POLICY PAPER

Foundational Paper: The Current State of Natural Gas Supply and Demand

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The Energy Futures Initiative advances technically grounded solutions to climate change through evidence-based analysis, thought leadership, and coalition-building. Under the leadership of Ernest J. Moniz, the 13th U.S. Secretary of Energy, EFI conducts rigorous research to accelerate the transition to a low-carbon economy through innovation in technology, policy, and business models. EFI maintains editorial independence from its public and private sponsors.

Abstract

Natural gas plays a critical role in the global clean energy transition, both to help meet decarbonization goals and provide reliable, secure, and affordable energy. The unprecedented events of the COVID-19 pandemic and Russia's invasion of Ukraine have underscored the importance of natural gas on a global scale. This paper reviews the role of the U.S. in producing and supplying natural gas to meet demand both domestically and internationally for its allies and trading partners in Europe and Asia. The path forward is riddled with challenges, and the U.S. will have to address regulatory bottlenecks, overcome market competition, and navigate global constraints around its use and exports of natural gas. With a cohesive strategy, the U.S. can overcome barriers and utilize natural gas to meet both energy security and decarbonization needs in a sustainable manner.

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1. Introduction

The Russian invasion of Ukraine has greatly complicated the global energy security and decarbonization landscape, forcing the nations of the world to simultaneously consider both imperatives in their policy responses to the crisis. Reduced Russian gas flows to Europe contributed to record highs in European gas prices (and indirectly Asian spot liquefied natural gas (LNG) prices) in the third quarter of 2022. At the same time, natural gas prices in the United States last summer reached their highest levels since 2008. The invasion of Ukraine, subsequent sanctions on Russian energy exports, and the ensuing energy security challenges in Europe have caused high energy price volatility, which limits active market participants and further increases volatility further due to financial pressures.[1]

As the world's third largest crude oil and second largest natural gas producer, Russia has weaponized its energy supplies. Europe obtains 40% of its gas and 30% of its oil from Russia.[2,3] In retaliation for Western sanctions imposed on Moscow over its invasion of Ukraine, Russia has punished countries it deems "unfriendly" (those that side with Ukraine) by slowing gas exports via the Nord Stream 1 pipeline.[4] Russia has also blamed these same sanctions for causing problems in the gas supply by claiming that these sanctions prolonged maintenance times to the damaged Nord Stream 1 pipeline (Figure 1).[5]

At the same time, volatility in energy prices and sanctions have raised domestic issues for Russia. In 2021, Russia produced 762 billion cubic meters (bcm) of natural gas and exported approximately 210 bcm via pipeline[6] In that same year, oil and natural gas revenues supplied Russia with 45% of its federal budget income.[7]

The West has worked to weaken Russia's ability to finance its war on Ukraine through targeted sanctions of Russia's oil and natural gas exports. The EU and G7 countries banned imports and enforced price caps on Russian energy exports, and between the first and third quarter of 2022, Russia's overall share of EU energy imports dropped from 25.5% to 15.1%, which amounts to a $6.4 billion difference in revenue.

In response, Russia has shifted the focus of its exports to Brazil, India, China, and South Africa; Asian demand alone could be enough to support a steady flow of Russian hydrocarbons.[8,9] It will, however, take both time and money to redirect Russian natural gas to Asian markets because natural gas trade requires specialized transportation and infrastructure.

To fill the gap left by Russia, the U.S. is playing an increasingly large role in meeting global natural gas demand and is a critical part of Europe's near-term strategy to wean itself off Russian gas. On March 25, 2022, the White House announced that the U.S. will rapidly increase exports of LNG to Europe by 15 bcm through 2022.[10] To put this in perspective, the United States sent 22 bcm of LNG to Europe in 2021, the highest quantity ever traded

between the two continents.[11] In 2022, U.S. exports to Europe more than doubled before the start of Q4 compared to all 2021. In addition to its value to energy security, these data underscore to value of the U.S. LNG contract structures that enable destination flexibility. Europe and Asia's demand for natural gas, however, exceeds what the U.S. system can currently supply.

The majority of export terminals are on the Gulf and East coast, which should make transporting LNG across the Atlantic cheaper than sending U.S. LNG to Asia.

On average, however, European LNG prices have been higher than Asian LNG prices in 2022. Absent the current crisis, this price difference should not occur as the differences in transport lengths between U.S. and Europe are substantially shorter than those between the U.S. and North Asia.[12]

Support of European allies could, however, come at a cost. Favoring European over Asian markets could diminish the role of a critical fuel – natural gas – in meeting decarbonization goals of key Asian allies and could increase energy security concerns for energy import-dependent nations in Asia such as Japan and South Korea.

Three factors could constrain the ability of the U.S. to meet mounting demand from both Europe and Asia: climate policies that would reduce long-term demand for hydrocarbons and inhibit the investments needed to meet near- to mid-term needs; limited capacity at export (liquefaction) and import (regasification) facilities; and domestic pressure to slow production in the U.S. due to concerns about high consumer prices and climate change.

Figure 1: Timeline of natural gas-related energy security events during the war in Ukraine[13]

- 02/22/22 the German government suspends certification of the Nord Stream 2 natural gas pipeline.[14]
- 03/08/22 The U.S. prohibits liquefied natural gas imports of Russian origin.[15]
- 03/23/22 Putin demands 'unfriendly countries' pay for Russian gas in rubles.[16]
- 05/18/22 The European Commission presents the REPowerEU Plan to transform Europe's energy system by ending the EU's dependence on Russian fossil fuels.[17]
- 06/15/22 Russia cuts deliveries through Nord Stream 1 pipeline by 75% - from 170m cubic meters of gas a day to roughly 40m cubic meters.[18,19]
- 09/02/22 Russia announces further delays to reopening Nord Stream 1 to Europe after 10 and 3-day stoppage periods in July and August, respectively.[20]
- 09/07/22 Putin threatens to cut off all energy supplies to the EU if a price cap on Russian gas is imposed. So far, Russian natural gas deliveries to EU dropped by 48% in 2022.[21]

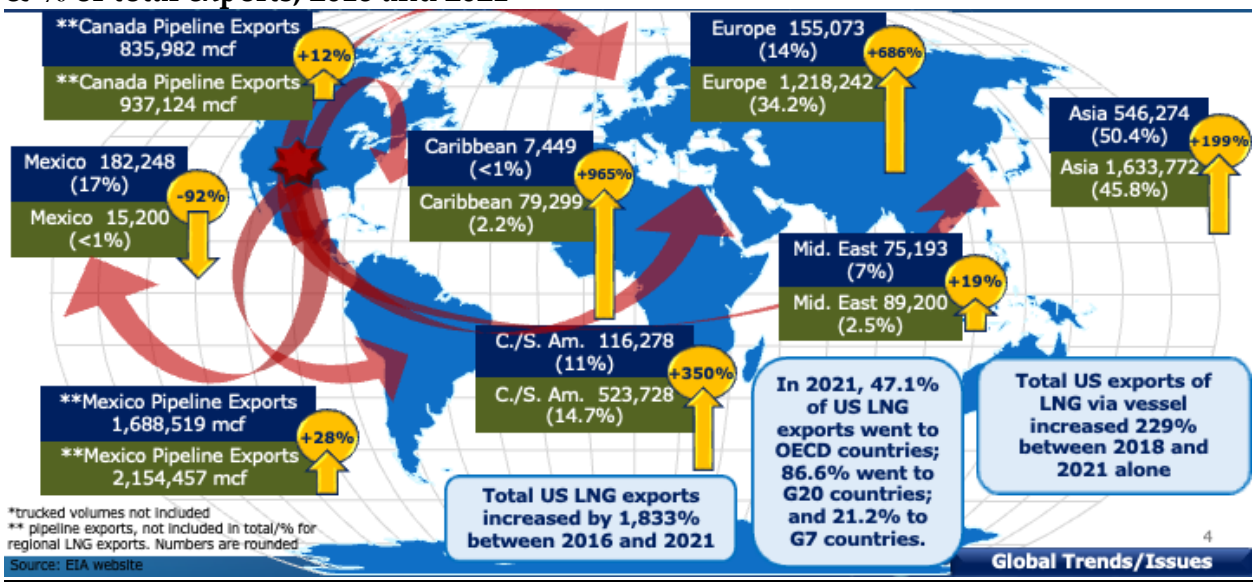
- 12/19/22 European Union energy ministers agree to a price cap on Russian gas. If prices exceed 180 euros per megawatt hour for three days on the Dutch Title Transfer Facility (TTF) gas hub's front-month contract, which serves as the European benchmark.[22,a,b]
- 02/15/23 The price cap on Russian gas goes into effect.

