was 74.6%, with December 2020 drawing most attention, as soaring Asian and European LNG prices drove utilisation rates to record heights in certain export markets, such as the US. This came on the heels of the preceding period when it appears nearly 160 cargoes were cancelled between April and November 2020, with the majority of these cancellations taking place between June and August – a seasonally softer period for gas demand. As of February 2021, 139.1 MTPA of liquefaction capacity was under construction or sanctioned for development, but only 8.9 MTPA of that overall capacity increase is expected to come online in 2021. Energía Costa Azul LNG T1 (3.25 MTPA), located in Baja California, Mexico, was the only liquefaction project sanctioned in 2020. Hence, last year resulted in one of the lowest levels of sanctioned liquefaction capacity seen in recent years.

Proposed New Liquefaction Plants

892.4 MTPA

Proposed aspirational liquefaction capacity in pre-FID stage, Feb. 2021

Currently, 892.4 MTPA of aspirational liquefaction capacity is in the pre-FID stage, the majority of which is in the United States and Canada. Africa has 103.9 MTPA of proposed liquefaction capacity and could emerge as a key LNG export region if these projects materialise. In the Middle East, Qatar Petroleum has taken the final investment decision for the North Field East (NFE), the world's largest LNG project, which will raise Qatar's LNG production capacity from 77 MTPA to 110 MTPA. The project involves the construction of four new LNG mega-trains with a capacity of 8 MTPA each. With the NFE project progressing, this will reposition Qatar as the world leader in terms of liquefaction capacity, overtaking Australia who currently has the most liquefaction capacity. The COVID-19 pandemic, which inflicted further price shocks on gas markets, has forced cash-strapped developers to hold back on capital intensive pre-FID liquefaction projects. This puts small-scale LNG in the spotlight, as it remains a growing segment within the wider LNG sector, thanks to significant commercial potential and lower investment costs. One notable example is Elba Island LNG (2.5 MTPA), which comprises ten trains, each with a capacity of 0.25 MTPA.

Shipping

572 Vessels

LNG fleet, end-2020

There were 572 active LNG vessels at the end of 2020, including 37 floating storage and regasification units (FSRUs) and four floating storage units (FSUs). The global fleet grew by 7% with the delivery of 35 vessels, two of which are FSRUs. 34 of the new vessels are fitted with membrane containment systems, and 23 of them feature X-DF propulsion systems.

Demand reductions stemming from the COVID-19 pandemic, alongside a mild winter at the start of 2020, resulted in a relatively low growth of only 1% in the number of LNG voyages, compared to 0.4% growth in LNG Trade. Charter rates started the year at ~US$70,000 per day for steam turbine, ~US$90,000 for TFDE and ~US$105,000 for X-DF/ME-GI vessels, before sliding towards ~US$20,000 for steam turbine, ~US$30,000 for TFDE and ~US$40,000 for X-DF/ME-GI vessels, trading thereabouts until August 2020. As the Northern Hemisphere experienced colder-than-normal temperatures during the fourth quarter, freight demand and charter rates rebounded, reaching record highs at the end of the year, peaking at ~US$112,000 for steam turbine, ~US$163,000 for TFDE and ~US$177,000 for X-DF/ME-GI vessels.

Regasification Terminals

850.1 MTPA

Global nominal regasification capacity, Feb. 2021

Global regasification capacity has increased to 850.1 MTPA as of February 2021, following capacity additions of 19.0 MTPA in 2020. For three consecutive years, total regasification capacity additions were lower than additions in liquefaction capacity. 4 new regasification terminals entered commercial operations, and 4 expansion projects at existing terminals were successfully completed during 2020.

The Asia-Pacific region continues to experience strong demand growth. China, Chinese Taipei, India and Myanmar added significant regasification capacity in 2020, totalling 12.9 MTPA, despite several terminals with planned start-up in 2020 being delayed to 2021. This was largely a direct result of the COVID-19 outbreak, which caused worldwide supply chain disruptions along with potential delays in investments and permitting processes. As of February 2021, 39 markets are equipped with LNG receiving capabilities.

With the rise in global LNG trade, regasification capacity additions are anticipated to occur in established regions as well as new import markets. Two new markets – Myanmar and Croatia – joined the ranks of LNG importers over the past year. As of February 2021, 147.3 MTPA of new regasification capacity is under construction, including 19 new onshore terminals, 10 FSRUs and eight expansion projects at existing terminals. By year-end 2021, 72.3 MTPA of additional regasification capacity is set to come online through newbuild terminals and expansion projects at existing terminals. Notably, this could include new importers such as Ghana, El Salvador, Vietnam, and Nicaragua.

Floating and Offshore Regasification

115.5 MTPA

Global Floating and Offshore Regasification Capacity, Feb 2021

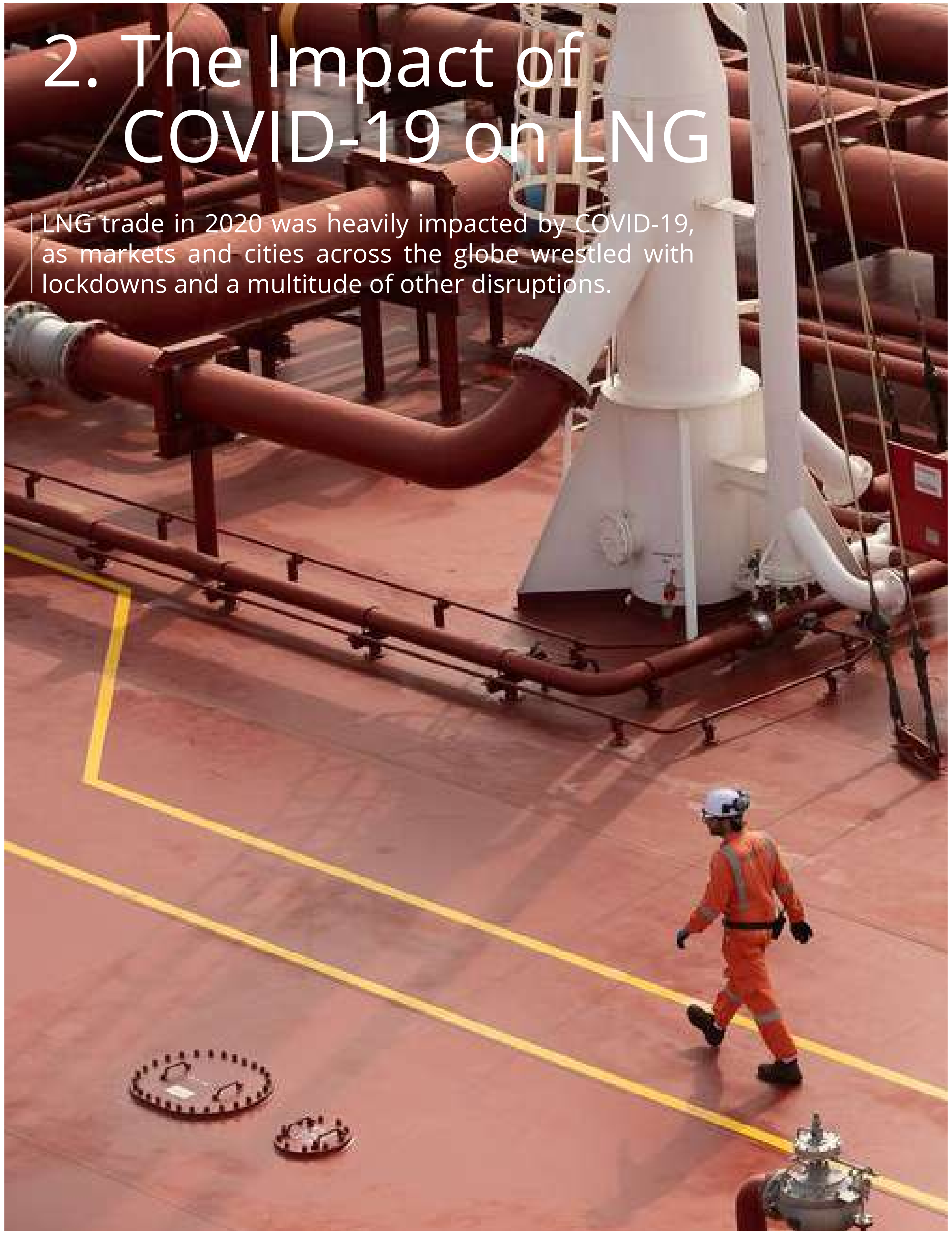
Regasification capacity at operational offshore terminals grew by 5.6 MTPA in 2020 through the construction of one new floating terminal at Acu Port in Brazil. In January 2021, Croatia commissioned its first LNG import facility through a 1.9 MTPA FSRU deployed at the Krk LNG terminal. As of February 2021, floating and offshore regasification capacity worldwide has reached 115.5 MTPA at 27 terminals. Another 10 floating and offshore regasification terminals are currently under construction, representing a further 33.4 MTPA once commissioned. Seven offshore/floating terminals are scheduled to enter service by year-end 2021, including new importers Ghana, El Salvador and Nicaragua. Established markets are also expanding their regasification capabilities through the chartering of FSRUs – Brazil commissioned two FSRU-based LNG import terminals in the past two years, and India is expected to bring its first FSRU-based terminal into service in the first quarter of 2021, thereby giving the market both onshore and floating regasification capabilities. Furthermore, at least five additional FSRUs (including conversions) were in the order book as of February 2021.

LA SEINE - Courtesy of TMS Cardiff Gas

[1] Source: GIIGNL

2. The Impact of COVID-19 on LNG

LNG trade in 2020 was heavily impacted by COVID-19, as markets and cities across the globe wrestled with lockdowns and a multitude of other disruptions.



Shell's Terminal at Hazira – Courtesy of Shell

2.1 LNG TRADE

LNG trade in 2020 was heavily impacted by COVID-19, as markets, cities and producers across the globe wrestled with lockdowns and a multitude of other disruptions. Significant reductions in levels of economic activity affected demand, which in turn had to be balanced by supply curtailments, a balancing act to reconcile demand shocks with contracting, operational and market dynamics. At the beginning of 2020, Rystad Energy projected LNG trade to grow 8% year-on-year, but the pandemic impact caused it grow only slightly to 356.1 MT , with the total number of LNG voyages growing by only 1% from 2019. However, it was one of the few commodities that showed growth in 2020, demonstrating the resilience, flexibility and reliability of the gas sector.

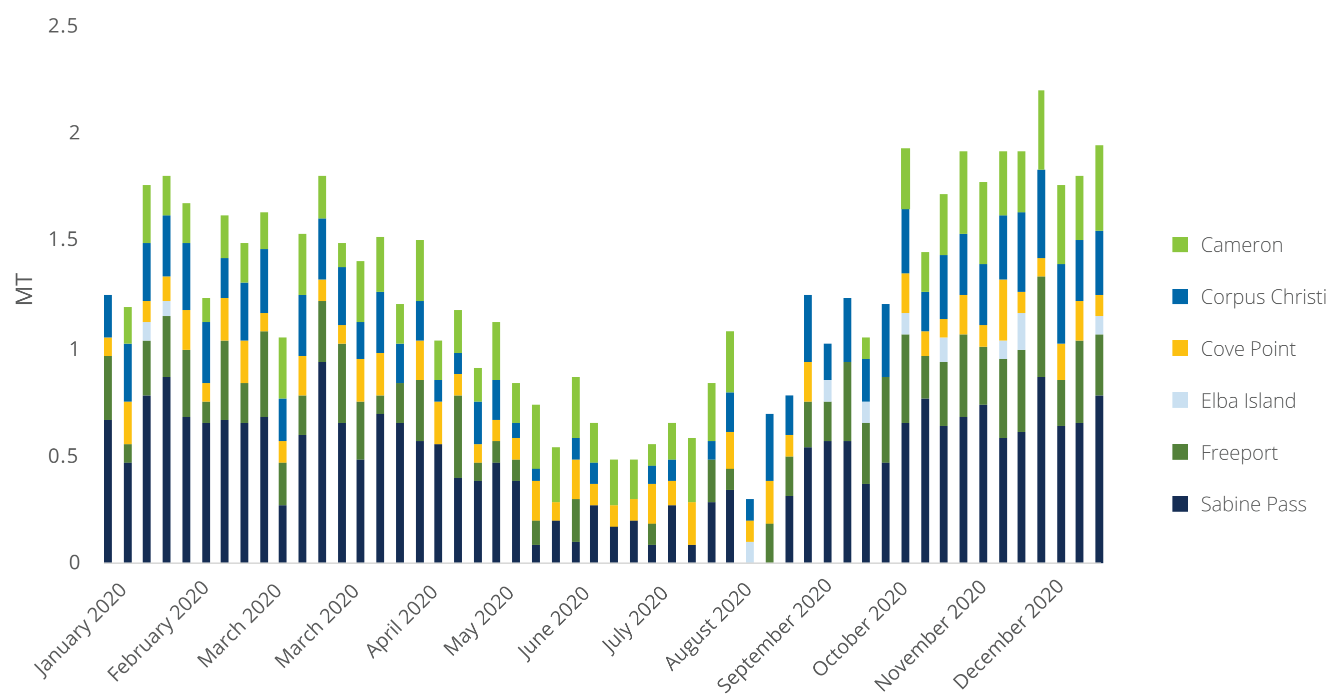
The first impact of the virus was felt when Asian LNG imports started to fall towards the end of February, as Japan, China and South Korea experienced lower economic activity. This was against the backdrop of a relatively warm winter and high inventory levels. As China went into lockdowns, many cargoes were diverted to India and South Korea. Supply remained healthy in the first quarter as Qatar and Australia maintained production, and US producers still attempted to ramp up output. This excess supply was absorbed by Europe once many Asian markets went into lockdowns, with buyers taking advantage of low prices, substituting some piped gas with LNG. However, Spain, Italy and France – the largest importers in Europe – soon also announced lockdowns. By the end of March, Europe's storage filled up, and buyers began using flexibility clauses in their US offtake contracts to cancel cargos for summer deliveries, causing Gulf Coast LNG terminals to cut exports.

Reacting to the effects of COVID-19 on European and Asian demand, coupled with seasonal demand fluctuations, US LNG exports fell by 70% from May to August, mostly from curtailments by Sabine Pass and Corpus Christi. Trade flows towards Asia regained some ground in 3Q 2020 as demand in China and India outweighed a decrease in shipments to Japan and South Korea. This can be attributed to lower overall utlisation rates in the larger importing nations due to an overall drop in global gas demand, allowing for opportunistic buying. Balancing out the pandemic's negative impact on demand, a very cold Northern hemisphere winter, together with a tighter freight market, spawned an LNG supply squeeze towards the end of 4Q 2020.

2.2 LIQUEFACTION

For much of the year, COVID-19 related demand shocks and the oil and gas price environment had a material impact on LNG supply. LNG producers with high short-run marginal costs and flexible contract structures were faced with the decision to shut down individual trains, shut down plants entirely, or recycle gas to keep facilities running. These decisions were framed by market, commercial and technical considerations, as liquefaction plants are generally designed to run at close to full capacity. Global supply curtailment came almost entirely from US Gulf Coast export terminals, with weekly US exports falling to a low of 0.29 MT in late August, illustrated in Figure 1.1.

Figure 2.1: US weekly LNG exports in 2020



Source : Rystad Energy, Refinitiv

Beyond short-term supply, COVID-19 also severely impacted liquefaction development. Companies delayed final investment decisions (FIDs) on projects up to 2021 and beyond, due to the uncertain economic climate – deferment of capital expenditure was a priority for developers. At the beginning of 2020, 11 trains totaling 87.3 MTPA of capacity were expected to reach FID in 2020, and in practice only one project did so – the Energía Costa Azul LNG T1 terminal (3.25 MTPA) in Baja California, Mexico. This is also in stark contrast with 2019, when seven projects representing a collective capacity of 70.8 MTPA reached FID.

FID's originally targeted for 2020 by developers included Driftwood LNG T1-8 (11.0 MTPA), Woodfibre LNG T1-2 (2.1 MTPA), NextDecade's Rio Grande LNG T1-3 (16.2 MTPA), Goldboro LNG T1-2 (10.0 MTPA) and the Lake Charles LNG project (16.45 MTPA). Developers have announced FIDs to be postponed to 2021, in hope of a stronger and more stable market. In addition, regulators in the United States approved NextDecade's decision to abandon a sixth train at Rio Grande LNG, while instead increasing the capacity of the remaining five trains to achieve a total liquefaction capacity of 27 MTPA. FID for this project has also been delayed until 2021.

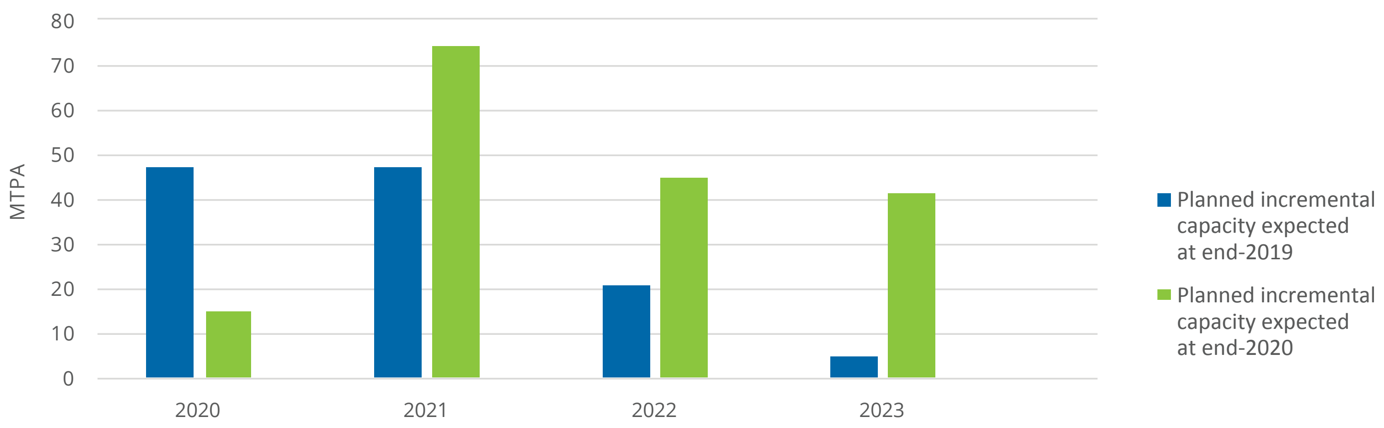
In a bid to delay delivery of the Gimi FLNG unit (2.5 MPTA), which is destined for the Greater Tortue Ahmeyim project in Senegal/Mauritania, BP issued a force majeure claim to the main contractor Golar LNG in April. This was settled with an 11-month extension for delivery instead, with no known payment to either party. Citing the effects of COVID-19, YPF in Argentina issued a similar force majeure claim on a 10-year charter for the already producing FLNG Tango (0.5 MPTA) which was signed in 2018, concluding in October with a US$150m settlement for termination. Gazprom's FLNG project Portovaya LNG (1.5 MPTA), Petronas' FLNG Dua (1.5 MTPA) and Yamal LNG's fourth train (0.9 MPTA) have also experienced delays and are now expected to come online in 2021.

It is worth noting that LNG plants that did manage to start up in 2020 were underpinned by long-term sales and purchase agreements (SPAs). The Cameron LNG T1–3 (12.0 MTPA) has long term tolling agreements with Mitsubishi, Mitsui and Total. Similarly, the Elba Island LNG project (2.5 MTPA) is supported by a 20-year SPA with Shell, which had subscribed to its full liquefaction capacity, while Freeport LNG T1–2 (10.2 MTPA) has tolling agreements with BP, Osaka gas and JERA.

2.3 REGASIFICATION

The pandemic affected the pace of construction at several LNG regasification plants globally, both due to financial constraints and operational difficulties related to lockdowns. Many plants scheduled to start up in 2020 failed to do so, with developers and financiers choosing to wait for stable market conditions to complete construction. Within the year, at least 11 regasification plants under construction – totaling 41.1 MPTA of capacity and 2.8 million cubic meters of storage – had their startup delayed to 2021 or later. Figure 1.2 outlines this trend, where capacity expected to come online in 2020 was pushed out in time, resulting in significantly more capacity expected to be added in the years to come. It is worth noting that construction of new projects did commence, resulting in a 45% higher volume of planned capacity start-ups for 2020-2023 at the end of 2020 when compared to the end of 2019. A substantial share of new regasification projects that were approved and began construction in 2020 were in Asia, particularly in China, representing a strong appetite for LNG within the region.

Figure 2.2: Planned incremental regasification capacity



Source : Rystad Energy, Refinitiv

COVID-19's impact on regasification development was mostly felt in Asia, with at least seven plants, totaling 28.0 MPTA of capacity, experiencing delays. Four large projects in India – the H-Gas LNG Gateway (6.0 MTPA), Jafrabad FSRU (5.0 MTPA), Chhara LNG (5.0 MTPA) and Dabhol LNG 2 (5.0 MTPA) – were delayed by a year each, with economic pressure, financing issues and COVID-19-related supply chain issues cited as reasons for the delays. Two Chinese projects – Chaozhou Huafeng LNG 1 (1.0 MTPA) and Wenzhou LNG (3.0 MTPA) – were delayed by a year and are now due to become operational in 2021 and 2022, respectively. Furthermore, expansion plans for several existing Chinese terminals were also hit by delays.

Elsewhere, Ertugrul Gazi (7.5 MPTA), an FSRU bound for the Gulf of Saros terminal in Turkey, is now expecting delivery in 2022. Cyprus FSRU (0.6 MTPA) and New Fortress LNG (3.0 MPTA) in Mexico have both been delayed by a year, from 2021 and 2020 respectively, while Ghana's Tema (1.7 MPTA) has been delayed by a year to 2021.

2.4 LNG SHIPPING

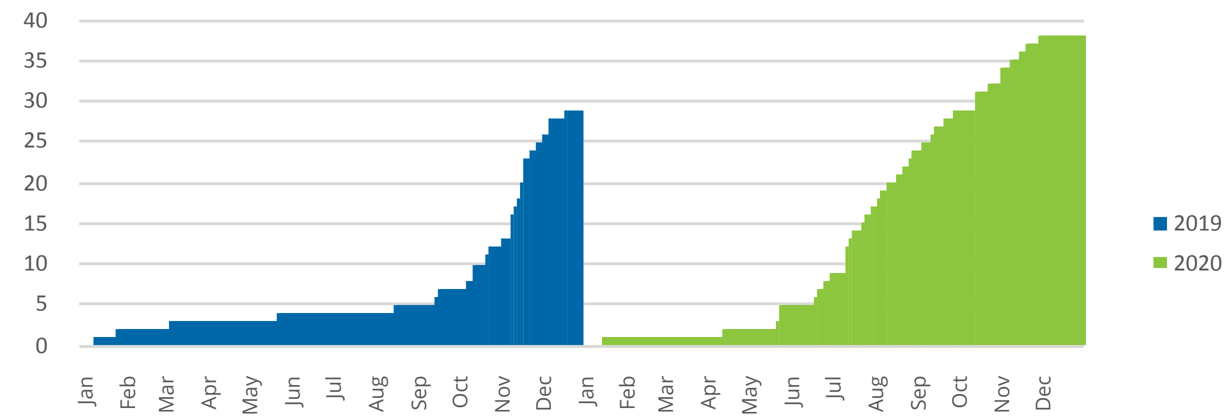
The global pandemic crisis created a challenging business environment for vessel owners and operators in the LNG shipping sector. The main themes affecting LNG shipping through this unprecedented year have been: significant demand disruption, subsequent sustained lower charter rates, the increased use of floating LNG storage[1], a shift towards new ways of working, and delays in newbuild deliveries.

The reduction in global gas consumption led to supply curtailments and hence demand disruption for LNG freight. American exports of LNG became less economic for most companies based on netback pricing, while virus-related market conditions often caused vessels to change course mid-voyage. For example, in early February, four carriers from the Middle East were forced to change route or even return to the Gulf. While US curtailments primarily balanced the market, non-US curtailments due to economic and operational factors contributed to supply tightness. The consequence of this through the year was cargo cancellations as LNG players balanced oversupply and uncertain global demand.

This translated into material impacts on LNG charter rates for much of 2020. Reduced demand for shipping saw spot prices shift lower from January through mid-March, before staging a brief rally caused by arbitrage opportunities between basins. As this arbitrage closed, lower US exports kept freight rates relatively low, trading at approximately US$20,000 for steam turbine, US$30,000 for TFDE and US$40,000 for X-DF/ME-GI vessels from May to August. These sustained low rates contributed in part to the increased use of vessels as floating LNG storage during the year.

The slow steaming of LNG carriers to maximise trading positions is usually only executed as a short-term bridge into winter, but the spread of COVID-19 incentivised the use of this option to manage demand disruption. Historically, high operating expenditure and boil-off gas rates have hindered players from storing LNG at sea even in the short-term, using vessels almost exclusively for transport. However, excess gas supply and low freight rates incentivised the use of loaded vessels as short-term storage at sea earlier in the year. The economics of doing so were further boosted by the availability of newer vessels with lower boil-off gas rates, many of which are not on long-term charters.

Figure 2.3: Cumulative number of global LNG voyages longer than 40 days



Source : Rystad Energy, Refinitiv

Evidence of this type of short-term floating LNG storage use is apparent in Figure 1.3, showing the progression of the cumulative number of LNG voyages over 40 days from 2019 to 2020, an indicator of such trades. These longer voyages are higher in volume and ramp up earlier in 2020 when compared to 2019, motivated by market conditions created by the pandemic.

COVID-19 has also shown the LNG shipping sector's resiliency, as operations have continued successfully despite extraordinary circumstances. This has in part been supported by the emergence of new ways of working in daily operations and amid an acceleration of broader trends such as digitalization and cloud computing.

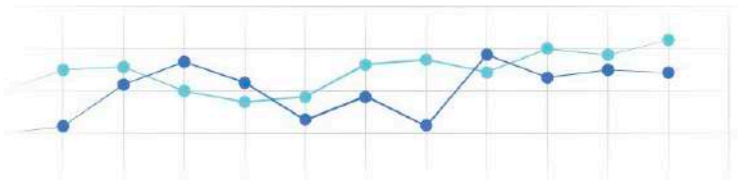
Forced to cope with the realities of the virus, daily operations have changed in several ways for the LNG shipping sector. For example, terminal operations and cargo loading and unloading can now take place without human contact between vessel and external crews. Within the realm of digitalization, a shift to acceptance of digital documents has occurred while remote vetting and inspections have become the norm. Cloud-based solutions have also allowed ship engineering training to take place in simulators and through remote learning.

Another part of the industry that has been impacted significantly by COVID-19 is shipbuilding. The steep drop in LNG freight prices caused shipowners to exercise options early in the year to defer delivery of newbuilds when available. An example of this was Flex LNG's deferral of the LNG carriers Flex Aurora and Flex Amber by a quarter. Delays attributable to the virus have caused 12 vessels scheduled for delivery in 2020 to be pushed out to 2021, three of which are FSRUs. These vessels experienced delays due to impacted supply chains – outbreaks and lockdowns delayed shipbuilding operations sporadically through the year and often hindered the timely arrival of raw materials and marine equipment.

[1] Floating LNG storage in this context refers to short-term slow steaming of vessels to maximise trading positions

3 LNG Trade

Global LNG trade increased to **356.1 MT**[1] in 2020, an increase of **1.4 MT**.



Japan imported
74.4 MT
(-2.4 MT vs. 2019)

Australia became the largest exporter with a total of
77.8 MT
of exports

1st

Qatar was the second largest exporter, exporting
77.1 MT

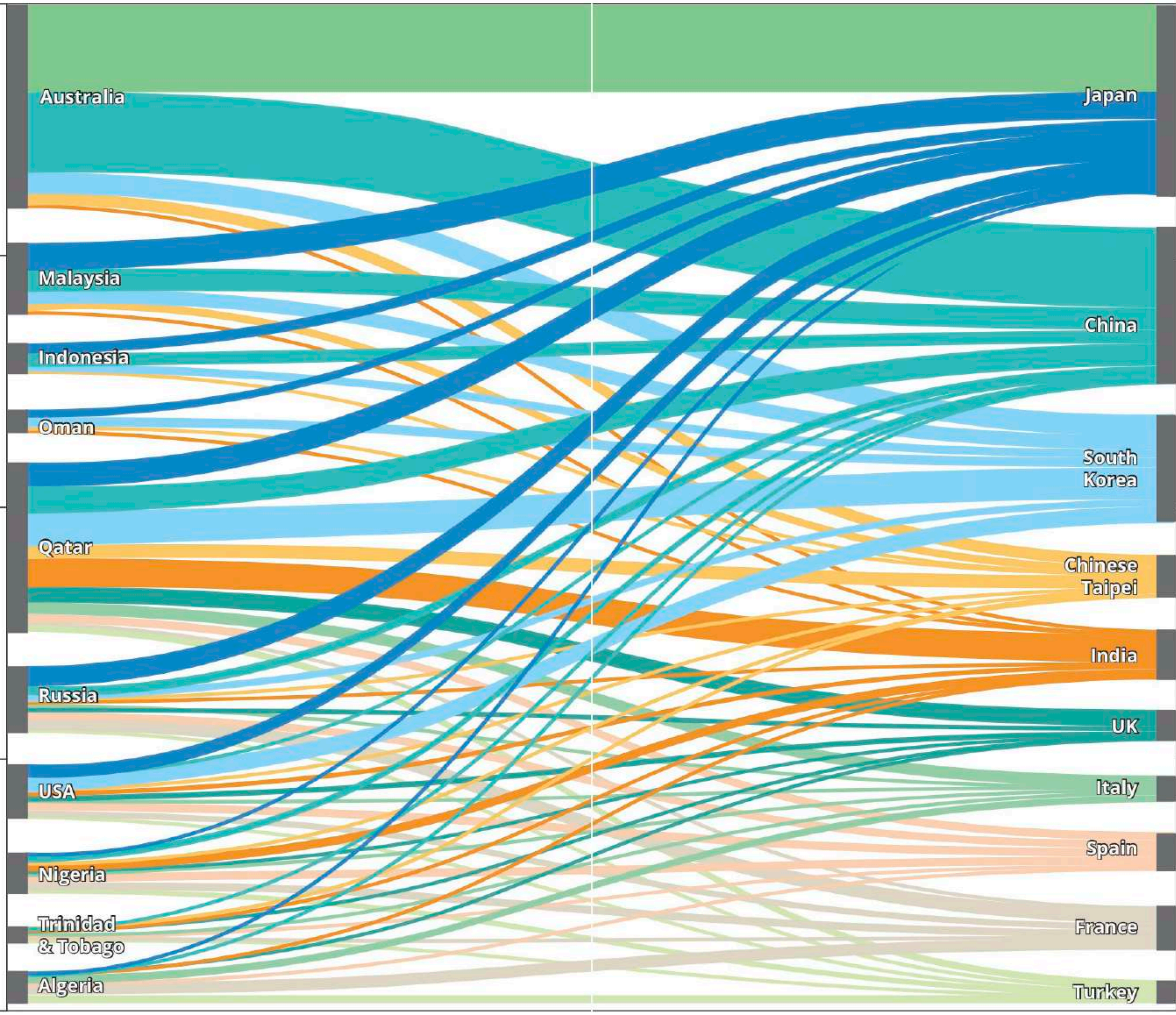
2nd

The USA exported
44.8 MT,
11 MT more than in 2019

3rd

Russia remained the world's fourth largest exporter at
29.6 MT

4th



China imported
68.9 MT
(+7.2 MT vs. 2019)

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

India imported 2.7 MT more than in 2019
26.6 MT

European imports dropped to
81.6 MT
(-4.3 MT)

[1] Source: GIIGNL

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

3. LNG Trade

Despite COVID-19 impacts on demand and supply, global LNG trade continued its upward trend in 2020 for another consecutive year of growth, reaching 356.1 MT. The increase in trade, however, was much smaller compared to the growth seen in 2019, at only 1.4 MT versus 40.9 MT.

Gas Agility – Courtesy of MOL

3.1 OVERVIEW

Growth in exports were driven mainly by the US (+11 MT) and Australia (+2.4 MT). Australia overtook Qatar as the largest LNG exporter in the world, exporting 77.8MT in 2020 versus 75.4 MT in 2019, while Qatar exported 0.7 MT less in 2020 from 77.8 MT in 2019. The US remained the 3rd largest exporter of LNG at 44.8 MT, and Russia retains its spot as the 4th largest exporter with 29.6 MT of exports in 2020. The largest exporting region continues to be Asia Pacific with a total of 131.2 MT of export in 2020 which is a decrease of 0.6 MT versus 2019.

A significant number of markets exported less volumes in 2020 than they did in 2019, a result of a mix of technical issues, demand drops due to COVID-19 related restrictions, commercial challenges due to price developments, and feedgas challenges. The biggest drops in export levels were seen by Trinidad & Tobago (-2.4 MT), Malaysia (-2.4 MT), Egypt (-2.1 MT), Algeria (-1.7 MT) and Norway (-1.6 MT).

While in 2019, increases in net imports were largely driven by Europe as a result of netbacks, in 2020 increases in net imports were driven mostly by key LNG buyers such as China, India, Chinese Taipei and South Korea, increasing their net imports by a total of 11.7 MT. Asia Pacific continues to be the largest net importing region at 147.1 MT, a slight drop of 1.2 MT versus 2019. Asia as a net importing region is still the second largest at 107.3 MT, an increase of 9.5 MT compared to 2019. This growth was driven by the increase in net imports by China (+7.2 MT) and India (+2.7 MT). The only new importing market in 2020 was Myanmar, who imported 0.2 MT of LNG in 2020.

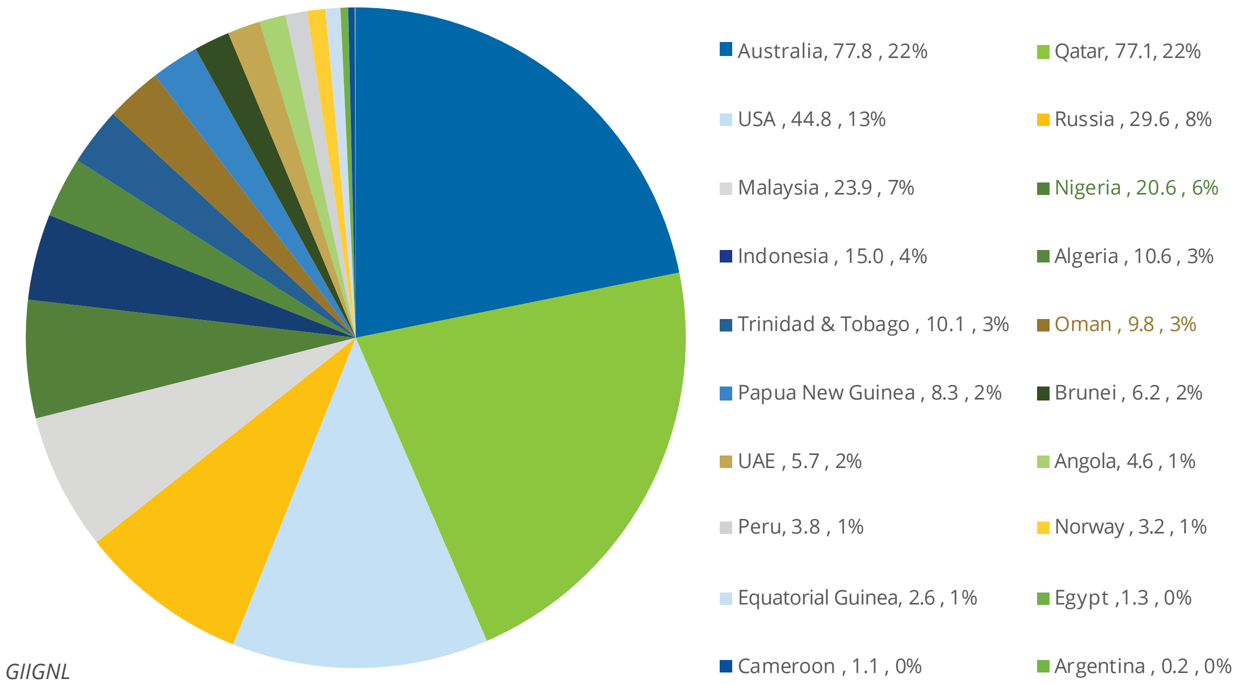
Global LNG Trade	LNG Exporters & Importers	LNG Re-Exports
+1.4 MT Growth of global LNG trade	Myanmar commenced LNG imports in 2020, and is therefore the 39th importing market[1]	+1 MT Re-exported volumes increased by 66% YOY in 2020
Global LNG trade reached an all-time high of 356.1 MT in 2020, another year of consecutive growth. China provided 7.2 MT in new net import demand, and Asia increased net imports by 9.5 MT. Contractions were largest in Mexico (-3 MT), France (-2.5 MT) and Japan (-2.4 MT).	China, India, Chinese Taipei, the United States (Puerto Rico), and Brazil increased net imports through expansion of import capacity. Growth in exports came from the United States (+11 MT) and Australia (+2.4 MT).	Re-export activity increased in 2020 to 2.6 MT (1.6 MT in 2019). Asia received the largest volume of re-exports (1.59 MT), while Asia Pacific re-exported the highest volumes (1.25 MT).

Shell's Terminal at Hazira - Courtesy of Shell

[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.

3.2 LNG EXPORTS BY MARKET

Figure 3.1: 2020 LNG Exports and Market Share by Market (in MT)

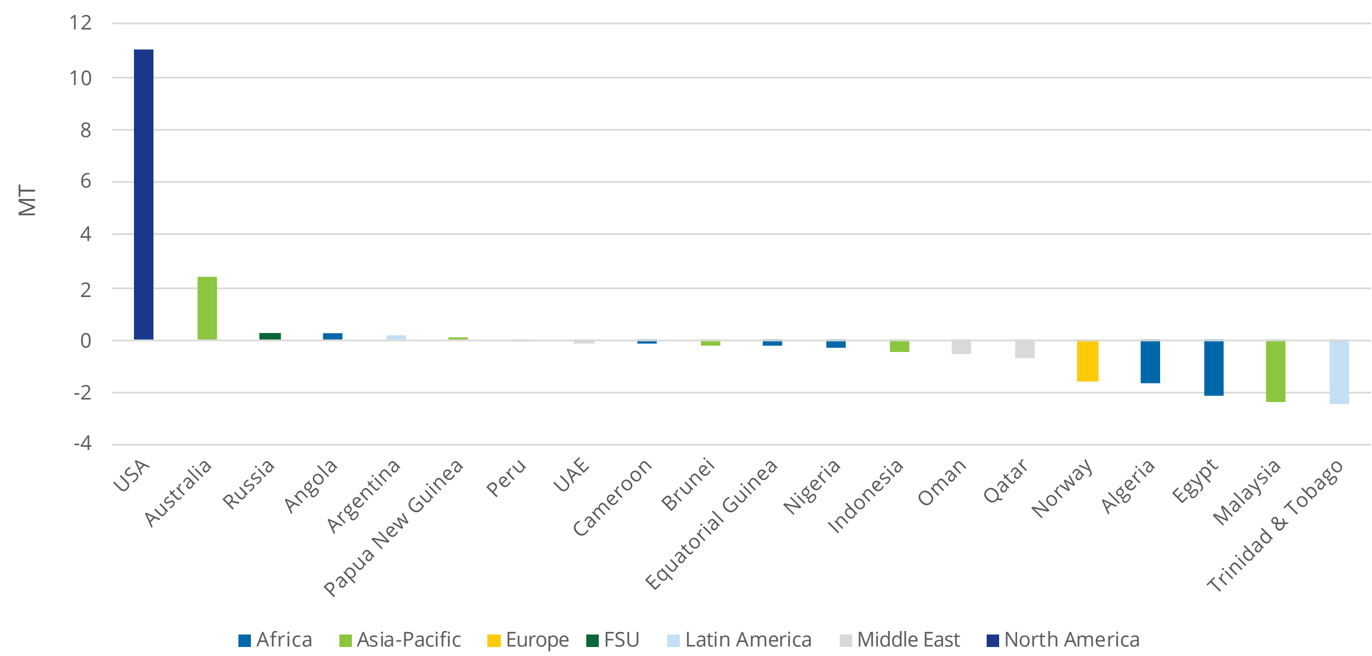


Source : GIIGNL

All of the liquefaction capacity added in 2020 was from the US, and no new markets started exporting.

Australia overtook Qatar as the largest exporter in 2020, exporting 77.8 MT, an increase of 2.4 MT, while Qatar exported 77.1 MT, each capturing a 22% market share of exports. Australia's increase was likely the result of the ramp up in volumes from Ichthys, and high utilization across existing projects for a large part of the year. The other notable increase in exports was from the United States, who remains in third place, and exported 11MT more than in 2019, as a result of trains starting up at Freeport LNG, Cameron LNG and Elba Island. The US exported 44.8 MT in 2020, an increase of 33% compared to 2019, despite cargo cancellations as a result of COVID-19 demand implications. Russia remains at fourth place, exporting a total of 29.6MT in 2019, a small increase of 0.3 MT versus 2019. Angola and Papua New Guinea benefited from improved feedgas availability with minor increases in exports: 0.2 MT and 0.1 MT respectively.

Figure 3.2: 2020 Incremental LNG Exports by Market Relative to 2019 (in MT)



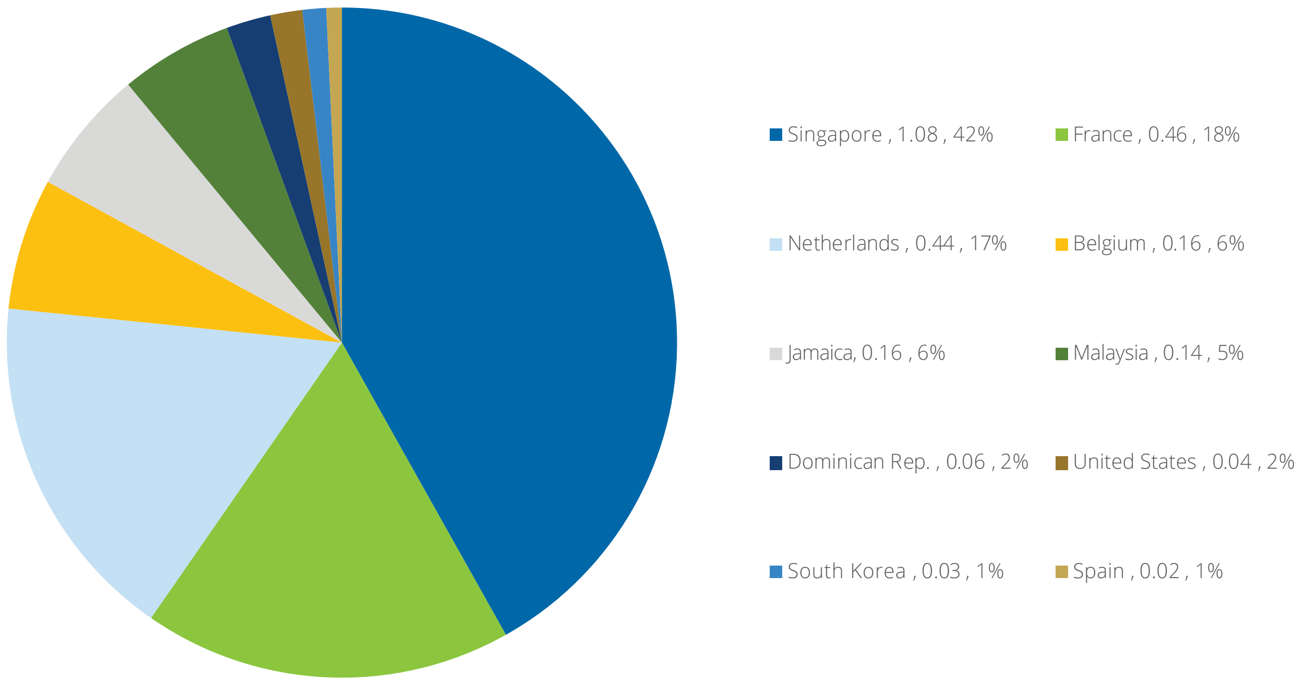
Source : GIIGNL

Large decreases in exports were seen in Trinidad & Tobago, Malaysia, Egypt, Algeria and Norway, who collectively reduced exports by 10.1 MT compared to 2019. Trinidad & Tobago reduced exports by 2.4 MT as a result of feedgas availability challenges, while Malaysia (-2.4 MT) and Egypt (-2.1 MT) lowered exports as a result of changing economics as a result of the price volatility seen in 2020. Algeria reduced exports (-1.7 MT) for similar reasons, having to compete with US volumes into Europe, while Norway (-1.6 MT) faced technical issues at Snøhvit LNG. Smaller decreases were seen in Qatar (-0.7 MT), Oman (-0.5 MT) and Indonesia (-0.5 MT). Exports reduced in a total of 14 markets, totaling a decrease in exports of 12.7 MT in those markets compared to 2019.

Asia Pacific remained the largest export region, exporting a total of 131.2 MT in 2020, a small decrease of 0.6 MT compared to 2019, driven by a drop in exports from Brunei (-0.2 MT), Indonesia (-0.5MT) and Malaysia (-2.4 MT) but offset by the aforementioned increase in exports from Australia (2.4 MT). The largest regional increase in exports came from North America due to the stellar increase in exports from the United States mentioned earlier (+11 MT). The largest decrease in regional exports was seen in Europe, solely driven by the technical issues in Norway, a drop of 33% compared to 2019.

Re-exported trade increased in 2020 by 66% from 1.6 MT to 2.6 MT, equal to roughly 1% of global LNG trade in 2020, an increase of 0.6% compared to 2019. Re-exports were loaded in 10 markets and Singapore and France continued to top the list as they did in 2019, re-exporting 1 MT and 0.5 MT respectively. Singapore almost doubled its' re-exports compared to 2019. The Netherlands also increased re-exports by 0.3 MT to 0.4 MT. Markets that re-exported volumes in 2019, but did not do so in 2020 were China, India and Lithuania. Conversely, South Korea did not re-export volumes in 2019, but did load 0.03 MT of re-exported volumes in 2020. Asia Pacific loaded 48% of all re-exported volumes, followed closely by Europe at 42%.

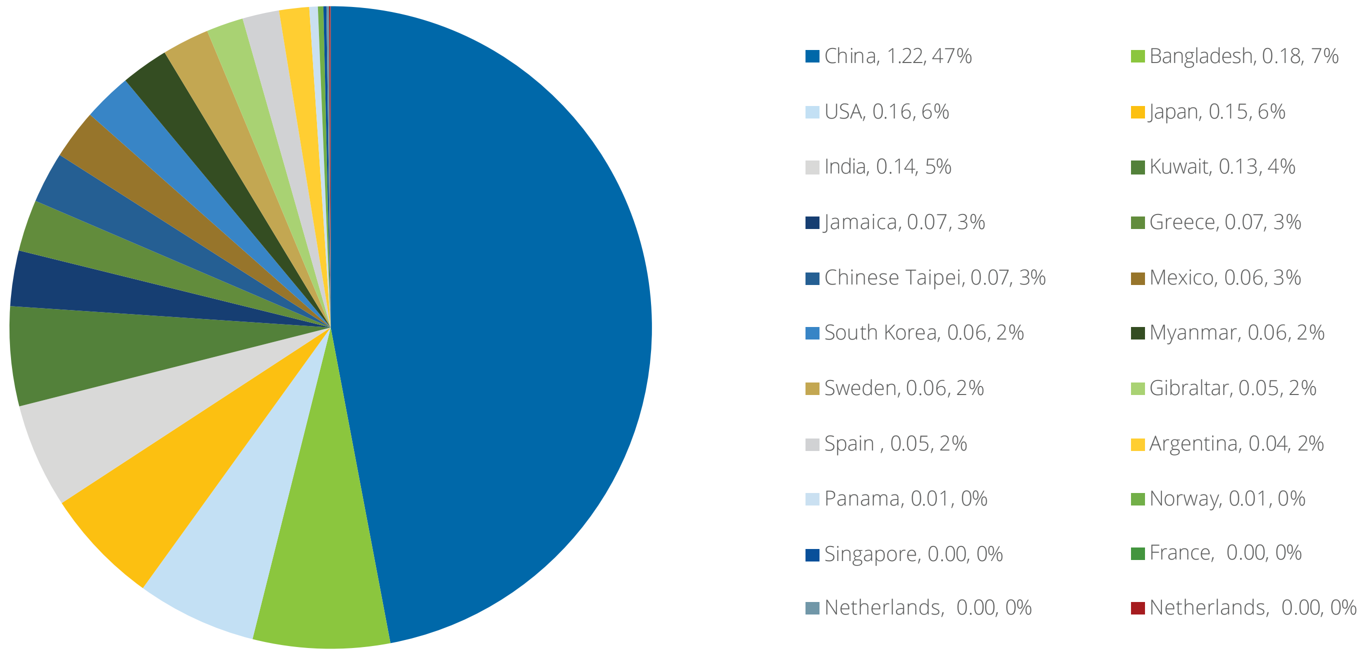
Figure 3.3: Re-Exports Loaded by Re-loading Market in 2020 (in MT)



Source : GIIGNL

In 2020, 22 markets received re-exported volumes, versus 19 markets in 2019. Markets that received re-exported volumes in 2020, but did not do so in 2019 were Kuwait, Mexico, Myanmar, Spain, Argentina, Singapore, France and the Netherlands. Markets that did not receive re-exported volumes in 2020 despite doing so in 2019 are Malaysia, the United Arab Emirates, Pakistan, Lithuania and Finland.

Figure 3.4: Re-Exports Received in 2020 by Receiving Market (in MT)



Source : GIIGNL

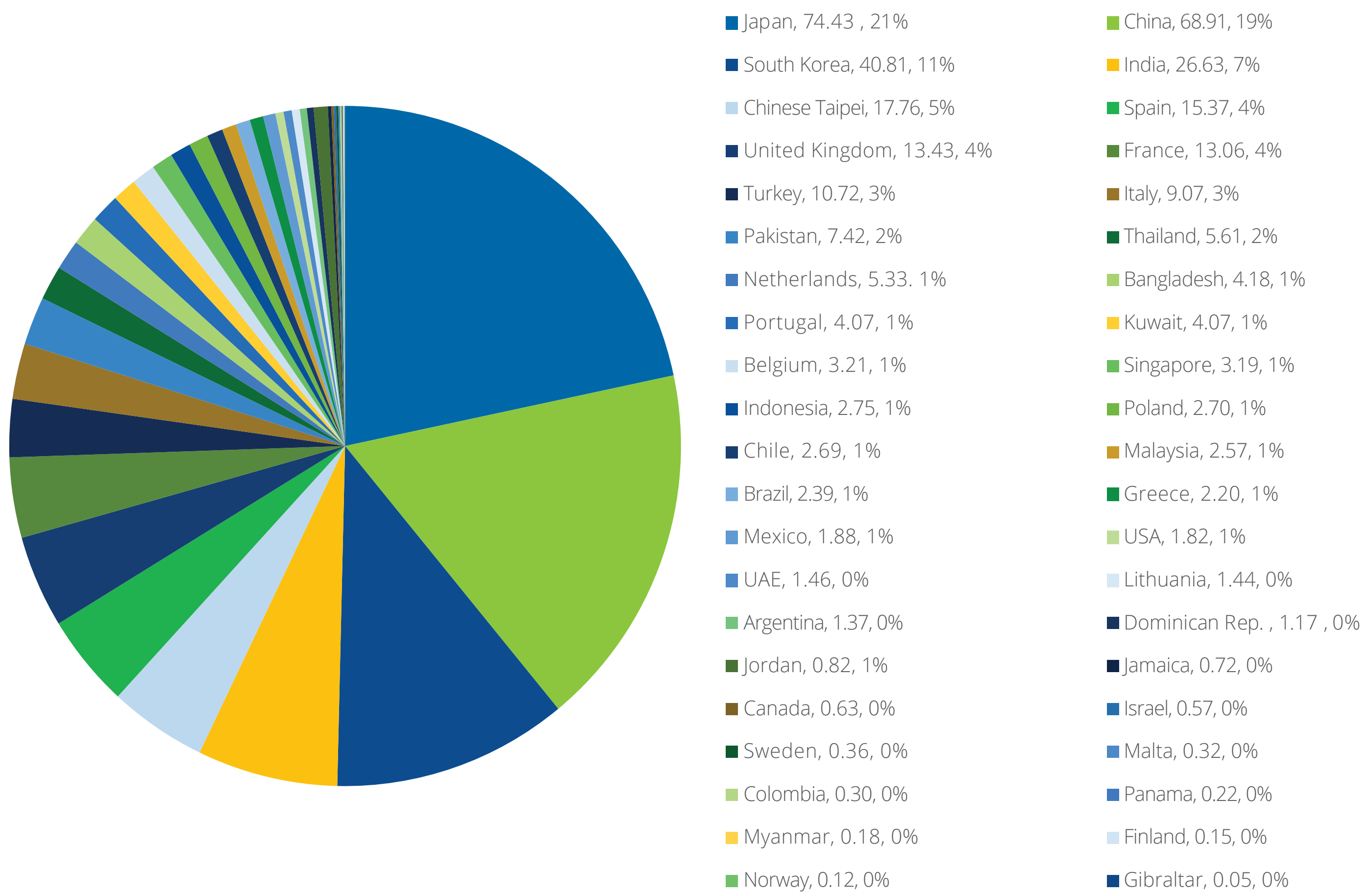
SCF LA PEROUSE - Courtesy of SOVCOMFLOT

3.3
NET LNG IMPORTS BY MARKET

Myanmar was a new addition to the list of global LNG net importers in 2020, importing 0.2 MT. Growth in net imports was dominated by long-standing importing giants China, India, Chinese Taipei and South Korea – adding a total of 11.7 MT of net imports in 2020 despite waves of COVID restrictions. Turkey also increased net imports by 1.35 MT. The largest increases in net imports was seen in Asia, growing net imports by 10%, or 9.5 MT, compared to 2019.

