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ISSUE BRIEF

US Liquefied Natural Gas Exports Outlook

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Liquefied Natural Gas Exports Benefit US Security and Prosperity

A sharp rise in US liquefied natural gas (LNG) export capacity is underway, largely underpinned by long-term sales contracts and propelled by the ongoing revolution in US shale gas development. The US shale revolution is one of the biggest stories in the history of petroleum development and continues to generate immense economic benefits to the US economy, including low-cost supply to industry and manufacturing sectors, infrastructure development, job growth, and low prices for consumers. It also contributes to US geopolitical, diplomatic, and economic influence in global markets and improves energy security and flexibility for markets and consumers.

Projects currently under construction will raise US LNG capacity from about 14 billion cubic meters (bcm) per year to about 90 bcm by 2020, although actual production may be somewhat less (see table 1). Beyond those already under construction, additional projects have been approved but await final investment decisions, which have slowed considerably as global LNG prices have slumped. Despite the current low-price environment, long-term demand is strong and US LNG exports will grow as gas production expands and costs stay low. The US Energy Information Administration (EIA) projected in its January 2017 Annual Energy Outlook that US natural gas production will continue to rise through 2050 and gas exports will help drive the United States to become a net energy exporter.[1]

Geopolitically, US LNG exports will help integrate markets, diversify supplies, and enhance US and global energy security by adding to the flexibility and connectivity of global gas markets. The ability to ship natural gas by sea in addition to pipelines makes gas consumers less vulnerable to disruptions and price differences in gas imports. A more flexible global gas market and the availability of LNG exports will help remove political leverage from producers that have supplied traditionally isolated markets. Increased LNG availability has already contributed to flattening global gas prices and will continue to reduce gas market isolation. This will boost the United States' economic influence in international markets and its geopolitical and diplomatic weight in international business and political dealings.

The **Energy Diplomacy Initiative** (EDI), as part of the Atlantic Council's Global Energy Center, aims to drive a global conversation on critical climate and energy security challenges, with the objective to prevent conflict and build bridges through energy ties, provide everyone with access to reliable, affordable, sustainable, and modern energy, and galvanize communities for climate action around a more stable, secure, and prosperous world.

1 US Energy Information Administration, *Annual Energy Outlook 2017*, January 5, 2017, https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf.

The EIA expects US natural gas production to increase by 1.9 percent in 2017 following a dip in output last year. US gas production increased every year during 2005-15, setting a record in 2015 when it rose by 5 percent.[2] The EIA forecasts production to grow by about 4 percent annually from 2016 to 2020, about the same rate as from 2005 to 2016.[3]

Growth in natural gas production will continue to provide abundant domestic supply at relatively low prices and reduce carbon dioxide emissions. Natural gas is the cleanest of hydrocarbons, and a combination of new technologies, increased efficiency, and fuel switching from coal to natural gas has reduced US carbon dioxide emissions in recent years. According to the EIA, in 2016 US energy-related carbon dioxide emissions fell by 1.7 percent and were 14 percent below the 2005 level.[4]

Two independent studies on the macroeconomic impacts of US LNG exports commissioned by the US Department of Energy (DOE) have confirmed the economic benefits to the US economy of exporting LNG at least up to the level of 200 bcm per year. A report by NERA Economic Consulting in 2012 concluded that LNG exports would provide a net economic gain for the nation's gross domestic product (GDP) up to an export level of at least 120 bcm per year.[5] A second report by the Center for Energy Studies at Rice University's Baker Institute and Oxford Economics, issued in 2015, found that the macroeconomic impact of further increasing LNG exports from 120 bcm per year to 200 bcm per year would be marginally positive and increase the nation's GDP from 2026 to 2040.[6] The Department of Energy said these studies will inform DOE decisions on whether to approve LNG exports, suggesting projects totaling at least 200 bcm of export capacity will be approved.[7]

Market Uncertainties Ahead

While growth in LNG export capacity is likely to keep the market for LNG well supplied through the remainder of this decade, analysts disagree on prospects for LNG demand and supply in the years just beyond 2020. Low LNG prices in recent years have raised questions about the competitiveness of high-cost LNG and caused a sharp drop in financial investment decisions (FIDs) for new projects intended to drive supply growth beyond 2020. Warnings range from an extended glut of LNG supply because of over investment and slow demand growth to an approaching supply shortage caused by a drop-off in new projects.

