

The Evolution of Midstream Energy
Infrastructure: Poised for the Transition

EPISODE 8

Liquefied Natural Gas (LNG) Market Overview

AUGUST 2023

CONFIDENTIAL

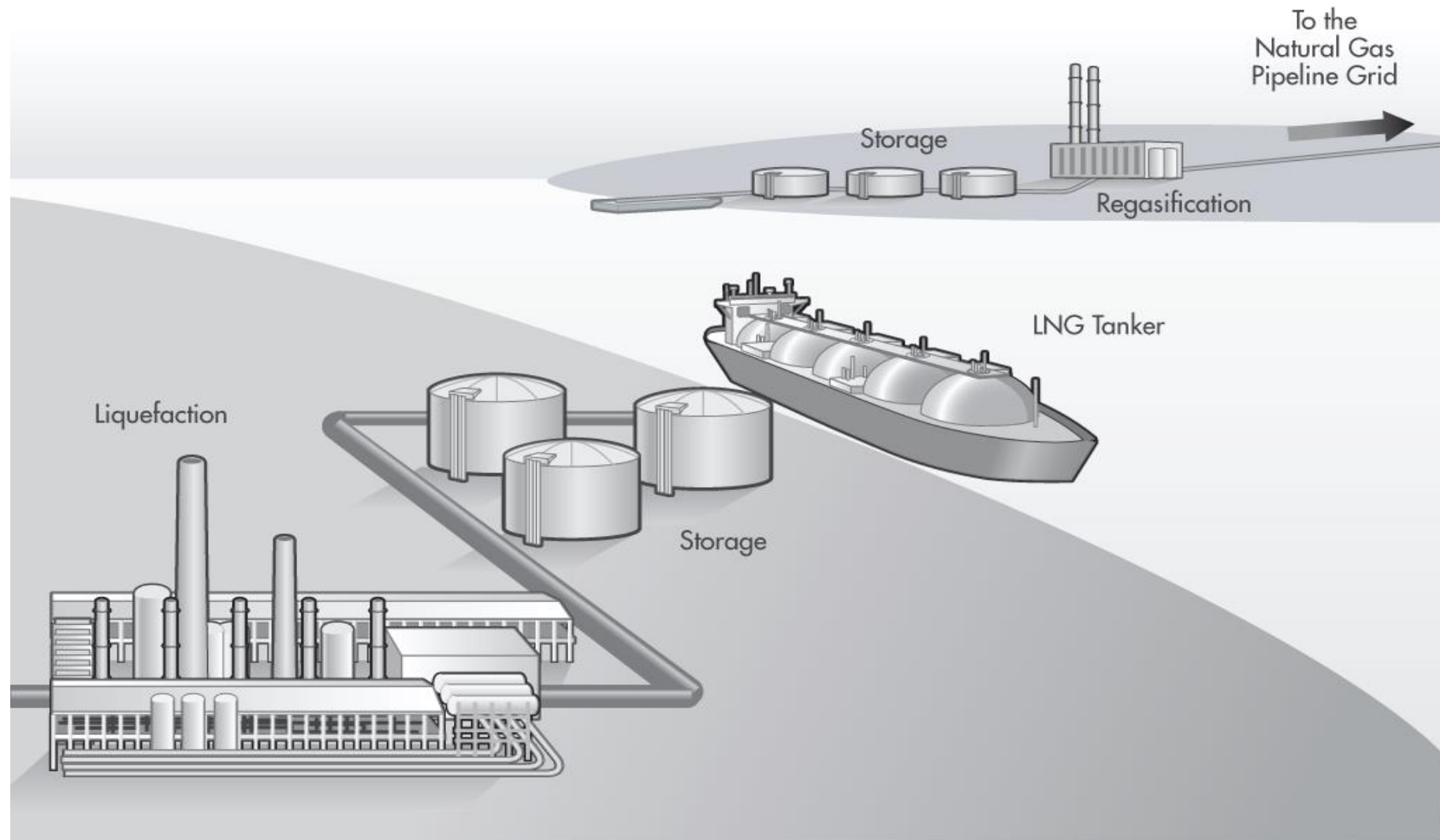
What is LNG?

- Liquefied Natural Gas (“LNG”) is natural gas that has been cooled from a gaseous state to a liquid state at a temperature of approximately -260 degrees Fahrenheit, or -162 degrees Celsius.
- By converting the natural gas to a liquid form, the volume of the LNG is ~600 times smaller when compared to natural gas in the gaseous state.
- The smaller volumetric form of LNG allows for economical long-haul transportation of natural gas where pipeline connectivity is not available.
- Shipping is the primary means of long-haul transportation of LNG, particularly when transporting to regions that do not have adequate access to the natural gas needed to support domestic consumption.
- The LNG industry is a global market where buyers and sellers from different continents can transact to ship or receive LNG.



The LNG process begins with natural gas entering a liquefaction facility where it is cooled into a liquid form. From there, the LNG is sent to cooled storage facilities via pipeline where the gas is held until loaded onto LNG tanker ships.

The ships transport the LNG to import terminals where the gas is sent through a regasification process to restore the gas back to a gaseous state where it can be sent via pipeline to the end-use consumers.