[a] Once triggered, trades would not be permitted on the front-month, three-month and front-year TTF contracts at a price more than 35 euros/MWh above the reference LNG price. This effectively caps the price at which gas can be traded, while allowing the capped level to fluctuate alongside global LNG prices - a system designed to ensure EU countries can still bid at competitive prices for gas in from global markets.
[b] The contract hit a record high of 343 euros in August. ($1 = 0.9419 euros)

2. The U.S.' Role in Meeting Global LNG Demand

Even before the Russian invasion of Ukraine and resulting energy crisis in Europe, the U.S. had emerged as a major global LNG supplier. The U.S. became the largest producer of both natural gas and oil in the world when it surpassed Russian natural gas production in 2011, and Saudi Arabia's petroleum production in 2018.[23] From 2016 to 2021, total U.S. LNG exports increased by 1,833% and in 2021, 47.1% of U.S. LNG exports went to OECD countries, 86.6% to G20 countries, and 21.1% to G7 countries (Figure 2). The increase in U.S. LNG exports resulted from increased global demand, increased LNG export capacity, and increased international natural gas and LNG prices, particularly in Europe and Asia.[24] This growth in exports indicates an aggressive market pull and the U.S.'s willingness to meet demand by supplying allies with affordable and reliable energy to ensure security and lower global emissions through coal to gas fuel switching.

Figure 2: US LNG by Vessel/Pipeline Export Destinations by Region, Total Volume (mcf) & % of total exports, 2018 and 2021[25]



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

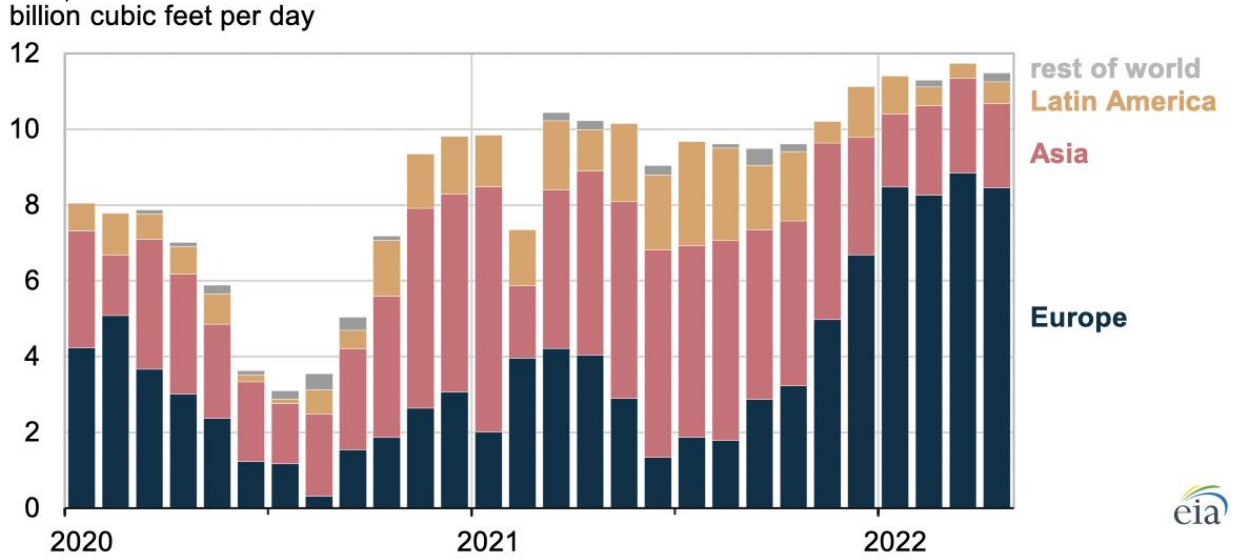
As projects came online in 2022, the U.S. became the world's largest LNG exporter during the first half of the year, when exports increased by 12%, averaging 11.2 billion cubic feet per day (Bcf/d). In 2022, US LNG exports contracted with Asian buyers started to be

diverted to Europe in response to the crisis because the contractual terms allowed volumes to be redirected to the highest bidder.

Even before the conflict in Ukraine, the U.S. was already increasing its LNG export volumes to Europe. From 2016 to 2021, Europe increased its imports of U.S. LNG 686%, accounting for 34% of the U.S.'s exported gas (Figure 2). In 2021, demand was relatively low in Europe during the warm summer months but quickly ramped up to fill storage facilities ahead of winter.[26] America became the largest LNG supplier to the EU and United Kingdom in 2021, accounting for 26% of total imports.[27]

Europe replaced Asia as the primary destination of U.S. LNG exports in the several months at the end of 2021 and the beginning of 2022 (Figure 3). During the first four months of 2022, the United States exported 74% of its LNG to Europe, compared with an annual average of 34% in 2021.[28] During this time, LNG imports from the U.S. to the EU and the U.K. more than tripled compared with 2021, averaging 7.3 Bcf/d and accounting for 49% of total imports. In that same time period, LNG imports from Russia and Qatar accounted for only 14% each (2.1 Bcf/d).[29]

Figure 3: Monthly U.S. liquefied natural gas exports by destination region (Jan 2020-Apr 2022)[30]



Source: EIA, U.S. liquefied natural gas exports to Europe increased during the first 4 months of 2022

As the U.S. has diverted its LNG supply to Europe, Asian countries have been forced to use more accessible and affordable energy sources, such as coal.[31] In 2020 and most of 2021, Asia was the main destination for U.S. LNG exports, accounting for almost half of the total exports.[32] China and South Korea were top destinations for U.S. LNG exports in 2021. During the first four months of 2022, U.S. LNG exports to Asia declined by 51%, averaging 2.3 Bcf/d compared and an annual average of 4.6 Bcf/d in 2021. In 2022, China received only six LNG cargoes from the United States in January–April 2022 (0.2 Bcf/d, compared with 1.2 Bcf/d in 2021). The low demand was fueled by pandemic-related lockdown

