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The Global Energy Market:
Comprehensive Strategies to Meet
Geopolitical and Financial Risks



The Future of Russian Natural Gas Exports

Peter R. Hartley and Kenneth B. Medlock III



THE JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY
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THE GLOBAL ENERGY MARKET: COMPREHENSIVE STRATEGIES TO MEET GEOPOLITICAL AND FINANCIAL RISKS

THE G8, ENERGY SECURITY, AND GLOBAL CLIMATE ISSUES

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ABOUT THE GLOBAL ENERGY MARKET STUDY

The Global Energy Market: Comprehensive Strategies to Meet Geopolitical and Financial Risks—The G8, Energy Security, and Global Climate Issues examines a variety of scenarios for the future of global energy markets. Some of these scenarios evaluate factors that could trigger a regional or worldwide energy crisis. The study assesses the geopolitical risks currently facing international energy markets and the global financial system. It also investigates the consequences that such risks could pose to energy security, pricing, and supply, as well as to the transparent and smooth operation of the global market for oil and natural gas trade and investment. By analyzing these threats in depth, the study identifies a series of policy frameworks that can be used to fortify the current market system and ensure that it can respond flexibly to the array of threats that might be encountered in the coming years. The study also looks at the impact of emerging climate policy on the future of world energy markets.

ABOUT THE ENERGY FORUM AT THE JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY

The **Baker Institute Energy Forum** is a multifaceted center that promotes original, forward-looking discussion and research on the energy-related challenges facing our society in the 21st century. The mission of the Energy Forum is to promote the development of informed and realistic public policy choices in the energy area by educating policymakers and the public about important trends—both regional and global—that shape the nature of global energy markets and influence the quantity and security of vital supplies needed to fuel world economic growth and prosperity.

The forum is one of several major foreign policy programs at the James A. Baker III Institute for Public Policy of Rice University. The mission of the Baker Institute is to help bridge the gap between the theory and practice of public policy by drawing together experts from academia, government, the media, business, and nongovernmental organizations. By involving both policymakers and scholars, the institute seeks to improve the debate on selected public policy issues and make a difference in the formulation, implementation, and evaluation of public policy.

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ABOUT THE INSTITUTE OF ENERGY ECONOMICS, JAPAN

The Institute of Energy Economics, Japan (IEEJ), was established in June 1966 and specializes in research activities in the area of energy from the viewpoint of Japan's national economy in a bid to contribute to sound development of Japanese energy supply and consumption industries and to the improvement of domestic welfare by objectively analyzing energy problems and providing basic data, information and the reports necessary for policy formulation. With the diversification of social needs during the three and a half decades of its operation, IEEJ has expanded its scope of research activities to include such topics as environmental problems and international cooperation closely related to energy. The Energy Data and Modeling Center (EDMC), which merged with the IEEJ in July 1999, was established in October 1984 as an IEEJ-affiliated organization to carry out such tasks as the development of energy data bases, the building of various energy models and the econometric analyses of energy.

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THE FUTURE OF RUSSIAN NATURAL GAS EXPORTS

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I. INTRODUCTION

Russia's status as a current and future energy producer is close to unrivaled. It is home to the world's largest natural gas reserves, and is also currently the world's largest natural gas producer. Moreover, due to its unrivaled natural gas resource base, Russia is capable of increasing its future production. As of January 1, 2007, the *Oil and Gas Journal* (OGJ) estimates of Russian proved reserves of natural gas were 1,680 trillion cubic feet (tcf) (or 47,570 billion cubic meters (bcm)), and according to the United States Geologic Survey (USGS), the mean estimate of undiscovered, technically-recoverable natural gas resource is 1,168 tcf (33,074 bcm), with the estimated resource in place at more than 3,300 tcf (93,400 bcm). Russia therefore has the potential to enhance its status as a global natural gas supplier. According to the U.S. Energy Information Administration (EIA), in 2006 Russian dry gas production was 23.2 tcf (657 bcm) and exports equaled 7.8 tcf (220.9 bcm). To put this into perspective, global dry gas production was 104.8 tcf (2,968 bcm) in 2006, meaning Russia accounted for more than 20 percent of global production with Europe its primary export market.

Enhancing Russia's status in energy markets is the fact that Russia also holds the eighth-largest proven reserves of crude oil in the world, and ranks a close second in oil

production to the world's largest oil producer, Saudi Arabia. In fact, when both oil and natural gas are considered, Russia exports more hydrocarbons than Saudi Arabia. Accordingly, Russia's position as a major global energy supplier has significant implications for its foreign policy in general, as well as its relationships with major energy-consuming countries.

In 2006, Russian exports, primarily to Europe, equaled 7.8 tcf. Europe as a whole now relies on Russia for about one-quarter of its natural gas supply with the dependence of some European countries even higher. For example, Russia supplies over one-third of Germany's requirements, and East European and Baltic countries, which were closely integrated with Russia in the Communist era, rely on a higher percentage of Russian gas for their energy needs.

Gazprom produces more than 80% of Russia's natural gas and controls access to Russia's domestic natural gas pipeline system. While renegotiating export prices to Ukraine in the winter of 2006, when demand in both Ukraine and Western Europe was high, Gazprom temporarily reduced supply to Ukraine. While the principal motivation may have been a desire to raise Ukrainian prices closer to netback parity with European market prices, the move was widely interpreted as an attempt to interfere in Ukrainian domestic politics by discouraging the ascent to power of a pro-Western candidate for President. In addition, the event substantially raised energy security concerns among European consumers.

Concern is also mounting over Russia's ability to meet its future contractual commitments. Russian natural gas production dipped to about 10 percent below 1992 levels in 1997, but has rebounded since. Since 2005, gas production has been flat, but

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slightly higher than 1992 levels. Despite the increase in production since 1997, strong growth in domestic demand and exports has required Russia to increase its imports of natural gas from Caspian states. This, however, may not be sustainable, and prompted the Ministry of Industry and Energy to state in October 2006 that Russia could face a natural gas shortage as early as 2010.

Expansion of Russian domestic natural gas production will require massive new investments, but Gazprom is restricted in its ability to use external capital. In addition, Gazprom has difficulty generating internal investment funds since more than 70% of its production is sold domestically at highly subsidized prices (currently approximately \$0.80 per thousand cubic feet (mcf) according to EIA (2008)). Despite such difficulties, Gazprom has devoted capital resources in aggressive pursuit of downstream assets outside of Russia as part of its marketing strategy, instead of investing in the development of domestic natural gas resources.

In late 2006, the Russian government proposed a gradual increase in natural gas prices to market-based levels and in May 2008, the government approved tariff increases of up to 28.6% in 2008, followed by 19.9% in 2009, 28% in 2010, and 40% in 2011. Fearing the inflationary consequences, the government has stopped short of the original goal of complete liberalization by 2011, at least for the industrial sector.

Even with domestic natural gas price increases, Russian natural gas production may not be sufficient to satisfy demand in the short-term. In addition, a commitment to raise future prices may perversely discourage production in the near term. To the extent that Gazprom can sell less natural gas domestically at current low prices (for example,

through quantity rationing or by ceding market share), it will have more gas to sell at future higher prices.

Russian natural gas production in 2006 was 2.4 percent above 2005 output, but Gazprom's share declined from 85.9% to 83.9%. Other Russian firms Novatek, Lukoil, and Rosneft collectively had total production capacity of about 6.4 tcf per year in 2006, or about one-third of Gazprom's output. The production share of independent producers is expected to increase in coming years as the Ministry of Industry and Energy has stated that Russian independent producers are expected to supply more than half of the country's industrial needs by 2015 (Blagov, 2007). However, growth of output from these independents may require investments in pipeline capacity, and, perhaps more importantly, full access to Gazprom's existing pipeline infrastructure, an option that presents political difficulty.¹

Over half of Gazprom's production comes from mature fields in West Siberia that are declining at an average rate of 0.7 tcf per year according to a recent International Energy Agency report (IEA, 2006). Gazprom therefore needs to develop new fields. According to Glazov (2007), total domestic production must increase substantially by 2030 to meet projected domestic demand and contracted exports. This will have to come from a combination of Gazprom's own production, the production of independents, and imports from Caspian states.

In 2005, Gazprom entered a joint venture to construct the offshore pipeline Nordstream to transport natural gas through the Baltic Sea from Russia to Germany.²

¹ Access is vital to expanded use of associated gas, rather than simply flaring it, and both former President Vladimir Putin and current President Dmitry Medvedev have publicly demanded that Gazprom facilitate third party access.

² Gazprom's partners in the project are BASF/Wintershall, E.ON Ruhrgas and N.V. Nederlandse Gasunie.

Natural gas supply is projected to come from the Yuzhno-Russkoye oil and natural gas reserves in the Yamal Peninsula, and the Ob-Taz bay and Shtokmanovskoye fields.³ In 2007, Gazprom also announced plans to develop two other fields in the Yamal peninsula to supply existing pipelines through Ukraine and Belarus and financed partly by projected revenues from the price increases to those countries. Finally, Gazprom has also announced plans to upgrade production and transmission systems in Eastern Siberia with a goal of exporting to China (Gazprom, 2008). Despite these announcements, the projects have not progressed much beyond the planning stage and, therefore, the future of Russian natural gas exports remains uncertain.

In this paper, we use the Rice World Gas Trade Model (RWGTM) to compare the behavior of the world natural gas market in a Reference Case with corresponding outcomes under three scenarios for disruptions to Russian production and exports:

- Scenario 1: Yamal peninsula and Kara Sea resources remain undeveloped
- Scenario 2: Russian exports are severely, but only temporarily, reduced in 2010, perhaps for political reasons
- Scenario 3: Asian pipeline infrastructure from Russia remains undeveloped

II. THE RICE WORLD GAS TRADE MODEL

To analyze and compare the scenarios, we use the Rice World Gas Trade Model (hereafter referred to as RWGTM), a dynamic spatial general equilibrium model of the world market for natural gas developed by scholars at Rice University.⁴ The RWGTM proves and develops reserves, constructs transportation routes and calculates prices to equate demands and supplies while maximizing the present value of producer rents

³ See <http://www.nord-stream.com/en/> for more detail.