One of the biggest questions impacting future demand for LNG is whether gas will be embraced as a bridge fuel in climate change policies. While natural gas provides the most energy per unit of carbon dioxide emissions of any hydrocarbon fuel, it has yet to fulfill its potential in replacing oil and coal, especially outside the United States.[8]

A slowdown or short hiatus in FIDs would benefit US LNG exporters who have already made investment decisions and allow LNG demand to catch up with supply. This would also boost LNG prices, further benefitting high-cost LNG producers. However, this scenario could be undercut somewhat by a recent announcement from Qatar that it will end its moratorium on further development of its massive North Field. Qatar, the world's largest LNG supplier, plans to add 20.7 bcm per year of new LNG production in the next five to seven years. While this would amount to less than 6 percent of current internationally traded LNG supply, due to valuable condensate components in the gasfield the estimated cost for Qatar LNG delivered to market is only about $5.20 per million British thermal

2 US Energy Information Administration, "US Natural Gas Production Reaches Record High in 2015," *Today in Energy*, April 15, 2015, https://www.eia.gov/todayinenergy/detail.php?id=25832.

3 US Energy Information Administration, *Short-Term Energy Outlook*, March 7, 2017, https://www.eia.gov/outlooks/steo/report/natgas.cfm; US Energy Information Administration, *Annual Energy Outlook 2017*.

4 US Energy Information Administration, "US Energy-Related CO2 Emissions Fell 1.7 Percent in 2016," *Today in Energy*, April 10, 2017, https://www.eia.gov/todayinenergy/detail.php?id=30712.

5 W. David Montgomery, Robert Baron, Paul Bernstein, Sugandha D. Tuladhar, Shirley Xiong, and Mei Yuan (project team), *Macroeconomic Impacts of LNG Exports from the United States*, Prepared for the US Department of Energy by NERA Economic Consulting, December 3, 2012, https://energy.gov/sites/prod/files/2013/04/f0/nera_lng_report.pdf.

6 Adrian Cooper, Michael Kleiman, Scott Livermore, and Kenneth B. Medlock III (primary authors), *The Macroeconomic Impact of Increasing US LNG Exports*, Prepared for the US Department of Energy by the Center for Energy Studies at Rice University's Baker Institute and Oxford Economics, October 29, 2015, https://energy.gov/sites/prod/files/2015/12/f27/20151113_macro_impact_of_lng_exports_0.pdf.

7 Nick Snow, "Two DOE Studies Examine Macroeconomic Impacts of LNG Export," *Oil and Gas Journal*, December 28, 2015, http://www.ogj.com/articles/2015/12/two-doe-studies-examine-macro-economic-impacts-of-lng-exports.html.

8 Stuart Elliott, "Global LNG Outlooks Contest Conventional Wisdom of Supply Glut," Platts, March 10, 2017, http://www.platts.com/latest-news/natural-gas/london/analysis-global-lng-outlooks-test-conventional-26683006.

Italy's first cargo of US LNG was delivered from Sabine Pass to the floating storage and regasification unit (FSRU) Toscana on December 7, 2016. FSRUs are increasingly popular because they are quicker and less expensive to install than onshore facilities. *Photo credit*: Wallacepc67/Wikimedia.

unit (mbtu). The price is close to the breakeven price of Russian pipeline gas but $2-3 below the full-cycle price for US LNG at today's Henry Hub price of about $3 per mbtu.[9]

US LNG exports have thus far proved flexible and agile in finding and reaching gas markets globally amid demand shifts and occasionally rapid price changes. However, at a breakeven price of about $7-8 per mbtu at recent Henry Hub prices, fewer cargoes than some analysts expected have gone to Europe, and more to Latin America and Asia. Gas prices at Germany's border started and ended 2016 with prices over $5 per mbtu, but averaged only about $4.35 per mbtu for the year, meaning that US LNG could generally cover marginal costs, but not longer-term breakeven costs.

