

MODELING THE EFFECT OF FUTURE US LNG SUPPLY

EUROPE SEES BIGGEST ECONOMIC GAINS FROM US LNG, WHILE RUSSIA THE MOST PAIN

Despite challenges with US LNG exports, it is entirely possible that additional export capacity could get approved and built, and that total US LNG exports could exceed the volumes already approved, or even potentially the 14.5 bcf/d (150 bcm) Russia currently sells to members of the

European Union.⁸⁵ Given the uncertainty surrounding both market demand and policy support for future US LNG supply, we assess the impact of both 9 bcf/d (93 bcm) and 18 bcf/d (186 bcm) of US LNG exports on European and global gas markets.

We find that European consumers stand to benefit considerably from US natural gas exports. While more

MODELING

In conducting our analysis, we employ the World Energy Modeling System Plus (WEPS+) used by the EIA to produce the International Energy Outlook (IEO).¹ WEPS+ integrates with the EIA's National Energy Modeling System (NEMS) that is used to produce the Annual Energy Outlook (AEO), the most commonly used long-term projection of US energy supply and demand, allowing for harmonized US and global energy outlooks.²

For global natural gas projections in particular, WEPS+ relies on EIA's International Natural Gas Model (INGM), which combines estimates of natural gas reserves, resources and extraction costs, energy demand, and transportation costs and capacity in order to estimate future production, consumption, and prices of natural gas. INGM incorporates regional energy consumption projections by fuel from the WEPS+ model, as well as more detailed US projections from NEMS. An iterative process between INGM and WEPS+ is used to balance world natural gas markets, with INGM providing supply curves to WEPS+ and receiving demand estimates developed by WEPS+.

INGM uses regional natural gas demand estimates from NEMS for the United States rather than those computed as part of the WEPS+ output, so that the final output for

the United States is consistent with AEO projections. The model assumes that while contracts with pricing formulas related to crude oil or fuel oil prices dominate LNG trade and pipeline supply from Russia to Europe, marginal supply and demand decisions will reflect the marginal costs based on supply, demand, and transport fundamentals as reflected in short-term nodal and seasonal market prices. In addition, while LNG contracts may constrain trade in the near term, the model assumes markets are flexible over the long term and LNG will flow to the demand locations that value the LNG the most.

We use as our reference case a scenario in which the US exports no natural gas, to isolate the energy market impact of potential US LNG exports. We then compare this to a 9 bcf/d (93 bcm) and 18 bcf/d (186 bcm) scenario. US natural gas production costs are based on the version of NEMS used to produce the 2013 AEO, which is integrated into the most recent version of WEPS+ at the time of publication. In the 2013 AEO, natural gas prices at Henry Hub are \$4.13 per mmBtu (in real 2011 USD) in 2020, \$4.87 per mmBtu in 2025 and \$5.4 per mmBtu in 2030. Further details on our modeling approach are included in Appendix I.