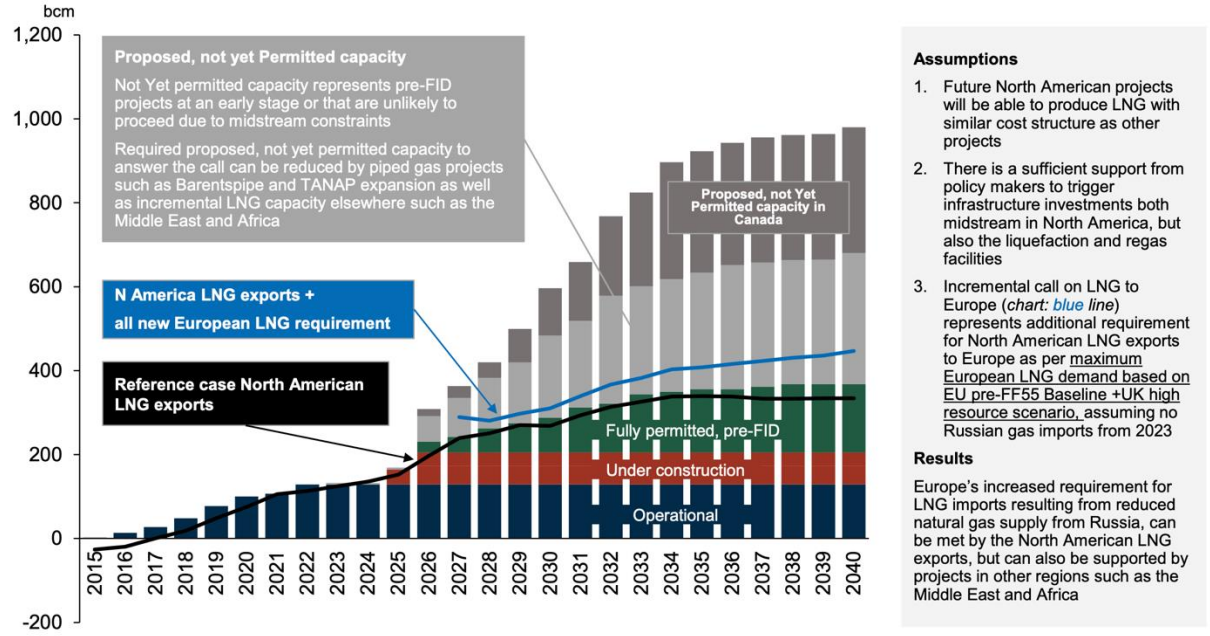
measures, as well as a mild winter and high LNG spot prices, which reduced demand for spot LNG imports. U.S. LNG exports to South Korea and Japan also declined by 0.6 Bcf/d and 0.5 Bcf/d, respectively.[33] Overall, the U.S. was able to reduce Asian LNG exports with limited detriment to Asian markets due to dampened demand driven by a mild winter and economic stagnation in China during Covid. With expectations of increased demand in 2023, Asian countries remain concerned that the U.S. will not be able to meet both Asian and European LNG demand.

3. U.S. LNG Exports: Opportunities, Challenges, and Competition

A. Opportunities

U.S. LNG export capacity is poised to increase due to natural gas production growth and construction of new terminals. Natural gas production, demand, and liquefaction capacity is expected to grow through 2040 based on current laws, regulations, and market conditions (Figure 4).[34,35] Much of the modeled growth in natural gas production is based on these expectations.[36]

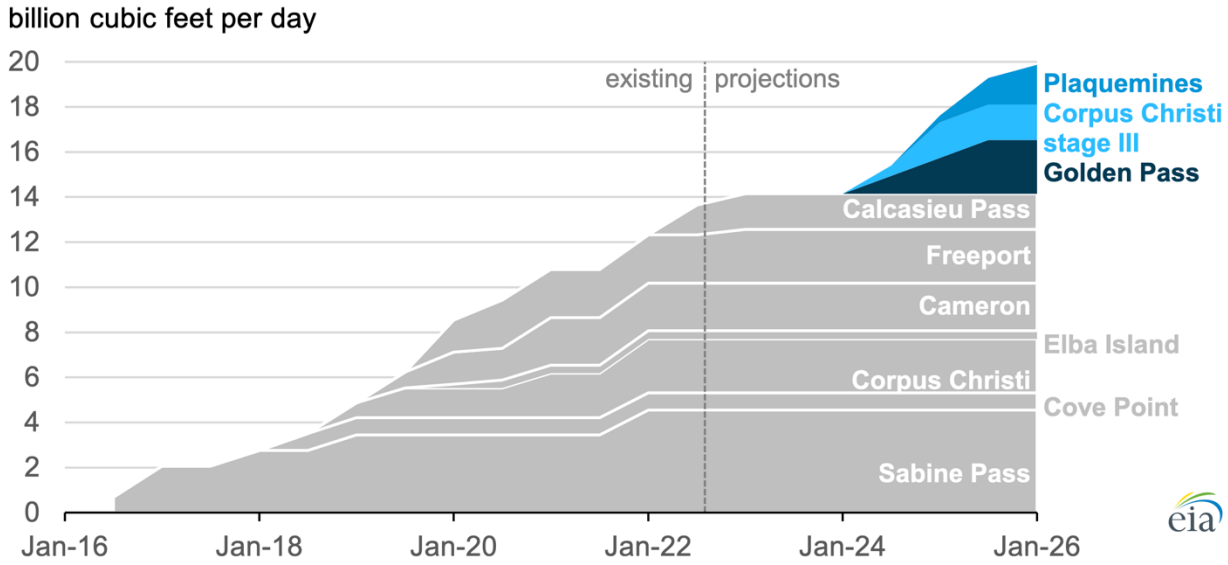
Figure 4: North America LNG exports capacity vs European LNG imports requirements[37]



Source: Rystad, Rebalancing Europe's gas supply – September 2022

In addition to being the world's largest LNG exporter (11.1 Bcf/d during the first half of 2022), the U.S. also has more LNG export *capacity* than any other country and has significant additional capacity from pending projects that have already received requisite approval.[38] Since 2016, 10 new LNG export projects have been approved by the Federal Energy Regulatory Commission (FERC), and as of 2022, seven of these export projects have been built and are operational with a total export capacity of 14 Bcf/d. By 2026, the remaining three that have FERC approvals are expected to be operational(Box 1); in total, the ten facilities will have a daily export capacity of just under 20 billion cubic feet (Figure 5).[39] As of April 2022, FERC had approved an additional nine export terminals with an expected export capacity of 11.828 Bcf/d; these projects, however, are not yet under construction and are in need a final investment decision (FID) to enter the construction phase.[40,c]

Figure 5: U.S. Liquefied natural gas export projects: existing and under construction (2016-2025) Bcf/d [41]



Source: EIA, U.S. LNG export capacity to grow as three additional projects begin construction

[c] 1) Lake Charles, LA: 2.2 Bcfd, 2) Lake Charles, LA: 1.186 Bcfd, 3) Hackberry, LA: 1.41 Bcfd, 4) Port Arthur, TX: 1.86 Bcfd, 5)Pascagoula, MS: 1.5 Bcfd, 6) Jacksonville, FL: 0.132 Bcfd, 7) Brownsville, TX: 0.55, 8) Brownsville, TX: 3.6, 9) M. Nikiski, AK: 2.63

Box 1: U.S. LNG export terminals 2025

Once completed, the three export projects under construction will expand U.S. LNG peak export capacity by a combined 5.7 Bcf/d by 2025:

- **Golden Pass LNG** consists of three standard-size trains, each with a peak capacity of 0.8 Bcf/d, for a total capacity of 2.4 Bcf/d. Golden Pass LNG is on the site of an existing regasification facility and will use shared infrastructure, which helps to reduce project costs and shorten the construction timeline.
- **Plaquemines LNG** consists of 24 mid-scale trains, each with a peak capacity of 0.07 Bcf/d. Each liquefaction train is part of a two-unit block for a total of 12 blocks with a combined peak capacity of 1.8 Bcf/d.
- **Corpus Christi Stage III** is on the site of an existing terminal with three liquefaction trains in operation. Each of the 14 new, mid-scale trains under construction has a peak capacity of 0.11 Bcf/d. Each train is part of a two-unit block for a total of seven blocks with a combined peak capacity of 1.6 Bcf/d.

Source: EIA, U.S. LNG export capacity to grow as three additional projects begin construction

B. Domestic Challenges

In order to meet domestic gas demand (particularly in the country's Northeast region), several challenges will need to be overcome, including (but not limited to) regulatory issues (permitting and the Jones Act) and elevated domestic prices.