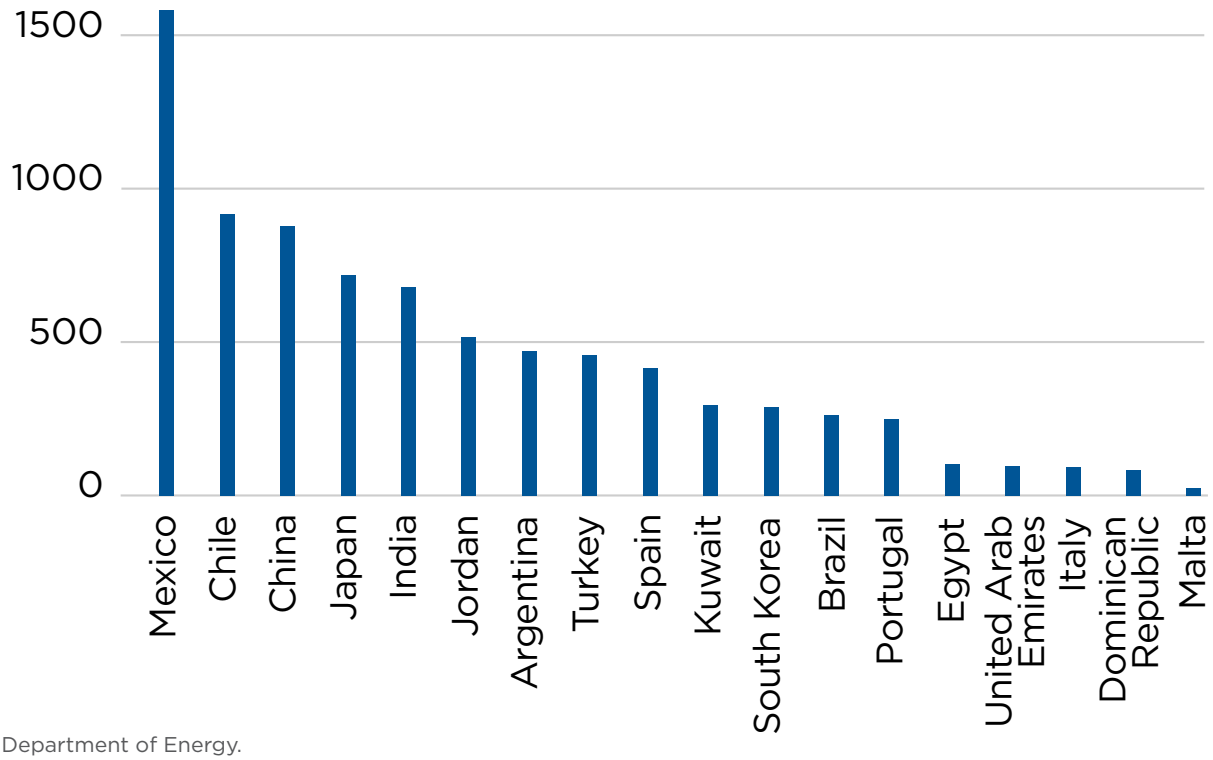
Despite the disadvantageous cost comparison with piped gas, US LNG exports are by no means the highest-cost LNG. Rather, US LNG projects benefit from the low cost of available natural gas, the extensive pipeline network that enhances availability, and the economics associated with converting former import terminals into export terminals. For example, nearly all the projects currently under construction already had existing port and storage facilities.

US LNG exports have also benefited from the relatively large share of global liquefaction capacity that is currently offline due to lack of gas feedstock, security, and unplanned technical problems. At present, the International Energy Agency (IEA) estimates that worldwide about 65 bcm per year of LNG capacity is unavailable, primarily in Algeria, Egypt, Indonesia, Trinidad and Tobago, and Yemen.[10]

9 Howard Rogers, *Qatar Lifts Its LNG Moratorium*, Oxford Institute for Energy Studies, April 2017, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/04/Qatar-Lifts-its-LNG-Moratorium.pdf.

10 International Energy Agency, *Global Gas Security Review*, November 2016, https://www.iea.org/publications/freepublications/publication/GlobalGasSecurityReview2016.pdf.

Figure 1. Destination of US LNG Exports in 2016 in million cubic meters



Source: US Department of Energy.

Looking ahead, another positive sign for US LNG exporters is slow growth in gas production and LNG supplies in several competing suppliers. Gas production is falling in the Netherlands due to concerns over induced seismicity and a government mandate to extend the life of the Groningen gasfield. Norway's gas output is stable, LNG supply growth from Australia has slowed, and Russia's objective of major gas trade with China and other Asian markets is falling well short of potential.[11] So while Europe has proved a difficult destination for US LNG, Asia remains an attractive market. Sales to Asia have also received a boost from the expansion of the Panama Canal.

On the more negative side, LNG prices remain low, except for a spike during the winter of 2016, and LNG is having a difficult time competing with coal and pipeline gas in Europe and coal in Asia. Some investments in coal-fired electric power facilities predate the fall in gas prices, locking in some growth in the commitment to and use of coal. Coal is also benefitting from a lack of commitment to natural gas as part of a strategy to reduce carbon emissions. Countries such as China, Poland, Germany, the Philippines, and Turkey, for example, all use coal, in some cases low-grade coal, because it is cheaper and available in many cases from indigenous supplies, in contrast to natural gas, which needs to be imported. In many instances, the costs imposed for carbon emissions are nonexistent or too small to swing the balance from coal toward increased use of pipeline gas or LNG as a preferred fuel to further climate objectives.