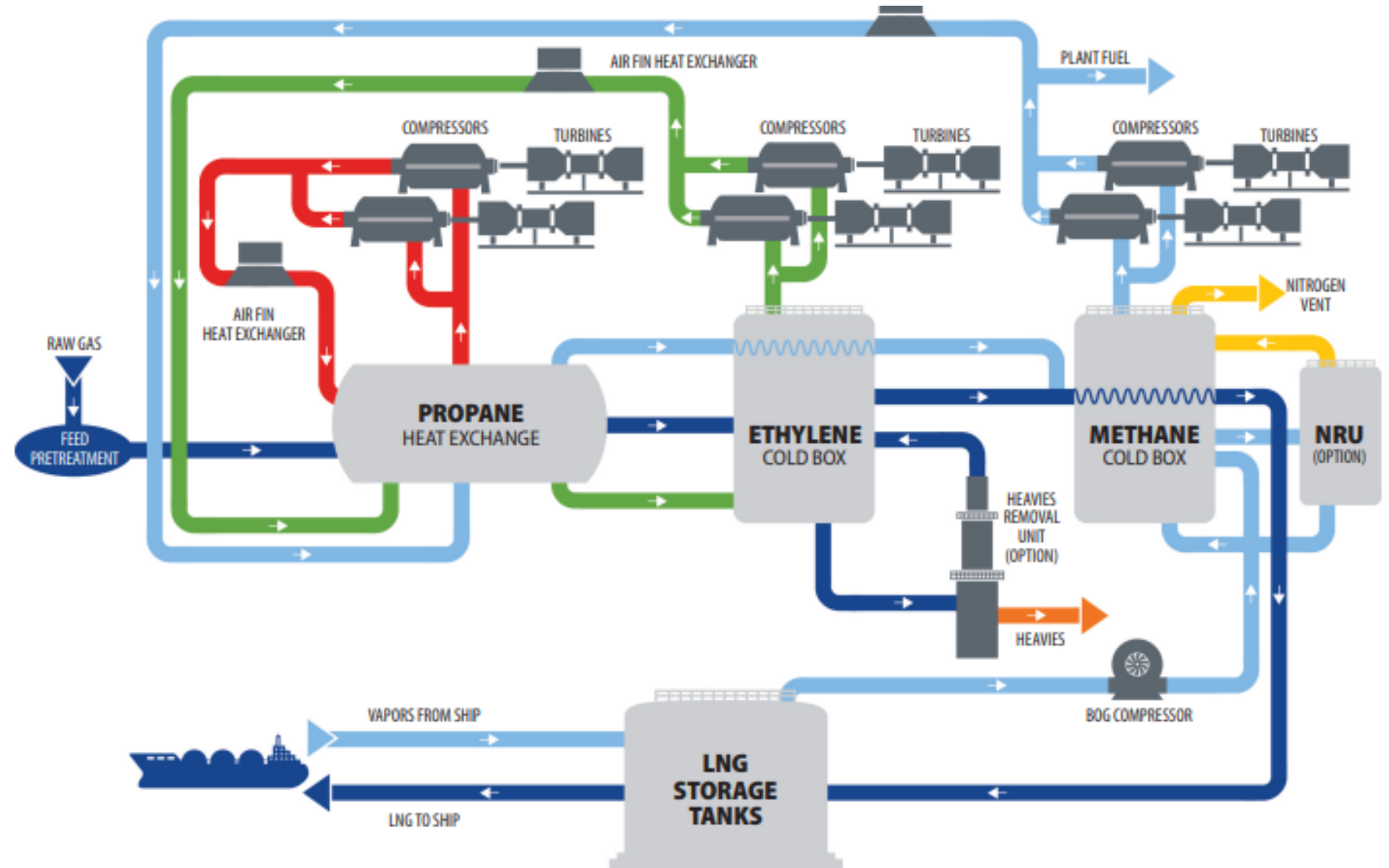


Source:
<https://energyknowledgebase.com/topics/liquefied-natural-gas.asp>

Liquefaction Process

There are multiple process designs for liquefaction, but all processes generally involve heat exchangers, refrigerants, and compressors.

In this diagram, natural gas moves through three refrigeration cycles where the natural gas is progressively cooled to a temperature of -260 degrees Fahrenheit, or -162 degrees Celsius.



Source: Conoco Phillips Optimized Cascade Process

Global demand for LNG is expected to increase over the next decade, primarily driven by Asian demand growth.

The expected growth in Asian markets will be used for energy security, reducing CO2 emissions from existing power generation, and for further economic development.

Incremental LNG demand 2020-2040



Source: Shell LNG Outlook 2022

Asian markets represented ~65% of global demand in 2022 with Japan, China, and South Korea representing almost 50% of global demand.

European markets represented ~20% of global demand in 2022.

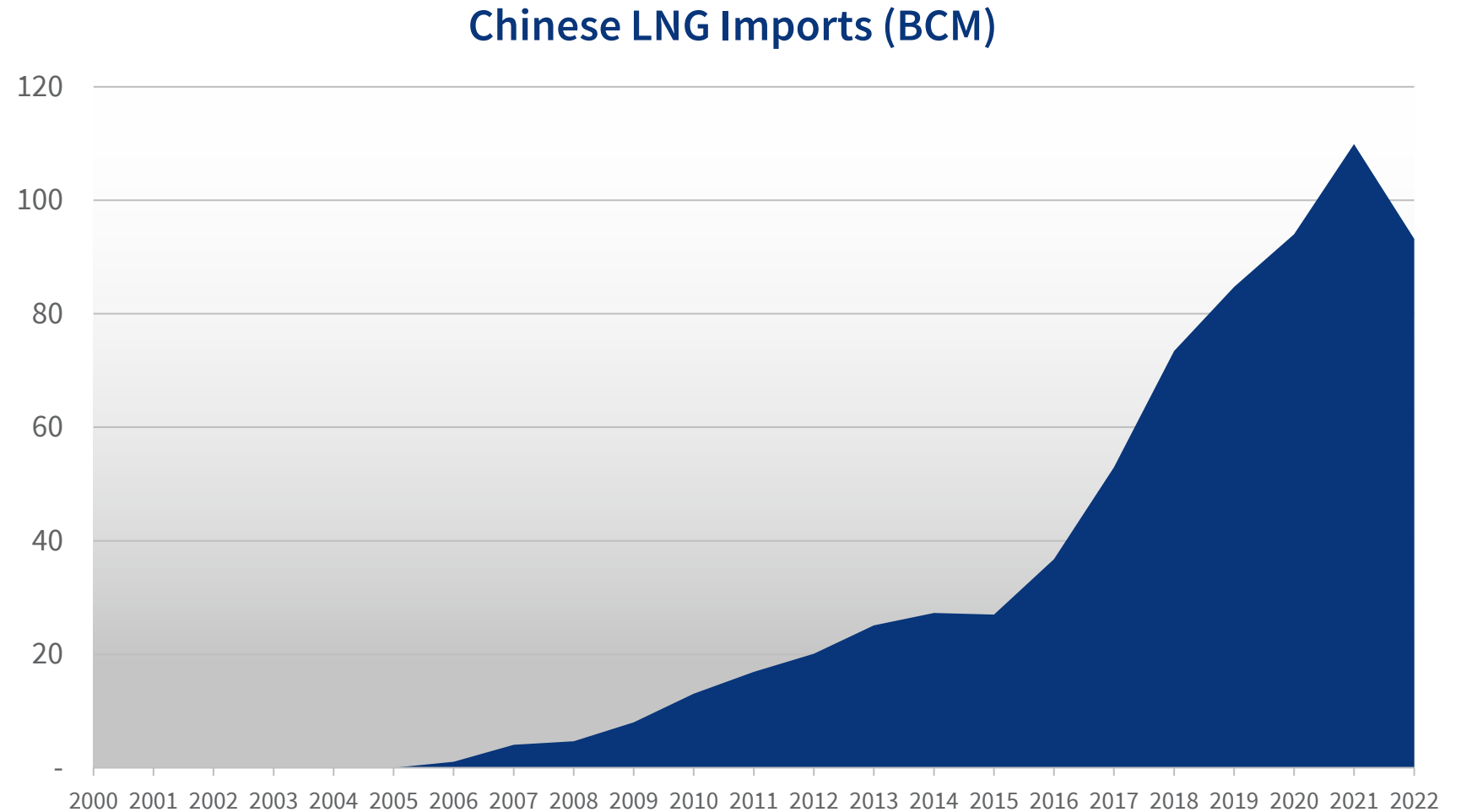
Demand (2022)	BCM	mt	Bcf	Bcf/d	%
Japan	98.1	72.1	3,463	9.49	18.5%
China	86.0	63.3	3,038	8.32	16.3%
South Korea	64.1	47.2	2,264	6.20	12.1%
France	33.6	24.8	1,188	3.25	6.4%
Taiwan	27.1	20.0	958	2.62	5.1%
India	27.1	19.9	956	2.62	5.1%
Spain	26.2	19.3	927	2.54	5.0%
UK	25.6	18.8	904	2.48	4.8%
Netherlands	16.2	11.9	572	1.57	3.1%
Turkey	14.5	10.7	511	1.40	2.7%
Other	110.4	81.2	3,899	10.68	20.9%
Total	529	389	18,680	51.2	100%