⁴ The RWGTM is described in detail in *Natural Gas and Geopolitics From 1970 to 2040*, edited by Amy Jaffe, David Victor and Mark Hayes, Cambridge University Press (2006).

within a competitive framework. By developing both pipeline transportation routes and LNG delivery infrastructure, the RWGTM provides a framework for examining the effects of critical economic and political influences on the global natural gas market within a framework grounded in geologic data and economic theory.

The resource data underlying the model is based on the World Resource Assessment of the USGS as well as data for existing reserves from the *Oil and Gas Journal* database. Long- and short-run capital and operating cost curves for resource development were derived using data from the National Petroleum Council (NPC). Demand for natural gas is determined endogenously as the equilibrium price of natural gas adjusts, although there are also exogenous influences such as the level of economic development, the price of competing fuels, and population growth. The data used in estimating the demand relationship were obtained from the EIA, the IEA, the World Bank, and the Organization of Economic Cooperation and Development (OECD). The costs of constructing new pipelines and LNG facilities were estimated using data on previous and potential projects available from the EIA, IEA and various industry reports. The extent of regional detail in the model varies based primarily on data availability and the potential influence of particular countries on the global natural gas market. For example, large consuming and producing countries, such as China, the United States, India, Russia, and Japan, to name a few, have extensive sub-regional detail in order to understand the effect that existing or developing intra-country capacity constraints could have on current or likely future patterns of natural gas trade. In sum, there exist over 280 demand regions and more than 180 supply regions. Output from the model includes regional natural gas prices, pipeline and LNG capacity additions and flows, growth in

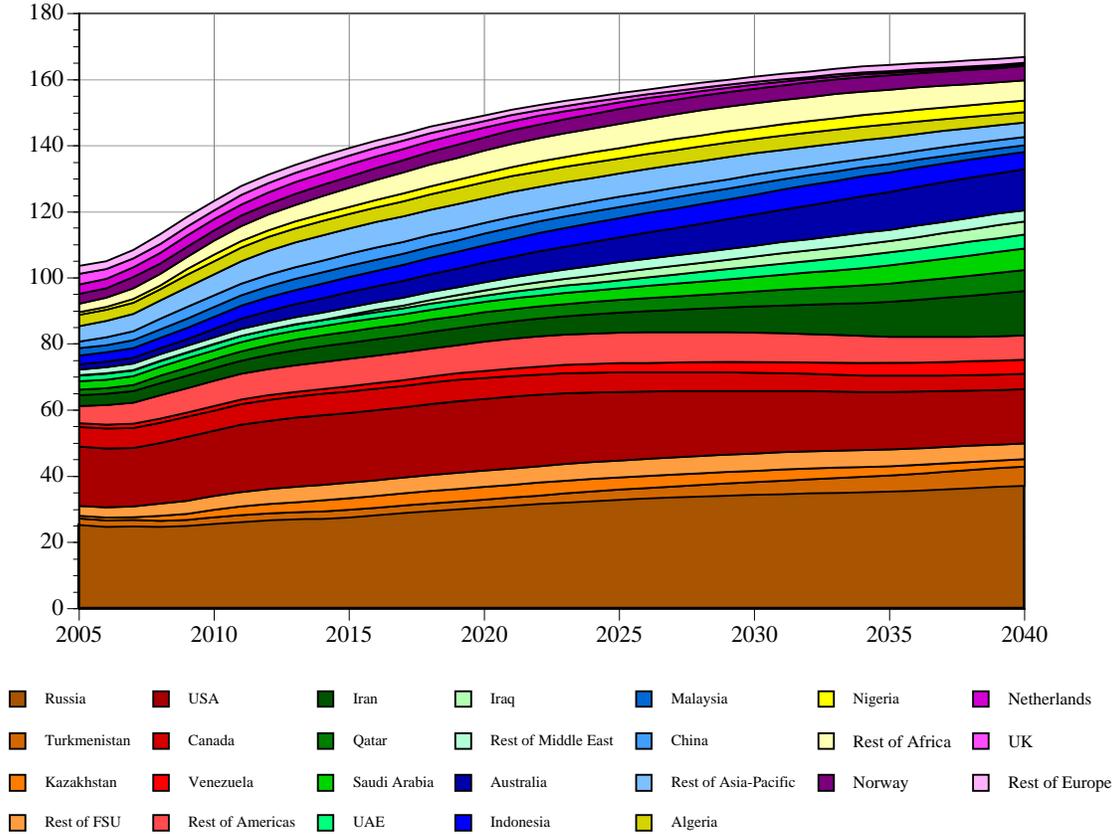
natural gas reserves from existing fields and undiscovered deposits, and regional production and demand.

III. REFERENCE CASE

We begin this section on the results of the Reference Case with a brief discussion of the results for the global gas market and follow with a more detailed description of the results for Russia, Europe and Asia. We call these set of results the Reference Case because it is the case to which all other cases will be compared. We consider the Reference Case as the one case in which economic, rather than political, considerations are the principle force in governing investment and operations in the global gas market. Each of the scenarios, therefore, when referred to the Reference Case, provides a clear picture of the costs associated with particular political constraints or other shocks.

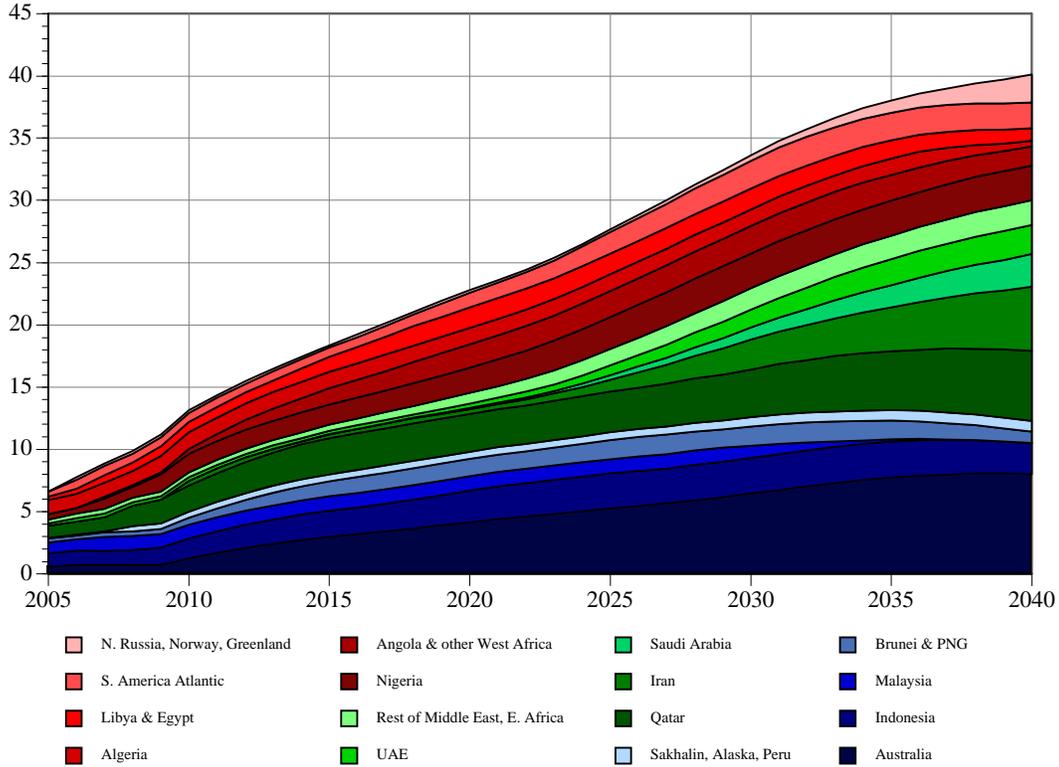
Figure 1 presents the Reference Case supply projections. It should be noted that the figures generally present the data in regional aggregates in order to clearly discern trends.

Figure 1. Reference Case Supply



The Reference Case indicates that Russia will be the single largest producer of natural gas throughout the model time horizon. Notably, most of the growth in Russia occurs to support eastward exports, as supplies are developed to serve markets in Northeast Asia. In the Reference Case, Eastern Siberian natural gas begins flowing into Northern China at the beginning of the next decade and eventually flows into the Korean peninsula. Despite the lack of significant expansion to the west, Russia remains the largest single supplier of natural gas to the European market, primarily by pipeline.

Figure 2. Reference Case LNG Exports



Russia ultimately provides natural gas supplies by both pipeline and LNG into both the Pacific and Atlantic basins. Figure 2 summarizes LNG exports in the Reference Case. In the Pacific basin, production in the Sakhalin region is exported as LNG and also by pipeline to Japan. In addition, Sakhalin production, as well as Eastern Siberian production, provides supply by pipeline to Northeast China and the Korean Peninsula. In the Atlantic Basin, production in the Barents Sea eventually provides natural gas exports in the form of LNG beginning in the mid-2030s, but the majority of the gas produced in the region is exported via the Northern European pipeline to Germany. The fact that Russia ultimately provides supply to both basins means that it will play a key role in

global price arbitrage since the “netback” price from sending supplies in any direction has to be the same.

Figure 1 also indicates that the Middle East emerges to a position of prominence over time. The largest exporters in the region are Qatar, the United Arab Emirates (UAE), Iran, and eventually Iraq. As Figure 2 suggests, all Qatari and UAE exports occur as LNG, with Qatar being the largest exporter in the region through 2030. By contrast, Iraq begins to export natural gas north to Europe by pipeline through Turkey after 2015. Iranian natural gas is also exported by pipeline, with growth in overall exports largely coming via the development of a pipeline to Pakistan and India beginning in 2025, and as LNG much earlier in the time horizon. In addition, existing export infrastructure from Iran is expanded to move natural gas to Europe through Turkey and Armenia.

