Atlantic Council
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Surging Liquefied Natural Gas Trade

How US Exports Will Benefit European and Global Gas Supply Diversity, Competition, and Security

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Eurasian Energy Futures Initiative

As a joint initiative of the Atlantic Council's Global Energy Center and Dinu Patriciu Eurasia Center, the Eurasian Energy Futures Initiative covers critical energy issues in the wider Eurasian space.

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Cover photo credit: Reuters/Sergei Karpukhin. A liquefied natural gas (LNG) carrier is anchored near an LNG plant on the Eastern coast of Russia in 2009.

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EXECUTIVE SUMMARY

A surge in new supplies of liquefied natural gas (LNG) is about to hit the global market over the next several years. LNG export projects already under construction worldwide will add up to 175 billion cubic meters (bcm) of LNG capacity by 2020, mainly from Australia and the United States, and additional projects will move ahead as developers line up more customers.

The rise in LNG supplies will encounter substantially lower gas prices than in recent years and a slowdown in global gas demand, raising questions about the economics of LNG projects. For US exporters, liquefaction and tanker transport will add about $5.30 per million British thermal units (mbtu) in costs for LNG sent to Japan. The cost is similar to liquefy, transport, and regasify LNG sent to Europe, where the cost of regasifying LNG needs to be included to compare its price with pipeline gas.[1] With average prices for LNG falling below $8 per mbtu in Japan and even lower in Europe, there is little margin for profit even with Henry Hub prices currently at about $2.40 per mbtu.[2] However, LNG exporters are likely to continue selling as long as their variable costs can be covered.

Even in a low-price market environment, LNG can have a vital impact.

For US exporters, the outlook is more favorable for companies who have concluded a final investment decision to go ahead with an LNG export project. Most of these projects are under construction and have much of their planned output already contracted to sell over twenty years. Most of the US sales will not begin until after the next two years, when demand may be stronger. The majority of Australia's projects will already be up and running by 2018 and therefore pose less competition for US exporters seeking to acquire new LNG customers. US projects are also ahead of proposed projects offshore East Africa and in the Eastern Mediterranean, which may not come online until after 2020.

Perhaps most importantly, US LNG export projects complement European Union (EU) gas policy and energy security strategy, which entail building infrastructure to further integrate European gas markets, especially in Central and Eastern Europe and the Baltic region. The EU also seeks to further diversify gas supplies to promote market competition and to improve security by protecting against supply cutoffs from Russia. The centerpiece of this effort could be the completion of a North-South Corridor that connects Poland, Slovakia, Czech Republic, Hungary, and Croatia with gas pipelines extending from the Świnoujście LNG import terminal in Poland to a proposed LNG import terminal on Krk Island in Croatia, with connections to the Baltic countries and to Ukraine, Moldova, Romania, Bulgaria, Austria, Greece, Turkey, and the Balkan countries. Such a system would connect national gas grids and enable gas supplies from Western Europe and from Azerbaijan via Georgia and Turkey, and LNG from new sources including the United States to reach countries currently dominated by Russian gas supply. This network would also move critical gas supplies to formerly isolated countries if Russian gas supplies were cut off.[3]

US LNG exports are not directed by the US government to any particular country, so companies have to find their own customers. Companies planning to export LNG have to apply for approval to sell to countries with whom the United States does not have free trade agreements, which include major LNG importers such as Japan, Spain, India, and the United Kingdom. A recent task force report published in July 2015 by the Atlantic Council recommended that this condition

1 James Jensen, "Costs of Transporting Gas from Henry Hub to Market," November 1, 2015. According to these cost estimates, the cost of regasifying LNG in Europe is roughly equal to the additional cost of shipping US LNG to Asia rather than Europe.

2 Reuters, "Japan Nov Average LNG Spot Arrival Price at Lowest since March 2014," December 8, 2014, http://www.reuters.com/article/lng-japan-spot-idUSL3N13Y0WE20151209#Kc6jGswppChBiBIT.97.

3 For more details and a comprehensive discussion of the EU's proposed North-South Corridor, see Atlantic Council, *Completing Europe: from the North-South Corridor to Energy, Transportation, and Telecommunications Union*, November 20, 2014, http://www.atlanticcouncil.org/publications/reports/completing-europe-from-the-north-south-corridor-to-energy-transportation-and-telecommunications-union.

be eliminated.[4] The Trans-Pacific Partnership is likely to give signatories free trade status, easing the path for participating countries without such status to purchase US LNG. This would most benefit Japan, as the largest LNG importer gaining this status.

US LNG exports will add to the growing trade in LNG that is gradually helping to integrate the three major regional gas markets: North America, Europe, and Asia. This integration has already reduced the difference in gas prices between Asia and Europe; as recently as early 2014 gas prices were several dollars higher per mbtu in Asia. Prices in North America are unlikely to be substantially impacted by LNG exports, at least over the next five to ten years, because an overwhelming share of gas supplies will be produced domestically and continue to be priced according to the Henry Hub pricing mechanism. The costs of additional infrastructure and shipping will also limit LNG exports.

Longer term, gas demand is likely to rebound, aided by renewed environmental concerns prompted by discussions at the United Nations Conference on Climate Change in Paris in late 2015. The International Energy Agency (IEA) recently forecast that US LNG exports will rise to 60 bcm per year by 2020. Europe and China will be two of the prime targets for LNG exporters. The IEA further estimates that gas import demand in 2020 will be 70 bcm higher in Europe and 90 bcm higher in China than in 2014 and that Asia's annual net gas import needs will continue rising and will reach 400 bcm by 2040. The IEA also notes that Europe's two primary options for incremental imports are LNG and Russian pipeline gas at least until 2020, when Azerbaijani gas exports are scheduled to begin reaching Europe.[5]

The impact of US LNG prices will be felt in foreign markets. US LNG will add to the diversification of supply both in European and Asian markets, which will also contribute to more competitive pricing.

The impacts are positive for both the United States and its trading partners, economically, politically, and environmentally. Recent analysis funded by the US Department of Energy found that raising annual LNG exports to as much as 200 bcm would stimulate the US economy with very little rise in domestic gas prices. LNG exports also strengthen US economic and political relationships with trading partners.[6] Environmentally, gas burns more cleanly than other fossil fuels and is a versatile and efficient fuel for power generation, industrial and residential use, and other purposes.

Even in a low-price market environment, LNG can have a vital impact. In Europe, LNG prices should not be compared with the prices of Russian gas in Germany, Netherlands, and the United Kingdom because these are the lowest in Europe. The great lesson in Europe is that the countries with the fewest alternatives to Russian gas pay the highest prices.

Policy officials can make these benefits easier to attain in several ways, including by making LNG easier to export from the United States and easier to access in Europe.

Specifically, US policy officials could deem that all US LNG exports are in the national interest, regardless of free trade agreement status. This action would also eliminate the requirement that LNG exporters selling LNG to countries without free trade status show that their LNG shipments will not damage the United States economically, something that exporters do not need to do for countries with such status.

US policy officials should also include free energy trade in all future free trade agreements, including the Transatlantic Trade and Investment Partnership.

In Europe, policy officials could accelerate the completion of the North-South Corridor by approving and financing key projects, such as the Krk Island LNG terminal in Croatia, north-south pipelines connecting the Polish Świnoujście and Krk Island LNG terminals, and pipelines that connect underused LNG terminals in Spain and Portugal to Central and Eastern Europe.

European policy officials could also expand the North-South Corridor by supporting additional LNG imports by Italy, Greece, and Turkey in the south and connecting these and LNG terminals in the Baltic countries to the North-South Corridor. Policy officials should also consider ways to make Ukrainian gas storage capacity part of the North-South Corridor.

4 Atlantic Council, *Empowering America, How Energy Abundance Can Strengthen US Global Leadership,* July 2015, http://www.atlanticcouncil.org/publications/reports/empowering-america-how-energy-abundance-can-strengthen-us-global-leadership.

5 International Energy Agency (IEA), *Gas Medium-Term Market Report 2015*, June 2015; Fatih Birol, IEA, presentation at Center for Strategic and International Studies on the IEA's "World Energy Outlook 2015," November 30, 2015, http://csis.org/event/ieas-world-energy-outlook-2015.

6 US Department of Energy, "The Macroeconomic Impact of Increasing U.S. LNG Exports," October 29, 2015. http://energy.gov/sites/prod/files/2015/12/f27/20151113_macro_impact_of_lng_exports_0.pdf

RECENT TRENDS IN GLOBAL GAS MARKETS

The last decade was an eventful one for natural gas, highlighted by a dramatic revolution in US shale gas production. This revolution reversed the trend of rising US gas imports, forcing many LNG import terminals to close and prompting a rush to convert them into LNG export terminals. Globally, LNG trade continued to grow, including LNG redirected from the United States to other destinations, making the impact of the US shale gas revolution felt in foreign markets before even a drop of new LNG from the United States was exported.