Source: GIGNL Annual Report 2023

China is now one of the world's largest importers of LNG. This growth in LNG demand has been spurred by the significant growth in the industrial and manufacturing industries over the last decade.

Chinese domestic production of natural gas is limited due to geographical constraints, resulting in the need for increased LNG imports to meet increasing domestic demand.

Source: Statistical Review of World Energy 2023



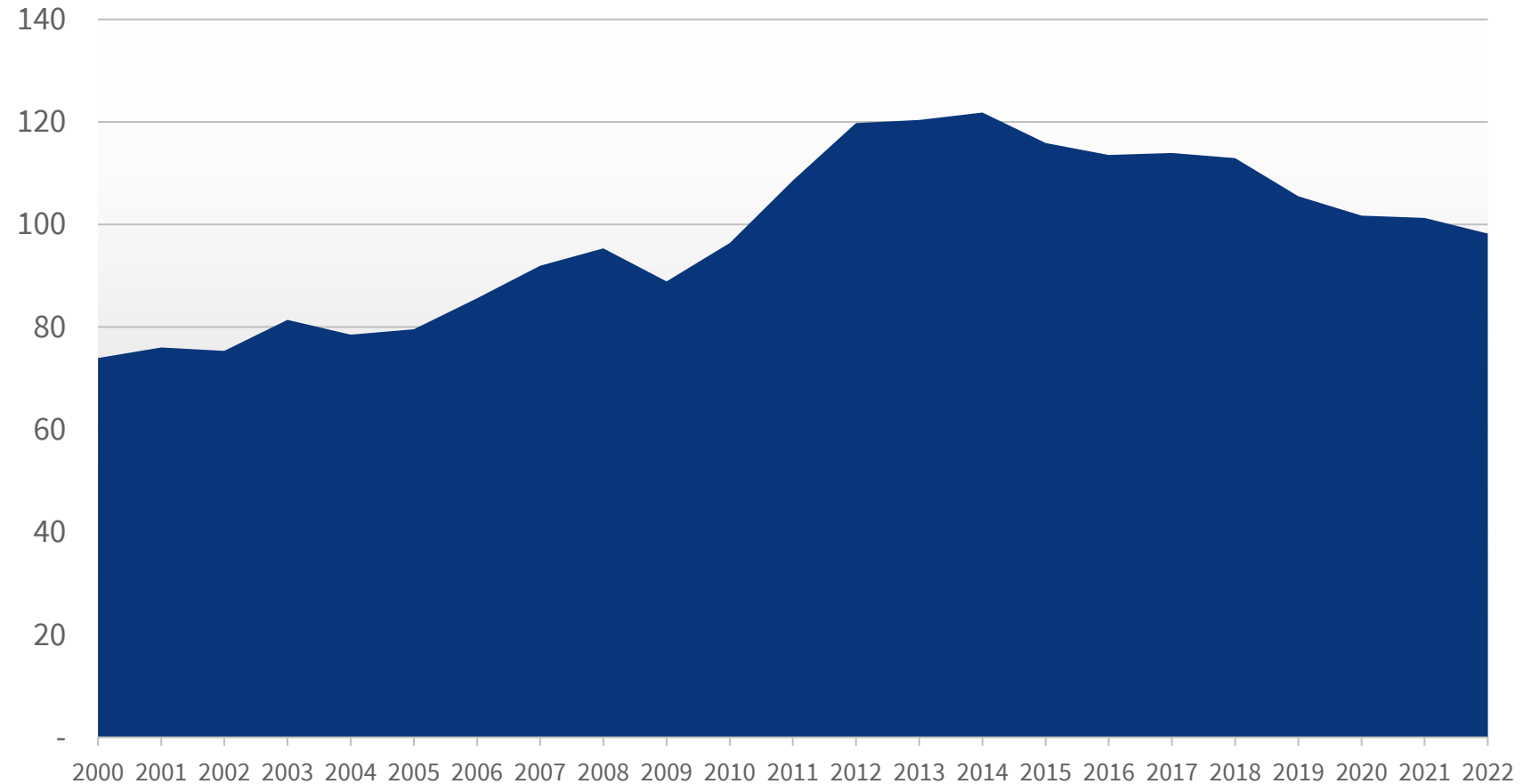
Japan has historically been one of the largest importers of LNG over the last decade.

This high level of demand resulted from the Fukushima nuclear disaster in 2011, which wiped out the country's large-scale nuclear power plants.

As a result of this disaster and the lingering effects of nuclear waste, the Country prioritized natural gas power plant development.

Source: Statistical Review of World Energy 2023

Japanese LNG Imports (BCM)



European demand for LNG has seen a resurgence due to Russian energy sanctions limiting supply, and a pivot away from coal-fired power generation.

LNG demand in Europe hit record highs in 2022 due to lower pipeline inflows to continental Europe as a result of the Russia/Ukraine Conflict.