US LNG Exports and Infrastructure Growth

The capacity of US LNG exports will continue to grow as construction proceeds on projects that already have reached final investment decisions, despite the sharp drop in decisions to move ahead on new projects not already under construction. The projects under construction are all supported in large part by long-term contracts. The decline in final Investment decisions is not surprising, given the low prices for LNG and the number of proposed projects to export LNG. Further investment decisions to proceed with new projects will depend on the availability of new customers willing to sign contracts. Many analysts anticipate that LNG prices will remain low through the end of this decade, which is likely to lead to further postponements in

11 Ibid.

Table 1. Existing, Under Construction, and Approved US LNG Export Terminals

LNG Export Terminal	Major Stakeholders	Capacity (bcm/year)	Start Up Date
Existing US LNG Export Terminals			
Kenai LNG, AK	ConocoPhillips	2	1969
Sabine Pass, LA (trains 1-2)	Cheniere Energy	12.2	2016
US LNG Export Terminals Approved and Under Construction			
Sabine Pass, LA (trains 3-4)	Cheniere Energy	12.2	2017
Cove Point LNG, MD (train 1)	Dominion	7.1	2017
Elba Island LNG, GA (trains 1-6)	Kinder Morgan	2	2018
Cameron LNG, LA (trains 1-2)	Sempra and Partners	10.8	2018
Freeport LNG, TX (train 1)	Freeport LNG	6.9	2018
Corpus Christi, TX (train 1-2)	Cheniere Energy	12.2	2019
Elba Island LNG, GA (trains 7-10)	Kinder Morgan	1.3	2019
Freeport LNG, TX (train 2)	Freeport LNG	6.9	2019
Cameron LNG, LA (train 3)	Sempra and Partners	5.4	2019
Sabine Pass, LA (train 5)	Cheniere Energy	6.1	2019
Freeport LNG, TX (train 3)	Freeport LNG	6.9	2020
US LNG Export Terminals Approved and Not Under Construction			
Sabine Pass, LA (train 6)	Cheniere Energy	6.1	Unknown
Cameron LNG, LA (trains 4-5)	Sempra and Partners	10.9	2021
Corpus Christi, TX (train 3)	Cheniere Energy	6.1	Unknown
Golden Pass, TX	Golden Pass LNG	21.2	2021-22
Lake Charles, LA	Magnolia LNG	10.9	2022
Lake Charles, LA	Shell	20.4	Unknown

Source: LNG Allies, Federal Energy Regulatory Commission, International Energy Agency, and International Gas Union.

investment decisions in the short term, but will over time also stimulate more demand for LNG.[12]

The United States exported nearly 5.2 bcm of LNG in 2016, all from Cheniere's Sabine Pass terminal in Louisiana. US LNG exports from Sabine Pass were delivered to eighteen destinations in 2016, with more than 60 percent of the total volume going to customers in the Western Hemisphere.[13] This compares to exports of about 0.7 bcm in 2015, excluding re-exports, all by the Kenai LNG terminal in Alaska.

The total capacity of new US LNG projects approved by the US Federal Energy Regulatory Commission (FERC) and Department of Energy has reached 168 bcm per year. Of this amount, 12 bcm per year of capacity was completed and operating at the end of 2016 at the Sabine Pass export terminal, another 78 bcm per year of capacity is under construction and scheduled to come online between now and 2020, and 76 bcm per year of capacity is in projects fully approved but awaiting

12 Helen Robertson, "The Great LNG Market Showdown," *Petroleum Economist*, April 5, 2017, http://www.petroleum-economist.com/articles/midstream-downstream/lng/2017/the-great-lng-market-showdown.

13 US Department of Energy, *LNG Monthly*, 2017, https://energy.gov/sites/prod/files/2017/03/f34/LNG%202016_0.pdf. Data exclude a small amount of LNG exported to Barbados by vessels carrying International Organization for Standardization shipping containers.

Table 2. Non-US LNG Export Terminals Under Construction

Country	LNG Export Terminal	Major Stakeholders	Capacity (bcm/year)	Start Up Date
Malaysia	Malaysia LNG	Petronas	4.9	2017
Malaysia	Petronas FLNG SATU	Petronas	1.6	2017
Australia	Gorgon LNG (train 3)	Chevron	7.1	2017
Australia	Wheatstone LNG (train 1)	Chevron	6.1	2017
Indonesia	Sengkang LNG	Energy World Corp.	0.7	2017
Australia	Prelude FLNG	Shell	4.9	2018
Australia	Ichthys LNG (trains 1-2)	Inpex, Total	12.1	2018
Australia	Wheatstone LNG (train 2)	Chevron	6.1	2018
Russia	Yamal LNG (train 1)	Novatek	7.5	2018
Russia	Yamal LNG (train 2)	Novatek	7.5	2019
Malaysia	Petronas FLNG 2	Petronas	2.0	2020
Russia	Yamal LNG (train 3)	Novatek	7.5	2020
Indonesia	Tangguh LNG (train 3)	BP	5.2	2020