The largest importing regions, consistent with 2018 and 2019, were Asia Pacific and Asia (147.1 MT and 107.3 MT respectively), although Asia Pacific's market share of total net LNG imports declined by 1% compared to 2019.

Figure 3.5: 2020 LNG Imports and Market Share by Market (in MT)



Source : GIIGNL

Demand from Asia Pacific was supported through growth in net imports into Chinese Taipei, South Korea and Thailand, but was challenged by a significant decrease in net imports in Japan (-2.4 MT), Indonesia (-0.9 MT), and smaller decreases of 0.1 MT in both Malaysia and Singapore. These developments were likely driven by a colder early winter in Asia Pacific, the volatile price environment and changes in domestic energy mixes and demand.

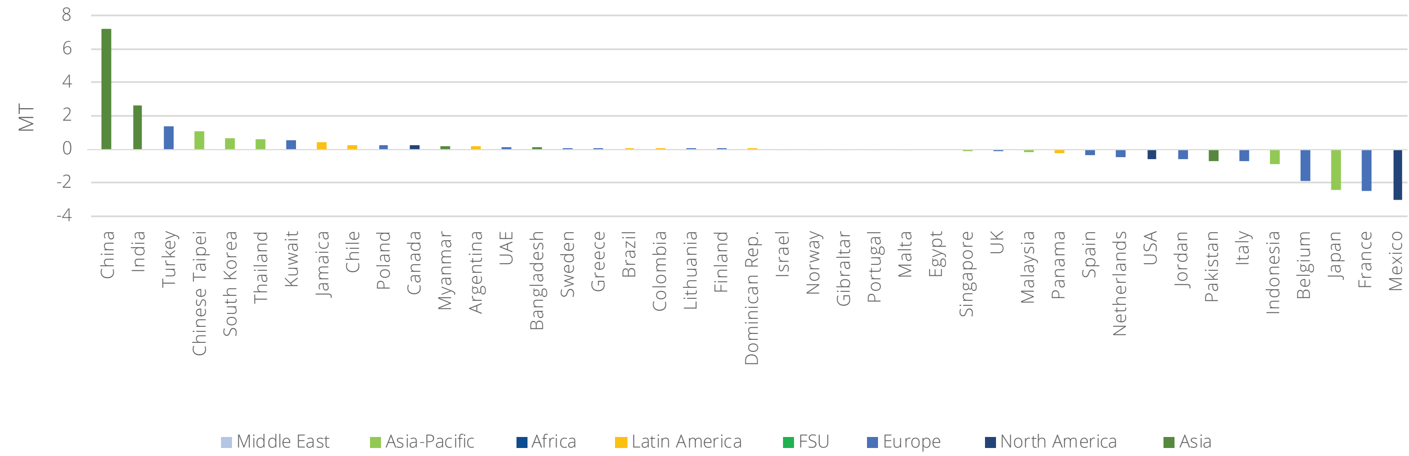
Asia's market share grew with support from China, India, Myanmar and Bangladesh – collectively adding 10.2 MT of net imports. While COVID-19 meant significant restrictions for some of these markets, they likely also benefited from the lower price period in 2020 and purchased additional short- term volumes, and expansion of regasification capacity in some cases.

European net imports declined by 4.3 MT in 2020 to 81.6 MT – a direct result of extended lockdowns in many Euopean markets, lowering activity levels, as well as the increased share of renewables in the energy mix. Market share was more or less maintained though, at 23%, supported by growth in net imports by Turkey (1.4 MT) and Poland (0.2 MT). The largest decreases were seen in France (-2.5 MT) and Belgium (-1.9 MT).

Egypt and Argentina continue to be volatile import/export markets with domestic gas availability and international gas pricing influencing energy export strategies. While Argentina ramped up exports initially in 2020, it stopped exporting by middle of the year as domestic demand increased, and ultimately terminated the charter of Tango FLNG, instead importing 0.2 MT of LNG. Egypt's Idku LNG was curtailed due to the price environment for parts of 2020, but ramped up exports again towards the end of the year. With Damietta also restarting, net imports into Egypt ceased in 2020.

Latin America imported an additional 0.8 MT of LNG, mostly supported by growths in net imports by Jamaica and Chile. North American net imports decreased by 3.4 MT, mostly as a result of Mexico importing 3 MT less than in 2019. Lastly, Middle Eastern net imports remained stable at 6.9 MT, with an increase in net imports seen in Kuwait (0.5 MT), while Jordan decreased imports by 0.6 MT.

Figure 3.6: Incremental 2020 LNG Imports by Market & Incremental Change Relative to 2019 (in MT)



Source : GIIGNL

3.4
LNG INTERREGIONAL TRADE

The largest global LNG trade flow route continues to be intra-Asia Pacific trade (84.3 MT), driven mainly by continued ramp up in exports from Australia, into Japan (29 MT) and South Korea (8 MT). Most of the remaining supply out of Asia Pacific ended up in Asia, as was the case in 2019, being the second largest LNG trade flow in 2020 – 46.4 MT with 29.7 MT from Australia to China alone.

The third largest trade flow is from the Middle East to Asia Pacific at 33.9 MT – with most of those supplies being exported from Qatar. There also significant flows from the Middle East to Asia at 33.1 MT, driven mostly by volumes from Qatar and the UAE to India and Pakistan.

African exports flowed mainly to Europe and Asia (22.4 MT and 12 MT respectively), under pressure due to reduced exports from Cameroon, Equatorial Guinea, Nigeria, Algeria and Egypt in 2020. European imports from Africa had to compete with low cost imports from the US, which meant a reduction of flows. While India was still a big customer of African LNG, that volume also decreased compared to 2019, with India taking more volumes from Qatar instead, for example. China imported more volumes from Russia in 2020, and instead imported less from Africa. Imports into Asia Pacific from Africa increased however, to 3.7 MT, from 3.46 MT, mostly driven by a small increase of flows into Japan from Nigeria.

Flows from North America went mostly into Europe (18.5 MT, up from 12.7 MT in 2019) and Asia Pacific (12.7 MT, up from 9.5 MT). A large chunk of the additional US exports into Europe went into Spain, the UK and Turkey. In Asia Pacific, additional exports from the US mostly went into Japan and South Korea due to the netbacks being favourable for part of 2020.

FSU/Russian exports were similarly focused on Europe (12.6 MT, a decrease from 15.1 MT in 2019) and Asia Pacific (10.7 MT, up from 8.8 MT in 2019). Chinese Taipei's imports from Russia increased, while Russian exports to France, the Netherlands, Belgium all decreased compared to 2019.

With exports from Latin America slipping in 2020, as a result of reduced exports from Trinidad & Tobago, exports within Latin America decreased marginally (down to 2.2 MT from 2.6 MT in 2019), decreased into Europe (-1.9 MT), and decreased into North America (-0.5 MT). A small increase was observed into Asia Pacific (0.6 MT), mainly into South Korea.

Lastly, European volumes remained within Europe (3 MT), meaning Norway's lowered exports were mainly imported into other European markets, with most of those volumes going into Lithuania, France, Spain and the Netherlands.

Table 3.1: LNG Trade Between Regions, 2020 (in MT)

Exporting Region / *Importing Region*	Asia-Pacific	Middle East	Africa	North America	Former Soviet Union	Latin America	Europe	Reexports Received	Reexports Loaded	**Total**
Asia-Pacific	84.3	33.9	3.7	12.7	10.7	2.7	-	0.3	1.3	**147.1**
Asia	46.4	33.1	12.0	6.6	5.8	1.8	-	1.6	-	**107.3**
Europe	-	21.9	22.4	18.5	12.6	4.0	3.0	0.2	1.1	**81.6**
Latin America	0.1	0.6	0.7	5.2	0.1	2.2	0.1	0.1	0.2	**8.8**
North America	0.3	-	0.4	0.8	-	2.6	0.1	0.2	-	**4.3**
Middle East	-	3.1	1.7	1.0	0.4	0.7	-	0.1	-	**6.9**
Africa	-	-	-	-	-	-	-	-	-	**-**
Total	**131.2**	**92.6**	**40.8**	**44.8**	**29.6**	**14.0**	**3.2**	**2.6**	**2.6**	**356.1**

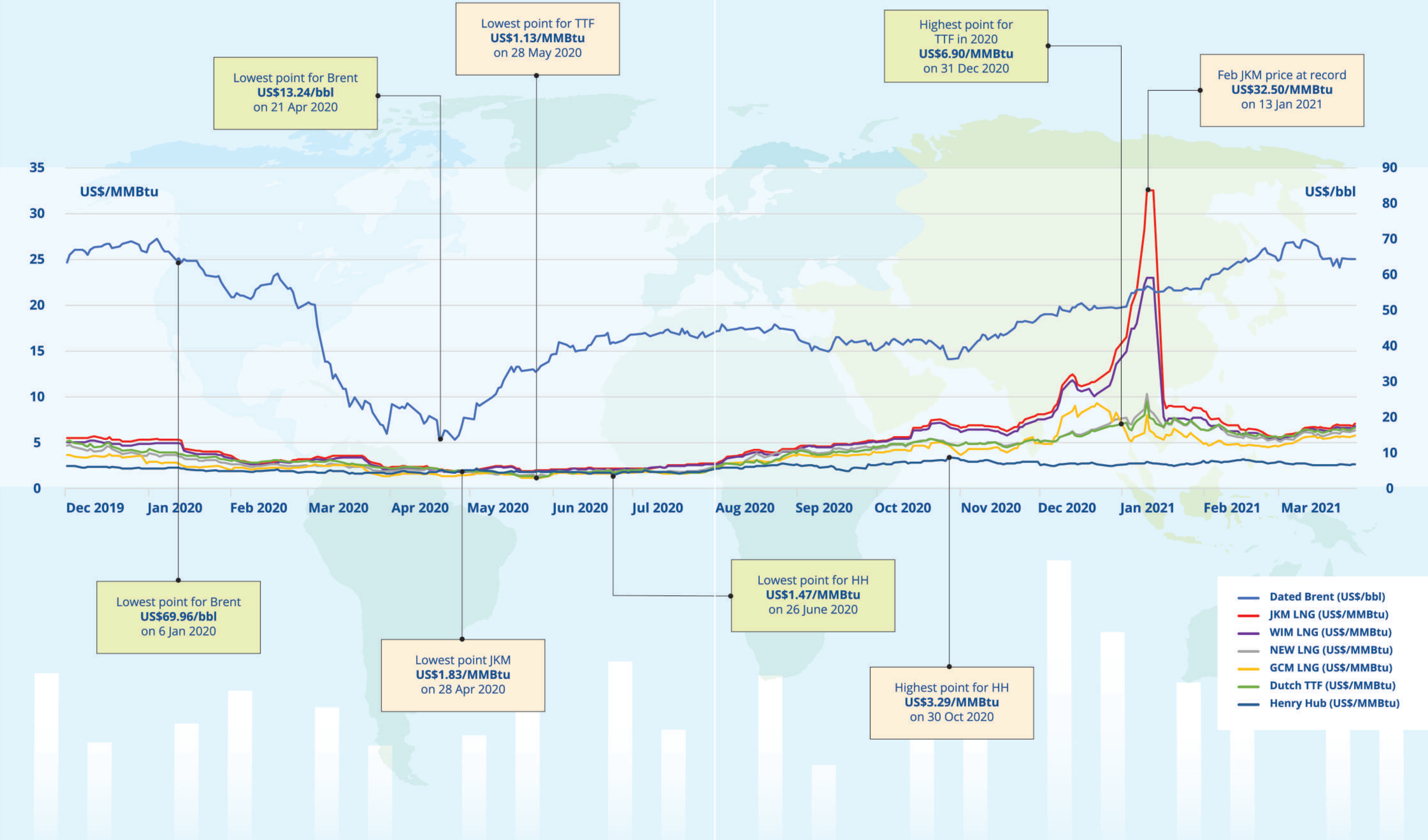
Source : GIIGNL

Table 3.2: LNG Trade Volumes between Markets, 2020 (in MT)

Markets	Algeria	Angola	Argentina	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	2020 NET IMPORTS	2019 NET IMPORTS
China	0.06	0.35	-	29.67	0.66	0.39	0.13	0.14	5.37	6.38	2.54	-	1.16	2.90	1.13	8.20	4.92	0.19	0.30	3.21	1.22	-	68.91	61.68
India	0.21	2.35	-	1.04	0.07	0.39	0.13	0.56	-	-	2.94	-	1.24	-	-	10.72	0.68	0.50	3.32	2.36	0.14	-	26.63	23.98
Pakistan	0.27	0.07	-	-	-	-	0.32	-	0.13	0.06	0.46	-	0.20	-	-	4.64	0.13	-	0.33	0.79	-	-	7.42	8.10
Bangladesh	0.07	-	-	-	-	-	-	0.06	-	-	0.55	-	-	-	-	2.98	0.07	-	-	0.27	0.18	-	4.18	4.07
Myanmar	-	-	-	-	-	-	-	-	-	0.12	-	-	-	-	-	-	-	-	-	-	0.06	-	0.18	0.00
ASIA	0.61	2.77	-	30.71	0.73	0.78	0.57	0.76	5.50	6.57	6.48	-	2.60	2.90	1.13	26.54	5.79	0.69	3.95	6.63	1.59	-	107.31	97.84
Japan	-	-	-	29.05	3.96	-	0.06	-	2.16	10.59	1.36	-	2.45	3.42	0.63	8.69	6.14	-	1.03	4.73	0.15	-	74.43	76.87
South Korea	-	0.40	-	8.10	0.32	0.13	0.06	0.06	2.77	5.00	0.34	-	4.01	0.29	1.66	9.46	2.11	0.07	0.18	5.83	0.06	0.03	40.81	40.14
Chinese Taipei	-	-	-	4.73	0.25	-	0.12	-	1.14	0.71	0.39	-	0.06	1.62	-	4.96	2.40	0.12	0.18	1.01	0.07	-	17.76	16.66
Thailand	-	-	-	0.79	0.19	0.06	0.07	0.05	0.21	0.98	0.19	-	0.15	0.07	-	2.18	-	0.13	-	0.54	-	-	5.61	5.00
Singapore	-	0.20	-	2.31	0.06	-	0.06	0.08	0.22	-	-	-	0.13	-	-	0.46	0.06	0.07	-	0.61	-	1.08	3.19	3.30
Indonesia	-	-	-	-	-	-	-	-	2.75	-	-	-	-	-	-	-	-	-	-	-	-	-	2.75	3.65
Malaysia	-	-	-	1.94	0.70	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-	-	0.14	2.57	2.71
ASIA PACIFIC	-	0.60	-	46.92	5.49	0.19	0.37	0.19	9.25	17.28	2.35	-	6.80	5.40	2.29	25.74	10.71	0.39	1.39	12.72	0.29	1.25	147.12	148.32
Spain	0.39	0.28	0.12	-	-	-	0.07	0.70	-	-	2.97	0.38	-	-	0.13	2.25	2.61	1.57	-	3.88	0.05	0.02	15.37	15.72
United Kingdom	0.03	-	-	-	-	-	0.14	-	-	-	0.26	0.30	-	-	-	6.53	2.07	0.74	-	3.36	-	-	13.43	13.55
France	2.96	0.13	-	-	-	-	-	-	-	-	2.91	0.53	-	-	0.07	1.38	3.44	0.30	-	1.79	-	0.46	13.06	15.57
Turkey	3.96	0.07	-	-	-	0.07	0.07	0.13	-	-	1.32	0.07	-	-	-	2.26	0.16	0.39	-	2.22	-	-	10.72	9.37
Italy	2.14	0.06	-	-	-	-	-	0.06	-	-	0.14	0.00	-	-	-	5.05	-	0.06	-	1.57	-	-	9.07	9.77
Netherlands	0.06	0.20	-	-	-	-	-	0.07	-	-	0.28	0.37	-	-	0.07	0.18	2.58	0.25	-	1.71	-	0.44	5.33	5.79
Portugal	0.06	0.07	-	-	-	-	-	0.06	-	-	2.28	0.06	-	-	-	0.21	0.49	0.06	-	0.78	-	-	4.07	4.12
Belgium	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	1.84	0.64	-	-	0.88	-	0.16	3.21	5.08
Poland	-	-	-	-	-	-	-	-	-	-	0.06	0.25	-	-	-	1.64	-	0.05	-	0.70	-	-	2.70	2.46
Greece	0.19	-	-	-	-	-	0.05	-	-	-	0.16	0.06	-	-	-	0.54	0.07	-	-	1.05	0.07	-	2.20	2.11
Lithuania	-	-	-	-	-	-	-	-	-	-	-	0.75	-	-	-	-	0.21	-	-	0.48	-	-	1.44	1.40
Sweden	-	-	-	-	-	-	-	-	-	-	-	0.14	-	-	-	-	0.15	-	-	-	0.06	-	0.36	0.26
Malta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22	-	0.10	-	-	0.32	0.37
Finland	-	-	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-	0.14	-	-	-	-	-	0.15	0.14
Norway	-	-	-	-	-	-	-	-	-	-	-	0.10	-	-	-	-	0.01	-	-	-	0.01	-	0.12	0.12
Gibraltar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	0.05	0.05
EUROPE	9.80	0.80	0.12	-	-	0.07	0.33	1.02	-	-	10.36	3.04	-	-	0.26	21.89	12.58	3.65	-	18.51	0.24	1.08	81.59	85.89
Chile	-	-	-	0.07	-	-	-	0.51	-	-	-	-	-	-	-	-	-	0.53	-	1.58	-	-	2.69	2.45
Brazil	-	0.08	0.05	-	-	-	-	-	-	-	0.03	-	-	-	-	-	-	0.26	-	1.98	-	-	2.39	2.32
Argentina	0.04	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	0.62	0.08	0.25	-	0.30	0.04	-	1.37	1.20
Dominican Republic	0.06	-	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-	-	0.55	-	0.57	-	0.06	1.17	1.15
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	0.34	-	0.43	0.07	0.16	0.72	0.28
Colombia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	-	0.09	-	-	0.30	0.23
Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	0.01	-	0.22	0.43
LATIN AMERICA	0.10	0.08	0.09	0.07	-	-	-	0.51	-	-	0.03	0.05	-	0.03	-	0.62	0.08	2.13	-	5.15	0.12	0.21	8.84	8.05
Mexico	-	-	-	0.07	-	-	-	0.07	0.24	-	0.15	-	-	-	0.07	-	-	0.45	-	0.76	0.06	-	1.88	4.89
United States of America	-	-	-	-	-	-	-	-	-	-	0.15	-	-	-	-	-	-	1.50	-	-	0.16	0.04	1.82	2.41
Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.63	-	-	-	-	0.63	0.39
NORTH AMERICA	-	-	-	0.07	-	-	-	0.07	0.24	-	0.30	0.06	-	-	0.07	-	-	2.58	-	0.76	0.22	0.04	4.34	7.69
Kuwait	0.06	0.26	-	-	-	0.06	0.06	0.06	-	-	0.69	-	0.13	-	-	2.27	-	-	-	0.34	0.13	-	4.07	3.55
United Arab Emirates	-	0.13	-	-	-	-	-	-	-	-	0.21	-	0.22	-	-	-	0.21	0.13	0.37	0.19	-	-	1.46	1.36
Jordan	-	-	-	-	-	-	-	-	-	-	0.14	-	-	-	-	0.06	0.21	0.27	-	0.13	-	-	0.82	1.40
Israel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.24	-	0.33	-	-	0.57	0.57
MIDDLE EAST	0.06	0.39	-	-	-	0.06	0.06	0.06	-	-	1.03	-	0.35	-	-	2.34	0.42	0.65	0.37	0.99	0.13	-	6.92	6.88
2020 EXPORTS	10.58	4.64	0.21	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	-
2019 EXPORTS	12.23	4.41	0.05	75.39	6.41	1.27	3.45	2.80	15.47	26.21	20.84	4.72	10.26	8.23	3.80	77.80	29.32	12.50	5.83	33.75	1.56	1.56	-	354.73

Source : GIIGNL

4 LNG and Gas Pricing



4. LNG and Gas Pricing

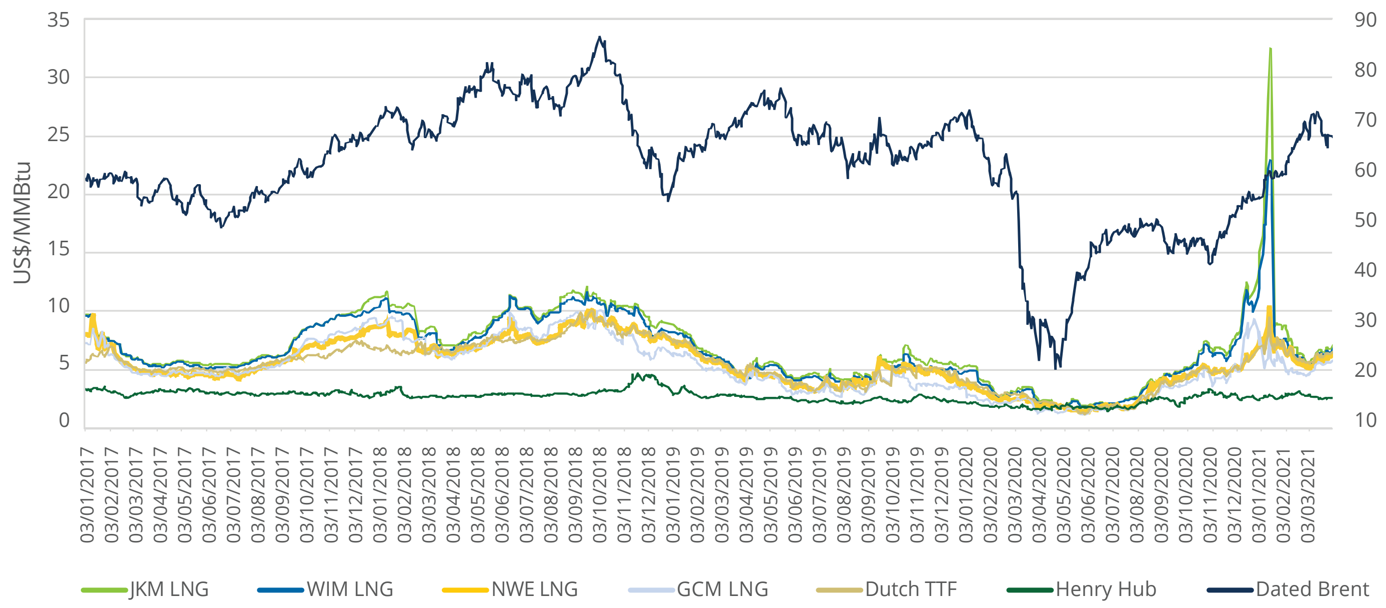
The global LNG market experienced an eventful 2020, during which spot prices of cargoes trading in the Atlantic and Asia Pacific basins plummeted to record lows in the first six months, and then waged a breath-taking rally to hit multi-year highs at the start of 2021.

The outlook for LNG prices in 2020 was important for a range of market participants – from suppliers targeting final investment decisions for new liquefaction projects, to buyers and sellers seeking to lock in fresh long-term agreements, as well as new entrants looking to set up LNG trading desks.

Gibraltar LNG Regasification Terminal – Courtesy of Shell

4.1 ASIA-PACIFIC LNG MARKET PRICE TRENDS

Figure 4.1: Comparison of major LNG, pipeline gas and oil benchmarks



Source: S&P Global Platts

US$32.50/MMBtu

February JKM price at record high on January 13, 2020

The Platts JKM benchmark for cargoes delivered into Northeast Asia started 2020 at US$5.26/mmBtu, before falling gradually to US$1.82/mmBtu on April 28.

In an abundantly supplied spot LNG market, due to a milder than usual winter and increased production from Australia, Russia and the US, the COVID-19 pandemic further exacerbated the supply glut due to the limited buying appetite of major importers in Asia, such as Japan, South Korea, Chinese Taipei, China and India. This wide-scale demand reduction led to deferments and cancellations of spot and long-term cargoes by end-users, which further depressed spot prices. Between April and July, JKM was hovering at parity with the price of US natural gas amid a supply imbalance in Asia and Europe. The lack of margin potential resulted in at least 172 cancellation of US offtake cargoes over the May-to October loading period, according to a Platts tally.

In India, LNG demand for power generation strengthened significantly in the first nine months of 2020, as power plants looked to capitalize on record low spot LNG prices, helping boost margins at prevailing electricity prices. The capacity of gas-fired power plants averaged 6.1 GW in India during the first three quarters of 2020, representing an increase of 600 MW compared to the same period last year. In contrast, capacity of coal-based power plants in the same three quarters averaged 106 GW, a decline of 11 GW year on year. The Platts West India Marker (WIM), which reflects spot LNG prices for cargoes delivered to India and the Middle East, hit a historical low of US$1.76/mmBtu on April 23. A warmer-than-usual winter, additional supply from Australia and the US, along with COVID-19 inflicted demand curtailment, pulled down the average of January to October delivered WIM prices to US$3.17/mmBtu from US$5.62/mmBtu in 2019.

US LNG cancellations started to rebalance the market through summer, but a slew of production issues across global LNG facilities sparked an unprecedented supply-driven price rally. These issues include outages at US and Australian facilities in August, the shutdown of Norway's Hammerfest project in September, as well as production issues in Qatar, Malaysia, and Nigeria in November.

Average LNG inventory levels in Japan, South Korea and Chinese Taipei were more than 30% above the five-year average through the first three quarters of 2020 as COVID-induced demand loss, along with contractual LNG import obligations, led to bloated stocks, Platts Analytics research shows. However, as winter set in, a rapid draw-down in storage levels took inventories in Japan, South Korea, and Chinese Taipei to about 10 Bcm, just below the five-year average. The low stock levels were driven by an unprecedented cold snap sweeping across the region in mid-December as well as the above-mentioned production issues.

Shipping constraints in the Panama Canal restricted supply from the Atlantic region as well, with vessels facing a longer shipping route around the Cape of Good Hope into Asia. Platts Analytics data showed that in Q4'2020, transits through the Panama Canal took an average of 84 hours per transit (around 3.5 days). This was a 16 hour or 23% increase from a year ago. These exceptional wait times at the Canal forced many US LNG exporters to chart a longer, more expensive route to Asia, either sailing south around the Cape of Good Hope in South Africa or sailing east through the Mediterranean and Suez Canal. Platts Analytics voyage data show that LNG transits around the Cape of Good Hope more than doubled year-on-year during this period to last winter, with around 1.2 vessels rounding the horn every day. As a result, the spot shipping market tightened significantly, with the Atlantic Basin charter rate reaching a record-high of US$300,000/d on January 11, which implies that the vessel costs for shipping a cargo to Asia, utilizing the longer Cape of Good Hope route, rose as high as US$6/mmBtu.

Furthermore, downstream gas and power prices in Asia surged as major cities like Tokyo, Seoul and Beijing were gripped by the worst cold spell in decades for a week in January. In a move last seen after the 2011 Fukushima nuclear-reactor incident, Japan's Tepco Power Grid was reported to be seeking to purchase electricity from private companies. The 24-hour average electricity price in Japan was at 154.47 Yen/kWh on Jan. 13, which is equivalent to US$432/mmBtu, according to the Japan Electric Power Exchange. This was a more than a 25-fold increase from the 5.81 Yen/kWh price on December 1. In China, trucked LNG prices surged to around Yuan 10,000/mt (US$29.60/mmBtu) in the northern Beijing-Tianjin-Hebei region towards the end of the year, nearly double the Yuan 5,000-6,000/mt seen in mid-December.

As a result of the spike in downstream gas and power prices, end-users in northeast Asia increased their search for prompt LNG cargo deliveries in the months of January and February 2021. On January 13, 2021, the February JKM price rose to a record US$32.50/mmBtu. The price backwardation of the spot market also widened to historic levels due to prompt price strength, with the spread between first-half and second-half of the month reaching US$13.45/mmBtu. However, the end of the cold snap, arrival of Atlantic shipments in Asia and steep backwardation meant that March and April delivery prices were significantly lower, with the April JKM assessed at US$5.72/mmBtu on February 26, 2021.

Despite the rapid increase of prices toward the end of 2020, the annualized volatility for JKM in 2020 was at 0.505 standard deviation. This was lower than the 0.707 and 0.637 of the Dated Brent and Henry Hub gas benchmarks.

Platts published 1,031 bids, offers and trades in its Asia Pacific physical Market on Close (MOC) process in 2020, compared to 1,682 bids, offers and trades in 2019. The number of bids, offers and trades published during the MOC process fell to the lowest level of the year in May 2020, as overall spot LNG demand was affected significantly by the pandemic and the reduced seasonal trading. Volumes remained relatively low over the June-August period when spot supply was hit hard by US cargo cancellations.

However, China's strong recovery from the pandemic and higher logistical flexibility presented a strong draw for companies looking to deliver LNG cargoes into Northeast Asia. Out of the 38 cargoes performing against spot trades reported in the MOC process, 51% have been delivered to ports in China, and 30% to ports in Japan. Furthermore, 52% of all bids published in the MOC process had a Chinese discharge port nominated as primary discharge port. This compares to 20% and 13% for Japanese and Korean port nominations in MOC bids respectively.

Gibraltar LNG Regasification Terminal – Courtesy of Shell

4.2 ATLANTIC LNG MARKET PRICE TRENDS

The Platts Northwest Europe (NWE) assessment fell to US$1.34/mmBtu on May 28, the lowest ever recorded since Platts began assessing this market nearly 10 years ago. The Platts NWE assessment lost roughly a quarter of its value through March and almost half its value through Q2'20.

The coronavirus pandemic meant that many major markets were subject to wide scale government -imposed shut-downs and loss of energy consumption, raising concerns over the global supply/demand LNG imbalance. The March lockdown of India further caused a spillover effect into the already over-supplied TTF market, which in turn sent European LNG prices to uncharted lows.

As a result of this, the optionality for cross-basin optimization was minimized. The premium for the first half of June JKM to first half of May DES NWE was US$0.76/mmBtu at the start of March, falling to US$0.49/mmBtu by the end of the month. The Dutch TTF front-month April contract also sunk to an all-time low of US$1.14/mmBtu equivalent on May 28, or a 19.5 cents/mmBtu discount to the Platts NWE assessment. The negative net-backs for US-loading shipments resulted in the significantly high number of US cargo loadings being cancelled.

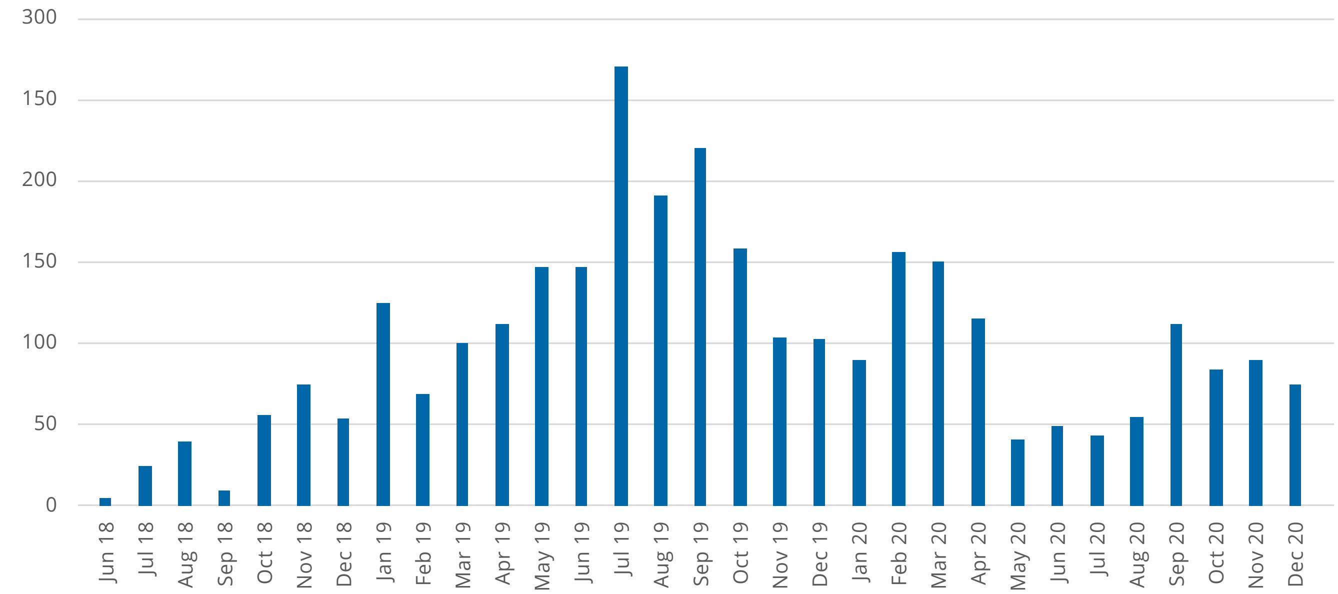
On average, the Platts NWE held a US$0.12/mmBtu discount to the TTF over the year, reflecting the economic preference for pipeline gas over LNG. Platts assessed prices for delivered LNG in the Mediterranean (MED) averaged a US$0.068/mmBtu discount to TTF. This was reflective of the stronger fundamental demand for LNG in the Mediterranean, and the lower interconnectivity to gas hubs in the region.

Increased winter buying activity amid forecasts of a cold winter, along with supply disruptions in the US, Norway, and Nigeria in Q3, sparked a significant rebound in the prices of European LNG and US FOB cargoes. The Platts NWE assessment hit a 2020 record high of US$7.48/mmBtu on Dec 31, while the Platts FOB Gulf Coast Marker reached the highest level since October 8, 2018, at US$9.30/mmBtu on December 24. During this period, the NWE and MED assessments held US$0.55/mmBtu and US$0.35/mmBtu premiums to TTF, as LNG supply diminished amid competition for spot sales to the Pacific basin. Prices rose attracting volume into Europe. The NWE assessment closed the year higher than MED as Northwest Europe bid up cargoes. A strong US$0.800/mmBtu to US$1.000/mmBtu positive spread between the UK's NBP and the Dutch TTF saw several cargos pulled into UK terminals. US LNG feedgas demand hit a new record near 11.6 bcfd on Dec. 13 across the six major liquefaction facilities on the Gulf and Atlantic coasts, Platts Analytics data show.

Despite the significant netbacks from Asia, there were several US cargoes bound for European shores for December delivery as a tight freight market hindered flow into the Pacific Basin. The Platts Atlantic and Asia Pacific day rate were assessed at US$150,000 and US$130,000/day on Dec. 14, over four times the daily rates in July. European gas prices were buoyed by lower temperatures in the region at the start of 2021, with the Platts NWE for April deliveries assessed at US$5.24/mmBtu on February 26, 2021.

Market participants continued to be active in the MOC process for the Atlantic LNG market with 22 bids and offers reported during 2020. This compares with 57 MOC bids and offers in 2019.

Figure 4.2: Platts Asia-Pacific & Atlantic LNG Physical Market on Close (Bids, Offers & Trades)



Source: Platts

Jeju LNG Terminal - Courtesy of KOGAS

4.3 CRUDE OIL MARKET PRICE TRENDS

The oil markets witnessed a turbulent first half of the year as end-user demand was decimated by the pandemic and markets slumped because of a global oversupply. The global oil benchmark, Dated Brent, was assessed by Platts at US$13.24/bbl on April 21, down almost 80% from the start of the year. This was the lowest that the benchmark has been assessed since March 18, 1999.

Driven by supply cuts by OPEC and 10 other key exporting markets, including Russia, as well as optimism about a sustained recovery in demand as the world gets vaccinated, the oil benchmark rose to an eight-month high of US$51.97/bbl on December 18. The crude oil benchmark then continued its long rising streak into the new year--strengthening to US$66.06/mmBtu on February 26, 2021 amid robust Chinese demand, as well as colder weather in Europe and north America.

The majority of LNG contracts globally remained linked to Brent crude oil prices, with long-term LNG contracts signed earlier in 2020 close to a 11% slope to the Dated Brent—tracking the fall in LNG spot prices in the first half of the year. Assuming an average slope of 13% for older contracts and 11% for newer ones, Brent-linked LNG contracts for delivery over the full year of 2020 were priced at US$5.82/mmBtu and US$4.93/mmBtu, respectively. This compares with the full-year average of US$3.94/mmBtu for JKM-linked contracts signed at parity to the LNG benchmark. Brent-linked contracts had a higher average delivery price than JKM-linked contracts in the first three quarters of the year, but the JKM price rally meant that contracts for delivery in the winter months of November and December carried much higher average prices.

5 LNG Liquefaction Plants

Global liquefaction capacity reached **452.9 MTPA** in 2020.

Capacity Additions for 2020

20MTPA of liquefaction capacity brought online

5% year-on-year growth vs 2019

Australia
87.6MTPA
Market with the highest liquefaction capacity

Qatar
77.1MTPA
Market with the second highest liquefaction capacity

USA
Capacity added in the USA
+20 MT

Pre-FID

892.4 MTPA of liquefaction capacity currently in pre-FID stage as of Feb 2021

351.6MTPA from USA

50.0MTPA from Australia

37.2 MTPA from Mozambique

227.8MTPA from Canada

44.0MTPA from Russia

FIDs and Under Construction

Energia Costa Azul T1
Only 1 project took FID in 2020
3.3MTPA

Qatar Petroleum took FID on North Field East in Feb 2021
32MTPA

139.1MTPA of liquefaction capacity under construction or sanctioned for development as of Feb 2021

5. LNG liquefaction plants

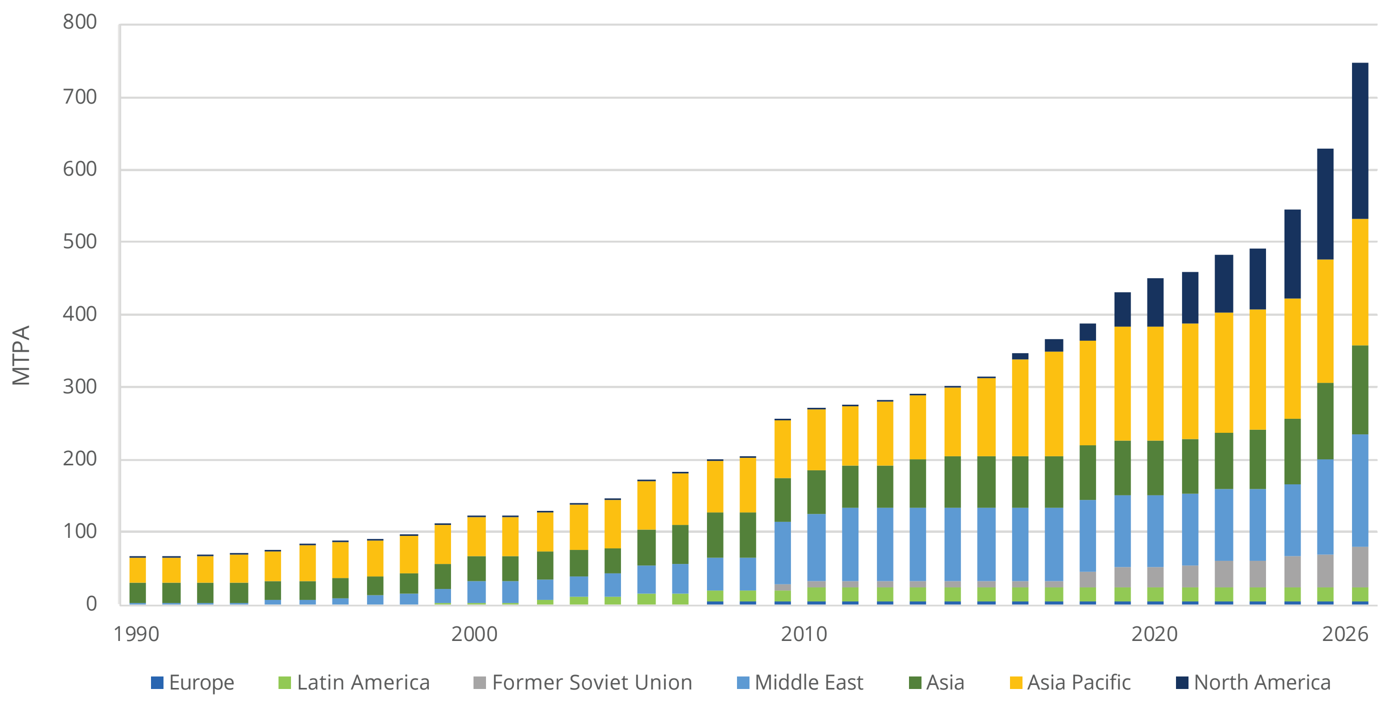
In 2020, 20.0 million tonnes per annum (MTPA) of liquefaction capacity was brought online, increasing global liquefaction capacity to 452.9 MTPA[1] at the end of the year. The average global utilisation rate in 2020 was 74.6%, compared to 81.4% in 2019.

Gorgon Plantsite - Courtesy of Chevron

[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.

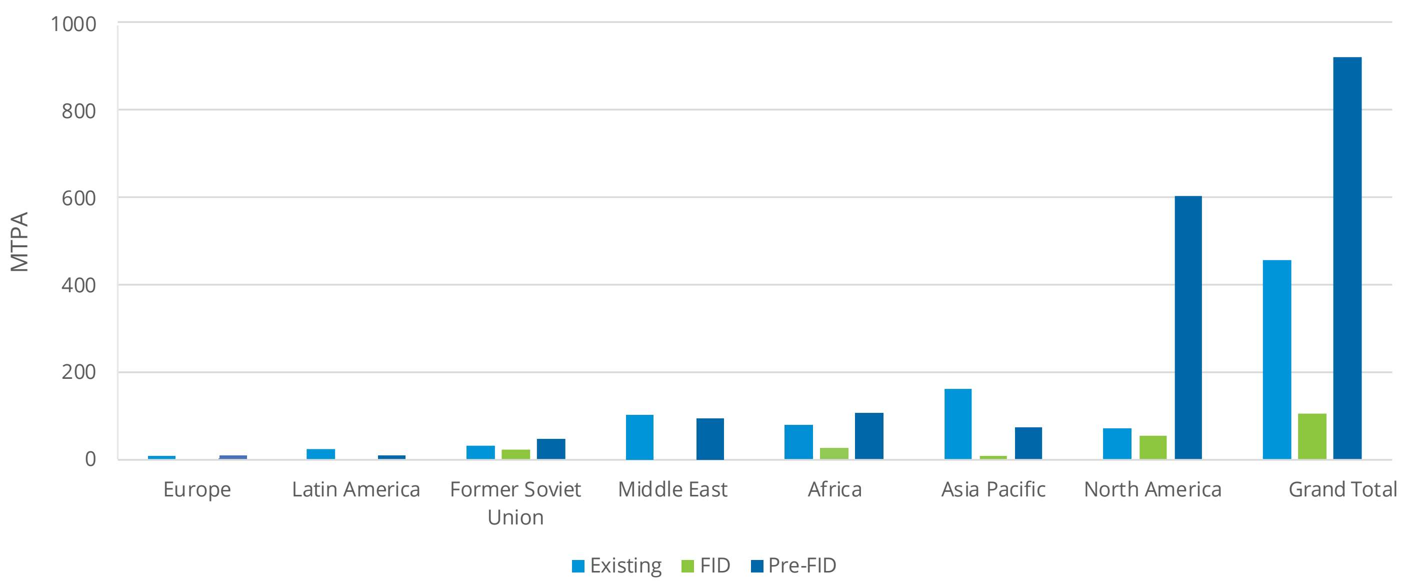
5.1 OVERVIEW

Figure 5.1: Global liquefaction capacity growth by region, as of February 2021



Source: Rystad Energy

Figure 5.2: Global liquefaction capacity by region, as of February 2021



Source: Rystad Energy

Freeport LNG T2 (5.1 MTPA) was the first to begin commercial operations in January 2020, while Freeport LNG T3 (5.1 MTPA) began commercial operations in May 2020, under their tolling agreements with Total and SK E&S. This marks the full commercial operation of the three-train facility in Texas. In the US state of Louisiana, Cameron LNG T2 (4.0 MTPA) and T3 (4.0 MTPA) started commercial deliveries in March and August 2020, respectively. Elba Island T4-T10 (1.75 MTPA) were also brought online in 2020, with the last train starting up in late August 2020.

Commercial operation is expected in 2021 for Yamal LNG T4 (0.9 MTPA), Sengkang LNG T1 (0.5 MTPA), Portovaya LNG T1 (1.5 MTPA), Corpus Christi LNG T3 (4.5 MTPA) and Petronas PFLNG Dua (1.5 MTPA). With these projects coming online, global liquefaction capacity is forecasted to expand to 459.3 MTPA by the end of 2021.

The volume of sanctioned liquefaction capacity in 2020 fell to its lowest since 2008, totaling only 3.25 MTPA. This is driven solely by one project, the Energía Costa Azul LNG T1 (3.25 MTPA) liquefaction terminal in Baja California, Mexico. A final investment decision (FID) was announced in mid-November after two delays in 2020. First LNG production from its phase 1 is anticipated in late 2024. The sanctioned capacity of 3.25 MTPA for 2020 stands in stark contrast to 2019, when 71.3 MTPA of liquefaction capacity was sanctioned.

The COVID-19 pandemic was a key factor in the low volume of sanctioned liquefaction capacity in 2020. Lockdowns and supply chain issues stagnated plant construction and companies delayed FIDs on potential liquefaction projects by several years due to the uncertain economic climate. Goldboro LNG T1 (5.0 MTPA) in Nova Scotia, Canada was signaling FID in 2020, but has been delayed to 2021. The Lake Charles LNG project (16.45 MTPA) has also delayed FID to 2021, with its operator Energy Transfer evaluating alternatives to advance the project by increasing the number of equity partners and reducing its size to two trains from the original plan for three, with a total capacity of 11.0 MTPA. Tellurian aims to begin construction of its proposed Driftwood LNG terminal (16.6 MTPA) in Louisiana in 2021 but it has also not reached FID. The company scaled back its midstream plans significantly, saying in August that it plans to build just one of four proposed pipelines during the first phase of Driftwood. Venture Global previously anticipated FID for Plaquemines LNG (21.6 MTPA) to be achieved by the end of 2020 but has now revised this to mid-2021. Freeport LNG had hoped to sanction a fourth train by end of 2020 at its export terminal south of Houston and has likewise postponed these plans to 2021.

The Corpus Christi LNG terminal expansion has also been delayed to 2021, with Cheniere Energy placing more emphasis on securing contracts in the near term for additional LNG production from its existing liquefaction trains Corpus Christi T1–3 (13.5 MTPA). In August, the Federal Energy Regulatory Commission (FERC) approved NextDecade's plans to remove the sixth train at Rio Grande LNG from the scope, increasing the capacity of the remaining five trains to 5.4 MTPA of liquefaction capacity per train from the original 4.5 MTPA. The total liquefaction capacity at Rio Grande LNG is 27.0 MTPA. FID for Phase 1 of this project has also been delayed until 2021. Australia's biggest LNG exporter Woodside has deferred targeted FID for its Scarborough, Pluto LNG T2 (4.5 MTPA) and Browse backfill projects in response to its decision to downsize overall capital expenditure for 2020.

With a sizable number of liquefaction projects being delayed last year, the spotlight is on 2021. However, with COVID-19 still prevalent in many parts of the world, it is uncertain how this will continue to impact liquefaction projects this year. It seems likely that future liquefaction investments will continue to be underpinned by long-term sales and purchase agreements (SPAs) to secure financing, as demonstrated by the new projects that came online in 2020. The Elba Island (2.5 MTPA) liquefaction project is supported by a 20-year SPA with Shell, which subscribed to its full liquefaction capacity. Similarly, Cameron LNG T1–3 (12.0 MTPA) has long-term tolling agreements with Mitsubishi, Mitsui and Total, while Freeport LNG T1–2 (10.2 MTPA) has tolling agreements with BP, Osaka Gas and JERA.

Despite the delays and negative sentiment, the Calcasieu Pass LNG liquefaction plant (10.0 MTPA) in Louisiana and Golden Pass LNG liquefaction plant (15.6 MTPA), both under construction, are on track to start up on time. Calcasieu Pass LNG is scheduled to come online in 2022 while Golden Pass plans to have the first three trains commercially operational in 2024.

Currently, 892.4 MTPA of aspirational liquefaction capacity is in the pre-FID stage. Global liquefaction capacity would increase three-fold if all these projects materialise, although this is highly unlikely. Most of the proposed capacity is in North America (604.4 MTPA), with 351.6 MTPA located in the United States, 227.8 MTPA in Canada and 25.0 MTPA in Mexico. This is followed by Africa (103.9 MTPA), the Middle East (60.3 MTPA) and Asia-Pacific (73.4 MTPA). About 50.5 MTPA of liquefaction capacity is proposed in the rest of the world. Overall, the market upheaval caused by COVID-19 has temporarily muted investor appetite for new multibillion-dollar LNG infrastructure and has forced many developers to push back their targets for FIDs until 2021 or later. This year is poised to be a pivotal year, where growing hopes of a quick recovery could change the LNG demand and supply prospects for the better.

5.2 GLOBAL LIQUEFACTION CAPACITY AND UTILISATION

452.9 MTPA

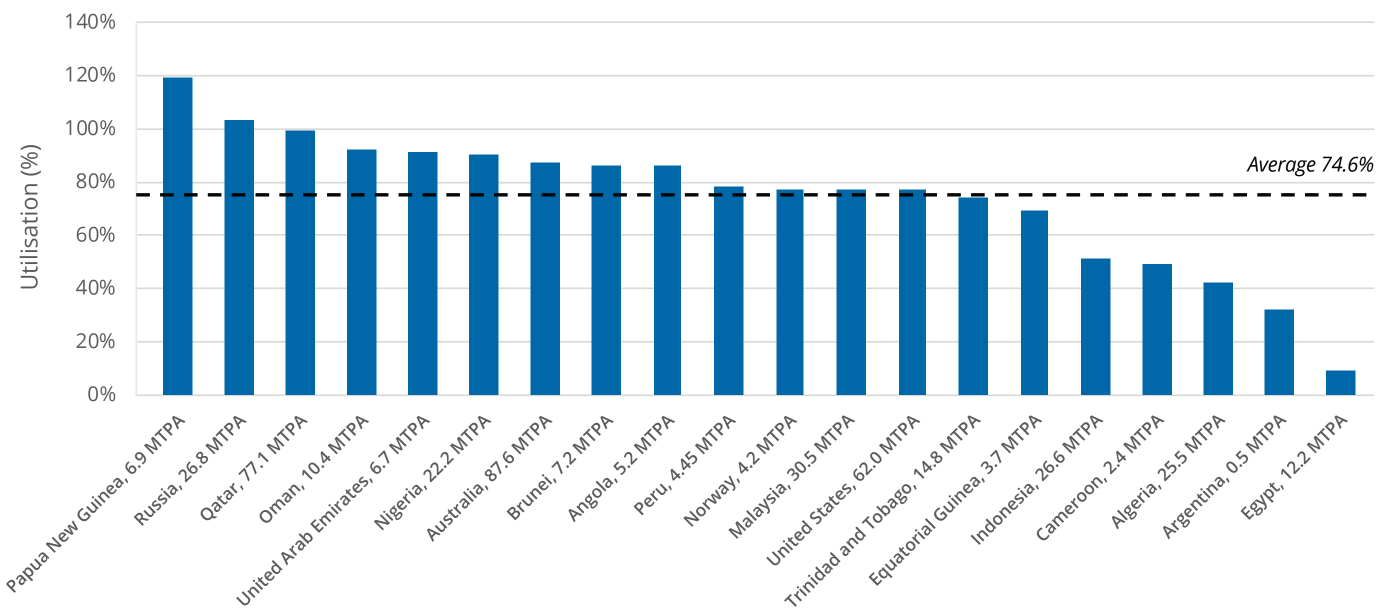
Global liquefaction capacity, End of 2020

Global liquefaction capacity reached 452.9 MTPA at the end of 2020 and the utilisation rate was 74.6%[1] on average compared to 81.4% in 2019.

Six out of 22 LNG exporting markets[2] achieved utilisation rates of more than 90% in 2020, including Papua New Guinea, Russia, Qatar, Oman and United Arab Emirates.

[1] Utilisation is calculated on a prorated basis, depending on when the plants are commissioned. Only operational facilities are considered
[2] The 22 markets include Yemen and Libya, although Yemen LNG and Marsa El Brega LNG have suspended operations

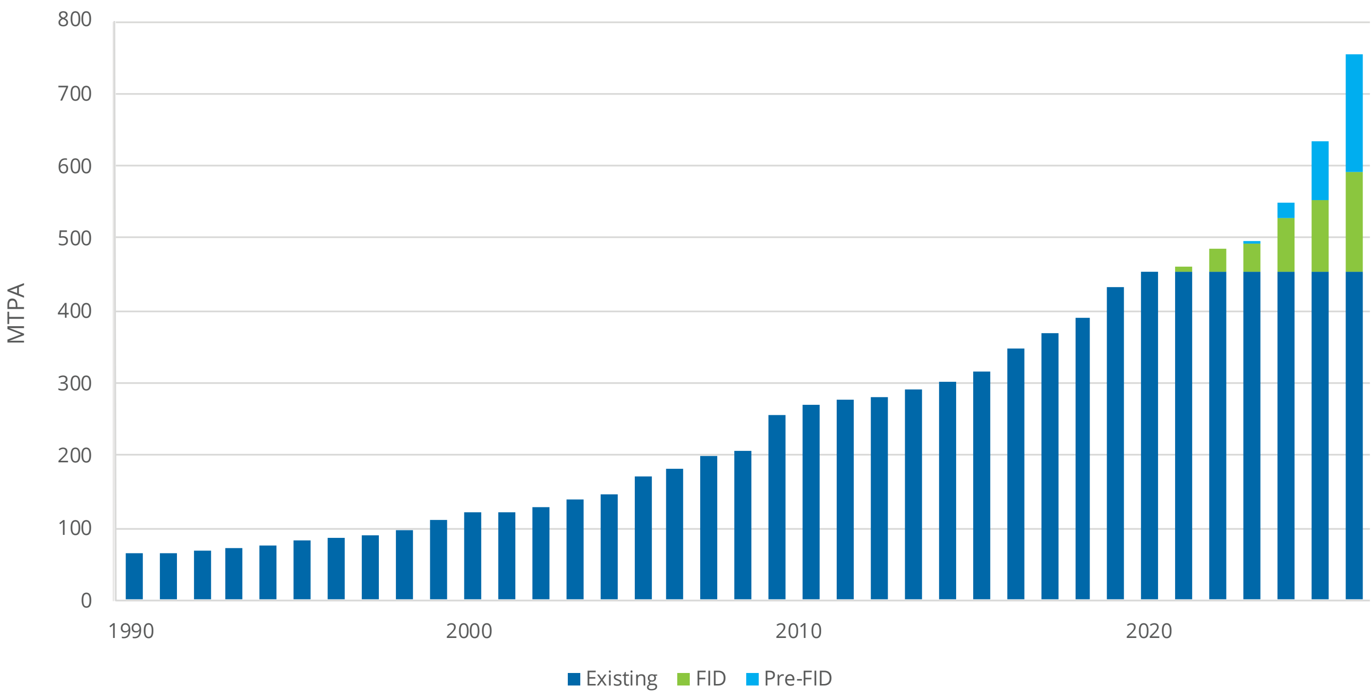
Figure 5.3: Global liquefaction capacity utilisation in 2020 (Capacity is pro-rated)



Source: Rystad Energy, Refinitiv

The increase in liquefaction capacity in 2020 came largely from US projects. Cameron LNG T2-3 (8.0 MTPA), Freeport LNG T3 (5.1 MTPA) and Elba Island T4-10 (1.75 MTPA) all contributed to global capacity additions last year.