European demand for LNG is expected to remain elevated for the coming years as the continent is expected to eliminate or significantly reduce its reliance on natural gas from Russia.

Source: Statistical Review of World Energy 2023

European LNG Imports (BCM)



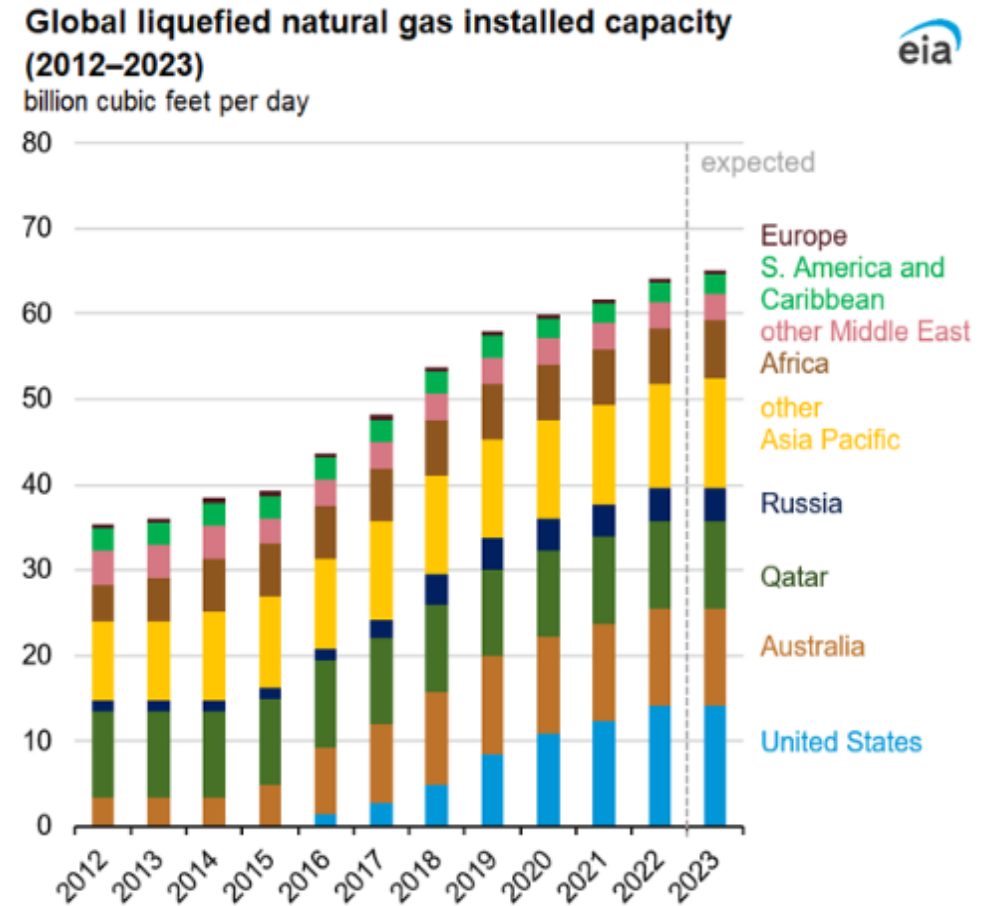
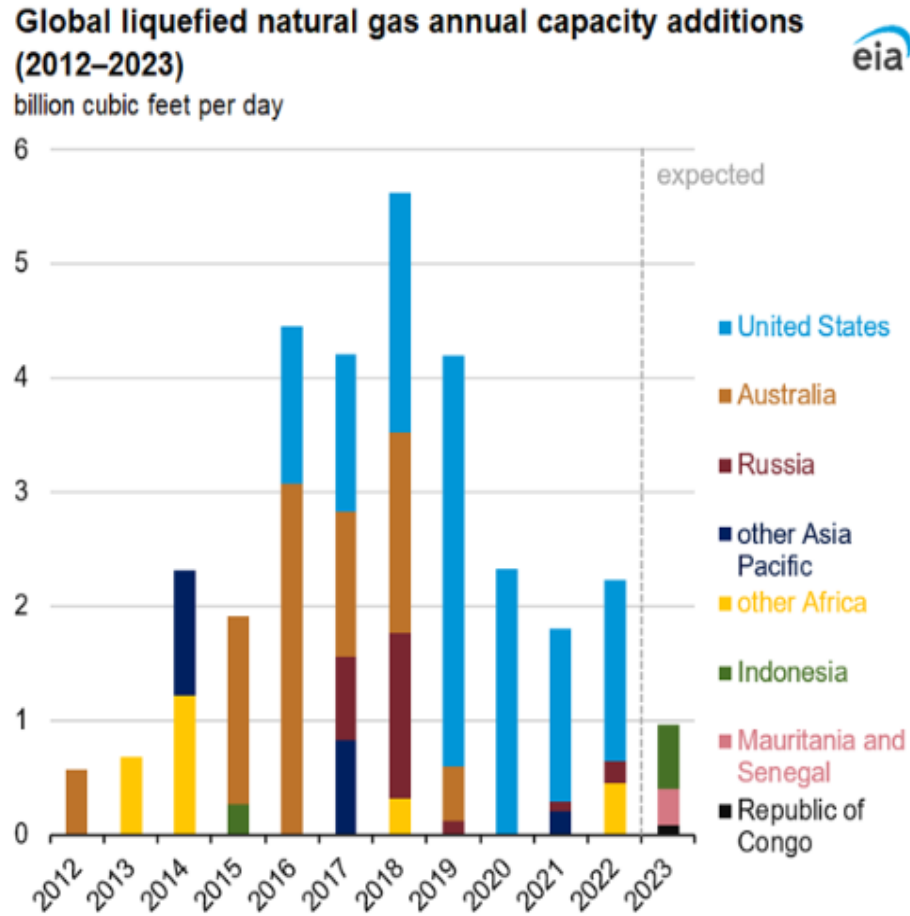
Qatar and Australia have been the two largest suppliers over the past five years, but the U.S. increased its market share to ~20% in 2022 from ~4% in 2017 as a result of new projects that have come online.