Overall growth in LNG supply is strongest from Australia and the countries of the Middle East. Qatar is an early leader in supplying LNG from the Middle East because other resource-rich players lack existing infrastructure and need to bear substantial fixed costs to enter the LNG market. Thus, Qatar benefits from the principle of “first mover advantage” as demand must grow sufficiently to encourage expansion both within and by other regional suppliers. Otherwise, additional early entry would drive down prices and lead to inadequate returns on investment. Therefore, entry by countries other than Qatar must be delayed until world demand in excess of alternative sources of supply is large enough to accommodate these incremental supplies.

The share of total world gas production coming from the Middle East is projected to rise from current levels of about 10 percent to just over 14 percent by 2025, and account for about 25 percent of all LNG shipments globally. Roughly half of Middle East

LNG production is projected to flow into the Atlantic Basin, with the United States likely to receive about 20 to 25 percent of its LNG supplies from the Middle East.

Figure 3. Reference Case Demand

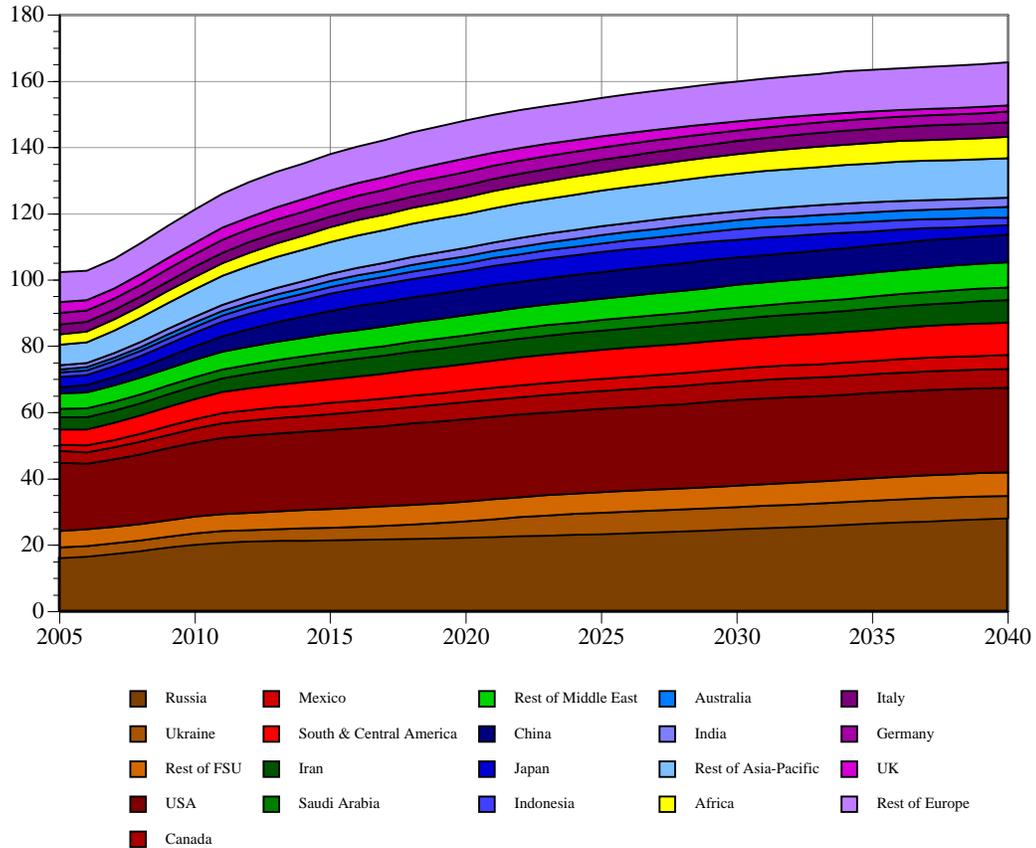
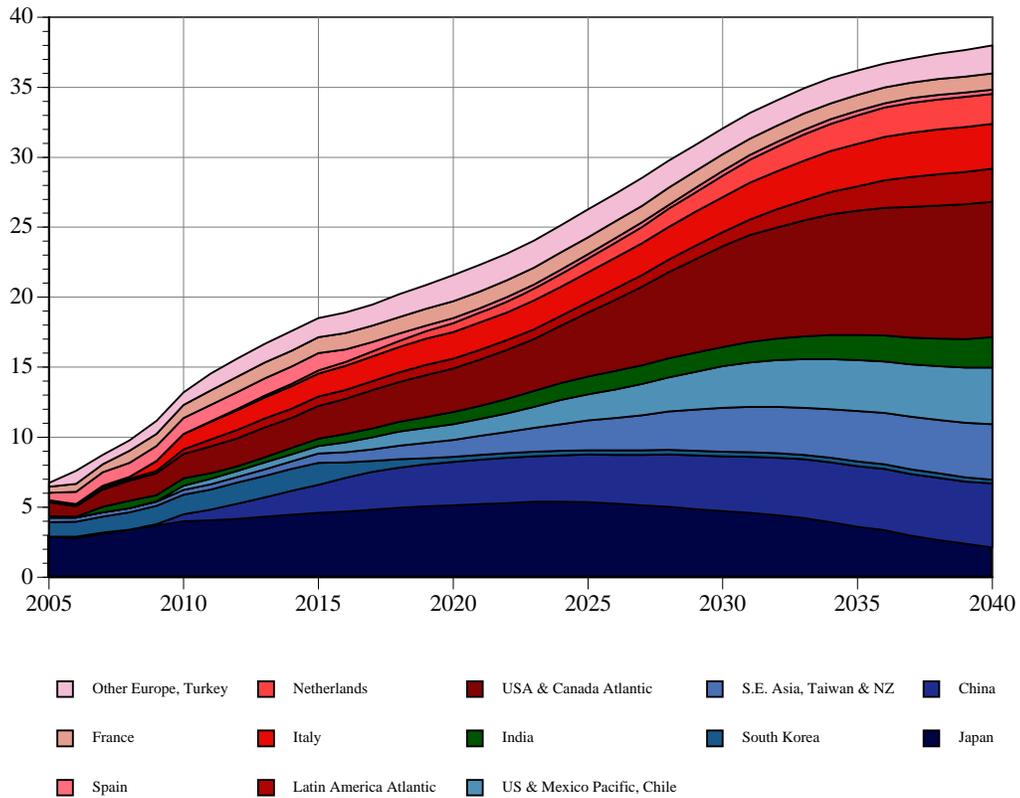


Figure 3 provides the demand projections for the Reference Case. The largest consuming regions are the traditional natural gas markets of North America, Europe and the FSU. The fastest growing regions, however, are Asia and Asia-Pacific, where demand growth tops 3.5 percent per year through 2030. Demand growth in the very populous markets of China and India, in particular, shifts the flow of global supplies toward Asia over time.

Figure 4 summarizes global LNG imports. As demand growth in North America, Europe and Asia outstrips domestic sources of supply, LNG imports into these regions grow substantially, and make up the majority of all LNG regasification.

Figure 4. Reference Case LNG Imports



LNG plays a critical role in balancing the North American market in particular, as it is not connected by land, and hence pipeline, to major sources of supply in Russia and Middle East. A substantial amount of LNG is imported into Mexico and Canada over the modeling time horizon. In fact, Mexican imports into the Baja peninsula and the Gulf of California, and Canadian imports into New Brunswick, ultimately are redirected to serve rising demand in the United States.

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In Europe, strong demand growth, coupled with dwindling domestic supply, renders imports from multiple sources inevitable. Europe imports via pipeline from Africa, the Middle East, and Russia and via LNG from multiple sources in North and West Africa, the Middle East, South America, and eventually, the Russian Arctic. High demand growth in India and China also affect world LNG trade. In particular, the model suggests that Chinese LNG imports will grow by roughly 19 percent a year through 2030.