Outside the United States, the decade was marked by record-high natural gas prices, caused by contractual linkages to soaring oil prices, spurred in turn by a series of oil supply disruptions and geopolitical concerns in an array of producing countries, among them Iraq, Libya, Iran, Syria, Sudan, Yemen, and Nigeria. The 2011 Fukushima nuclear disaster in Japan led to the closure of Japan's other nuclear power plants and sent LNG prices skyrocketing. In Europe, two disruptions in Russian gas supplied through Ukraine, the EU's passage of the Third Energy Package, and the launch of the EU's European Energy Union ushered in a new approach to dealing with Russia's monopoly practices in European gas markets. Safety and security concerns in processing natural gas were underscored by a major terrorist attack on the In Amenas gas processing plant in Algeria, which killed forty workers.

> The share of LNG in the world gas trade grew from one-quarter to one-third during the decade.

Soaring gas prices spawned new investment, including continued development of Qatar and Iran's North Dome and South Pars gasfield—the world's largest—and the start of development of Russia's massive Bovanenko field in the Yamal Peninsula, Turkmenistan's Galkynysh field, and the next phase of Azerbaijan's Shah Deniz field, which will supply gas to Europe through the Southern Corridor.[7] Major new gas resources were discovered in East Africa and the Eastern Mediterranean, Turkmenistan's Galkynysh field was confirmed as the world's second largest, and major construction started on new LNG export facilities by Australia and the United States.

The last decade also saw a number of major new international gas pipelines, including the South Caucasus gas pipeline from Azerbaijan to Turkey, the Nord Stream pipeline from Russia under the Baltic Sea to Germany, the Myanmar-China gas pipeline, the completion or start of construction on a set of four large-capacity gas pipelines from Turkmenistan to western China, an interconnector pipeline between the United Kingdom and Netherlands, the Langeled pipeline from Norway to the United Kingdom, and the Medgaz pipeline from Algeria to Spain.

Also notable are the major gasfield and international gas pipeline projects that were planned or proposed last decade that did not get developed or built. These include Russia's Shtokman gasfield, the South Stream pipeline from Russia under the Black Sea to Europe, the Turkmenistan-Afghanistan-Pakistan-India gas pipeline, the Trans-Caspian Pipeline from Turkmenistan to Azerbaijan, the Iran-Pakistan pipeline, the Nabucco pipeline from Turkey to Austria, and the Galsi gas pipeline from Algeria to Spain.

Something else that did not happen is significant development of shale gas outside North America, which is likely to remain constrained by unfavorable investment conditions. The US surge was spurred by a rather unique set of conditions, which include favorable private property and mineral rights ownership laws; technology advances; open domestic markets; a geological database from more than a century and a half of oil and gas production; a transparent, stable, and predictable regulatory environment; and entrepreneurship that has yet to be replicated outside of North America.[8]

7 The Southern Corridor will consist of an expanded South Caucasus Pipeline from Azerbaijan through Georgia to Turkey, the Trans-Anatolian Pipeline through Turkey, and the Trans-Adriatic Pipeline across Greece and Albania to Italy. See BP, "The Southern Gas Corridor," http://www.bp.com/en_az/caspian/operationsprojects/Shahdeniz/SouthernCorridor.html.

8 See Edward C. Chow, Center for Strategic and International Studies, statement to the Senate Energy and Natural Resources

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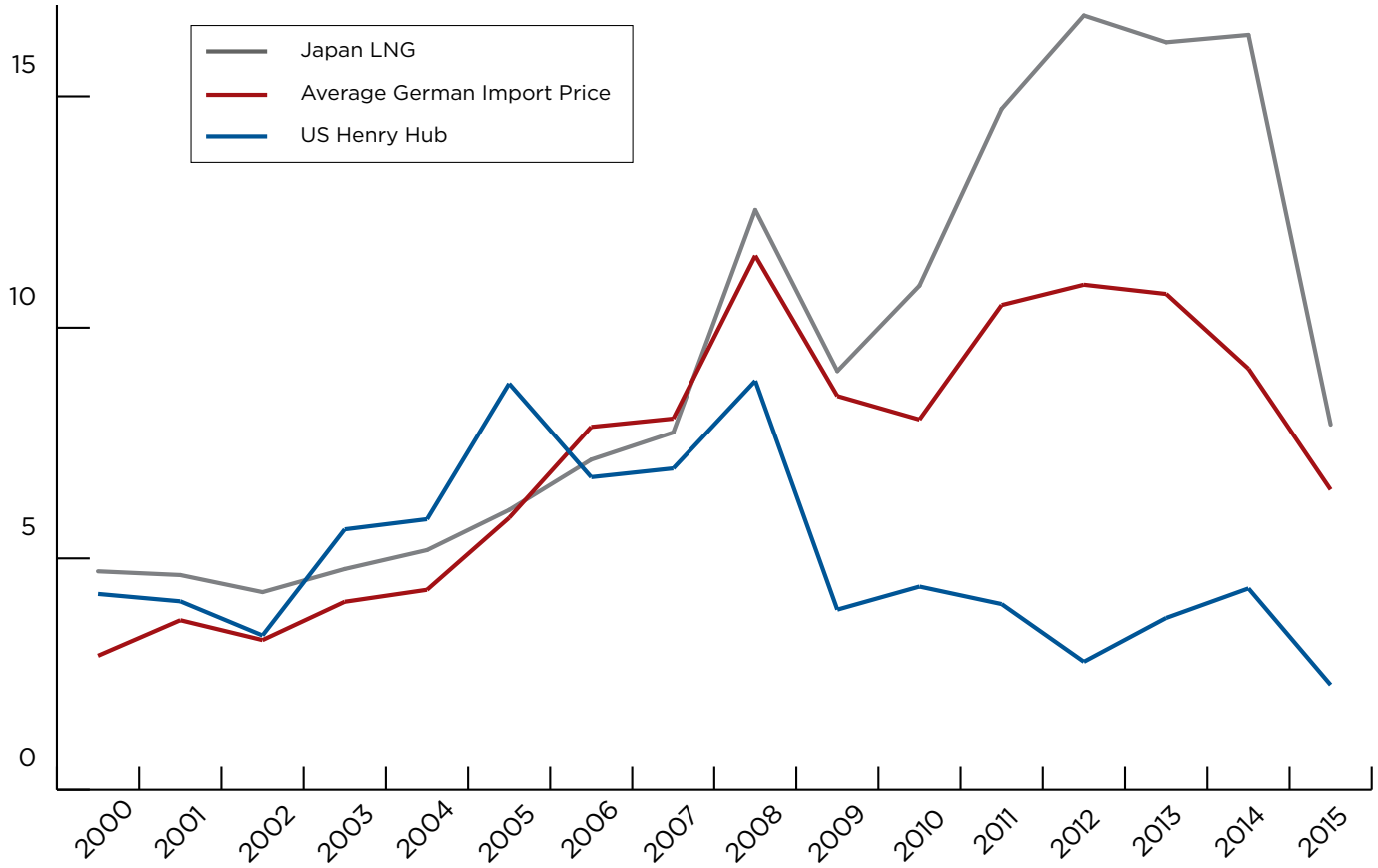
Figure 1. Global Natural Gas Prices, 2000-15 ($/mbtu)



Sources: BP Statistical Review of World Energy, June 2015; Platts.com; Quandl.com
Note: Prices for 2015 are prices for October; all others are average yearly prices.

Global natural gas production grew strongly during most of the past decade, rising by 28 percent to 3.46 trillion cubic meters (tcm) in 2014. World production of LNG grew faster, increasing by 85 percent to 333 bcm in 2014. Global trade in natural gas also experienced strong growth, rising by 47 percent to nearly 1 tcm in 2014. Moreover, the share of LNG in the world gas trade grew from one-quarter to one-third during the decade.[9]

Natural gas prices reached record heights in the Asian and European markets, while US Henry Hub prices peaked in the first half of the last decade and then fell as the shale gas revolution gained traction. Prices in all three of these major gas markets fell sharply in 2015, driven by growing supply; decreased demand growth, especially in China; the continuing effect of lower oil prices working their way through the time lags that delayed their impact on prices in long-term gas contracts; and the ongoing impact of the return of nuclear power plant operations in Japan (see figure 1).

LNG exports have begun to link the major regional gas markets of Asia, Europe, and North America, although regional prices diverged sharply during 2009-14 before prices started to converge again in 2015. The decade ended with Asian gas prices only about a dollar higher than average European prices, while prices remained much lower in North America despite the trend toward greater convergence. The decade also ended with considerable excess capacity both in gas liquefaction in LNG exporting countries and regasification in importing countries, caused by the slowdown in demand growth and more competition from pipeline sales as prices fell. Because of the soaring gas prices earlier in the decade, however, considerably more LNG liquefaction and regasification capacity is being built, planned, and proposed.

Committee, "Importing Energy, Exporting Jobs. Can It Be Reversed?" March 25, 2014, http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=1377b293-4899-4f0b-a1d6-0ace09941fba.