Natural gas prices are expected to remain high until supply begins to catch up to demand. Futures prices for gas delivered in January 2024 have decreased from $6.50 per mbtu in September 2022 to $5.60 per mbtu, but prices remain far higher than those in September 2021 ($3.65) and 2019 ($2.90). Although an increase in global LNG demand should not impact domestic prices because liquefaction terminals were expected to be running at full capacity in 2022, prices have increased on average from $3.89/mbtu in 2021 to $6.45/mbtu in 2022.[42] U.S. gas consumers should be insulated from the extreme energy prices Europe is experiencing because of limits on the amount of LNG available for shipping, but U.S. consumers still faced higher gas bills than in recent years.[43]

As a result, pundits and policymakers have raised concerns about whether further expansion of LNG export capacity will continue to increase domestic natural gas prices. The Federal Energy Regulatory Commission's recent winter reliability report pointed to the continued growth of LNG exports, lower-than-average gas storage, rising domestic gas consumption, and tepid gas production growth as key factors underpinning higher gas prices for U.S. consumers.[44] This report suggested that the amount of gas that U.S. consumers have available to them is limited because of the amount of gas allocated for export and conversely, when this gas becomes available, the pressure on high prices for consumers would be relieved. For example, an outage at the Freeport LNG terminal cut U.S. export capacity by about 15%, which pushed some 2 Bcf/d of lost feed gas demand back into the domestic market, sparking a 12% drop in Henry Hub prices. In general, however, domestic prices are expected to fall back below $5/MMBtu by the end of March 2023 and are expected to remain there through 2027 and 2030, even with the expectations of added U.S. LNG export projects.[45]

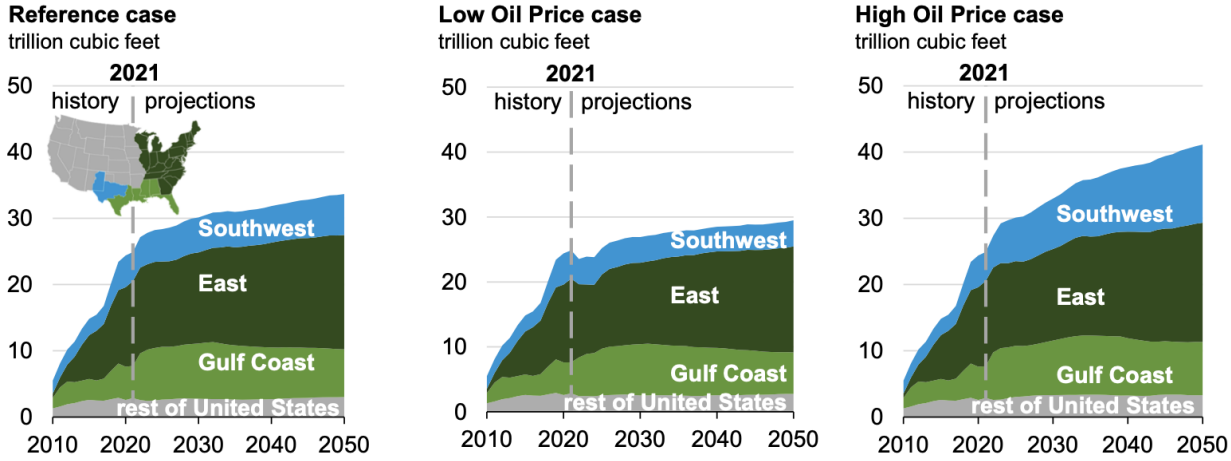
While elevated prices may incentivize producers and thus reduce potential shortages, the low price of oil could stall U.S. gas production as more than half of projected U.S. natural gas production is associated natural gas,[d] or natural gas produced concurrently from oil production in tight oil plays.[e] Shale gas and associated natural gas from tight oil plays are the primary contributors to the long-term growth of U.S. natural gas production through 2050. In EIA's reference case (Figure 6), more than half of the growth in natural gas production between 2020 and 2050 is associated natural gas from tight oil plays, primarily the Wolfcamp play in the Permian Basin (Southwest region). The Marcellus and Utica shale gas plays in the Appalachia Basin (East region), and the Haynesville play in the Mississippi-Louisiana Salt Basins (Gulf Coast region) account for most of the growth in shale gas production during this same period.[46]

EIA anticipates that world oil price assumptions will influence the amount of gas produced from tight oil plays. Higher world oil prices, such as those in the High Oil Price case, increase the incentive to target oil plays, increasing the projected amount of associated natural gas. The opposite occurs in the Low Oil Price case: LNG exports are largest in the High Oil Price case, which is prompted by growth in production in the Southwest.[47] EIA projects that the proximity of the Wolfcamp and Haynesville plays to LNG export terminals will lead to growth in natural gas production in those regions. In contrast, natural gas from the Appalachian plays (Marcellus and Utica) are not close to LNG export terminals and pipeline infrastructure is still limited; Appalachian production is predominantly driven by the region's relatively low production costs.[48]

[d] Associated-dissolved natural gas, also referred to as associated gas, is natural gas produced by oil wells. By contrast, non-associated gas is natural gas produced by natural gas wells. Some states define an oil well versus a natural gas well differently based on different gas-oil ratios (GOR)

[e] Tight oil is one of the oil resources where the shale is the source rock and the oil also accumulates in shale or nearby. It generally refers to shale oil, similar to shale gas. In geology, a petroleum play, or simply a play, is a group of oil fields or prospects in the same region that are controlled by the same set of geological circumstances. The term is widely used in the realm of exploitation of hydrocarbon-based resources.

Figure 6: Dry natural gas production from shale resources, AEO2022 oil price case[49]



Note: *Shale resources* includes natural gas production from tight oil formations and excludes natural gas from tight gas formations.

Source: EIA, Annual Energy Outlook 2022

Regulatory bottlenecks could also prevent new gas facilities and infrastructure from coming online. For example, as noted above, the lack of pipeline capacity from Appalachia to Northeastern states limits their access to affordable and reliable gas from Appalachia, and by extension, exports of that gas to other countries from Northeastern terminals. Projects like the Constitution Pipeline or the Northeast Supply Enhancement (NESE) project could have bridged the gap between Appalachia's abundant supply and New England's high demand, but they were blocked by political opposition. Regulatory setbacks and opposition from environmental groups blocked the Constitution Pipeline project, intended to transport natural gas from Pennsylvania's Marcellus Shale into New York.[50] The NESE project is a 26-inch diameter pipeline proposed by Transcontinental Gas Pipe Line Company LLC (Transco) that would transport natural gas from Pennsylvania through New Jersey, but it has been repeatedly blocked by state regulators in New York and New Jersey due to fears of Clean Water Act violations.

In addition to gas projects, greater transmission capacity is needed throughout the Northeast not only to connect clean energy projects to the grid but also to ship electricity back and forth across regions to accommodate fluctuations in renewable output.[51] The lack of pipeline and electrical capacity drives the region's dependence on foreign LNG and fuel oils. To conserve natural gas and maintain affordable energy prices during the recent cold snap in January 2023, many natural gas plants switched to burning reserves of fuel oil, which produced 3.55 billion pounds of carbon dioxide in January alone, up 4,800% from emissions from fuel oil in January 2021. New England's grid's total carbon dioxide emissions totaled about 8.8 billion pounds in January 2022, up 44% from the year-ago period.[52,53]

Another regulatory challenge in the Northeast is the Jones Act (also known as the Merchant Marine Act of 1920), a federal statute that requires that shipping between U.S. ports be on ships that are US-flag, built, owned, and crewed. The Jones Act has been identified as a

cause of making the transport of fuel oil to the region more difficult and expensive,[f] and could limit LNG imports in the region due to the lack of Jones Act-compliant LNG tankers.[54] Most of the LNG used by the Northeast currently comes from Trinidad and Tobago. Pipeline development in New England has also been met with fierce opposition.[55]

Table 1: Annual LNG exports by major producing nations 2021[56]

Country	LNG (Bcm)	Global Share	Var. 2021/2020
Australia	109	21.10%	1.00%
Qatar	105.9	20.70%	-0.20%
United States	95.4	18.00%	49.80%
Russia (Europe)	27.4	5.20%	6.10%
Russia (Asia)	13.9	2.70%	-9.80%
Rest of World	165.6	32.3%	-------
Total	517.2	100%	4.5%

Data from International Group of Liquefied Natural Gas Importers, 2022 Annual Report

C. Global Competition

In 2020, the International Energy Agency (IEA) reported that North America has been almost the sole source of global growth on the supply side, accounting for close to 80% of increases in exports between 2019 and 2025. North American exports are expected to almost triple in the next five years, driven by the wave of recently approved U.S. liquefaction projects, in addition to Canada's first export project which should be completed by 2025.[57]