Figure 12: Change in annual natural gas expenditures by value
Billion 2011 USD

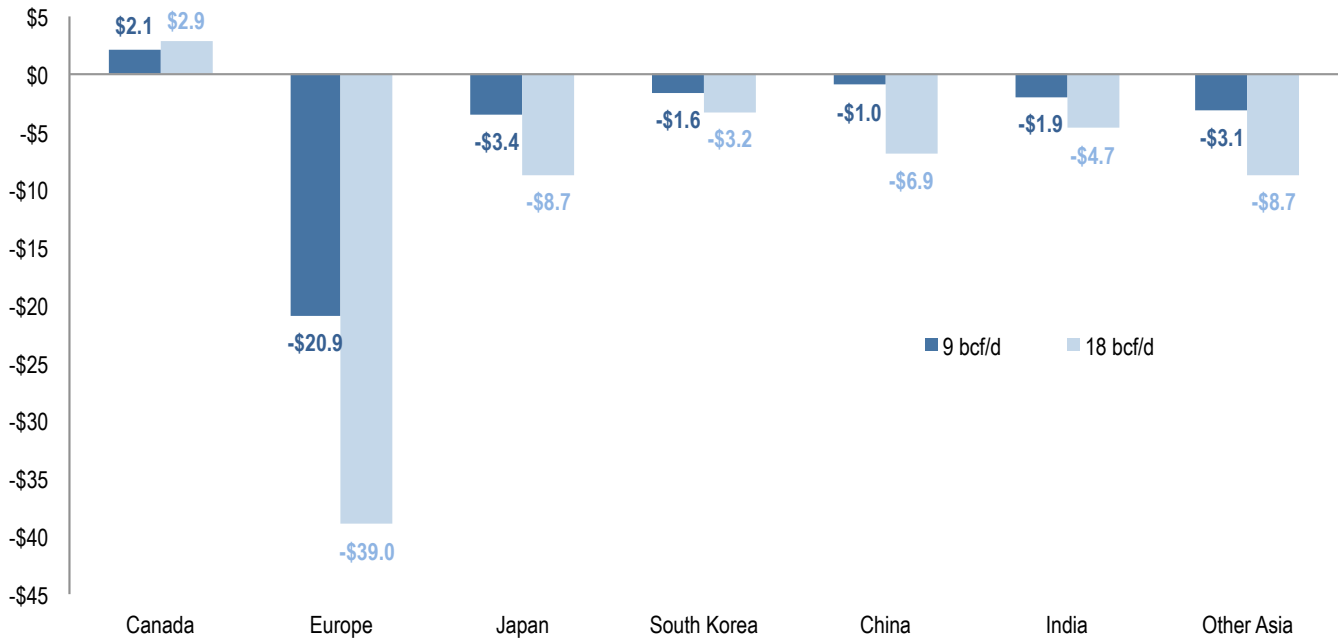


Figure 13: Change in annual natural gas expenditures by percent
Percent

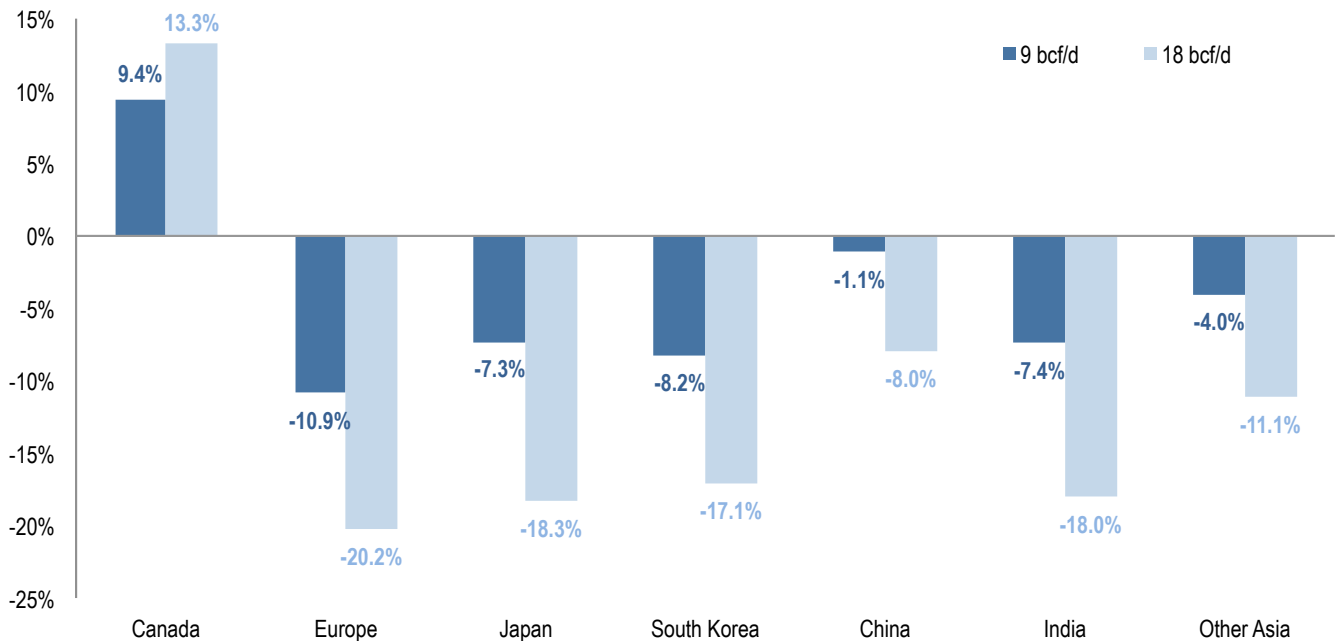


Figure 14: Change in annual natural gas export revenue by value
Billion 2011 USD

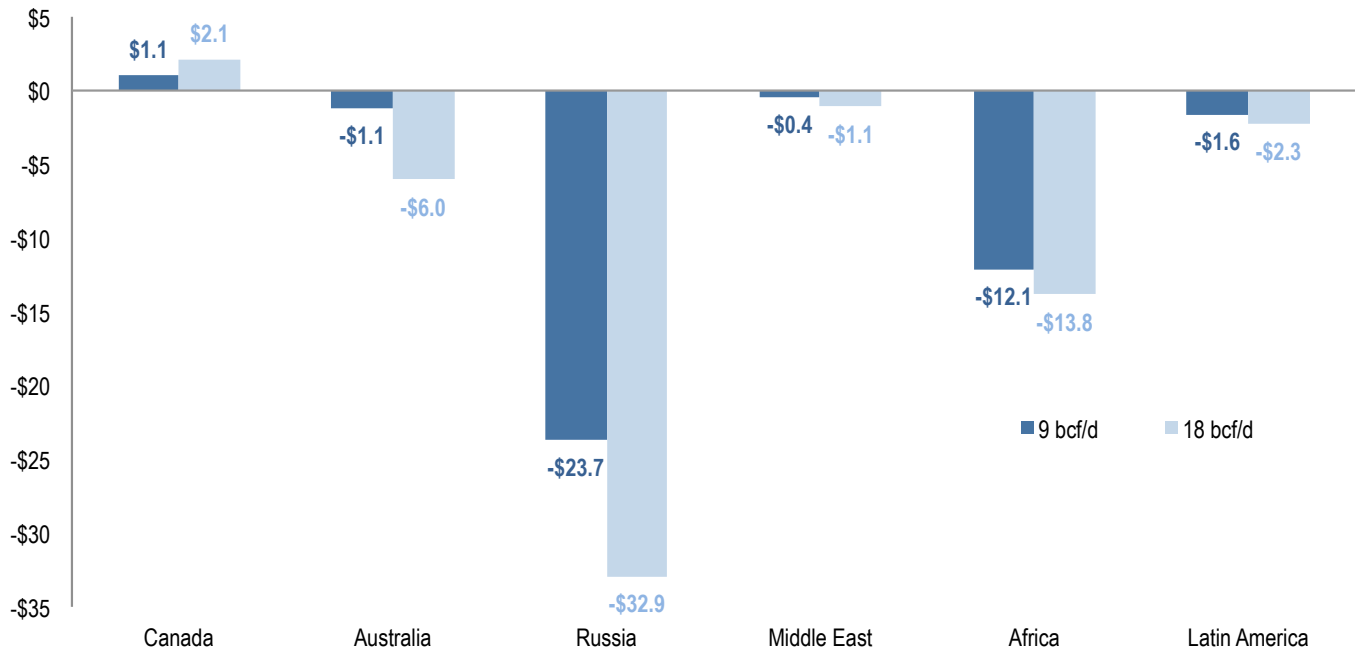
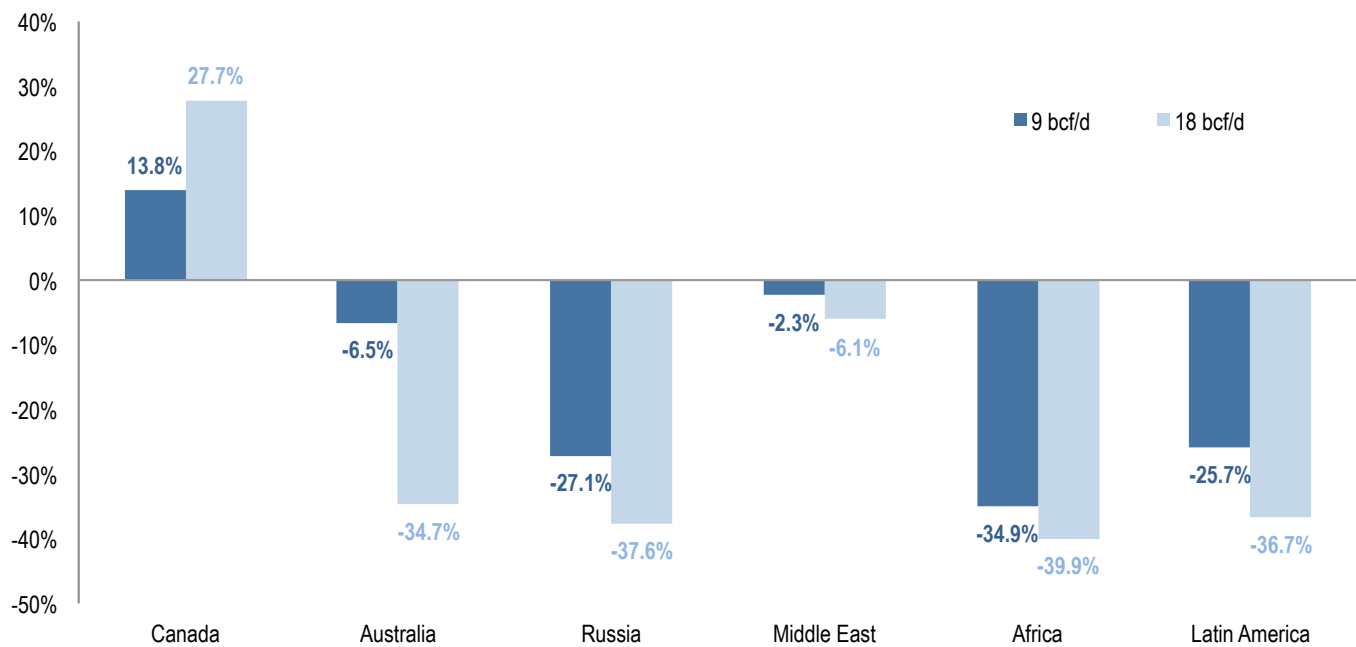


Figure 15: Change in annual natural gas export revenue by percent
Percent



volume goes to Japan than to Europe in our modeling, additional supply puts downward pressure on prices globally, and the magnitude of the resulting benefit—in dollar terms—is greater in Europe due to greater overall gas consumption. At 9 bcf/d (93 bcm) of US LNG exports, European consumers, including Ukraine, save \$21 billion on natural gas per year (Figure 12), representing an 11% reduction in total natural gas expenditures (Figure 12). At 18 bcf/d (186 bcm) of US exports, these savings grow to \$39 billion a year, or a 20% decline in gas expenditures.

Just as Europe is the largest economic winner from US LNG exports in our modeling, Russia is one of the largest economic losers. A small decline in sales volume and a large decline in sales price to Europe translates into a \$24 billion (Figure 14), or 27% (Figure 15), reduction in annual export revenue at 9 bcf/d (93 bcm) of US LNG exports relative to a world where US gas is not sold abroad. That grows to \$33 billion at 18 bcf/d (186 bcm), or 38%, and accounts for 1.1% of projected Russian GDP.