Figure 5. Reference Case Gas Trades

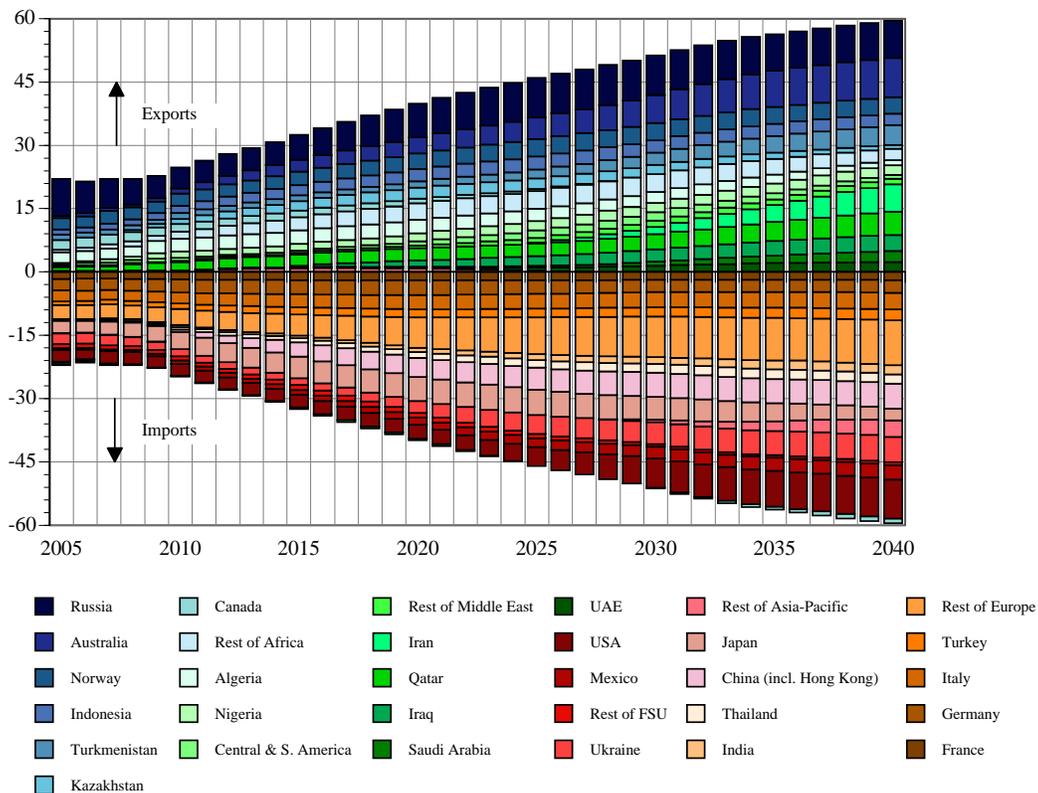


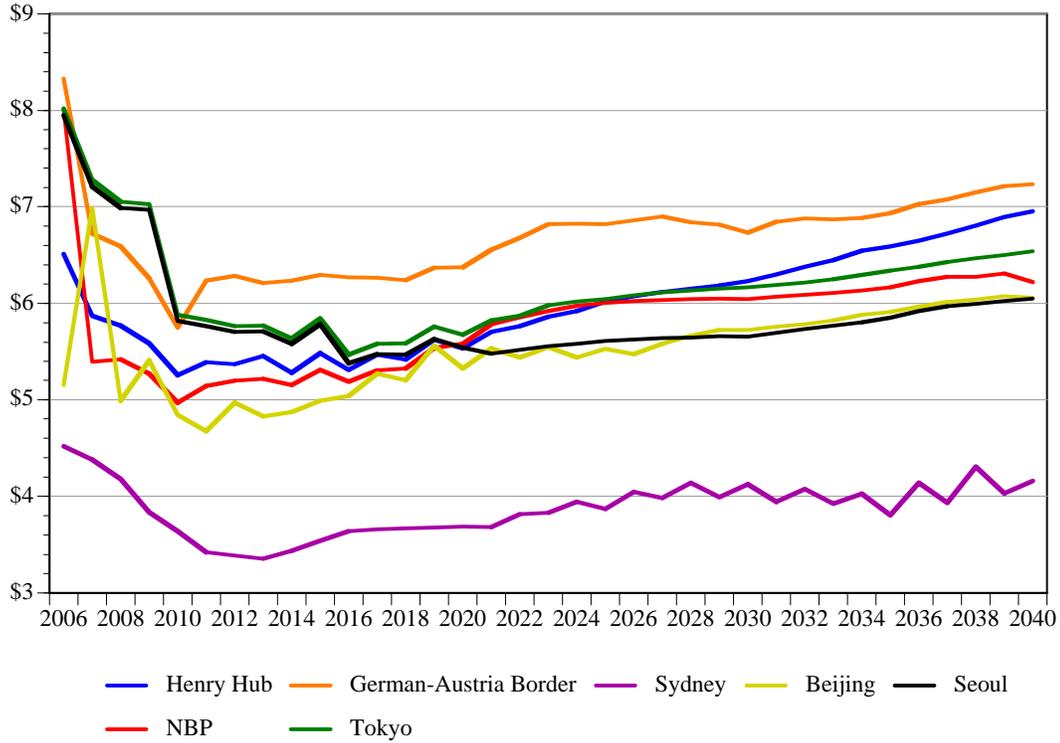
Figure 5 summarizes overall trade in natural gas in the Reference Case, whether by pipeline or LNG. A prominent feature is the rapid growth in exports by the Middle East and imports by the United States, Western Europe and Northeast Asia. The proportionate increase in overall exports from the Middle East is, however, less than their

increasing share of LNG exports alone. This is not too surprising, because the Middle East is less well-suited than Russia or the FSU republics of Turkmenistan and Kazakhstan for supplying exports via pipeline. In fact, while geography limits to some extent the pipeline potential of Middle East supplies, it also allows Middle East natural gas to have better access to the sea, and hence favors LNG.

Figure 6 presents just a few of the price paths produced in the model from the many that are generated for all major demand and supply locations around the world. The prices at Henry Hub in the United States and the National Balancing Point (NBP) in the United Kingdom are of interest because these are liquid points that have developed as salient locations for contract and derivatives trading. Prices at the German-Austrian border are of interest because they are the highest prices in Europe and essentially represent the balance point between natural gas flowing in from the west (the North Sea and LNG), the south (North Africa) and the east (Russia and other former Soviet Republics). The three prices in Northeast Asia (Tokyo, Seoul and Beijing) are relevant to this paper as they reflect the other major market served by Russia. The Sydney price has been included to show how low prices can be in an exporting country with high transport costs (including, in this case, transport prices between the consumption center and the export location).

The price at Henry Hub starts out below the prices in Seoul, Tokyo and Western Europe. This changes after 2020, however, as the United States becomes a major importer of LNG, and Northeast Asian markets are increasingly served by pipeline from the Russian Far East. By the end of the period, the Henry Hub price is second only to the price on the German-Austrian border.

Figure 6. Reference Case Selected Prices



An interesting break that occurs around 2020 involves the three prices in Northeast Asia. Prior to 2020, prices in Tokyo and Seoul are closely related. This is a result of Japan and South Korea relying on LNG from the same sources through 2020. After 2020, however, Seoul prices begin to track Beijing prices more closely while Tokyo prices are closer to prices at the NBP. The reason for these changes is that both China and South Korea rely on pipeline gas from Russia, while prices in Tokyo and the NBP in the United Kingdom are linked because both countries draw their marginal supplies as LNG from Middle East.

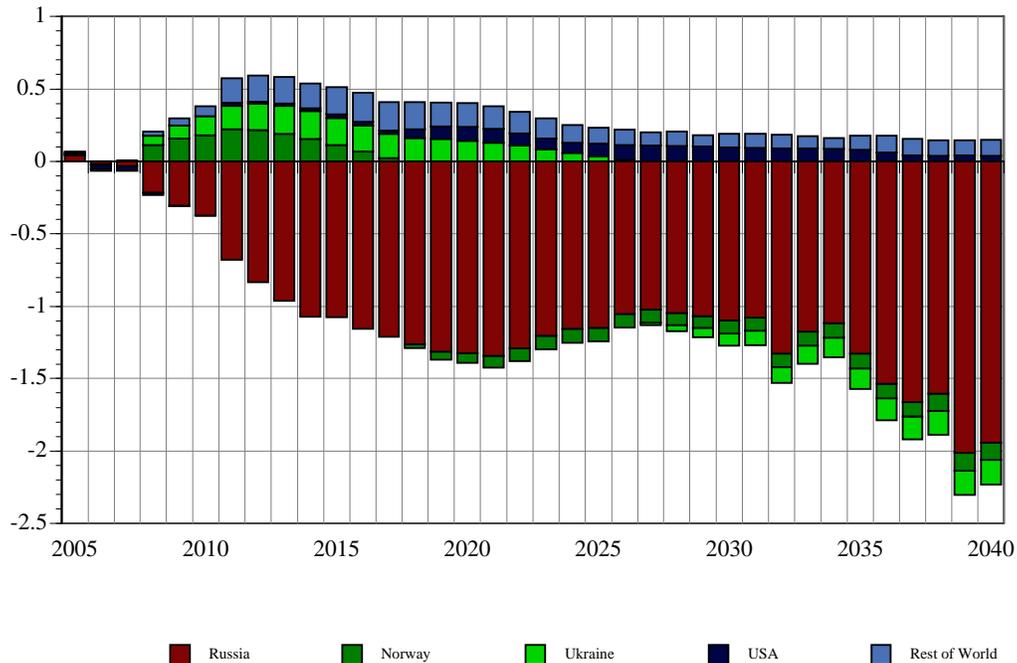
IV. SCENARIO ANALYSIS

Scenario 1: Yamal Peninsula and Kara Sea resources remain undeveloped

In this scenario, we prohibit the development of natural gas resources in the Yamal Peninsula and Kara Sea. Thus, 440 tcf (12.5 tcm) of the estimated 978 tcf (27.5 tcm) of technically recoverable natural gas in place is removed from potential development relative to the Reference Case.

Figure 7 graphs the changes in supply as a result of the withdrawal of these Russian resources from the market. Not surprisingly, the net result is a decline in overall Russian production, which becomes more pronounced after 2015 and reaches more than 2 tcf per year by the late 2030s.

Figure 7. Supply Changes under Scenario S1 Relative to the Reference Case



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The reduction in Russian supply stimulates three major supply responses. First, both Ukraine and Norway shift domestic production from the future to the present, as lower near-term Russian production opens the door to increasing European market share. Norway increases production from 2010–2017, but ultimately sees declining production beyond 2018 as resource development costs begin to rise due to depletion constraints. In Ukraine, the stimulus to domestic production lasts longer (until 2025), but the reduction in production in later years is also slightly more pronounced. Thus, in the cases of Norway and Ukraine, the supply changes are intertemporal, with production increases in early years being countered with production decreases in later years.

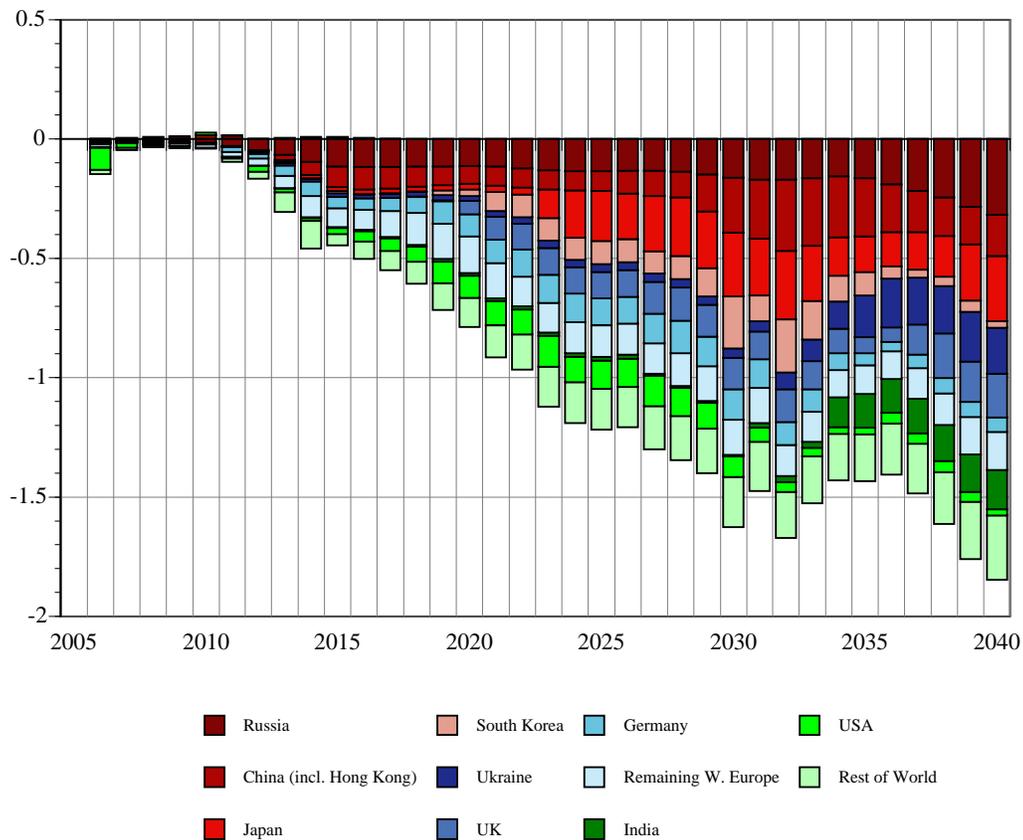
The United States is the other major country to increase production. In contrast to Norway and Ukraine, however, U.S. production rises throughout the period to 2040. There is also an increase in aggregate supply from the rest of the world through 2040, but these supply changes are generally very small in any single country (so much so that they do not show up clearly in the graphic). These increases are the result of higher prices that result as Europe must rely more on LNG in the absence of Yamal development.