Figure 5.4: Global liquefaction capacity development from 1990 to 2026



Source: Rystad Energy

Wheatstone LNG – Courtesy of Chevron

Compared with 2019, 2020 saw a decline in average global liquefaction capacity utilisation from 81.4 % to 74.6%. This was largely due to lacklustre demand from a warmer winter in the Northern hemisphere exacerbated by the COVID-19 pandemic amid oversupply of gas. Moreover, a sustained period of lower LNG prices and increased competition among gas supply sources eroded margins and put pressure on gas and LNG producers.

The US suffered a disproportionate decline in liquefaction capacity utilisation, primarily due to its flexible commercial arrangements that give off-takers the right, but not obligation, to lift cargoes. Utilisation in the US dropped from 96.9% in 2019 to 76.5% in 2020. In fact, feedgas deliveries to the six major US LNG export terminals plunged to their lowest level since the beginning of 2020 in June amid a wave of cargo cancellations due to weak market conditions. The largest declines in exports were seen at Sabine Pass LNG and Corpus Christi LNG, primarily due to weak margins and the flexibility provided in the commercial structure of US LNG contracts. However, utilisation rates in the US recovered quickly in the last months of 2020. Several factors, including increased LNG demand due to a cold winter in key Asian and European markets as well as unplanned outages in prime LNG export markets such as Australia, Qatar and Nigeria, caused LNG prices to soar. This led to an increase in LNG exports from the US, which drove utilisation to new records in December 2020. Egypt's LNG export facilities sustained low utilisation levels of 9.5% due to forced curtailment at the Idku LNG (7.2 MTPA) export facility in March 2020. Egyptian LNG exports were already heavily reduced in the first quarter of 2020, with only six cargoes shipped. In October, the Idku LNG plant came back online and was set to increase its utilisation into 2021 and beyond. Amid the negative impacts of low oil prices and the COVID-19 pandemic, LNG exports from West Africa have been resilient. Nigeria's LNG exports in 2020 stayed strong, with the nation's only export facility NLNG (22.2 MTPA) achieving a utilisation rate of 90.4%. West Africa's second-largest LNG exporter, Angola, increased utilisation at its only plant, Angola LNG T1 (5.2 MTPA), from 78.5% in 2019 to 86.5% in 2020, owing to ample gas produced at the offshore gas fields of Quiluma, Atum, Polvo and Enguia.

Another prime factor that affects utilisation of existing LNG export facilities is outages. In the US, Cameron LNG was shut down for over a month after Hurricane Laura caused a power outage in August. Earlier in May, a fire that broke out in a mixed refrigerant compressor at the Elba Island LNG (2.5 MTPA) caused three liquefaction units to shut down. One of the units is yet to be restarted as of February 2021. In Norway, Hammerfest LNG (4.2 MTPA), also known as Snøhvit LNG, could possibly be offline until the end of 2021 due to severe damage caused by a fire that broke out in one of the five power turbines, resulting in an unplanned shutdown in September 2020. Prelude FLNG (3.6 MTPA) off Australia was troubled by an electrical trip and was shut down for 10 months from February 2020, resuming full production in January this year.

5.3 LIQUEFACTION CAPACITY BY MARKET

87.6 MTPA

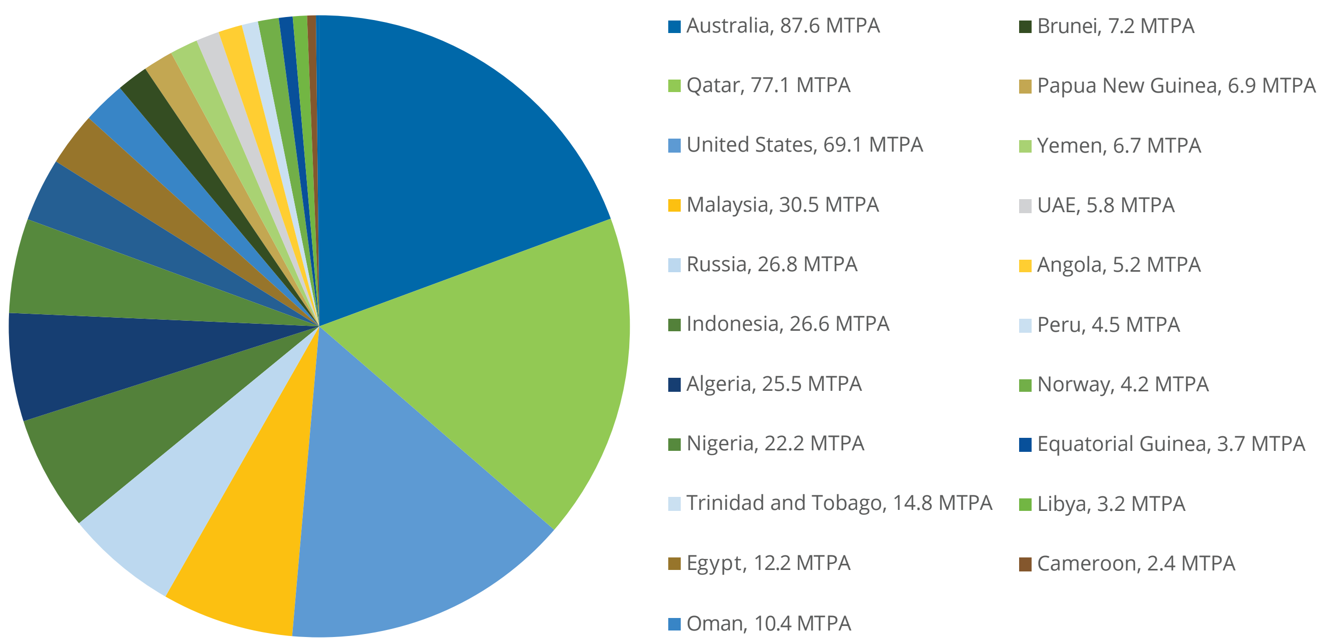
Operational Liquefaction Capacity in Australia, as of Feb 2021

Operational

As of February 2021, there were 21 markets[1] with operational LNG export facilities. Australia took the lead with 87.6 MTPA of operational liquefaction capacity, followed by Qatar with 77.1 MTPA. The United States trailed behind with 69.1 MTPA, growing its liquefaction capacity by a remarkable 20.0 MTPA in 2020. This capacity addition was contributed by Cameron LNG T2–3 (8.0 MTPA), Freeport LNG T2–3 (10.2 MTPA) and Elba Island T4–10 (1.75 MTPA). These were the only three projects globally that started commercial operations in 2020. The top three LNG exporting markets currently represent more than half of the global liquefaction capacity.

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

Figure 5.5: Global operational liquefaction capacity by market



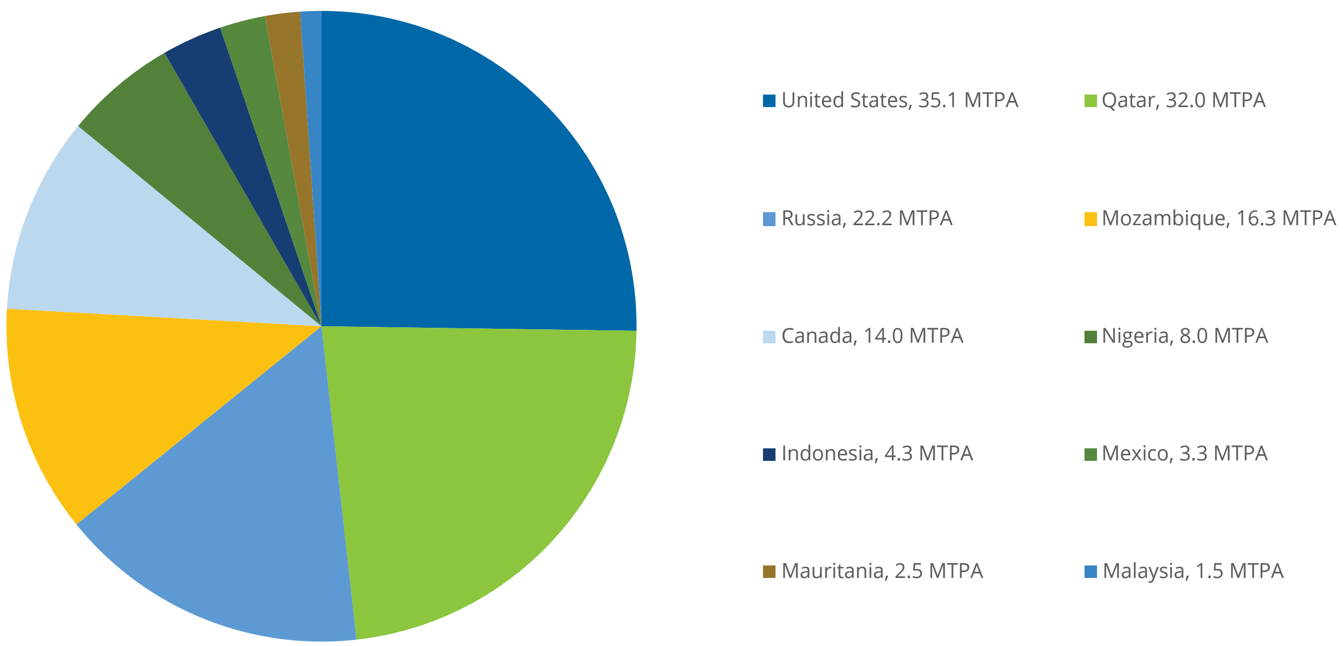
Source: Rystad Energy

Under construction/FID

As of February 2021, 137.3 MTPA of liquefaction capacity was under construction or sanctioned for development. Approximately 25.6% of this capacity is in North America. The Energía Costa Azul LNG T1 (3.25 MTPA) in Mexico was the only liquefaction plant train that was sanctioned in 2020, while LNG giant Qatar Petroleum took the final investment decision for the development on the North Field East (NFE) project in February 2021, adding 32 MTPA to global sanctioned liquefaction capacity.

Several projects globally are currently under construction and progressing towards completion in 2021. Projects that are expected to begin commercial operations this year include Corpus Christi LNG T3 (4.5 MTPA) in the US, Portovaya LNG T1 (1.5 MTPA) and Yamal LNG T4 (0.9 MTPA) in Russia, Sengkang LNG T1 (0.5 MTPA) in Indonesia and PFLNG Dua (1.5 MTPA) in Malaysia. Meanwhile, several projects are signaling FID in 2021. These include the two-train Port Arthur LNG (13.5 MTPA) in Texas, where construction is expected to begin in 1Q 2022, following FID. Sempra aims to bring Port Arthur T1 online in 1Q 2026, followed by T2 in the latter half of 2026. Another project signaling FID in 2021 is Driftwood LNG Phase 1 (11.0 MTPA) in Louisiana, which involves the construction of eight liquefaction trains, each capable of producing 1.38 MTPA. Tellurian has delayed the timeline for FID to mid-2021 from 2020 as COVID-19 and challenging market conditions have made it more difficult to finalise commercial agreements. Similarly, targeted FIDs for the Canadian Goldboro LNG (10.0 MTPA), Woodfibre LNG (2.1 MTPA) and NextDecade's Rio Grande LNG (27.0 MTPA) have also been delayed to 2021.

Figure 5.6: Global sanctioned liquefaction capacity by market as of February 2021

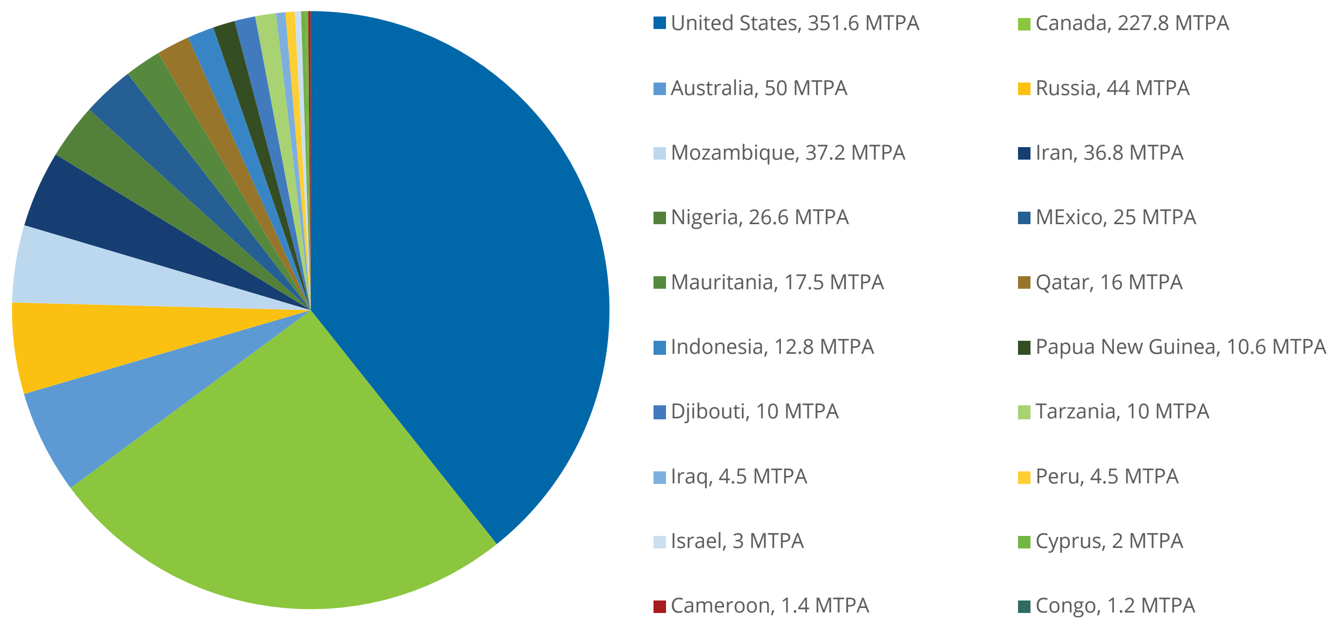


Source: Rystad Energy

Proposed

There is currently 892.4 MTPA of aspirational liquefaction capacity in the pre-FID stage. However, a large portion of the pre-FID projects are likely not to progress. Given the weak economic landscape in 2020, 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 5.7: Global proposed liquefaction capacity by market



Source: Rystad Energy

Out of the 892.4 MTPA of aspirational liquefaction capacity in the pre-FID stage, the United States accounts for 39.4% (351.6 MTPA), followed by Canada at 25.5% (227.8 MTPA) and Australia at 5.6% (50.0 MTPA). Russia follows closely behind with 44.0 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. Another example is Driftwood LNG (27.6 MTPA), also in Louisiana, which consists of 20 liquefaction trains built in four phases. The facility will process feedgas from the existing interstate pipeline system of the Columbia Gulf Transmission, which interconnects about 14 interstate pipelines.

Out of the 227.8 MTPA of liquefaction capacity proposed in Canada, 179.3 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 the west coast of Canada to Asia are lower than from 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 adapted various strategies to reduce their carbon emissions to comply with environmental regulations. Both Kitimat LNG (18.0 MTPA) and Woodfibre LNG (2.1 MTPA) are powered by clean, renewable hydroelectricity. Similarly, LNG Canada T3-T4 (14.0 MTPA) has selected natural gas turbines for the liquefaction process to minimise fuel use and will be powering a portion of its liquefaction plant with renewable energy as well. There are also four proposed projects on Canada's east coast totaling 48.5 MTPA of liquefaction capacity. Bear Head LNG (12.0 MTPA), Saguenay LNG (10.95 MTPA) and AC LNG (15.5 MTPA) have yet to achieve much commercial momentum due to pipeline transportation and gas supply challenges while Goldboro LNG (10.0 MTPA) announced the delay of the targeted FID to mid-2021 instead of 3Q 2020.

In Australia, investments have recently been more focused on upstream backfill projects rather than new liquefaction projects. Woodside has proposed developing the Browse area fields for the existing North West Shelf LNG (16.7 MTPA), the Julimar field for Wheatstone LNG T1-2 (8.9 MTPA), the Pyxis field for Pluto LNG T1 (4.9 MTPA) and the Scarborough field for the proposed Pluto LNG T2 (5.0 MTPA). Pluto LNG T2 (5.0 MTPA) failed to reach FID in 2020 and the announced plan is now for the project to reach FID in the second half of 2021, with operations anticipated to start in 2025. Darwin LNG (3.7 MTPA) is expected to run at a lower utilisation from 2021 to 2025 owing to the end of life for the Bayu-Undan field, while FID for the Barossa field to backfill Darwin LNG is being postponed beyond 2020. Ichthys Phase 2 made some progress, with Inpex awarding FEED contracts to McDermott and Saipem. The Phase 2 development was originally expected to commence in the first half of 2020 with targeted completion in 2025. Developments of further coal seam gas to LNG projects are unlikely in the future, given that existing projects such as the Queensland Curtis LNG, Australia LNG and Gladstone LNG are already facing supply constraints.

In February 2021, Qatar Petroleum took the final investment decision for its NFE project, which will raise Qatar's LNG production capacity from 77 MTPA to 110 MTPA. Qatar has also announced future plans of an additional 16 MTPA of liquefaction capacity from its North Field South (NFS) project. If the project materialises, this will further increase Qatar's LNG production to 126 MTPA by 2027.

Russia has 44.0 MTPA of proposed liquefaction capacity, in addition to Arctic LNG 2 (19.8 MTPA), which was sanctioned in 2019 and is currently under construction. In Eastern Russia, Far East LNG, also named 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 sufficient yet. In addition, there are the proposed developments of Pechora LNG (2.6 MTPA) and Ob LNG (4.8 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 2. Leveraging their Yamal LNG T4 (0.9 MTPA) experience, Ob LNG (4.8 MTPA) will use Novatek's proprietary technology, Novatek Arctic Cascade. Another proposed project, Baltic LNG (10.0 MTPA), is situated on the Baltic Sea Coast and targets exports to the European market.

The recent gas discoveries in Africa have increased proposed liquefaction capacity to 103.9 MTPA for the continent. Situated in northeastern Africa, Djibouti LNG is expected to bring 10.0 MTPA of liquefaction capacity online if the project progresses further. In West Africa, 45.5 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 seen numerous attempts to reach FID amid ownership changes and project alterations. As with the OK LNG (12.6 MTPA) project in Nigeria, Brass LNG was designed to monetise gas that is currently being flared or reinjected, as well as to develop new gas fields. However, the monetisation of gas has been met with political and technical challenges, which has caused delays. An FLNG unit (1.4 MTPA), proposed by NewAge off Cameroon is being discussed, using feed gas from the Etinde joint venture. With Mozambique LNG (Area 1) (12.9 MTPA) and Coral South FLNG (3.4 MTPA) currently under construction, the dual-train Rovuma LNG (Area 4) (15.2 MTPA) remains in the pre-FID stage with some signs of progress on the Mamba gas field upstream development led by Eni. However, the Mozambique government has approved the project's development plan for the production, liquefaction and marketing of natural gas from three of the reservoirs in the Mamba complex. Tanzania is also planning its long-delayed first LNG plant, Tanzania LNG (10.0 MTPA), with FID targeted for 2022 and start-up targeted for 2028. Though Tanzania is well situated as a point of supply to Asian markets, the project is expected to face strong competition from under-construction projects in the US, Mozambique, Canada and Qatar. Nevertheless, if the proposed liquefaction facilities do materialise, East Africa could emerge as a key LNG producing region in the future.

In Asia-Pacific, Australia has the largest aspirational capacity of 50.0 MTPA. The Pluto LNG T2 (4.5 MTPA) proposed by Woodside has signaled to reach FID in H2 2021, scheduled to produce its first cargo in 2026. Other projects such as Darwin LNG T2 (3.5 MTPA) and Ichthys expansion T1, T2 (8.9 MTPA) have not reported further progress. Declining production from existing resources are posing a supply challenge in Australia, where operators have placed more emphasis on looking for backfill supply for existing liquefaction plants. In Papua New Guinea, Total and the Papua New Guinea government have signed a fiscal stability agreement and renewed the retention lease over the large Elk-Antelope gas fields for the dual-train Papua LNG project (5.4 MTPA). Meanwhile, the PNG LNG expansion (2.7 MTPA) is still under discussion, with plans to downsize the expansion to four trains instead of five as previously planned. In Southeast Asia, Indonesia has proposed 12.8 MTPA of liquefaction capacity, mainly from Abadi LNG (9.5 MTPA), which would be supplied from the Abadi gas and condensate field in the Masela PSC. Progress for this project has slowed in 2020 and it is expected to be delayed further.

Decommissioned and idle

There were no announcements of LNG plants being decommissioned in 2020.

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 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.

In Egypt, plans to restart the Damietta LNG (5.0 MTPA) plant have progressed, with its first cargo lifted in late February 2021. Damietta LNG was idled in 2012 after feedgas 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.

To date, there is 43.3 MTPA[1] capacity at operational LNG production 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 2020.

5.4 LIQUEFACTION TECHNOLOGIES

Air Products Technologies Account For

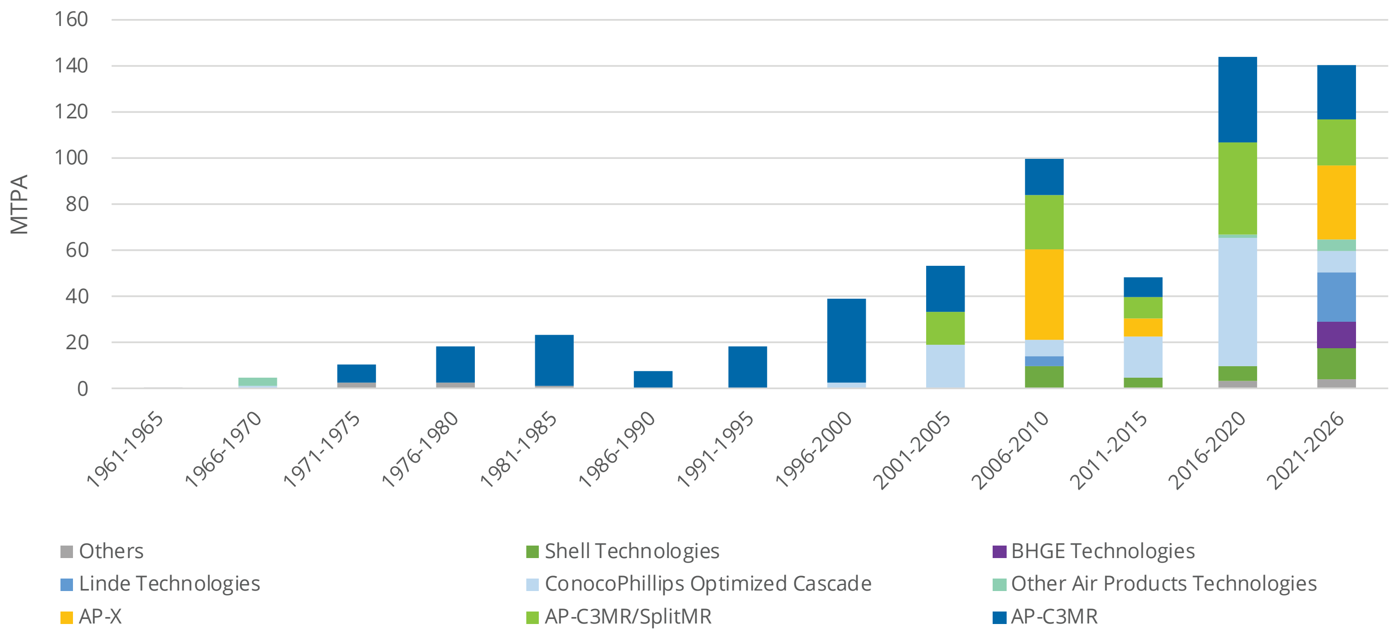
67.5% of Global Operational Capacity

The liquefaction trains that began operations in 2020 used a variety of liquefaction technologies, with Air Products technologies being the most widely used. Air Products technologies account for around 67.5% of operational capacity globally. Cameron LNG T2-T3 and Freeport LNG T2-T3 employed the Air Products AP-C3MR process, which currently makes up over 37% of operational capacity globally (excluding the SplitMR variation), while Elba Island T1–10 employed the proprietary Shell Movable Modular Liquefaction System process.

The evolution of liquefaction technology dates to the early 1960s. Among the earliest LNG export facilities, Arzew GL4Z used the Pritchard Cascade process 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 Celcius.

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

Figure 5.8: Installed liquefaction capacity by technology and start-up year (future projects only include sanctioned ones)



Source: Rystad Energy

Since the AP-C3MR was first introduced at Brunei LNG in 1972, it has attained the dominant position among liquefaction technologies over the years, occupying close to 53% of operational capacity globally as of 2020 (including the SplitMR variation). The growing share of the AP-C3MR technology (including the SplitMR variation) was primarily driven by QatarGas, totaling around 30 MTPA since the start-up of QatarGas 1 T1 in 1996. Damietta LNG was the first LNG plant to deploy the C3MR/SplitMR technology, which further improves AP-C3MR technology by optimising its machinery configuration, achieving higher turbine utilisation.

Air Products' AP-X technology emerged in 2009 in the QatarGas 2 project, supporting a liquefaction capacity of 7.8 MTPA per train, the highest achieved 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 sanctioned, which consists of four mega trains, each of 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 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 55% in the 2016 to 2020 period. Competition increase in the 2000s, mainly due to ConocoPhillips' Optimized Cascade Process, which now comprises 100.3 MTPA of operational capacity, or 22%, making it the second leading liquefaction technology. ConocoPhillips' Optimized Cascade Process was first used in Kenai LNG back 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, Cameron LNG T4–5 and Freeport LNG T4 signaling FID in 2021, Air Products' dominance might be reinforced again with 28.6 MTPA of liquefaction capacity sanctioned.

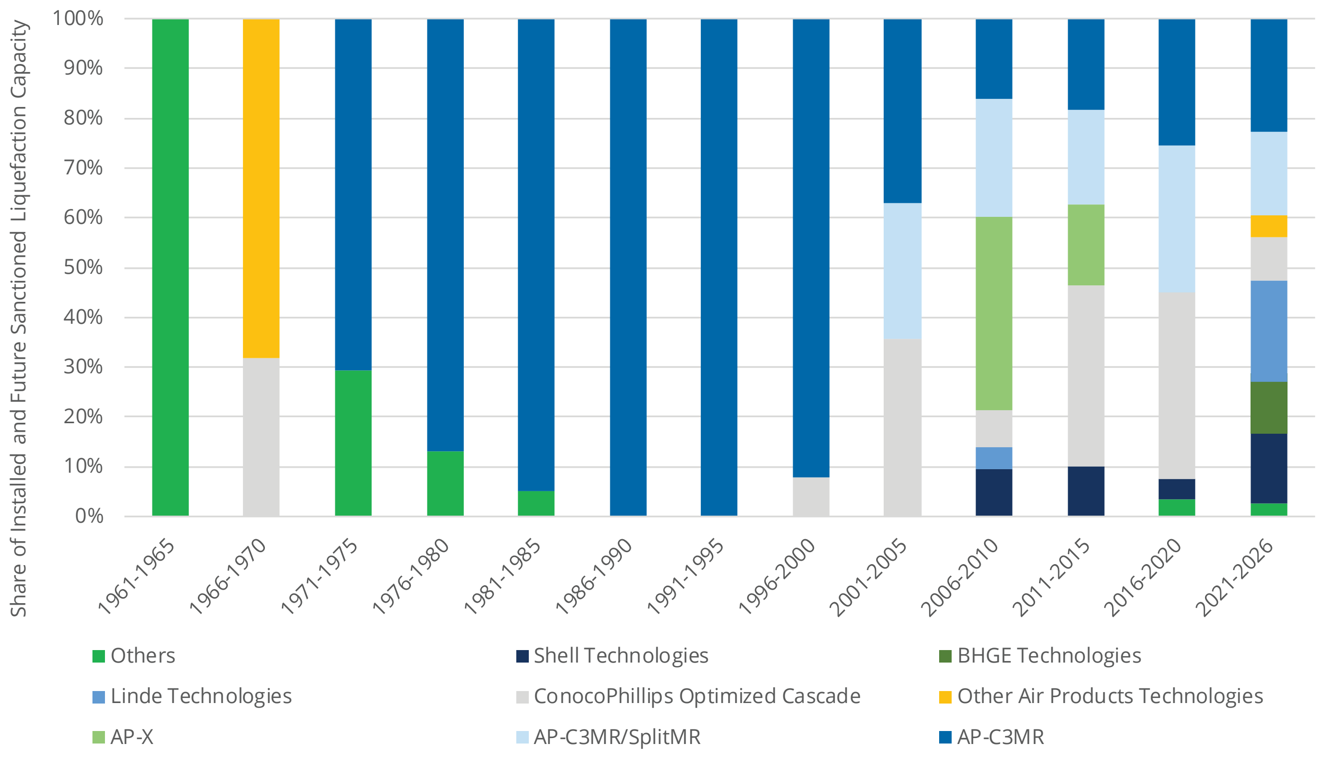
As the LNG industry moves towards 2021-2026, a growing number of new entrants are expected in the liquefaction technology market, mainly due to the notable growth in small- to mid-scale LNG trains. As the interest to explore for smaller volumes of stranded gas grows and access to LNG project financing 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 could also offer cost and execution time savings. Between 2022 and 2026, Venture Global LNG is expected to start its Calcasieu Pass LNG (18 trains) using BHGE's Single Mixed Refrigerant (SMR) liquefaction technology, with each liquefaction module delivering 0.56 MTPA. Tortue/Ahmeyim FLNG will also come online with Black & Veatch's PRICO technology (0.6 MTPA per train, totaling 4 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 technology. The Shell DMR technology will be used in LNG Canada (scheduled for start-up in 2025), after its application in Sakhalin 2 LNG and Prelude FLNG. Novatek's Arctic Cascade process, designed for the Arctic climate, will be used for Yamal LNG T4 (0.9 MTPA).

Small FLNGs, due to safety reasons (minimising highly flammable refrigerants) and space limitations with their small deck footprints, mostly use relatively simple liquefaction technologies. 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 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) on Air Products AP-DMR technology and Prelude FLNG (3.6 MTPA) on Shell DMR technology.

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 for new projects as governments and companies commit to decarbonisation efforts.

Figure 5.9: Share of liquefaction technology in installed liquefaction capacity by start-up year (future projects only include sanctioned ones)



Source: Rystad Energy

5.5 FLOATING LIQUEFACTION (LNG-FPSOS)

7.2 MTPA

Operational Floating Liquefaction Capacity Worldwide as of Jan 2021

At the end of February 2021, there were three operational[1] FLNG units globally. The most recent FLNG delivered is the PFLNG Dua (1.5 MTPA), Petronas' second FLNG unit. It set sail from South Korea on its maiden voyage to the Rotan Gas field 140 kilometres off Kota Kinabalu, Sabah in February 2020. It was ready to start up on 27 August 2020, on track for its commercial launch in 2021. Of the existing units, Prelude FLNG (3.6 MTPA), deployed at the Browse Basin off Western Australia, suspended production following an electrical trip in February 2020. Full operations were restored in January this year. As of January 2021, there is a total of 7.2 MTPA operational floating liquefaction capacity worldwide. This is expected to grow to 8.7 MTPA in 2021, following start-up of the Petronas PFLNG Dua.

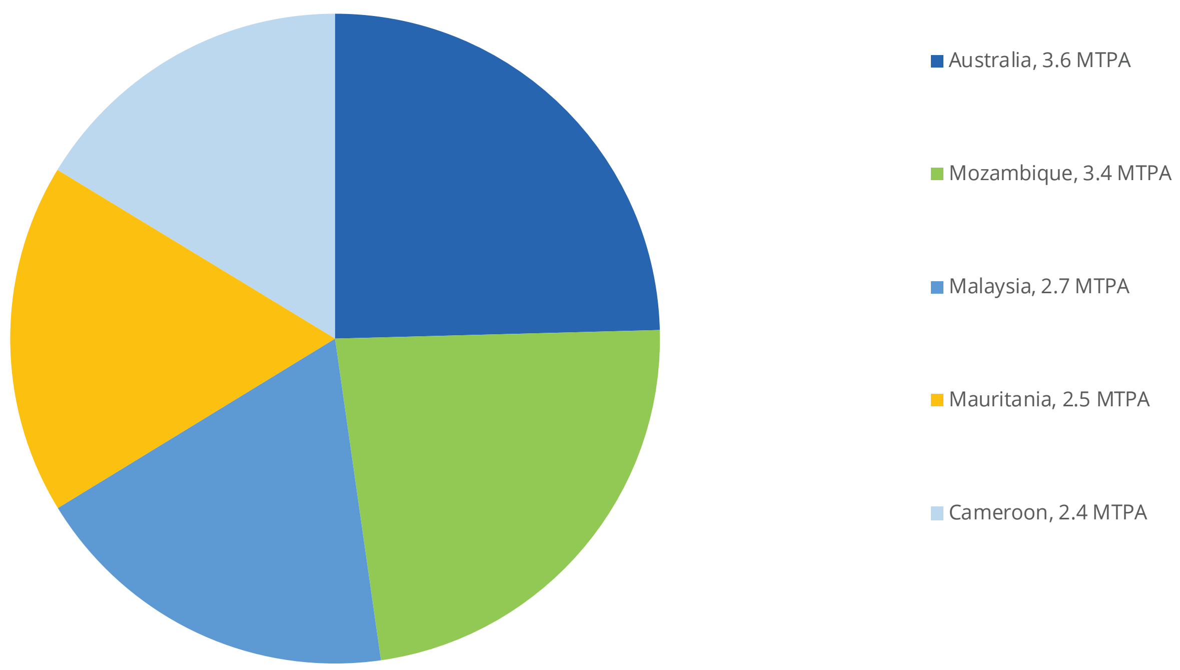
In light of the COVID-19 pandemic, 2020 was a quiet year in terms of FLNG project sanctioning, with no FIDs being reached. This was mainly due to the uncertain economic landscape fueled by the COVID-19 pandemic, which has slowed the pace of investments into floating liquefaction plants. Supply chain disruptions and companies' efforts to defer capital expenditure have also caused delays. 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 12 months, postponing start-up of the facility to mid-2023. In late March, Exmar's Tango FLNG (0.5 MTPA) was provided a written notification of force majeure under the charter and services contract shortly after commercial start-up in November 2019. Its charterer declared that the impact of the COVID-19 pandemic has hindered its ability to meet its obligations under the tolling agreement. Settlement has been reached and the Tango FLNG vessel is currently available for other projects.

Two further FLNGs were on the orderbooks as of February 2021. The Coral South FLNG facility (3.4 MTPA) has completed its onshore-modules fabrication campaign configuring the entire gas treatment and liquefaction plant. This is in line with the expected sail-away in 2021 and start-up in 2022. The unit is destined for the Coral field in Mozambique's prolific Area 4 block. The second FLNG on order is the Tortue Ahmeyim FLNG (2.5 MTPA), a converted LNG carrier. As mentioned earlier, the delivery of the Tortue Ahmeyim FLNG will be delayed until mid-2023.

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

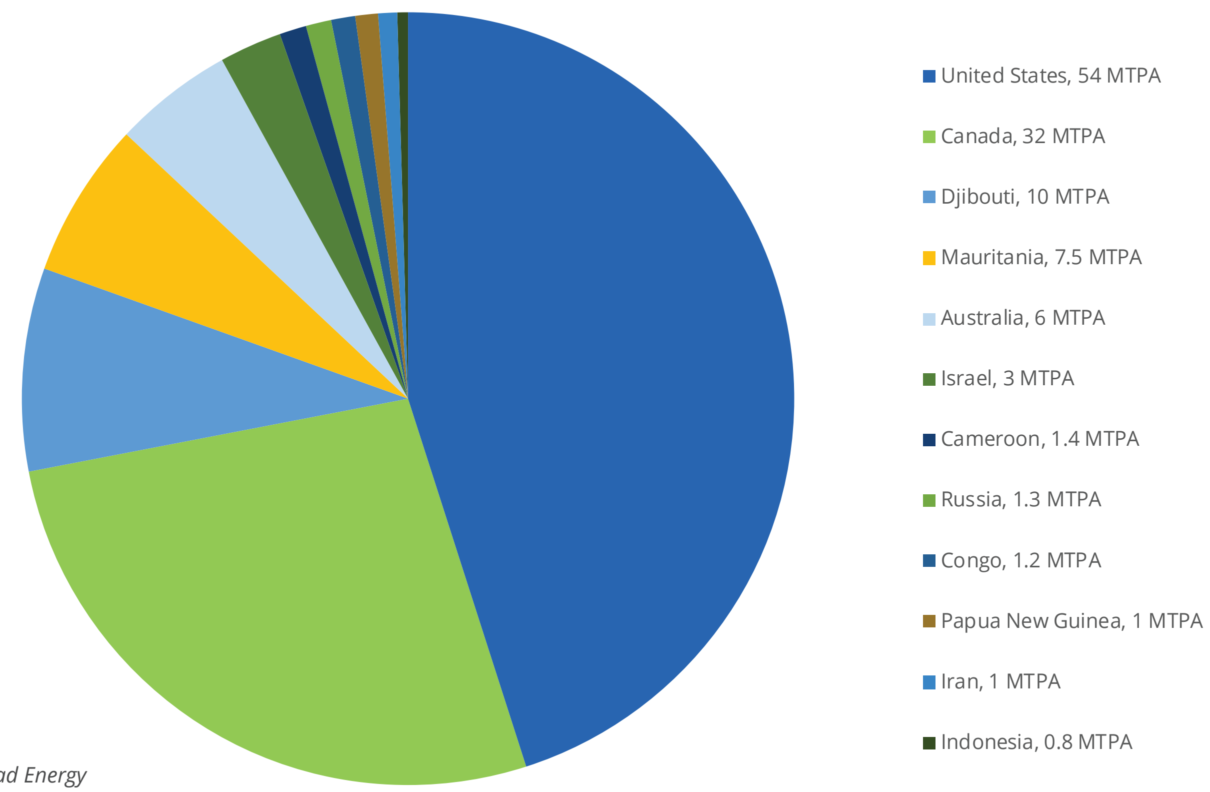
The FLNG sector remains in the early stages of development, with challenges related to financing and project overruns exacerbated by the COVID-19 pandemic. There have been several planned and proposed FLNG projects, only a quarter of which have been realised. Amongst those that have materialised, the 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 South FLNG was financed with project financing. Until recently, the Gandria FLNG (Fortuna) was supposed to be placed in the orderbook. However, the project's operator was unsuccessful in securing project financing and its license lapsed at the end of 2018. The Gandria FLNG is one of several projects that highlights the financing challenges that have been further hampered by the COVID-19 pandemic.

Figure 5.10: Global sanctioned and operational FLNG liquefaction capacity as of February 2021



Source: Rystad Energy

Figure 5.11: Global proposed FLNG liquefaction capacity



Source: Rystad Energy

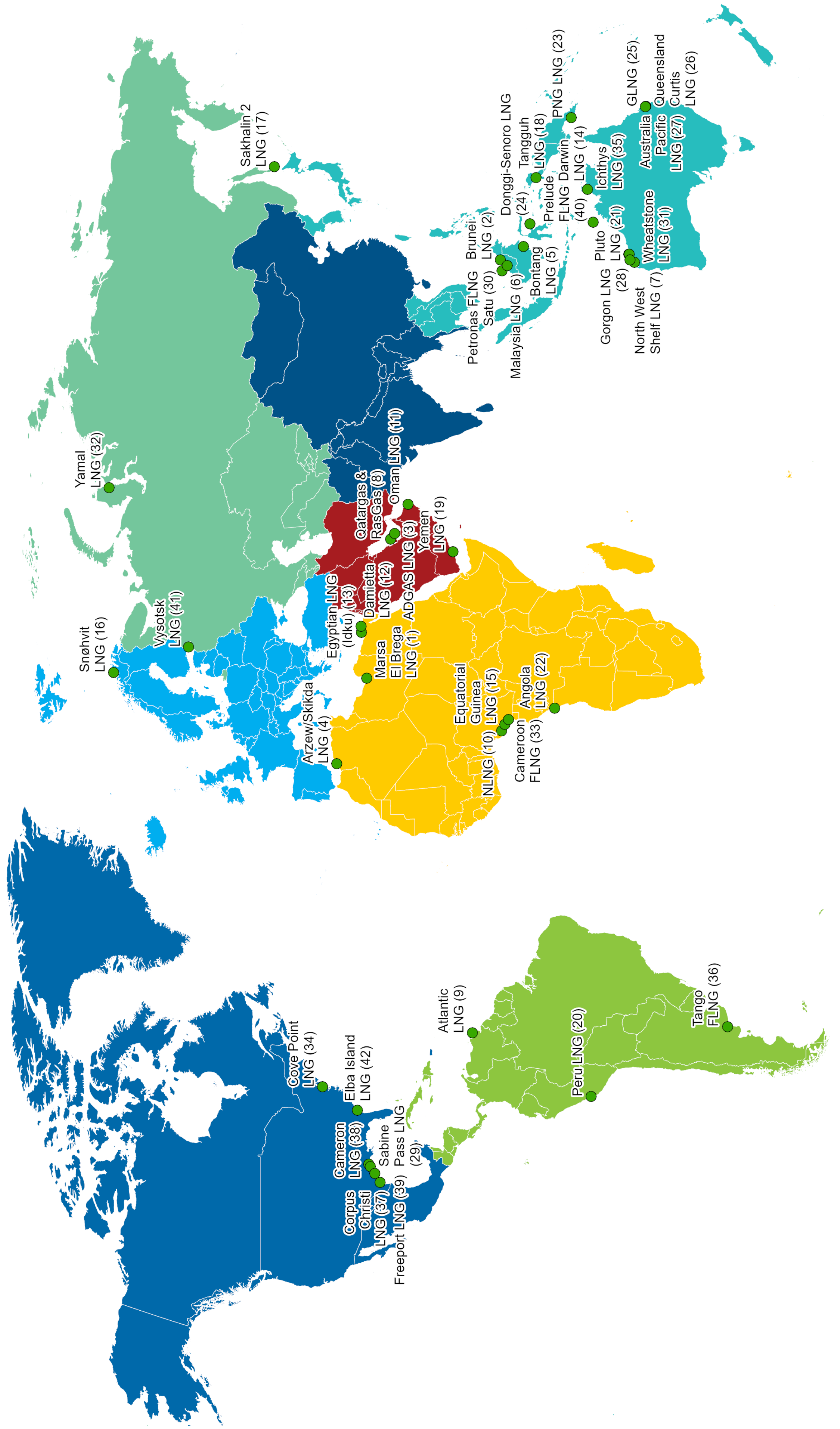


Figure 5.12: Global Liquefaction Plants, February 2021

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

Sakhalin – Courtesy of Shell

There is currently 119.2 MTPA of aspirational liquefaction capacity proposed as FLNG developments. Of the proposed capacity, 86.0 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 development concepts aim to save both construction time and cost as 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 proposed capacity of 20.1 MTPA. This includes the Djibouti FLNG project that is planned for three phases with a total liquefaction capacity of 10.0 MTPA. For the rest of the world, there is 13.1 MTPA of FLNG liquefaction capacity proposed.

There has been significant development in floating liquefaction technology in recent years, primarily in the design of the FLNG units. Rapid innovation has meant that the cost level of the first generation of highly bespoke FLNGs built by Shell, Petronas and Eni at significant expense has been greatly reduced by the second generation of FLNGs, commonly referred to as standardised FLNGs. 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 concept. The TwinHull maximises efficiency and cost savings to optimise offshore gas fields. This design comprises 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" with regards to the targeted field, they have greater flexibility in deployment and reduced lead times combined with significant cost savings. As well as their suitability for smaller, remote, offshore gas fields, FLNGs can offer advantages over onshore projects in terms of land constraints and environmental challenges. They can even serve as a stopgap solution for larger fields until onshore liquefaction trains come online.

5.6 RISKS TO PROJECT DEVELOPMENT

Market Outlook

Supply-demand outlooks set the tone for projects that are actively under development and have yet to reach final investment decisions (FID). How many will go forward, versus potential up- and downsides to forecasted demand, is key to determining exactly when the market balances. Projects typically have a lead time of ~5 years between FID and commercial operations, and thus pre-FID developers will have to think through this uncertainty from the mid-2020s onward now.

While it is relatively easy to see what's coming on the supply side, given the long lead times for liquefaction projects, predicting demand is much more difficult. The significant number of final investment decisions (FIDs) which were taken in 2019 implied that developers believed a glut in the market was expected to fade after 2020, and their volumes would find markets. However, 2020 has shifted opinions on both the supply side – with almost no FIDs taken and most projects delayed, as well as the demand-side, although implications may be shorter lived given shorter timelines to build out regasification infrastructure and signals of demand recovery in significant markets. Uncertainty however remains as parts of the world remain under lockdown at the time of writing this report.

Supply Wave

The current wave of additional supply coming to market, COVID-19 impacts and volatile global prices are challenging new projects seeking final investment decisions and is leading to project FIDs being delayed. There were more than a dozen liquefaction plants scheduled for a final investment decision (FID) in 2020, but only one project took a positive FID. All others were deferred. So far in 2021, Qatar has taken FID on its' North Field East mega-expansion project, which likely has a further deterrent effect on developers as key buyers remain hesitant to sign long term agreements as they face continued demand uncertainty.

There is a significant competitive advantage for LNG project developers in geographic locations with access to low cost resources, proximity to high volume and/or high value markets, and opportunity to achieve competitive liquefaction project costs. Financing multi-billion dollar projects involves equity investments, shareholder and commercial loans or, where applicable, project finance with the involvement of export credit agencies and development banks providing political risk insurance for markets lacking sufficient regulatory and mega-project track record. In such a complex and challenging business environment, expansion of existing projects with a proven track record and strong balance sheet also have a significant competitive advantage.

Contracting Trends

Many projects are seeking to reach an FID in 2021 to come online in the mid-2020s, when some market participants expect material new LNG supply will be needed. However, most proposals that have not reached FID remain (partially) uncontracted and are competing for buyers willing to commit to long-term contracts in a relatively low-priced environment. Buyers are increasingly looking to minimize carbon emissions. Additionally, the potential for relatively lower cost expansions and backfill opportunities, in addition to expiring contracts at legacy projects, may reduce the amount of capacity required from new projects in the near term. Some developers have shown the ability to move forward on projects without a heavily contracted project, mostly by taking volumes into their own portfolio, where developers who lack a marketing arm are seeing the most challenges in progressing. This is especially evident among the US Gulf Coast where developers are offering shorter term contracts (10-15 year) rather than the traditional 20 year SPA. This however typically comes at a cost to project financing, which means higher lifting costs. Buyers continue to look for shorter (and more flexible) contracts both in terms of destination flexibility and volume, and while that gap appears to be closing, it remains ones of the greatest risks to project development. Additionally, in 2020 and early 2021, even developers with strong balance sheets have signalled a reluctance to take such FIDs without long term contracting in place for most volumes out of a project going forward.

5.7 UPDATE ON NEW LIQUEFACTION PLAYS

The wave of LNG export project approvals in 2020 suggests that the risk of an abrupt tightening in global LNG around the mid-2020s may be easing, with a significant volume looking to come online around 2025-2026, although COVID-19 has already triggered some of these to face delays, as well as security issues in some areas adding to potential risk. A steady flow of additional projects will be required to meet demand and there is still considerable disagreement between buyers and sellers about what kind of business models and contracting structures will underpin new investment decisions, all while major upstream investors look to renewables or high grading assets to protect their balance sheets and deliver on energy transition commitments and ambitions.

While projects that can come to market relatively quickly and at a lower cost (such as the brownfield Qatari expansion) are the ones most amenable to the industry's current focus on capital discipline and short-cycle investments, large-scale greenfield projects can also find a place in the new gas order supported by new emerging markets.

Middle East

In February of 2021, Qatar Petroleum announced that it had taken FID for the North Field East (NFE) LNG project, with the EPC being rewarded to Technip and Chiyoda. The project targets being onstream by late 2025. The contract comprises of 4 LNG mega trains with a capacity of 8MTPA each, bringing the market's total export capacity to 110MTPA, up from the current 77MTPA. The project will also consist of helium extraction, refining, gas treatment and gas liquids recovery. A more recent announcement on the approx. US$30 bln project, includes climate related initiatives such as power supply from the national grid, and an integrated carbon capture project, with targets set on capturing 7MTPA of Co_2 by 2030. QP is already looking ahead with a next phase of expansion being the North Field South project which would include another 2 mega trains adding a further 16MTPA of capacity online and bringing total capacity up to 126MTPA.

In Oman, the debottlenecking project continues with the 0.5MTPA project that was completed in late 2019, and an additional project of 1MTPA looking to be complete early in 2021. The debottlenecking will enable Oman LNG to increase production from its 3 train plant at Qalhat from 10.4 MTPA to 11.5 MTPA.

United States

The USA has six export facilities online with 24 trains in service. The U.S. accounted for all new global liquefaction capacity added in 2020, and is the world's third largest LNG exporter, behind Australia and Qatar.

Supported by abundant supplies of shale gas and growing liquefaction capacity, the USA's LNG export experienced a meteoric rise that started with the first commercial LNG cargo shipped from Cheniere's Sabine Pass in Louisiana in 2016. Since then, six operating LNG export facilities (Sabine Pass, Freeport LNG and Corpus Christi LNG in Texas, Cove Point LNG in Maryland, Cameron LNG in Louisiana and Elba Island in Georgia), have added capacity, and one more train is due to be completed at Sabine Pass. Further capacity is being constructed at Calcasieu Pass and Golden Pass.

Numerous additional projects are looking to ride the second wave of U.S. gas exports in another round of development.

In terms of projects sanctioned in 2019 that are currently under construction:

- Sabine Pass T6 - Cheniere - After reaching FID on Train 6 in June, Cheniere advised that it expects the facility's additional capacity to enter service in 2022. Cheniere continues to highlight gains from debottlenecking at both Sabine Pass LNG and Corpus Christi LNG and has achieved another 5 MTPA of LNG capacity from those activities, equivalent to a 10th company cumulative train.
- Calcasieu Pass - Venture Global –Site construction has been underway since February 2019, FID was taken in August 2019, and the project is expected to reach its Commercial Operations Date (COD) in 2022, but should see first exports in late 2021, a year ahead of schedule. This is thanks to improved logistics and planning, and the ability to start up modular trains in blocks. The 10 MTPA facility is under construction at the intersection of the Calcasieu Ship Channel and the Gulf of Mexico. The Calcasieu Pass project is expected to cost $4.25 billion. The LNG facility includes nine 1.2MTPA liquefaction blocks, two 200,000m³ full containment LNG storage tanks and two ship-loading berths. The facility is electrically driven and will be powered by a 611MW combined cycle gas turbine power plant with an additional 25MW gas-fired turbine.
- Golden Pass – 70% Qatar Petroleum and 30% ExxonMobil – the $10+ billion project will have a capacity of 18.1 MTPA at the three train facility. Exports are announced to commence in 2024 and 2025 , with trains in service on a staggered schedule. The joint venture announced FID in February 2019 and started on site construction activities in May 2019. The project will sell LNG to Ocean LNG, which is the joint venture marketing company owned by the affiliates. In 2019, Ocean LNG signed a sale and purchase agreement (SPA) for the project's entire output.