It is important to note that these findings are derived both from the production and transportation costs in the model and its assumption that over the long term both pipeline gas and LNG will be priced at the margin. If oil-linked contracts persist between 2020 and 2030, and prices continue to be set above marginal cost, then consumers could see an even larger cost reduction to the extent US LNG exports allow consumers to renegotiate these contracts. On the other hand, if oil-linked contracts above marginal cost are still prevalent between 2020 and 2030 and consumers are not able to renegotiate, the potential cost savings from US LNG exports could be considerably less.

SEVERAL FACTORS WILL MUTE THE IMPACT OF US LNG ON EUROPEAN ENERGY SECURITY

Although the potential impact of planned US LNG exports on European gas expenditures could be considerable, the impact of US LNG exports on European security and Russian foreign policy is limited by four factors:

- US LNG will take several years to enter the market;
- US LNG exports will result in a much smaller increase in global gas supply than the volume of US exports;
- European LNG infrastructure does not allow imports to replace Russian gas into Eastern and Central Europe; and
- Natural gas revenue is a small share of Russia's energy export revenues.

Exports of US LNG are years away from start up

US LNG will not hit the market soon enough to play any role in the outcome of the current crisis in Ukraine. Cheniere Energy's Sabine Pass Terminal in Louisiana is the only US lower-48 LNG export terminal currently under construction, and only two additional terminals—Sempra's Cameron LNG project in Louisiana and Freeport LNG Development's Freeport terminal in Texas—have won final FERC approval as of August 2014. At least two other already approved projects have more or less established timelines and are approaching final investment decision. The Sabine Pass terminal is expected to start commercial operations in 2016, while the other projects are only expected to be operational after 2018 (Table 3). As a result, in our modeling we explore

Table 3: US LNG export terminals with firm investment plans

Project Type	Status	Project	Region	Start Date	Bcf/d
Brownfield	Under Construction	Sabine Pass (train 1-4)	US Gulf Coast	2016	2.2
Brownfield	Firm Plan	Freeport LNG	US Gulf Coast	2018	1.8
Brownfield	Firm Plan	Cove Point LNG	US East Coast	2018	0.8
Brownfield	Firm Plan	Lake Charles LNG	US Gulf Coast	2019	2.0
Brownfield	Firm Plan	Cameron LNG	US Gulf Coast	2020	1.7

Source: FERC, DOE, Goldman Sachs, press reports.

the impact of both our 9 bcf/d (93 bcm) and 18 bcf/d (186 bcm) scenarios in the 2020-2025 time frame.

US LNG projects will displace higher cost projects elsewhere, limiting supply growth

While the introduction of US LNG exports in the global gas market will likely put downward pressure on world gas prices, it will have a relatively modest impact on the actual quantity of gas Russia sells to Europe (Figure 16). As a result, even with a high 18 bcf/day (186 bcm) of US LNG exports, Europe is unlikely to have the ability to completely cut itself off from Russian gas, nor could it cope with the sudden disappearance of those supplies. There are three reasons for this:

- the loss of other supplies to the global market that result from US LNG exports,
- the economics of Russian gas into Europe, and
- the existing long-term gas contracts between Gazprom and its European customers, most of which will still be in place in 2025.

First, not all the gas that the United States will sell abroad can be considered additional global supply. US LNG terminals are competing with other gas projects and producers

around the world for customers. The reduction in global gas prices as a result of US exports discussed above attracts new consumers, but also crowds out other producers. In economic terms, lower-cost US projects shift the global gas supply curve down and to the right, changing the point at which supply meets demand—the price—making some higher cost sources of supply uncompetitive.

In our modeling, Russian production falls by 0.7 bcf/d (7.2 bcm) in response to 9 bcf/d (93 bcm) of US LNG (Figure 17). European production falls by roughly the same amount, however, as some higher cost North Sea production struggles to compete. The biggest decline is in Africa, where US supply crowds out prospective African LNG projects. Additionally, increased foreign demand for US natural gas leads to a modest increase in domestic prices and reduction in domestic consumption. While the amount of gas the US produces for export rises, there is a small decline in the amount produced for the domestic market. Overall US production increases in response to higher US LNG exports, but not quite as much as the total exported volume. All told, 9 bcf/d (93 bcm) of US exports increases net global supply by 1.5 bcf/d (16 bcm).⁸⁶ The same dynamic occurs at 18 bcf/d (186 bcm) (Figure 18).