Global export LNG export volumes are also increasing. Africa accounts for most of the residual growth in exports, sourced from projects under development in Mozambique (Coral FLNG, Mozambique LNG), capacity expansion in Nigeria (NLNG train 7), and a cross-border offshore project in Mauritania and Senegal (Tortue FLNG).[58] Russia's LNG exports are set to increase by almost 20% by 2025, driven by capacity development from the Yamal peninsula. Supply from the Asia Pacific region should remain stable, with Australian exports plateauing and output from traditional exporters such as Indonesia and Malaysia decreasing slightly.[59]

Export volumes are also increasing in the Middle East. Qatar recently announced plans for the North Field Expansion[g], which includes six LNG trains that will ramp up Qatar's liquefaction capacity from 77 million tons per annum (mtpa) to 126 mtpa by 2027, which is approximately a 64% production increase by 2027. A self-imposed 12-year moratorium on

[f] The U.S. Maritime Administration lists just 56 vessels that comply with the law, only a subset of which can move fuel to New England (8).
[g] The North Field is part of the world's biggest gas field that Qatar shares with Iran, which calls its share South Pars.

further developing LNG extraction from the North Field was lifted in May 2021, allowing Qatar Petroleum (QP) to proceed with the North Field LNG Expansion, which will increase LNG production in two phases. The first phase of the North Field project is expected to increase capacity by 43% from 77 mtpa to 110 mtpa by 2025. The second phase, called the North Field South Project (NFS), will further increase the production capacity from 110 mtpa to 126 mtpa, a total 64% increase by 2027.[60]

In 2022, prices for spot purchases of natural gas reached unprecedented levels, regularly exceeding the equivalent of USD $250 for a barrel of oil. High gas and coal prices account for 90% of the upward pressure on electricity costs around the world. To offset shortfalls in Russian gas supply, Europe imported 66% more LNG (50 bcm) in 2022 compared with the previous year. As noted, this action has been balanced by the lower demand from China, lockdowns and subdued economic growth limited demand for natural gas, but higher European LNG demand has diverted gas away from other importers in Asia.[61]

4. Global LNG Market Constraints

With the growth in natural gas demand around the world, Europe and Asia will compete for imports as the producers, namely the U.S. and Qatar, work to to ramp up their export capacities. Global LNG trade is expected to reach 585 billion cubic meters per year (bcm/y) by 2025, an increase of 21% compared to 2019. Emerging Asian markets are expected to be the driving force behind the expansion of LNG imports, led by China and India, however, the sudden demand from Europe creates challenges for LNG trade flows.[62] The United States and Qatar account for almost all of the net growth on the export side.

A. Europe

With competing demands of energy security and decarbonization timelines, the EU is in the process of reconciling these two goals with Russia's weaponization of its energy supplies, including natural gas. The EU is currently the world's largest LNG importer, but its LNG import capacity only meets around 40% of its total gas demand (157 bcm in regasified natural gas per year). As noted, in the first half of 2022, the United States was the largest LNG supplier to the EU – almost 50% of total imports, doubling from 2021.

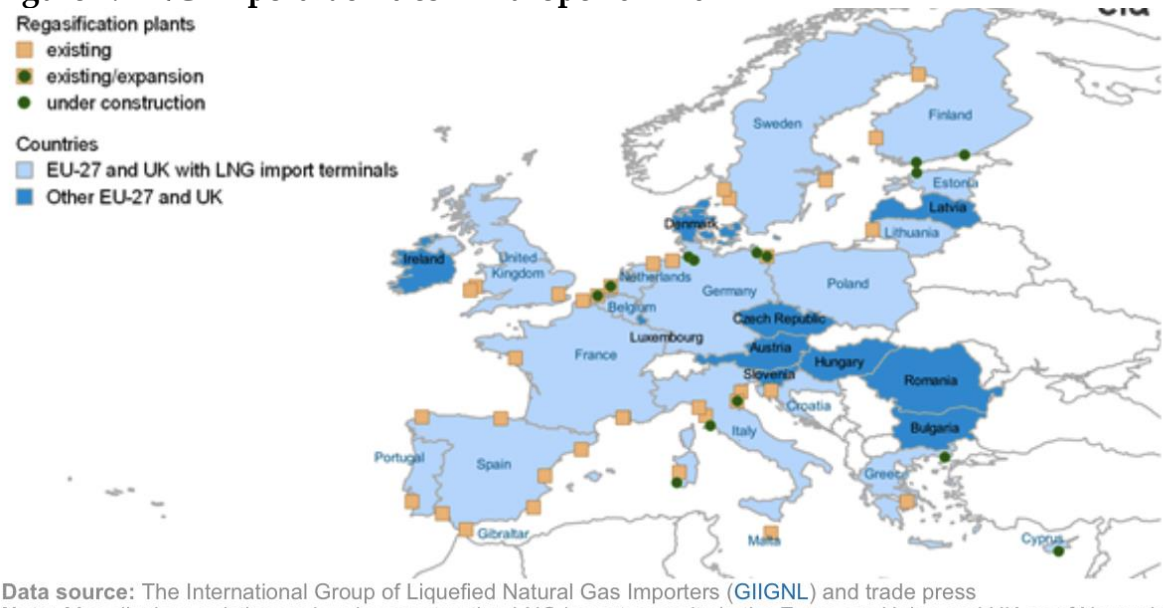
The EU has been making a concerted effort to increase gas reserves in the short term to secure sufficient supplies, but access to LNG infrastructure is uneven across the EU. Because existing EU gas production is declining, it is no longer a viable option for replacing Russian gas. Concerns about earthquakes that have been attributed to drilling have, for

example, led the Netherlands to restrict production in its Groningen gas field, where production has declined from 54 bcm in 2013 to 4.5 bcm in 2022.

In response to this decrease, the loss of Russian supplies and the need for increased imports, the EU's plan has been to build more regasification and storage infrastructure (Figure 7).[63] In June 2022, the European Council adopted a proposal by the European Commission to ensure that storage capacities in the EU were filled before the colder months and could be shared across the Union. In October 2022, the average gas storage levels among member states was over 92%, and by December 2022, the average gas storage levels among member states had dropped slightly to 88%.[64]

Most EU member states have gas storage facilities in their territory. Storage capacities in five countries (Germany, Italy, France, the Netherlands, and Austria) make up two-thirds of the EU's total capacity. Under a new regulation, countries that do not have storage facilities are required to store 15% of their annual domestic gas consumption in stocks located in other member states. This mechanism strengthens the security of EU gas supplies while sharing the financial burden of filling the EU's storage capacities. Member states with lower storage capacities plan to collaborate with those owning larger facilities to secure their reserves.[65]

Figure 7: LNG import facilities in Europe 2022-2024[66]