Other projects slated by their proponents for near term FID are:

- Corpus Christi Stage 3 – Cheniere - FID on the Corpus Christi Stage 3 project is contingent on acquiring the essential financing arrangements and commercial support for the project. Stage 3 is being developed for up to seven midscale liquefaction trains with a total capacity of approximately 10 MTPA. The Stage 3 site is adjacent to the existing three liquefaction trains. Cheniere expects to make a positive FID on Stage 3 in 2021.
- Jordan Cove - Pembina - Jordan Cove LNG is a proposed 7.8 MMTPA LNG export facility to be located at the Port of Coos Bay, Oregon. The proposed facility includes five 1.5 MTPA trains and two 160,000m3 LNG storage tanks. Jordan Cove would be the first natural gas export facility sited on the U.S. West Coast. The project has faced mounting environmental opposition over the years. Despite receiving federal approvals, the project has been denied key state permits, most notably in January of 2021, when the Federal Energy Regulatory Commission denied a petition by the sponsors to waive Oregon's regulatory authority in denying the needed state environmental permits.
- Freeport Train 4 - Freeport - Freeport LNG is looking to develop a fourth natural gas liquefaction unit. This expansion will allow for the export of an additional 5.1 MTPA LNG, increasing the site's total export capability to 20.4 MTPA. The project will also include a fourth pre-treatment unit and will use electric motors with variable frequency drive for the cooling and liquefaction compression power. Train 4 will be constructed adjacent to the first three trains. The Train 4 EPCC was to be undertaken on a fixed price contract with KBR (whereas Trains 1 to 3 were carried out by CB&I, Chiyoda and Zachry), but with the noted exit of KBR from the LNG construction business, the project must be re-bid. Final Investment Decision for Freeport LNG's Train 4 was originally slated for the first quarter of 2020, but given market challenges, has requested (and has received approval) from FERC to extend the time required to begin construction to 2027.
- Driftwood - Tellurian – The facility will consist of five LNG "blocks", with each block comprised of one gas pre-treatment unit and four liquefaction units. Each of the 20 liquefaction units will produce up to 1.38 MTPA of LNG, using Chart Industries' Integrated Pre-cooled Single Mixed Refrigerant (IPSMR®) liquefaction technology. The LNG facility will use 20 GE refrigeration compressors driven by BHGE LM6000PF+ drivers. The LNG will be stored in three 235,000 m3 LNG storage tanks. Bechtel signed four LSTK turnkey agreements, with each agreement covering one of the four phases. Tellurian has repeatedly delayed FID and is now targeting an FID in 2021.
- Magnolia - LNG Ltd - Magnolia LNG is a mid-scale LNG export project, with four trains, each with a plant capacity of 2 MTPA of LNG for a total of up to 8 MTPA to be built on the Industrial Canal near Lake Charles. The patented OSMR® liquefaction uses a combined heat and power plant and a steam-driven pre-cooling refrigeration system. The project was purchased by privately held industrial developer Glenfarne Group LLC in June of 2020 and received FERC extension of project completion to Q2 of 2026.
- Lake Charles - Energy Transfer (sole developer post Shell exit in March 2020) – This brownfield export facility would include three liquefaction trains with a combined capacity of 16.45 MTPA.
- Port Arthur - Sempra - The initial phase of this project is expected to include two liquefaction trains, up to three LNG storage tanks and associated facilities to enable the export of approximately 11 MTPA of LNG.
- Rio Grande - Next Decade – Next Decade are working towards FID by the end of 2021 and commencing commercial operations in 2025. The project initially originally looked to export in two phases, with three trains at 13.5 MTPA per phase. Advancements in LNG technologies allows the total number of LNG trains to be decreased from 6 to 5. Also of note is Rio Grande LNG's entry into carbon capture technologies (partnering with Occidental) to reduce value chain emissions in the hopes of creating an improved (and unique) marketing proposition.
- Plaquemines - Venture Global – This project includes 18 liquefaction blocks developed in two phases, with each block having a nameplate capacity of 1.2 MTPA and consisting of two modular mid-scale trains of 0.626 MTPA Single Mixed Refrigerant liquefaction units and ancillary support facilities. It will also contain four 200,000m3 storage tanks. The facility will use a combined-cycle gas-turbine (CCGT) power plant with a generating capacity of approximately 611 megawatts (MW) plus an additional 25 MW gas-fired turbine for phase one.
- Brownsville - Annova - Project Discontinued in March 2021. This project was set to be a 6.5 MTPA LNG export facility at the Port of Brownsville, Texas. The decision to immediately discontinue the liquefaction project came after power generator Exelon tried, and failed, to find a "suitable offer" to sell its majority stake in the project. As opposed to some brownfield projects, this greenfield project saw increased challenges in securing sufficient long-term contracts to sanction the project.
- Cameron Parish – Commonwealth – This is an 8.4 MTPA LNG liquefaction and export facility. The facility will have six 40,000 m3 modular storage tanks. Each of the facility's six liquefaction trains will be capable of producing 1.4 MTPA, and will be constructed using a modular approach. Notable alterations of the project is the involvement of Gunvor who (as well as signing SPA's for ~3 MTPA) has taken over volumetric marketing efforts of the project.
- Alaska - Alaska Gasline Development Corporation (AGDC) - Outside the continental US, the proposed $43.4 billion 20 MTPA Alaska LNG project continues to work towards sanction. The project received FERC authorization in Q2 of 2020, but remains in early development.

Canada

Resources in Canada remain a potential boon to both the LNG market and Canada's financial and economic future. With higher feedgas costs compared to other markets, the oil price collapse impacted the future of LNG projects more than most, but the prolific Canadian gas basins will keep many of the prospective projects in the mix for the foreseeable future. In 2020, and continuing into 2021, challenges around transiting the Panama Canal highlight the advantage of North American Pacific Basin projects, in addition to the improved economics of decreased shipping requirements.

Around 15 projects are active in Canada today, with only LNG Canada, a joint venture owned by Shell, Petronas, PetroChina, Mitsubishi and KOGAS reaching FID in October 2018, while the other remain uncertain for the time being:

- Woodfibre LNG (West, 2.1 MTPA): A smaller low-emission project that is reportedly close to FID. BP is a noted foundational buyer with .75 MTPA of off-take for 15 years as well as an HOA in place with CNOOC for another .75 MTPA. Pacific Oil and Gas announced project sanction is contingent upon awarding of the EPC contract, and are targetnig FID in 2022.

- Kitimat LNG - Chevron/Woodside- (West, 20 MTPA): With a focus on global portfolio optimization, Chevron (the would-be operator) halted all spending on the Kitimat project in early 2021. The decision to halt funding followed an unsuccessful effort since 2019 to sell its' 50% share in the project.

- Cedar LNG (West, 3–4 MTPA): Owned by Haisla First Nation; is just commencing environmental review.

- Goldboro LNG (East, 10 MTPA): Secured 4.5 MTPA commitment from Uniper in Germany.

Mexico

- Sempra's Costa Azul regas facility achieved FID late in 2020. Sempra has signed two SPA's for 20-year LNG sales-and-purchase agreements for the 2.5MTPA export capacity of Phase 1 of the project located in Baja California, Mexico. Energia Costa Azul (ECA) LNG Phase 1 is a single-train liquefaction facility to be integrated into the existing LNG import terminal. ECA's existing facilities include one marine berth and breakwater, two LNG tanks of 160,000 m^3 each, LNG vaporizers, nitrogen injection systems and pipeline inter-connections. The liquefaction project would add natural gas receipt, treatment and liquefaction capabilities and loading of LNG cargoes.

- Mexico Pacific Limited's 12.9 MTPA project on the West Coast of Mexico, Puerto Libertad in Sonora could also see momentum due to significant upstream infrastructure already in place. Geographically the project is similar in distance to the Permian as US Brownsville projects and will leverage an underutilized and robust pipeline network for feedgas. Physical permits have been approved, but the project lacks a Mexican export permit.

East Africa

Mozambique is expected to become one of the world's largest Mozambique is expected to become one of the world's largest LNG exporters, with two major projects fully sanctioned (the Area 1 Mozambique LNG Project and the Area 4 ENI led Coral Sul LNG-FPSO ultra-deepwater project). The third (the Area 4 Rovuma LNG Project) has been delayed indefinitely. Early days of development are seeing significant domestic challenges, from both COVID and militant activity near the sites.

In September 2019, Total acquired Anadarko's 26.5% stake in the Area 1 Mozambique LNG Project from Occidental after Occidental acquired Anadarko. This makes Total the largest shareholder and operator of the project. Mozambique LNG is the market's first onshore LNG development and the project includes the construction of a two train liquefaction plant with a capacity of 12.9MTPA. The Final Investment Decision (FID) on Mozambique LNG was announced in June 2019, and the project is expected to come into production by the mid-2020's.

The Area 1 project is currently experiencing challenges, including the COVID-19 outbreak at its construction site and nearby attacks by insurgents linked to Islamist militants in the Cabo Delgado province. In Q1 2021, Total had to suspend work at the construction site as Islamist insurgents attacked a nearby town in the Cabo Delgado province. The on-site workforce was reduced to absolute minimums which follows a January change when Total reduced its on-site workforce as insurgents came closer to the construction site. Total has mentioned a restart to construction after the government increased security, but that plan has now been abandoned given heightened attack activity.

An adjacent project, Area 4 Rovuma LNG led by Eni and ExxonMobil, will in the first phase consist of two liquefaction trains of 7.6 MTPA for total capacity of 15.2 MTPA. The planned FID for the project has been delayed indefinitely.

LNG development in Tanzania is at a more preliminary stage. Shell and Equinor are understood to still be committed to a project; however, significant regulatory challenges remain. Proposals to build a $30 billion two train LNG plant, with total capacity of 10MTPA, have been under consideration since 2011, clouded by fiscal uncertainty in Tanzania's extractives industry.

West Africa

The Greater Tortue LNG-FPSO project straddling the Senegal and Mauritania border, continues its' development. However, the project has encountered some delays due to COVID-19, including an associated six-month force majeure around resource mobilization, constructions and installations in April of 2020. As a result, first production has been delayed by one year to 2023. Based on experience gained from converting the Hilli LNGC into an FLNG vessel for the Cameroon Kribi development, the project will use the Golar Gimi LNGC for conversion by Keppel (who received full go ahead in 2019), enabling the FLNG vessel to begin producing cargoes in 2022. The Phase 1 FLNG facility is designed to provide 2.5 MTPA of LNG for global export as well as making gas available for domestic use in both Mauritania and Senegal. The project partners now look to make the final investment decision (FID) for Phase 2 of the project in 2022-2023, with potential start-up in 2026. The previously mentioned Phase 3 has been put on hold.

With FID taken in 2019 on Nigeria LNG Train 7, additional de-bottlenecking, work continues. Construction could not commence due to lockdowns in the region of the site location as a result of the COVID-19 pandemic. The expansion will increase NLNG facilities' production capacity to 30 MTPA, with first LNG expected in 2025. The expansion project will produce an additional 7.6 MTPA with additional feed gas treatment facilities (producing 4.2 MTPA) and additional (producing 3.4 MTPA) processing of treated gas from existing pre-treatment facilities. The existing trains will be debottlenecked through the addition of a single new cold box (or heat exchanger), rather than a series of incremental process improvements across each train.

Russia

The three key players in the Russian gas industry (Gazprom, Novatek and Rosneft) each developed a strategy that was compatible with its own asset base and previous experience, and as a result three different approaches to LNG developments in Russia have emerged. The 16.5 MTPA Yamal LNG project commissioned its Train 3 in 2019, and the smaller scale .9MTPA Train 4 (using a Russian designed Arctic Cascade process) is expected to start up in 2021.

In September 2019, Novatek's Arctic LNG 2 project was sanctioned. The LNG project will consist of three (3) liquefaction trains with overall production capacity of 19.8 MTPA. The start-up of LNG T1 is scheduled for 2023, with LNG T2 and T3 to be started in 2024 and 2026 respectively. Arctic LNG 2 employs an innovative concept using gravity-based structures (GBS) and provides for localising the majority of fabrication in Russia (whereas Yamal imported fabricated modules). The GBS construction and installation of LNG modules are performed at a new casting basin located in the Murmansk Region. A consortium of TechnipFMC, Saipem and NIPIGAS was awarded the EPC contract, with the GBSs be built by the Russian company. The facility will use Linde's LNG liquefaction technology. The project consists of three GBSs, which are artificial islands to be installed in shallow water. An example of how this concept is constructed within a 'casting basin', floated out, towed to location and installed, is the Adriatic LNG offloading, storage, and re-gasification terminal (albeit the Arctic 2 GBSs are much larger and complex, and support processing liquefaction facilities). The GBS LNG concept requires modularisation of the process units for integration on the GBS top slab at construction yard. The GBSs will be made of highly reinforced and prestressed concrete. Each GBS will house membrane LNG storage tanks and on top they will support the processing facilities, utilities and living quarters etc. Construction and integration of the GBSs and topsides modules will take place in the Murmansk yard. After commissioning in the construction yard, the GBSs will be floated out and towed to the Arctic LNG location and ballasted down ono the seabed.

Following the Shell exit of the project, Gazprom and RusGasDobycha look to advance the Baltic LNG project. In March 2019, Gazprom announced that the LNG plant will be part of a large complex that it intends to create, consisting of facilities for processing 45 bcm/year and producing 13 MTPA of LNG, 4 MTPA of ethane, as well as ~2.5 MTPA of LPG. Gazprom and RusGazDobycha intend to commission the complex by the end of 2024.

Obskiy LNG is a newly planned project by Novatek in Yamal, with a capacity of 5 MTPA, underpinned by large gas deposits south of the project. Novatek plans to build two 2.5 MTPA trains east of the current Yamal LNG site using its patented Arctic Cascade gas liquefaction process. The project is targeting FID in 2021, and could see first gas in 2025.

Australia

With the great LNG buildout concluded in 2019, Australia now looks to projects to support current infrastructure, namely backfill projects to maintain feedgas supply to existing export projects.

One notable project is the Scarborough gas field which Woodside plans to monetise through an expansion of the existing Pluto LNG facility, via a second train. Woodside awarded a FEED contract to Bechtel for Pluto Train 2, which will utilise the ConocoPhillips Optimised Cascade process. The FEED contract includes the option to construct a 5MTPA train, subject to a positive FID originally planned for 2020, but as with many projects delayed due to the pandemic and the oil price collapse. FID is now targeted for late 2021. Woodside and BHP will equity lift LNG. Woodside has three contracts to sell Scarborough volumes, with PERTAMINA for .5 MTPA, ENN for 1 MTPA and Uniper for 1 MTPA. Should a successful FID be seen in 2021, first LNG is likely in 2025. Comments from Woodside indicate that an optimized project schedule and improvements in off-shore capacity drive the project up from 7.5 MTPA to nearly 8 MTPA.

Woodside also proposes to build a 5km, 30inch interconnector pipeline to transport wet gas between the expanded Pluto LNG facility and the North West Shelf (NWS) Karratha Gas Plant (KGP), to fill short-term spare capacity at the latter.

The Browse development is to backfill the existing NWS LNG trains, with an FID previously slated for 2021, but also delayed. Woodside is operator of the Browse fields and the development concept includes a 900 km pipeline to the existing North West Shelf infrastructure.

In early 2021, Santos and partner SK E&S reached FID on the 4 tcf Barossa gas field which will look to backfill the Santos operated Darwin LNG plant. The Darwin plant will take on life extensions to modify the plant to be ready for the Barossa gas as well.

Papua New Guinea

In 2020 PNG LNG achieved another production record, surpassing 2019's production of 8.3 MTPA by 0.6MT to reach 8.9MTPA from the existing two train (3.45MTPA each) facility. In February 2021, Oil Search announced that Train 3 is no longer part of its future development plans, and intends to focus on the Papua LNG facility and expansion instead.

The expansion of the PNG LNG project (Papua LNG) is planned to be a three-train 8.1 MTPA expansion (each train 2.7MTPA) on the existing PNG LNG site, sharing infrastructure with PNG LNG. The new LNG trains are underpinned by gas from P'nyang for one train (for the ExxonMobil lead grouping) and two trains based on gas from Elk-Antelope (for the Total led group). Coming to an agreement on a new production sharing agreement that meets the needs of all stakeholders has taken time, with the FEED entry timeline impacted.

Key commercial agreements and pre-FEED activities for the three-train integrated development are all largely complete and subject to the completion of the P'nyang Gas Agreement. The deal with the government for the P'nyang gas field, which is being negotiated by PNG LNG venture operator ExxonMobil, will set the fiscal terms for the development of P'nyang, an important part of a planned three train expansion and a critical milestone prior to the shareholders taking FID

Eastern Mediterranean

Egypt was the world's eighth biggest LNG exporter in 2009 with three trains operating at two facilities. However, population growth and energy subsidies fuelled domestic consumption, while a challenging investment regime deterred exploration investment. As a result, gas production fell, there were gas shortages and the government prioritised domestic needs over gas exports. This resulted in the government requiring gas to be diverted to the domestic market. As a result, the market stopped LNG exports and began importing LNG via two floating storage and regasification units (FSRUs) in 2014. Egypt only became self-sufficient in natural gas again in late 2018 and the Egyptian LNG Idku facility has been exporting at reduced rates since 2016. In 2019 the IDKU facility saw exports surge as international gas prices provided economic incentive to resume stronger exports. With the oil price collapse and weakened LNG prices due to weak demand, exports fell from 3.6MTPA to 1.6MTPA as economics were likely better to feed the domestic market. The Damietta facility to the East, was also able to restart as ENI pushed to settle outstanding disputes between parties and the authorities. Damietta, which had not exported LNG since 2012, was quickly able to restart the facility and exported its first cargo since that time on Feb 22, 2021.

Delek and Chevron (previously Noble), partners in the large Leviathan field off Israel's Mediterranean coast, are considering multiple LNG monetization options, (including potentially leasing a newbuild LNG-FPSO from either Golar or Exmar).

Indonesia

Tangguh Train 3 construction is progressing with the BP-operated LNG export facility in Indonesia adding 3.8 MTPA of production capacity to the existing facility, bringing total plant capacity to 11.4 MTPA. The project also includes two offshore platforms, 13 new production wells, an expanded LNG loading facility, and supporting infrastructure. The targeted start date for Tangguh T3 was pushed back in mind-2020 to 2022 due to the pandemic. This is the 2nd announced delay to the project, after natural disasters and financial issues with a contractor pushed back the project.

The Sengkang LNG facility, which has been delayed for more than 12 years, primarily due to unresolved issues with Indonesian authorities, continues to remain on hold. Construction of the LNG terminal is reportedly 80% complete. After a multi-year halt in construction due to a land use dispute, the project was permitted to resume construction in February 2021.

Malaysia

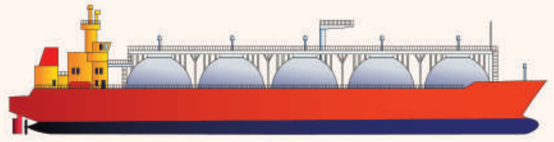
Construction of Petronas' second floating LNG facility (PFLNG2 Dua) Construction of Petronas' second floating LNG facility (PFLNG2 Dua) is complete and this second LNG-FPSO has been installed on the Murphy-operated Rotan field 240 kilometres offshore Sabah. PFLNG2 Dua will boost Malaysia's total LNG production capacity by another 1.5 MTPA. The LNG-FPSO is designed to extract gas from deepwater reservoirs at depths up to 1,300 metres. PFLNG2 set sail from South Korea in its maiden voyage to the Rotan Gas Field, located offshore Sabah, Malaysia in February 2020 and recently achieved first gas in early February 2021.

6 LNG Shipping

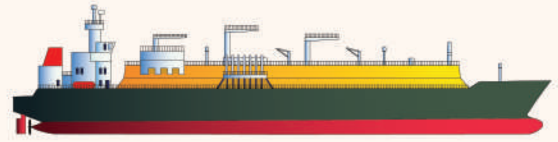
The global LNG fleet grew by **7% year-on-year** in 2020.

5,757
trade voyages, an increase of
1% year-on -year

572 active vessels / **35** new vessels

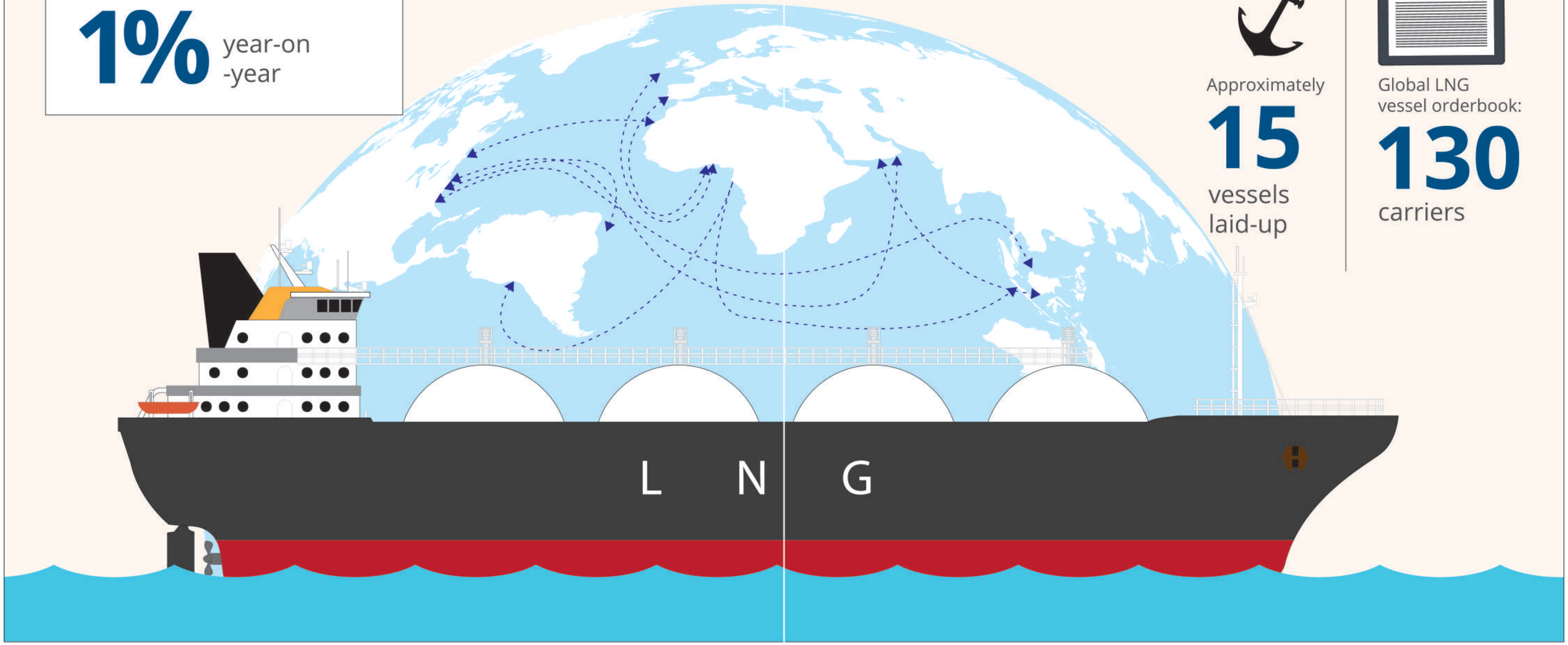


Including
37 FSRUs / **4** FSUs



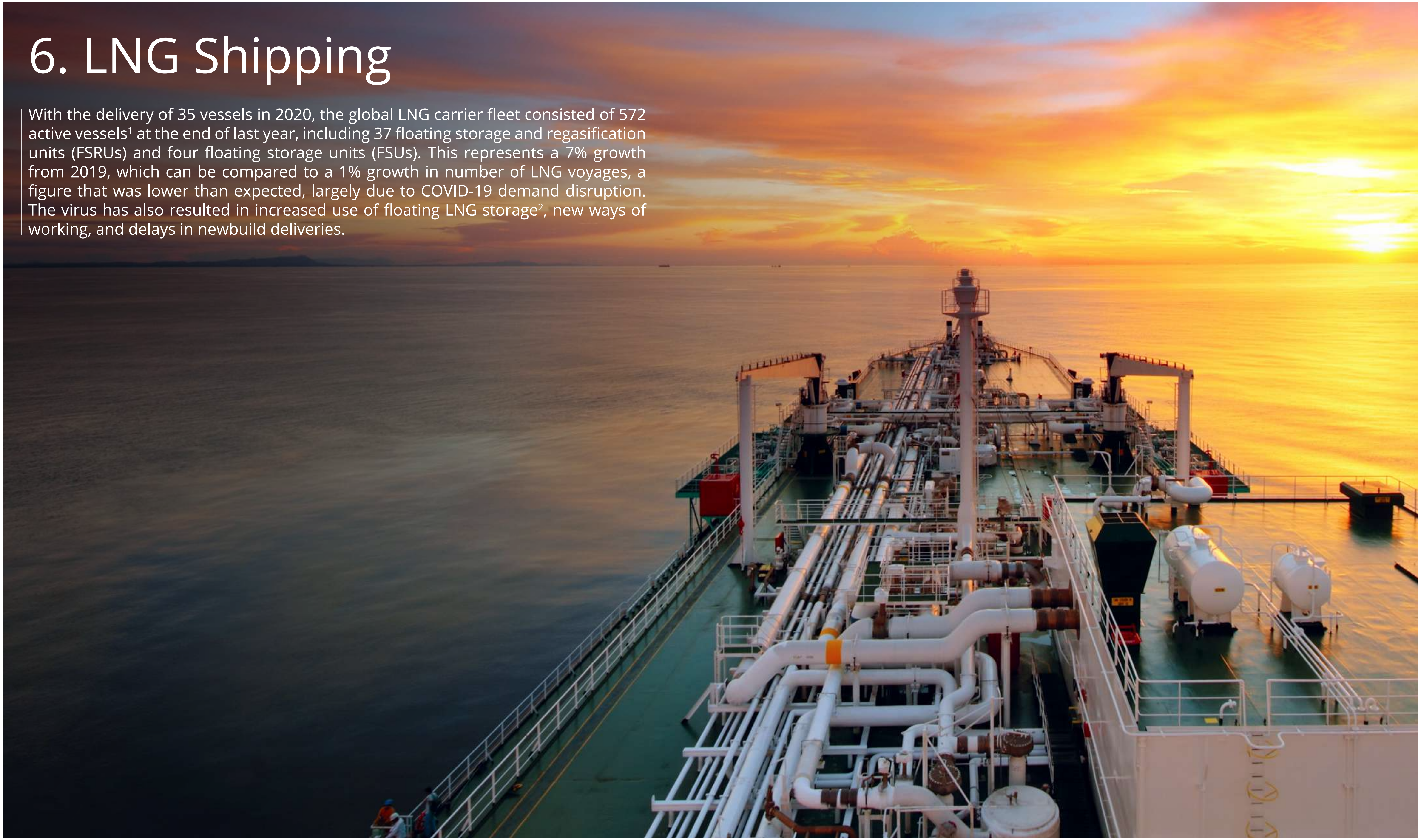
Approximately
15
vessels laid-up

Global LNG vessel orderbook:
130
carriers



6. LNG Shipping

With the delivery of 35 vessels in 2020, the global LNG carrier fleet consisted of 572 active vessels[1] at the end of last year, including 37 floating storage and regasification units (FSRUs) and four floating storage units (FSUs). This represents a 7% growth from 2019, which can be compared to a 1% growth in number of LNG voyages, a figure that was lower than expected, largely due to COVID-19 demand disruption. The virus has also resulted in increased use of floating LNG storage[2], new ways of working, and delays in newbuild deliveries.

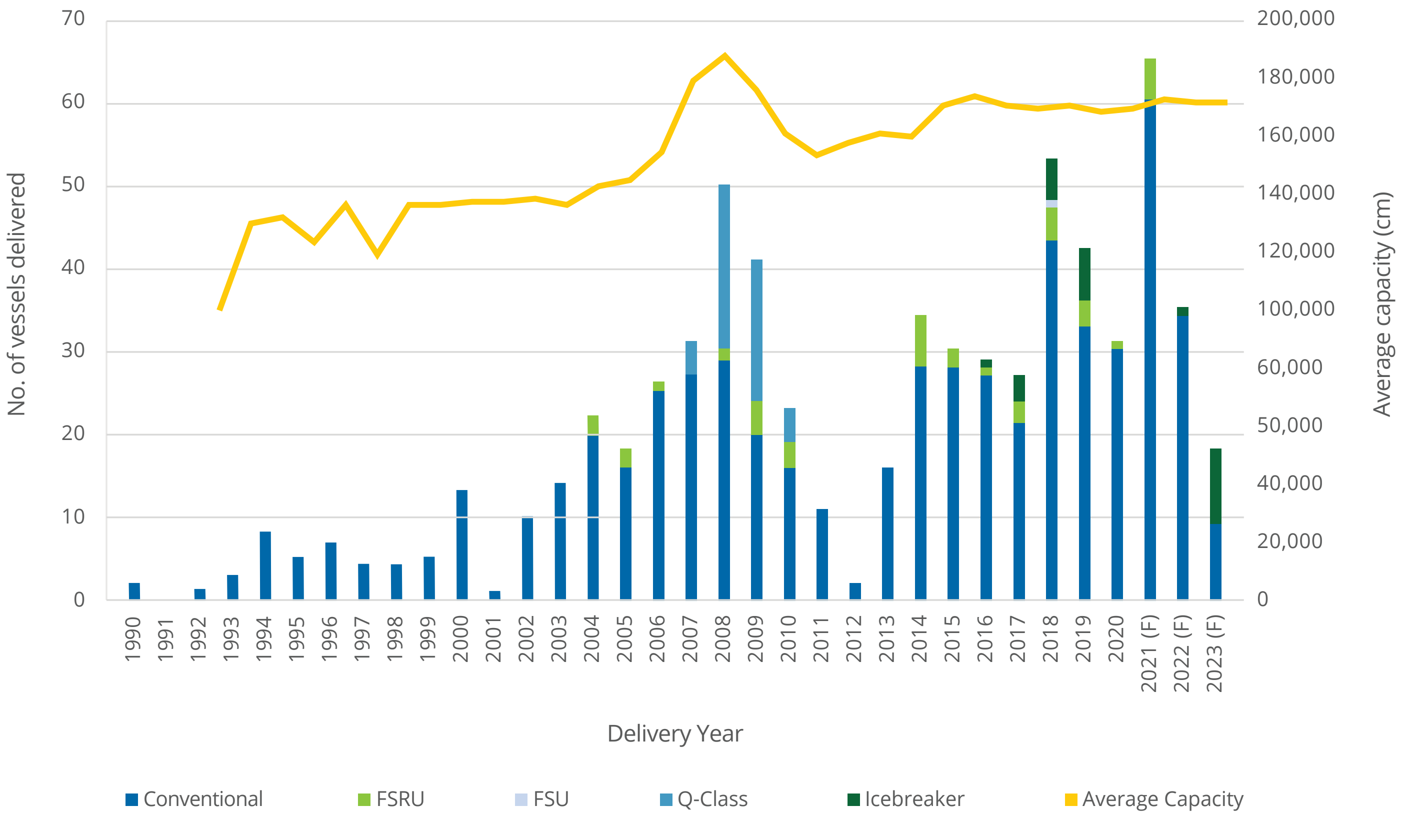


LNG Carrier from Gorgon – Courtesy of Chevron

[1] Only LNG carriers with capacity of 30,000 cm and greater were included in this report.
[2] Floating LNG storage in this context refers to short-term slow steaming of vessels to maximize trading positions. For elaboration on COVID-19's impact on LNG shipping, please refer to dedicated chapter.

6.1 OVERVIEW

Figure 6.1: Global active LNG fleet and orderbook by delivery year and average capacity, 1990-2025



Source: Rystad Energy

130 LNG Vessels

Under Construction at End 2020

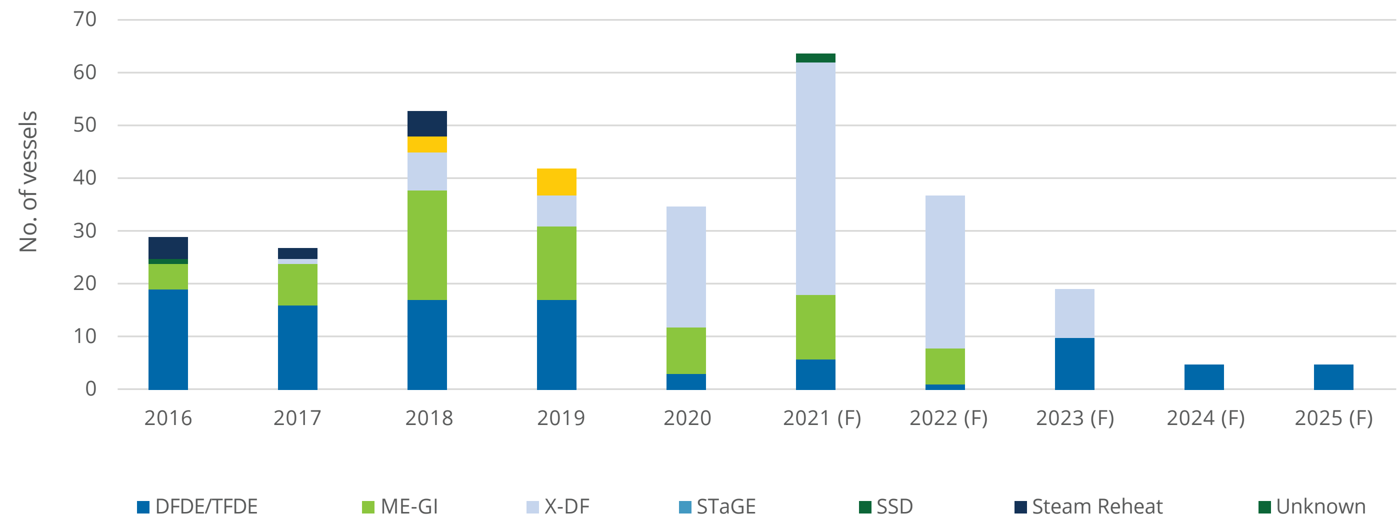
The LNG shipping market developed rapidly from the early 2000s, following a general upward trend during the previous decade. The 2008 global financial crisis resulted in a slowdown in orders, with only one newbuild LNG carrier ordered in 2009. This resulted in a short decline in deliveries until 2013, but the market has since picked up, with deliveries in recent years exceeding previous annual deliveries.

Of the 35 newbuilds delivered in 2020, all but one were between 170,000 cubic metres (cm) and 180,000 cm in size. Vessels of this size remain within the limits of a 2016 Panama Canal expansion transit while maximising 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.

The global LNG fleet is relatively young, a consequence of the rapid increase in liquefaction capacity over the past two decades. Vessels under 20 years of age make up 90% of the active fleet – newer vessels are larger and more efficient, with far superior project economics over their operational lifetime. Only 11 active vessels are 30 years or older, including five that have already been converted into FSRUs and FSUs. There were approximately 15 laid-up LNG carriers at the end of 2020.

The global LNG orderbook has 130 vessels under construction as of year-end 2020, a significant number, equivalent to 23% of the currently active fleet. This illustrates shipowners' expectations that LNG trade will continue to grow, in line with scheduled increases in liquefaction capacity. However, there were only 39 LNG carrier orders in 2020, a drop from 50 in 2019, a result of COVID-19's impact on market conditions. An expected 64 carriers are to be delivered in 2021, including 8 that were originally scheduled for delivery in 2020. The orderbook includes 21 Icebreaker-class vessels – highly innovative and capex-intensive ships that have the capabilities required to traverse the Arctic region.

Figure 6.2: Historical and future vessel deliveries by propulsion type, 2016-2025



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, X-DF systems will dominate in the years 2021–2023 as well, with 82 systems on order as of end-2020. There are 19 competing M-type, electronically controlled (ME-GI) system vessels under construction, together representing a major shift from the popular propulsion systems of the past – the steam turbine and dual-fuel diesel-electric (DFDE) engines. South Korean shipbuilders - Hyundai Heavy Industries, Samsung Heavy Industries and Daewoo Shipbuilding remain the top three LNG carrier builders on the market.

Spot charter rates are affected by the balance between shipping demand and supply, in turn driven by LNG demand and the size of the LNG carrier fleet. At the beginning of 2020, traders were uncertain about the effects of COVID-19, with rates at ~US$70,000 per day for steam turbine, ~US$90,000 for TFDE and ~US$105,000 for X-DF/ME-GI vessels. As the virus started to substantially impact demand for LNG, spot charter rates for all vessel types inched lower, trading at a range around ~US$20,000 for steam turbine, ~US$30,000 for TFDE and ~40,000 for X-DF/ME-GI vessels until August 2020. Tighter supply from mid-August led to prices climbing steadily towards December, as the price differential between the Pacific and Atlantic basin increased. With global LNG prices hitting record highs in December, charter rates soon followed, shifting upwards and concluding the year at ~US$105,000 for steam turbine, ~US$150,000 for TFDE and ~US$165,000 for X-DF/ME-GI vessels.

There were 5,757 LNG trade voyages undertaken in 2020, a 1% growth compared to 5,701 in 2019. This low growth rate was the result of the coronavirus impact on demand alongside a mild winter in the beginning of the year, the effect of which was lessened by absorption of excess supply by East and North Asian markets.

SCF Barents - Courtesy of SOVCOMFLOT

6.2 LNG CARRIERS

Containment systems

LNG containment systems are designed to store LNG at a cryogenic temperature of -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 in this section, modern newbuilds have for the most part adopted the membrane type.

Table 6.1: Overview of containment systems

	Membrane	Self-supporting
Current Fleet Count	454	118
Current Fleet proportion (%)	79%	21%
Systems	GTT-designed: Mark III, Mark III Flex, Mark III Flex+, 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	• More robust in harsh weather conditions • Partial-loading possible • Faster construction
Disadvantages	• Partial-loading restricted • Less robust in harsh ocean 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 converted into gas during a voyage. This is referred to as boil-off gas, a direct result of heat transferred from the atmospheric environment, liquid motion (sloshing of LNG), the tank-cooling process and the tank-depressurisation process. Boil-off rates in recently built LNGCs at laden condition are below 0.10% of total volume per day (in older LNGCs averaging around 0.15% of total volume per day). Membrane and self-supporting systems can be further split into specific types, which are examined below.

Prism Agility - Courtesy of SK E&S

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, breaking GTT's membrane monopoly.

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, although partial fillings may be restricted due to sloshing. GTT states a boil-off-rate of 0.07% for its Mark III Flex+ and future NEXT1 membrane system (or other evolutions of the NO96) – additional insulation thickness is required for these record low levels.

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. Independent self-supporting spherical tanks also allow for partial loading during a voyage. However, 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 to 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 cubic-metre 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.

Even if Moss Rosenberg and IHI SPB tank types represents slightly above 20% of the fleet in service, there are currently no LNG carriers under construction with such self-supporting tanks although the technology is still available and fully approved by the international regulations.

Lastly, the LNT A-BOX is a self-supporting design 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 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 newbuild with this system in place, Saga Dawn, was delivered in December 2019. In August 2020, LNT Marine signed a join design project cooperation with Wuhu Shipyard and Shanghai Merchant Ship Design & Research Institute, aiming to develop a design for a shallow draft 40,000 cm carrier with LNT A-Box in place.

Propulsion systems

Propulsion systems impact capital expenditure, operational expenses, emissions, vessel size range, vessel reliability and compliance with regulations. This means 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 propulsion solution for LNG carriers. Increasing fuel oil costs and stricter emissions 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 prevalence 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) and low-pressured Winterthur Gas & Diesel X-DF.

For propulsion units, special mention should be made for ABB Azipod units, which have been deployed in the 15 ARC7 icebreaker units in service for Yamal LNG. These motors are housed in a submerged pod outside the LNG carrier's hull, with 360-degree rotation capabilities. The resulting heightened manoeuvrability enables the highly powered units to navigate efficiently through the Arctic, through ice up to 2.1 metres thick. The success has led to a new order of ABB Azipod units for the additional icebreakers relevant to the Arctic LNG-2 project developed by Novatek.

As propulsion systems are manufactured by third parties such as Wärtsilä, MAN B&W and Wintherthur Gas & Diesel, different shipbuilders generally offer a variety of propulsion systems. As such, shipowners are not restricted to specific shipbuilders or geographies when choosing the newbuild specifications that best match their purpose.

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 is difficult nowadays. 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 (GCU). Maintenance costs are also relatively low.

The key disadvantage of steam turbines is the low efficiency, running at 35% efficiency when fully loaded (most efficient). The newer generations of propulsion systems, DFDE/TFDE and X-DF/ME-GI engines, are more than 25% and 50% more efficient when compared to the steam turbine. There are currently 220 active steam turbine propulsion vessels, making up 39% of the total current fleet. There are no steam turbine vessels being built currently, showing the high adoption rates of newer technologies.

An improvement on the steam turbine was introduced in 2015, involving reheating of the steam in-cycle in order to improve efficiency by more than 30%. Aptly named the Steam Reheat system (or Ultra Steam Turbine), there are 12 active vessels with the propulsion in place but zero newbuilds due.

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

DFDE propulsion was introduced in 2006 as the first alternative to steam turbine systems, able to run on both diesel and boil-off gas. It does so in two separate modes, diesel 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. Eventually in gas mode, knocking and misfiring could happen in case 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 were only three DFDE/TFDE vessels delivered in 2020, increasing the number of active vessels to 183, representing 33% of the current fleet. There are currently 27 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 31 Q-Flex and 13 Q-Max-classed LNGCs running SSDR systems.

IMO regulations relating to sulphur and nitrogen emissions might impact the feasibility of SSDR engines, requiring existing engines to burn low-sulphur fuels or even convert propulsion system type. 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 new environmental regulations and the introduction of third-generation engines, there are currently no SSDR engines on order.

High-pressure slow-speed dual-fuel (ME-GI)

Introduced in 2015 by MAN B&W, the M-type, electronically controlled, gas injection propulsion system (commonly known as ME-GI), pressurises boil-off gas 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 58 vessels fitted with ME-GI systems have been delivered since 2015, with 19 additional newbuilds with the system under construction.

MAN B&W is in the process of testing a new engine based on the ME-GI make, the M-type, electronically controlled, gas admission system (ME-GA) 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. The system is expected to be available for commercial delivery from the end of 2021.

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

Originally introduced by Wärtsilä, the Winterthur Gas & Diesel 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, similar to the ME-GI system, a small amount of fuel oil is used as a pilot fuel. As the maintained pressure is low, the system is easier to implement and integrate with a range of vendors.

In terms of fuel consumption and efficiency, LNG carriers equipped with ME-GI and X-DF are comparable. Safety and emissions are the areas where the X-DF stands out, winning over the ME-GI as it has 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.

There are currently 37 vessels with the X-DF system in service. The orderbook for LNG carriers contains an impressive 82 X-DF vessels, representing 63% of total newbuilds to be delivered – with safety, efficiency and controlled emissions, the X-DF is currently the preferred propulsion system among shipowners.

Steam turbine and gas engine (STaGE)

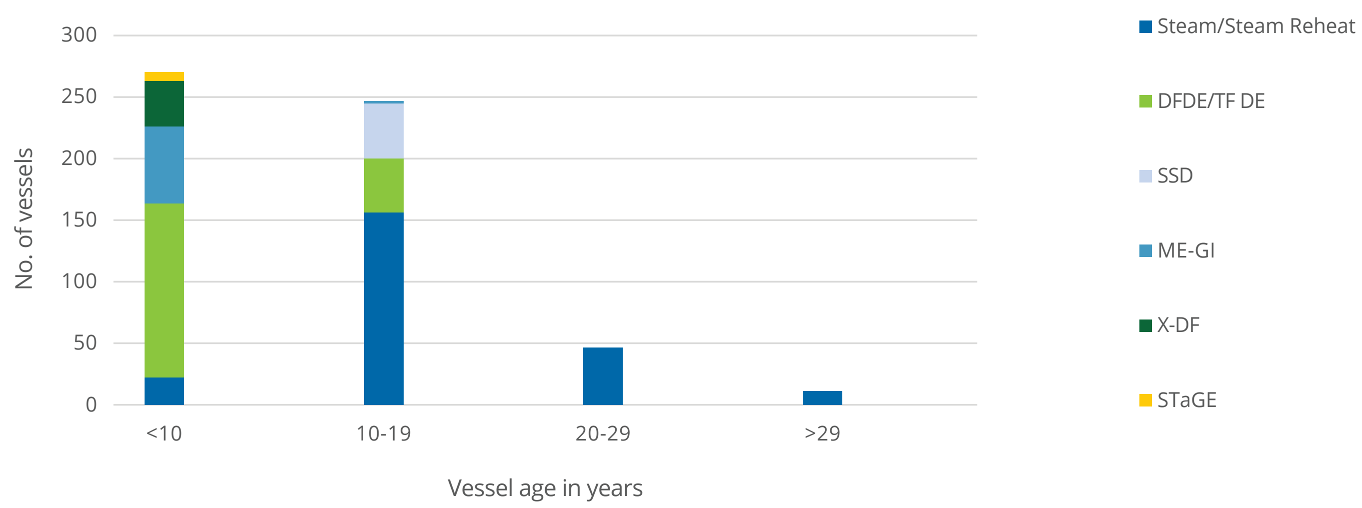
First introduced in a 2018 delivery, the Sayaringo STaGE propulsion system runs both a steam turbine and a dual-fuel engine. Waste heat from running the dual-fuel engine is recovered to heat feedwater and to generate steam for the steam turbine, significantly improving overall efficiency. The electric generators attached to the dual-fuel engine power both a propulsion system and the ship, eliminating the need for an additional turbine generator. In addition to efficiency, the combination of two propulsion systems improves the ship's adaptability while reducing overall emissions.

A Japanese innovation, STaGE systems have been produced exclusively by Mitsubishi, with eight newbuilds delivered during 2018 and 2019. There are currently no STaGE vessels on order.

Fleet propulsion system breakdown by vessel age

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

Figure 6.3: Current fleet propulsion type by vessel age



Source: Rystad Energy

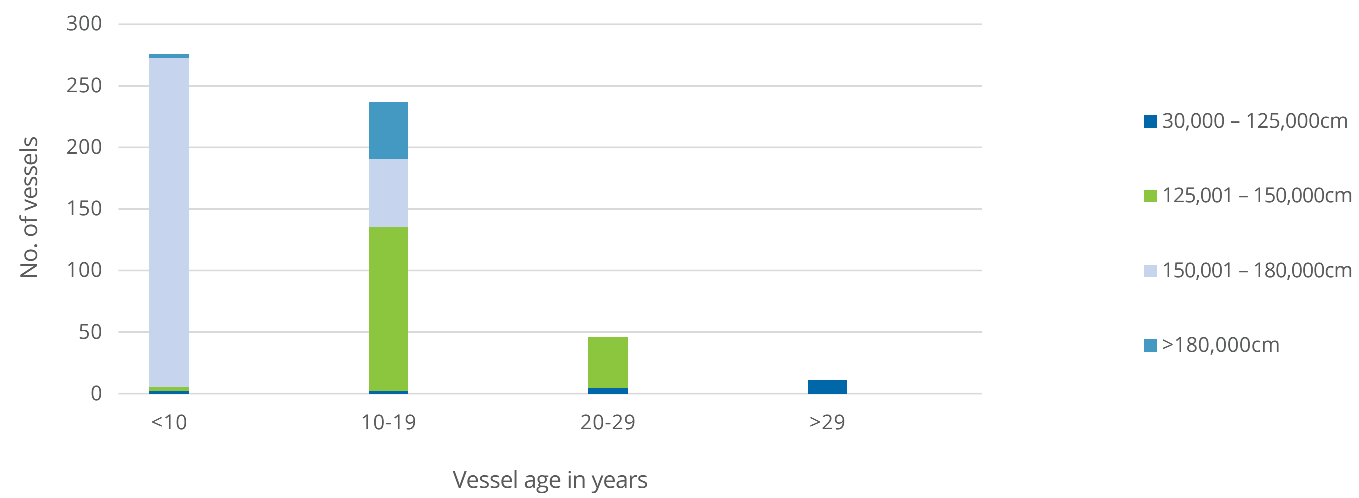
Vessel age and capacity

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 single vessel, Golar Mazo, was laid up during last year, bringing the tally of laid-up LNG carriers to approximately 15 at the end of 2020. This represents a drop of about 25% from 2019 as several previously laid-up vessels were scrapped.

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

Figure 6.4: Current fleet capacity by vessel age



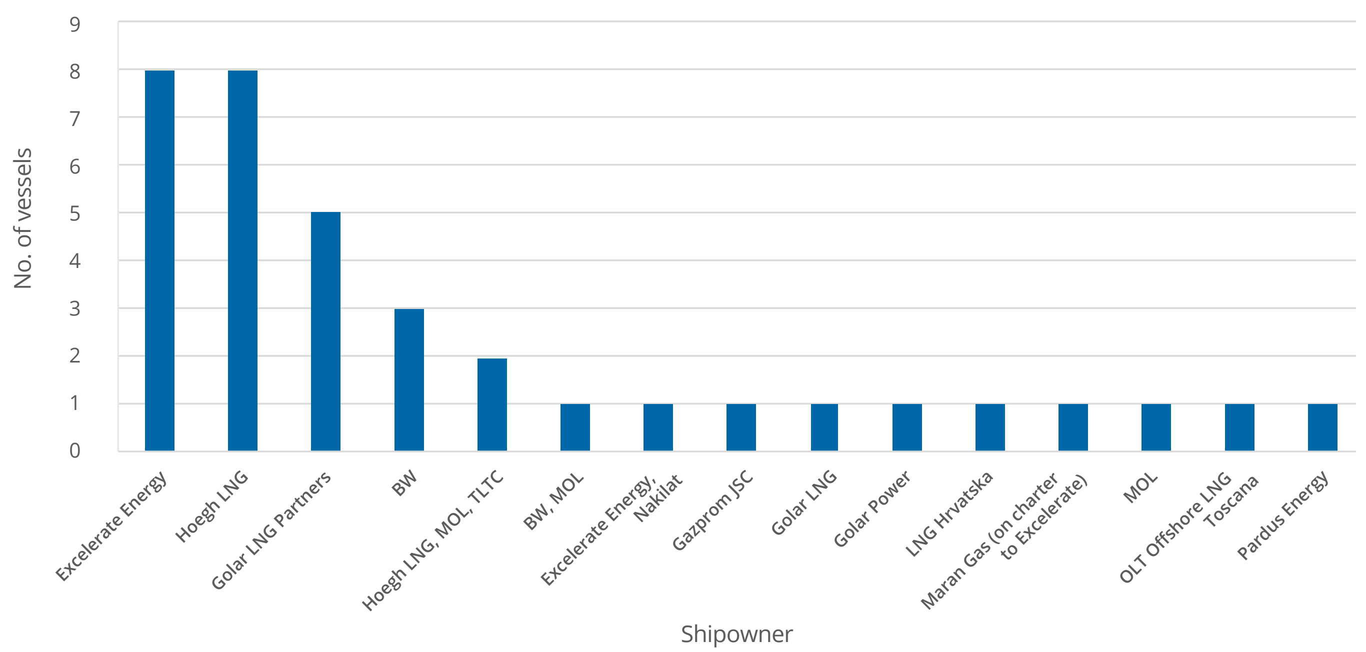
Source: Rystad Energy

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 to 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, making up 57% of the current fleet. The technological developments that steered adoption of this size are the new 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 quota – 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, in May 2019 became the first Q-Flex type LNG vessel and the largest LNG carrier by cargo capacity to transit the Panama Canal.

6.3 FLOATING STORAGE AND REGASIFICATION UNIT OWNERSHIP (FSRUs)

Figure 6.5: Active number of FSRUs by shipowner (vessel count)



Source: Rystad Energy

As their name suggests, FSRUs are used for LNG storage and regasification directly, in addition to being regular LNG carriers save 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. Last year saw two FSRU deliveries, Excelerate Sequoia and Vasant 1. A total of 37 FSRUs make up 6% of the active global LNG fleet. Shipowners Excelerate Energy, Hoegh LNG and Golar LNG Partners continue to maintain the largest fleets of active FSRUs.

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 to land-scarce regions or hard-to-reach areas.

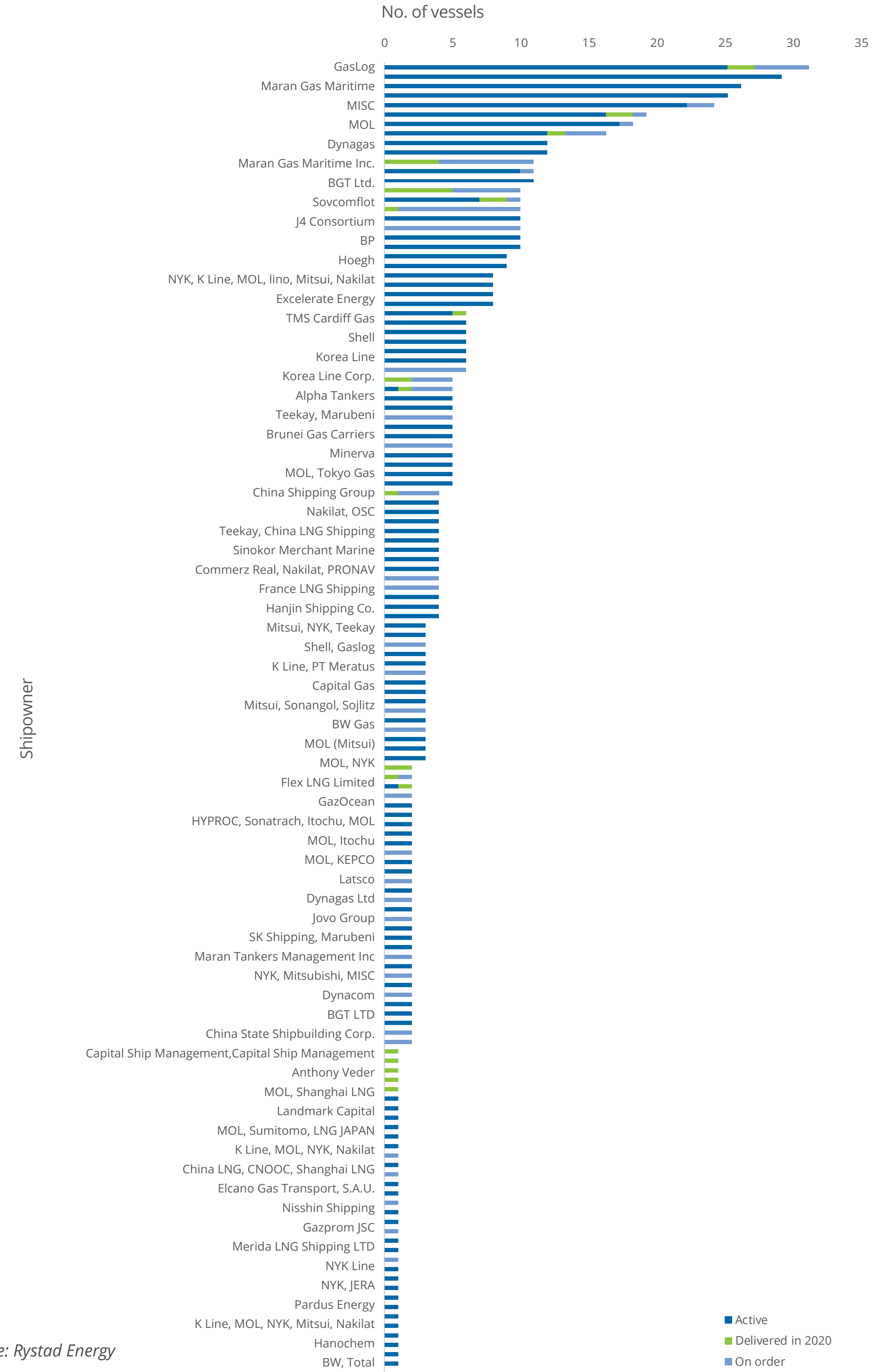
Capital expenditure and construction duration of an FSRU can be as little as half that of an onshore terminal, but this is balanced by higher operating expenditures. FSRUs can either be built with a newbuild hull or converted from an old LNG carrier. Newbuild FSRUs offer design flexibility and a wider 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 vessels. In addition, spikes in charter rates can motivate shipowners to use the ships as LNG carriers, reducing the number of FSRUs operating as regasification or storage units. Within the current global fleet, only 24 FSRUs were used as regasification terminals for the entirety of 2020, illustrating the extent to which operators are capitalising on their adaptability.