Supply (2022)	BCM	mt	Bcf	Bcf/d	%
Qatar	107.4	79.0	3,793	10.39	20.3%
Australia	106.7	78.5	3,768	10.32	20.2%
USA	102.6	75.5	3,622	9.92	19.4%
Russia	43.6	32.1	1,538	4.21	8.2%
Malaysia	37.5	27.6	1,325	3.63	7.1%
Nigeria	19.3	14.2	683	1.87	3.7%
Indonesia	19.0	14.0	672	1.84	3.6%
Oman	15.2	11.2	535	1.47	2.9%
Algeria	13.6	10.0	481	1.32	2.6%
Papua New Guinea	11.4	8.4	403	1.10	2.2%
Other	52.7	38.7	1,859	5.09	10.0%
Total	529	389	18,680	51.2	100%

Source: GIGNL Annual Report 2023

Export Capacity Additions by Region

The U.S. has been the largest developer of incremental capacity over the last 5 years, which has been assisted by Midstream pipeline connectivity to all major gas producing basins.



Source: EIA Natural Gas Weekly, February 1, 2023.

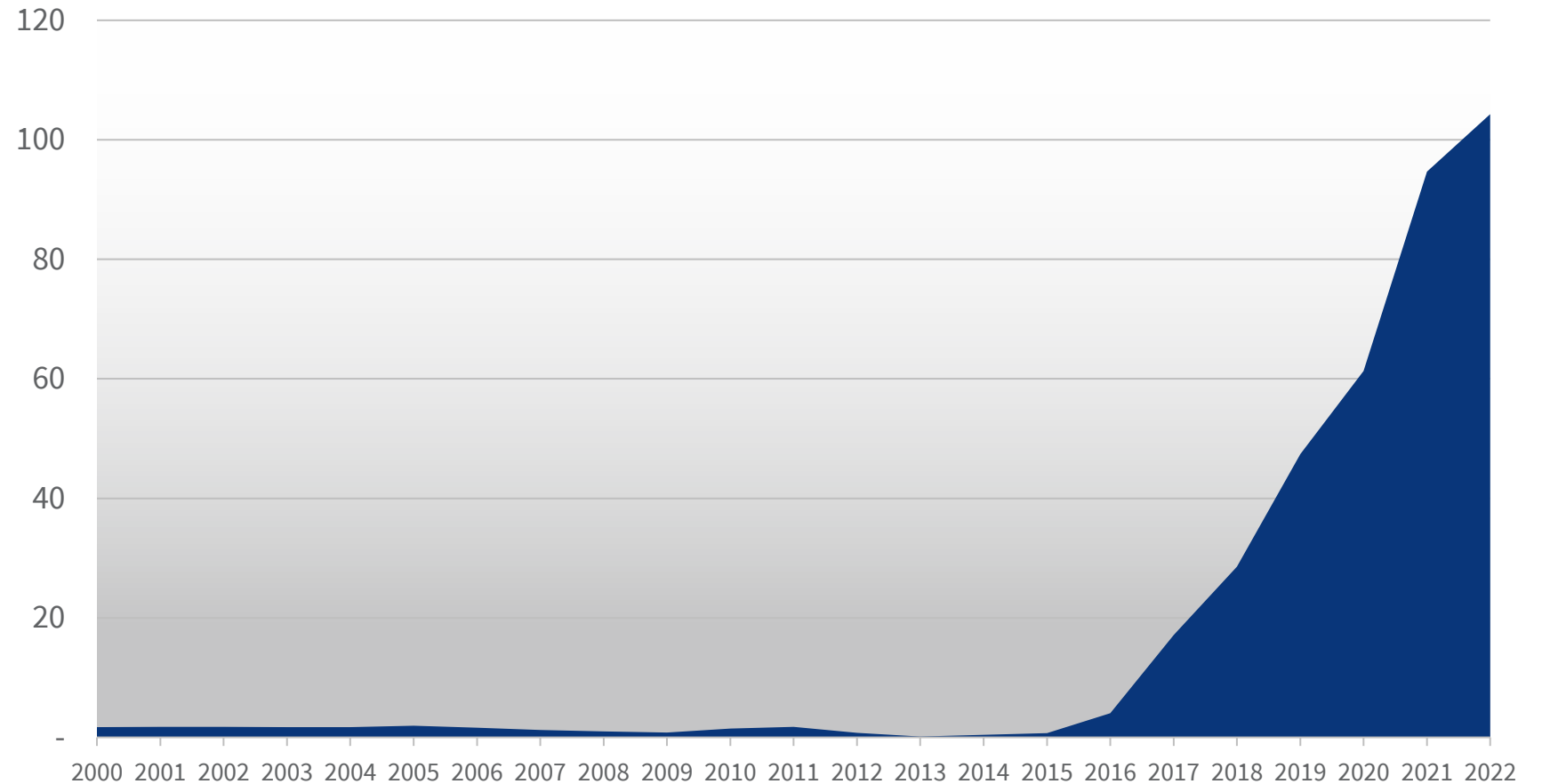
The shale revolution has turned the U.S. into a low-cost and reliable producer of natural gas.

As a result, the U.S. has significantly ramped its export capacity to supply incremental volumes to the global natural gas market.

The U.S. is now one of the top 3 largest suppliers of LNG along with Qatar and Australia.