9 BP, *Statistical Review of World Energy 2015*, June 2015, http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.

GAS SUPPLY GROWTH LIKELY TO SLOW

The fall in global natural gas demand and prices since early 2014 is likely to slow gas production for at least the next five years. The IEA recently forecast that gas production growth will increase at an average annual rate of 1.9 percent during 2014-20, down from an average rate of 2.4 percent during the previous ten years. However, the IEA anticipates that gas production growth is likely to grow at a higher rate beyond 2020 as demand picks up and gas prices strengthen.[10]

While global production may slow, US gas production, including shale gas production, will continue to grow, buoyed by lower production costs as drilling and recovery techniques become more efficient, increased operator focus on the most productive resources, and reduced prices and profit share for suppliers of equipment and services. According to IEA analysis, the United States and Australia will account for the largest portion of the 410 bcm increase in annual world gas production from 2014 to 2020, with US output growing by 114 bcm and Australia output growing by 80 bcm.[11]

> The United States and Australia will lead the expansion in both gas and LNG supply over the next few years.

The IEA forecast suggests that production gains for other potential gas exporters will be modest through 2020, with the possible exception of an additional 51 bcm in the Caspian region. Most of this boost will come from planned increases in gas sent by Turkmenistan through pipelines to China and the beginning of gas shipments by Azerbaijan through the Southern Corridor pipelines to Europe.

Major gains in gas production elsewhere in the world are unlikely to generate large new export volumes, at least in the next five years. The IEA estimates China's annual gas production will increase by 47 bcm through 2020, which would account for nearly two-thirds of Asia's total net increase, excluding Australia. The Middle East is led by Iran's projected growth of 24 bcm and Saudi Arabia's increase of 23 bcm over this period.[12] Exports from Iran will be constrained by limited export infrastructure and strong domestic demand, including for gas injection into oilfields to enhance oil production, Iran's growing petrochemical industry, and general consumption. Saudi gas will be consumed domestically.

Importantly, ten major gas exporting countries that, according to BP data, accounted for more than 70 percent of global gas exports in 2014, including both LNG and pipeline exports, will have little to no growth in gas production through 2020 based on IEA's medium-term forecast.[13] These include Russia, Qatar, Norway, Canada, Netherlands, Algeria, Malaysia, Indonesia, Nigeria, and Bolivia. The lack of major new exports from this group provides Australia and the United States a window of opportunity to boost exports over the next five years and perhaps beyond, if gas demand rebounds after its projected slump for the next few years.

Several factors limit production in this group, many linked to low gas demand and prices. Russia and Canada will be constrained by low demand for exports from Europe and the United States, respectively, and a lack of export infrastructure to new markets through 2020. Russia's most significant new ventures to increase gas exports include a major new gas pipeline to China and LNG export projects, but they may not be available until after 2020. Qatar has imposed a moratorium on further development of its enormous North Dome field and Netherlands has imposed production caps on its Groningen field, the country's largest, to extend its production life. Norway has reduced investment because of low gas prices, while Algeria is finding it difficult to attract foreign investment despite improving its fiscal terms. Malaysia and Indonesia may achieve some modest gains, but Nigeria's gas output is declining as the nation continues to delay reforms.

10 Ibid.

11 Ibid.

12 Ibid.

13 BP, *Statistical Review of World Energy 2015*, op. cit.; IEA, *Gas Medium-Term Market Report 2015*, op. cit.

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The Kenai LNG Plant in Alaska has exported US LNG to Japan for more than forty years. *Photo credit*: ConocoPhillips Alaska.

Bolivia's production has leveled off as key fields decline and lower gas prices constrain investment.

The United States and Australia will lead the expansion in both gas and LNG supply over the next few years. The IEA forecasts that LNG exports will increase by about 164 bcm through 2020 and the United States and Australia will account for 90 percent of the increase.

Looking beyond 2020, the good news for US LNG exporters is that experts predict shale gas development outside North America will continue to stall due to a lack of supportive conditions in other countries.

MARKETS FOR NATURAL GAS WILL CONTINUE TO GROW

Despite the consensus view that the gas market is likely to remain slack over the next five to ten years, demand should grow in the major markets of Asia, Europe, and North America, and stronger markets for gas are likely to emerge in Africa, Latin America, and the Middle East. The IEA predicts gas demand will increase at an average annual rate of 2 percent during 2014-20, slightly faster than production growth but a slowdown from average growth of 2.3 percent over the past ten years. The IEA also sees a slack market for LNG through 2020 because of competition from coal and renewable resources as well as between the growing number of LNG suppliers. In addition, if low prices persist, project postponements and rising demand could cause LNG markets to start to tighten up substantially by 2020, according to the IEA.[14]

Demand for natural gas will continue to increase faster in Asia, led by China's 10 percent average annual growth through 2020, according to the IEA. Despite recent downgrades to projected gas demand, the IEA still expects that China's imports will increase by more than 90 bcm during 2014-20, buoyed by challenges developing its shale gas reserves and efforts to address pollution problems.[15]

Overall gas demand growth in Europe will remain low, but falling domestic production will help boost Europe's demand for gas imports to a level 70 bcm higher in 2020 than in 2014, according to the IEA. The IEA further estimates that Europe's LNG imports will roughly double during that period to more than 90 bcm.[16] US LNG exporters should benefit from the prospect of an additional 45 bcm of new European LNG imports and EU efforts to diversify gas import sources and improve energy security by providing countries dependent on gas from Russia a new alternative.

Constraints in supply could also push growth in gas import demand in Africa, Latin America, and the Middle East. The IEA estimates gas demand will outpace indigenous gas production in all three regions. In Africa, security problems, energy price subsidies, and unattractive investment terms have dampened energy development. Much of the Middle East has unmet gas demand, particularly on the Arabian Peninsula. In Latin America, Argentina and Brazil will increase LNG imports while Colombia and Uruguay will begin importing LNG, according to the IEA.[17]

> As in the past decade, risks abound and geopolitical events, major accidents, technological change, and even project delays could impact markets significantly.

The 2015 Paris climate conference is likely to impact environmental policies, which should help boost natural gas demand. The impact could be strong if the conference leads to the adoption of emissions trading schemes. Despite the release of methane into the atmosphere that occurs particularly during production operations, natural gas is largely considered environmentally preferable to other fossil fuels, such as coal and oil. The largest use of gas is for electric power generation, where it continues to replace coal and oil, and will continue to do so, especially if environmental policies contribute to fuel use decisions. But more governments, especially in developing countries, would have to adopt stronger environmental policies to dramatically impact gas demand. We do see wider use of natural gas to address pollution problems in large urban areas, including in countries such as China and India. Also, the fastest growing sector of natural gas use is the transportation sector, where both compressed gas and LNG are used to power vehicles and, in October 2015, the world's first LNG-powered container ship began service.[18] The potential for further

14 IEA, *Gas Medium-Term Market Report 2015*, op. cit.

15 Ibid.

16 Ibid.

17 Ibid.

18 Energy Information Administration (EIA), Natural Gas Weekly Update, "World's First LNG-Powered Container Ship, the Isa Bella

growth in the use of gas for transportation is large, but more government support for infrastructure, such as refueling stations, would be needed to achieve most of this potential.

As in the past decade, risks abound and geopolitical events, major accidents, technological change, and even project delays could impact markets significantly. Nevertheless, a number of developments could have favorable effects on US LNG export opportunities:

- One of these is the uncertain outcome of the major gas deal Russia and China agreed to in May 2014. An expert on Russian energy stated in October 2015 that there is still no concrete agreement. He said that Chinese banks are not providing the $20 billion in loans for the Power of Siberia pipeline and gasfield development projects required to supply the agreed volume of 65 bcm of Russian gas per year to China, instead offering only about $12 billion. He added that the Chinese are likely to use market leverage to exact further concessions from Russia because China has clear access to LNG and will use Russia to close the gap between other gas sources and China's needs, rather than lock in a large dependency and price commitment for Russian gas.[19]
- European disagreements with Russia over Ukraine and the EU's charges of antitrust behavior by Gazprom could further heighten concerns over the risk of Russia's use of gas as political leverage and lead to more cutbacks in Europe's purchases of Russian gas supplies and more imports of LNG from elsewhere than presently envisioned.

Over the longer term, gas demand in Asia will outpace Asian gas production, creating a deficit of some 400 bcm by 2040, according to the IEA. The size of the deficit will depend most importantly on China's progress in developing its shale gas resources.[20]

of the Marlin Class, Begins Service," October 29, 2015, http://www.eia.gov/naturalgas/weekly/.

19 Ilya Zaslavskiy, presentation at Center for Strategic and International Studies, "The Present and Future of Russia's Economy and Energy Sector," October 26, 2015, http://csis.org/event/present-and-future-russias-economy-and-energy-sector.