The demand changes in Figure 8 are spread fairly evenly across the globe. This is not too surprising, since while demand is elastic everywhere, marginal supply elasticities will vary considerably from one country to the next. The fact that demand goes down everywhere, however, also reflects linkage between markets that LNG and some long distance pipelines provide, allowing price changes in one region to transmit to all regions.

One very interesting feature of Figure 8 is that while Japan and China do not directly import natural gas from the Yamal Peninsula and Kara Sea, they show among the largest declines in demand, especially beyond 2025. Looking more closely at the detailed

flows (not pictured), we discover that the eventual flow of natural gas from East Siberia to West Siberia, and from Sakhalin to Nahodka, are both much stronger when the Yamal Peninsula and Kara Sea resources remain undeveloped. This occurs as some East Siberian resources are developed and transported west to utilize the emptying pipeline infrastructure to Europe from West Siberia. The net result is an increase in price in Northeast Asia relative to the Reference Case.

Figure 8. Demand Changes under Scenario S1 Relative to the Reference Case

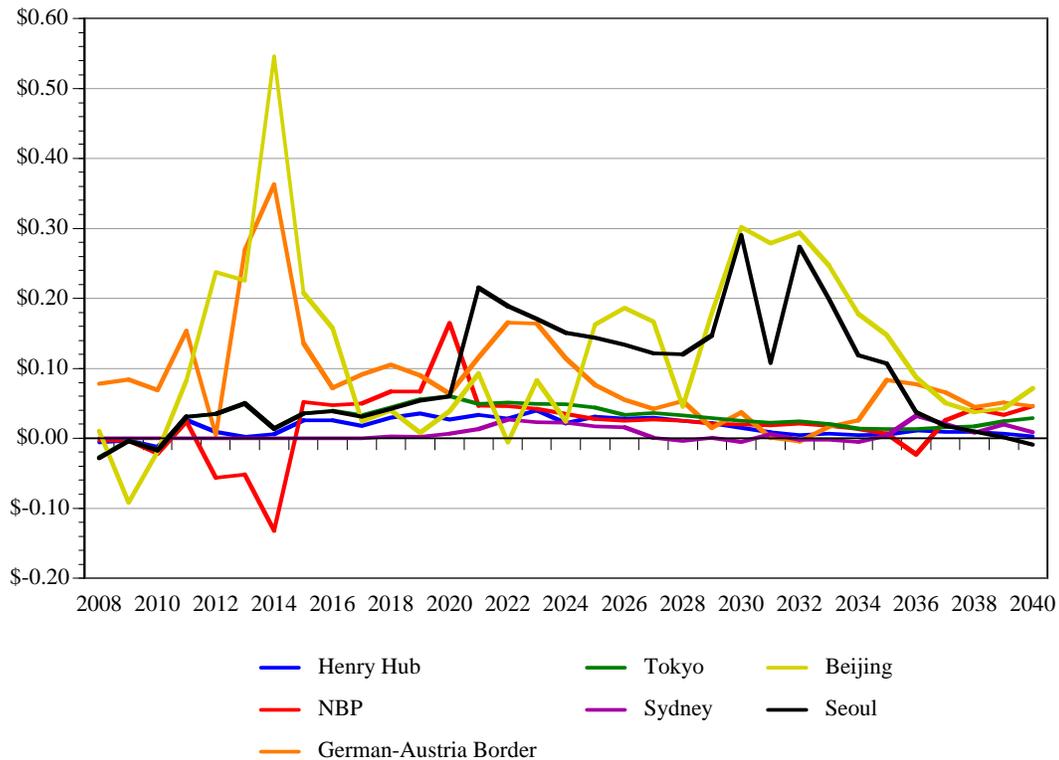


This can be seen clearly in Figure 9, which shows the change in prices in selected locations as a result of the restrictions on Yamal Peninsula and Kara Sea development. The largest price changes are in Seoul and Beijing as prices there now more closely track

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Tokyo prices than in the Reference Case. The movement of East Siberian natural gas west results in greater LNG import demand in Northeast Asia, which keeps the prices in that region more closely linked. In effect, the advantage of access to relatively low cost pipeline gas from Russia disappears when Russia does not develop sufficient resources in the west to serve the West European market.

Figure 9. Selected Price Differences in Scenario S1 Relative to the Reference Case



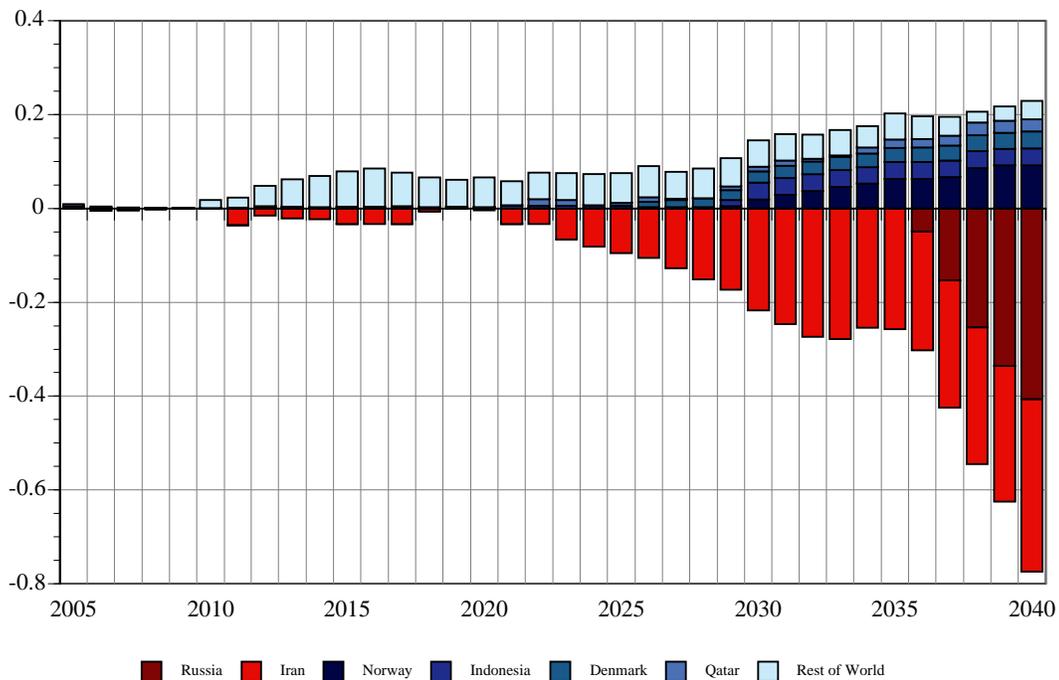
Throughout the period from 2015 to 2040, the restrictions on Yamal Peninsula and Kara Sea development also impact prices and demand in Europe, especially Germany and Ukraine. The marginal source of natural gas is more expensive absent the Yamal and Kara Sea developments, as it must come from East Siberia or as LNG.

The effects on LNG production of not developing the resources in the Yamal Peninsula and Kara Sea are interesting (see Figure 10). Not surprisingly, there is a loss of

Russian LNG exports from the Barents Sea toward the end of the model time horizon, as those resources are diverted to pipeline infrastructure. However, LNG exports from Iran decline. This occurs because reduced Russian supply encourages more imports of gas to Eastern Europe from the Middle East via pipeline. With a larger pipeline export market to Eastern Europe via Turkey, Iran sees an increase in pipeline exports at the expense of exports of LNG.

Norway and Denmark (Greenland) also experience an increased demand for exports, which follows since they are close competitors for Russian LNG exports from the Arctic. Finally, Indonesia and Qatar dominate as marginal suppliers of increased LNG imports into Northeast Asia (see Figure 11), which arises to offset the reduced supply of pipeline gas to that region from Russia, as discussed above.