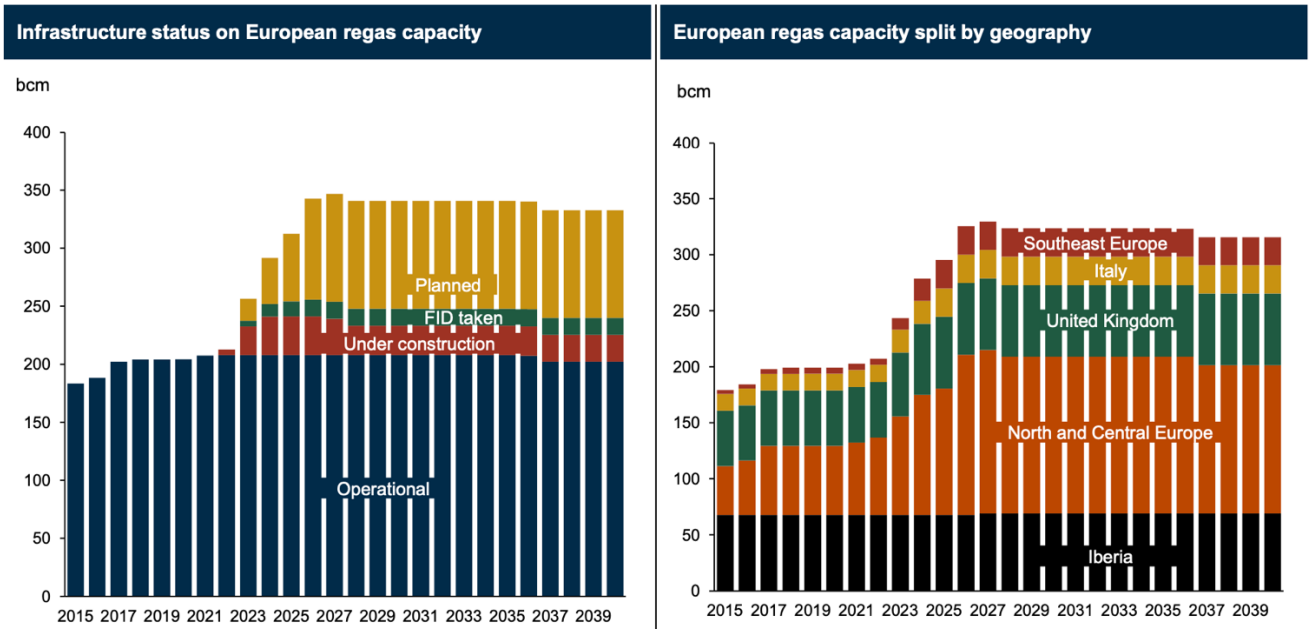
Data source: The International Group of Liquefied Natural Gas Importers (GIIGNL) and trade press
Note: Map displays existing and under construction LNG import capacity in the European Union and UK as of November 2022. Capacity under construction is expected to come online in 2023–24. LNG = liquefied natural gas.

Additional LNG imports to Europe are limited by the current high levels of storage utilization and the lack of associated infrastructure. Although current storage levels are expected to be able to support Europe through the winter, infrastructure limitations presented a challenge for ships delivering LNG to Europe. In October 2022, about ten percent of the LNG vessels in the world (60 tankers), were sailing to or anchored around Northwest Europe, the

Mediterranean, and the Iberian Peninsula. The wave of LNG tankers driven by high prices overwhelmed the ability of the European regasification facilities to unload the cargoes in a timely manner. European regasification capacity and shortage of pipelines connecting countries that have regasification facilities is an underlying and ongoing infrastructure issue and concern. As a result, the amount of LNG on the water — floating storage — increased and drove down natural gas prices.[67]

Europe still has the potential and ability to increase its regasification capacity in the short term (Figure 8). Since Russia's invasion of Ukraine in February 2022 and the reduction in natural gas pipeline imports from Russia that followed, European countries have reactivated development of previously dormant regasification projects and have started development of new projects.[68] In the near-term, LNG import capacity in the EU and UK will expand by 34%, or 6.8 Bcf/d (0.19 Bcm/d), by 2024 compared with 2021.[h, 69] In 2021, Iberia and North and Central Europe accounted for over 30% of the market each; however, North and Central Europe is expected to drive the regasification capacity in Europe over the next two decades. In 2022 approximately 1.7 Bcf/d of the new and expanded LNG regasification capacity has been added in the Netherlands, Poland, Finland, Italy, and Germany. In the longer-term, regasification capacity is expected to grow to 330 bcm by 2040 if all the planned projects proceed (Figure 8).

Figure 8: European LNG regas/import capacity can grow by 120 bcm to 330 bcm per year[70]



Source: Rystad, Rebalancing Europe's gas supply – September 2022

Many of the new regasification projects in Europe can be developed relatively quickly by chartering Floating Storage and Regasification Units (FSRU) and by building pipelines to transport regasified natural gas to connecting pipelines onshore. Other regasification

[h] In 2021, European regasification capacity stood at 207bcm.

projects in Europe will expand capacity at the existing onshore terminals and implement upgrades to increase existing terminals' throughput (Box 2).[71] Projects currently under construction in Germany, Poland, Finland, Italy, Greece, and France could add an additional 3.5 Bcf/d of new capacity by the end of 2023. The new EemsEnergy terminal in the Netherlands (0.8 Bcf/d capacity) consists of two FSRU vessels and received its first import cargo in September 2022. A new FSRU terminal at Wilhelmshaven Port in Germany (0.7 Bcf/d capacity) has been completed in November 2022.[72]

Box 2: Regasification Facilities Under Construction in Europe

Regasification terminals currently under construction in seven EU countries could add an additional 3.5 Bcf/d of new capacity by the end of 2023:

- **Germany** is developing three new FSRU terminals, which will cumulatively add 1.4 Bcf/d of regasification capacity at Lubmin, Brunsbuttel, and Wilhelmshaven. Two terminals (at Lubmin and Brunsbuttel) are expected to start operations this winter, and the second terminal at Wilhelmshaven is expected online in 2023.
- **Poland** will expand capacity at the existing LNG regasification terminal at Świnoujście by 0.2 Bcf/d to reach a total capacity of 0.8 Bcf/d by December 2023.
- **France** will add 0.4 Bcf/d of regasification capacity using an FSRU vessel called Cape Anne at Le Havre port, which is expected to come online in fall 2023.
- **Finland** and **Estonia** are jointly developing an FSRU terminal in the Finnish port of Inkoo, which will add 0.5 Bcf/d capacity and is expected to come online this winter.
- **Italy** is developing an FSRU terminal near the port of Piombino, which will add 0.5 Bcf/d of capacity and will likely come online in spring 2023.
- **Greece** will bring online an FSRU vessel at Alexandroupolis port by the end of 2023, with 0.5 Bcf/d of regasification capacity.

Source: EIA, Europe's LNG import capacity set to expand by one-third by end of 2024

Although Europe is on track to increase imports by developing greater regasification and pipeline capacity, Europe has significantly less capacity than Asia. In 2021, Europe had 24% of global regasification facilities compared to Asia's 53%, and Europe's regasification facilities only make up 14.5% of global regasification capacity compared to Asia's 72% (Table 2). Although a disproportionate amount of U.S. gas was rerouted to Europe in 2022,

Asia will remain a dominant player as the region recovers from the pandemic in the new year.

Table 2: Liquefaction and regasification facilities by region (2021)[73]

Region	Liquefaction Facilities (80)	Liquefaction Capacity (liq m^3)	Regasification Facilities (169)	Regasification Capacity (liq m^3)
North America	26% (21)	4,414,000	12% (20)	6,673,000
Africa	14% (11)	2,163,800	0%	0
Australia	15% (12)	2,778,000	0%	0
Middle East	23% (18)	3,100,000	5% (8)	1,839,900
Asia	18% (14)	3,242,000	53% (90)	55,130,600
Europe	3% (2)	280,000	24% (40)	11,097,906
South America	3% (2)	260,000	7% (11)	1,850,200

Source: International Group of Liquefied Natural Gas Importers, 2022 Annual Report

B. Asia

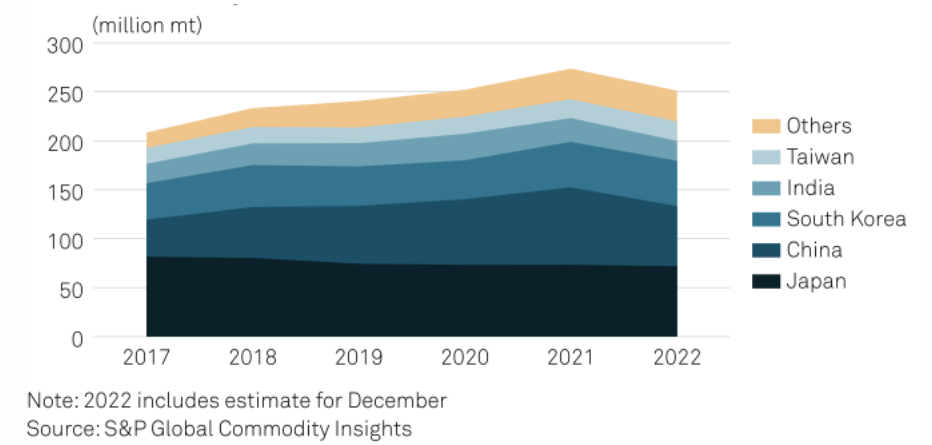
Although regasification capacity in Asia remains the largest in the world, Asian LNG markets will grapple with another year of uncertainty in 2023 as both supply and demand fundamentals are impacted by a range of macroeconomic, geopolitical, and weather-related factors.[74] At the macro level, rising interest rates and efforts by central banks to control inflation will directly impact economic growth and energy demand in most economies, including electricity consumption and natural gas demand. As Asian governments fight to avoid a recession, most of them remain concerned about foreign currency reserves and the strength of the U.S. dollar, which will dictate how they will expand their imports of LNG in the future.[75]

The strong growth in LNG consumption forecasted in Asia for the next two decades is expected to be driven by the use of natural gas in the industrial sector as a cleaner fuel and demand in the electricity sector where natural gas is expected to displace coal and liquids and supplement renewables as a transition fuel. The timing and speed of growth will depend upon the pace of global economic recovery post-COVID and the measures undertaken globally to reduce carbon emissions.