Source: International Energy Agency and International Gas Union.

final investment decisions to begin construction. With the addition of the 2 bcm of capacity at the Kenai LNG export terminal, the United States will likely have a total capacity of about 92 bcm per year by 2020, making it one of the top three LNG exporters in terms of capacity globally, alongside Qatar and Australia.[14]

A host of other possible US LNG export projects are at various stages of pre-approval, including ten projects proposed to FERC with pending applications, four in "pre-filing" status with FERC, and others with less formal statuses.[15] These projects are not all likely to be undertaken, but the total potential planned capacity for these projects is 400 bcm per year.[16] These projects are particularly less likely than approved projects to move ahead under the predicted market conditions over the next four years, but there are exceptions. Projects commonly take about four years to complete after a final investment decision, so investors making a final decision in the near term would most likely face post-2020 market conditions.

Global LNG Export Infrastructure Plans

The US LNG outlook plays a key role in development of LNG infrastructure globally. Total global LNG capacity additions will likely amount to approximately 146 bcm per year by 2020, about half of which will be in the United States. This is in comparison with global trade of about 355 bcm in 2016, or about 40 percent of currently traded gas.[17] While most of this capacity will come from projects in Australia, Indonesia, and Malaysia, nearly one-third of the non-US capacity additions could come from Novatek's Yamal LNG terminal—if the company is successful in completing its planned three trains over the next four years. At present, the Yamal project has long-term contracts for only one of the three trains.[18]

14 International Gas Union, *2017 World LNG Report*, April 2017, http://www.igu.org/sites/default/files/103419-World_IGU_Report_no%20crops.pdf.

15 FERC, "North American LNG Export Terminals Proposed," May 1, 2017, https://www.ferc.gov/industries/gas/indus-act/lng/lng-proposed-export.pdf.

16 International Gas Union, *2017 World LNG Report*.

17 BP, *BP Statistical Review of World Energy June 2016*, https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2016/bp-statistical-review-of-world-energy-2016-full-report.pdf.

18 International Group of Liquefied Natural Gas Importers, *The LNG Industry*, GIIGNL Annual Report, 2016 Edition, January 2016, http://www.giignl.org/sites/default/files/PUBLIC_AREA/Publications/giignl_2016_annual_report.pdf.

Countries are also adding new regasification terminals, prompted in part by increased availability of LNG at low prices. Regasification facilities are considerably cheaper to build than liquefaction plants and many governments and commercial firms consider them essential for economic growth and security. Seven of the new facilities will be floating storage and regasification facilities and will help expand the number of LNG importers. Some countries, such as Poland and Lithuania, recognize that regasification facilities are critical to supply diversity and security regardless of whether they are used at capacity.

The largest share of new regasification capacity will be built in China and India, where gas demand is rising. From 2017 through 2021, the two countries will account for about 50 bcm per year of new regasification capacity, accounting for about 37 percent of total additions worldwide.[19]

Changing LNG Markets

LNG has a big and growing role in integrating global gas markets. In 2016, LNG trade increased by 5 percent to about 355 bcm.[20] Lower prices for LNG and more options for importers have forced LNG sellers to adapt to competition from pipeline gas and other fuels such as coal and renewable energy sources. The result is a more flexible LNG global market.

LNG prices have historically been linked to oil prices—however, the influence of oil prices on gas contracts has declined considerably, helping to lower LNG prices and reduce price differences among contracts. The extent of oil indexation in gas contracts is down from an average of 76 percent to 40 percent since 2010. The lengths of purchase commitments in new contracts that LNG importers are willing to sign has also grown shorter, down from eighteen to thirteen years.[21]

A rise in the number of relatively small floating storage and regasification units (FSRUs) has also made the LNG market more flexible—and has increased the number of countries importing LNG to include thirty-five countries and Puerto Rico.[22] Between 2012 and 2016, LNG demand from FSRUs tripled to about 41 bcm per year. Indonesia, Pakistan, Argentina, Brazil, Egypt, Jordan, and Turkey have all added FSRUs in recent years.[23] These facilities are quicker and cheaper to install, make imports of small amounts of LNG more available and efficient, and have become a common way for countries with small markets to become LNG buyers. Some of the units consist of a tanker that can regasify LNG onboard and move from place to place, and are thus able to serve more than one small market.