20 Birol, "World Energy Outlook 2015," op. cit.

US LNG EXPORTS

US exports are poised to surge over the next several years, driven by the US boom in shale gas production and a large differential between gas prices in the United States and those in Asia and Europe, the other major markets, especially during 2011-14. A dramatic decline in oil and gas prices in Asia and Europe since late 2014 and slower growth in global gas demand could undermine the profitability of US LNG exports. However, interest among major consumers in US LNG remains strong as a means to improve competition and diversification in markets abroad and to provide additional protection against supply disruptions, especially in Europe. Prices for long-term contracts are generally linked to Henry Hub prices, which is attractive for both parties. Some prices for shorter-term sales are linked to pricing indices in consuming regions.[21]

Currently, five LNG export terminals with a combined planned capacity of 99 bcm per year are under construction in the lower forty-eight states and most of this capacity is scheduled to be operating by 2018, according to the Federal Energy Regulatory Commission (FERC) and the IEA.[22] These exports will join existing LNG exports from the Kenai export terminal in Alaska, which began operating in 1969 and is shipping LNG to Japan.[23] The Kenai facility has an export capacity of 2 bcm per year. The IEA expects most of the US capacity to be online by 2020, which will make the United States the world's third-largest LNG exporter, behind Australia and Qatar. Most of the capacity that will be available to export from US LNG terminals by 2018 is already contracted to customers.[24]

The IEA expects most US capacity to be online by 2020, which will make the United States the world's third-largest LNG exporter, behind Australia and Qatar.

Additional planned or proposed LNG export projects in the United States face higher risks and uncertainty. In addition to the existing Kenai LNG terminal in Alaska and the five LNG export terminals under construction in the lower forty-eight states, ten LNG export projects have been proposed to FERC and twelve more are in various stages of planning and preparation to file proposals with FERC or the US Maritime Administration (MARAD), which addresses offshore LNG projects. These projects are not under construction and have not reached final investment decisions. Some of these projects are likely to go ahead, but market analysts expect others will be postponed or cancelled because of lower gas demand and prices (see table 1).

The major consulting firm Wood Mackenzie is surprised that more LNG export projects worldwide have not been postponed, given that forty-five major oil and gas production and development projects were delayed in 2015. Wood Mackenzie notes that companies shelving projects risk invalidating any contracts for LNG sales that have previously been agreed upon, but the firm's head of global gas and LNG research believes that the pace of postponement will increase as LNG supplies grow.[25]

21 For example, Cheniere Energy announced in August 2015 that it had arranged to sell LNG to Électricité de France (EDF), S.A., at a price linked to the Dutch Title Transfer Index, a natural gas pricing index in Europe. See International Group of Liquefied Natural Gas Importers, "EDF and Cheniere Sign TTF-Indexed Spa," August 11, 2015, http://www.giignl.org/news/edf-and-cheniere-sign-ttf-indexed-spa.

22 Federal Energy Regulatory Commission (FERC), "North American LNG Import/Export Terminals," September 29, 2015, http://ferc.gov/industries/gas/indus-act/lng/lng-approved.pdf.

23 Argus, "Alaska Kenai LNG to Resume Exports in May," April 30, 2015, http://www.argusmedia.com/News/Article?id=1031741.

24 Fereidun Fesharaki, presentation at Center for Strategic and International Studies, "The Global LNG Market Outlook: Too Many Sellers, Not Enough Buyers," September 25, 2015, http://csis.org/event/global-lng-market-outlook-too-many-sellers-not-enough-buyers.

25 Wood Mackenzie, "Where Are All the LNG Project Postponements?" September 3, 2015, http://www.ferc.gov/industries/gas/indus-act/lng/lng-proposed-export.pdf.

Table 1. Planned and Proposed US LNG Export Terminals

LNG Export Terminal	Major Stakeholders	Capacity (bcm/year)	Start Up Date
US LNG Export Terminals Approved and Under Construction			
Sabine Pass, LA (trains 1-4)	Cheniere Energy	22.7	2016
Cameron LNG, LA (trains 1-3)	Sempra and Partners	17.6	2018
Cove Point LNG, MD	Dominion	8.3	2018
Freeport LNG, TX (trains 1-3)	ConocoPhillips	18.6	2018-19
Corpus Christi, TX (trains 1-3)	Cheniere Energy	18.6	2018-19
Sabine Pass, LA (trains 5-6)	Cheniere Energy	13.4	2019
US LNG Export Terminals Pending FERC/MARAD Approval			
Oregon LNG, OR	Leucadia National	13.4	2019
Elba Island, GA	Kinder Morgan	4.1	2018
Lake Charles LNG, LA	Energy Transfer	20.7	2020
Magnolia LNG, TX	LNG Ltd.	12.9	2018
Jordan Cove Energy, OR	Veresen	8.3	2019
Golden Pass, TX	ExxonMobil, Qatar Petroleum	20.7	2019
Delfin LNG, LA*	Fairwood LNG	12.4	2019
Gulf LNG, MS	Kinder Morgan	15.5	2018
Calcasieu Pass, LA	Venture Global LNG	14.5	2019
Cameron LNG, LA (trains 4-5)	Sempra and Partners	14.5	2020
In FERC "Pre-Filing" Process			
CE FLNG, LA	Cambridge Energy	6.2	2019
Louisiana LNG, LA	Parallax Energy	8.3	2019
Downeast LNG, ME	Downeast Liquefaction	3.1	2020
Alaska LNG, AK	BP, ConocoPhillips, ExxonMobil, Alaska	31.0	2025
Annova LNG, TX	Exelon	9.3	2020
Port Arthur LNG, TX	Sempra	14.5	2021
Rio Grande LNG, TX	NextDecade	36.2	2020
Texas LNG Brownsville, TX	Texas LNG, Samsung	6.2	2020
Freeport LNG, TX (train 4)	ConocoPhillips	7.2	2020
Corpus Christi, TX (trains 4-5)	Cheniere Energy	14.5	2021
Plaquemines LNG, LA	Venture Global LNG	29.0	2020
Bear Head LNG, Nova Scotia**	LNG Ltd.	12.9	2019

* Offshore terminal requiring approval by the US Maritime Administration rather than Federal Energy Regulatory Commission.
** Bear Head LNG has filed with the US Department of Energy to export US gas to Canada and other nations.

Sources: Federal Energy Regulatory Commission, US Energy Information Administration, and International Energy Agency.

US COMPETITIVENESS IN THE LNG MARKET

The US gas industry delivers gas dependably and at a competitive price. In the domestic market, the gas industry has paralleled the oil sector in reducing costs to support production volumes, especially by cutting costs for services and equipment. US exporters of LNG face additional challenges, including added liquefaction and LNG shipping expenses, competition from foreign LNG exporters, and competition from pipeline exports. As in the US market, LNG exporters also have competition from other fuels, especially coal and renewable resources. In the Asian market, US LNG exporters must deal with a large decline in LNG demand from Japan as nuclear power generation comes back online following its shutdown after the 2011 Fukushima nuclear plant accident.

Australia is the United States' chief foreign rival for the Asian LNG export market. According to the IEA, Australia will add six new LNG export terminals between mid-2015 and 2020, with a total capacity of over 70 bcm per year. IEA data collected from the companies' websites indicate that about 90 percent of the capacity of new Australian LNG terminals is already under contract to Asian customers.[26]

Australia has two main advantages over the United States. One is geographic proximity to customers, which means it will enjoy lower LNG shipping costs. Another is that most of Australia's new LNG export capacity will be available before new US capacity, giving Australia an edge in securing contracts for projected gas demand growth.

However, US LNG exporters can still be competitive in Asia, and enjoy two advantages over Australian projects, at least over the next few years: lower gas production costs and lower capital costs for new infrastructure, including liquefaction facilities.[27] Production costs are lower in the United States because more gas is produced onshore, contrasted with the more expensive offshore gas projects in Australia. Existing onshore pipelines used to deliver gas to LNG terminals and existing LNG import facilities in the United States provide additional cost-saving efficiencies. Four of the five US LNG export terminals under construction are being converted from LNG import facilities and benefit from existing ports, storage facilities, and onshore pipeline connections that previously distributed natural gas from the import terminal to customers and can be adapted to feed gas to the new export terminal. The only project under construction that was not previously used as an import terminal is Cheniere's Corpus Christi project in Texas, which was originally planned as an LNG import terminal but never reached the operating stage. It will include the construction of a twenty-three-mile long, forty-eight-inch diameter, bi-directional pipeline.[28]

Customers outside of North America will also be attracted to LNG from the United States because it will provide them a new source of natural gas, excepting the small amounts of LNG that are already exported from the Kenai LNG terminal and LNG that is re-exported from import purchases that are no longer needed. New supplies of LNG from the United States will expand diversification of energy sources in markets abroad, enhance competition, and in several cases, notably in Europe, substantially improve energy security. The benefits LNG can provide for Europe's energy security could help LNG compete with pipeline gas in Europe from Russia, Europe's dominant supplier. European customers have committed to purchasing US LNG volumes equivalent to 30 percent of the capacity of the first four new LNG export terminals, according to the IEA.[29] This amounts to about 20 bcm per year.