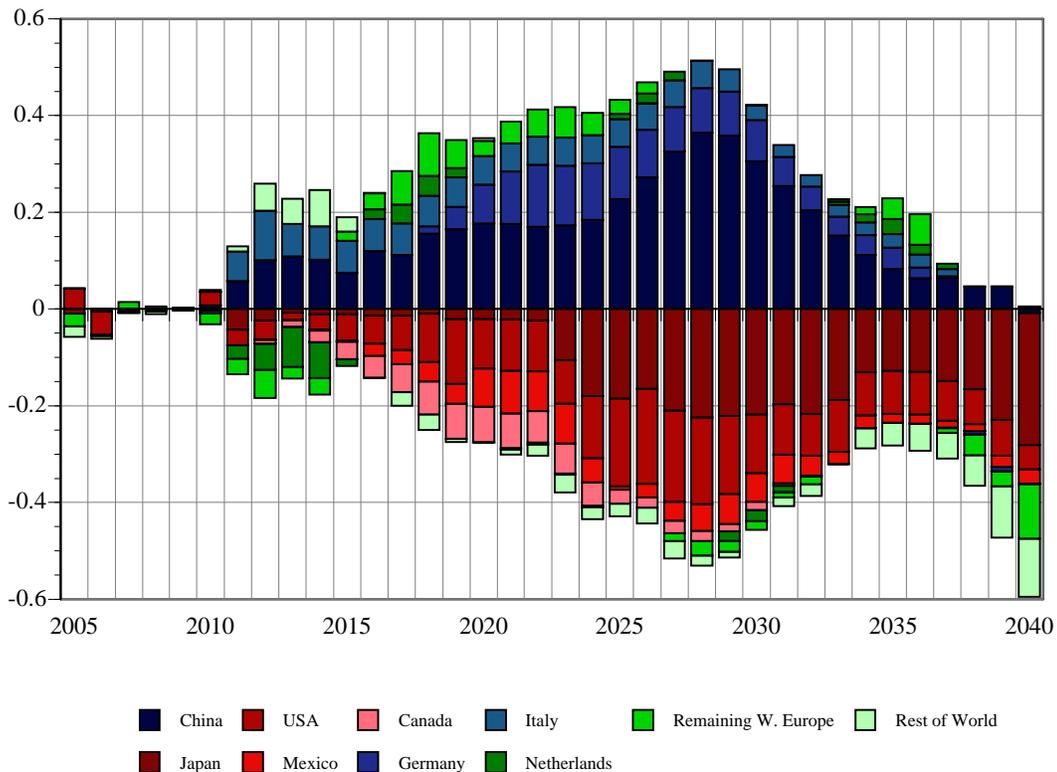
Figure 10. Changes in LNG Exports in Scenario S1 Relative to the Reference Case



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The reduction in pipeline flows from Russia into Europe that results when Yamal and Kara Sea resources are not developed is offset, to some extent, by an increase in LNG imports into Europe. Figure 11 indicates that LNG imports into Germany, Italy, the Netherlands, and the Remaining Western Europe rise collectively by as much as 0.26 tcf (7.4 bcm) per year, or 700 million cubic feet per day (mmcf/d) (19.8 mmcm/d). This is the equivalent of adding an average-size LNG import terminal to Europe. As mentioned above, China's imports of LNG rise substantially, largely due to displacement of supplies from the Russian Far East. The added competition for LNG supplies tends to raise price everywhere, which results in slightly higher domestic production and slightly lower demand in North America, meaning North American LNG imports are lower.

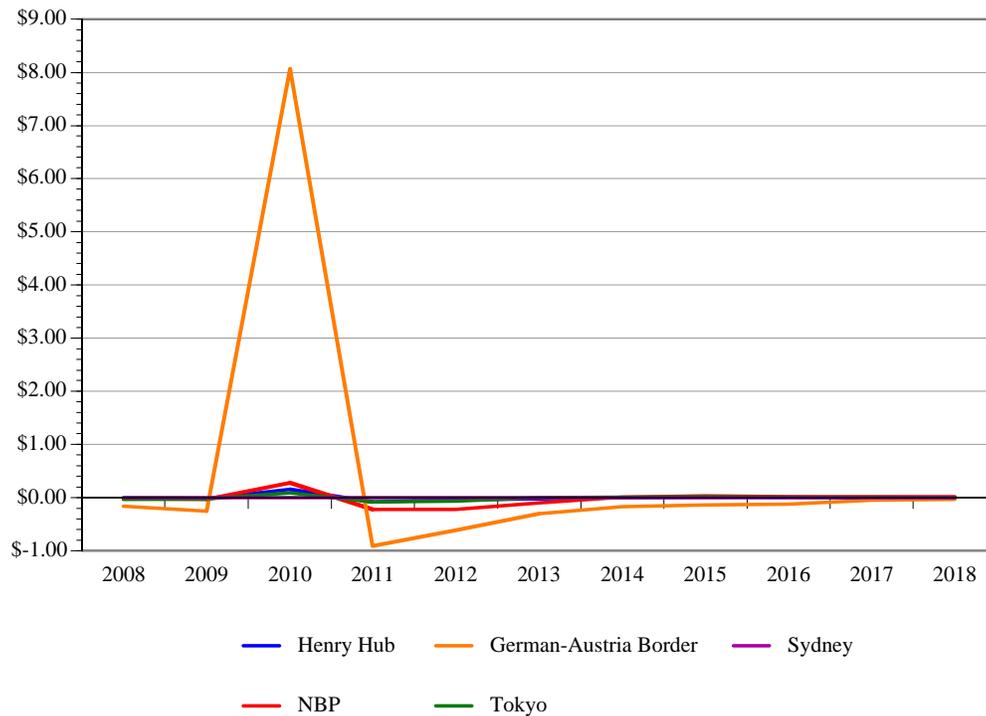
Figure 11. Changes in LNG Imports in Scenario S1 Relative to the Reference Case



Scenario 2: Russian exports are severely reduced in 2010

In this case, we consider an abrupt but temporary suspension of Russian natural gas exports to Europe in 2010. Specifically, the export of Russian natural gas is reduced to roughly half of the Reference Case in 2010. This amounts to the equivalent of a six-month cut-off of Russian supplies to Europe. The case highlights the dramatic impact that such a disruption can have on the European market as price spikes to \$15/mcf (see Figure 12 and Figure 6), which is about triple that in the Reference Case. Scenario 2 also brings to light, however, the substantial risk to Russia of exercising such a strategy. Specifically, Europe responds to such a short-term disruption by both reducing demand and increasing imports from elsewhere. This ultimately results in Russian exports to Europe being lower than in the Reference Case through 2020, so that Russia effectively sacrifices future market for a decade for potential short-term economic and political gain.

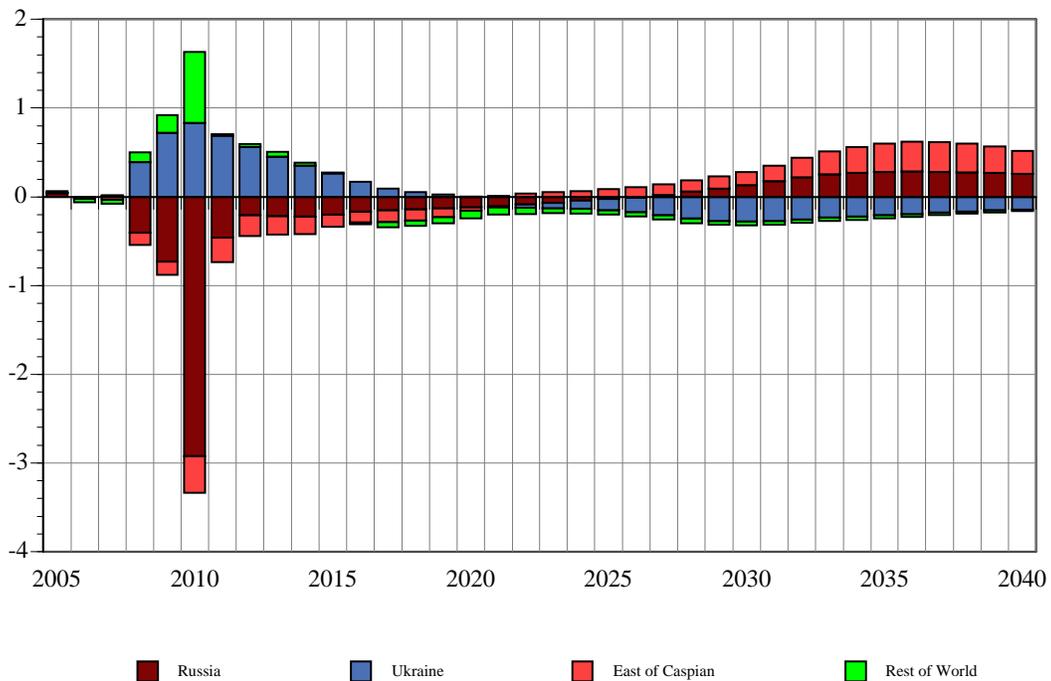
Figure 12. Selected Price Differences in Scenario S2 Relative to the Reference Case



Russian Natural Gas Exports

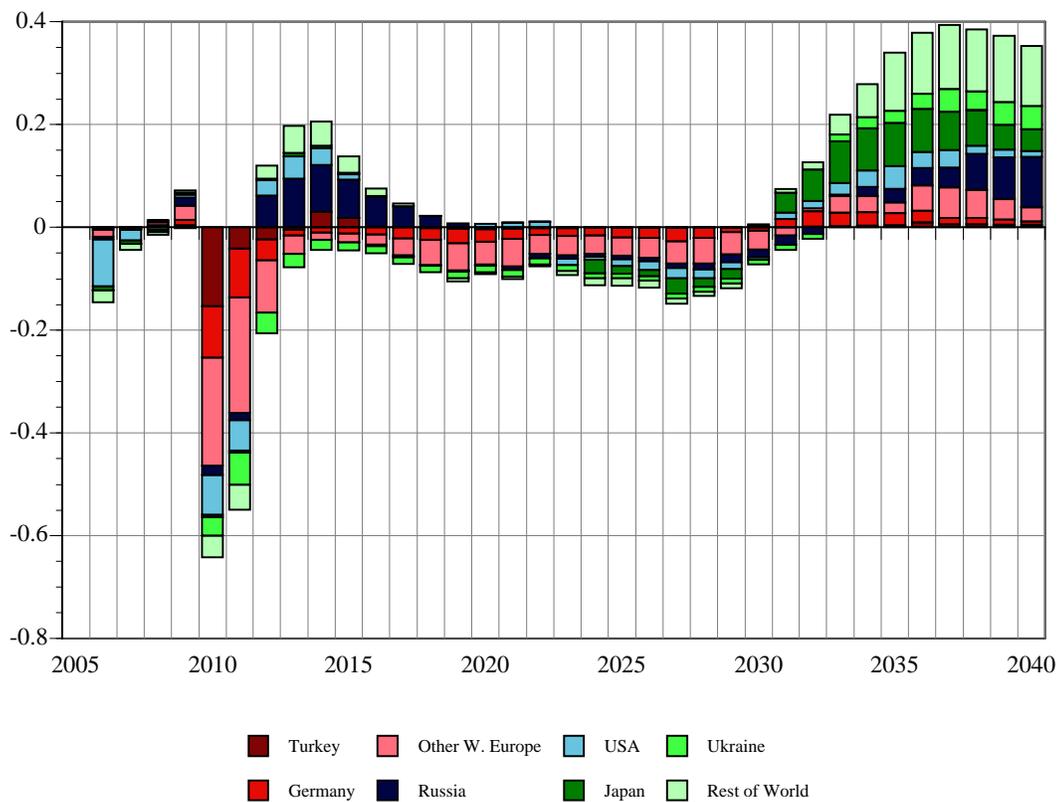
Figure 13 indicates the changes in supply relative to the Reference Case. Not surprisingly, the largest changes occur in 2010, which is the year of the shock. While Russian supply is significantly lower, so is supply collectively from the group of countries “East of the Caspian” (Kazakhstan, Turkmenistan and Uzbekistan). Supply from these countries is curtailed because their production is captive to Gazprom’s infrastructure. Thus, any action Russia takes to exert market power over its European customers in 2010 will also affect those producers from which it purchases natural gas. An obvious counterweight here would be the availability of alternative export infrastructure. If pipeline routes across the Caspian, south through Iran, or east to China were expanded or developed, then the impacts on the “East of Caspian” countries would be smaller. However, in 2010, no such infrastructure will have been developed.