Source: Statistical Review of World Energy 2023

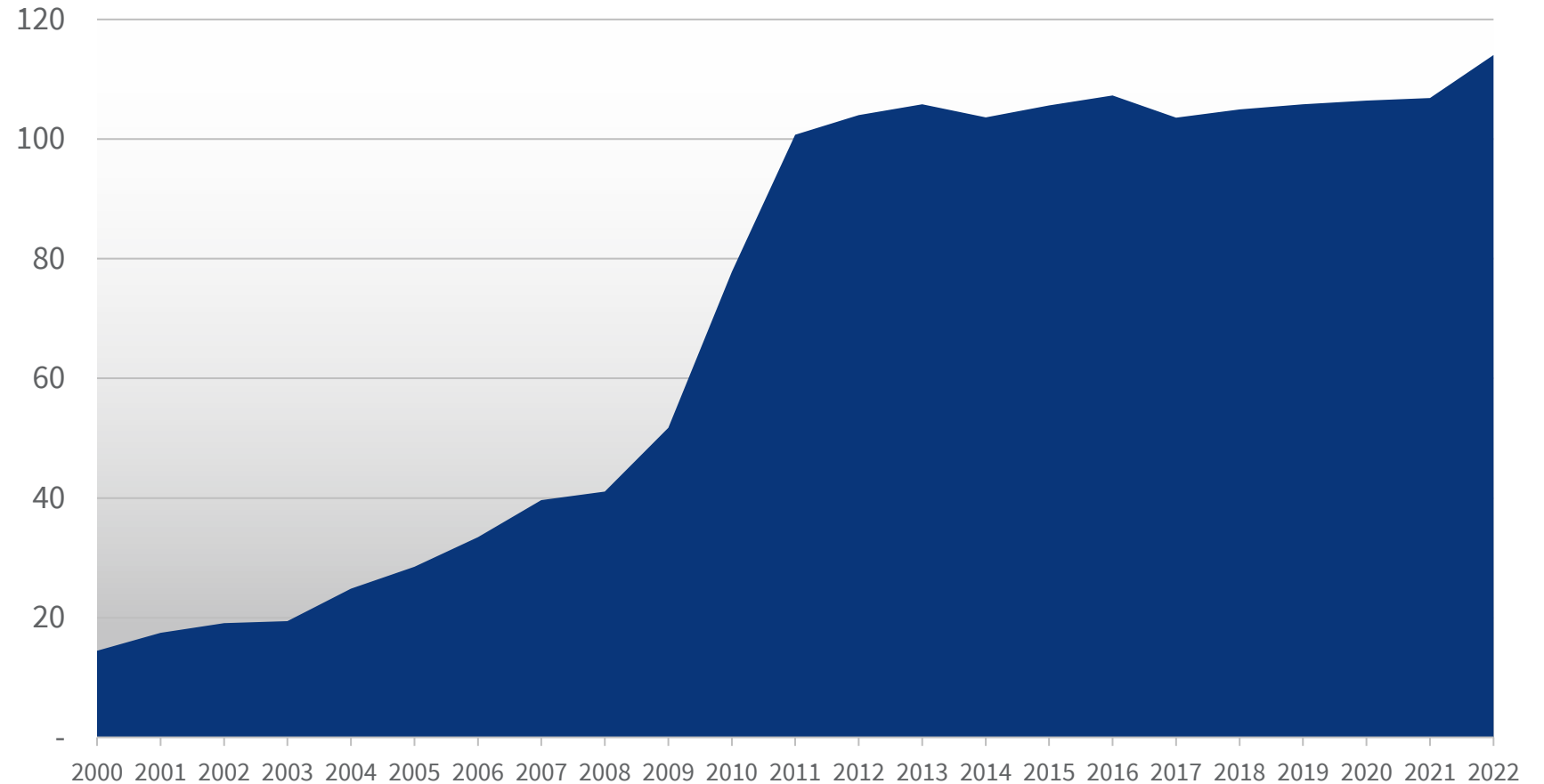
U.S. LNG Exports (BCM)



Qatari exports have been flat over the past decade with ~65% of volumes sent to Asian Markets.

The Qataris are currently targeting a large-scale expansion to increase capacity by 30-40% starting in 2024 with an estimated cost of ~\$30bn.

Qatari LNG Exports (BCM)

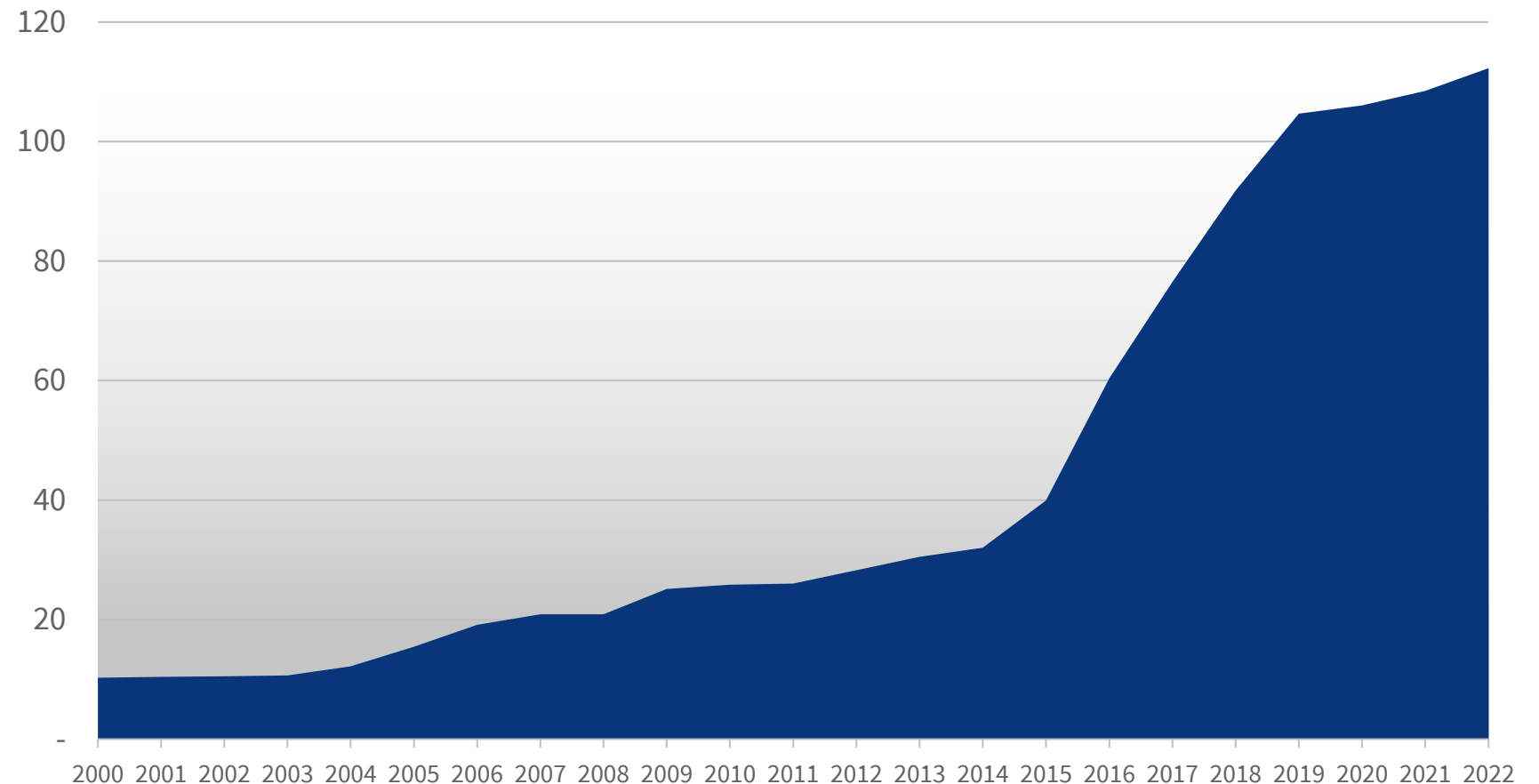


Source: Statistical Review of World Energy 2023

Australian LNG exports have ramped significantly over the last decade due to the build out of large-scale LNG infrastructure projects.