Despite falling gas prices over the past eighteen months, natural gas and LNG in particular will still face strong competition from coal, especially in Asia. In China, gas prices are uncompetitive with coal, which remains the fuel of choice for existing and new power generation facilities, according to the IEA. Lower gas prices have narrowed the spread, however, helping to boost gas demand for residential use, especially in

26 IEA, *Gas Medium-Term Market Report 2015*, op. cit.

27 ICF International, "Recent Australian Natural Gas Pricing Dynamics and Implications for the US LNG Export Debate," August 29, 2014.

28 OilOnline Press, "EIA: LNG Export Terminals under Construction, More Planned," OilOnline.com, April 17, 2015, https://www.oilonline.com/news/midstream/eia-lng-export-terminals-under-construction-more-planned.

29 IEA, *Gas Medium-Term Market Report 2015*, op. cit.

urban areas, and support China's policy to promote gas-fueled vehicles to combat pollution. Several other Asian countries have implemented policies to prioritize coal over gas in new electric power projects because of past high gas prices, according to the IEA. In India, coal remains substantially cheaper than gas to fuel electric power generation, although the IEA notes that lower gas prices will increase demand for gas use to avoid power shortages rather than displace coal.[30]

30 Ibid.

Will US LNG Exports Be Profitable?

Lower natural gas demand and prices raise the question of whether LNG exports from the United States can still be profitable. Gas prices were substantially higher when plans for LNG export terminals were made. During 2011-14, prices for LNG delivered to Japan averaged nearly $16 per mbtu. In Europe, prices for pipeline gas delivered to Germany averaged $10 per mbtu. Gas prices in the United States averaged less than $4 per mbtu during this period, offering plenty of room for profit for US exporters, even after adding the costs of liquefaction and shipping.[1]

At present, prices worldwide are considerably lower. The landed price of LNG in Japan has fallen to $7.40 per mbtu, and the price of gas delivered to Europe is $6.24 per mbtu.[2] These prices will fluctuate, but they do pose much greater risks for all new LNG exporters. For US exporters, a leading expert on gas liquefaction and LNG trade recently put the combined cost of liquefaction and shipping from the Gulf Coast of the United States to Japan at about $5.30 per mbtu, including the cost of Panama Canal tolls. The combined cost of sending LNG to Europe is similar because the added expense of regasification offsets most of the savings in shipping costs. Even at the early-January price of about $2 per mbtu for US gas, LNG would not be profitable in some European destinations, and any further erosion in Japanese prices or escalation of US prices would jeopardize profits in shipping LNG to Japan.[3]

US LNG might still be competitive in Europe, however, because prices quoted for major markets, such as Germany and the United Kingdom, are among the lowest in the region. Prices for Russian pipeline gas are highest for countries that have the fewest alternatives to Russian gas, and some countries have none. The Former Yugoslav Republic of Macedonia, Poland, Bosnia Herzegovina, Czech Republic, Bulgaria, Lithuania, Denmark, Slovenia, Ukraine, and Greece all paid 25-50 percent more than Germany for Russian gas in 2013, according to data compiled by Radio Free Europe.[4] In 2014, Lithuania began operating its new Independence LNG terminal, a Floating Storage and Regasification Unit (FSRU), and received a 23 percent discount from Gazprom, underscoring Russia's use of monopoly pricing.[5]

Also, the upstream oil sector has shown dramatically over the past eighteen months that as prices go down, so do costs. The upstream gas sector is already benefitting from the lower costs of equipment and services. Liquefaction expenses are likely to be relatively firm because of the large capital costs involved, but LNG shipping costs are likely to be less rigid. New LNG tankers that took years to build continue to enter the global fleet, so the supply is plentiful. This could be an important factor supporting continued growth in LNG trade.[6] Even if prices fall below levels needed for a profit, exporters are likely to continue supplying LNG if variable costs are met.

1 BP, *Statistical Review of World Energy*, op. cit.

2 Platts, "Japan LNG Buyers Pay $7.40/MMBTU on Average for Spot Cargoes in Nov: METI," December 9, 2015, http://www.platts.com/latest-news/natural-gas/tokyo/japan-lng-buyers-pay-740mmbtu-on-average-for-27034774; Quandl.com, "Natural Gas Prices and Charts," https://www.quandl.com/collections/markets/natural-gas.

3 Jensen, "Costs of Transporting Gas from Henry Hub to Market," op. cit.

4 Radio Free Europe, using data from Gazprom, Izvestia, Eurostat, Eurogas, and Ukrainian government, "Gazprom's Grip: Russia's Leverage over Europe," November 9, 2015.

5 Hidetoshi Azuma, American Security Project, "The Rise of Lithuanian LNG: A Long-Term Opportunity for the United States," November 4, 2014, http://www.americansecurityproject.org/the-rise-of-lithuanian-lng-a-long-term-opportunity-for-the-u-s/.

6 Bloomberg Business, "LNG Shipping Rates Fall to Lowest since 2010 in Boon for Traders," February 19, 2015, http://www.bloomberg.com/news/articles/2015-02-20/lng-shipping-rates-fall-to-lowest-since-2010-in-boon-for-traders.

EU LNG STRATEGY OFFERS OPPORTUNITIES FOR US EXPORTERS

Europe's future natural gas strategy and goals complement plans in the United States to export LNG. Two main pillars of Europe's gas strategy are diversified supplies and stronger integration of European markets and infrastructure. Connecting national pipeline networks in the Baltics and Central and Eastern Europe with Western Europe is especially important because countries in these regions depend on Russian gas and lack adequate links to import gas from other sources in the event of a cutoff.[31] Moreover, Russia proved itself unreliable as a supplier by cutting off gas supplied through Ukraine in January 2006 and again in January 2009. Moscow has also raised anxieties about its behavior by invading Georgia in 2008, cutting off gas flows from Turkmenistan in 2009, annexing Crimea in 2014, and continuing to aid separatists in Ukraine.

The threat of an intentional disruption of gas supply by Russia adds to the security imperative for Europe to diversify its gas supply and expand infrastructure and pipeline links to existing, isolated networks. To do that, the European Commission is developing a strategy for LNG and gas storage as part of its plans to create an Energy Union that incorporates EU members, nonmembers within Europe, and some neighboring countries.[32]

Russia's discriminatory and monopolistic gas pricing and other tactics, such as preventing Turkmenistan and Russian companies other than Gazprom from transiting gas for export from Russia, are also cause for concern. The prices Gazprom charges vary by country, and not because of differences in transit costs. The United Kingdom, Netherlands, and Germany pay the lowest prices because they have the most access to alternative gas supplies, and hence have competitive markets to combat Gazprom's marketing tactics. Countries with the least access to alternative gas supplies have historically paid the highest prices.[33] Lithuania's experience gaining a 23 percent discount from Gazprom following the opening of a new LNG terminal in late 2014 underscores the importance of having an alternative supply even in a low-price global market, because isolated markets are always vulnerable to monopoly pricing.[34]

US LNG would be a new source of gas for Europe, helping to diversify its gas supply and provide additional competition and security.

LNG already plays an important role in Europe's energy supply, but a large volume of unused regasification capacity in Europe's LNG facilities provides an attractive opportunity for more imports. In 2014, the EU imported 45 bcm of LNG, or 13.5 percent of its total gas imports, down from 14 percent in 2013 and 19 percent in 2012, as pipeline prices became more competitive.[35] The potential for higher LNG imports to Europe is immense. Total capacity to import LNG into the EU is 197 bcm, leaving 152 bcm of existing unused regasification capacity for additional imports.[36] This unused capacity could easily accommodate much of the new US LNG export capacity that will be installed over the next five to ten years.

Moreover, US LNG would be a new source of gas for Europe, helping to diversify its gas supply and provide additional competition and security. Currently, Europe imports LNG primarily from Qatar, Algeria, and Nigeria. Qatar has curbed its expansion of LNG exports for the next several years, and Algeria and Nigeria have limited capabilities to increase their LNG exports mainly due to difficulties in attracting investment. Other than US LNG, the most reliable new LNG exports over the next five years are likely to come from Australia,

31 European Commission, *Consultation on an EU Strategy for Liquefied Natural Gas and Gas Storage,* July 8, 2015, https://ec.europa.eu/energy/sites/ener/files/documents/LNG%20consultation%20-%20publication.pdf.

32 Ibid.

33 Radio Free Europe, "Gazprom's Grip: Russia's Leverage over Europe," op. cit.

34 Azuma, "The Rise of Lithuanian LNG," op. cit.

35 BP, *Statistical Review of World Energy*, op. cit.; Eurogas, "Statistical Report 2014," http://www.eurogas.org/uploads/media/Eurogas_Statistical_Report_2014.pdf.

36 European Commission, *Consultation on an EU Strategy*, op. cit.

Malaysia, and Indonesia, which are all likely to target Asian customers. Other possible new sources include East Africa and the Eastern Mediterranean, which the IEA judges will not be available until after 2020.