Figure 13. Supply Changes under Scenario S2 Relative to the Reference Case



Supply from Ukraine and the Rest of the World increase in response to the shock, but not enough to completely offset the lost exports. This is indicative of the fact that demand response is also an important factor of managing the cut-off (see Figure 14). Also of note is the fact that supplies are different in the years preceding the shock. This is the result of producers making dynamic investment decisions. Basically, producers anticipate such a shock and begin to develop supplies accordingly. However, given the lead times for development, they do not have enough time to fully adjust supplies to counter the Russian cut-off.⁵

Figure 14. Demand Changes under Scenario S2 Relative to the Reference Case



⁵ This brings up an important point regarding this scenario. If there is the perception of risk that supplies will be cut off, investments in alternative supplies will be made to account for that risk. However, if little time is present between the perception of the risk and an actual cut-off of supply, it is unlikely that the investments will be able to fully counteract the cut-off in supply.

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As already noted, the effect of the shock is not limited to the year in which it occurs. In fact, the sum of lost production from 2010 through 2020 is almost as great as the cut-off itself. Beyond 2020, however, Russian supplies grow in excess of the Reference Case as they must replace the declining production from other suppliers.

The high prices that result from the sudden cut-off of supplies have longer-term impacts. Specifically, since demand is path-dependent, if any force acts to significantly alter demand, it will remain different for some time as long as nothing acts to push it back. In this case, the supply shock encourages a response that lowers demand relative to Reference Case for a substantial number of years. Figure 14 indicates that the response is greatest in Turkey, Germany, Other Western Europe and Ukraine, which is not surprising as these are the regions that are the most directly affected by the shut-off of Russian exports west (and via Bluestream in the case of Turkey). It is also interesting to note that demand in Russia declines slightly in 2010. The cut-off of exports precludes some developments in Russia that also would have benefited Russian consumers.

Figure 15, showing changes in LNG exports, also illustrates another margin of adjustment to a restriction of Russian exports. Iran produces less LNG in 2010 so that more of its supplies can be exported north through Turkey via pipeline. Beyond 2030, however, Iranian exports of LNG are higher than in the Reference Case. The explanation can be found by noting that Figure 13 shows a rebound in production in Russia and “East of Caspian” countries at that time. This occurs because the production that is lost prior to 2020 due to the curtailment of Russian exports in 2010 allows for an increase in production at a later date. In turn, the higher production from Russia and the “East of

Caspian” countries reduces the demand for Iranian pipeline exports beyond 2030, thus allowing Iran to export more of its supply as LNG.

Figure 15. Changes in LNG Exports in Scenario S2 Relative to the Reference Case

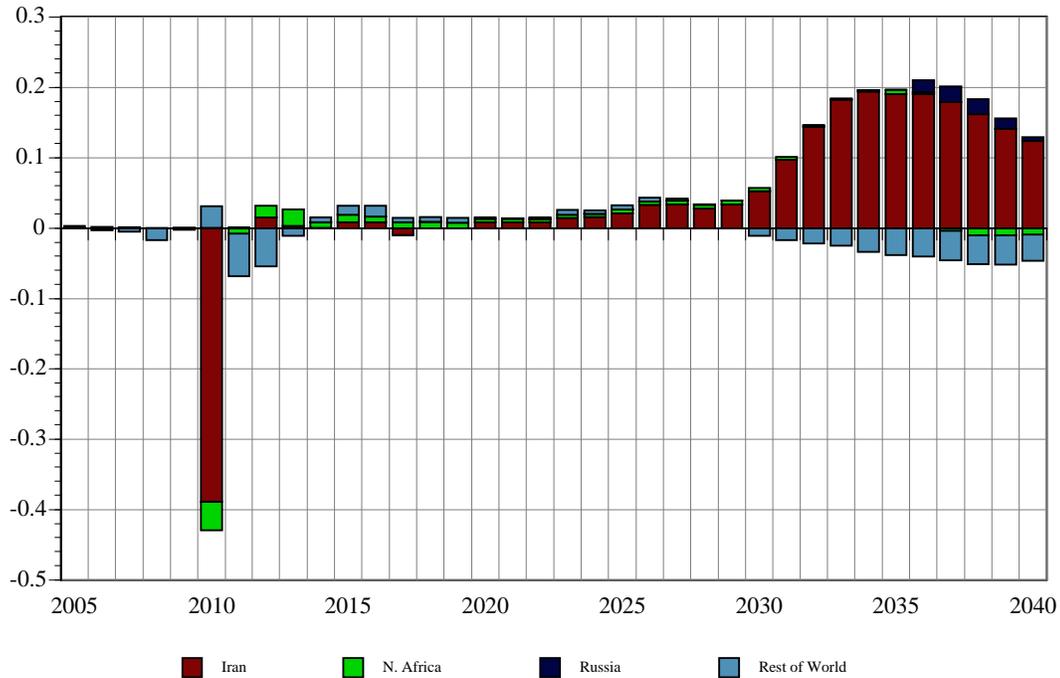


Figure 16 shows the change in LNG imports relative to the Reference Case that result from the cut-off in Russian exports. This shows that the ability to trade LNG can help diffuse the effects of the supply reduction throughout the world and thus lessen its impacts on Russia’s immediate neighbors. Specifically, Figure 16 shows that imports of LNG into the United States are curtailed in 2010 to allow more imports into Europe. European consumers effectively outbid U.S. consumers for LNG supplies in the wake of the Russian cut-off.

Figure 16 also reveals that the imports of LNG into Italy, Turkey, Belgium and the United Kingdom rebound to a higher level after 2013. Thus, Russia loses market

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share beyond 2010 as a result of its actions. Also, the year after the reduction in Russian exports, LNG imports into Western Europe and Turkey decline as Russian exports return. This also allows a rebound in imports to the United States. Comparing Figures 15 and 16, it also is clear that overall LNG supply and LNG demand do not respond similarly. This reflects that fact that using more LNG in Europe as opposed to the United States cuts down on fuel lost in shipping.