Despite this, FSRUs are expected to remain a popular storage and regasification solution for years to come. There are four FSRU newbuilds due for delivery in 2021, alongside three conversions currently taking place in Singapore shipyards.

6.4 2020 LNG ORDERBOOK

Figure 6.6: Global LNG fleet and approximate orderbook by shipowner[3]



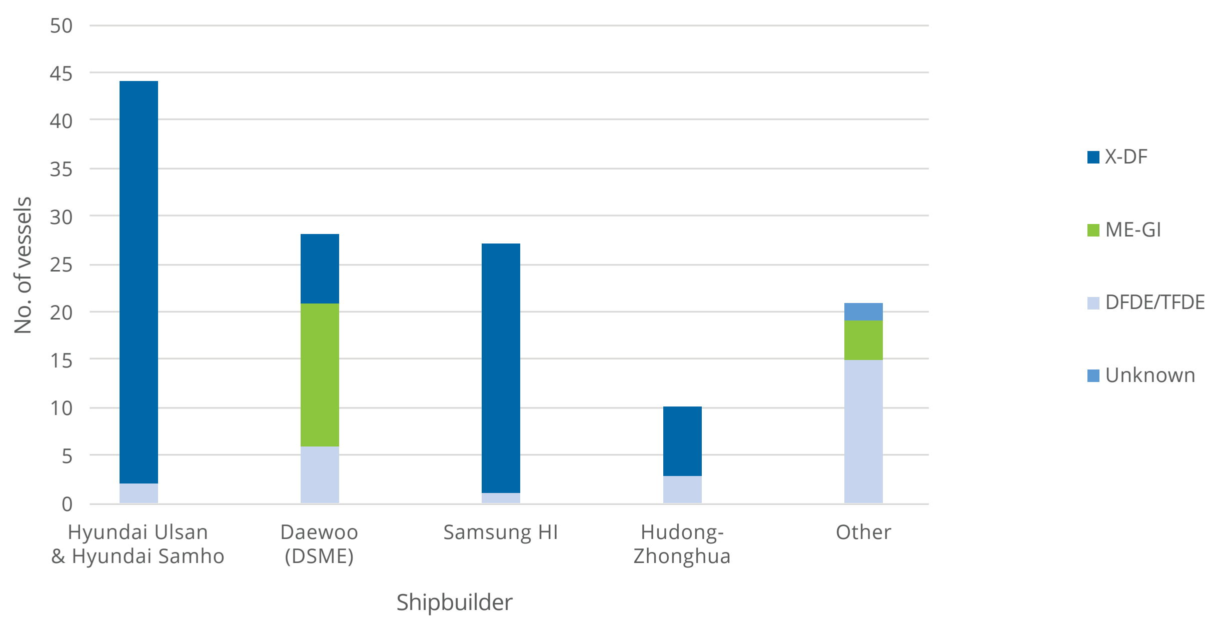
Source: Rystad Energy

[3] Shipowners or consortiums with four or more current and ordered vessels were included.

64 LNG Vessels
Scheduled for Delivery in 2021

There are 130 LNG carriers and newbuild FSRUs under construction as of year-end 2020, of which 39 were ordered in 2020. This is a drop from 50 new vessel orders in 2019, a result of uncertainty over COVID-19's impact on market conditions. Fast-growing Smart LNG, a joint venture between Novatek and Sovcomflot, has 15 icebreaker vessels on order to support the Arctic LNG 2 project, while Maran Gas has seven units on order. Knutsen is also expanding its LNG fleet with nine vessels on order from various shipbuilders, earmarked for long-term charters to players such as Shell. Of the 130 vessels, 64 are scheduled for delivery in 2021, 37 in 2022, 19 in 2023 and 5 each in 2024, 2025.

Figure 6.7: LNG newbuild orderbook by propulsion type and builder



Source: Rystad Energy

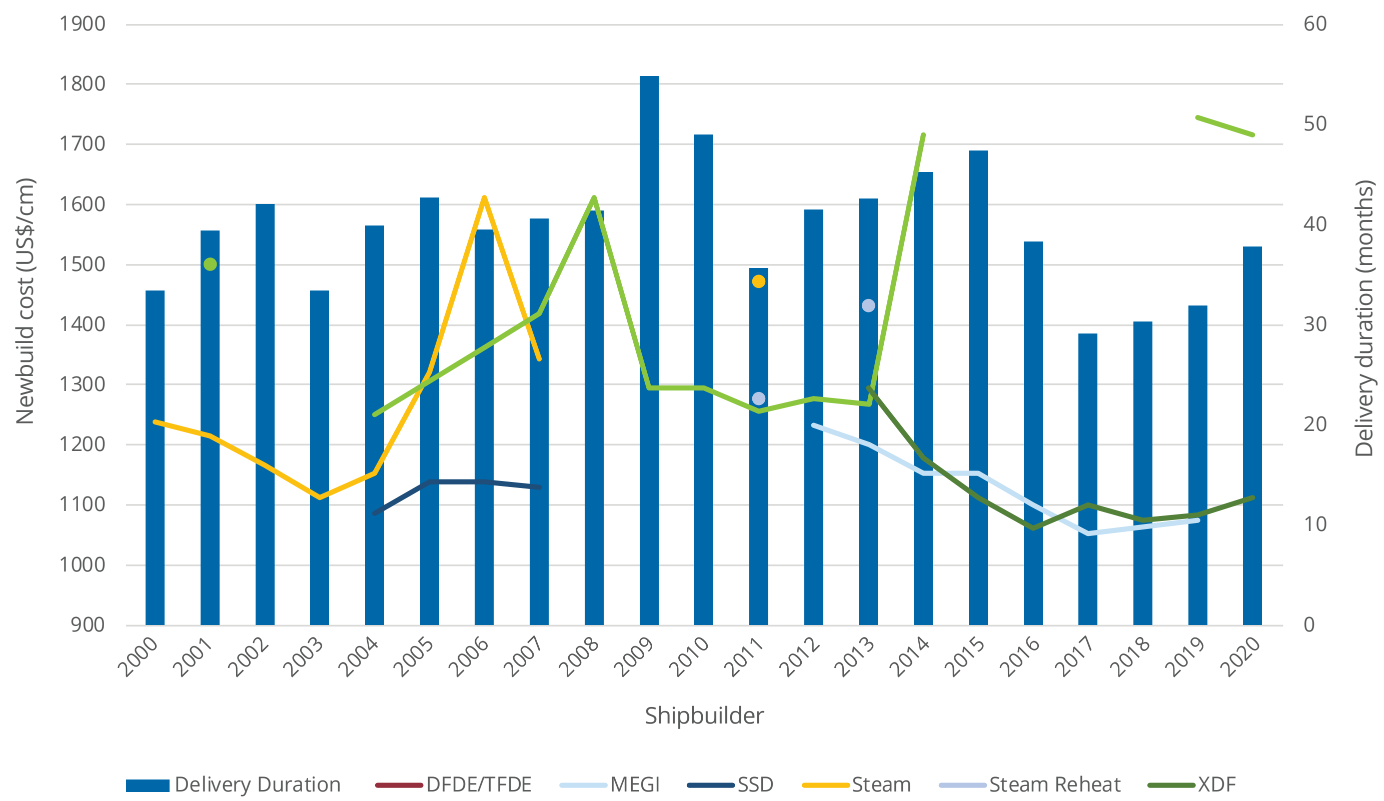
Capitalising on better fuel efficiencies and lower emissions, X-DF has become the new propulsion system of choice, with 82 currently on order. The competing ME-GI system has 19 orders, while TFDE/DFDE account for 27 vessels. Some 94% of the vessels on order are above 170,000 cm in size, showing a clear trend towards larger vessels that the new Panama Canal locks can now accommodate.

South Korean shipbuilders Hyundai, Daewoo and Samsung Heavy Industries are the top three shipbuilders for LNG vessels, with 44, 28 and 27 units on order, respectively. Hyundai and Samsung are working on a large proportion of newbuilds with X-DF systems, while Daewoo's orders cover X-DF, ME-GI and DFDE/TFDE vessels. Chinese builder Hudong-Zhonghua is currently working on ten vessels, seven of which are X-DF and three DFDE/TFDE.

FRU Torman Dry Tow – Courtesy of Bureau Veritas

6.5 VESSEL COSTS AND DELIVERY SCHEDULE

Figure 6.8: LNG vessel delivery schedule and newbuild cost, 2000-2020



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 is the 2014 peak of over US$1,700/cm due to 15 ice-breaker class vessels ordered to service Yamal LNG. These vessels, delivered in 2017, were priced at about US$320 million each, 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 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 50 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 2009, reaching over 50 months in the years following introduction of DFDE/TFDE systems. As Korean shipbuilders are becoming more experienced in delivering X-DF and ME-GI vessels, the average delivery duration for newbuild orders is expected to remain around 30 months.

6.6 CHARTER MARKET

US$105,000

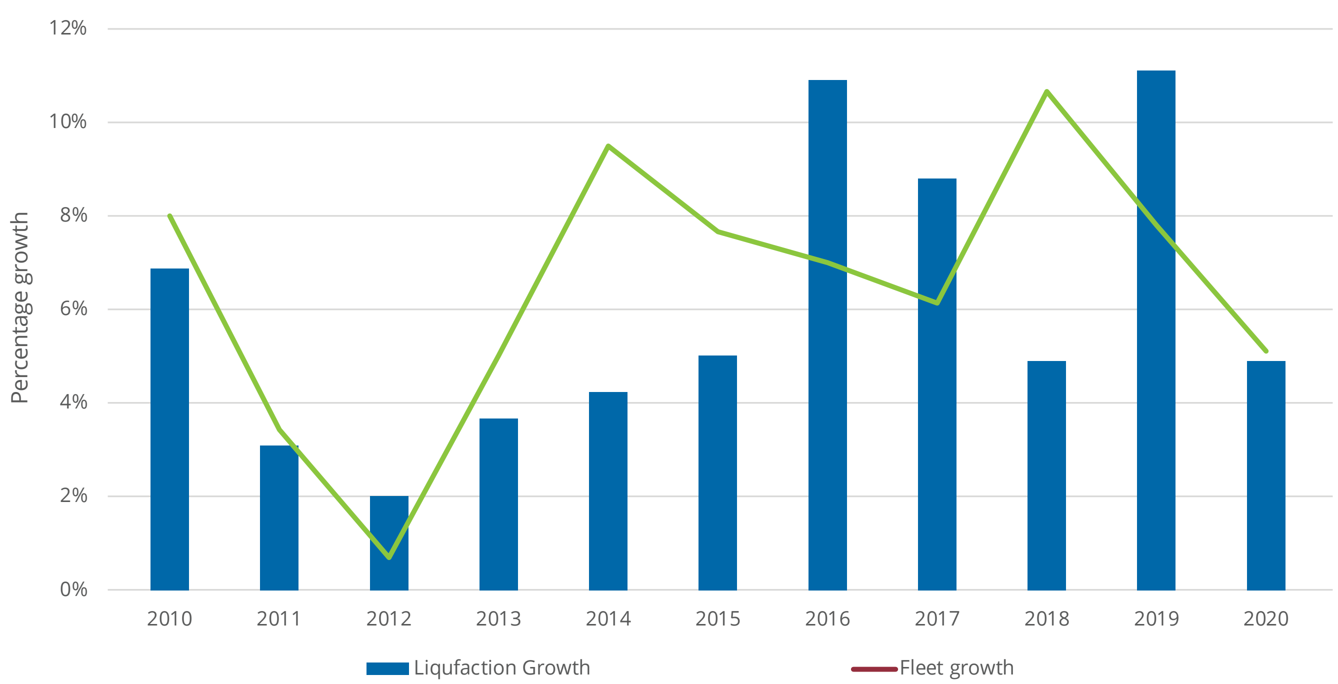
for steam turbine, US$150,000 for TFDE and US$165,000 for X-DF/ME-GI vessels Peak Charter Dayrates in 2020

Shipping costs constitute a high proportion of netback calculations when delivering LNG. Therefore, charter rates are seriously considered when formulating market strategies by both buyers and sellers, depending on the terms of individual contracts.

Historically, LNG was marketed with long-term contracts, encouraging shipowners to enter term charters with large players. 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 and ME-GI engines. In addition, vessels using steam turbine engines tend to be smaller in size, lowering demand as spot cargos tend to be at least 150,000 cm. Finally, charterers conscious about vessel emissions or boil-off rates also increasingly demand newer technologies, which widens the price differential further. Market participants must accurately balance fuel efficiencies, boil-off gas savings and higher costs when choosing which propulsion system to charter.

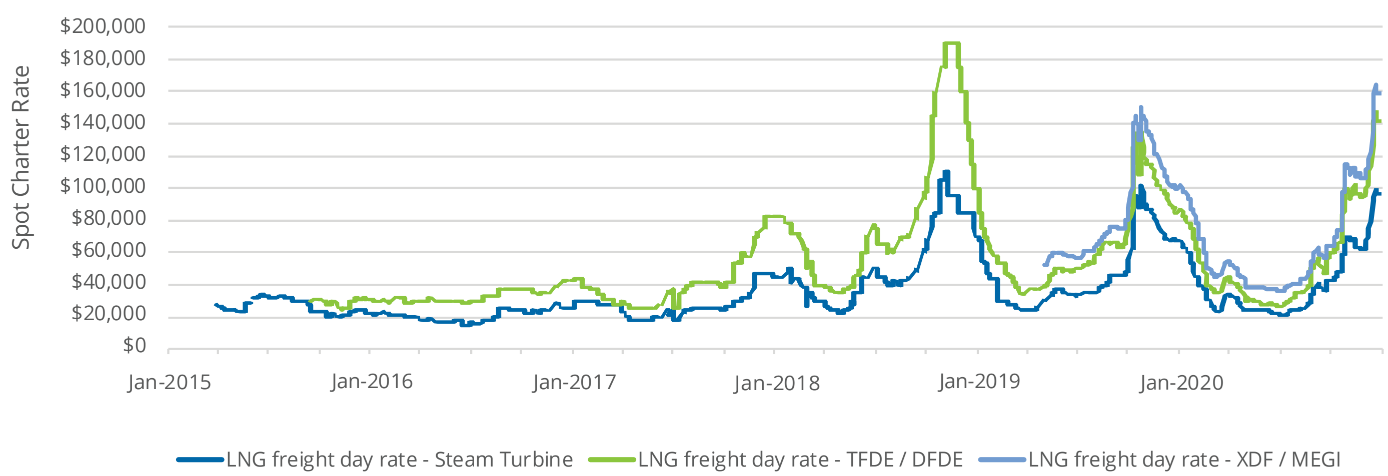
Figure 6.9: Liquefaction capacity growth vs LNG global fleet count growth, 2010-2020



Source: Rystad Energy

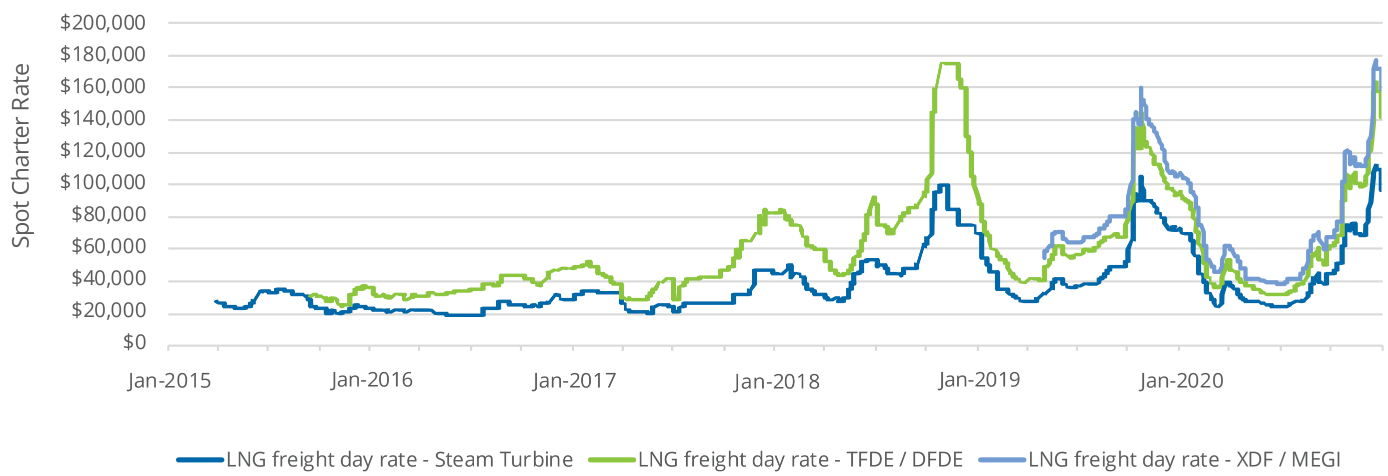
In the early 2010s, fleet growth was well balanced with additional liquefaction coming online, resulting in a stable charter market. However, the rate of vessel deliveries far outweighed that of liquefaction capacity growth from 2013 onwards, resulting in a glut of LNG shipping capacity and a steady decline in charter rates. This continued until 2015, after which they remained between US$15,000 and US$50,000 per 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, 4Q 2018 saw an unprecedented spike in charter prices with TFDE day rates reaching US$190,000 per day for most of November. This was partially attributable to winter storage filling up quickly, leaving vessels off the charter market while they waited to discharge cargo.

Figure 6 .10: Spot charter rates east of Suez, 2015-2020



Source: Rystad Energy research and analysis, Argus Direct

Figure 6.11: Spot charter rates west of Suez, 2015-2020



Source: Rystad Energy, Argus Direct

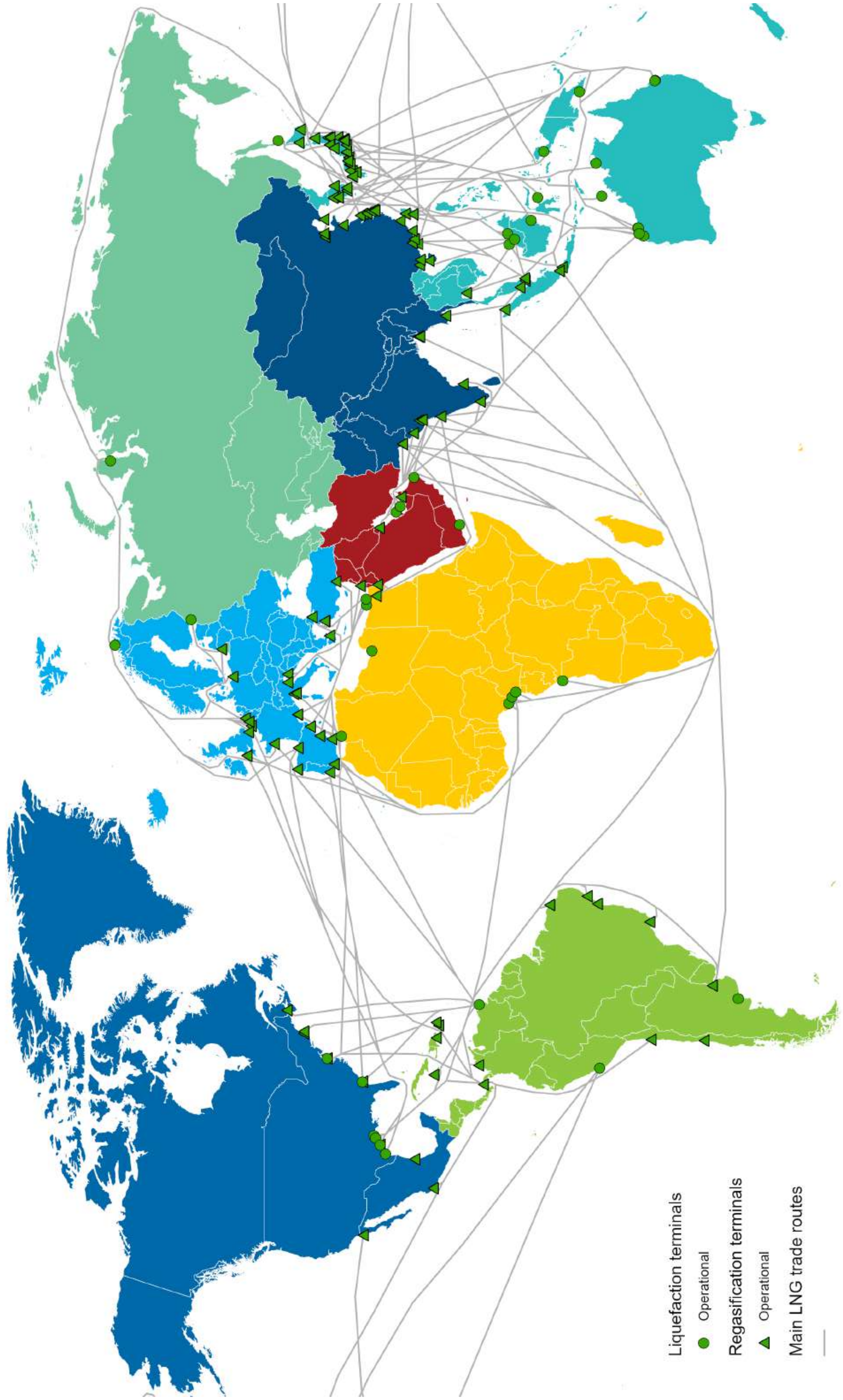
Following the peak in 4Q 2018, rates slowly returned to about US$30,000/day for steam turbine vessels and about US$40,000/ day for TFDE/DFDE vessels in 2Q 2019, following regular seasonal variations till 3Q 2019. In October 2019, US sanctions against Chinese state-owned shipping company COSCO removed many vessels available for charter in both the Atlantic and Pacific basins. Dayrates spiked, hitting a peak of US$105,000 for steam turbine vessels, US$145,000 for TFDE/DFDE vessels and US$160,000 for X-DF/ME-GI vessels, before ticking lower into 2020.

With traders initially uncertain about the effects of COVID-19, spot charter rates started 2020 at about US$70,000 per day for steam turbine, US$90,000 for TFDE and US$105,000 for X-DF/ME-GI vessels. As the virus started to substantially impact demand, 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, pushing dayrates down to a range of around US$20,000 for steam turbine, US$30,000 for TFDE and US$40,000 for X-DF/ME-GI vessels from May to August 2020. These depressed charter rates incentivised the use of LNG vessels as floating storage throughout the year – and it is worth noting that shipowners were operating at a financial loss at such charter rates.

A tighter supply/demand balance from mid-August led to rates climbing steadily towards December as the price differential between the Pacific and Atlantic basin increased. This is 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 in December, charter dayrates soon followed, shifting upwards and concluding the year at about US$105,000 for steam turbine, US$150,000 for TFDE and US$165,000 for X-DF/ME-GI vessels.

[4] Floating LNG storage in this context refers to short-term slow steaming of vessels to maximize trading positions.



Source: Rystad Energy

Figure 6.12: Major LNG Shipping Routes, 2020

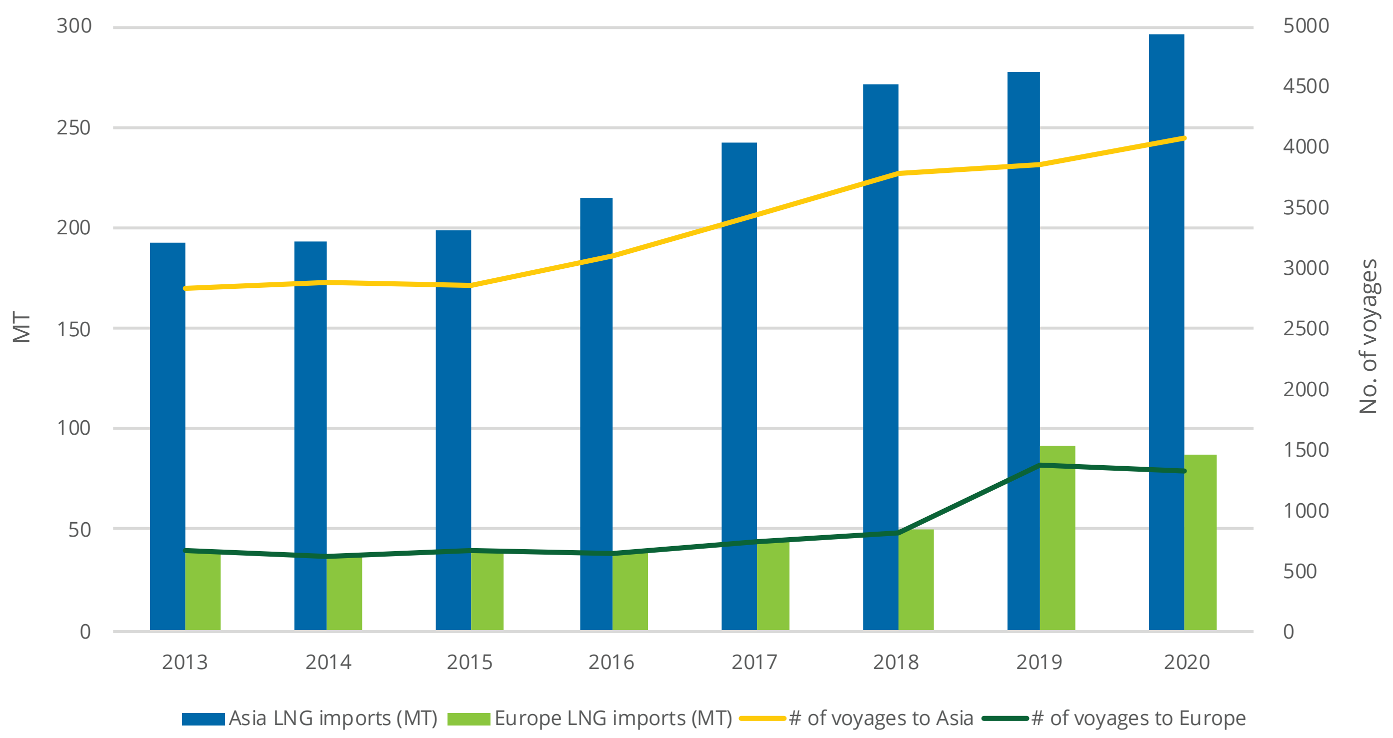
6.7 FLEET VOYAGES AND VESSEL UTILISATION

5,757 LNG Trade Voyages
in 2020

Despite additional liquefaction capacity, 2020 was characterised by limited growth in the number of voyages and vessel utilisation, although the market was slightly helped by floating storage capacity[4]. A total of 5,757 LNG trade voyages were undertaken in 2020, up 1% from 2019, contrasted with a 5% growth in liquefaction capacity. This minimal growth was the result of COVID-19's impact on demand alongside a mild winter in the beginning of the year.

Characteristically, LNG carriers at sea reduced speed and then increased the amount of LNG afloat compared with the total storage capacity on shore in a kind of floating storage as a short-term bridge before winter to meet larger end-of-year demand last year. High charter rates and boil-off gas have normally made storing LNG earlier in the year or for longer periods uneconomical. Last year, however, 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. This dampened the effect that demand destruction otherwise would have had on vessel utilisation in 2020.

Figure 6.12: LNG imports and number of voyages to Asia and Europe, 2013-2020



Source: Rystad Energy, Refinitiv

Before 2020, the number of LNG trade voyages both to Europe and Asia trended upwards, with increasing liquefaction and vessel deliveries. In addition, 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 past the Panama Canal, compared to 14,500 nm and 45 days through the Suez Canal and close to 16,000 nm and 49 days via the Cape of Good Hope. However, due to the popularity of this route, the Panama Canal has become a bottleneck for this voyage, with some vessels in 2020 even changing course due to long waiting periods.

There were 4,067 voyages to Asia this year, a 6% increase from 2019 attributable to an absorption of excess supply by East and South Asian markets. In contrast, the number of voyages with European destinations fell by 4%, attributable to COVID-19 related demand impact alongside increased pipeline imports from Russia and Norway. Europe also faced a milder winter compared to Asia, contributing to less relative demand as netback pricing pulled cargos towards East and South Asia.

The most common voyage globally in 2020 was from Australia to Japan, with 427 voyages. The most common voyage to Europe in 2020 was from Qatar to Italy, with 74 shipments. Japan, China and South Korea took the highest number of cargos globally, receiving 1357, 971 and 566 vessels, respectively. The average number of voyages completed per vessel was 10.1 in 2020, a slight decline from the 2019 level of 10.5. The voyage time averaged at 13.7 days in 2020, increasing slightly from 2019 due to additional floating storage trades.

6.8 NEAR-TERM SHIPPING DEVELOPMENTS

Shipping companies attempt to get fully aligned with present and future environmental requirements, reduce emissions and be fuel efficient. Among the ship's emissions the topic that has been under most scrutiny recently has been pollution to the air. Public opinion, and therefore being seen as environmentally sustainable, has become more and more relevant for the stakeholders around ship-owners including investors, financiers, insurance companies, etc., and emissions to the air are possibly the most important factor considered currently by the whole industry.

The maritime industry as a whole is led by the IMO in terms of regulatory framework, and they also cover air pollution regulations. The organization has already implemented regulations to reduce SOx and NOx in the short-term. The IMO sulphur cap (0.5% maximum content) from January 2020 has not been a major issue for ship-owners and the majority have chosen to comply, use low sulphur oil fuels, use HFO with scrubbers or switch to LNG fuel. But the shipping sector is now facing new challenges in terms of energy efficiency.

Although fuel efficiency was already addressed by the IMO by means of the EEDI (Energy Efficiency Design Index) for new ships since 2013, a further reduction of CO_2 emissions by 2030 and 2050 is considered. This regulatory framework will include specific measures covering new and existing ships and is currently under discussion at the IMO Marine Environment Protection Committee (MEPC).

The mid-to-long term strategy of the IMO for further reduction of CO_2 emissions from ships, and the new regulations to address energy efficiency index for existing ships, are under the so called Energy Efficiency Existing Ship (EEXI) and the Carbon Intensity Index, known as CII. The vision of the IMO has encompassed a reduction in sulphur content in fuels globally and regionally, lower lever of NOx emissions, also regionally, and long term carbon dioxide emission reductions compared to 2008 levels by 2050.

Shipowners are facing additional challenges to be able to comply with these expected CO_2 emission reductions as the existing fleet age is more than 10 years, and technologies have evolved significantly in the last few years. More specifically, from January 2023, all ships above 400 GT will have to provide a calculation file to the flag administrations and recognized organizations, such as class societies. These organizations will have to assess the calculation and issue a new certification of compliance with a required level of energy efficiency (required EEXI).

LNG carriers are generally using the Boil Off Gas (BOG) as fuel for energy production on board and to propel the ship. It is also well known that LNG fuel can reduce CO_2 emissions up to 25%, depending on the technology used on board, which is a good way to be compliant regarding carbon emissions. Nevertheless, steam turbine propelled ships, mainly built before 2014, still make up approximately one third of the LNG carrier fleet, and these have a significant gap in terms of efficiency compared to more modern DFDE/TFDE and DF 2-stroke designs.

From a technology point of view one of the main alternatives to comply with the new EEXI & CII IMO regulations is the limitation of ship's power for propulsion, which is the main fuel consumer on board. However, LNG carriers have other operational issues, mainly in terms of pressure and temperature control of the cargo tanks (BOG handling), which makes these ships very specific in terms of fuel utilization. The vast majority of ships older than 5 years are not equipped with re-liquefaction or subcooling systems.

The industry has realised that the reduction of propulsion power will obviously lead to a reduced fleet speed, which may impact the LNG supply chain if no other steps are taken. This could new supply-demand dynamics.

Despite the fact around 60 steam turbine ships will be older than 25 years by 2023, scrapping may not be an option (as opposed to speed limitation or retrofitting) to further reduce the CO_2 emissions, since the LNG transportation segment will still need the volumes to be delivered to import terminals.

A big effort has been made in the LNG carrier industry in recent years and the transition to highly efficient DF 2-stroke engine, containment systems with low BOG rate and re-liquefaction or subcooling systems is helping owners to be fully flexible, satisfy charterers' requirements and perform well in terms of fuel efficiency and BOG handling. However, there are still few vessels delivered with these modern designs since 2016.

The challenges with regards to EEXI and CII are of course to be considered by the entire shipping community, and owners are presently assessing their fleet to ensure ships will be compliant from 2023. Although other future bunker fuels are being proposed, LNG will play a significant role as a marine fuel and transition fuel to cleaner energies, and could also be used for the production of methanol or ammonia using renewable energy.

Other specific developments in the LNG industry involving floating concepts, is the deployment of additional gas to power projects, utilising LNG. The FSRU industry is mature but is evolving rapidly as the proposed concepts could be a combination of storage, regasification and power generation, all in one, or by means of separated floaters. Today FSRUs are typically LNG carriers that carry the necessary certification for international transportation of LNG, but more and more projects involving conversions of old LNG carriers into FSU and FSRU are being developed. Two of the latest projects, both very novel, are the Gasfin FRU/FSU in Tema port, Ghana and the Jawa Satu FSRU, delivered respectively by Jiangnan and SHI shipyards at the end of 2020 and expected to enter in operation in 2021. The Gasfin FRU/FSU is the first ever project to combine an FRU and FSU globally. The FRU is a newly constructed, non-propelled barge type, and the FSU is the LNG carrier "LNG Flora" that is still being converted into an FSU in Singapore. The Jawa Satu FSRU is the first newbuild LNG carrier-FSRU specifically designed for a long term LNG import project. This means that although the unit has propulsion and ship shape the design is really around the concept of a permanent floating import terminal.

Prism Agility - Courtesy of SK E&S

7 LNG Receiving Terminals

19 MTPA of receiving capacity was added in 2020.

+4 new terminals in 2020

+4 expansion projects at existing terminals

850.1 MTPA of global regasification capacity as of February 2021

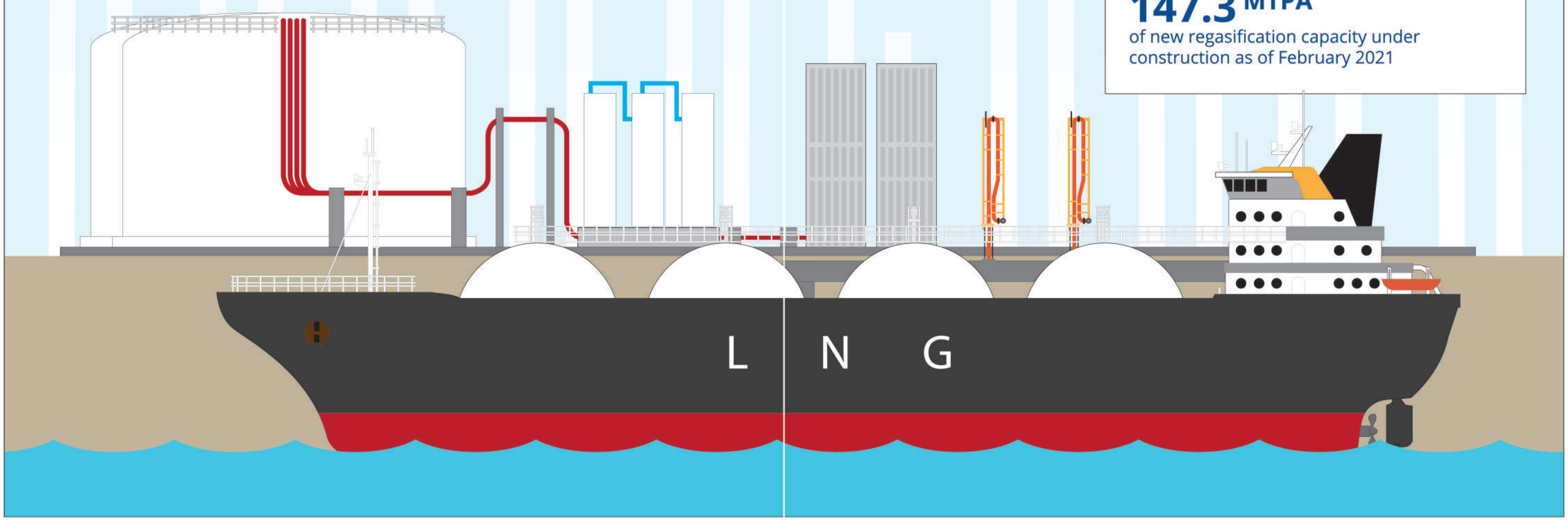
China and Chinese Taipei expanded existing LNG plants

Growth in **2020**

Was primarily driven by existing LNG markets: **China, India, Chinese Taipei, the USA (Puerto Rico) and Brazil**

2 new FSRUs **Brazil and Croatia**

147.3 MTPA of new regasification capacity under construction as of February 2021



7. LNG Receiving Terminals

As of February 2021, global LNG regasification capacity reached a high of 850.1 MTPA. Supported by a strong appetite for natural gas, LNG receiving capacity has continued to grow. Expansion in import capacity was primarily driven by existing LNG markets including China, India, Chinese Taipei, the United States (Puerto Rico), and Brazil. New import markets emerged for the first time since 2018[1] with Myanmar adding their first regasification terminal in 2020 and Croatia in early 2021.

In 2020, four new terminals and four expansion projects at existing terminals were completed, amounting to a 19.0 MTPA increase in global regasification capacity. Most additions in global receiving terminal capacity in 2020 came from the Asia and Asia Pacific markets, where India and Myanmar each added a new terminal, affirming the regions' stand-out growth. Notably, floating regasification terminals are on the rise as well through the commissioning of two new terminals in Brazil and Croatia in late 2020 and early 2021, respectively. Additionally, projects in the pipeline include the scheduled start-up of two FSRU-based terminals in India as well as another replacement FSRU with a larger receiving capacity in Pakistan. China was anticipated to pose strong growth momentum in 2020. It successfully expanded three existing terminals by year-end but saw at least five LNG projects with scheduled start-ups in 2020 delayed until 2021. The slippage in construction was, to a large degree, a direct impact of the COVID-19 outbreak which caused worldwide supply chain restrictions and delays in material and component delivery.

Established import markets are expected to drive most near-term regasification capacity additions. This is particularly the case in Asia, where there is a strong pipeline of under construction regasification projects in China and India to support strong gas demand. Many new LNG importers are also expected to significantly contribute to regasification capacity growth in the near future, including Ghana, El Salvador, Cyprus, and Nicaragua. All these markets are in advanced stages of constructing their first LNG import terminals, which are all scheduled to come online within the next two years. Several other new markets have planned additional regasification capacity, including Cote D'Ivoire, Morocco, and Germany. However, many of these markets have experienced delays in project development due to various challenges such as securing financing and navigating regulations related to infrastructure development. Despite these challenges, the global LNG market is expected to continue to see the addition of one or two new LNG importers each year on the back of growing LNG-to-power developments.

Incheon LNG Terminal - Courtesy of KOGAS

[1] Excludes Russia's Kaliningrad and Bahrain's LNG receiving terminals which have yet to reach commercial start-up after being commissioned in Jan-19 and Apr-20, respectively. Kaliningrad's FSRU and Bahrain's FSU were redeployed as LNG carriers under short-term charters in 2020.

7.1 OVERVIEW

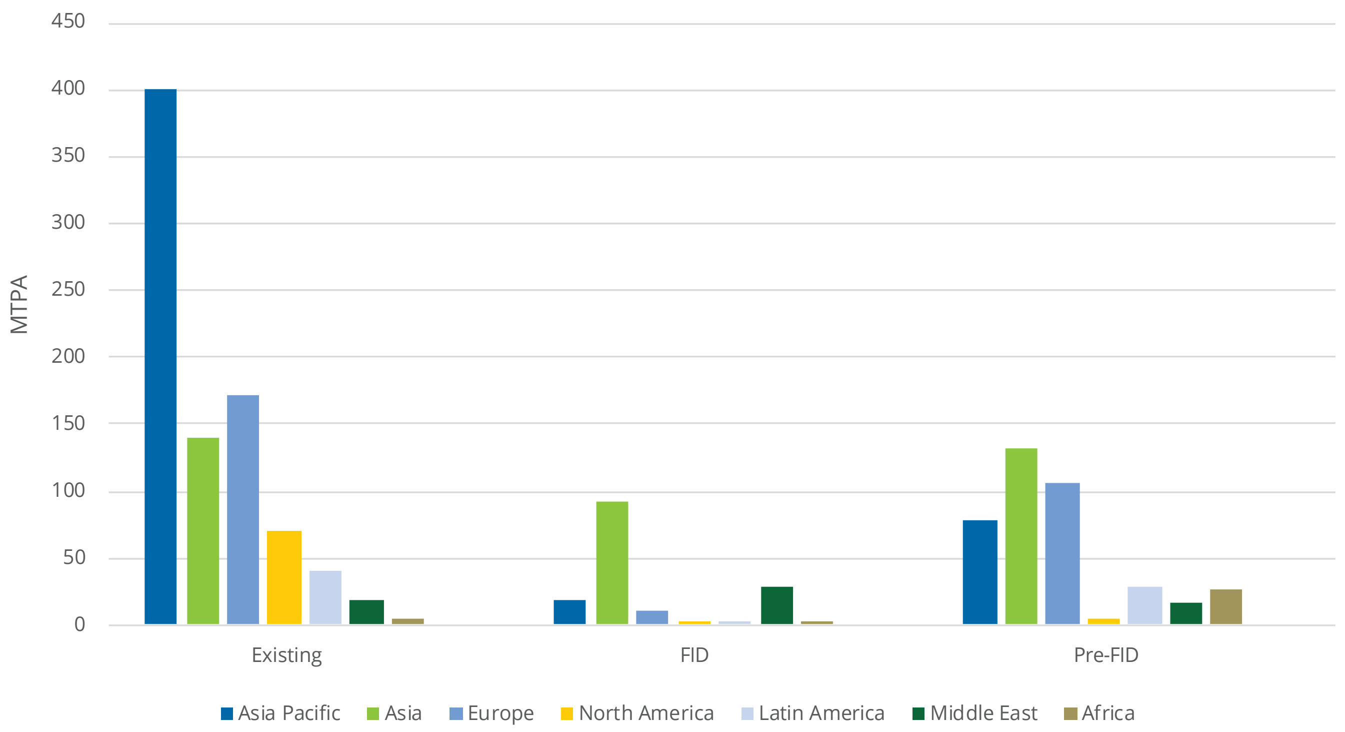
850.1 MTPA

Global LNG Regasification Capacity as of Feb 2021

As of February 2021, global LNG regasification capacity was 850.1 MTPA across 39 markets[2]. 19.0 MTPA of receiving capacity was added in 2020 with the commissioning of four new import terminals and the completion of four expansion projects at existing terminals, with the greatest addition of 5.6 MTPA from a new floating terminal in Brazil. Among existing LNG markets, three terminals were built in Brazil, India, and the United States (Puerto Rico), while China and Chinese Taipei contributed to additional growth in regasification and storage capacity by expanding four existing terminals. 2020 marked the debut of the first LNG import terminal in Myanmar. 5.6 MTPA of floating regasification capacity was added when Brazil's latest LNG import facility at the Acu Port entered service in late 2020[3]. 2020 saw a reversal versus 2019, when floating regasification projects added slightly more capacity than onshore regasification facilities. Notably, the majority of new markets, such as Croatia and Ghana (currently under construction), have shown a predisposition to utilise floating-based solutions through the charter of an FSRU or FSU as their first LNG regasification terminals.

The Asia and Asia Pacific[4] regions currently account for the largest share of operational LNG regasification capacity globally and are anticipated to continue to grow through capacity expansions at both existing and new markets (Figure 6.1). The expansion of regasification capacity in North America has been limited as domestic gas production has accelerated in recent years. In addition to Sabine Pass and Cove Point, which have been operating notionally as bi-directional import/export facilities, several other North American import terminals have been or are currently being converted to liquefaction export facilities, including Elba Island, Freeport, Cameron and Golden Pass. FSRUs have continued to play an important role in equipping new markets with regasification capacity. Following the addition of its first floating regasification terminal in 2018, Bangladesh successfully expanded its capacity by commissioning another FSRU project in 2019. Brazil witnessed the addition of a new offshore terminal in December 2020 when it received its commissioning cargo. In early 2021, Croatia imported its first series of commercial LNG cargoes through an FSRU deployed at the Krk terminal, the market's first LNG import facility. FSRUs have proven to be a quick approach for new markets to access global LNG trade subject to the availability of pipeline and offloading capabilities. On the other hand, established LNG importers, such as China and South Korea, have expanded regasification capacities through the construction of onshore terminals, a stable long-term solution that allows for future storage expansion.

Figure 7.1: LNG regasification capacity by status and region, as of February 2021



Source: Rystad Energy

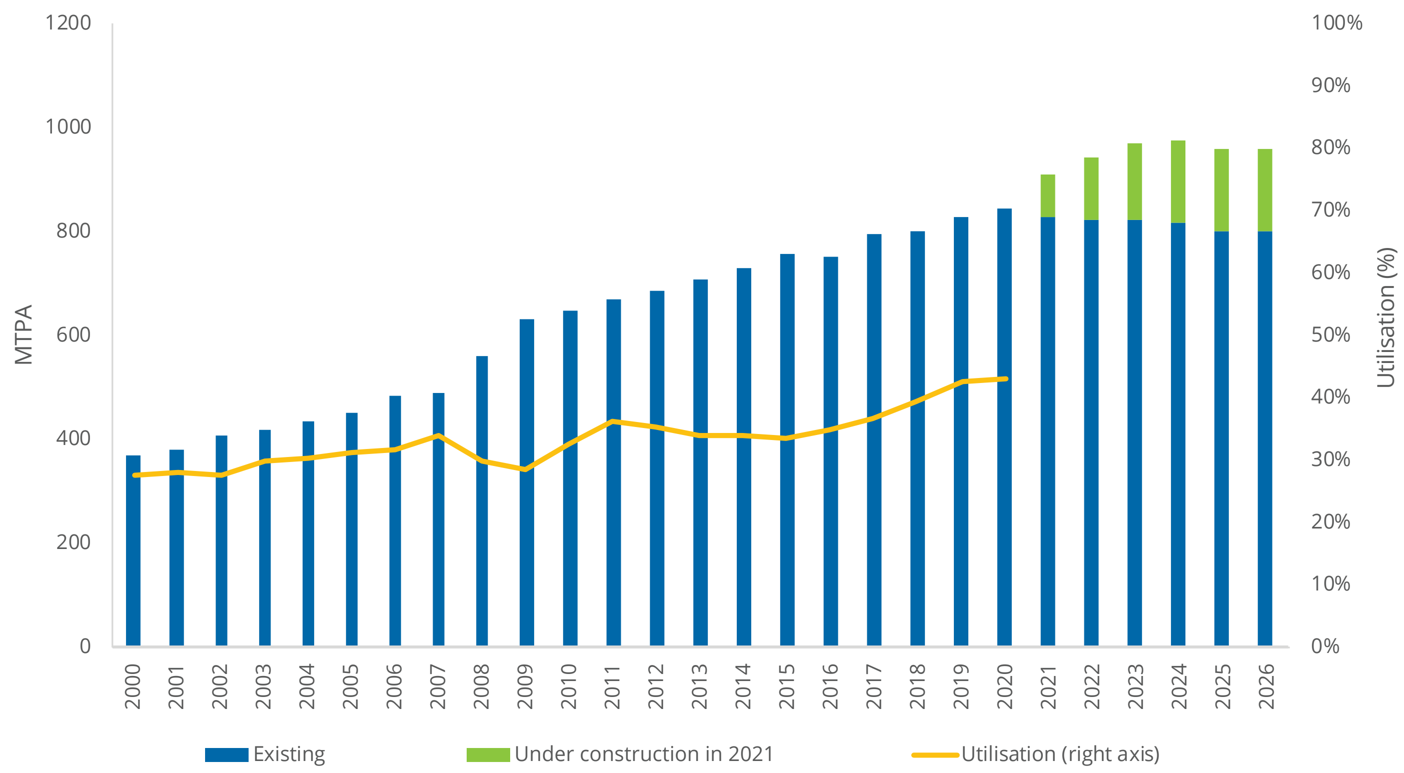
[2] The total number of markets excludes those with only small-scale (<0.5 MTPA) regasification capacity such as Finland, Malta, Norway, and Sweden. It includes markets with large regasification capacity that only consume domestically produced cargoes, such as Indonesia.
[3] Commercial operations of the Sergipe power project in Brazil also commenced in first quarter of 2020. The chartered FSRU Golar Nanook has been hooked-up and commissioned since the loading of its first LNG cargo from FLNG Hili Episeyo in early 2019. Sergipe – Golar Nanook FSRU is excluded from list of new builds in 2020 as it is accounted for in 2019 as per its year of commissioning.
[4] Please refer to Chapter 10: References for an exact definition of each region.

7.2 RECEIVING TERMINAL CAPACITY AND GLOBAL UTILISATION

In 2020, 19.0 MTPA of net regasification capacity was added globally. Capacity additions were 19% lower in 2020 compared to 23.4 MTPA in the previous year. Notably, at the beginning of 2020, 47.1 MTPA of global import capacity was set to be commissioned by end of the year. The shortfall between actual and expected capacity additions was, among other factors, driven by COVID-19 induced disruptions to construction schedules. More than a handful of terminals located in India and China were forced to postpone start up to 2021. Despite delays in terminal start-ups, net capacity addition in 2020 was still on par with the average net addition in the last five years. The number of global LNG importers has expanded in the past decade, adding one or two new markets in most years. This was no exception in 2020, when one new market – Myanmar (onshore) – joined the group of LNG importers. Another new market – Croatia – commissioned its first LNG import terminal through the deployment of an FSRU in early 2021. Notably, FSRUs are serving an increasingly important role in enabling new importers to access LNG supply quicker, as seen in Egypt in 2015 and Bangladesh in 2018, and with several new floating terminals now under construction in new markets.

Four new regasification terminals came online in 2020, representing 12.6 MTPA of regasification capacity. Three of these terminals are onshore regasification facilities commissioned in Asia and North America, with one in India (Mundra), Myanmar (Thanlyin), as well as in the United States (San Juan). As part of an LNG-to-power project to supplement electricity during the summer months and tackle power shortages, the Thanlyin import terminal entered full operations in late 2020. Offloaded LNG at the terminal is expected to be regasified and used as fuel for generators in the Thilawa and Thaketa regions. This follows the arrival of its 126,000 cubic-meter FSU and construction being completed of the onshore regasification facility and permanent jetty where the FSU is moored. Due to the shallowness of the Yangon river, a second FSU is moored outside the mouth of the river while another LNG tanker shuttles LNG cargoes between the two FSUs. Limited import and power generation at Thaketa site commenced in mid-2020 by using a temporary jetty at the Thilawa port designed for smaller vessels. One floating-based regasification terminal entered service in late 2020. Brazil's Acu Port received its first commercial cargo in late 2020, following the arrival of its deployed FSRU BW Magna a few months prior. LNG cargoes will be supplied to the soon-to-be operational GNA-1 thermoelectric plant in the vicinity. Commercial operations of the Sergipe power project in Brazil also commenced in the first quarter of 2020. The chartered FSRU Golar Nanook has been hooked-up to the power station and commissioned since the loading of its first LNG cargo from FLNG Hili Episeyo in early 2019.[5]

Figure 7.2: Global receiving terminal capacity, 2000-2026[6]



Source: Rystad Energy

[5] Sergipe – Golar Nanook FSRU is excluded from list of new builds in 2020 as it is accounted for in 2019 as per its year of commissioning.
[6] The above forecast only includes projects sanctioned as of February 2021. Regasification utilisation figures are calculated using regasification capacity prorated based on terminal start dates. Owing to short construction timelines for regasification terminals, additional projects that have not yet been sanctioned may still come online in the forecast period. Capacity declines over the forecast period as FSRU charters conclude, although new charters may be signed during this time.