Besides fitting in well with the EU's overall strategy to increase diversification of gas sources, promote more competition, and enhance security, US LNG exports could play a particularly key role in addressing diversification in Central and Eastern Europe, where infrastructure expansion is most critical and energy security is most at risk. The EU has identified the countries that are especially vulnerable because they are heavily dependent on one supplier and have little or no access to LNG. These are Bulgaria, Croatia, Czech Republic, Estonia, Finland, Hungary, Latvia, Romania, Slovakia, and Slovenia, which the EU says "may require particular attention when developing LNG as an additional source of gas supply, notably by improving access to LNG through enhanced regional cooperation ensuring better access through interconnections, if missing, to existing LNG terminals and/or the removal of possible regulatory or technical barriers to access."[37]

The absence of LNG availability for these countries has helped highlight the need for the EU to complete the expansion of key infrastructure in the Baltics and Central and Southeastern Europe. The expansion would enable these regions to access LNG for diversification, competition, and security of gas supply, and for the smooth functioning of gas markets. In particular, the European Commission consultation document on LNG strategy cites the importance of LNG supplies to open a North-South Corridor that would improve supply diversification, competition, and security in this region. The Atlantic Council, in partnership with Central Europe Energy Partners and with the cooperation of the Central and Eastern Europe Development Institute, helped stimulate interest in the corridor by publishing a report in November 2014 entitled "Completing Europe, from the North-South Corridor to Energy, Transportation, and Telecommunications Union" that identified key facilities, including LNG terminals, needed to complement other measures the EU has undertaken to establish a North-South Corridor and fulfill the goal of unifying Europe. The effort gained further momentum in a meeting of leaders of these countries, US diplomats, and Atlantic Council representatives in New York on the margins of the United Nations General Assembly opening in September 2015.[38]

As outlined in the November 2014 Atlantic Council report, the centerpiece of the North-South Corridor should be a new bidirectional gas pipeline extending from Poland through the Czech Republic, Slovakia, and Hungary to Croatia. It would be anchored at each end by a new LNG import terminal. Poland's new Świnoujście LNG terminal on the Baltic Sea would anchor the pipeline in the north, and a new LNG terminal at Krk Island on Croatia's Adriatic Sea coast would anchor the southern end. The corridor would be connected to major existing pipelines crossing its path and new extensions and interconnections would link it to pipeline networks in all EU countries in Central and Eastern Europe, and eventually to nonmembers in the Balkans. The North-South Corridor would be complemented in the north by a new gas pipeline linking Poland with the Baltic countries and new LNG import terminals in the Baltics, and in the south by the Southern Corridor gas pipeline system that will deliver gas from Azerbaijan through Georgia to Turkey, Greece, Albania, and Italy.

The EU has already made considerable progress expanding gas supply options and integrating infrastructure in Central and Eastern Europe.

- Poland's 5-bcm-capacity Świnoujście LNG terminal is completed and received its first LNG shipment in December 2015. [39]
- The European Commission announced an agreement in October 2015 to build a pipeline linking Poland and Lithuania.[40]
- Lithuania installed the 4-bcm-capacity Independence FSRU LNG terminal in late 2014. Estonia and Finland are planning to build a gas pipeline interconnector under the Baltic Sea and both are pursuing plans to build LNG import facilities.
- A number of new interconnector pipelines have been built and some border crossings of existing pipelines have been modified to enable reverse flow. As a result, Poland, Hungary, and Slovakia can now all send gas eastward into Ukraine. Many of the projects have been formally prioritized

37 Ibid.

38 For more details and a comprehensive discussion of the EU's proposed North-South Corridor, see the Atlantic Council, *Completing Europe, from the North-South Corridor to Energy, Transportation, and the Telecommunications Union*, November 20, 2014, http://www.atlanticcouncil.org/publications/reports/completing-europe-from-the-north-south-corridor-to-energy-transportation-and-telecommunications-union.

39 Bloomberg, "Poland Opens LNG Terminal, Pledges to End Russian Dependence," October 12, 2015, http://www.bloomberg.com/news/articles/2015-10-12/poland-opens-lng-terminal-pledges-to-end-russian-gas-dependence.

40 European Commission, "First Gas Interconnector between Poland and Lithuania Ends Energy Isolation of the Baltic States," October 15, 2015, https://ec.europa.eu/energy/en/news/first-gas-interconnector-poland-%E2%80%93-lithuania-ends-energy-isolation-baltic-states.

by the European Commission as a Project of Common Interest and are eligible for funds from the Connecting Europe Facility.

Nevertheless, considerable work remains to complete the North-South Corridor, especially to fill in the missing links needed to diversify gas imports and make them accessible to countries that are most vulnerable. Besides the pipeline from Poland to Croatia, the most critical missing link is the much-discussed Krk Island LNG import terminal. Some recent discussions have focused on starting with a small-capacity or even a floating storage regasification unit. The Krk Island project appears to have renewed momentum, but other possibilities include the nearby Adriatic LNG import terminal in northern Italy, expansion of Greece's Revythoussa LNG terminal near Athens, a proposed new LNG terminal at Kavala or a floating terminal at the port of Alexandropoulos in eastern Greece, and even an expansion of the Marmara Ereglisi or Egegaz Aliağa LNG terminals in western Turkey.

Other critical missing links in the North-South Corridor include the Ionian Adriatic Pipeline and the West Balkan Ring, which together could help supply gas from either the Krk Island LNG terminal or the Southern Corridor to most of the Balkan states. The Ionian Adriatic Pipeline would stretch from southern Albania to northern Croatia and connect the Trans-Adriatic Pipeline—part of the Southern Corridor—with pipeline infrastructure in Croatia. The West Balkan Ring would provide pipelines that deliver gas from the Ionian Adriatic Pipeline into neighboring Balkan countries. Bulgaria also critically requires the construction of the Interconnector Greece Bulgaria to receive the 1 bcm of gas it has purchased from the Trans-Adriatic Pipeline, or any other gas from Greece or Turkey.

The European Commission plans other major infrastructure additions and improvements that will benefit market access for US LNG exporters. Perhaps most importantly, the European Commission has prioritized building infrastructure that will help move gas from LNG terminals in Spain and Portugal northward into France and on to Central Europe, where it is needed to diversify supply. Currently, Spain receives more LNG supplies than any other European country, but infrastructure bottlenecks prevent much of this gas from moving into France and beyond. The European Commission plans new pipeline connections across the Pyrenees into France and eastward from France to ease these bottlenecks. This will enable a higher rate of LNG imports for terminals on the Iberian Peninsula and France, which share a total of twelve LNG terminals but have not been able to fully use their capacity

Russia Won't Let Turkmenistan Export Gas to Europe

Turkmenistan—home of the world's second-largest gasfield—is unable to export its gas to Europe, a fact that partially explains why Europe must broaden its list of gas suppliers. Russia is protecting its dominance of the European gas market by denying Turkmenistan access to pipeline routes that could reach European customers. Surpassed in size by only the North Dome-South Pars field held jointly by Qatar and Iran, Turkmenistan's Galkynsyh gasfield would pose a significant threat to Russia's gas sales in Europe if it had an export outlet.[1]

Russia allowed Turkmenistan to export its gas through Russia to Ukraine from 1991 through early 2009, even after Moscow designated Gazprom as the sole buyer of all Turkmen gas entering Russia. But in April 2009 Moscow stopped deliveries of all gas from Turkmenistan to Russia and Ukraine after a suspicious explosion disrupted Turkmenistan's main pipeline system to Russia. The explosion occurred after Russia reduced the intake volume at a compression station north of Turkmenistan's border, causing a pressure surge and explosion in one of Turkmenistan's pipelines, disrupting flow in all three pipelines in the corridor. Moscow claims that it had instructed Turkmenistan to reduce the volume of flow, but Ashgabat accused Moscow of engineering the explosion deliberately.[2]

Turkmenistan's other option to send gas to Europe is through a pipeline running under the Caspian Sea to Azerbaijan, where it could be added to Azerbaijani gas and delivered to Europe through an expanded Southern Corridor running through Georgia and Turkey to Greece, Albania, and Italy. Russian President Vladimir Putin is adamant that the approval of all five Caspian Sea littoral states—Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan—are needed for a project of this magnitude, and Russia and Iran firmly oppose it. Russia maintains that the legal status of the sea needs to be resolved first and has also cited environmental issues as a reason for opposition.[3]

1 Abdelghani Henni, "Gas for Cash: The Future of Turkmenistan," Society of Petroleum Engineers, November 11, 2014, http://www.spe.org/news/article/Turkmenistan-Gas-for-Cash.

2 "Turkmenistan, an Exporter in Transition" in Simon Pirani, ed., *Russian and CIS Gas Markets and Their Impact on Europe*, (Oxford: Oxford University Press, 2009).