Exports are expected to remain flat going forward given no incremental projects coming online and potential resource constraints.

Australian LNG Exports (BCM)

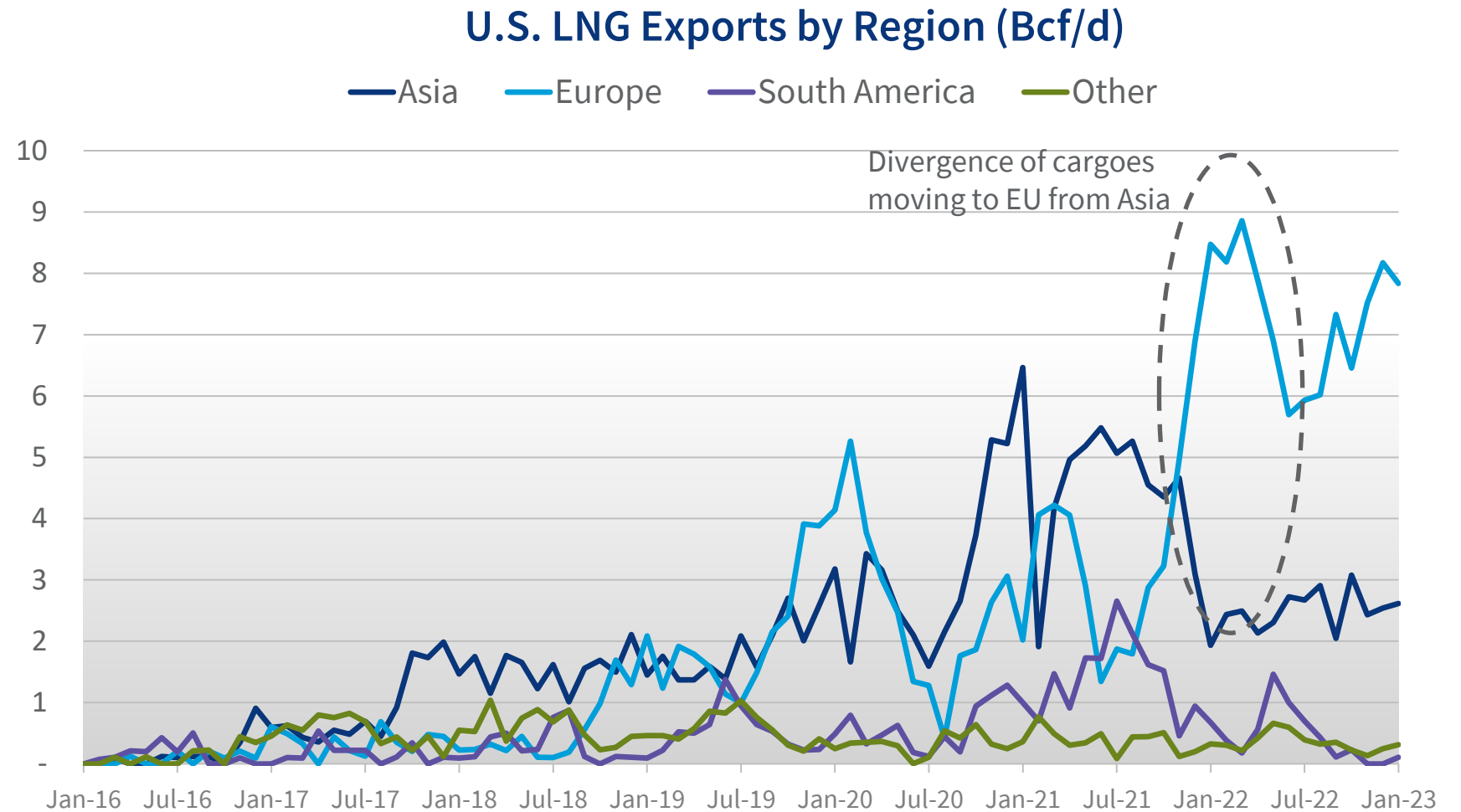


Source: Statistical Review of World Energy 2023

Asia and Europe have been the two main destination regions for U.S. LNG.

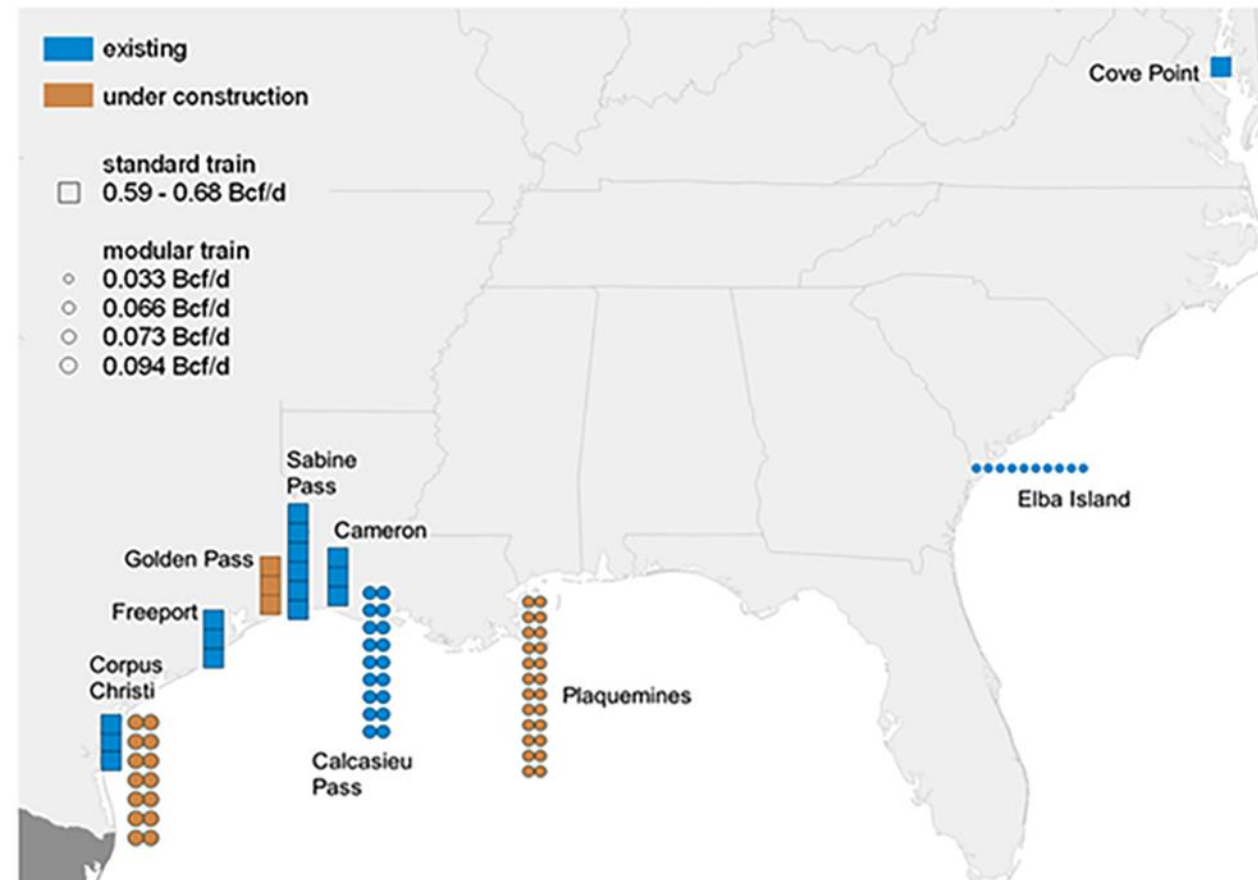
In 2022, geopolitical tensions and tight inventories resulted in cargoes being diverted away from Asia and towards Europe in order to help shore up Europe's energy supply heading into the next winter heating season.