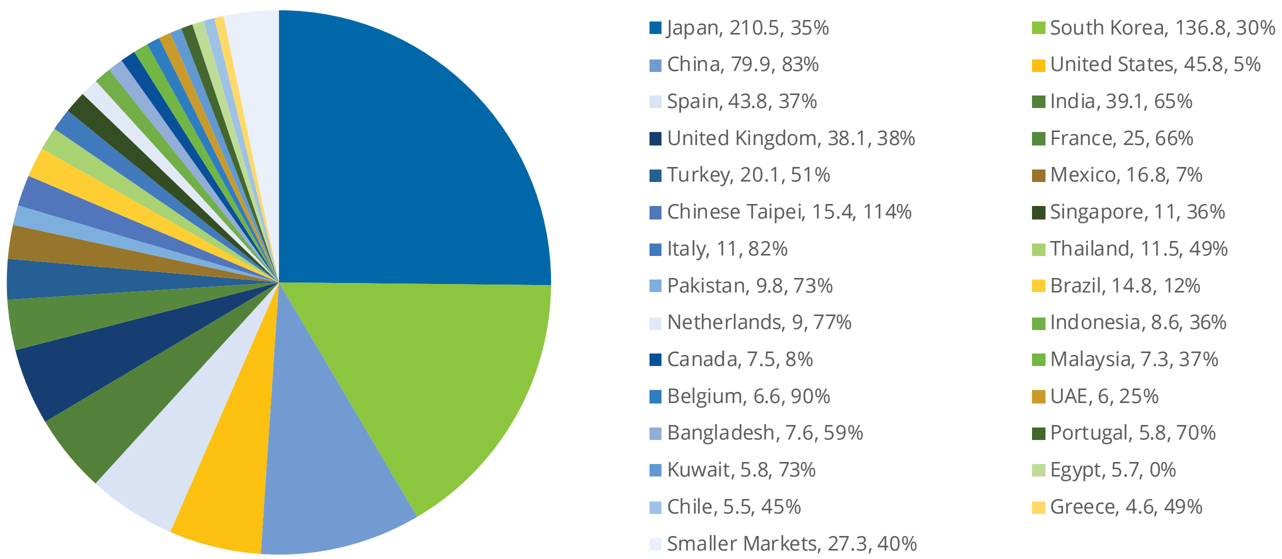
Four expansion projects were completed at existing regasification terminals in 2020. Chinese Taipei completed its expansion project at the Taichung terminal, which saw the addition of 1.5 MTPA of regasification capacity and three additional storage tanks. Over the second half of 2020, China successfully put three newly expanded terminals into operation at Qidong, Zhejiang Ningbo and Shanghai (Yangshan), adding 4.9 MTPA of regasification capacity in total. Combining the 12.6 MTPA added via new terminals and the 6.4 MTPA added through expansion projects, total regasification capacity added globally in 2020 reached 19.0 MTPA.

One new terminal came online in January 2021, adding 1.9 MTPA at Croatia's Krk facility. As of February 2021, 147.3 MTPA of new regasification capacity is under construction. This includes 19 new onshore terminals, 10 FSRUs, and eight expansion projects at existing receiving terminals . Over 70% 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 in the lead. China has nine new onshore terminals under construction in addition to five expansion projects at existing terminals. India, on the other hand, is set to experience a rapid ramp-up of LNG terminals as it is building five new terminals and one expansion project at an onshore terminal. India is showing strong appetite for floating terminals. Currently, all existing terminals are onshore, but three of the five new terminals under construction are FSRUs and are set to come online in early 2021. Seven new markets without existing regasification capacity are eyeing first LNG imports over the next five years as the construction of debut LNG terminals is underway. This includes markets such as Ghana, El Salvador, Nicaragua, Cyprus, Vietnam, and the Philippines. In July 2020, Cyprus' first terminal officially started construction with a ground-breaking ceremony at Vassilikos. It is expected to be operational by the end of 2022. This follows the contract award to a Chinese consortium for the construction of Cyprus' first LNG regasification terminal. Through the construction of four floating and three onshore terminals, these seven new markets will add 11.2 MTPA of regasification capacity to the global LNG market. Additional terminal construction and regasification capacity expansion projects in existing markets are underway in Chinese Taipei, Indonesia, Japan, Kuwait, Mexico, Pakistan, Poland, Thailand, and Turkey. In February 2020, India's Karaikal terminal held a ground-breaking ceremony, and it is set to commission the terminal by the end of 2021.

Average regasification utilisation levels across global LNG markets in 2020 remained unchanged at 43% when compared to 2019. Natural gas demand has grown proportionately to the expansion in regasification capacity in 2020, maintaining average global regasification utilisation rates at similar levels as a year earlier. Regasification terminal capacity generally exceeds liquefaction capacity to meet peak seasonal demand and ensure sufficient supply. On a monthly basis, utilisation rates across global regasification terminals fluctuated, reaching the highest utilisation during the peak period between November to January. The cyclical fluctuation in utilisation rates is likely a result of seasonality in LNG demand, as well as the geographical distribution of LNG importers, since winter months in the Northern Hemisphere drive the greatest demand for LNG regasification.

7.3 RECEIVING TERMINAL CAPACITY AND UTILISATION BY MARKET

Figure 7.3: LNG regasification capacity by market (MTPA) and annual regasification utilisation, 2020[8]



Source: Rystad Energy

[7] Excludes Russia's Kaliningrad and Bahrain's LNG receiving terminals which have yet to reach commercial start-up after being commissioned in Jan-19 and Apr-20, respectively. Kaliningrad's FSRU and Bahrain's FSU were redeployed as LNG carriers under short-term charters in 2020.

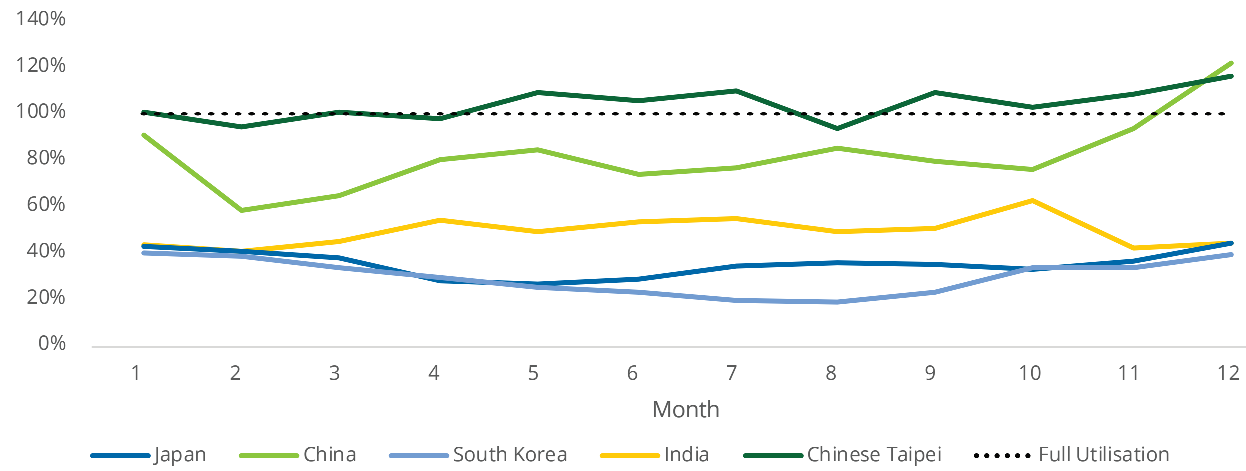
[8] "Smaller Markets" includes (in order of size): Jordan, Argentina, Poland, Jamaica, Lithuania, Colombia, Israel, Ghana, Dominican Republic, Panama, Myanmar. Regasification utilisation figures are based on 2020 trade data and prorated regasification capacity based on terminal start dates in 2020. Prorated capacity in 2020 is displayed in this graph.

As of February 2021, Japan had the highest global regasification capacity with 210.5 MTPA, representing 25% of global capacity. While Japan has not added new regasification capacity since 2018, it has plans to expand importing abilities through new terminals and expansion projects. The new 0.5 MTPA Niihama receiving terminal on the northern coast of Shikoku in Western Japan is scheduled for operation in February 2022. By year-end 2020, Japan's regasification utilisation dipped slightly to 35% down from 36% in 2019.

With six existing import terminals contributing 136.8 MTPA of regasification capacity to the global LNG market, South Korea retained its position as the second-largest market by capacity in 2020. However, its place as the second-largest importer was overtaken by China in 2017. Natural gas anticipated to continue to play an essential role in power generation to sustain the security of supply and fulfil growing energy demand in South Korea, calling upon additional LNG import. Based on the 9th Basic Energy Plan for Long-term Electricity Supply and Demand published in May 2020, more coal-fired power plants will be phased out in South Korea in favour of gas and renewables sources. While South Korea does not have any terminals under construction currently, a handful of projects have been proposed which could expand regasification capacity gradually over the next decade. South Korea's utilisation rate has stayed almost unchanged since 2019, standing at 30%.

With continuous and consistent clean energy policies aimed at improving air quality and reducing emissions, China is expected to see an increase in natural gas consumption in the industrial, residential, power and transportation sectors, in part driven by coal-to-gas switching. China has experienced very rapid growth in terms of regasification capacity among global LNG importers. Since China overtook South Korea as the second-largest LNG importer in 2017, it has expanded its total LNG receiving capacity from 48.3 MTPA before 2017 to 83.9 MTPA by end-2020. This expansion involved the commissioning of eleven new-builds and five expanded LNG import terminals between 2017 and 2020, adding a total of 35.6 MTPA of import capacity. In 2020, expansion projects were successfully completed at three existing regasification terminals – Qidong, Zhejiang Ningbo and Shanghai (Yangshan), accounting for 4.9 MTPA of capacity combined. With nine new onshore terminals under construction and five existing terminals undergoing expansion, China is anticipated to add another 56.0 MTPA of regasification capacity over the next few years through 2024. Once these projects that are under construction come online, China will have expanded its regasification capacity by more than 70%. At least five of these projects, including both new terminal construction and expansion plans at existing terminals, were originally expected to be completed in 2020. However, the commissioning of these terminals was pushed back to 2021, in part due to COVID-19 disruption to construction schedules and financial difficulties experienced by Chinese companies. China is anticipated to experience strong regasification capacity growth in the near term and close in on the gap with South Korea and Japan. In 2020, China's regasification utilisation was at a record 83%, up by over 7% from 2019 utilisation numbers. Despite lockdown measures, China's increasing appetite for natural gas outstripped its rate of regasification capacity expansion. Peak season utilisation rates at China's import terminals have consistently exceeded nameplate regasification capacities in recent years, with the highest average utilisation rate observed at 113% in December 2020. COVID-19 induced delays to China's capacity expansion projects have contributed to additional tightness in its import value chain. Moreover, there is a need to ensure that newly built terminals are sufficiently connected to the local grid to support send-outs. As a temporary measure, some LNG buyers have started trucking LNG from regasification terminals to key demand centres, as they wait for infrastructure to be built or become accessible. However, while LNG demand in China is set to rise on the back of strong governmental support for increased consumption of the relatively cleaner fuel, LNG imports may fluctuate in response to economic conditions, coal use, pipeline imports and domestic gas production.

Figure 7.4: Monthly 2020 regasification utilisation by top five LNG importers

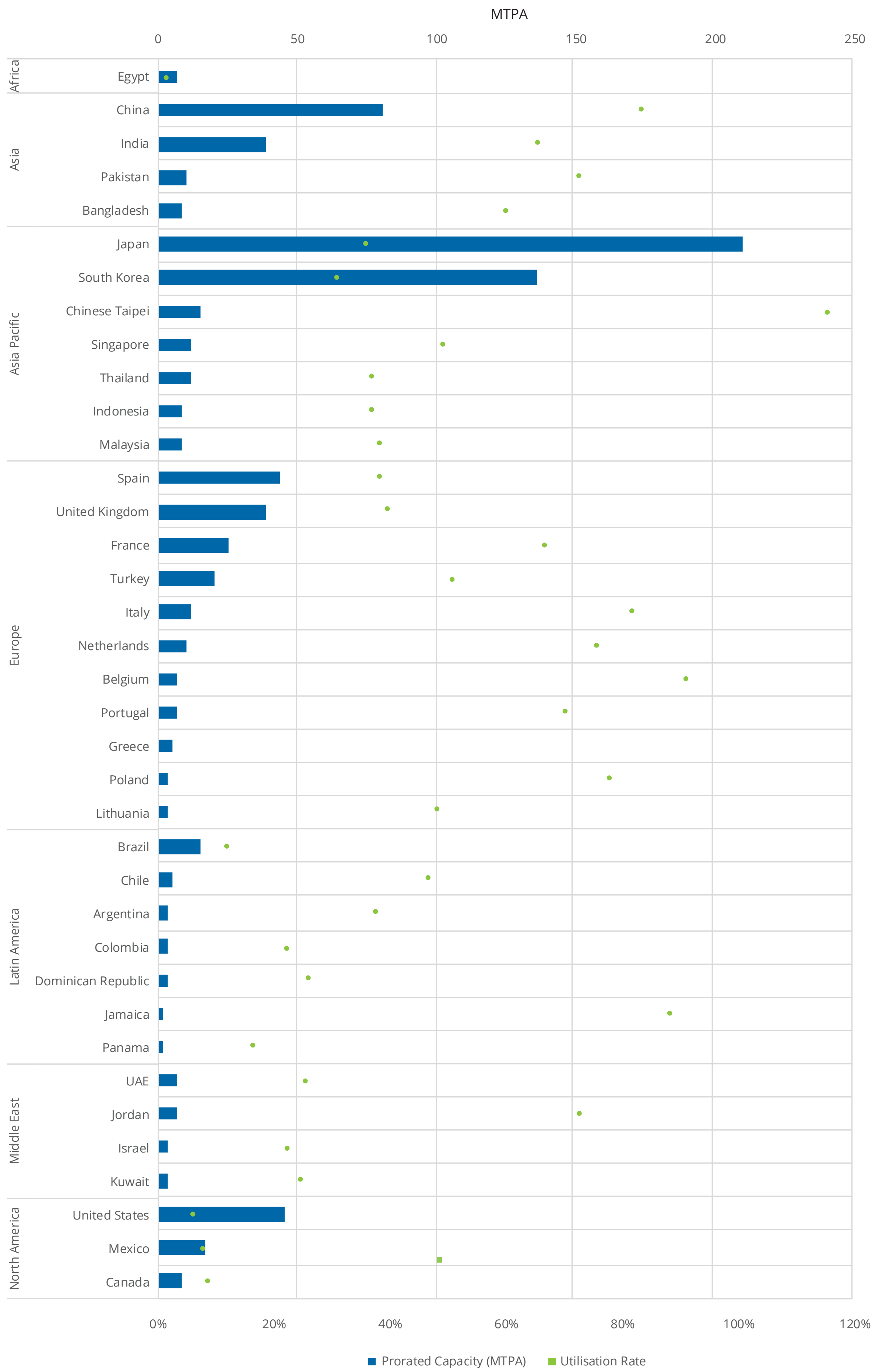


Source: Rystad Energy, Thomson Reuters Eikon

As the world's fourth-largest importer, India has experienced exceptionally strong growth over the past decade, increasing its import capacity by more than 150%. Despite contributing only 39.5 MTPA of total regasification capacity by the end of 2020, India has another 27 MTPA of import capacity under construction as of February 2021. As of February 2021, India has a total of six operational import terminals. Only one LNG import terminal (Mundra) was commissioned in 2020, adding 5.0 MTPA of receiving capacity. India intended to commission its first FSRU-based terminal in 2020 but several factors including COVID-19 induced short-term financial strains and harsh weather conditions have contributed to slippages in construction schedules. Both the 6.0 MPTA Jaigarh and 5.0 MTPA Jafrabad terminals have postponed commissioning to early 2021. Jafrabad has already received its FSRU, which is temporarily operating as an LNG carrier while waiting for the completion of the terminal construction. Jaigarh's FSRU is scheduled for delivery in the first quarter of 2021. In February 2020, a ground-breaking ceremony marking the start of construction was held at the Karaikal terminal, with a planned start-up for the fourth quarter of 2021. India's utilisation rate remained relatively flat at 65%, a slight dip from 67% in 2019. This reflects the availability of spare capacity to support growth in India's LNG demand, which is expected to increase significantly due to increased gas demand in city gas distribution.

Despite a relatively low import capacity of 15.5 MTPA as of the February 2021, Chinese Taipei is among the top 15 importers of LNG globally, in part driven by its clean energy plan, targeting to phase out coal and nuclear in electricity generation. In fact, it has registered the highest annual regasification utilisation rate globally in 2020, reaching a high of 116%. Both its operational terminals were utilised above their nameplate regasification capacities in nine out of 12 months. In 2020, Chinese Taipei successfully expanded its Taichung terminal by 1.5 MTPA. To support further growth in LNG import, Chinese Taipei is also adding capacity through the construction of a third LNG import terminal (Taoyuan), set to come online in 2026, as well as a fourth terminal in Taichung. However, both regasification terminals have faced extensive opposition from environmental groups, causing repeated delays as terminal operators implement mitigation measures to mollify environmental concerns. Chinese Taipei's regasification utilisation rate is likely to remain elevated in the near term.

Figure 7.5: Receiving terminal import capacity and regasification utilisation rate by market in 2020



Source: Rystad Energy

In the past five years, European markets have been slow in adding regasification capacity despite accounting for over a quarter of the total global regasification capacity. In early 2021, Croatia gained access to the global LNG market as a new importer. It began commercial operations following the arrival of the 1.9 MTPA FSRU LNG Croatia at the Krk terminal and completion of successful testing. Apart from Croatia, Tukey was the only other European market that saw capacity addition in the past three years. Following the commissioning of a new 5.4 MTPA regasification terminal (Dortyol FSRU) in 2018, Turkey expanded capacity at the Etki terminal by chartering a larger-capacity 5.7 MTPA FSRU to replace the original unit, expanding the terminal's total send-out capacity by 2.0 MTPA. Turkey's fifth regasification terminal (Gulf of Saros) is currently under construction and is scheduled to be completed within two years by 2022. Similar to Turkey' third and fourth terminals, the Gulf of Saros terminal is also FSRU-based. The FSRU will first be used to supply LNG at the Dortyol import terminal to replace its existing FSRU before being deployed at the Gulf of Saros terminal.

Utilisation rates at European terminals have remained elevated at around 62% in 2020. Despite low utilisation rates in the past five years, European terminals have experienced a surge in LNG import volume since late 2018. European markets have been absorbing LNG supplies from the US and Russia in part due to weaker Asian LNG demand during summer months of 2019 and low prices in Asia. Moreover, Europe's liquid market and slightly higher netback (due to narrowing of the spread between Asian spot and European prices) attracted new LNG supplies to the region. LNG import levels to Europe were slated to see additional growth in 2020 as buyers took advantage of low market prices and substituted pipeline imports with LNG in the first half of 2020. While LNG imports to Europe dipped subsequently following the introduction of lockdown measures, 2020 experienced an overall slight increase in LNG import levels, which propped up the utilisation rates at import terminals across the region. Import terminals located in Belgium, Italy, Netherlands, and Poland experienced some of the highest utilisation rates, averaging around 81%. Poland's utilisation rate grew the most by 12 percentage points compared to in 2019. Utilisation rates at regasification terminals are less uniform across European markets, ranging from 37% in Spain to 90% in Belgium. Utilisation rates of regasification facilities at terminals depend on a multitude of factors including total market regasification capacity, infrastructure connectivity, liquidity and tradability of the wholesale gas market, competitiveness of regasification tariffs and attractiveness of the capacity allocation mechanism amongst others. With the largest regasification capacities among European markets, regasification terminals in the UK and Spain have generally seen lower utilisation rates at around 38% and 37% respectively, despite receiving some of the highest volume of LNG cargoes in the region. Given the diversification of service offerings beyond regasification operations, including storage, truck loading and reloading activities, assessments of utilisation should be expanded to account for these offerings as the needs of the LNG market evolves.

The United States is the fourth largest market in terms of total operational regasification capacity. As of February 2021, the seven operational regasification terminals in the United States have a combined import capacity of 45.9 MTPA. However, overall utilisation rates at most terminals have been very low, averaging only 5% in 2020. Close to half of the LNG imported to the United States in 2020 was received by two terminals in Puerto Rico. The Penuelas terminal has experienced high volumes of LNG imports in recent years, reaching 119% utilisation in 2019. However, with the start-up of its second FSRU-based terminal at San Juan in early 2020, tightness in the LNG import value chain has eased considerably as Puerto Rico's overall regasification utilisation rate fell to 60% in 2020. Excluding Puerto Rico's terminals, only a handful of US terminals received LNG cargoes between 2018 and 2020, and these were mostly used as tank cooling supplies at bidirectional facilities, capable of both liquefaction and regasification services. Given the United States' large-scale domestic production of shale and tight gas resources, the market (excluding Puerto Rico) is likely to further reduce LNG imports and prioritise the construction of LNG export over import terminals.

Latin America has seen its regasification capacity double to 39.7 MTPA over the past five years. The region is expected to add another 3.6 MTPA of import capacity through the construction of two new FSRU-based terminals in new markets (El Salvador and Nicaragua). In late 2020, Brazil added another floating terminal at Acu Port, where the chartered FSRU BW Magna arrived in late 2020, following receipt of its commissioning LNG cargo from United States' Cove Point LNG. The Acajutla project in El Salvador, which recently started conversion work on its designated FSRU, is scheduled to be operational by the end of 2021. Nicaragua's FSRU-based terminal is anticipated to be in operation in early 2021 instead of at end of 2020 due to minor delays in permitting and construction.

One interesting LNG import project in the final stages of development is Kuwait's Al Zour terminal. The Al Zour LNG Import terminal project includes the construction of a regasification facility, eight LNG storage tanks with a capacity of 225,000 cubic metres (cm) each, and marine facilities, including two marine jetties and berthing facilities for loading. The project also includes other components, such as 14 HP pumps, boil-off gas (BOG) and flare facilities. Once fully operational, the facility is expected to regasify approximately 22 MTPA of LNG and will have a storage capacity of 1.8 million cm of LNG.

TY LNG Terminal – Courtesy of Kogas

Table 7.1: LNG receiving terminals, 2019-2020

Receiving Capacity	New LNG onshore import terminals	New LNG Offshore terminals	Number of regasification markets
+19.0 MTPA Net growth of global LNG receiving capacity	**+3** Number of new onshore regasification terminals	**+1** Number of new offshore LNG terminals	**+1** Markets with regasification capacity end-2020
Net nameplate regasification capacity grew by 19.0 MTPA from 829.2 MTPA at end-2019 to 848.2 at end-2020 and reached 850.1 by February 2021. Capacity at new terminals reached 12.6 MTPA while expansion projects amounted to 6.4 MTPA.	New onshore terminals were added in India (Mundra), Myanmar (Thanlyin), and United States (San Juan). Four expansion projects at existing onshore terminals were completed in China (Qidong, Zhejiang Ningbo and Shanghai Yangshan) and Chinese Taipei (Taichung). Croatia's Krk terminal entered commercial operations in January 2021.	One offshore terminal came online in Brazil (Acu Port)[9] after receiving its commissioning cargo in late 2020.	The number of markets with regasification capacity increased to 38 by year end-2020[7], following the addition of one new market –Myanmar. This has increased to 39 with the addition of Croatia in early 2021.

7.4 RECEIVING TERMINAL LNG STORAGE CAPACITY

66.6 mmcm
Global Storage Capacity

Regasification terminals with higher receiving capacity are generally equipped with a high volume of storage capacity. With the addition of four new receiving terminals and four expansion projects in 2020, global storage capacity neared 66.6 million cubic meters (mmcm). The average storage capacity for existing terminals in the global market was 419 thousand cubic meters (mcm) in 2020, a slight drop of 11 thousand cubic meters below the average of 2019. Storage capacity has climbed steadily with the construction of new LNG terminals and the increasing pace of expansion at existing facilities.

Similar to the geographical distribution of regasification capacity, over 50% of existing LNG storage capacity is in Japan, South Korea, and China, ranging from 0.01 to 3.36 mmcm in storage capacity per terminal. Markets in Asia and Asia Pacific have the highest share of the global storage capacity, driven by the region's need to secure gas supply and enhance flexibility, among other factors. This is often observed in markets with seasonal demand and, in certain markets, the lack of adequate connectivity to gas infrastructure. In Japan, South Korea, and China, there are limited gas storage options available outside of LNG terminals.

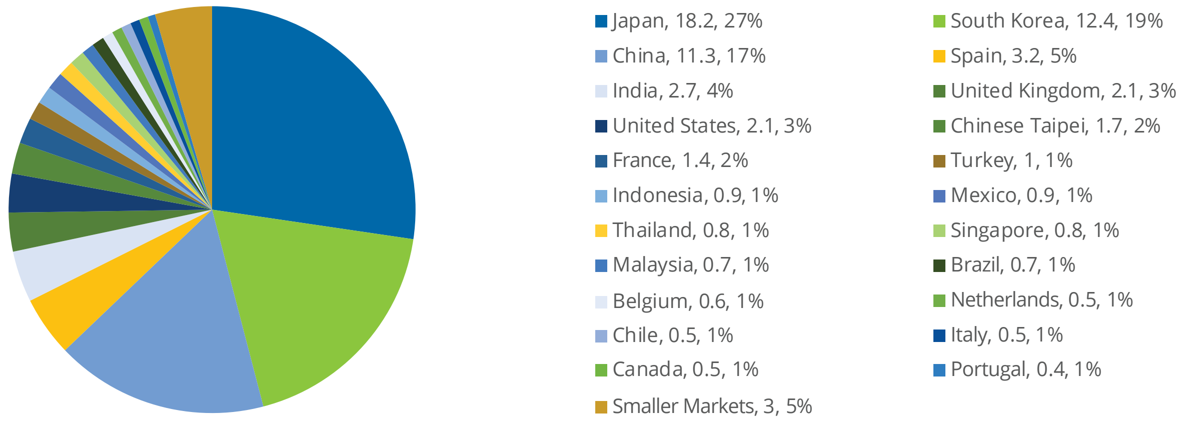
New terminals and project expansions have increased natural gas storage capabilities by 2.17 mmcm in 2020, compared to 1.40 mmcm in additions in 2019. China contributed 48% of this year's storage capacity additions (1.04 mmcm) through the successful completion of three capacity expansions at existing terminals in Qidong, Yangshan (Shanghai), Zhejiang Ningbo. The largest increase in storage capacity (0.48 mmcm) was added at the Taichung terminal in Chinese Taipei and Zhejiang Ningbo terminal in China, each of which constructed three new 160,000 cubic meters LNG storage tanks. India and Myanmar followed, adding 0.32 mmcm and 0.13 mmcm of storage at the Mundra and Thanlyin terminal, respectively. In terms of offshore facilities, the installation of a new FSRU and FSU added 0.17 mmcm and 0.03 mmcm of storage at Brazil's Acu Port and Puerto Rico's San Juan terminal, respectively.

Notably, the development of global storage capacity has shown signs of divergence. In established LNG markets, the construction of new onshore terminals supports the growth of storage capacity through its support for the installation of larger storage tanks as well as further expansion to storage. In newer markets, however, the frequent deployment of FSRUs translates into substantially lower storage capacity per terminal. As of early 2021, the average storage capacity at onshore terminals (0.47 mmcm) is observed to be larger than that of offshore terminals (0.16 mmcm).

2020 has been a key year for the Spanish market with the introduction of the "Tanque Virtual de Balance (TVB)". Pioneered by the Spanish gas system, TVB was launched in April 2020 and has commercially aggregated the LNG storage capacity at the six Spanish operational terminals into a single virtual LNG storage tank. The management of all Spanish storage capacity as a single virtual point is a worldwide reference and promotes the use of infrastructures.

[9] Brazil's Sergipe (Golar Nanook FSRU) is excluded from list of new builds in 2020 as it is accounted for in 2019 when it was hooked-up to the power station and loaded its first LNG cargo. It also excludes Russia's Kaliningrad and Bahrain's terminals which have yet to reach commercial start-up after being commissioned in Jan-19 and Apr-20, respectively. Kaliningrad's FSRU and Bahrain's FSU were redeployed as LNG carriers under short-term charters in 2020.

Figure 7.6: LNG storage tank capacity by market (mmcm) and % of total, 2020[10]



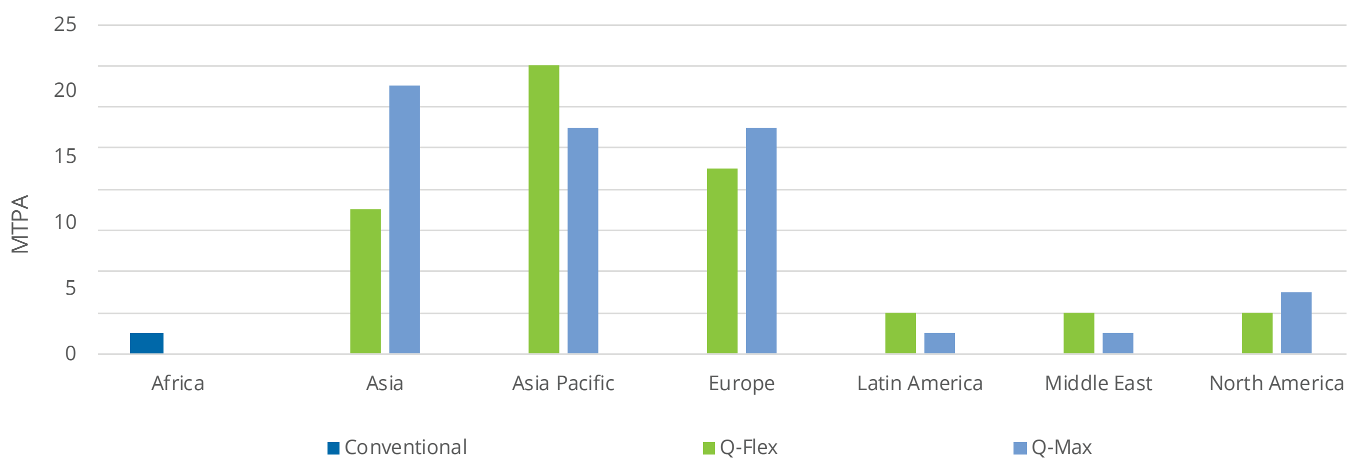
Source: Rystad Energy

7.5 RECEIVING TERMINAL BERTHING CAPACITY

The berthing capacity at a regasification terminal determines the type of LNG carriers it can accommodate. Most regasification terminals are built to handle conventional-sized ships, which are mostly between 125,000 to 175,000 cubic meters in capacity. With the increased utilisation of Q-Class carriers and worldwide expansion in storage capacities in recent years, several high-demand markets are scaling up their maximum berthing capacity at existing and new-built onshore terminals to accommodate a larger variety of vessels. This ranges from Q-Class carriers to small-scale vessels below 10,000 cubic meters. In 2018, Singapore's LNG terminal modified its secondary jetty to accommodate vessels between 2,000 to 10,000 cubic meters on the back of growing small-scale LNG. In new markets, however, FSRU-based, or small-scaled regasification terminals generally have smaller berthing capacities.

As the largest LNG tankers in existence, Q-Flex and Q-Max vessels can carry approximately 210,000 cubic meters and 266,000 cubic meters of LNG respectively, almost 80% more than conventional LNG carriers. As of 2020, 40 operational regasification facilities have the capacity to receive Q-Max vessels. Of these 40 terminals, almost 60% are in the Asia or Asia Pacific regions, while the Middle East and Latin America have one such terminal each. Slightly smaller in capacity, Q-Flex vessels can be berthed at an additional 36 terminals, which are also primarily located in Asia or Asia Pacific regions. The remaining 56 terminals are equipped with sufficient berthing capacity to handle most modern LNG vessels, which are generally below 200,000 cubic meters. Notably, onshore terminals accounted for 85% of terminals capable of handling Q-Flex and Q-Max size vessels. On the other hand, offshore terminals are better equipped to accommodate conventional sized LNG carriers, though around 43% of FSRU-based terminals are capable of berthing Q-Class vessels. In 2020, one new terminal capable of receiving Q-Flex vessels was added in India. The Mundra terminal is designed with a berth capable of receiving LNG tankers between 75,000 to 260,000 cubic meters.

Figure 7.7: Maximum berthing capacity of LNG receiving terminals by region, 2020[11]



Source: Rystad Energy

[10] "Smaller Markets" include (in order of size): Portugal, Poland, Bangladesh, Greece, Panama, Egypt, Lithuania, Colombia, Dominican Republic, Jordan, Argentina, UAE, Israel, Myanmar, Jamaica. Each of these markets had less than 0.4 mmcm of capacity as of February 2021.
[11] Terminals that can receive deliveries of more than one size of vessel are only included under the largest size that they can accommodate.

7.6 FLOATING AND OFFSHORE REGASIFICATION

33.4 MTPA

of Floating and Offshore Terminals Under Construction, Feb 2021

Floating and offshore regasification developments have experienced stellar growth over the past decade, having grown from a single terminal in 2005 to 27 terminals as of February 2021. Even though most of the existing regasification are onshore facilities, with the ratio of existing onshore to floating and offshore regasification terminals at 4:1, an increasing number of new FSRU-based projects entered operations in recent years, steadily growing the proportion of floating regasification terminals.

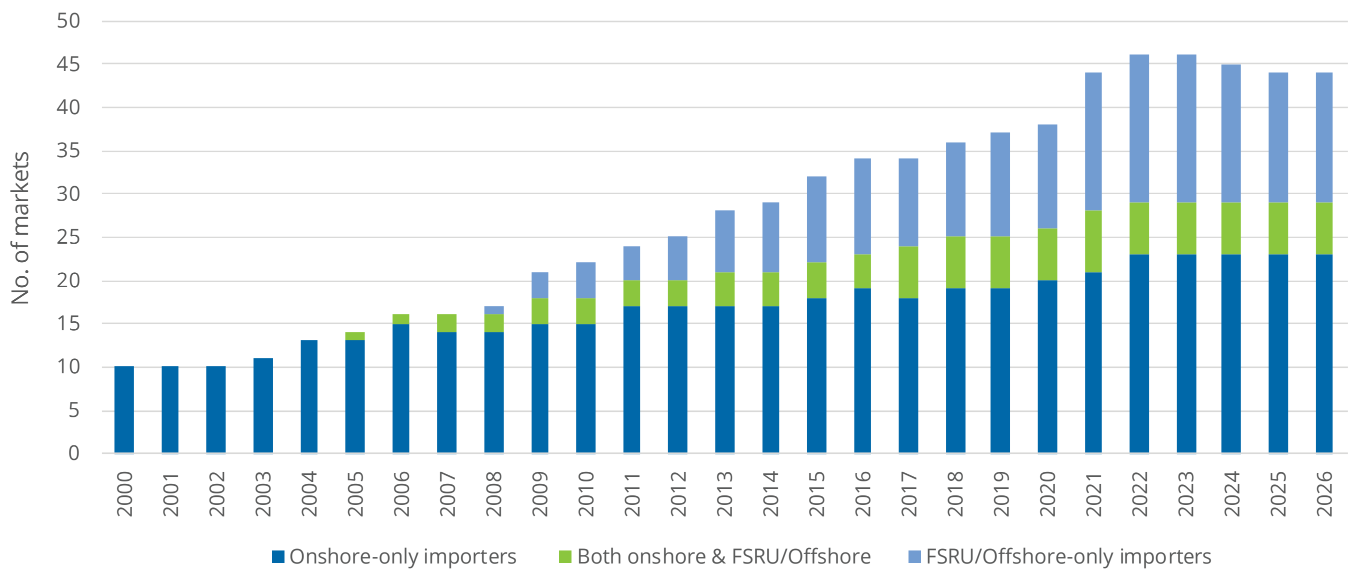
As of February 2021, there are 10 floating and offshore terminals under construction, with a combined regasification capacity totalling 33.4 MTPA. The majority of these terminals have announced plans for commissioning in 2021-2022 and, if successful, will see the entry of four new LNG import markets – Ghana, El Salvador, Nicaragua, and Cyprus. Several new markets have entered the global LNG market through the addition of FSRU-based or offshore terminals in the past few years, including Bangladesh in 2018 and Croatia in 2021.

Conversion work for the FSRU heading for El Salvador commenced in late 2020 and it is on track to be operational by the end of 2021. Ghana has received its first floating regasification unit (FRU) in January 2021. The FRU will be deployed at the Tema terminal, which is anticipated to be operational in the first quarter of 2021. Nicaragua's Puerto Sandino terminal is expected to be commissioned in the first quarter of 2021, which is a minor delay from its originally targeted operational date of end of 2020 due to permitting and construction issues.

Of the 39 existing LNG import markets as of February 2021, 19 imported LNG through FSRUs (or offshore[12]), while six of these had onshore terminals as well. Other markets building floating or offshore solutions include India, Turkey, and Indonesia. India has announced plans to add its first FSRU-based terminal by the end of 2021. Two of India's FSRU-based terminals (Jaigarh and Jafrabad) were originally planned for commissioning in 2020 but are now postponed to 2021 due to several factors, including poor weather conditions and COVID-19 measures that caused construction slippages. The Jafrabad terminal took delivery of its chartered FSRU in late 2020. As the construction of the jetty is still in progress, the FSRU will be utilised as an LNG carrier in the Indian and international waters. This further highlights the flexibility and fast-track capabilities of FSRU over its traditional onshore counterparts.

Two new floating terminals became operational between 2020 and early 2021: Brazil's 5.6 MTPA Acu Port terminal and Croatia's 1.9 MTPA Krk terminal. As of February-2021, the total global active floating and offshore import capacity stood at 115.5 MTPA at 27 terminals.

Figure 7.8: Number of regasification markets by type, 2000-2026[13]

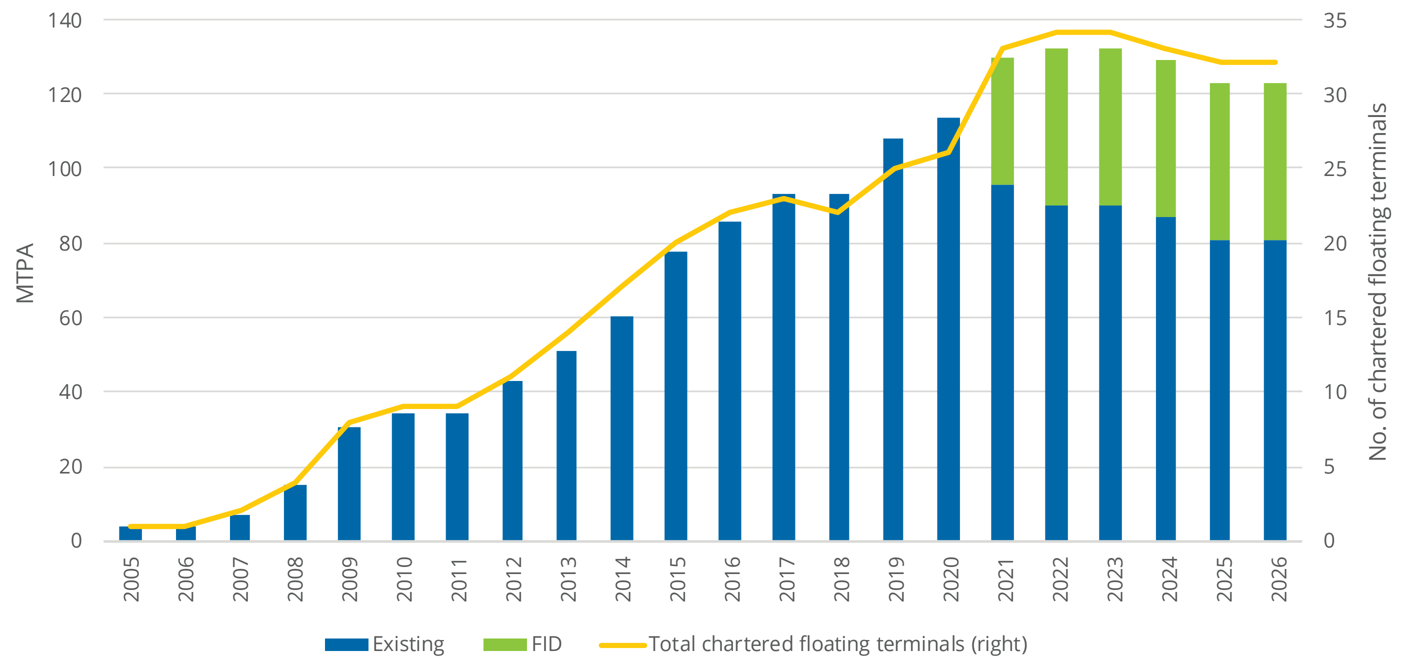


Source: Rystad Energy

[12] Offshore terminals include Italy's Adriatic and Malaysia's Melaka, which utilises gravity-based offshore regasification and offshore regasification jetty (JRU) + permanently moored FSU, respectively.

[13] The chart only includes importing markets that had existing or under-construction LNG import capacity as of year-end 2020. Owing to short construction timelines for regasification terminals, additional projects that have not yet been sanctioned may still come online in the forecast period. The decrease in the number of markets with receiving terminals is due to the expiration of FSRU charters, although new FSRU charters may be signed during this period.

Figure 7.9: Floating and Offshore Regasification Capacity by Status and Number of Terminals, 2005-2026[14]



Source: Rystad Energy

The rising prevalence 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 new-built terminal, markets must weigh the benefits and drawbacks of each option (FSRU and onshore terminal) against specific market requirements, conditions, and constraints. In recent years, FSRUs have enabled several new markets, including Croatia, Bangladesh, Jordan, and Pakistan to receive their first LNG cargoes in a relatively short period. The short construction period and delivery time and ease of relocation of FSRUs compared to an onshore terminal can meet potential near-term gas demand surges in a time-efficient manner. This is done by complementing domestic production or accelerating a market's fuel-switching process. On average, FSRUs are less capex-intensive than land-based terminals due to the common practice of chartering FSRUs from third parties. As they only require minimal onshore space and construction, the greater flexibility offered by FSRUs makes them an attractive option for markets with limited land and port availability.

Onshore terminals, on the contrary, offer a different combination of advantages compared to FSRU. Markets with substantial requirements for storage and regasification capacities can benefit from developing an onshore terminal, which typically supports the installation of larger storage tanks and regasification capacity relative to a floating terminal. Onshore projects are also less exposed to location-dependent risk factors including vessel performance, and potentially longer downtime due to rough seas or meteorological conditions. As a permanent asset, onshore terminals allow for easier on-site storage and regasification capacity expansions, if required, making them an economical solution for markets that require longer-term supply security.

As of February 2021, there are five FSRUs with a capacity of over 60,000 cubic meters on the order book. With several FSRUs temporarily being used as conventional LNG carriers, and multiple others open for charter at the same time in the past year, near-term floating regasification capacity can likely satisfy demand. However, the FSRU market is anticipated to tighten in the longer term. 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 vessels. As the global LNG market expands, the strategic importance of being time-efficient and cost-effective in terminal commissioning is set to grow, particularly in new import markets.

Onshore Terminals	FSRUs
Provides a more permanent solution	Allows for quicker fuel switching or complementing domestic production.
Offers longer-term supply security	Greater land and port requirement flexibility
Greater gas storage capacity	Requires lower capital expenditures (capex)
Requires lower operating expenditures (OPEX)	Easier to site

[14] The forecast only includes floating capacity sanctioned as of year-end 2020. Owing to short construction timelines for regasification terminals, additional projects that have not yet been sanctioned may still come online in the forecast period. The decrease in the number of markets with receiving terminals is due to the expiration of FSRU charters, although new FSRU charters may be signed during this period.

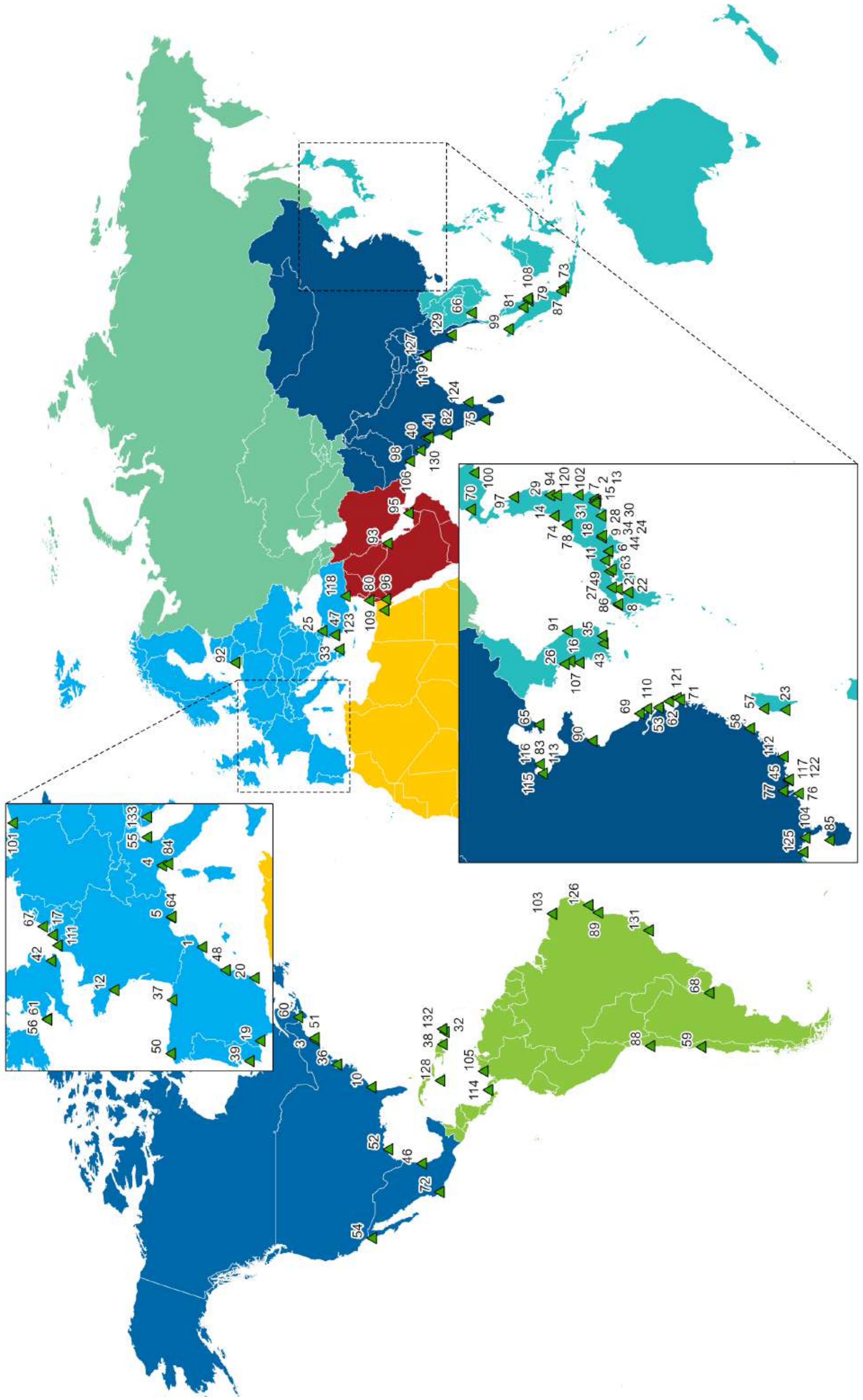


Figure 6.10: Global LNG Receiving Terminal Locations

Note: Terminal Numbers Correspond to Appendix 5: Table of Global LNG Receiving Terminals.
Source: Rystad Energy

7.7 RECEIVING TERMINALS WITH RELOADING AND TRANSHIPMENT CAPABILITIES

Highest Re-Exports in 2020 – France,

1.9 MTPA

In recent years, a growing number of LNG import markets have transformed their terminals into LNG hubs capable of re-exporting imported LNG cargoes to other destinations in the global LNG market. Receiving terminals in these markets have diversified their service offerings beyond traditional regasification operations to better address the needs of the evolving LNG markets. Additional value-adding services include ship reloading, LNG transhipment, small-scale LNG bunkering and truck loading. Generally, re-exporting activities increase profitability for traders by taking advantage of arbitrage opportunities between regional markets as well as logistical factors within certain markets. With the rise of terminals with reloading and transhipment capabilities, re-export volumes from markets with reloading terminals have expanded steadily. For the fifth consecutive year, France re-exported the most cargoes globally in 2020 at 1.9 MTPA via its Montoir, Fos Cavaou, and Dunkirk terminals. Belgium followed closely behind, with the Zeebrugge terminal re-exporting a total of 1.8 MTPA, representing an eight-fold increase from 2019. After Belgium, Singapore re-exported the third largest volume of cargoes in 2020 at 1.3 MTPA. All three re-export markets have experienced a strong surge in re-export volumes of at least 60% from 2019. Total re-exported LNG volumes by global re-exporters in 2020 have more than doubled since 2019. Other European markets such as the Netherlands and Spain have historically sent out high re-export volumes but experienced a gradual reduction in re-export volumes in recent years, in part driven by narrowing of price differentials between Asia and Atlantic spot. Re-exports from Asia and Asia Pacific region have grown steadily since 2016, contributing to around 30% of global re-exported volumes. Most re-exports from Asia and Asia Pacific were driven by Singapore, followed by South Korea and India.

Value-adding services including transhipment and bunkering services can be performed at terminals with multiple jetties, such as the Montoir-de-Bretagne terminal in France. Established markets in Europe have terminals such as Gate LNG, Barcelona, Huelva, and Cartagena that can provide this functionality for compatible ships as small as 500 cubic meters. Several receiving facilities have enhanced their infrastructure to provide transhipment, bunkering, and truck loading capabilities. In early 2020, Belgium's Zeebrugge terminal commenced transhipment operations for the delivery of LNG from the Yamal production terminal in Siberia under a 20-year contract which may see up to 8 MTPA of LNG transhipped at the Zeebrugge terminal. With additional capacity from the newly installed fifth storage tank and other process facilities at the Zeebrugge terminal in late 2019, transhipment from the icebreaking LNG vessels from the Yamal production terminal to conventional LNG carriers can now happen without having to be docked simultaneously. LNG transhipment services allow for the transfer of cargo between two ships or break-bulking (i.e., dividing up large cargo into smaller ones) as a means of optimizing LNG carrier operations. Two forms of transhipment are available – 'Ship-to-Ship' transfers which utilise two berths to conduct direct LNG operations (simultaneous unloading and reloading) without passing through the terminal's storage tank. Another method involves unloading operations and temporary storage at the terminal before reloading, often used in break-bulking. For example, ice-breaking LNG tankers can load cargoes onto conventional tankers suitable for operations in the standard marine waters.

Within the Spanish market, the introduction of the Tanque Virtual de Balance (TVB) and the new reloading tariff, which has been reduced by between 67% and 98%, could create the conditions for Spain to become an LNG hub. The volume of bunkering operations from truck-to-ship in Spain has increased considerably during 2020, with the Huelva terminal seeing a 14-fold increase in loading activity. In late 2020, a new tariff methodology was implemented involving a large reduction in reloading fees, especially for small sized ships and bunker vessels for ship-to-ship bunkering. With greater economic competitiveness, higher reloading activities and increased bunkering modality have been observed at Spanish terminals.

Singapore's Jurong terminal completed the modification of its second jetty to receive and reload LNG carriers with capacity between 2,000 and 10,000 cubic meters. The jetty enables regional small-scale LNG distribution and LNG bunkering services. The recently commissioned San Juan terminal in the United States (Puerto Rico) is equipped with micro fuel-handling capabilities, capable of conducting truck operations that will deliver LNG to local microgrids, industrial users and supply natural gas to power plant units in the region. France's Dunkirk terminal launched its truck loading service with a loading capacity of 3,000 slots per year after its newly built loading bay entered service in mid-2020. Additionally, the Dunkirk terminal has adapted its existing jetty to accommodate the berthing of small-scale LNG carriers and bunker vessels with a capacity of 5,000 cubic meters or more. In early 2021, India's Hazira terminal launched its first truck-loading unit as part of efforts to expand downstream services, particularly to supply South Asian markets. As of February 2021, 28 terminals in 15 different markets have reloading capabilities.

Table 7.2: Regasification terminals with reloading capabilities as of February 2020

Market	Terminal	Reloading Capacity (mcm/h)	Storage (mcm)	No. of Jetties	Start of Re-Exports
Belgium	Zeebrugge	6	560	1	2008
Brazil	Guanabara Bay	1	171	2	2011
Brazil	Bahia	5	136	1	N/A
Brazil	Pecém	1	127	2	N/A
Colombia	Cartagena	0.005	170	1	N/A
Dominican Republic	AES Andres LNG	N/A	160	1	2017
France	Fos Cavaou	4	330	1	2012
France	Montoir-de-Bretagne	5	360	2	2012
France	Dunkirk LNG	4	570	1	2018
France	Fos Tonkin	1	150	1	N/A
India	Kochi LNG	N/A	320	1	2015
Japan	Sodeshi	N/A	337	1	2017
Jamaica	Port Esquivel	N/A	170	1	2019
Mexico	Energia Costa Azul	N/A	320	1	2011
Netherlands	Gate LNG	10	540	3	2013
Portugal	Sines LNG Terminal	3	390	1	2012
Singapore	Jurong	8	564	2	2015
South Korea	Gwangyang	N/A	530	1	2013
Spain	Cartagena	7.2	587	2	2011
Spain	Huelva	3.7	620	1	2011
Spain	Mugardos LNG	2	300	1	2011
Spain	Barcelona LNG	4.2	760	2	2014
Spain	Bilbao	3	450	1	2015
Spain	Sagunto	6	600	1	2013
United Kingdom	Grain	Ship-dependent	960	1	2015
United States	Freeport LNG	2.5	320	1	2010
United States	Sabine Pass LNG	2.5	800	2	2010
United States	Cameron LNG	2.5	480	1	2011

Incheon LNG Terminal - Courtesy of KOGAS

8. Natural Gas (LNG & CNG) as Fuel for Marine and Road Transportation

With the implementation of stricter environmental legislation to reduce emissions at both the local and international level, a growing number of marine vessel owners are considering the use of cleaner alternative bunker fuels to achieve compliance.