3 Eurasianet, "EU Issues New Challenge to Russia with Caspian Pipeline Project," May 2, 2015, http://www.eurasianet.org/node/73276.

because of the bottlenecks.[41] In addition, Finland and Estonia are both seeking funding for separate LNG import facilities and plan to build an interconnector pipeline beneath the Baltic Sea between the two countries.[42]

Besides building new infrastructure, the European Commission has focused on removing regulatory and other barriers to greater LNG use in Europe. The European Commission has cited administrative burden, lengthy permitting and licensing procedures, financing, and delays in full implementation of recent EU energy laws and regulations as obstacles that need to be removed to facilitate entry of new LNG suppliers along the entire LNG supply chain.[43]

The European Commission is also embarking on an effort to reach beyond the borders of the EU with plans to expand infrastructure and integrate markets with common laws and regulations. In February 2015, the European Commission announced a framework strategy that says the commission will seek to strengthen relations with the Energy Community by ensuring effective implementation of the EU's energy acquis, energy reforms, and incentives for energy investments within the Energy Community.[44] The Energy Community includes all of the Balkan states that are not EU members as well as Ukraine and Moldova. These countries are committed to implementing all EU energy laws and regulations. The integration of this group and other neighboring countries that are observers in the Energy Community into the European Energy Union would provide additional benefits to US LNG exporters targeting the EU by expanding the market and easing the movement of gas supplies.[45]

41 European Commission, *Consultation on an EU Strategy*, op. cit.

42 IEA, "Gas Medium-Term Market Report 2015," op. cit.

43 European Commission, "Consultation on an EU Strategy," op. cit.

44 European Commission, "A Framework Strategy for a Resilient Energy Union," February 25, 2015, http://ec.europa.eu/priorities/energy-union/docs/energyunion_en.pdf.

45 The Energy Community was established by a treaty in October 2005. Contracting parties outside the EU are Albania, Bosnia and Herzegovina, Kosovo, Former Yugoslav Republic of Macedonia, Moldova, Montenegro, Serbia, and Ukraine. Observers are Armenia, Georgia, Norway, and Turkey. See Energy Community, "Who We Are," https://www.energy-community.org/portal/page/portal/ENC_HOME/ENERGY_COMMUNITY/Who_are_we.

Turkey Demonstrated Security Role of LNG in 2009 Cutoff of Russian Gas

Turkey's experience coping with Russia's cutoff of gas supplied through Ukraine in January 2009 is a good example of how LNG supplies can play a critical security role. At the time, Turkey depended on imports for 95 percent of its total gas supply of about 37 bcm per year, and Russia provided more than 60 percent of those imports through two routes. Most of Turkey's Russian gas, about 14 bcm per year, was delivered through the Western Balkan pipeline transiting Ukraine, Moldova, Romania, and Bulgaria, which was the first gas to be cut. Deliveries stopped on January 5, 2009, for sixteen days. Russian flows to Turkey via the Blue Stream pipeline supplied directly from Russia through a pipeline under the Black Sea, about 9 bcm per year, were unaffected. Turkey's other gas imports came by pipelines from Azerbaijan and Iran and as LNG from Algeria and Nigeria. The LNG represented only about 14 percent of Turkey's total gas supplies, but played a much larger role during the crisis.[1]

Turkey's access to LNG turned out to be crucial to its ability to manage its supply shortfall during the cutoff of Russian gas through Ukraine. During the crisis, LNG imports surged to 28 percent of Turkey's gas imports, double its average for the year. Turkey has two LNG import terminals, Egegaz Aliağa and Marmara Ereglisi. The Egegaz Aliağa terminal was built by a private company in 2001 and then remained idle due to regulatory restrictions on imports. Turkey's state-owned company, Botas, hired the facility in 2007 and used it to help manage winter peaks in gas demand. Turkey had planned to import two LNG spot cargoes during the first quarter of 2009, but at the very start of the Russia-Ukraine gas crisis, Ankara made the decision to secure these two cargoes quickly and directed them to the Egegaz Aliağa terminal.[2]

The value of the LNG to Turkey's gas needs was even more critical at the time it was delivered because at that point the duration of the disruption of Russian gas through Ukraine was still unknown. Turkey made some other adjustments, including reducing demand, but the LNG access proved to be vital to help avoid the shutdowns and hardships suffered by some other countries, especially Bulgaria and other countries in Southeast Europe. The entire region could benefit from having the access to LNG that Turkey used to ease its way through the crisis.[3]

1 Zeyno Elbasi and Julian Bowden, "Russia-Ukraine Gas Crisis January 2009—How Turkey Managed Its Supply Shortfall," January 30, 2009.

2 Ibid.

3 Ibid.

LNG SAFETY AND SECURITY ISSUES

Compared with other fuels such as gasoline, diesel, liquefied petroleum gas, and natural gas in its gaseous phase, LNG is relatively safe and has a generally good record of safety and security.[46] LNG is a clear, colorless, and nontoxic liquid formed when natural gas, primarily methane, is cryogenically cooled to about -260°F. This shrinks the volume of gas by a factor of about 600, making it easier to transport and store.[47] LNG is stored and transported in liquid form and not under pressure, which also enhances its safety by making it more difficult to ignite, and its nontoxic character and light weight when it spills make it vaporize and dissipate easily. LNG is more difficult to ignite than liquid fuels but is flammable when it vaporizes and capable of causing major accidents if its vapors are ignited in confined spaces.[48]

Shipping LNG by tanker is safer than shipping crude oil. Property and liability insurance are cheaper for LNG shipping, largely because the liability for environmental damage is much larger for crude oil.[49] A compilation of major LNG incidents over more than fifty years by LNG engineering and consulting specialist CH·IV International shows that LNG tanker accidents at sea are rare, and most tanker incidents involving a release of LNG take place during loading and unloading operations. A total of thirty-five incidents involving thirty-four LNG tankers and one barge are recorded, resulting in thirteen releases of LNG.[50] This compares with more than 105,000 LNG carrier voyages over this period.[51]

The rarity of major LNG tanker accidents means there is a lack of empirical data on large LNG spills. As a consequence, Sandia National Laboratories used models in 2004 when asked by the US Department of Energy, in anticipation of growing LNG imports into the United States, to assess the impacts of possible releases of LNG by tankers. The report noted that "the LNG industry has an exemplary safety record" and that, regarding LNG tankers at sea, "risks from accidental LNG spills, such as from collisions and groundings, are small and manageable with current safety policies and practices."[52]

Some serious industrial accidents have involved releases of LNG caused by equipment failures, poor materials, and safety errors, in some cases causing deaths and destruction. In most instances, these accidents are similar to any hazard involving uncontained methane in the right proportion to air when it meets a source of ignition. The risks of intentional incidents, such as terrorist attacks, are also a concern because the specific set of conditions needed to create a damaging event are more likely if they are arranged. These conditions include a release of LNG, vaporization, and a source of ignition while the vapor cloud is within its flammability range. For methane vapors derived from LNG, the flammability range is about 5-15 percent methane in air at atmospheric pressure. The temperature needed for ignition is above 1,000°F, which requires a strong source of heat. Other hazards include direct exposure of skin or equipment to extremely cold LNG and asphyxiation from vapors in a confined space with no oxygen.[53]

Equipment and safety procedures continue to improve as accidents occur. The worst LNG accident in history occurred in 1944 when a new LNG storage tank installed at a plant in Cleveland, Ohio, failed shortly after being placed in service. Dense gas filtered into the sewer system where it mixed with water and sewer gas and ignited, killing 128 people. An investigation by the US Bureau of Mines found that a low content of nickel alloy was used in the steel to make the tank because stainless steel alloys were scarce during World

46 Edward Dodge, "How Dangerous Is LNG?" Breakingenergy.com, December 22, 2015, http://breakingenergy.com/2014/12/22/how-dangerous-is-lng/.

47 Sandia National Laboratories, "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill over Water," November 2004, http://www.energy.ca.gov/lng/documents/2004-12_SANDIA-DOE_RISK_ANALYSIS.PDF.

48 Dodge, "How Dangerous is LNG?" op. cit.

49 Ibid.

50 CH·IV International, "Safety History of International LNG Operations," March 2, 2014, http://www.ch-iv.com/assets/documents/safety-history.pdf.

51 Center for Liquefied Natural Gas, LNG Safety and Security Facts," November 23, 2015, http://thehill.com/images/stories/whitepapers/pdf/CLNG_SafetyandSecurityFacts.pdf.

52 Sandia National Laboratories, "Guidance on Risk Analysis," op. cit.

53 Bureau of Economic Geology's Center for Energy Economics, *LNG Safety and Security*, The University of Texas at Austin, June 2012, http://www.beg.utexas.edu/energyecon/LNG_Safety_and_Security_Update_2012.pdf.