Despite these longer-term trends, the share of LNG trade conducted under long-term contracts has grown since 2013, although overall contract lengths have shortened, and in 2016 more LNG regasification capacity was added in onshore facilities than in FSRUs, in large part because the capacity of FSRUs is much smaller than that of onshore facilities.[24]

US LNG Will Compete with Russian Pipeline Gas in Europe

Competition between Russian gas and US LNG in European and Asian markets is underway, as exporters in both countries seek to increase exports to both markets. In Europe, US shale gas has been depressing Russian prices since at least 2009 by reducing US demand for imports, diverting LNG exports previously intended for the US market elsewhere, including Europe. Looking ahead, Russia's plan to add two new pipelines to Europe, Nord Stream 2 and TurkStream, to help increase its European market share will further competition with US LNG to meet Europe's growing gas needs as indigenous supplies decrease and gas demand increases. The European Union's (EU's) stated interests in diversifying its gas supplies to enhance competition and security is a good match with growing LNG exports, however, and offers a good opportunity for the EU as well as US exporters. According to Russia's state-run energy giant Gazprom, Russia exported a record 179.3 bcm of natural gas in 2016 to Europe, including Turkey, an increase of 12.5 percent over 2015 exports despite EU efforts to improve its energy security by expanding gas import diversity.[25]

In a 2016 communication explaining the EU LNG and gas storage strategy, the European Commission (EC) wrote that "As regards [to] LNG, the prospect of a dramatic (50%) expansion in global supply over

19 International Gas Union, *2017 World LNG Report*.
20 Ibid.
21 International Energy Agency, *Global Gas Security Review*.
22 International Gas Union, *2017 World LNG Report*.
23 Robertson, "The Great LNG Market Showdown."
24 International Gas Union, *2017 World LNG Report*.
25 "Europe," Gazprom, April 17, 2017, http://www.gazprom.com/about/marketing/europe/.

the next few years and consequently of lower prices presents a major opportunity for the EU, particularly when it comes to gas security and resilience."[26] The EC document also touts LNG as a benefit to environmental goals.

To this end, the EC is emphasizing the integration of national pipeline grids and completion of interconnecting infrastructure to support LNG imports and gas distribution. The EC is also helping fund new infrastructure to increase diversity and interconnectivity. New projects—including the Midcat pipeline, which can deliver gas from LNG import terminals in Spain to France and on to Central Europe; the Trans-Anatolian Pipeline through Turkey, a key component of the EU-backed Southern Gas Corridor; expansion of Romania's gas pipelines and connections to neighboring states; and a planned LNG import terminal at Krk in Croatia—have all received funds from the EC as part of this effort.

However, while the EU has released an LNG strategy and is providing funds for some infrastructure projects, it is not necessarily taking full advantage of the opportunity presented by growing LNG supplies. Much more needs to be done to complete missing infrastructure for gas.[27] Europe needs more LNG import capacity on its southeastern coast, but planned projects have made slow progress. Moreover, authority to determine energy policies and incentives is primarily the prerogative of national governments rather than the EU, leading to variations in preferences for how natural gas—as compared with other fuels such as coal, renewables, and nuclear power—is used.

Countries also retain a significant say in gas import infrastructure, as evidenced by Germany's insistence that it does not need EU approval for Russia's Nord Stream 2 gas import pipeline, which some EU members oppose. Russia continues to strongly push Nord Stream 2 and TurkStream to expand capacity and access to the European market and make good on its desire to end Ukrainian transit. Gazprom, for example, is seeking use of additional capacity in some pipelines in northern Europe, such as the OPAL and proposed EUGAL pipeline, to deliver gas from Nord Stream 1 and 2. Under the guise of EU rules on third-party access, Gazprom is also eyeing use of a planned expansion of capacity in the Trans-Adriatic Pipeline, part of the EU-backed Southern Gas Corridor, to distribute its own gas in southern Europe.[28]

Moscow is particularly motivated to expand gas exports to Europe because its efforts to strike a big gas deal with China have fallen short. Lack of agreement on price and China's preference for the flexibility of LNG supplies have delayed a large commitment, and the long-term outlook is unclear. Gazprom is also sitting on as much as 100 bcm per year of additional gas production capacity that it would like to market in Europe.