Figure 16: Impact of US LNG on European gas suppliers

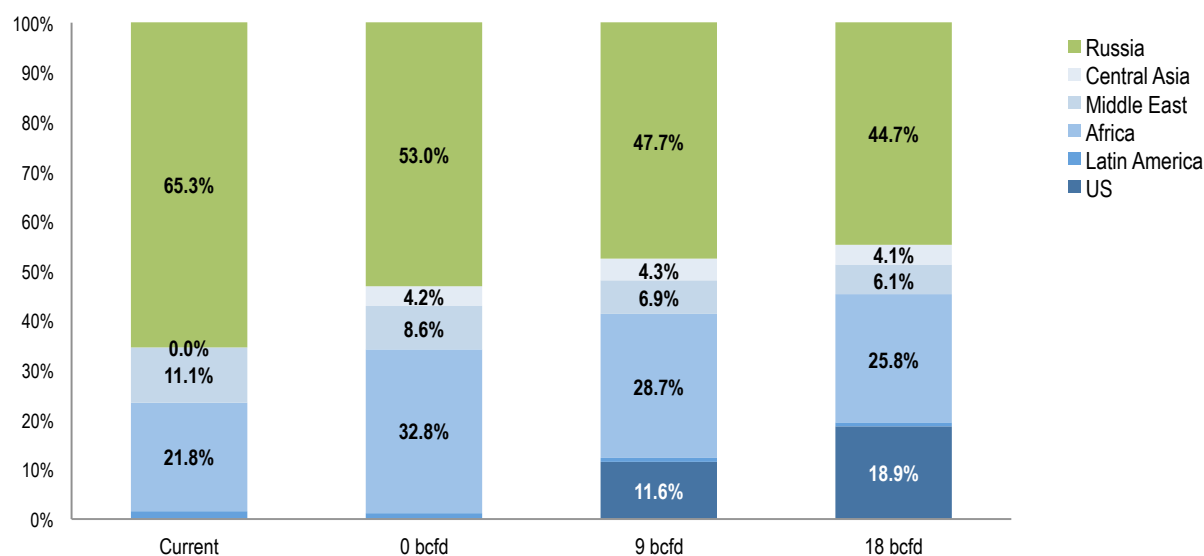


Figure 17: Impact of 9 bcf/d of US LNG exports on global gas supply Bcf/d

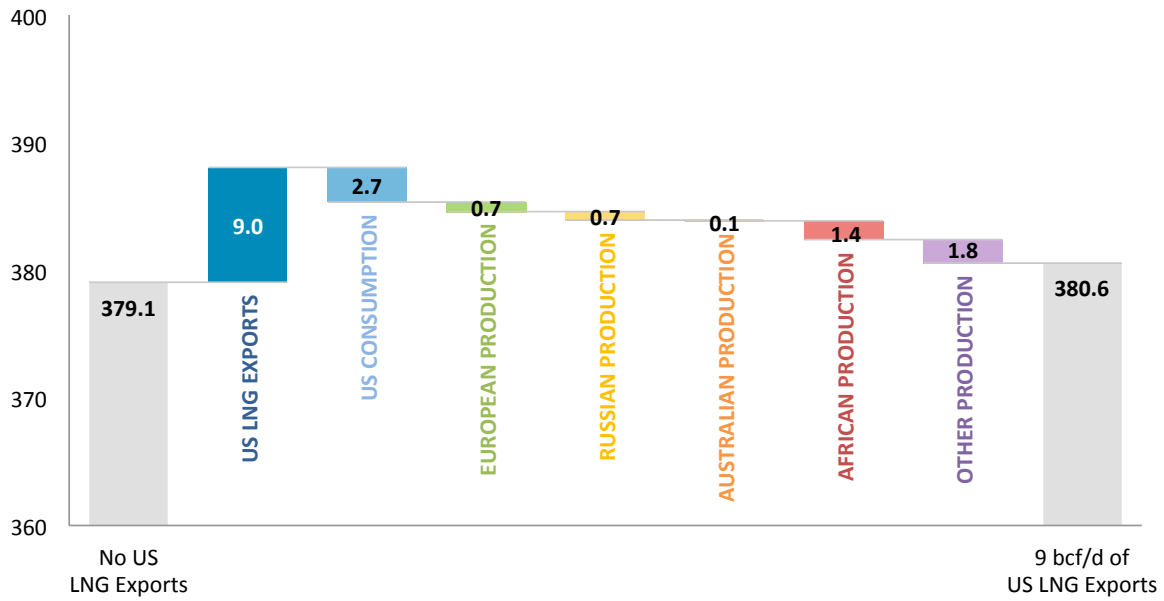


Figure 18: Impact of 18 bcf/d of US LNG exports on global gas supply Bcf/d

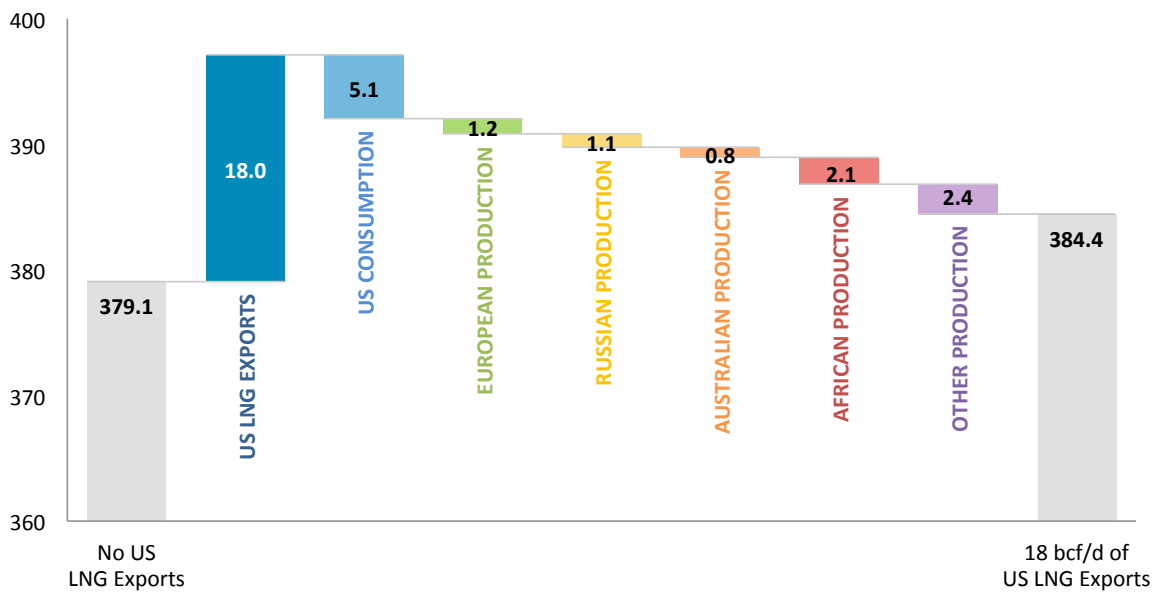
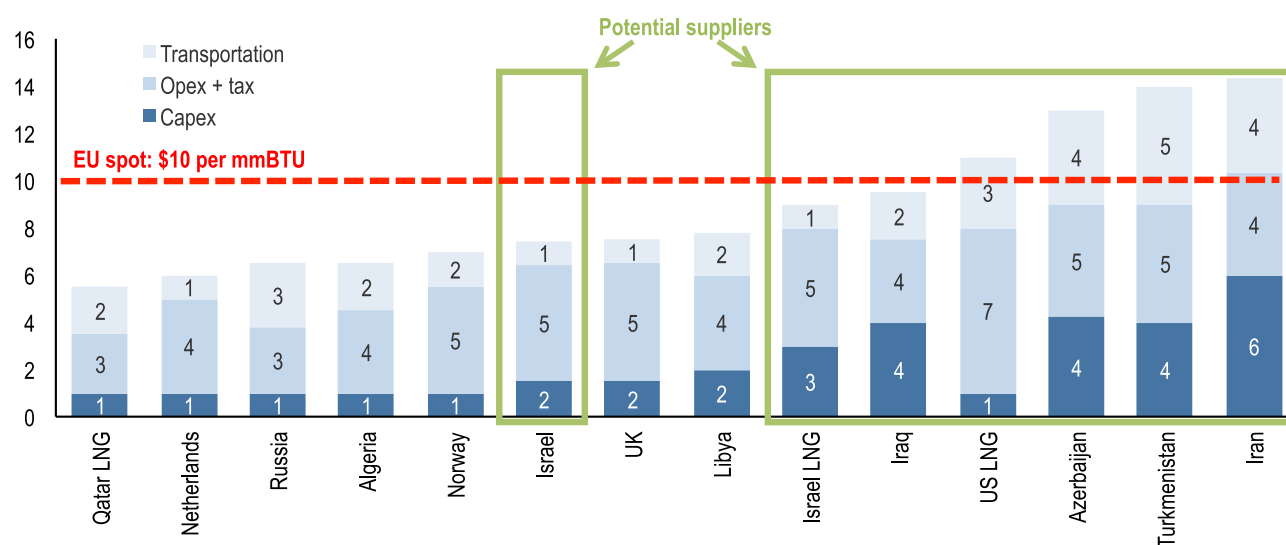


Figure 19: Marginal cost of natural gas suppliers to Europe
\$ per mmBtu



Source: Morgan Stanley, IHS.

The second factor tying Europe to Russian gas is that it is relatively cheap and will likely remain competitive in the European market for the foreseeable future. Russia is among the lowest cost suppliers of gas in the European market, along with other existing gas exporters like Qatar, Algeria, and Norway (Figure 19). In our modeling, Russia's share of European gas⁸⁷ imports declines modestly in response to US LNG exports but still accounts for nearly half of all imports, even in the 18 bcf/d (186 bcm) scenario. While Europe has the physical ability over the long-term to replace all the gas it currently buys from Russia, such a move would require significant political intervention and is highly unlikely to occur only on commercial grounds. Gazprom appears to be sensitive to such political risk, and in its recent cutoff of supplies to Ukraine is walking a fine line between trying to exert its energy leverage without undermining its reputation as a reliable supplier.

Even if it were economic for Europe to replace Russian gas, volume obligations under existing long-term gas contracts would make it immensely difficult to do so. Such obligations will continue to require Gazprom's customers

in OECD Europe to take delivery of at least 10 bcf/d (103 bcm) of Russian gas in 2020, and more than 9 bcf/d (93 bcm) until 2027. These volumes assume a 70% take-or-pay commitment in European gas contracts.⁸⁸

Russia has no real alternative market for much of its current and future natural gas production in the traditional West Siberian gas producing basins, and thus has an incentive to remain price competitive in Europe. Gazprom has long been working to diversify its exports to reduce its reliance on the European natural gas market, primarily via pipeline gas supplies to China. As discussed earlier, Russia recently concluded a long-term gas supply contract with China.⁸⁹ However, as noted, the feed gas to the new Russia-China pipeline link will be sourced from new East Siberian developments, which are not linked to European markets and as such the deal is unlikely to result in any diversion of Russian gas currently sold to Europe.