Currently, many Asian countries are confronted with declining local natural gas supplies, creating a situation where demand is outstripping supply and causing power generators and large industrial consumers in those countries to increasingly look at imported LNG as an alternative. In addition to being 50% cleaner than oil in terms of CO_2 emissions, LNG can be 50% cheaper than oil in terms of MBtus depending on market rates.

Historically, the three major Asian LNG import markets were Japan, South Korea, and Taiwan. China and India began importing LNG in the early 2000's followed by seven other Asian countries in the early 2010s: Thailand, Singapore, Malaysia, Pakistan, Indonesia, Bangladesh, and Myanmar. Hong Kong, Vietnam, and the Philippines are constructing or plan to construct LNG import facilities in the near future, and Sri Lanka and Cambodia have been mentioned as possible importing countries. According to a recent study of the Oxford Institute for Energy Studies, total emerging Asian market LNG demand has the potential to grow to over 147 Mtpa by 2050; Asian LNG imports, however, were reduced in 2022 (Figure 9).

Figure 9: Asian LNG imports shrink in 2022[76]



The International Energy Agency (IEA) projects that the Asia Pacific region will increase LNG imports, from 69% of total global share in 2019 to 77% by 2025. China alone could account for 22% of total LNG demand in 2025, contributing almost 40% of growth in total imports over the forecast period. India is also expected to be a leader in LNG demand growth accounting for about 20% of incremental trade and could increase imports by 50% between 2019 and 2025 to support strong growth in demand. Bangladesh and Pakistan, two more recent LNG buyers, are expected to experience strong import growth rates to support their increasing consumption and offset the decline of domestic production. Southeast Asian markets are also expected to increase their imports to supply the development of new import capacity in Thailand and Vietnam.[77] China, which has been the growth engine for LNG demand until 2022, is on course to import the lowest amount of LNG since 2019. Several companies in China are in the process of a major regasification capacity buildout over the next two years – upward of 50 million mt by end-2024 – but with international spot prices still higher than downstream prices in much of the country, the prospects for near-term growth are weak.[78]

Asian LNG importers are seeking the protection of long-term contracts due to the volatility of spot markets, while European energy companies and utilities are looking to tie up gas supply to replace Russian volumes in the years ahead. Japan's gas buyers are being driven by the need to switch out Russian volumes and replace expiring contracts. Chinese firms are covering spot exposure and securing demand from new LNG terminals, Indian

companies need affordable gas to replace spot imports and some Southeast Asian firms are looking to enter the gas market for the first time.[79]

Volatile and high prices and supply challenges in the global market have crimped LNG demand in Asia. LNG prices in Asia in October were up 300% compared to last year. Correspondingly, in China and India, LNG demand has been reduced by 21% and 18% year on year, respectively, due partly to the high fuel costs and economic slowdown from the pandemic. Pakistan and Bangladesh have slashed imports by 16% and 15%, respectively. As a result, the average utilization of existing LNG terminals in all four countries has fallen compared to the third quarter of last year. As Asian countries search for less expensive energy supplies, their fuel-switching choices, policy shifts, and underutilization of existing LNG terminals have started to materialize into high-profile delays and cancellations of proposed new LNG import projects.[80]

5. LNG Market Growth in the Climate Context

Natural gas, and especially LNG, will play a critical role in energy transition over the next 20-30 years, including supplying energy to the fast-growing markets, such as those in the Asia Pacific regions. The increased use of natural gas has already contributed to a reduction in CO_2 emissions and an improvement in local air quality in many countries around the world, including the United States, and will continue to do so as it replaces coal in electricity generation and diesel as a transportation fuel. Natural gas is also a key complement to wind and solar generation development as it provides affordable back generation to compensate for the intermittency of these renewable sources, and it can also rapidly respond to increases in demand. Absent the development of affordable long duration storage, natural gas will serve as a critical backstop for ensuring reliable uninterrupted delivery of electricity, as illustrated in Box 3.

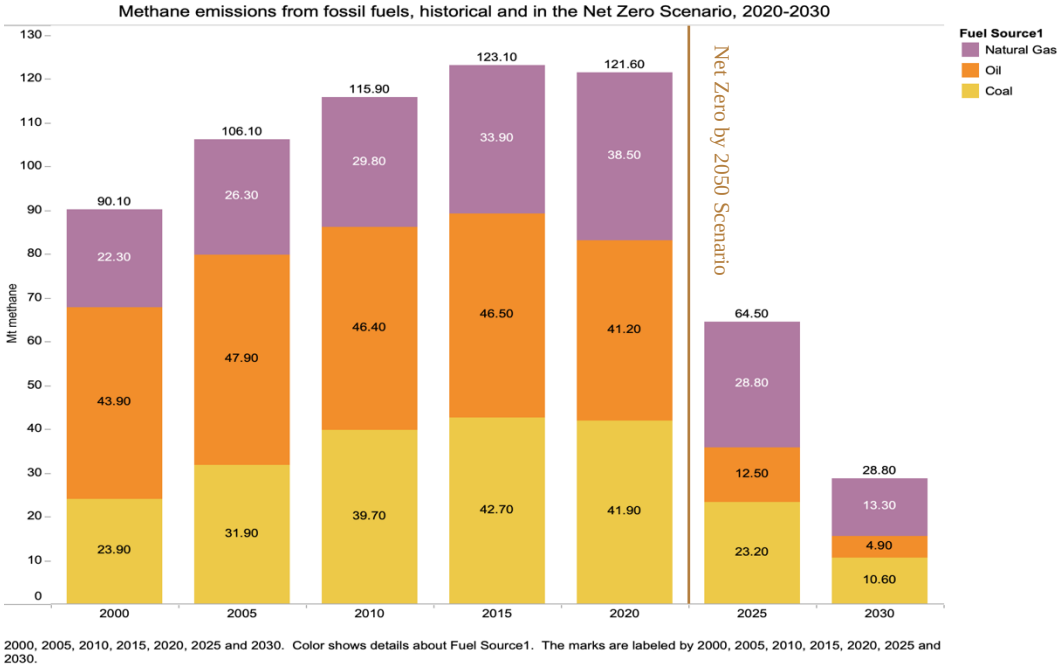
Although natural gas is less carbon intensive than coal or oil and critical for the energy transtion, methane emissions from natural gas remain a major concern. According to the Intergovernmental Panel on Climate Change, today's concentrations of methane in the atmosphere are higher than at any time in at least 800,000 years, and methane has contributed around 30% of observed global warming to date. The energy sector is responsible for around 40% of total methane emissions attributable to human activity, second only to agriculture. Of the 135 million tons of energy-related methane emissions, 39 Mt are from extracting, processing, and transporting natural gas.[81] At the same time, the prevention of methane leaks also presents an opportunity; in 2021, leaked methane from

fossil fuel operations would have provided an additional 180 bcm of gas available, an amount similar to all the gas used in Europe's power sector.[82]

Europe is struggling to simultaneously meet its decarbonization goals and energy security needs as it continues to import LNG to offset Russian imports. In 2021, the European Investment Bank and over a dozen European states pledged to cease financing fossil fuel projects abroad. Europe is actively seeking new supplies of natural gas from countries around the world while also maintaining opposition towards development of additional production projects of its own reserves.[83] Europe has also been willing to pay higher prices for imported natural gas that poorer nations cannot afford, thus resulting in a shift in less-developed nations to more affordable and reliable forms of energy, such as coal.[84] In addition, even though Europe has pulled natural gas supplies away from Asia, many countries in the EU are not signing long-term contracts with LNG importers, as this action would be contrary to the EU's long-term decarbonization vision and policies.