War II. This was cited as a factor in the tank failure.[54] The four other LNG accidents that caused fatalities all involved plant personnel at LNG facilities.[55]

- In 1977, the wrong aluminum alloy on a replacement valve at the liquefaction facility and LNG export terminal at Arzew, Algeria, failed when it came into contact with cryogenic temperatures, causing a release of LNG. No vapor ignited, but a worker was frozen to death. Valves used in LNG facilities are currently made with stainless steel.[56]
- In 1979, LNG leaked through an LNG pump electrical penetration seal, vaporized, passed through two hundred feet of underground electrical conduit and into an electrical substation at the LNG import terminal at Cove Point, Maryland. The normal arcing contacts of a circuit breaker ignited the air-fuel mixture, causing an explosion that killed one worker and injured another. Subsequently, building codes related to equipment and systems downstream of the pump seal were changed.[57]
- In 1983, a liquefaction column ruptured due to overpressurization produced by a blind flange left in a flare line, killing three workers with shrapnel. No LNG was involved as the incident occurred during purging of the liquefaction column with warm natural gas before LNG was introduced. The gas caught fire, which was extinguished in about thirty minutes.[58]
- In 2004, a leak in the refrigerant system created a vapor cloud that was drawn into a steam boiler at the Skikda LNG liquefaction plant in Algeria, causing the boiler to overpressurize and rupture. The rupture ignited the vapor cloud and produced an explosion and fire caused by the confined nature of the gas leak and an ensuing fireball. The blast and fire killed twenty-seven workers, injured seventy-two, and destroyed three LNG processing trains. A joint US Department of Energy and FERC report found "that there were local ignition sources, a lack of 'typical' automatic equipment shutdown devices and a lack of hazard detection devices."[59]

LNG is relatively safe and has a generally good record of safety and security.

As shown by the responses to serious accidents, safety in the LNG industry continues to evolve and improve with better standards for materials and equipment, superior engineering design, technology advances especially in materials and sensors and other detection devices, greater use of multiple layers of protection for processing equipment and facilities, and improved emergency response procedures and capabilities. The threat to the public from LNG accidents is particularly low, largely because of the physical separation of LNG operations from the public. Safe distances from facilities and safety zones established for LNG tankers in the United States are based on LNG vapor dispersion data, blast data, thermal radiation data, and other factors required by regulations.[60]

Sandia National Laboratories assessed the potential impact of intentional attacks, such as by terrorists, on LNG tankers and other LNG facilities as a distinctly bigger threat to infrastructure and personnel than accidents, largely because of the greater likelihood that LNG releases caused intentionally would be ignited and a higher likelihood that attacks could be planned and executed near concentrations of infrastructure and people. Based on modeling and historical accident data, the greatest damage to property and largest impact on public safety from the ignition of a vapor cloud has remained within five hundred meters of a spill, with lower impacts at distances beyond sixteen hundred meters even from large spills. With the ability to select a time and place for an attack, however, terrorists could stage attacks on LNG tankers near critical infrastructure such as bridges, tunnels, commercial and industrial areas, LNG loading and unloading terminals, harbors, and populated areas. Most terrorist scenarios led to a vapor cloud with an ignition source that produced a fire almost immediately, but scenarios that produced a vapor cloud with greater dispersion and a delayed ignition were also possible. Intentional attacks that led to cascading damage to two or more LNG tanks on a ship were also found to be possible under some conditions. While Sandia National Laboratories conducted its assessment on LNG tankers, similar scenarios could apply to LNG storage tanks and other LNG facilities.[61]

54 Ibid.

55 CH·IV International, "Safety History of International LNG Operations," op. cit.

56 Ibid.

57 Ibid.

58 Ibid.

59 Ibid.

60 Bureau of Economic Geology, *LNG Safety and Security*, op. cit.

61 Sandia National Laboratories, "Guidance on Risk Analysis," op. cit.

IMPLICATIONS AND RECOMMENDATIONS

Global demand for natural gas continues to grow and markets for LNG are still expanding. LNG supplies are likely to continue to increase and link the major regional markets of North America, Europe, and Asia. More connectivity between the major gas markets means more diversity of gas sources and routes; more price competition; less monopoly pricing; more pressure on oil-indexed prices; and more demand for gas as a low-risk, competitive fuel.

For the United States, LNG exports offer an opportunity to produce and sell more gas without paying more at home. Growth of US LNG exports will benefit the US economy and are unlikely to affect the price of natural gas in the United States. Any gas that leaves US shores will have to be profitable at a price of about $5 per mbtu above the Henry Hub price to cover the additional costs of liquefaction and shipping to Europe and Asia, depending on how much further costs might be reduced, if at all.[62]

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Even though the current low prices for gas dampen the outlook for US LNG exports, several existing trends and a number of uncertainties could improve those prospects. For example, it is clear that European Commission policy to diversify its sources for gas and expand infrastructure to promote market integration and energy security offers an opportunity to US LNG exporters. Gas use for environmental reasons is growing and demand could get a strong boost if governments embrace even more favorable policies. The failure of the shale gas revolution to spread more strongly outside of North America due to the continued absence of conditions needed to support shale gas development also leaves a larger share of the gas market to US LNG.

Many of the world's largest gas producers, including Russia, are forecast to have anemic growth in gas production over the next five years. Meanwhile, the IEA predicts that Europe's import demand for natural gas will increase by 70 bcm from 2014 to 2020 and China's demand will rise by 90 bcm in this period.[63]

Prospects for new gas pipelines are relatively few and have a lot of uncertainty. New Russian pipelines, both to China and Europe, are particularly uncertain. Russia has also postponed its plans for the Yamal LNG project. Additional LNG projects are likely to be delayed or cancelled, including some in Canada and the United States. US gas pipelines to Mexico, Turkmen pipelines to China, and the Southern Corridor are among the international projects that are moving ahead, along with most of the LNG export projects in Australia and the United States.

Geopolitically, all US LNG exports are in the national interest because the more US LNG exports, the better it is for US trading partners. The market should determine where the LNG exports go, because adding to global supply improves everyone's security. Following free market signals also strengthens the incentive for US producers to invest in gas production, furthering US as well as global security. Economically, studies by the US Energy Information Administration and National Economic Research Associates found that US LNG exports would contribute to higher levels of GDP growth.[64]

62 For more information on the economic benefits of the shale gas revolution and energy abundance see the Atlantic Council's task force report on the US energy boom and national security, *Empowering America, How Energy Abundance Can Strengthen US Global Leadership*, July 2015, http://www.atlanticcouncil.org/publications/reports/empowering-america-how-energy-abundance-can-strengthen-us-global-leadership.

63 IEA, *Gas Medium-Term Market Report 2015*, op. cit.

64 EIA, *Effect of Increased Levels of Liquefied Natural Gas Exports on US Energy Markets*, October 2014, https://www.eia.gov/analysis/requests/fe/pdf/lng.pdf; National Economic Research Associates, "Updated Macroeconomic Impacts of LNG Exports from the United States," March 24, 2014.

Policy officials can speed progress toward attaining these benefits by making LNG simpler to export from the United States and easier to access in Europe. In the United States, policy officials could eliminate requirements that make it easier for LNG exporters to sell to countries with free trade agreements with the United States. In doing so, they would eliminate the requirement that exporters without free trade status demonstrate that their exports will not adversely impact US economic interests.

US policy officials should also include free energy trade in all future free trade agreements, including the Transatlantic Trade and Investment Partnership. The Trans-Pacific Partnership is likely to be a step forward for LNG exports because it should give signatories free trade status as long as they grant national treatment to the United States. This will particularly benefit Japan as a major LNG importer. While it would also help streamline the LNG approval process for Trans-Pacific Partnership signatories, applicants to export LNG would still need approvals from the US Federal Energy Regulatory Commission for onshore projects and the US Maritime Administration for offshore projects. However, this piecemeal approach is still an obstacle to creating a global LNG market.[65]

In Europe, policy officials could accelerate the completion of the North-South Corridor by approving and financing key projects, such as the Krk Island LNG terminal, north-south pipelines connecting the Świnoujście and Krk Island LNG terminals, and pipelines that connect underused LNG terminals in Spain and Portugal to Central and Eastern Europe. European policy officials could also expand the North-South Corridor by supporting additional LNG supplies from Italy, Greece, and Turkey in the south and connecting these and LNG terminals in the Baltic countries to the North-South Corridor. Policy officials should also consider ways to make Ukrainian gas storage capacity part of the North-South Corridor.

65 Applications to countries with free trade status are presumed to be in the public interest and are approved by the US Department of Energy without delay. As a party to the Trans-Pacific Partnership, Japan and other signatories will be considered free trade partners for LNG unless there is an exception to national treatment on gas, which is unlikely. National treatment means that US exports would be treated the same as similar goods produced domestically by importing countries. Currently, the United States has free trade agreements with national treatment for natural gas with Australia, Bahrain, Canada, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Honduras, Jordan, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, Republic of Korea, and Singapore. Japan already has three supply contracts in place with US LNG exporters building facilities. See Tom Cutler, National Bureau of Asian Research, *The Trans-Pacific Partnership as a Pathway for US Energy Exports to Japan,* January 2015, http://www.nbr.org/downloads/pdfs/eta/ES_essay_cutler_012815.pdf.

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Bud Coote is a Senior Fellow with the Atlantic Council Global Energy Center. He recently retired from the Central Intelligence Agency (CIA) as the Agency's leading international energy analyst and a key adviser to senior US officials on a wide array of global energy issues. He helped to establish and build the CIA's energy program dating back to the early 1970s, producing actionable intelligence that directly supported and helped shape decisions made by US policy officials, foreign officials, and private companies.

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