Incheon LNG Terminal - Courtesy of KOGAS

8.1 MARINE LNG BUNKERING INFRASTRUCTURE

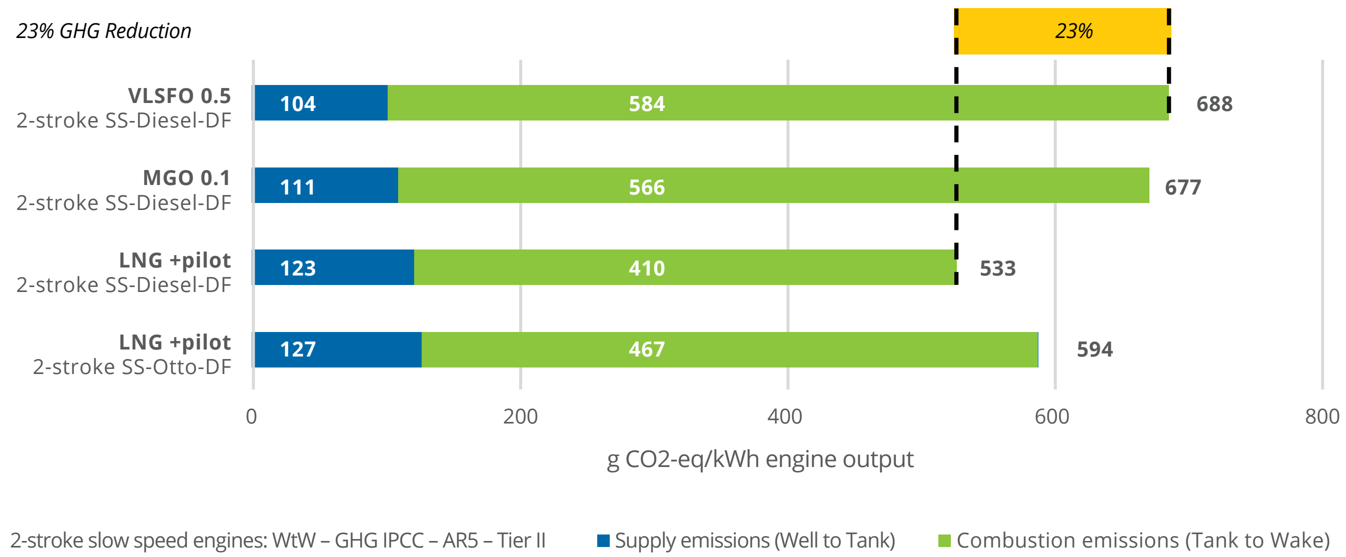
22 units

Global Operational LNG Bunkering Vessel Fleet, early 2021

With effect from January 2020, the International Maritime Organization (IMO) enforced a new global limit of 0.50% on the sulphur content of ships' fuel. 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 machinery (or conversion where possible) designed to operate on LNG, as well as the construction of related infrastructure. This creates a self-reinforcing feedback loop where the development of an efficient, secure, and competitive LNG supply chain and related bunkering infrastructure drive further adoption of LNG-fuelled vessels.

LNG is currently the best and immediately available solution at scale that can reduce the environmental impact of maritime transport and preserve air quality. According to the 2nd Lifecycle GHG Emission Study on the use of LNG as a Marine Fuel from Sphera (formerly thinkstep), greenhouse gas (GHG) reductions of up to 23% are achievable now from using LNG as a marine fuel, depending on the marine technology employed[1].

Figure 8.1: 2nd Lifecycle GHG Emission Study on the use of LNG as a Marine Fuel



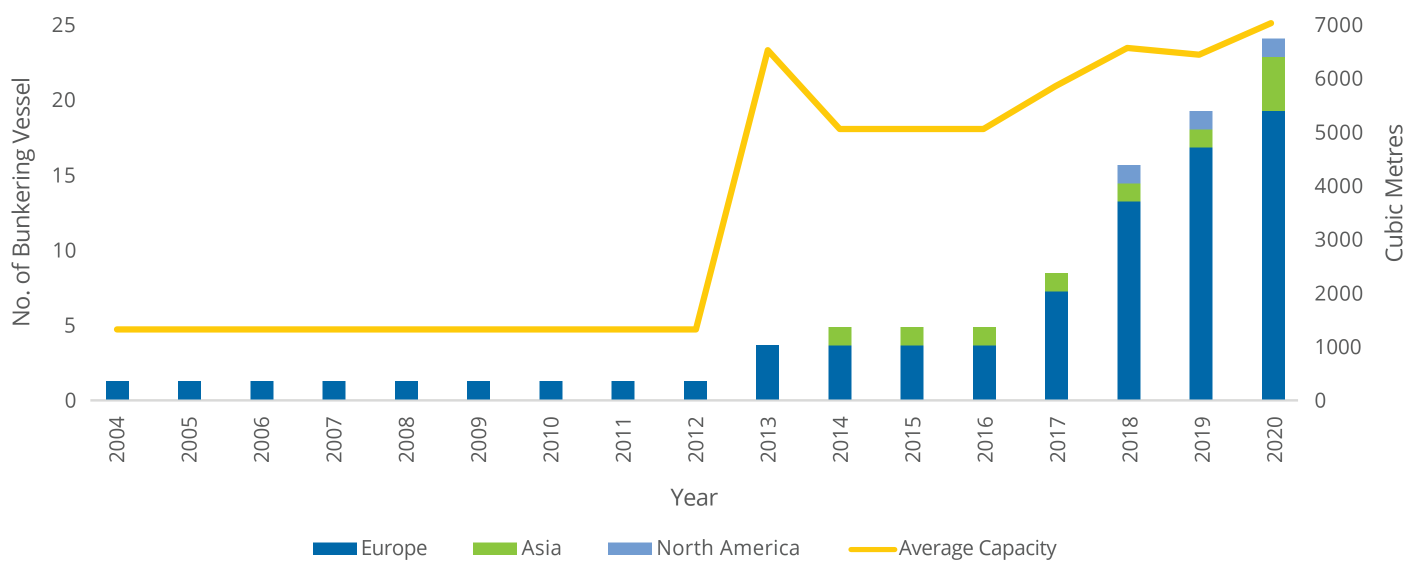
Source: Sphera

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. Generally, gas-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.

Early LNG bunkering market developments 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 between 1,000 to 20,000 cubic metres, 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 cubic metres. It has a long track-record of STS transfers, on top of small-scale LNG deliveries, along the Norwegian coast at approximately 200 cargo deliveries per year. In 2013, the world saw the first dedicated LNG bunkering vessel enter operations, the Seagas, at the port of Stockholm. The 187 cubic metre Seagas, converted from a small Norwegian ferry, delivers around 70 tonnes of LNG bunker fuel to the large Viking Grace ferry each week. Notably, LNG for the bunker vessel is loaded by trucks from the small-scale Nynashamn LNG terminal located almost 60 km south from the port of Stockholm.

[1] 2nd Life Cycle GHG Emission Study on the Use of LNG as Marine Fuel, Sphera, 2021. (https://sphera.com/research/2nd-life-cycle-ghg-emission-study-on-the-use-of-lng-as-marine-fuel/)

Figure 8.2: No. of LNG bunkering vessels by region and average vessel capacity, 2004-2020



Source: Rystad Energy

Although some small inland LNG barges were developed in China between 2014 and 2016 for bunkering purposes, Seagas remained the sole dedicated STS bunkering vessel for another three years. It was only in 2017 when three purpose-built LNG bunkering vessels with much larger capacities started operations: Engie Zeebrugge (about 5,100 cubic metres), Coralius (about 5,600 cubic metres), and Cardissa (about 6,500 cubic metres). Engie Zeebrugge primarily operates near the Zeebrugge region while the Cardissa and Coralius vessels serve the North Sea/Baltic Sea region, travelling from their Rotterdam and Risavika bases, respectively, to load and perform bunkering operations. The business case for these pioneering type projects made sense due to their proximity to LNG terminals as well as the ability to modify the respective regasification facilities to accommodate small-scale ships, such as at GATE in Rotterdam. In less than a year, another new 7,500 cubic metre LNG bunker vessel was launched (Kairos) in northern Europe. The Kairos vessel is based at the Klaipeda LNG terminal in Lithuania.

The expansion of LNG bunkering vessel infrastructure has also been enabled by conversion and ship upgrading. The world's sixth LNG bunkering vessel, Oizmendi, was converted from a heavy fuel oil/ marine diesel oil bunkering tanker into a multifuel bunkering vessel with 660 cubic metres of LNG capacity. It performed its first STS bunkering operation in the Port of Bilbao in early 2018 and will cover bunkering operations in the Iberian Peninsula. Another converted vessel, the 7,500 cubic metre Coral Methane, was modified and upgraded in 2018 with STS LNG bunkering capabilities in addition to its small-scale LNG carrier responsibilities. The highly mobile vessel carries out bunkering operations across multiple ports including Barcelona, Rotterdam, Marseille Fos and Tenerife. A remarkable LNG bunkering vessel that has entered in operation recently is the Gas Agility. The vessel has performed the first STS bunkering in the port of Rotterdam in November last year. She is equipped with membrane tanks of 18,600 cubic metres capacity and is the largest currently in operation.

Outside of Europe, Asia & Asia Pacifc and North America are equipped with a total of four LNG bunkering vessels. America's first LNG bunker barge (a non-self-propelled unit), Clean Jacksonville, has a capacity of 2,200 cubic metres and is the first of membrane cargo tank. It is stationed at the Florida port of Jacksonville and was built specifically to bunker LNG for TOTE containerships from 2018 onwards. As the United States' first bunker and supply articulated tug barge (ATB) unit and second operational LNG bunker barge after Clean Jacksonville, Q-LNG 4000 was delivered in early 2021. The long-anticipated ATB unit, with 4,000 cubic metres of carrying capacity, is under a long term charter to supply LNG sourced from Elba Island, Georgia to a fleet of cruise vessels at Port Canaveral, Florida. Additionally, it will provide ship-to-shore LNG deliveries to customers in the Gulf of Mexico at a small scale. In 2020 alone, Asia Pacific added two bunkering vessels – Kaguya in Japan and Avenir Advantage in Malaysia. Japan conducted its first STS LNG bunkering with the 3,500 cubic meter Kaguya vessel in late 2020. This vessel will be based at the Kawagoe Thermal Power Station and supply LNG fuel to other ships in the Chubu region. Similarly, in late 2020, Malaysia launched its STS LNG bunkering operations, chartering the 7,500 cubic metre Avenir Advantage from Future Horizon (a joint-venture between MISC Berhad and Avenir LNG). The vessel will provide STS bunkering operations in the region and transport LNG to small-scale customers. Singapore's first LNG bunkering vessel, FueLNG Bellina, was successfully delivered in early 2021 to FueLNG and will call at the Port of Singapore for STS LNG bunkering. FueLNG is a joint venture between Keppel Offshore & Marine Ltd (Keppel O&M) and Shell Eastern Petroleum (Pte) Ltd.

As of early 2021, the global operational LNG bunkering vessel fleet size has reached 22 units, including both self-propelled and tug-propelled bunker vessels. Close to 75% of the LNG bunkering vessels are operating in Europe. The fleet is still young as the majority of the active bunkering vessels were added in the past few years, with nine added between 2017 and 2018 and another seven between 2019 and 2020. The typical capacity of LNG bunkering vessels has increased over time from 1,000 cubic metres to the recent newbuilds of close to 20,000 meters in LNG fuel capacity.

Similarly, the development of shore-based LNG terminals capable of providing bunkering services, either as small-scale terminals or large terminals providing small-scale reload, 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 68 LNG terminals and ports offering LNG bunkering services, 44 terminals are in Europe, another 18 are in Asia and Asia Pacific and the remaining six are found in North and South America.

TY bunkering at Jeju loading berth – Courtesy of Kogas

Ports and terminals have either added to, or modified their facilities to offer LNG bunkering services gradually over the years in response to the expected increase in LNG bunkering demand. These shore-based facilities are often strategically located in regions with tighter emissions control regulations as well as at close proximity to LNG import terminals, enabling efficient distribution. Among LNG bunkering infrastructure, truck-to-ship is currently the most widely used configuration at terminals and ports due to its low capital investment and limited infrastructure required. This method is, however, restrictive in terms of its flow rates amongst other factors, which limit 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 capacity and higher bunkering rates. However, both methods require significantly higher capital investments in the form of bunker vessels and fixed infrastructure such as storage tanks and specialised loading arms.

Among markets near the North Sea and Baltic Sea, the development of LNG bunkering infrastructure is a relatively recent trend. The majority of the LNG bunkering facilities are part of a network of small-scale LNG terminals and ports, which expanded from 2010 onwards. This expansion was enabled by increasing small-scale LNG exports from Norway and reloading/trans-shipment services offered at large-scale LNG import terminals to small-scale LNG terminals and ports in the region. Several large-scale LNG terminals also offer truck-loading services and bunkering services directly from the terminal, which support the delivery of LNG to nearby ports to be loaded on vessels via truck-to-ship bunkering. Bunkering services became available at small-scale export terminals (Snurrevarden in 2004, Kollsnes in 2007, and Risavika in 2015), large-scale import terminals (GATE Rotterdam in 2013, Zeebrugge in 2015, Klaipeda in 2018) and small-scale import terminals (Pori in 2016, Lysekil in 2017, Tornio in 2019). The Risavika plant, one of Norway's newest liquefaction facilities, saw the commissioning of a dedicated bunkering facility in 2015 for the Fjord Line ferries. The bunkering facility is linked to the plant's 30,000 cubic metre 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, Polaris. Ships at the terminal can be filled via truck or directly from the terminal tanks by pipes.

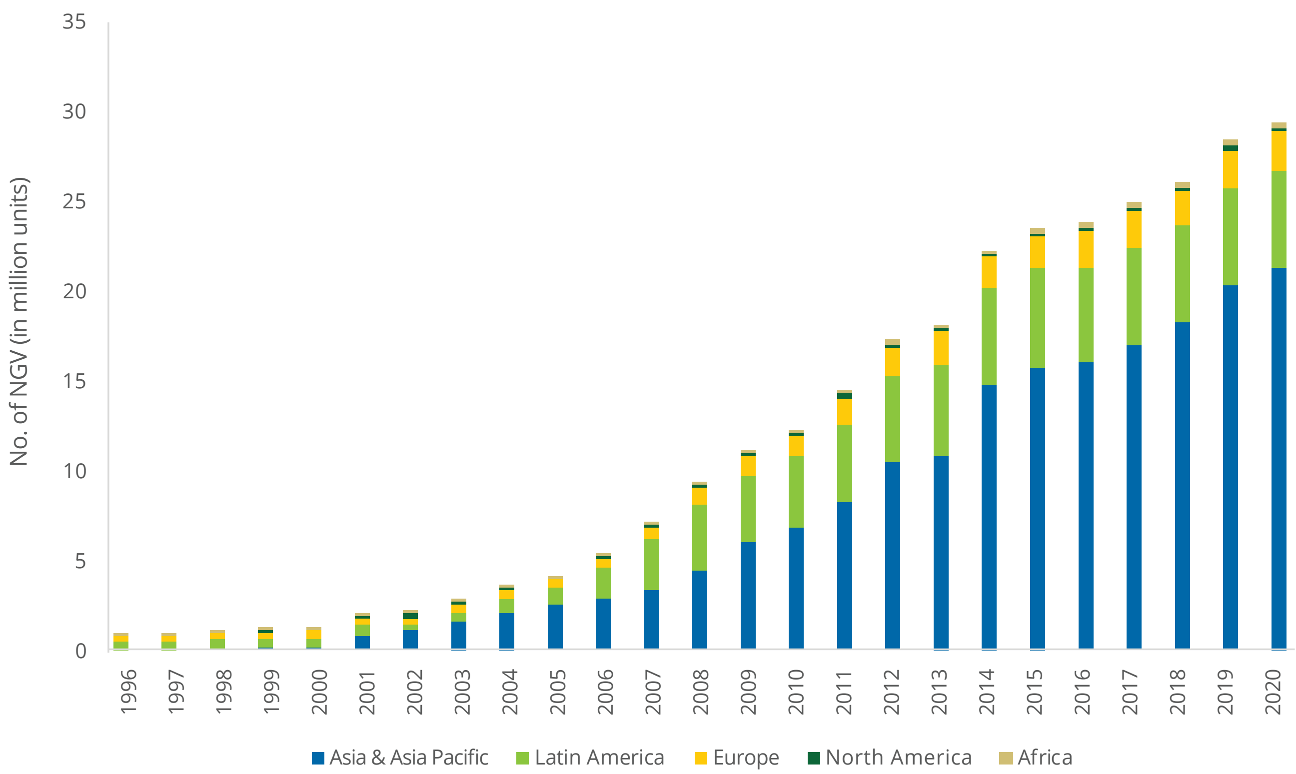
As some of the first few terminals to offer road tanker loading and cargo reloading, Iberian terminals have also started to diversify into LNG bunkering services. With support from the CORE LNGas hive initiative aimed at building an Iberian LNG bunkering network, several Spanish ports have added truck-to-ship bunkering infrastructure. Furthermore, they are now implementing additional terminal enhancements to accommodate small-scale carriers and develop direct jetty-to-ship services for LNG-fuelled vessels. In 2017, the Cartagena LNG regasification terminal completed its first direct bunkering to an LNG-fuelled tanker with 370 cubic metres of LNG, utilising the facility's tank-to-jetty pipework, hoses, and a dedicated jetty. In early 2021, Cartagena has completed another direct pipe-to-ship bunkering operation. The Bilbao terminal adapted its marine jetty to accommodate small-scale vessels ranging from 600 to 270,000 cubic metres in 2017 and carried out its first LNG bunkering operations through a five-hour truck-to-ship transfer in the same year. In a bid to encourage development of LNG bunkering at Spanish regasification terminals, a large reduction in reloading fees, especially for small-sized ships destined for ship-to-ship bunkering, has been implemented since September 2020 and will be applied for the next six years.

Within Asia Pacific, a growing number of markets, including Singapore, Japan, and South Korea, have plans to add LNG bunkering infrastructure, signifying an increased demand for LNG as a marine fuel in the region. Of the existing bunkering infrastructure available, Singapore's port has been equipped with truck-to-ship bunkering services since 2017 and completed over 250 truck-based fuelling operations. In fact, the port can now provide STS bunkering with the delivery of its first LNG bunkering vessel (FueLNG Bellina) in early 2021. It is also set to open Singapore's first dedicated LNG bunkering facility by the end of 2021, as part of an effort to develop Singapore into a global LNG bunkering hub. In Japan, the Port of Yokohama introduced truck-to-ship bunkering services in 2018 and has plans to offer STS bunkering. South Korea currently offers truck-to-ship bunkering at its Incheon port and has recently completed a bunkering trial involving a 7,500 cubic metres small scale LNG carrier between mainland and the Jeju Island, the SM JEJU LNG2.

The United States is also anticipated to become a significant player in the LNG bunkering market. Currently, its bunkering operations occur primarily at the Jacksonville port in Florida and Port Fourchon in Los Angeles. Jacksonville has conducted truck-to-ship operations since 2016 for two containerships and added STS bunkering services to the facility with the delivery of the Clean Jacksonville bunker barge in 2018. Port Fourchon completed the bunkering of its first LNG-fuelled vessel in 2016 and has plans to become a central LNG terminal in North America. With the arrival of the 4,000 cubic metres Q-LNG 4000 ATB unit and its dedicated tug Q-Ocean Service in early 2021, Port Canaveral in Florida is on track to be the United States' first LNG cruise port. 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.

8.2 ONSHORE LNG & CNG FUELLING INFRASTRUCTURE

Figure 8.3: Natural gas vehicle (NGV) fleet by region, 1996-2020



Source: Rystad Energy

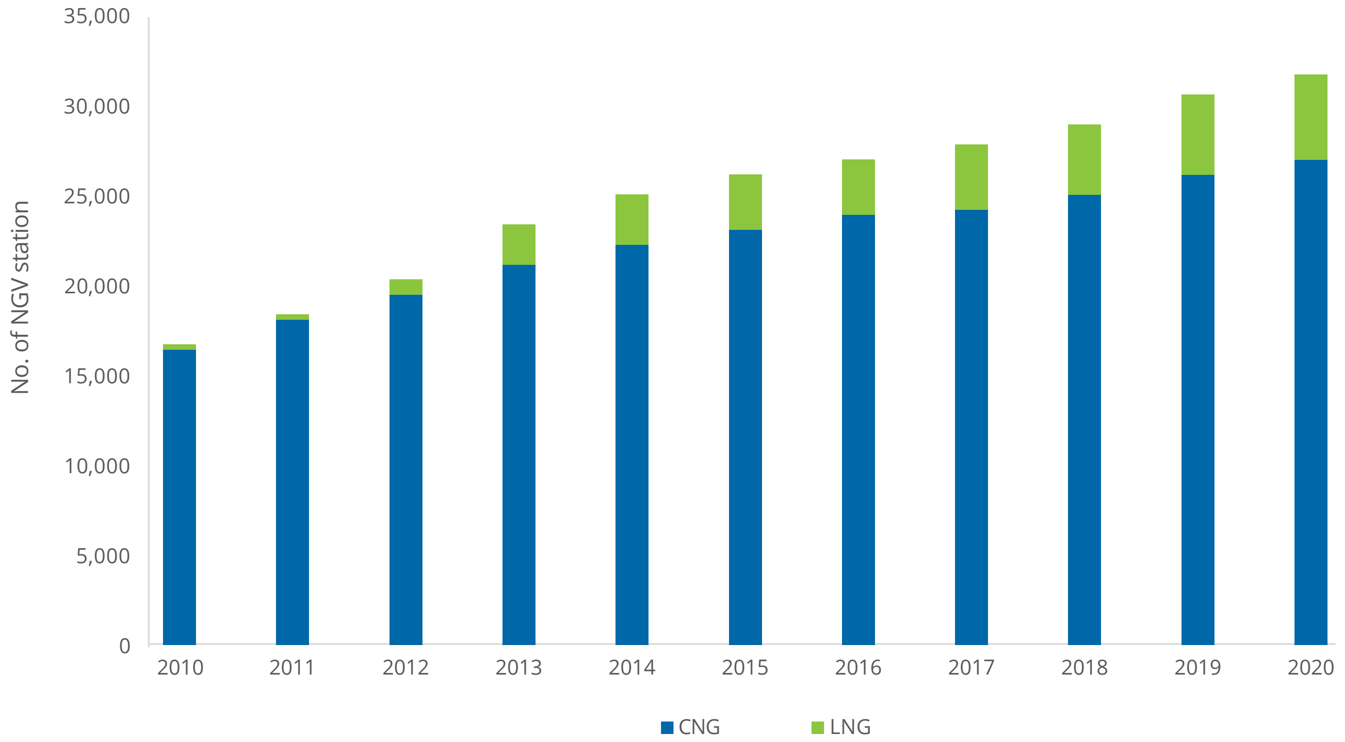
As of 2020, the global fleet of natural gas vehicles (NGVs) stands at 29.5 million units. Asia & Asia Pacific accounts for the largest share of the NGV market with 21.4 million operational units and a market share of 73%. This is followed by Latin America and Europe, each holding 19% (5.5 million units) and 7% (2.1 million units) market share respectively. Asia & Asia Pacific experienced an exponential surge in the adoption of NGV in the past two decades, more than doubling its NGV fleet from 2000 to 2010 and recording a remarkable CAGR of 12% between 2010 and 2020. In fact, the top three markets deploy over 50% of the world's NGV fleet. They are, in order, China, Iran and India. In contrast, NGV adoption is still at a nascent stage in Africa and North America. Both regions currently account for 2% (or 0.5 million units) of total NGVs.

Asia & Asia Pacific saw a rapid adoption of natural gas in many transportation sectors and the development of natural gas infrastructure in markets such as Pakistan, China, and India. The switch from gasoline or diesel to natural gas as an automotive fuel in Asia & Asia Pacific was largely bolstered by an increasing appetite for cleaner fuels in response to heightened environmental concerns over emissions and air pollution, the need for energy security and economic incentives. Government policies have been key in driving the deployment of NGV in numerous markets. As the largest NGV market with more than 6 million vehicles, China has actively supported the deployment of NGVs through the establishment of nation- and municipal-wide clean vehicle programs since 1999. Efforts have been made to enforce clean fuel targets, roll out financial subsidies to support NGV uptake in public transportation and advance development in NGV technology. Additionally, the National Development and Reform Commission (NDRC) regulated the gas prices up to 2015, to boost its economic competitiveness versus diesel and gasoline. Applications in heavy-duty vehicles have also grown in recent years as LNG-powered buses and trucks were a better alternative to diesel for the environment considering the difficulties in electrifying heavy-duty vehicles. The NGV industry in Iran and India followed a similar growth trajectory as China, where the introduction of favourable government initiatives aimed at addressing air pollution caused by the transportation industry in the early 2000s drove a large-scale uptick of NGVs. Holding some of the world's largest natural gas reserves, Iran has a strong business case to promote large-scale NGV deployment. Iran grew its NGV industry rapidly through a mix of subsidised infrastructure development and conversion facilities for gasoline cars to bi-fuel cars. NGV growth in India originated from its most urbanised cities, such as Delhi, which saw the mass conversion or replacement of the existing fleet of buses, taxis and autorickshaws to run on CNG as part of state-approved pollution mitigation policies.

Prior to 2000, the majority of the world's NGV fleet was concentrated in Latin America. Despite being overtaken by Asia & Asia Pacific, Latin America sustained strong growth in the number of NGV vehicles, growing from less than 1 million in 2000 to more than 4 million units by 2010, led by Argentina and Brazil. However, Latin America's NGV fleet has grown at a slower pace since 2010, with an average of 4% growth each year. Argentina has one of the highest NGV market penetrations worldwide. Its rapid NGV growth was simulated by strong government support beginning in the early 1980s, notably through the adoption of the Liquid Fuel Substitution Program aimed at switching from diesel to natural gas in the public transportation sector. This was in addition to the favourable price differential offered by natural gas relative to gasoline, in part accomplished by the government's efforts to remove taxes and enforce margin limits on natural gas sold to CNG stations. With a fleet of more than two million units, Brazil expanded its NGV fleet substantially in the 1990s along with a surge in the government-supported development of associated distribution infrastructure such as refuelling stations, pipelines, and conversion facilities. While the favourable prices of natural gas supported the economic displacement of gasoline in Brazil, the price differential of natural gas was less apparent relative to ethanol, which to an extent led to slowed NGV market penetration rates after 2010.

Within Europe, Italy is the most developed and largest NGV market, representing close to 55% of the fleet in the region. As one of the earliest adopters, Italy first introduced NGVs in the 1970s as part of the government's efforts to promote energy security through an active retrofit initiative of the existing vehicle fleet to CNG. Like other large NGV markets, environmental concerns over rising air pollution further sustained the switch to natural gas from gasoline and diesel as an automotive fuel. This led the Italian government to establish a series of subsidies and tax rebates for conversion and new purchases of NGV. Italy grew its NGV fleet by at least 50% between 2009 and 2019, making it the seventh-largest market globally with over one million units.

Figure 8.4: Global NGV refuelling stations by fuel type, 2010-2020

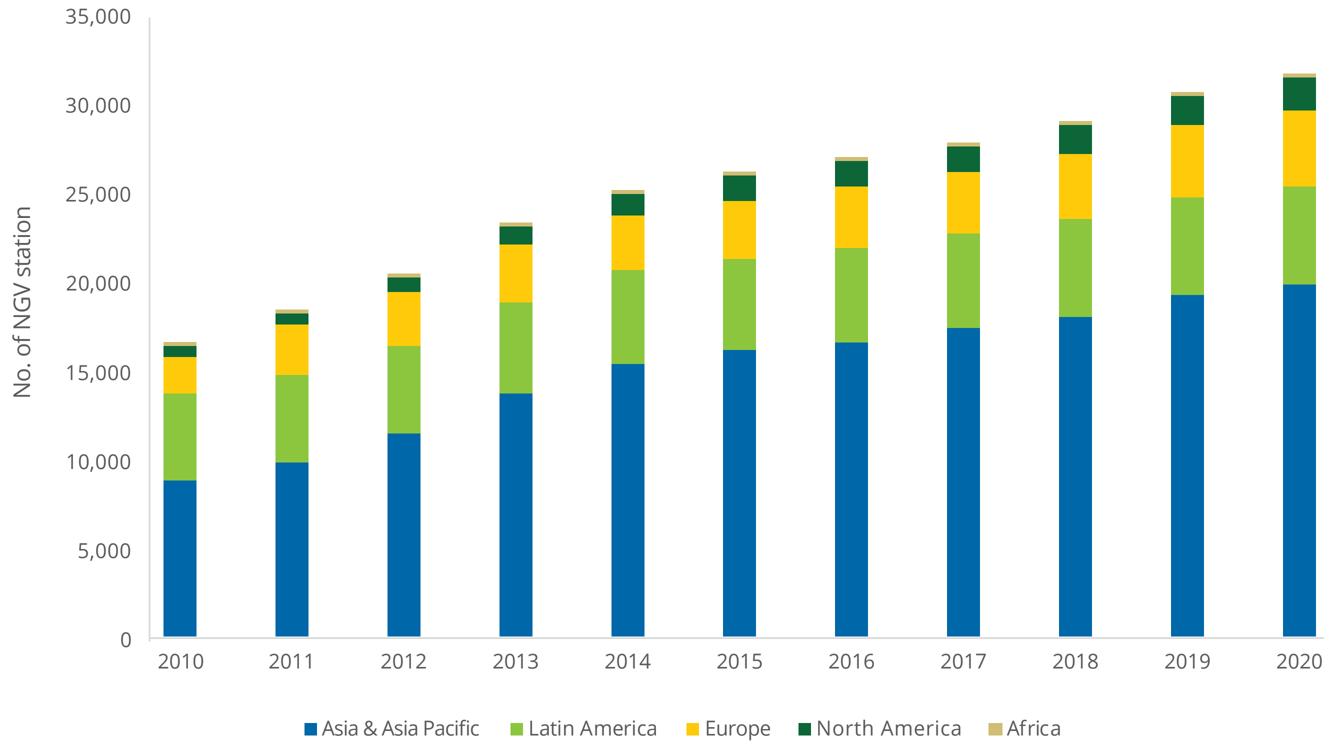


Source: Rystad Energy

Often presented as a "chicken and egg" conundrum, the development of refuelling infrastructure is highly correlated with the deployment of natural gas vehicles and fuel supply. In several key NGV markets, the availability of well-connected refuelling infrastructure has been essential to driving sustained utilisation of natural gas as an alternative automotive fuel. Onshore refuelling stations for NGVs generally take on two forms: compressed natural gas (CNG) stations equipped with pressurised dispensers, grid connection and compressor to transfer gas; and liquefied natural gas (LNG) stations equipped with insulated cryogenic storage tanks containing LNG transported by road tankers.

Over the past decade, there have been ongoing efforts to develop onshore refuelling infrastructure for CNG and LNG across key markets worldwide. As of end-2020, the total number of onshore refuelling stations globally stood at approximately 31,700, with CNG stations making up the bulk of refuelling infrastructure at 85%. Overall onshore refuelling infrastructure expanded steadily at a CAGR of 7% between 2010 and 2020, which to a large extent reflects active government initiatives to improve infrastructure connectivity. Notably, LNG stations saw a surge in development activity from 2013 onwards and are anticipated to continue along the same growth trajectory in LNG-focused markets such as China, Italy, and Argentina. On a regional level, Asia & Asia Pacific accounted for the highest number of onshore refuelling stations at 63% followed by Latin America at 18%, Europe at 13%, North America at 6% and Africa at 1%. Asia & Asia Pacific has experienced relatively strong growth in the development of NGV refuelling infrastructure and has increased its share of onshore refuelling infrastructure by 10% percentage points globally since 2010.

Figure 8.5: Global NGV refuelling stations by region, 2010-2020



Source: Rystad Energy

Asia & Asia Pacific has collectively added 19,800 onshore NGV refuelling stations, spearheaded by China, Iran, and Pakistan. China has the most widespread refuelling network with over 10,000 NGV stations. Since the early 2000s, the Chinese government has actively promoted the development of the NGV industry through a range of support policies in the form of construction of refuelling infrastructure, as well as pipeline and delivery network projects. Additionally, provincial governments extended subsidies to establish refuelling stations and introduced favourable land allocation schemes, driving the rapid development of refuelling stations in western cities. Construction of LNG refuelling stations rose after LNG was introduced in the early 2010s as an alternative fuel for heavy-duty vehicles to address diesel emissions. The surge in the number of LNG fuelling stations between 2012 and 2014 was in part driven by the favourable price differential natural gas had over diesel, as well as financial incentives offered by the government.

With one of the largest fleets of NGVs at over 4.5 million vehicles, Iran has 2,495 active CNG filling stations across the market. With investments from the private sector, Iran has expanded its refuelling network in recent years which has helped to alleviate concerns about insufficient refuelling infrastructure. While Pakistan has over 3,000 refuelling stations, the government is likely not in favour of expanding its CNG sector in the short term due to gas supply shortages which saw the suspension of gas supply to CNG stations across the market in early 2021, prioritizing demand from power and industry sectors instead.

In Latin America, onshore refuelling infrastructure has expanded to reach 5,700 stations to service its rapidly growing fleet of 5.5 million NGVs. With over 1,900 stations, Argentina has one of the largest refuelling networks in the region, which saw its development accelerated by the presence of a well-connected natural gas transmission and distribution system. CNG stations have been built across Argentina's urbanised areas predominantly through market-led developments. Further development in onshore refuelling capacity is expected in Argentina following the introduction of its first LNG-propelled heavy-duty vehicle fleet and the reduction of import tariffs for CNG- and LNG-fuelled trucks. In Brazil, the establishment of NGV stations has supported the development of pipelines in poorly connected regions. Additionally, CNG is delivered from the pipeline to refuelling stations via trailers with high pressurized tanks. Colombia has demonstrated significant growth and evolution of vehicles that run on natural gas during the last 20 years. Converting more than 550,000 light vehicles, Colombia has put to service more than 750 CNG fuelling stations around the market and around 170 mechanical workshops for this type of cars, representing private investments of close to $1 billion USD. From 1994-2020, this market in the north of South America has consolidated as the 8th largest in terms of natural gas vehicles. Today, they have a fleet of over 3500 buses and trucks running on CNG.

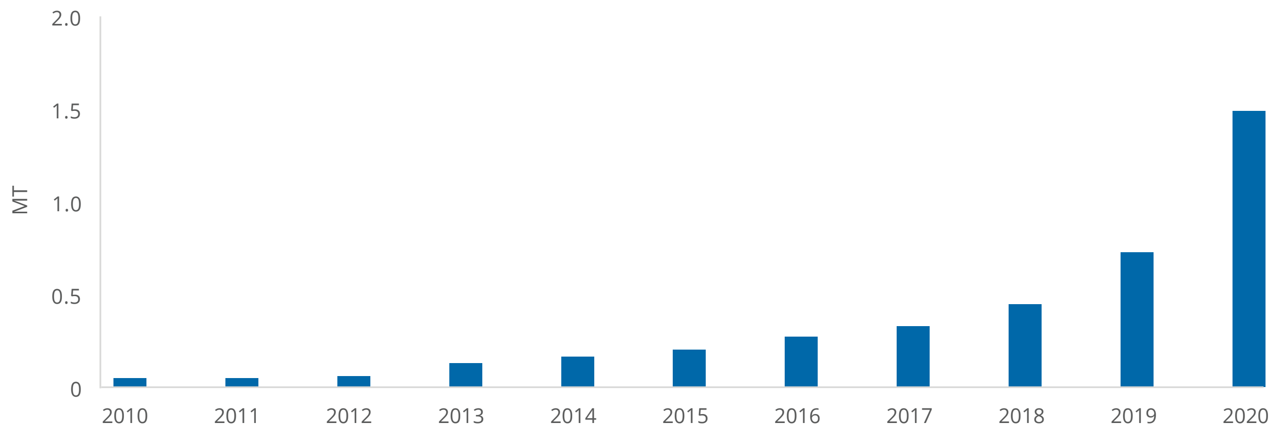
Europe currently has around 4,200 NGV refuelling stations, where CNG stations account for more than 90% of the facilities. Italy is the most developed NGV market with about 1,400 stations. Like Argentina, the development of Italy's refuelling network was supported by the presence of well-developed gas pipeline infrastructure, in addition to strong direct investment from national transmission system operator SNAM to boost natural gas mobility. With over half of the CNG stations in Europe being in Italy and Germany, further development in refuelling infrastructure is likely necessary to sustain growth in deployment of NGVs. In terms of LNG refuelling stations, Europe is anticipated to expand its LNG infrastructure to support growth of natural gas as an automotive fuel, especially for heavy-duty vehicles, as part of the European Union's Green Deal plan to reach carbon neutralality by 2050. Italy and Spain currently have the largest LNG refuelling network in Europe, accounting for 40% of LNG refuelling stations.

North America has built over 1,800 onshore refuelling stations to serve its expanding fleet of CNG- and LNG-powered vehicles, which currently stands at around 225,000 units. This translates to around 125 vehicles per fuelling stations. Compared to the global average of 810 vehicles per fuelling stations, North America has noticeably fewer vehicles per fuelling stations. The emergence of CNG and LNG markets in North America has been primarily driven by United States, which alone account for 78% of total NGV population and 74% of onshore refuelling stations in North America. Of the 1,800 refuelling stations, only half of these CNG and LNG stations are accessible by the public. Growing adoption of NGVs and expansion of refuelling infrastructure in the United States have been driven by competitive CNG prices over petroleum-based fuels due to the growth in shale gas production as well as government financial incentives (e.g., fuel tax exemptions) to cut down on harmful emissions and enhance energy security.

8.3 LNG & CNG DEMAND AS A TRANSPORTATION FUEL

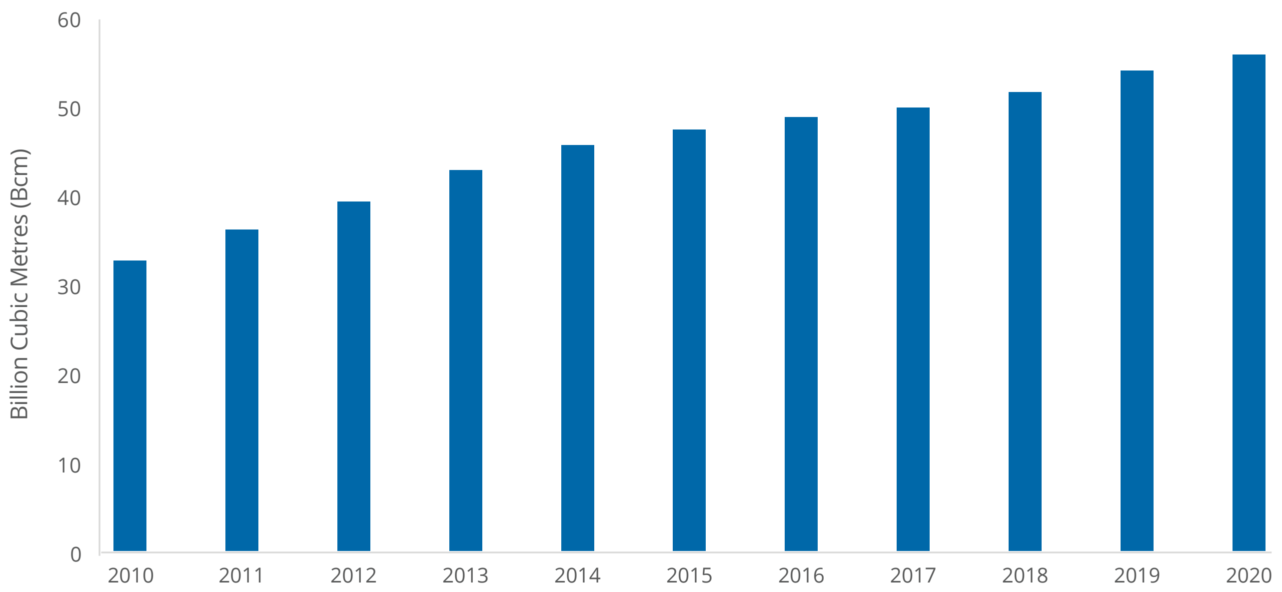
With stricter international and local environmental regulations as well as emission reduction ambitions, LNG consumption as a marine fuel has accelerated in recent years, achieving a five-fold volume growth in less than five years, reaching 1.5 million tonnes in 2020. The positive trajectory of LNG, often seen as a viable alternative fuel for the shipping industry, was on the back of a higher number of LNG-propelled vessels and development of LNG bunkering capabilities in recent years. On average, over 20 LNG-propelled vessels were added each year since 2017. With an operational fleet of 175 and order book of over 200, increasing interest in the adoption of LNG-powered vessels is anticipated to drive additional growth in demand for LNG as a marine fuel in the near term.

Figure 8.6: LNG consumption as a marine fuel, 2010-2020



Source: Rystad Energy

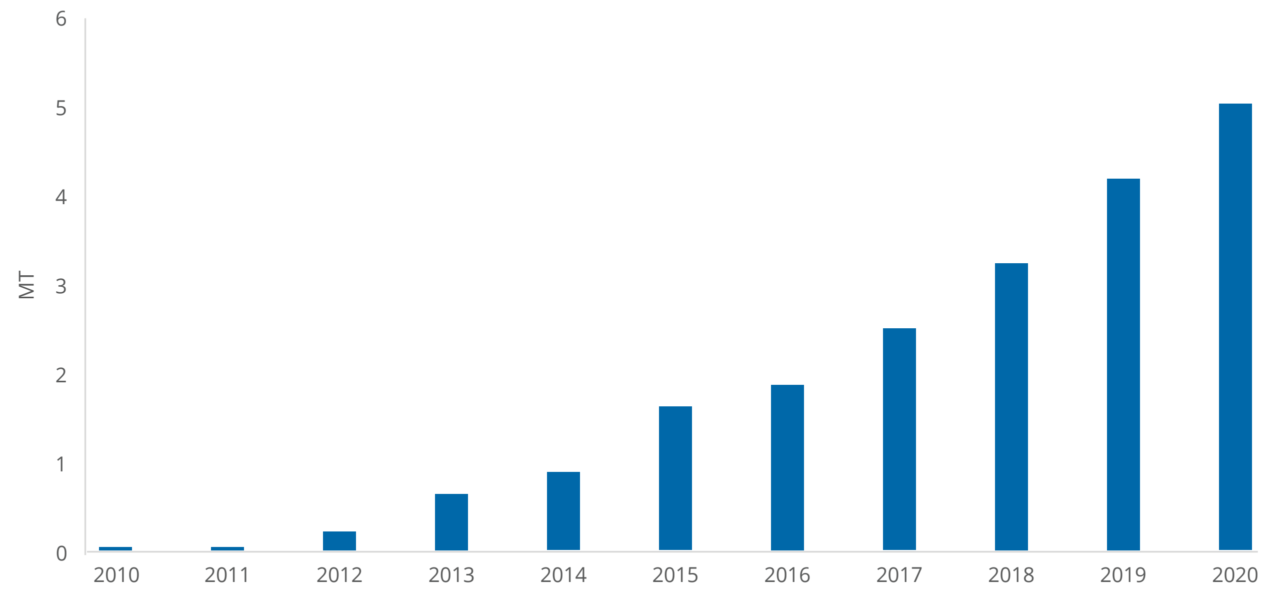
Figure 8.7: CNG consumption as a road fuel, 2010-2020



Source: Rystad Energy

With the majority of global NGV fleet composed of light-duty vehicles, CNG is currently the primary fuel driving natural gas consumption in road transportation. CNG consumption levels grew to 55.7 Bcm in 2020, experiencing a CAGR of 5.4% over the last decade. CNG demand levels have kept pace with global NGV deployment and development of gas transmission and delivery infrastructure since 2000. This is especially so in markets with high NGV penetration and well-developed refuelling networks. Global CNG fuel consumption currently arises from a small group of markets in Asia (e.g., China and India), Latin America (e.g., Argentina and Brazil) as well as Europe (e.g., Italy), with observed regional differences where urbanized cities with better-connected infrastructure generally consume more CNG as road fuel. The favourable price differential between gasoline and CNG prices has historically been critical in driving NGV penetration and CNG consumption levels. Subjected to regional differences, favourable price differentials between natural gas and gasoline have ranged from 40 to 60% on an energy equivalent basis in markets with strong penetration of NGVs. The relatively lower CNG price at the pump arose from a mix of government-led incentives (e.g., subsidies on natural gas or taxation on gasoline) in markets such as China and Italy and advantageous market mechanisms in markets with a surplus of natural gas over oil such as in Brazil, Iran, and the United States.

Figure 8.8: LNG consumption as a road fuel, 2010-2020



Source: Rystad Energy

LNG as road fuel has experienced a surge in demand in recent years, reaching a total of 11.7 million tonnes in 2020. This represents a doubling in consumption level since 2016. Among different types of natural gas as transportation fuel, LNG is generally used for long-range heavy-duty vehicles. To a large extent, this rapid expansion in fuel consumption owes to strong government efforts in markets across Asia and Europe to switch from diesel-based vehicles to alternatives in a bid to address eroding air quality. China has become the world's largest market for LNG as road fuel since the introduction of LNG as an alternative fuel for heavy-duty vehicles in the early 2010s. LNG consumption as an automotive fuel is, to a large extent, correlated with the cost competitiveness LNG fuel has over diesel. This in turn plays a role in shaping the purchase decisions of the typically higher priced LNG-propelled vehicles by minimizing the payback period. Governmental policies were also critical in driving adoption of LNG vehicles and LNG consumptions. One significant driver of LNG heavy-duty vehicle uptake relates to the enforcement of upgraded national emission standards (China VI) in July 2019 which tightened emission standards for nitrogen oxide and particulate matter. A surge in LNG truck purchases was also observed during 2017 partly in response to a ban on diesel trucks at Northern ports such as Hebei and Shandong and in the city of Tianjin. Europe is another demand centre for LNG as road fuel, particularly in the high mileage heavy-duty vehicle sector where alternative fuel technology (e.g., hydrogen fuel cell) has yet to attain comparable levels of technology and commercial readiness. With a growing preference for an LNG-fuelled fleet from haulage, logistics and transportation sectors across European markets such as Belgium, France, and the UK, LNG consumption as a road fuel is anticipated to pick up in the near term. Notably, the number of new registrations for LNG-powered vehicles in Europe increased almost three-fold in 2019 from the previous year.

9. References used in 2021 Edition

9.1 Data Collection

Data in Chapters 1, 2, 5, 6, 7 and 8 of the 2021 IGU World LNG Report is sourced from a range of public and private domains, including 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), GIIGNL, Rystad Energy, Refinitiv Eikon, DNV GL, Barry Rogliano Salles (BRS), company reports and announcements. Additionally, 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. .

Data Collection for Chapter 3

Data in Chapter 3 of the 2021 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.

Data Collection for Chapter 4

Data in Chapter 4 of the 2021 IGU World LNG Report is sourced from S&P Platts. 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.

Preparation and Publication of the 2021 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:

- American Gas Association (AGA), USA: Ted Williams
- Bureau Veritas, France: Carlos Guerrero
- Chevron, USA: Elias Cortina, Kevin Maxian
- Enagás, Spain: Angel Rojo Blanco, Alberto Crisostomo Garcia
- GIIGNL, France: Vincent Demoury, Ekaterina Dukhanina
- KOGAS, S. Korea: Taeki Kim, Youngkyeng Heo
- S&P Platts, Singapore: Kenneth Foo, Samer Mosis
- Rystad Energy, Norway: Martin Opdal, Jon Fredrik Müller, Ally Jitao Chen, Rishi Kashyap, Le Wen Chong
- Shell, The Netherlands: Birthe van Vliet

9.2 Definitions

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

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

East and West of Suez: The terms East and West of Suez refer to the location where 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.

Forecasted Data: Forecasted liquefaction and regasification capacity data only considers existing and sanctioned 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.

9.3 Regions and Basins

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

Figure 9.1: Grouping of markets into regions

9.4 ACRONYMS

CAPEX = Capital Expenditures
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 and 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 Expenditures
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

9.5 UNITS

bbl = barrel
bcfd = billion cubic feet per dat
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

9.6 Conversion Factors

Table 9.1: Overview of Conversion Factors

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

9.7 DISCREPANCIES IN DATA VS. PREVIOUS IGU WORLD LNG REPORTS

Due to the use of different data sources in the 2021 IGU World LNG Report compared to earlier IGU World LNG Reports, there may be some data discrepancies between stated totals for 2020 and earlier in this report, compared to those same totals stated in earlier reports.

In addition, the Trade section of this report is based on data from GIIGNL, whereas the remaining sections have used a wide range of sources. This has resulted in minor differences in the numbers reflected for total LNG trade, etc.

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	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; Total;	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%); Qatar Petroleum; ExxonMobil; Total; 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%); Qatar Petroleum; ExxonMobil; Total; Marubeni; Mitsui	AP-C3MR
8	Qatar	Qatargas 1 T3	1998	3.20	Qatargas* (0%); Qatar Petroleum; ExxonMobil; Total; 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%); Qatar Petroleum; ExxonMobil; 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; Total; Eni	AP-C3MR
8	Qatar	Rasgas 1 T2	2000	3.30	Qatargas* (0%); Qatar Petroleum; ExxonMobil; ITOCHU; Korea Gas; Sojitz; Sumitomo; Samsung; Hyundai; SK Energy; LG International; Daesung; Hanwha Energy	AP-C3MR
11	Oman	Oman LNG T1-T2	2000	7.10	Oman LNG* (0%); Omani Government; Shell; Total; Korea LNG; Mitsubishi Corp; Mitsui; Partex (Gulbenkian Foundation); ITOCHU	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
9	Trinidad and Tobago	Atlantic LNG T2	2002	3.30	Atlantic LNG* (0%); Shell; BP	Cono-coPhillips Optimized Cascade
10	Nigeria	NLNG T3	2002	3.30	NNPC (Nigeria)*; Shell; Total; 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	Cono-coPhillips 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%); Qatar Petroleum; ExxonMobil	AP-C3MR/ SplitMR
8	Qatar	Rasgas 2 T4	2005	4.70	Qatargas* (0%); Qatar Petroleum; ExxonMobil	AP-C3MR/ SplitMR
9	Trinidad and Tobago	Atlantic LNG T4	2005	5.20	Atlantic LNG* (0%); Shell; BP; NGC	Cono-coPhillips Optimized Cascade
10	Nigeria	NLNG T4	2005	4.10	NNPC (Nigeria)*; Shell; Total; 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	Cono-coPhillips Optimized Cascade
10	Nigeria	NLNG T5	2006	4.10	NNPC (Nigeria)*; Shell; Total; 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; Total; Korea LNG; Mitsui; Partex (Gulbenkian Foundation)	AP-C3MR
13	Egypt	Egyptian LNG (Idku) T1-T2	2005	7.20	Shell*; Petronas; EGPC (Egypt); EGAS; Total	Cono-coPhillips Optimized Cascade
10	Nigeria	NLNG T5	2006	4.10	NNPC (Nigeria)*; Shell; Total; 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; Total; Korea LNG; Mitsui; Partex (Gulbenkian Foundation)	AP-C3MR
14	Australia	Darwin LNG T1	2006	3.70	Santos*; Inpex; Eni; Tokyo Electric; Tokyo Gas	Cono-coPhillips Optimized Cascade
8	Qatar	Rasgas 2 T5	2007	4.70	Qatargas* (0%); Qatar Petroleum; ExxonMobil	AP-C3MR/ SplitMR
10	Nigeria	NLNG T6	2007	4.10	NNPC (Nigeria)*; Shell; Total; Eni	AP-C3MR
15	Equatorial Guinea	EG LNG T1	2007	3.70	Marathon Oil*; Sonagas G.E.; Mitsui; Marubeni	Cono-coPhillips Optimized Cascade
16	Norway	Snohvit LNG T1	2007	4.20	Equinor*; Petoro; Total; 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

[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
8	Qatar	Qatargas 2 T4-T5	2009	15.60	Qatargas* (0%); Qatar Petroleum; ExxonMobil; Total	AP-X
8	Qatar	Rasgas 3 T6-T7	2009	15.60	Qatargas* (0%); Qatar Petroleum; ExxonMobil	AP-X
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	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%); Qatar Petroleum; 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%); Qatar Petroleum; Shell	AP-X
21	Australia	Pluto LNG T1	2012	4.90	Woodside*; Kansai Electric; Tokyo Gas	Shell Propane Precooled 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; Total; 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; Total; 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
30	Malaysia	Petronas FLNG Satu	2017	1.20	Petronas*	AP-N

[1] Yemen LNG has not exported since 2015 due to 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
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	ConocoPhillips Optimized Cascade
32	Russia	Yamal LNG T1	2017	5.50	Novatek*; CNPC; Total; 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	ConocoPhillips Optimized Cascade
32	Russia	Yamal LNG T2	2018	5.50	Novatek*; CNPC; Total; Silk Road Fund	AP-C3MR
33	Cameroon	Cameroon FLNG	2018	2.40	Golar*	Black and Veatch PRICO
34	United States	Cove Point LNG T1	2018	5.25	Dominion Cove Point LNG LP*	AP-C3MR
32	Russia	Yamal LNG T2	2018	5.50	Novatek*; CNPC; Total; Silk Road Fund	AP-C3MR
33	Cameroon	Cameroon FLNG	2018	2.40	Golar*	Black and Veatch 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*	ConocoPhillips Optimized Cascade
32	Russia	Yamal LNG T3	2019	5.50	Novatek*; CNPC; Total; Silk Road Fund	AP-C3MR
35	Australia	Ichthys LNG T1-T2	2019	8.90	Inpex*; Total; CPC ; Tokyo Gas; Kansai Electric; Osaka Gas; Chubu Electric; Toho Gas	AP-C3MR/ SplitMR
36	Argentina	Tango FLNG	2019	0.50	Exmar*	Black and Veatch PRICO
37	United States	Corpus Christi T1	2019	4.50	Cheniere Energy*	ConocoPhillips Optimized Cascade
38	United States	Cameron LNG T1	2019	4.00	Cameron LNG* (0%); Sempra; Mitsui; Total; Mitsubishi Corp; Nippon Yusen Kabushiki Kaisha	AP-C3MR/ SplitMR
37	United States	Corpus Christi T2	2019	4.50	Cheniere Energy*	ConocoPhillips 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; Total; Mitsubishi Corp; Nippon Yusen Kabushiki Kaisha	AP-C3MR/ SplitMR
42	United States	Elba Island T4-T10	2020	1.75	Southern LNG* (0%); Kinder Morgan; EIG Partners	Shell MMLS

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
43	Indonesia	Sengkang LNG T1	2021	0.50	Energy World*	Chart Industries IPSMR
44	Malaysia	Petronas FLNG Dua	2021	1.50	Petronas*	AP-N
45	Russia	Portovaya LNG T1	2021	1.50	Gazprom*	Linde LIMUM
32	Russia	Yamal LNG T4	2021	0.90	Novatek*; CNPC; Total; Silk Road Fund	Novatek Arctic Cascade
37	United States	Corpus Christi T3	2021	4.50	Cheniere Energy*	ConocoPhillips Optimized Cascade
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 South 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; Total; JOGMEC; Mitsui	Linde MFC
48	United States	Calcasieu Pass LNG T1-T18	2022	10.00	Venture Global LNG*	BHGE SMR
49	Mauritania	Tortue/Ahmeyim FLNG T1	2023	2.50	BP*; Kosmos Energy; Petrosen; Société Mauritanienne des Hydrocarbures	Black and Veatch PRICO
29	United States	Sabine Pass T6	2023	5.00	Cheniere Energy*	ConocoPhillips Optimized Cascade
47	Russia	Arctic LNG 2 T2	2024	6.60	Novatek*; CNOOC; CNPC; Total; JOGMEC; Mitsui	Linde MFC
50	Mexico	Energía Costa Azul T1	2024	3.25	Sempra*	AP-C3MR
10	Nigeria	NLNG T7	2024	8.00	NNPC (Nigeria)*; Shell; Total; Eni	AP-C3MR
51	United States	Golden Pass LNG T1-T2	2024	10.40	Golden Pass Products*; Qatar Petroleum; ExxonMobil	AP-C3MR/SplitMR
52	Canada	LNG Canada T1-T2	2025	14.00	Shell*; Petronas; Mitsubishi Corp; PetroChina; Korea Gas	Shell DMR
53	Mozambique	Mozambique LNG (Area 1) T1-T2	2 025	12.88	Total*; Mitsui; ONGC (India); ENH (Mozambique); Bharat Petroleum Corp (BPCL); PTTEP (Thailand); Oil India	AP-C3MR
51	United States	Golden Pass LNG T3	2025	5.2	Golden Pass Products*; Qatar Petroleum; ExxonMobil	AP-C3MR/SplitMR
47	Russia	Arctic LNG 2 T3	2026	6.6	Novatek*; CNOOC; CNPC; Total; JOGMEC; Mitsui	Linde MFC
8	Qatar	QatarGas North Field East Expansion (T1 – 4)	2025	32.0	Qatargas* (0%); Qatar Petroleum	AP-X

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%)".