Source: EIA U.S. Natural Gas Exports and Re-Exports by Country data



The majority of U.S. LNG is exported out of the Gulf Coast region given the proximity and pipeline interconnectivity to the major producing basins.

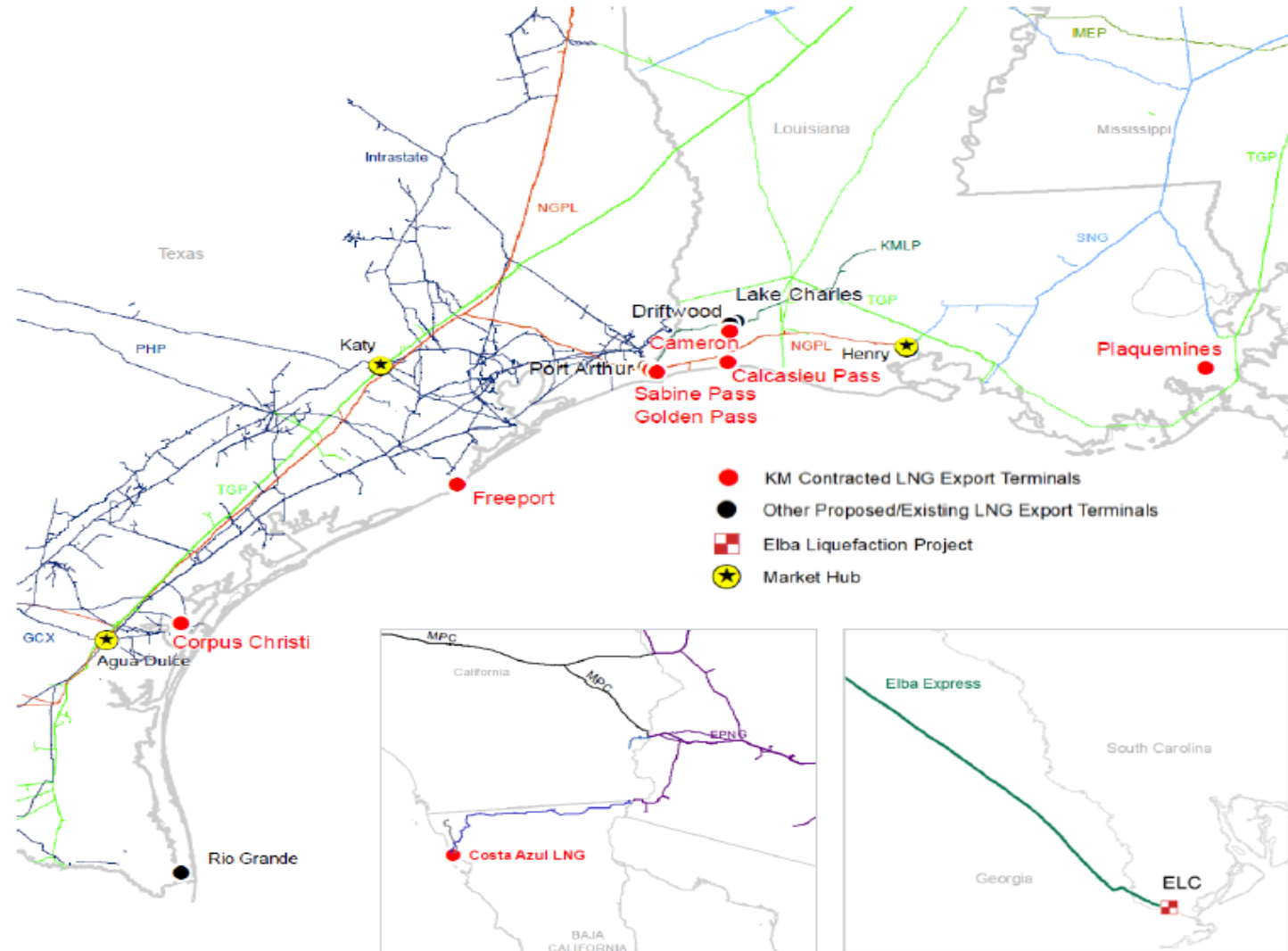
U.S. liquefied natural gas export projects—existing and under construction (2016–2025)



Source: EIA Natural Gas Weekly Update, August 25, 2022

U.S. Pipeline Infrastructure

Kinder Morgan Inc. estimates its assets are contracted to move 10 Bcf/d of natural gas to LNG export facilities by the end of 2025, and is evaluating an additional ~9 Bcf/d of opportunities.



Source: Kinder Morgan 2023 Investor Day, January 25, 2023

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Bcf is billion cubic feet.

Bcf/d is billion cubic feet per day.

BCM is billion cubic meters.

GIIGNL is the International Group of Liquefied Natural Gas Importers

LNG is liquefied natural gas.

MT is million tons.

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