Moscow wants to avoid competition from US LNG exports in Europe and has supported protests of shale gas development in Europe.[29] Another element of Gazprom's strategy is to keep Central Asian gas out of Europe by withholding third-party access to Gazprom's export pipelines and raising political, legal, and military obstacles to trans-Caspian pipelines.[30]

Whether Russia will try to keep US LNG out of its markets by underpricing its gas exports is still uncertain. While the increased availability of LNG due to US shale has helped depress Russian prices, low European prices—due largely to market forces and competition rather than monopolistic practices—have made it difficult for US LNG imports to compete. In 2016, the price of Russian gas at the German border averaged about $4.35 per mbtu and dipped below $4 per mbtu in May and September.

26 European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on an EU Strategy for Liquefied Natural Gas and Gas Storage*, February 16, 2016, https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v10-1.pdf.

27 See Atlantic Council and Central Europe Energy Partners, *Completing Europe: From the North-South Corridor to Energy, Transportation, and Telecommunications Union*, November 20, 2014, http://www.atlanticcouncil.org/images/publications/Completing-Europe_web.pdf.

28 Rochelle Toplensky and Neil Buckley, "Gazprom's Pipeline Ambition Faces Test in European Courts," *Financial Times*, February 14, 2017, https://www.ft.com/content/72bd7ecc-f29a-11e6-8758-6876151821a6; Agata Łoskot-Strachota and Konrad Popławski, "The EUGAL Project: The German Branch of Nord Stream 2," Ośrodek Studiów Wschodnich, June 15, 2016, https://www.osw.waw.pl/en/publikacje/analyses/2016-06-15/eugal-project-german-branch-nord-stream-2.

29 Andrew Higgins, "Russian Money Suspected Behind Fracking Protests," *New York Times*, November 30, 2014, http://www.nytimes.com/2014/12/01/world/russian-money-suspected-behind-fracking-protests.html?_r=0.

30 Bud Coote, *The Caspian Sea and Southern Gas Corridor: A View from Russia*, Atlantic Council, April 27, 2017, http://www.atlanticcouncil.org/images/publications/Caspian_Sea_and_Southern_Gas_Corridor_web_0427.pdf.

"A bigger question is that if Russia were to engage in a price war, what would winning look like and at what cost?"

To price US LNG out of the European market, Moscow probably would need to keep its own price at about $5 per mbtu or lower. At a Henry Hub price of about $3 per mbtu, the long-term breakeven cost of US LNG is about $8 per mbtu, but the short-term marginal cost is only about $5 per mbtu—a price at which US LNG can generally compete in the short term. This excludes the liquefaction cost of about $3 per mbtu but includes transportation costs as well as the Henry Hub price.[31]

Keeping gas prices around $5 per mbtu also serves other purposes for Russia. At this price coal and renewables are less competitive, which helps Russia find markets for its surplus gas production capacity. Russia also has the capability to undercut the price of US LNG, given its excess gas production capacity and a short-term marginal cost of about $4 per mbtu, but as more gas comes from the Yamal Peninsula in Russia's far north, long-term costs will rise.

A bigger question is that if Russia were to engage in a price war, what would winning look like and at what cost? Moscow could potentially lose revenue to prevent a small amount of US LNG from entering the European market, and at the same time run the risk of undercutting its own LNG aspirations. In 2007 Gazprom joined the Sakhalin 2 project, which has been exporting LNG since 2009. Gazprom is also a significant LNG trader, having signed several long-term contracts to buy and sell LNG during 2015.

While Gazprom has considered additional LNG projects in the Arctic and Baltic Sea,[32] it is Novatek that is poised to enter the LNG export market with its Yamal LNG project. According to the IEA, the Yamal LNG plant is scheduled to bring three trains of LNG online in three consecutive years, beginning in 2018. Each train would have a capacity of 7.5 bcm per year. In 2015, Novatek and its partners signed three long-term contracts to export a total of about 6.5 bcm per year, which is about enough for one train.[33] Even this amount would erode Gazprom's gas export monopoly, as well as provide additional gas exports that will compete in Gazprom's markets.[34] Most likely, Novatek will target Asia with its LNG sales. The China National Petroleum Corporation is one of the partners in the Novatek-led project.[35] Planned Russian LNG projects in the northwest initially targeted the US gas market for sales.[36]

Favorable Long-Term Outlook for LNG Demand

The long-term outlook for LNG demand is favorable, according to the major petroleum consulting companies Wood Mackenzie and FACTS Global Energy. Despite predicting numerous postponements or cancelations of new LNG export projects in 2015, both firms now see LNG demand recovering by the start of the next decade.[37]

Wood Mackenzie and FACTS Global Energy both consider Asia as key to LNG demand growth and predict a 50 percent increase in LNG demand between 2016 and 2035. Demand growth will be even higher in new Asian markets. Wood Mackenzie expects Southeast Asian LNG demand to grow by 80 percent and South Asian demand to grow by 70 percent by 2035.