Appendix 3: Table of Global Active LNG Fleet, Year-End 2019

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	SSD	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, lino, Mitsui, Nakilat	Daewoo	216,200	Membrane	Q-Flex	SSD	2008
9325697	Al Areesh	Teekay	Daewoo	151,700	Membrane	Conventional	Steam	2007
9431147	Al Bahiya	Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSD	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	SSD	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	SSD	2007
9337987	Al Ghariya	Commerz Real, Nakilat, PRONAV	Daewoo	210,200	Membrane	Q-Flex	SSD	2008
9337717	Al Gharrafa	Nakilat, OSC	Hyundai	216,200	Membrane	Q-Flex	SSD	2008
9397286	Al Ghashamiya	Nakilat	Samsung	217,600	Membrane	Q-Flex	SSD	2009
9372743	Al Ghuwairiya	Nakilat	Daewoo	263,300	Membrane	Q-Max	SSD	2008
9337743	Al Hamla	Nakilat, OSC	Samsung	216,200	Membrane	Q-Flex	SSD	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	SSD	2008
9132791	Al Jasra	J4 Consortium	Mitsubishi	137,200	Spherical	Conventional	Steam	2000
9324435	Al Jassasiya	Maran G.M, Nakilat	Daewoo	145,700	Membrane	Conventional	Steam	2007
9431123	Al Karaana	Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSD	2009
9397327	Al Kharaitiyat	Nakilat	Hyundai	216,300	Membrane	Q-Flex	SSD	2009
9360881	Al Kharsaah	Nakilat, Teekay	Samsung	217,000	Membrane	Q-Flex	SSD	2008
9431111	Al Khattiya	Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSD	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	SSD	2008
9397315	Al Mafyar	Nakilat	Samsung	266,400	Membrane	Q-Max	SSD	2009
9325685	Al Marrouna	Nakilat, Teekay	Daewoo	152,600	Membrane	Conventional	Steam	2006
9397298	Al Mayeda	Nakilat	Samsung	266,000	Membrane	Q-Max	SSD	2009
9431135	Al Nuaman	Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSD	2009
9360790	Al Oraiq	NYK, K Line, MOL, lino, Mitsui, Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSD	2008
9086734	Al Rayyan	J4 Consortium	Kawasaki	137,400	Spherical	Conventional	Steam	1997
9397339	Al Rekayyat	Nakilat	Hyundai	216,300	Membrane	Q-Flex	SSD	2009
9337951	Al Ruwais	Commerz Real, Nakilat, PRONAV	Daewoo	210,200	Membrane	Q-Flex	SSD	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
9397341	Al Sadd	Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSD	2009
9337963	Al Safliya	Commerz Real, Nakilat, PRONAV	Daewoo	210,200	Membrane	Q-Flex	SSD	2007
9360855	Al Sahla	NYK, K Line, MOL, lino, Mitsui, Nakilat	Hyundai	216,200	Membrane	Q-Flex	SSD	2008
9388821	Al Samriya	Nakilat	Daewoo	263,300	Membrane	Q-Max	SSD	2009
9360893	Al Shamal	Nakilat, Teekay	Samsung	217,000	Membrane	Q-Flex	SSD	2008
9360831	Al Sheehaniya	Nakilat	Daewoo	210,200	Membrane	Q-Flex	SSD	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	SSD	2008
9360867	Al Utouriya	NYK, K Line, MOL, lino, Mitsui, Nakilat	Hyundai	215,000	Membrane	Q-Flex	SSD	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.	87,300	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

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
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
9401295	Barcelona Knutsen	Knutsen OAS	Daewoo	173,400	Membrane	Conventional	TFDE	2009
9613159	Beidou Star	MOL, China LNG	Hudong-Zhonghua	171,800	Membrane	Conventional	SSD	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	Mitsui	137,500	Spherical	Conventional	Steam	1998
9388833	Bu Samra	Nakilat	Samsung	266,000	Membrane	Q-Max	SSD	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	170,799	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

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9684495	BW Singapore	BW	Samsung	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
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 LNG INC	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	DFM	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

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
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
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	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9779226	Diamond Gas Orchid	NYK	Mitsubishi	165,000	Spherical	Conventional	STaGE	2018
9779238	Diamond Gas Rose	NYK	Mitsubishi	165,000	Spherical	Conventional	STaGE	2018
9810020	Diamond Gas Sakura	NYK	Mitsubishi	165,000	Spherical	Conventional	STaGE	2019
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	SSD	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 Tankers	STX	159,700	Membrane	Conventional	TFDE	2015
9405588	Energy Confidence	Tokyo Gas, NYK	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

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
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 Tankers	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 Inc.	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
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	Frontline	Hyundai	174,000	Membrane	Conventional	X-DF	2020
9851634	Flex Artemis	Flex LNG Limited	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9857365	Flex Aurora	Frontline	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 Limited	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9360817	Fraiha	NYK, K Line, MOL, lino, Mitsui, Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSD	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

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
9256200	Fuwairit	MOL	Samsung	138,262	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
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 Inc.	Daewoo	173,400	Membrane	Conventional	ME-GI	2020
9626027	Golar Celsius	Golar Power	Samsung	160,000	Membrane	Conventional	TFDE	2013
9269207	Global Energy	TOTAL	Chantiers de l'Atlantique	74,100	Membrane	Conventional	Steam	2004
9253105	Golar Arctic	Golar LNG	Daewoo	140,000	Membrane	Conventional	Steam	2003
9626039	Golar Bear	Golar LNG	Samsung	160,000	Membrane	Conventional	TFDE	2014
9626027	Golar Celsius	Golar Power	Samsung	160,000	Membrane	Conventional	TFDE	2013
9624926	Golar Crystal	Golar LNG	Samsung	160,000	Membrane	Conventional	TFDE	2014
9624940	Golar Eskimo	Golar LNG Partners	Samsung	160,000	Membrane	FSRU	TFDE	2014
7361922	Golar Freeze	Golar LNG Partners	HDW	125,000	Spherical	FSRU	Steam	1977
9655042	Golar Frost	Golar LNG	Samsung	160,000	Membrane	Conventional	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
9654696	Golar Glacier	Golar LNG	Hyundai	162,000	Membrane	Conventional	TFDE	2014
9303560	Golar Grand	Golar LNG Partners	Daewoo	145,000	Membrane	Conventional	Steam	2005
9637325	Golar Ice	Golar LNG	Samsung	160,000	Membrane	Conventional	TFDE	2015
9633991	Golar Igloo	Golar LNG Partners	Samsung	170,000	Membrane	FSRU	TFDE	2014
9654701	Golar Kelvin	Golar LNG	Hyundai	162,000	Membrane	Conventional	TFDE	2015
9320374	Golar Maria	Golar LNG Partners	Daewoo	145,000	Membrane	Conventional	Steam	2006
9785500	Golar Nanook	Golar Power	Samsung	170,000	Membrane	FSRU	DFDE	2018
9624938	Golar Penguin	Golar Power	Samsung	160,000	Membrane	Conventional	TFDE	2014
9624914	Golar Seal	Golar LNG	Samsung	160,000	Membrane	Conventional	TFDE	2013
9635315	Golar Snow	Golar LNG	Samsung	160,000	Membrane	Conventional	TFDE	2015
9655808	Golar Tundra	Golar LNG	Samsung	170,000	Membrane	FSRU	TFDE	2015
9256614	Golar Winter	Golar LNG Partners	Daewoo	138,000	Membrane	FSRU	Steam	2004
9315707	Grace Acacia	NYK	Hyundai	150,000	Membrane	Conventional	Steam	2007
9315719	Grace Barleria	NYK	Hyundai	150,000	Membrane	Conventional	Steam	2007
9323675	Grace Cosmos	MOL, NYK	Hyundai	150,000	Membrane	Conventional	Steam	2008
9540716	Grace Dahlia	NYK	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	30,422	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
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

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
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 Principia	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	SSD	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
9629598	Lena River	Dynagas	Hyundai	155,000	Membrane	Conventional	DFDE	2013
9064085	Lerici	ENI	Sestri	65,300	Membrane	Conventional	Steam	1998
9388819	Lijmiliya	Nakilat	Daewoo	263,300	Membrane	Q-Max	SSD	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	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

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
9277620	LNG Dream	NYK	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, KPCO	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	Osaka Gas, NYK	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	Osaka Gas, MOL	Mitsubishi	155,000	Spherical	Conventional	Steam reheat	2016
9834325	LNG Megrez	MOL, Shanghai LNG	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2020
9834301	LNG Merak	MOL (Mitsui),COSCO	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2020
9322815	LNG Ogun	NYK	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	Hudong-Zhonghua	174,000	Membrane	Conventional	X-DF	2020
9256602	LNG Pioneer	MOL	Daewoo	138,000	Membrane	Conventional	Steam	2005
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	TOTAL	Chantiers de l'Atlantique	154,500	Membrane	Conventional	DFDE	2006
9645736	LNG Venus	Osaka Gas, MOL	Mitsubishi	155,000	Spherical	Conventional	Steam	2014
9490961	Lobito	Mitsui, NYK, Teekay	Samsung	160,400	Membrane	Conventional	TFDE	2011

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
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 G.M, Nakilat	Daewoo	145,800	Membrane	Conventional	Steam	2005
9753014	Maran Gas Chios	Maran Gas Maritime	Daewoo	173400	Membrane	Conventional	ME-GI	2019
9331048	Maran Gas Coronis	Maran G.M, 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
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 Inc.	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 G.M, Nakilat	Daewoo	173,400	Membrane	Conventional	ME-GI	2018
9658240	Maran Gas Troy	Maran Gas Maritime	Daewoo	159,800	Membrane	Conventional	TFDE	2015

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
9709491	Maran Gas Ulysses	Maran Gas Maritime	Hyundai	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 JSC	Hyundai	174,000	Membrane	FSRU	TFDE	2018
9770438	Marvel Crane	NYK	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	MOL	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	SSD	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	SSD	2009
9321768	Methane Alison Victoria	GasLog	Samsung	145,000	Membrane	Conventional	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	Shell	Samsung	170,000	Membrane	Conventional	TFDE	2010
9321770	Methane Nile Eagle	Shell, Gaslog	Samsung	145,000	Membrane	Conventional	Steam	2007
9425277	Methane Patricia Camila	Shell	Samsung	170,000	Membrane	Conventional	TFDE	2010
9253715	Methane Princess	Golar LNG Partners	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	138,270	Membrane	Conventional	Steam	2004

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
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	SSD	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, Iino, Mitsui, Nakilat	Daewoo	210,100	Membrane	Q-Flex	SSD	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	Golar LNG Partners	Rosenberg Verft	125,003	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	SSD	2009
9761267	Ougarta	HYPROC	Hyundai	171,800	Membrane	Conventional	TFDE	2017
9621077	Pacific Arcadia	NYK	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	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

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
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	SSD	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	170,132	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.	87,300	Self-Supporting Prismatic	Conventional	Steam	1993
9064073	Portovenere	ENI	Sestri	65,300	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
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

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
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
9414632	Sevilla Knutsen	Knutsen OAS	Daewoo	173,400	Membrane	Conventional	DFDE	2010
9418365	Shagra	Nakilat	Samsung	266,300	Membrane	Q-Max	SSD	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 G.M, Nakilat	Daewoo	145,700	Membrane	Conventional	Steam	2006

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
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	177,269	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	168,423	Membrane	Conventional	SSD	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
9334284	Tangguh Batur	NYK, Sovcomflot	Daewoo	145,700	Membrane	Conventional	Steam	2008

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cm)	Cargo Type	Vessel Type	Propulsion Type	Delivery Year
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	SSD	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	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	SSD	2008
9074652	Umm Al Ashtan	National Gas Shipping Co	Kvaerner Masa	135,000	Spherical	Conventional	Steam	1997
9308431	Umm Bab	Maran G.M, Nakilat	Daewoo	145,700	Membrane	Conventional	Steam	2005
9372731	Umm Slal	Nakilat	Samsung	266,000	Membrane	Q-Max	SSD	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 Inc.	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	SSD	2010
9132818	Zekreet	J4 Consortium	Mitsui	137,500	Spherical	Conventional	Steam	1998

Source : Rystad Energy Research and Analysis

Appendix 4: Table of Global LNG Vessel Orderbook, Year-End 2020

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9873852	Bw Helios	BW	Daewoo	174,000	ME-GI	2021
9873840	Bw Lesmes	BW	Daewoo	174,000	ME-GI	2021
9877133	LNG Rosenrot	MOL (Mitsui)	Daewoo	180,000	X-DF	2021
9859739	Daewoo 2485	Alpha Tankers	Daewoo	173,400	ME-GI	2021
9874820	Daewoo 2495	Maran Gas Maritime Inc.	Daewoo	173,400	ME-GI	2021
9877145	Daewoo 2499	MOL (Mitsui)	Daewoo	176,000	X-DF	2021
9881201	Daewoo 2500	Alpha Tankers	Daewoo	173,400	ME-GI	2021
9879674	Daewoo 2501	Maran Gas Maritime Inc.	Daewoo	173,400	ME-GI	2021
9880465	Daewoo 2502	Maran Gas Maritime Inc.	Daewoo	173,400	X-DF	2021
9880477	Daewoo 2503	Maran Gas Maritime Inc.	Daewoo	173,400	X-DF	2021
9885996	Daewoo 2505	MOL	Daewoo	176,000	X-DF	2021
9892717	Daewoo 2507	Maran Gas Maritime Inc.	Daewoo	173,400	X-DF	2021
9854624	Energy Endeavour	Alpha Tankers	Daewoo	173,400	ME-GI	2021
9862308	Flex Freedom	Frontline	Daewoo	173,400	ME-GI	2021
9859741	Global Star	Maran Gas Maritime Inc.	Daewoo	173,400	ME-GI	2021
9854375	Minerva Limnos	Minerva	Daewoo	173,400	ME-GI	2021
9854363	Minerva Psara	Minerva	Daewoo	173,400	ME-GI	2021
9883742	Daewoo 2504	Maran Gas Maritime Inc.	Daewoo	173,400	X-DF	2022
9887217	Daewoo 2506	Maran Gas Maritime Inc.	Daewoo	173,400	ME-GI	2022
9901350	Daewoo 2508	Maran Gas Maritime Inc.	Daewoo	173,400	ME-GI	2022
9896921	Daewoo 2509	BW	Daewoo	173,400	ME-GI	2022
9896933	Daewoo 2510	BW	Daewoo	173,400	ME-GI	2022
9918004	Daewoo 2514	Sovcomflot	Daewoo	172,500	TFDE	2022
9918016	Daewoo 2515	Sovcomflot	Daewoo	172,500	TFDE	2023
9918028	Daewoo 2516	Sovcomflot	Daewoo	172,500	TFDE	2023
9918030	Daewoo 2517	MOL	Daewoo	172,500	TFDE	2023
9918042	Daewoo 2518	MOL	Daewoo	172,500	TFDE	2023
9918054	Daewoo 2519	MOL	Daewoo	172,500	TFDE	2023
9861811	Hudong-Zhonghua H1787A	Dynagas Ltd	Hudong-Zhonghua	174,000	TFDE	2021
9834313	LNG Phecda	MOL (Mitsui)	Hudong-Zhonghua	174,000	TFDE	2021
9878876	Mulan	China State Shipbuilding Corp.	Hudong-Zhonghua	174,000	X-DF	2021
9861809	Transgas Power	Dynagas Ltd	Hudong-Zhonghua	174,000	TFDE	2021

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9905978	Hudong--Zhonghua H1788A	K-Line	Hudong-Zhonghua	80,000	X-DF	2022
9905980	Hudong--Zhonghua H1789A	K-Line	Hudong-Zhonghua	80,000	X-DF	2022
9878888	Hudong-Zhonghua H1828A	China State Shipbuilding Corp.	Hudong-Zhonghua	174,000	X-DF	2022
9892121	Hudong-Zhonghua H1829A	Cosco Shanghai, Cosco Oil Shipping, Jiafu Shipping	Hudong-Zhonghua	174,000	X-DF	2022
9892133	Hudong-Zhonghua H1830A	Cosco Shanghai, Cosco Oil Shipping, Jiafu Shipping	Hudong-Zhonghua	174,000	X-DF	2022
Unknown	Hudong-Zhonghua H1831A	Cosco Shanghai, Cosco Oil Shipping, Jiafu Shipping	Hudong-Zhonghua	174,000	X-DF	2022
9879698	Adamastos	Capital Gas	Hyundai	174,000	X-DF	2021
9862918	Aristarchos	Capital Gas	Hyundai	174,000	X-DF	2021
9862906	Aristidis I	Capital Gas	Hyundai	174,000	X-DF	2021
9892298	Asklipios	Capital Gas	Hyundai	174,000	X-DF	2021
9884021	Asterix 1	Capital Gas	Hyundai	174,000	X-DF	2021
9862920	Attalos	Capital Gas	Hyundai	174,000	X-DF	2021
9869306	Cobia LNG	TMS Cardiff Gas	Hyundai	174,000	X-DF	2021
9869265	Cool Racer	THENAMARIS LNG INC	Hyundai	174,000	X-DF	2021
9874454	Diamond Gas Crystal	NYK, Mitsubishi, MISC	Hyundai	174,000	X-DF	2021
9874466	Diamond Gas Victoria	NYK, Mitsubishi, MISC	Hyundai	174,000	X-DF	2021
9859820	Ertugrul Gazi	Turkiye Petrolleri Anonim Ortakligi	Hyundai	170,000	DFDE	2021
9862475	Flex Vigilant	Frontline	Hyundai	170,520	X-DF	2021
9862463	Flex Volunteer	Frontline	Hyundai	174,000	X-DF	2021
9872999	Hellas Athina	Latsco	Hyundai	174,000	X-DF	2021
9872987	Hellas Diana	Latsco	Hyundai	174,000	X-DF	2021
9895238	Hyundai Samho 8025	H-Line Shipping	Hyundai	174,000	X-DF	2021
9888481	Hyundai Ulsan 2939	SK Shipping	Hyundai	180,000	X-DF	2021
9892456	Hyundai Ulsan 3157	TEN	Hyundai	174,000	X-DF	2021
9872949	LNGships Athena	TMS Cardiff Gas	Hyundai	170,520	X-DF	2021
9872901	LNGships Manhattan	TMS Cardiff Gas	Hyundai	170,520	X-DF	2021
9874040	Ravenna Knutsen	Knutsen	Hyundai	30,000	DFDE	2021
9870159	Samsung 2302	NYK	Hyundai	174,000	X-DF	2021
9870525	Scf Timmerman	Sovcomflot	Hyundai	174,000	X-DF	2021

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9902756	Hyundai Samho 8026	H-Line Shipping	Hyundai	174,000	X-DF	2022
9903920	Hyundai Samho 8033	NYK	Hyundai		X-DF	2022
9904170	Hyundai Samho 8091	Knutsen	Hyundai	174,000	X-DF	2022
9904194	Hyundai Samho 8093	Knutsen	Hyundai	174,000	X-DF	2022
9904209	Hyundai Samho 8094	Knutsen	Hyundai	174,000	X-DF	2022
9884473	Hyundai Samho S971	France LNG Shipping	Hyundai	174,000	X-DF	2022
9886732	Hyundai Ulsan 3137	Dynacom	Hyundai	200,000	X-DF	2022
9886744	Hyundai Ulsan 3138	Dynacom	Hyundai	200,000	X-DF	2022
9902902	Hyundai Ulsan 3185	Korea Line Corp.	Hyundai	174,000	X-DF	2022
9902914	Hyundai Ulsan 3186	Korea Line Corp.	Hyundai	174,000	X-DF	2022
9902926	Hyundai Ulsan 3187	Korea Line Corp.	Hyundai	174,000	X-DF	2022
9902938	Hyundai Ulsan 3188	Korea Line Corp.	Hyundai	174,000	X-DF	2022
9922976	Hyundai Ulsan 3243	Knutsen	Hyundai	174,000	X-DF	2022
9904182	Hyundai Samho 8092	Knutsen	Hyundai	174,000	X-DF	2023
9918145	Hyundai Samho 8095	Knutsen	Hyundai		X-DF	2023
9918157	Hyundai Samho 8096	Knutsen	Hyundai		X-DF	2023
9917543	Hyundai Ulsan 3189	Unknown	Hyundai	174,000	X-DF	2023
9917555	Hyundai Ulsan 3190	Unknown	Hyundai	174,000	X-DF	2023
9917567	Hyundai Ulsan 3191	Korea Line Corp.	Hyundai	174,000	X-DF	2023
9917579	Hyundai Ulsan 3198	Korea Line Corp.	Hyundai	174,000	X-DF	2023
9922988	Hyundai Ulsan 3244	Knutsen	Hyundai	174,000	X-DF	2023
9778923	Imabari Saijo 8200	NYK Line	Imabari	178,000	ME-GI	2021
9789037	Imabari Saijo 8215	Unknown	Imabari	178,000	ME-GI	2022
9789049	Imabari Saijo 8216	Unknown	Imabari	178,000	ME-GI	2022
9789051	Imabari Saijo 8217	Unknown	Imabari	178,000	ME-GI	2022
9864837	Jiangnan	Jovo Group	Jiangnan	79,800	Unknown	2021
9864849	Jiangnan	Jovo Group	Jiangnan	79,800	Unknown	2021
9864796	Celsius Canberra	Celsius Shipping	Samsung	180,000	X-DF	2021
9863182	Dorado LNG	TMS Cardiff Gas	Samsung	152,880	X-DF	2021
9864928	Gaslog Galveston	GasLog	Samsung	174,000	X-DF	2021

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9864916	Gaslog Georgetown	GasLog	Samsung	174,000	X-DF	2021
9876660	Gaslog Wellington	GasLog	Samsung	176,400	X-DF	2021
9880192	Marvel Swan	Navigare Capital Partners	Samsung	174,000	X-DF	2021
9877341	Minerva Chios	Minerva	Samsung	174,000	X-DF	2021
9869942	Minerva Kalymnos	Minerva	Samsung	174,000	X-DF	2021
9874480	Samsung 2306	France LNG Shipping	Samsung	174,000	X-DF	2021
9874492	Samsung 2307	France LNG Shipping	Samsung	174,000	X-DF	2021
9875800	Samsung 2308	TMS Cardiff Gas	Samsung	170,520	X-DF	2021
9876737	Samsung 2312	GasLog	Samsung	176,400	X-DF	2021
9878711	Samsung 2313	Celsius Shipping	Samsung	180,000	X-DF	2021
9878723	Samsung 2314	Celsius Shipping	Samsung	180,000	X-DF	2021
9903425	Samsung 2315	Sinokor	Samsung	174,000	X-DF	2021
9893606	Samsung 2355	NYK	Samsung	174,000	X-DF	2021
9884174	Hyundai Samho 8032	France LNG Shipping	Samsung	174,000	X-DF	2022
9903437	Samsung 2316	Sinokor	Samsung	174,000	X-DF	2022
9903449	Samsung 2317	Sinokor	Samsung	174,000	X-DF	2022
9903451	Samsung 2318	Sinokor	Samsung	174,000	X-DF	2022
9888766	Samsung 2319	Nisshin Shipping	Samsung	174,000	X-DF	2022
9885855	Samsung 2332	Minerva	Samsung	174,000	X-DF	2022
9889904	Samsung 2336	J.P.Morgan	Samsung	174,000	X-DF	2022
9889916	Samsung 2337	J.P.Morgan	Samsung	174,000	X-DF	2022
9903437	Samsung 2316	Sinokor	Samsung	174,000	X-DF	2022
9903449	Samsung 2317	Sinokor	Samsung	174,000	X-DF	2022
9903451	Samsung 2318	Sinokor	Samsung	174,000	X-DF	2022
9888766	Samsung 2319	Nisshin Shipping	Samsung	174,000	X-DF	2022
9885855	Samsung 2332	Minerva	Samsung	174,000	X-DF	2022
9889904	Samsung 2336	J.P.Morgan	Samsung	174,000	X-DF	2022
9889916	Samsung 2337	J.P.Morgan	Samsung	174,000	X-DF	2022

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

IMO Number	Vessel Name	Shipowner	Shipbuilder	Capacity (cbm)	Propulsion Type	Delivery Year
9896452	Samsung 2365	MISC	Samsung	174,000	X-DF	2022
9896440	Samsung 2364	MISC	Samsung	174,000	X-DF	2023
9904546	Zvezda 041	Smart LNG	Zvezda	172,600	TFDE	2023
9904675	Zvezda 042	Smart LNG	Zvezda	172,600	TFDE	2023
9904687	Zvezda 043	Smart LNG	Zvezda	172,600	TFDE	2023
9904699	Zvezda 044	Smart LNG	Zvezda	172,600	TFDE	2023
9904704	Zvezda 045	Smart LNG	Zvezda	172,600	TFDE	2023
Unknown	Zvezda 046	Smart LNG	Zvezda	172,600	TFDE	2024
Unknown	Zvezda 047	Smart LNG	Zvezda	172,600	TFDE	2024
Unknown	Zvezda 048	Smart LNG	Zvezda	172,600	TFDE	2024
Unknown	Zvezda 049	Smart LNG	Zvezda	172,600	TFDE	2024
Unknown	Zvezda 050	Smart LNG	Zvezda	172,600	TFDE	2024
Unknown	Zvezda 051	Smart LNG	Zvezda	172,600	TFDE	2025
Unknown	Zvezda 052	Smart LNG	Zvezda	172,600	TFDE	2025
Unknown	Zvezda 053	Smart LNG	Zvezda	172,600	TFDE	2025
Unknown	Zvezda 054	Smart LNG	Zvezda	172,600	TFDE	2025
Unknown	Zvezda 055	Smart LNG	Zvezda	172,600	TFDE	2025

Source : Rystad Energy

Appendix 5: Table of Global LNG Receiving Terminals[15]

Existing as of February 2021						
Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
1	Spain	Barcelona LNG*	1969	12.5	Enagas (100%);	Onshore
2	Japan	Negishi	1969	12	JERA (50%); Tokyo Gas (50%);	Onshore
3	United States	Everett	1971	5.4	Exelon Generation (100%)	Onshore
4	Italy	Panigaglia LNG	1971	2.5	GNL Italia (100%);	Onshore
5	France	Fos Tonkin	1972	2.2	ENGIE (100%)	Onshore
6	Japan	Senboku	1972	15.3	Osaka Gas (100%);	Onshore
7	Japan	Sodegaura	1973	29.4	JERA (50%); Tokyo Gas (50%);	Onshore
8	Japan	Tobata	1977	6.8	Kitakyushu LNG (100%);	Onshore
9	Japan	Chita LNG	1977	18.4	JERA (50%); Toho Gas (50%);	Onshore
10	United States	Elba Island LNG	1978	12	Kinder Morgan (100%);	Onshore
11	Japan	Himeji	1979	14	Osaka Gas (100%);	Onshore
12	France	Montoir-de-Bretagne	1980	7.3	ENGIE (100%);	Onshore
13	Japan	Higashi-Ohgishima	1984	14.7	JERA (100%);	Onshore
14	Japan	Higashi-Niigata	1984	8.9	Nihonkai LNG (58.1%); Tohuko Electric (41.9%);	Onshore
15	Japan	Futtsu LNG	1985	16	JERA (100%);	Onshore
16	South Korea	Pyeongtaek LNG	1986	40.6	KOGAS (100%);	Onshore
17	Belgium	Zeebrugge	1987	6.6	Fluxys LNG SA (100%)	Onshore
18	Japan	Yokkaichi LNG Center	1987	7.1	JERA (100%);	Onshore
19	Spain	Huelva*	1988	8.6	Enagas (100%);	Onshore
20	Spain	Cartagena*	1989	8.6	Enagas (100%);	Onshore
21	Japan	Yanai	1990	2.4	Chugoku Electric (100%);	Onshore
22	Japan	Oita LNG	1990	5.1	Kyushu Electric (100%);	Onshore
23	Chinese Taipei	Yung-An	1990	9.5	CPC (100%);	Onshore
24	Japan	Yokkaichi Works	1991	2.1	Toho Gas (100%);	Onshore
25	Turkey	Marmara Ereglisi	1994	5.9	Botas (100%);	Onshore
26	South Korea	Incheon	1996	52.7	KOGAS (100%);	Onshore
27	Japan	Hatsukaichi	1996	0.9	Hiroshima Gas (100%);	Onshore
28	Japan	Sodeshi	1996	1.6	Shizuoka Gas (65%); TonenGeneral (35%);	Onshore
29	Japan	Shin-Minato	1997	0.3	Sendai Gas (0%); Gas Bureau (100%);	Onshore
30	Japan	Kawagoe	1997	7.7	JERA (100%);	Onshore
31	Japan	Ohgishima	1998	9.9	Tokyo Gas (100%);	Onshore
32	United States	EcoElectrica	2000	1.2	Naturgy (47.5%); ENGIE (35%); Mitsui (15%); GE Capital (2.5%)	Onshore
33	Greece	Revithoussa	2000	4.6	DEPA (100%)	Onshore
34	Japan	Chita Midorihama Works	2001	8.3	Toho Gas (100%);	Onshore
35	South Korea	Tongyeong LNG	2002	26.6	KOGAS (100%);	Onshore
36	United States	Cove Point LNG	2003	11	Dominion Cove Point LNG (100%);	Onshore
37	Spain	Bahía de Bizkaia Gas*	2003	5.1	ENAGAS (50%); EVE (50%);	Onshore

[15] Only floating terminals with active FSRU charter(s) or have chartered FSRU vessel(s) installed at site are included in the table.
* Following the launch of Tanque Virtual de Balance (TVB) in early 2020, all storage capacities at the six operational Spanish terminals are unified into a single virtual storage tank to increase liquidity.

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

Existing as of February 2021						
Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
38	Dominican Republic	AES Andres LNG	2003	1.9	AES (92%); Estrella-Linda (8%);	Onshore
39	Portugal	Sines LNG Terminal	2004	5.8	REN (100%);	Onshore
40	India	Dahej LNG	2004	17.5	Petronet LNG (100%);	Onshore
41	India	Hazira LNG	2005	5	Shell (100%)	Onshore
42	United Kingdom	Grain LNG	2005	15	National Grid Transco (100%);	Onshore
43	South Korea	Gwangyang	2005	2.3	POSCO (100%);	Onshore
44	Japan	Sakai LNG	2006	6.4	Kansai Electric (70%); Cosmo Oil (12.5%); Iwatani (12.5%); Ube Industries (5%);	Onshore
45	China	Guangdong Dapeng LNG	2006	6.8	Local Company (37%); CNOOC (33%); BP (30%)	Onshore
46	Mexico	Terminal de LNG Altamira	2006	5.4	Vopak (60%); ENAGAS (40%);	Onshore
47	Turkey	Aliaga Izmir LNG	2006	4.4	EgeGaz (100%);	Onshore
48	Spain	Sagunto*	2006	6.4	ENAGAS (72.5%); Osaka Gas (20%); Oman Oil (7.5%);	Onshore
49	Japan	Mizushima	2006	4.3	Chugoku Electric (50%); JX Nippon Oil & Energy (50%);	Onshore
50	Spain	Mugardos LNG*	2007	2.6	Grupo Tojeiro (50.36%); Gobierno de Galicia (24.64%); First State Regasificadora (15%); Sonatrach (10%);	Onshore
51	United States	Northeast Gateway	2008	4.5	Excelerate Energy (100%);	Floating
52	United States	Freeport LNG	2008	11.3	Michael S Smith Cos (57.5%); Global Infrastructure Partners (25%); Osaka Gas (10%); Dow Chemical (7.5%);	Onshore
53	China	Wuhaogou LNG	2008	1.5	Shenergy (100%)	Onshore
54	Mexico	Energia Costa Azul	2008	7.6	Sempra Energy (100%);	Onshore
55	Italy	Adriatic LNG	2009	5.8	Exxon Mobil (46.35%); Qatar Petroleum (46.35%); Edison (7.3%);	Offshore
56	United Kingdom	South Hook	2009	15.6	Qatar Petroleum (67.5%); Exxon Mobil (24.25%); TOTAL (8.35%);	Onshore
57	Chinese Taipei	Taichung LNG	2009	6	CPC (100%);	Onshore
58	China	Fujian LNG	2009	6.3	CNOOC (60%); Fujian Investment and Development Co (40%);	Onshore
59	Chile	GNL Quintero	2009	4	ENAGAS (60.4%); ENAP (20%); Oman Oil (19.6%);	Onshore
60	Canada	Canaport LNG	2009	7.5	Repsol (75%); Irving Oil (25%);	Onshore
61	United Kingdom	Dragon LNG	2009	7.5	Shell (50%); Ancala (50%)	Onshore
62	China	Yangshan LNG (Shanghai)	2009	3	Shenergy Group (55%); CNOOC (45%);	Onshore

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

Existing as of February 2021						
Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
63	Japan	Sakaide LNG	2010	1.2	Shikoku Electric Power Co. (70%); Cosmo Oil Co. Ltd (20%); Shikoku Gas Co. (10%);	Onshore
64	France	Fos Cavaou	2010	6	ENGIE (71.5%); TOTAL (28.5%);	Onshore
65	China	Dalian LNG	2011	6	CNPC (75%); Dalian Port (20%); Dalian Construction Investment Corporation (5%);	Onshore
66	Thailand	Map Ta Phut	2011	11.5	PTT LNG (100%);	Onshore
67	Netherlands	Gate LNG	2011	9	Gasuine (50%); Vopak (50%);	Onshore
68	Argentina	GNL Escobar - Excelerate Exemplar	2011	3.8	YPF (50%); Enarsa (50%);	Floating
69	China	Jiangsu Rudong LNG	2011	6.5	CNPC (55%); Pacific Oil and Gas (35%); Jiangsu Guoxin (10%);	Onshore
70	Japan	Ishikari LNG	2012	2.7	Hokkaido Gas (100%);	Onshore
71	China	Zhejiang Ningbo LNG	2012	6	CNOOC (51%); Zhejiang Energy Company (29%); Ningbo Power (20%)	Onshore
72	Mexico	Terminal KMS	2012	3.8	Samsung (37.5%); Mitsui (37.5%); KOGAS (25%);	Onshore
73	Indonesia	Nusantara Regas Satu - FSRU Jawa Barat	2012	3.8	Pertamina (60%); PGN (40%);	Floating
74	Japan	Joetsu	2012	2.3	JERA (100%);	Onshore
75	India	Kochi LNG	2013	5	Petronet LNG (100%);	Onshore
76	China	Zhuhai LNG	2013	3.5	CNOOC (30%); Guangdong Gas (25%); Guangdong Yuedian (25%); Local companies (20%);	Onshore
77	China	Jovo Dongguan	2013	1.5	Jovo Group (100%);	Onshore
78	Japan	Naoetsu LNG	2013	1.5	INPEX (100%);	Onshore
79	Singapore	Jurong	2013	11	EMA (100%)	Onshore
80	Israel	Hadera Deepwater LNG - Excelerate Expedient	2013	3	INGL (100%);	Floating
81	Malaysia	Melaka LNG	2013	3.8	Petronas (100%);	Offshore
82	India	Dabhol LNG	2013	2	Gail (31.52%); NTPC (31.52%); Indian Financial Institutions (20.28%); MSEB Holding Co. (16.68%);	Onshore
83	China	Caofeidian (Tangshan) LNG	2013	6.5	CNPC (51%); Beijing Enterprises Group Company (29%); Hebei Natural Gas (20%);	Onshore
84	Italy	Toscana - Toscana FSRU	2013	2.7	IREN Group (49.07%); First State Investments (48.24%); Golar LNG (2.69%)	Floating
85	China	Hainan LNG	2014	4.32	PipeChina (65%); Hainan Developing Holding (35%)	Onshore
86	Japan	Hibiki LNG	2014	2.4	Saibu Gas (90%); Kyushu Electric (10%);	Onshore
87	Indonesia	Lampung LNG - PGN FSRU Lampung	2014	1.8	Terminal: PGN (100%), FSRU: Hoegh LNG (100%)	Floating

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

Existing as of February 2021						
Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
88	Chile	GNL Mejillones 2 (onshore storage)	2014	1.5	ENGIE (63%); Ameris Capital AGF(37%);	Onshore
89	Brazil	Bahia LNG - Golar Winter	2014	3.8	Petrobras (100%);	Floating
90	China	Shandong (Qingdao) LNG	2014	3	Sinopec (99%); Qingdao Port(1%);	Onshore
91	South Korea	Samcheok LNG	2014	11.6	KOGAS (100%);	Onshore
92	Lithuania	Klaipeda LNG - Hoegh Independence	2014	3	Klaipedos Nafta (100%);	Floating
93	Kuwait	Mina Al Ahmadi - Golar Igloo	2014	5.8	Golar LNG (0%); Kuwait Petroleum Corporation (100%);	Floating
94	Japan	Shin-Sendai	2015	1.5	Tohoku Electric (100%);	Onshore
95	UAE	Dubai Jebel Ali - Execelerate Explorer	2015	6	Terminal: DUSUP (100%), FSRU: Excelerate Energy (100%)	Floating
96	Jordan	Jordan LNG - Golar Eskimo	2015	3.8	Golar LNG (0%); Jordan MEMR (100%);	Floating
97	Japan	Hachinohe	2015	1.5	JX Nippon Oil & Energy (100%);	Onshore
98	Pakistan	Port Qasim Karachi - Excelerate Exquisite	2015	4.1	Terminal: Elengy Terminal Pakistan Ltd. (100%), FSRU: Excelerate Energy (100%)	Floating
99	Indonesia	Arun LNG	2015	3	Pertamina (70%); Aceh Regional Government (30%);	Onshore
100	Japan	Kushiro LNG	2015	0.5	Nippon Oil (100%);	Onshore
101	Poland	Swinoujscie	2016	3.6	Gaz-System (100%);	Onshore
102	Japan	Hitachi LNG	2016	3.8	Tokyo Gas (100%);	Onshore
103	Brazil	Pecem LNG - Excelerate Experience	2016	5.4	Petrobras (100%);	Floating
104	China	Guangxi (Beihai) LNG	2016	3	PipeChina (100%)	Onshore
105	Colombia	Cartagena (Colombia) - Hoegh Grace	2016	3	Hoegh LNG (0%); Promigas (51%); Baru LNG (49%);	Floating
106	Pakistan	Port Qasim GasPort - BW Integrity	2017	5.7	Terminal: Pakistan GasPort Consortium Limited (95%); Trafigura (5%), FSRU: BW (100%)	Floating
107	South Korea	Boryeong LNG	2017	3	GS Caltex (50%); SK E&S (50%);	Onshore
108	Malaysia	Pengerang LNG	2017	3.5	PETRONAS (65%); Dialog Group (25%); Johor Government (10%);	Onshore
109	Egypt	Sumed - BW Singapore	2017	5.7	Terminal: EGAS (100%), FSRU: BW (100%)	Floating
110	China	Qidong LNG	2017	3.05	Xinjiang Guanghui Petroleum (100%)	Onshore
111	France	Dunkirk LNG	2017	9.5	EDF (65%); Fluxys (25%); TOTAL (10%);	Onshore
112	China	Jieyang LNG (Yuedong)	2017	2	PipeChina (100%)	Onshore
113	China	Tianjin (CNOOC)	2018	3.5	CNOOC (100%);	Onshore

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

Existing as of February 2021						
Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
114	Panama	Costa Norte LNG	2018	1.5	AES Panama (50.1%); Inversiones Bahia (49.9%);	Onshore
115	China	Tianjin FSRU - Hoegh Esperanza	2018	6	Terminal: CNOOC (100%), FSRU: Hoegh LNG (100%)	Floating
116	China	Tianjin (Sinopec)	2018	3	Sinopec (100%);	Onshore
117	China	Diefu LNG (Shenzhen)	2018	4	PipeChina (70%); Shenzhen Energy Group (30%)	Onshore
118	Turkey	Dortyol - MOL FSRU Challenger	2018	4.1	Botas (100%);	Floating
119	Bangladesh	Moheshkhali - Excelerate Excellence	2018	3.75	Terminal: PetroBangla (100%), FSRU: Excelerate Energy (100%)	Floating
120	Japan	Soma LNG	2018	1.5	JAPEX (100%);	Onshore
121	China	Zhoushan ENN LNG	2018	3	ENN (100%);	Onshore
122	China	Shenzhen Gas LNG	2019	0.8	Shenzhen Gas (100%);	Onshore
123	Turkey	Etki LNG terminal - Turquoise	2019	5.7	Terminal: Etki Liman (100%), FSRU: Kolin Construction (100%)	Floating
124	India	Ennore LNG	2019	5	Indian Oil Corporation (95%); Tamil Nadu Industrial Development Corporation (5%);	Onshore
125	China	Fangchenggang LNG	2019	0.6	PipeChina (100%)	Onshore
126	Brazil	Sergipe - Golar Nanook FSRU	2019	5.6	Elbrasil (50%); Golar Power (50%);	Floating
127	Bangladesh	Moheshkhali - Excelerate Excelerate	2019	3.8	Terminal: Summit Corp (75%); Mitsubishi (25%), FSRU: Excelerate Energy (100%)	Floating
128	Jamaica	Old Harbour - Golar Freeze	2019	3.6	New Fortress Energy (100%);	Floating
129	Myanmar	Thanlyin (Thilawa) LNG	2020	1.5	CNTIC VPower (100%);	Onshore
130	India	Mundra LNG	2020	5	GSCP (50%); Adani Group (50%);	Onshore
131	Brazil	Acu Port LNG - BW Magna	2020	5.6	Prumo Logistica (46.9%); Siemens (33%); BP (20.1%)	Floating
132	United States	San Juan - New Fortress LNG	2020	0.5	New Fortress Energy (100%)	Onshore
133	Croatia	Krk - Golar FSRU	2021	1.9	Terminal: HEP (85%); Plinacro (15%), FSRU: Golar (100%)	Floating

Appendix 6: Table of LNG Receiving Terminals Under Construction[16]

Under construction as of February 2020						
Reference Number	Market	Terminal Name or Phase Name	Start Year	Nameplate Receiving Capacity (MTPA)	Owners	Concept
134	India	H-Gas LNG Gateway (Jaigarh) - Hoegh Giant	2021	6	H-Energy Gateway Private limited (100%);	Floating
135	India	Jafrabad FSRU	2021	5	Swan Energy (63%); Government of Gujarat (26%); MOL (11%)	Floating
136	Ghana	Ghana Tema	2021	2	GNPC (50%); Helios (50%)	Floating
137	China	Binhai LNG	2021	3	CNOOC (100%);	Onshore
138	El Salvador	El Salvador FSRU	2021	2.3	Energía del Pacífico (100%);	Floating
139	Nicaragua	Puerto Sandino FSRU	2021	1.3	New Fortress Energy (100%);	Floating
140	Vietnam	Hai Linh LNG	2021	1	Hai Linh Energy (100%)	Onshore
141	Indonesia	Cilamaya - Jawa 1 FSRU	2021	2.4	Pertamina (26%); Humpuss (25%); Marubeni (20%); MOL (19%); Sojitz (10%)	Floating
142	India	Karaikal LNG	2021	1	AG&P (100%);	Floating
143	Kuwait	Al-Zour LNG Import Facility	2021	22	Kuwait Petroleum Corporation (100%);	Onshore
144	Bahrain	Bahrain LNG	2021	6	Bahrain LNG WLL (0%); NOGA (30%); Teekay Corporation (30%); Gulf Investment Corporation (20%); Samsung (20%);	Offshore
145	Russia	Kaliningrad FSRU	2021	2.7	Gazprom (100%);	Floating
146	China	Chaozhou Huafeng LNG	2021	1	Sinoenergy (55%); Chaozhou Huafeng Group (45%);	Onshore
147	India	Dhamra LNG	2021	5	Adani Group (50%); Total (50%)	Onshore
148	Mexico	New Fortress LNG	2021	3	New Fortress Energy (100%);	Onshore
149	China	Zhangzhou LNG	2022	3	PipeChina (60%); Fujian Investment and Development Co (40%)	Onshore
150	Philippines	Pagbilao LNG	2022	3	Energy World Corporation (100%);	Onshore
151	Turkey	Gulf of Saros terminal - Ertugrul Gazi	2022	7.5	Botas (100%);	Floating
152	Japan	Niihama LNG	2022	0.5	Tokyo Gas (50.1%); Shikoku Electric Power (30.1%); Other Japanese Partneers (19.8%);	Onshore
153	Vietnam	Thi Vai LNG	2022	1	PetroVietnam Gas (100%);	Onshore
154	Cyprus	Cyprus FSRU	2022	0.6	DEFA (100%);	Floating
155	China	Wenzhou LNG	2022	3	Sinopec (41%); Zhejiang Group (51%); Local firms (8%);	Onshore
156	Thailand	Nong Fab LNG	2022	7.5	PTT LNG (100%);	Onshore
157	China	Yueyang LNG	2022	1.5	Guanghui Energy (50%); China Huadian (50%);	Onshore
158	China	Longkou Nanshan LNG	2023	5	PipeChina (100%);	Onshore
159	China	Yangjiang LNG	2023	2	Guangdong Yudean Power (100%);	Onshore
160	China	Tianjin (Beijing Gas)	2023	5	Beijing Gas (100%)	Onshore
161	India	Chhara LNG	2023	5	HPCL (50%); Shapoorji Pallonji (50%)	Onshore
162	China	Yantai LNG	2024	5.9	GCL-Poly (100%);	Onshore
163	Chinese Taipei	Taoyuan LNG	2026	3	CPC (100%);	Onshore

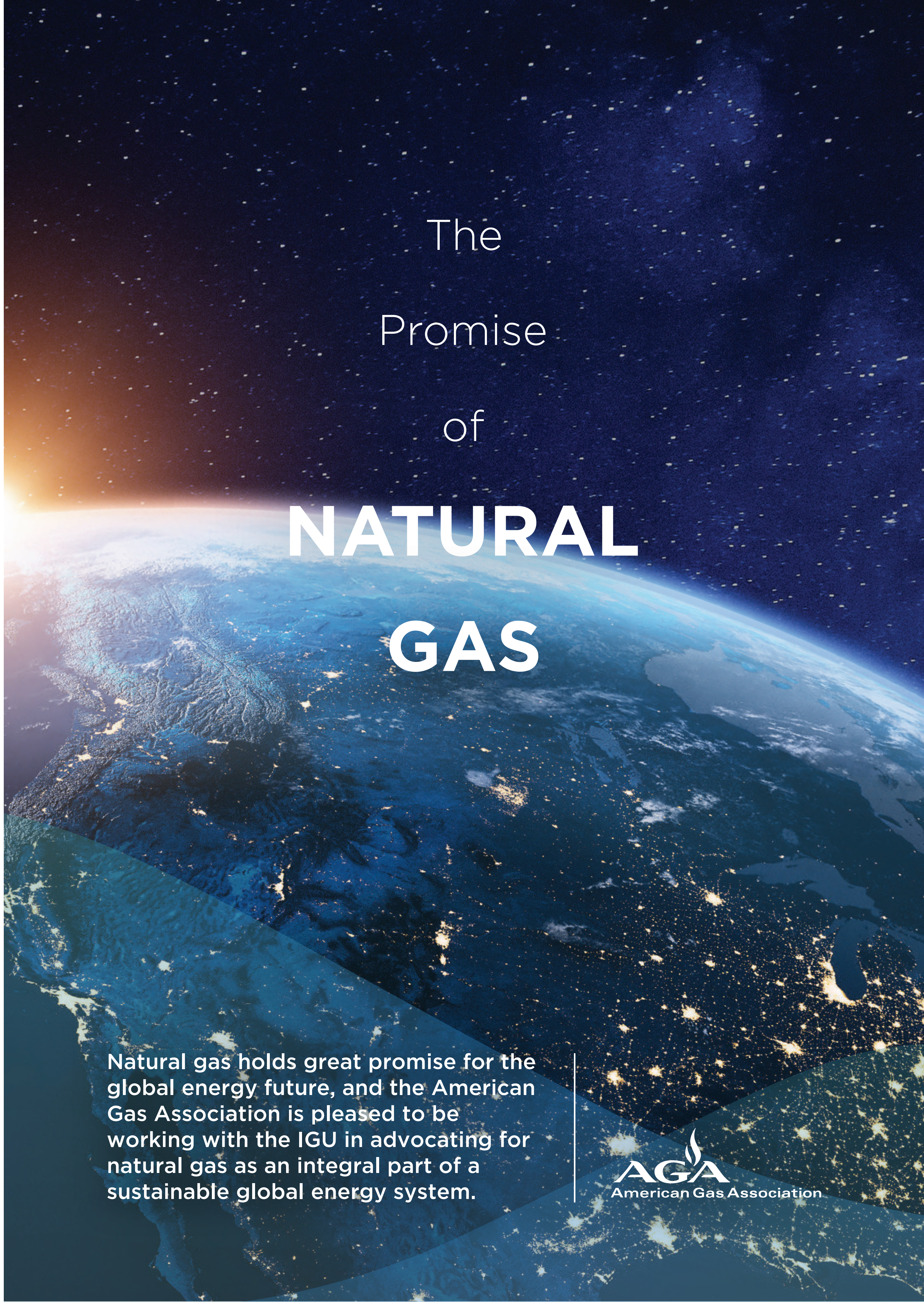
[16] Includes Russia's Kaliningrad terminal as it did not receive any cargoes after it was commissioned in January 2019. The terminal's FSRU was chartered out as an LNG carrier through December 2019. Bahrain's Bahrain LNG terminal is also included as it has yet to discharge any cargoes following its technical commissioning in January 2020.

Appendix 7: Table of Global LNG Bunkering Vessels

Operational as of February 2021					
Reference Number	Market	Vessel Name	Start Year	LNG Tank Capacity (Cubics Meters)	Concept
1	Norway	Pioneer Knutsen	2004	1,100	Bunker vessel
2	Europe	Coral Energy	2013	15,000	Bunker vessel
3	Sweden	Seagas	2013	187	Bunker vessel
4	China	Yidu inland river LNG bunker barge	2014	500	Bunker barge (by tug)
5	Belgium	ENGIE Zeebrugge	2017	5,100	Bunker vessel
6	Norway	Coralius	2017	5,600	Bunker vessel
7	The Netherlands	Cardissa	2017	6,500	Bunker vessel
8	Netherlands	Coral Methane	2018	7,551	Bunker vessel
9	Spain	Oizmendi	2018	600	Bunker vessel
10	Spain	Bunker Breeze	2018	1,200	Bunker vessel
11	United States	Clean Jacksonville	2018	2,200	Bunker barge (by tug)
12	Lithuania	Kairos	2018	7,500	Bunker vessel
13	Europe	Coral EnergICE	2018	18,000	Bunker vessel
14	Netherlands	FlexFueler 001	2019	1,480	Bunker barge (by tug)
15	Netherlands	LNG London	2019	3,000	Bunker vessel
16	Europe	Coral Fraseri	2019	10,000	Bunker vessel
17	Malaysia	Avenir Advantage	2020	7,500	Bunker vessel
18	Belgium	FlexFueler 002	2020	1,480	Bunker barge (by tug)
19	The Netherlands	Gas Agility	2020	18,600	Bunker vessel
20	Japan	Kaguya	2020	3,500	Bunker vessel
21	United States	Q-LNG ATB Bunker Barge 4000	2021	4,000	Bunker barge (by tug)
22	Singapore	FueLNG Bellina	2021	7,500	Bunker vessel

NOTES

NOTES


The
Promise
of
NATURAL
GAS
Natural gas holds great promise for the global energy future, and the American Gas Association is pleased to be working with the IGU in advocating for natural gas as an integral part of a sustainable global energy system.
AGA
American Gas Association

International Gas Union (IGU)
Att: Naturgy,
Plaça del Gas, 1,
Building C 2nd floor,
08003 Barcelona,
Spain

Telephone: + 34 93 412 97 89
Fax: + 34 93 402 54 26
E-mail: info@igu.org

Published by the International Gas Union (IGU) Copyright © 2021. The entire content of this publication is protected by copyright, full details of which are available from the publisher. All rights reserved. No part of this publication may be reproduced, stored in retrieval systems or transmitted in any form or by any means – electronic, mechanical, photocopying, recording or otherwise – without the prior permission of the copyright owner.