LNG development has also been part of Russia's long-term strategy to diversify its natural gas exports. If all current projects are executed as planned, Russia may have an ad-

ditional 6.8 bcf/d (70 bcm) of LNG liquefaction capacity by around 2020.⁹⁰ However, all Far Eastern projects are fed from East Siberian and Sakhalin Island developments, which do not currently supply the European market. Novatek's Yamal LNG development will also be supplied from a dedicated greenfield project in the far north Yamal Peninsula, and thus will not divert legacy gas production volumes away from Europe towards global LNG markets.⁹¹ Gazprom's Baltic LNG project may divert some gas from European pipeline imports, but will likely supply the Spanish LNG market.⁹² The vast Shtokman development in the Barents Sea is currently not deemed economically feasible.⁹³ Overall, even if the Russian LNG projects prove viable in the face of growing competition from US and Australian LNG projects, they will mobilize additional volumes and will not reduce Russia's ties to its main European export market.

Central and Eastern Europe lack infrastructure to receive LNG volumes

A major barrier to replacing Russian pipeline gas with imported LNG is infrastructure. European LNG regasification capacity is theoretically sufficient to displace all Russian imports with LNG, but all currently operational LNG import terminals are located in Western and Southern Europe. Central and Eastern European countries are only now beginning to develop LNG import terminals in the Baltic Sea region.

The dearth of LNG terminals in Eastern Europe is due in large part to the extensive long-distance pipeline network,

built during the 1970's, that connects the main Russian gas producing areas with European end-users. This pipeline network had a combined carrying capacity of 16 bcf/d (168 bcm) at the end of 2013, and the spare capacity in the system has only grown over the past decade as Russia diverted some of its Western European gas shipments to the newly-built Nord Stream pipeline running under the Baltic Sea⁹⁴ (Table 4). The Russian pipeline network crossing Central and Eastern Europe will have even greater excess capacity if Gazprom and its European partners move ahead with the construction of the South Stream pipeline, which would bring Russian gas to the Central European Gas Hub in Austria and to a host of transit countries in Southeastern Europe.

Central and Eastern European gas markets are relatively small and poorly integrated, and many of them are landlocked. Gas demand in Central and Eastern European countries is also relatively low compared to Western European importers. Poland has the biggest population in the region, comparable to that of Spain. However, it only imports about 1.1 bcf/d (11 bcm) of natural gas annually, roughly 40% of Spain's imports in 2013, due to the Polish electricity sector's dependence on cheap domestic coal.⁹⁵

The level of integration among these small Central and Eastern European gas markets is also relatively weak. The Soviet-era gas pipeline system spanning the region is oriented from east to west, while north-south connections were all but missing until the beginning of this decade. The gas trading infrastructure is also relatively immature in the re-

Table 4: Russia-Europe pipeline capacity

Pipeline System	Peak Transit Capacity	Est. Utilization
Existing via Central and Eastern Europe		
Ukraine (Soyuz/Brotherhood)	11.6 bcf/d	49%
Belarus (Yamal-Europe)	4.6 bcf/d	100%
Existing via Other Routes		
Nord Stream (Phase 1-2)	5.3 bcf/d	ca. 50%
Blue Stream	1.5 bcf/d	87%
Under construction/planned		
South Stream	6.1 bcf/d	n/a
Nord Stream (Phase 3-4)	2.7+ bcf/d	n/a

Source: Morgan Stanley, Oxford Institute for Energy Studies.

gion, and the only functional gas trading hub with sufficient liquidity serving the Central European region is located in Baumgarten, Austria.

Despite the many difficulties facing LNG infrastructure developments in Eastern Europe, a number of import terminal projects have recently broken ground (Table 5). Poland's 0.5 bcf/d (4.8 bcm) LNG import terminal in Swinoujscie is under construction and expected to start commercial operations by mid- 2015.⁹⁶ Lithuania's 0.3 bcf/d (3.0 bcm)⁹⁷ floating LNG regasification unit is also largely complete and will begin receiving cargoes in 2015.⁹⁸ The prospects of LNG projects in the Adriatic and Black Sea regions are less favorable, however. None of the previously proposed LNG regasification projects in the Southeast European region appear to be making significant progress at the moment.

Political reaction to the Ukraine crisis could potentially accelerate the pace of LNG import terminal construction, especially in the Eastern part of Europe. Financing large-scale infrastructure projects purely out of energy security considerations has proved challenging in the past, as illustrated by the failure of the Nabucco pipeline project, which would have transported gas from the Caspian to Europe as part of efforts to diversify the Continent's gas supply.⁹⁹ In the case of the Polish LNG project, howev-

er, EU funds totaling \$180 million—about 15% of total project cost—helped ease financing difficulties.¹⁰⁰ For Lithuania, a substantial loan from the European Investment Bank as well as a price discount, which the country's gas company has secured from Gazprom, has mitigated some of the country's \$600 million investment in a costly supply diversification project.¹⁰¹ Lithuania paid one of the highest rates for Russian gas among EU member states in 2013 of \$465 per thousand cubic meters, according to Reuters.¹⁰² However, the country's gas utility, Lietuvos Dujos, negotiated aggressively and managed to obtain a substantial price discount from Gazprom in May 2014 by using the option of alternative LNG supplies as a bargaining chip.¹⁰³

Russia's revenues from gas exports are low and provide little leverage for the West