The Middle East will also experience strong LNG demand growth, reflected in the rising number of floating storage and regasification units in Egypt, Jordan, Kuwait, and Abu Dhabi in recent years. Highlighting the role of LNG in connecting distant markets, LNG deliveries to Kuwait have come from as far away as Sakhalin and Louisiana.[38]

31 Bud Coote, *Surging Liquefied Natural Gas Trade: How US Exports Will Benefit European and Global Gas Supply Diversity, Competition, and Security*, Atlantic Council, January 2016, http://www.atlanticcouncil.org/images/publications/Surging_LNG_Trade.pdf.

32 James Henderson, *Russian LNG: Progress and Delay in 2017*, The Oxford Institute for Energy Studies, University of Oxford, March 2017, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/03/Russian-LNG---Progress-and-delay-in-2017-OIES-Energy-Insight.pdf.

33 International Group of Liquefied Natural Gas Importers, *The LNG Industry*.

34 International Energy Agency, *Global Gas Security Review*.

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A particularly bright spot for LNG demand is the growing use of LNG as a maritime fuel. Emission Control Area requirements in coastal waters and specific sea-lanes in North America and Europe have limited the maximum sulfur content of fuels to 0.1 percent by weight since July 2015, compared with the open-sea requirement that fuels be limited to 3.5 percent sulfur content. LNG emits virtually no sulfur oxides and less carbon dioxide and particulates than liquid fuels derived from oil. Moreover, in October 2016 the International Maritime Organization confirmed a plan to limit the allowed level of sulfur in marine fuels on the open seas to 0.5 percent by 2020.[39] Rotterdam added a third LNG fueling berth in 2016 in response to growing maritime demand, but LNG fueling infrastructure remains sparse. Government assistance in adding more maritime LNG fueling infrastructure could help accelerate its use and improve the cleanliness of the seas.[40]

Conclusions and Implications

The ample volume and high quality of shale gas resources in the United States and the unique combination of favorable infrastructure, known geology, a large and flexible service industry, technological expertise and innovation, market accessibility, and, probably most importantly, the rights of landowners to subsoil resources have allowed the United States to become a major LNG exporter and reap the accompanying benefits of stronger economic growth and improved domestic and global energy security. The existence of numerous LNG import terminals able to be converted into export terminals further argues for this path, as does the widening of the Panama Canal, which gives US exporters access to Atlantic and Pacific markets.

The diplomatic and geopolitical presence accompanying US operations in foreign markets provides additional opportunities for US leadership, including the environmental advantages of increasing gas use. The opportunity is especially important in the case of China and India where strong growth in LNG is forecast. Both ranked in the top five customers for US LNG exports in 2016. US LNG could also play a positive role in bringing cleaner and more dependable fuel to the Caribbean, where many small countries are stuck with dirtier, more expensive fuel. Jamaica has recently joined the Dominican Republic and Puerto Rico in importing LNG.

US LNG exports would also support Europe's efforts to increase its gas supply diversity and security and establish stronger market links with a major new supplier. Europe's expansion of its pipelines and other infrastructure in central and southern Europe and a new pipeline link for LNG imports from the Iberian Peninsula to central Europe will help reduce its reliance on imports of Russian gas and enhance market access for US LNG. Globally, as more countries open their markets to LNG, they will also gain additional energy benefits from the growing availability of LNG and flexibility of LNG trade.

These trends are already underway. The number of LNG export projects approved and under construction in the United States now is more than sufficient to keep capacity growth ahead of demand growth for at least the next four years. Warnings that a sharp drop in financial investment decisions will lead to shortages of LNG after 2020 seem premature. Despite a lead time of about four years needed to convert an import terminal into an export terminal, there appears to be ample time for market incentives to enable a supply correction if warranted.

The US government could simplify, shorten, and thereby improve the approval process by eliminating the distinction between sales to countries with free trade agreements and those without. This change would increase the agility of US sellers to move LNG cargoes to destinations where they are most needed, regardless of whether the buyer has a free trade agreement with the United States. The US Department of Energy's approval in April 2017 of all future LNG exports by the Golden Pass project to be delivered to countries without a free trade agreement with the United States was a big step in this direction.

Governments could provide a strong boost to US and global LNG exports by embracing natural gas as a bridge fuel to lower carbon emissions and pollution in coming years until cleaner fuels are more widely available and efficient. Carbon pricing measures, for example, could make gas more competitive and less expensive in comparison with other hydrocarbons.

Bud Coote is resident senior fellow at the Atlantic Council's Global Energy Center.

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