The pathway in the IEA's Net Zero by 2050 Roadmap, which would give the world an even chance of limiting the rise in global temperatures to 1.5 °C and avoiding the worst effects of climate change, requires energy-related methane emissions to fall by 75% by 2030. Reducing fossil fuel demand alone will not do the job quickly or effectively enough, which means early and concerted abatement efforts by governments and industry are essential. By 2030, all fossil fuel producers would need to reduce their emissions intensities down towards the level of the world's best operators today (Figure 10).[85]

Figure 10: Methane emissions from fossil fuels, historical and in the Net Zero Scenario, 2020-2030 (Mt methane) [86]



Source: International Energy Agency, Global Methane Tracker 2022

The Russian invasion presented European countries with a critical choice: to get gas from non-Russian sources or increase renewable sources like wind and solar. In July 2022, the European Parliament endorsed labeling some gas and nuclear energy projects "green," allowing them access to hundreds of billions of euros in cheap loans and state subsidies. The motivation for using LNG was primarily driven by energy security concerns and the associated need for a reliable energy source, particularly for industrial needs and heat. This vote, however, could undermine a competing European imperative to cut its greenhouse gas emissions by more than half by 2030, in part because of the associated methane emissions, which, as noted, are more potent than carbon dioxide in the first 20 years of emission.[87]

Meeting global LNG demand involves careful and long-term planning. LNG projects are built with a 20-year investment horizon—with firm sale contracts that extend 15 to 20 years and financing that lasts 10 to 15 years. New projects, once approved, require four to five years to build. Because of Europe's goals of climate neutrality by 2050, these timescales pose a problem for companies, based either in Europe or in the U.S.[88]

By the mid-2030s, Europe's need for gas in general, and for U.S. LNG in particular, is projected to decline. U.S. LNG could continue to be exported to Asian countries because of their generally longer timeframes for decarbonization. Asia is currently the biggest consumer of coal because of its availability and affordability. If U.S. LNG is produced at the highest environmental specifications without methane leaks along the production chain and is cost competitive with alternatives, LNG could be a reliable, affordable, and clean source of energy for Asia. In short, U.S. LNG could support European energy security needs in the near term and help displace coal in Asia in the longer term.[89]

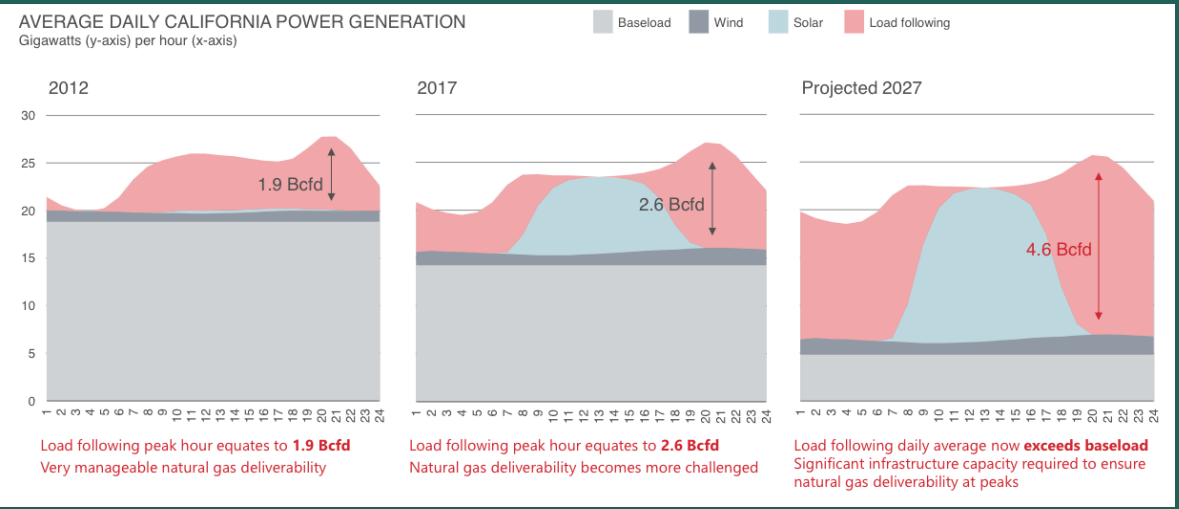
Box 3: Natural Gas Steps in When Renewables Drop Out – A California Case Study

Increased deployment of renewables puts strain on natural gas infrastructure as load-following plants quickly ramp up to balance the grid during times of high consumer demand and low renewable output.

Since 2012, California has increased the share of solar power in the state's electricity grid. During the summer 2021 heat wave, demand for electricity was at an all-time high and the grid could not meet demand, which resulted in rolling blackouts. As demand peaked in the evening hours, solar generation dropped off, and natural gas filled the supply gap.

In 2017, 2.6 Bcfd of natural gas was needed to accommodate consumer demand as solar generated electricity dropped off in the evenings. By 2027, California's projected installed solar capacity will require 4.6 Bcfd to meet peak demand, which will put immense strain on the gas network and requires the buildout of new infrastructure capacity to ensure natural gas deliverability (Figure B1).

Figure B1: Natural gas' role in balancing renewables in California



Source: Kinder Morgan, Energy Transition in Focus: Sector Coupling of Electric and Gas Systems - Benefits of Natural Gas Infrastructure

6. Conclusion

As the world struggles to reconcile both energy security and decarbonization goals in affordable ways, natural gas will likely continue to play a key role in the clean energy transition. This paper examines the present state of natural gas markets and how the U.S. can play a role in satisfying its own natural gas needs, along with those of its allies and partners around the world, particularly those in Europe and Asia. In the context of U.S. LNG, Europe will be a destination market in the short-term, and Asia is poised to be a long-term growth as it continues its economic development and growth while simultaneously working to meet its decarbonization goals.

In particular, five takeaways, and broad thematic questions raised by these takeaways, highlight the delicate balance between these energy security, decarbonization goals, and financial considerations for the flows of natural gas between the U.S., Europe, and Asia:

1. High prices of natural gas incentivize producers to develop projects, but low oil prices may stall U.S. production since over 50% of natural gas production is associated with tight oil plays.

   How should development of domestic natural gas projects proceed given uncertainty of the future of oil and gas prices?

2. Regulatory issues associated with infrastructure builds, permitting, and the Jones Act complicate the use of natural gas in some U.S. regions, leading to the use of more carbon-intensive alternatives by importing countries when no other fuel is available.

   What are strategies to build consensus around infrastructure and permitting issues given competing goals for diverse stakeholders?

3. E.U. countries have overtaken Asian countries as the destination for U.S. LNG exports due to the energy crisis and the flexibility of LNG contracts to go to the highest bidder, but its price cap will go into effect on February 15.

How will the E.U. price cap affect global LNG flows, especially as related to the U.S. export flow balance between Europe and Asia?

4. The EU is struggling to strike a balance between energy security and decarbonization targets; imports of LNG are often favored over new domestic projects to produce natural gas.

   What is the E.U.'s plan to balance its current energy security needs with its long-term decarbonization strategy, and how will its plan affect the nature of U.S. export contracts?

5. Asian countries are poised to increase their LNG consumption, but their fuel-switching choices, policy shifts, and underutilization of existing LNG terminals have started to delay and cancel high-profile proposed new LNG import projects.

   Since some Asian countries have turned to Russia for natural gas, how should U.S. export contracts respond to potential energy security issues in Asia?

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