Oil and gas play a major role in the Russian economy. The country exported \$356 billion of oil and gas in 2013, accounting for more than two-thirds of total Russian export revenues¹⁰⁴ and one-sixth of Russian GDP (Table 6). Most of this, however, was from oil rather than natural gas. Russia's crude oil and refined products exports amounted to \$283 billion in 2013, whereas the total value of Russian natural gas exports was less than \$73 billion, of which an

Table 5: Proposed Central and Eastern European LNG import terminals

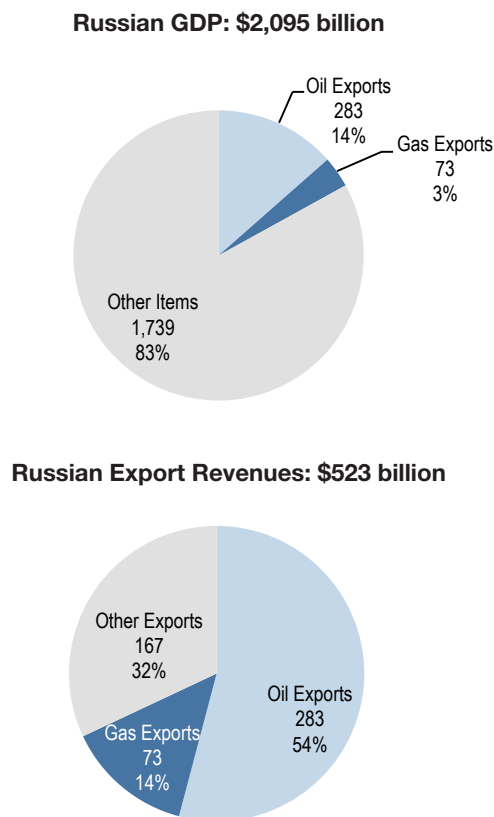
Country	Company	Name of Facility	Investment	Probability of Going Forward	Capacity (bcf/d)	Last Reported Start Date
Albania	Grupo Falcione	Fiere	New Facility	Low	1.2	2016
Croatia	Plinacro	Krk island	New Facility	Low	0.6	2016
Croatia	Total/Geoplin/E.On/OMV	Adria LNG	New Facility	Low	1.5	2017
Estonia	Balti Gaas	Paldiski	New Facility	Medium	0.25	2015
Estonia	Vopak, Elering	Muuga	New Facility	Low	0.28	2017
Finland	Gasum	Joddbole or Tolkkinen	New Facility	Medium	0.2	2019
Finland	Gasum	Pansio Harbour	New Facility (small scale)	Low	0.01	2015
Finland	Outokumpu	Tornio Harbour	New Facility (small scale)	Low	-	2016
Latvia	Latvenergo	Riga	New Facility	Low	0.48	2016
Lithuania	Klaipedos Nafta	Klaipeda	New Facility	High	up to 0.29	2014
Poland	Gaz-System, Polskie LNG	Swinoujscie	New Facility	High	0.48	2014
Poland	Gaz-System, Polskie LNG	Swinoujscie	Expansion	Medium	0.72	-
Romania	Gaz-System, Polskie LNG	Constanta	New Facility	Low	0.77	-
Ukraine	N/A	Yuzhnyi	New Facility	Low	0.48	2018

Source: Gas Infrastructure Europe Database (July 2013), Bloomberg Businessweek.

Table 6: The significance of oil and gas exports to the Russian economy

Export Revenues	\$ billion in 2013	% of GDP	% of Export Revenues
Crude Oil Export	174	8%	33%
Oil Products Export	109	5%	21%
Total Oil Export	283	14%	54%
Natural Gas Pipeline Export	67	3%	13%
LNG Export	6	0%	1%
Total Natural Gas Exports	73	3%	14%
Total Oil & Natural Gas Export	356	17%	68%

Source: BOFIT, Central Bank of Russia, metals & mining export revenues from Goldman Sachs.

Figure 20: Russian government revenue from natural gas exports

Source: BOFIT, Central Bank of Russia.

estimated \$54 billion came from European pipeline gas exports (Figure 20). Going forward, it is possible that natural gas's share of Russia's energy export revenue may rise as Moscow implements various tax reforms to encourage greater investment in its oil sector, particularly unconventional production, which could reduce the share of oil rents captured by the state.¹⁰⁵ Expanded sanctions, if they continue to target oil rather than gas production, may have a similar effect.

The relatively small role of gas export revenues in the economic growth formula of the world's second largest gas producer is due in part to the fact that about 60% of Russian gas production is consumed in the large and inefficient domestic gas market and another 7% is used to operate the country's pipeline network.¹⁰⁶ To put the size of Russia's domestic gas market in context, the 28 members of the European Union consumed 42 bcf/d (438 bcm) in 2012 while Russia consumed 40 bcf/d (413 bcm).¹⁰⁷ The European Union has a population 3.5 times the size of Russia and an economy that is eight times larger. Of the Russian gas that is exported, roughly a quarter is shipped to CIS countries, typically at a discount, further reducing natural gas export revenue.¹⁰⁸ This discount applied to Ukraine as well, until Gazprom decided to unilaterally revoke it in April 2014. In contrast, Russia only consumes 31% of the oil it produces at home,¹⁰⁹ with oil exports accounting for 14% of GDP in 2013.¹¹⁰