Figure 16. Changes in LNG Imports in Scenario S2 Relative to the Reference Case

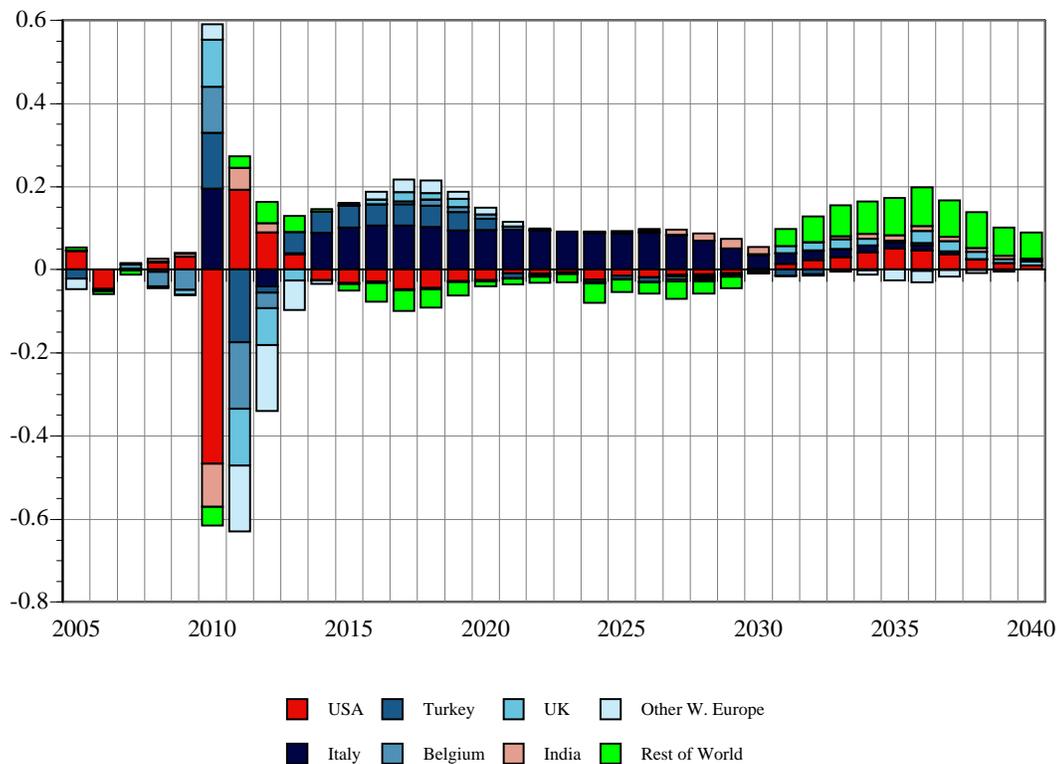
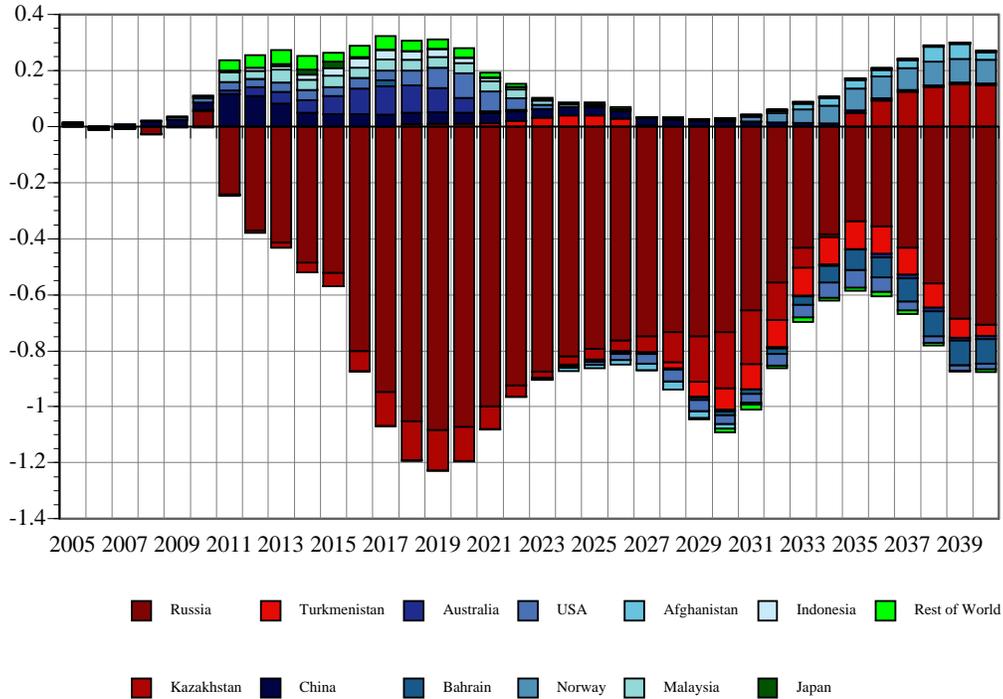


Figure 16 once again demonstrates that the temporary Russian curtailment of exports has long-term effects. In particular, imports of LNG into Western Europe and Turkey are higher from the middle of next decade through the end of the 2020s.

Scenario 3: Asian pipeline infrastructure from Russia remains undeveloped

In this scenario, we constrain the Reference Case by not allowing the development of pipeline infrastructure from Russia to Northeast Asia (China, Korea and Japan). Figure 17 presents the resulting changes in supply.

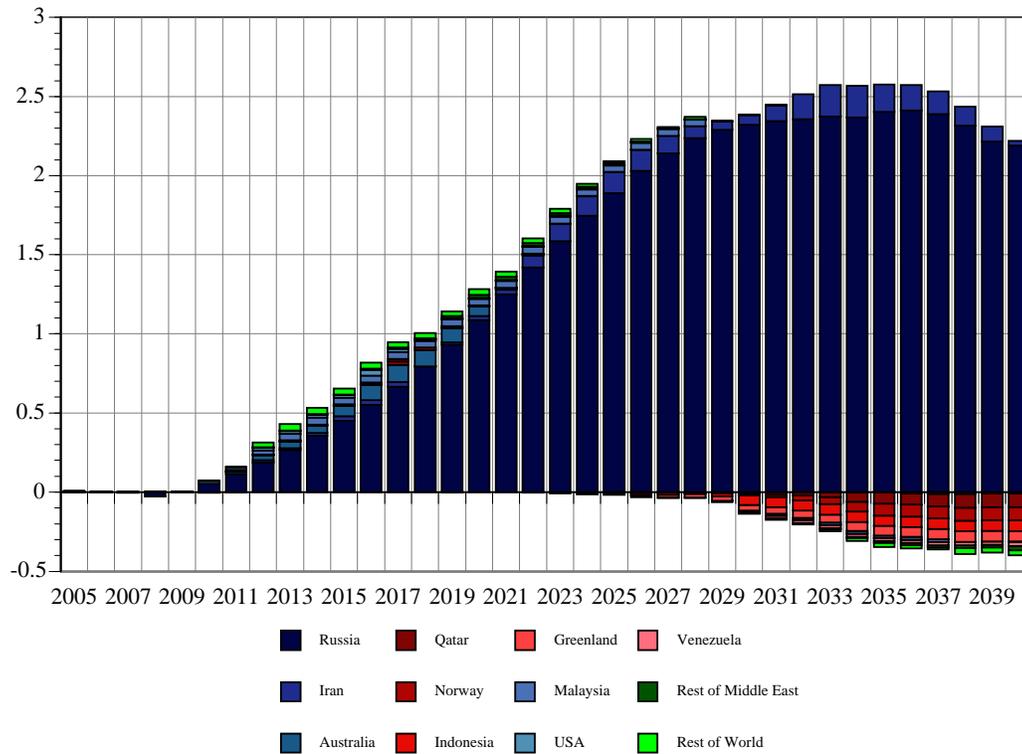
Figure 17. Changes in Supply under Scenario S3 Relative to the Reference Case



Russian supply is reduced in this case because the transport options are more limited, making it less desirable to develop sources of supply that now would have a much longer voyage to market. Kazakhstan and Turkmenistan are also negatively impacted, however, since the greater flow of Siberian supplies to the West pushes out some Central Asian supplies. The proposed pipelines from the Caspian region to China are not developed, despite the fact that they are allowed. Exports of natural gas via pipeline from Myanmar to China remain as in the Reference Case. Figure 17 also shows

that some of the major LNG exporters, such as Australia, Indonesia and Malaysia increase production in the short term to meet the increased demand for LNG imports in Northeast Asia.

Figure 18. Changes in LNG Exports in Scenario S3 Relative to the Reference Case

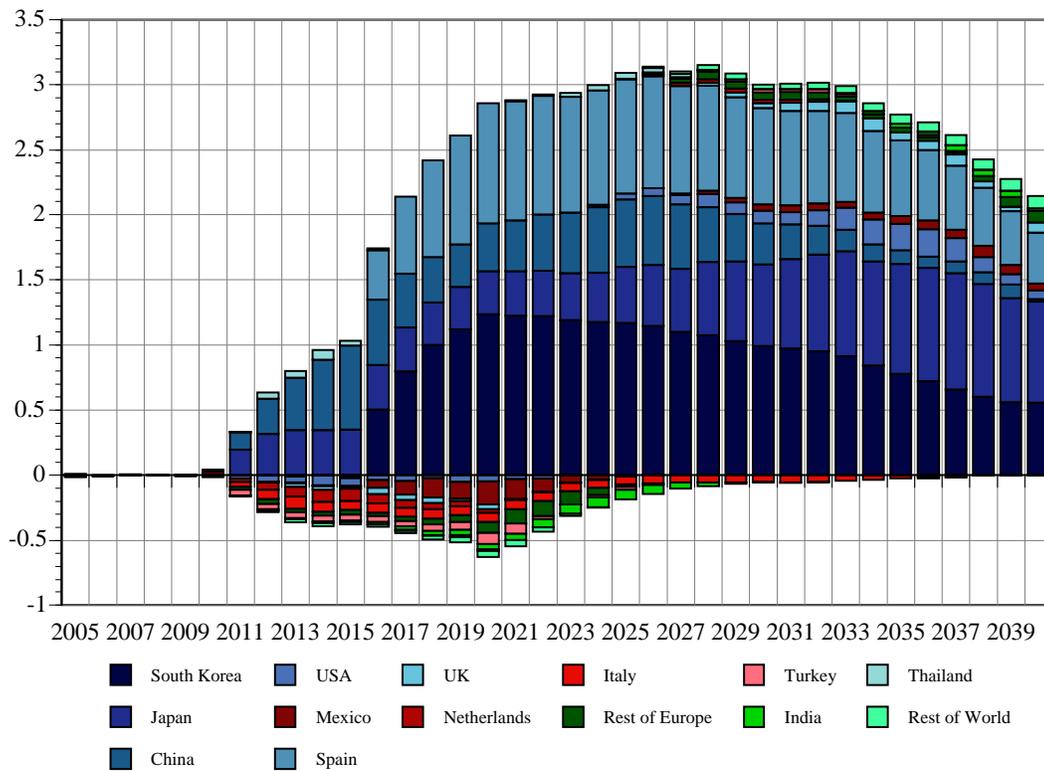


Nevertheless, Figure 18 shows that the major supplier of higher LNG volumes to Northeast Asia is Russia itself as Sakhalin supplies that were exported as pipeline gas in the Reference Case instead are exported as LNG. Substantially higher Russian exports of LNG in the long term (2030 and beyond) crowd out late-year developers of LNG in the Reference Case, such as Greenland and Venezuela, although Qatar, Norway and Indonesia also see modestly-reduced exports.

A virtual source of LNG for Northeast Asia would be a reduction in demand elsewhere in the world. Figure 19 graphs changes in LNG imports relative to the

Reference Case. However, world LNG imports expand in the aggregate, with South Korea, Japan and China taking the majority of the increase. The reductions in imports that do occur (from 2011–2030) are spread across many countries.

Figure 19. Changes in LNG Imports in Scenario S3 Relative to the Reference Case



The increase in Russian LNG exports from the Far East has another effect. It reduces the need to import LNG into Northeast Asia from the Middle East, allowing more Middle East LNG to flow west into Europe and the Atlantic Basin more generally. As a result, Figure 19 shows that Spain, in particular, also experiences increased LNG imports.

Figure 20. Changes in Demand under Scenario S3 Relative to the Reference Case

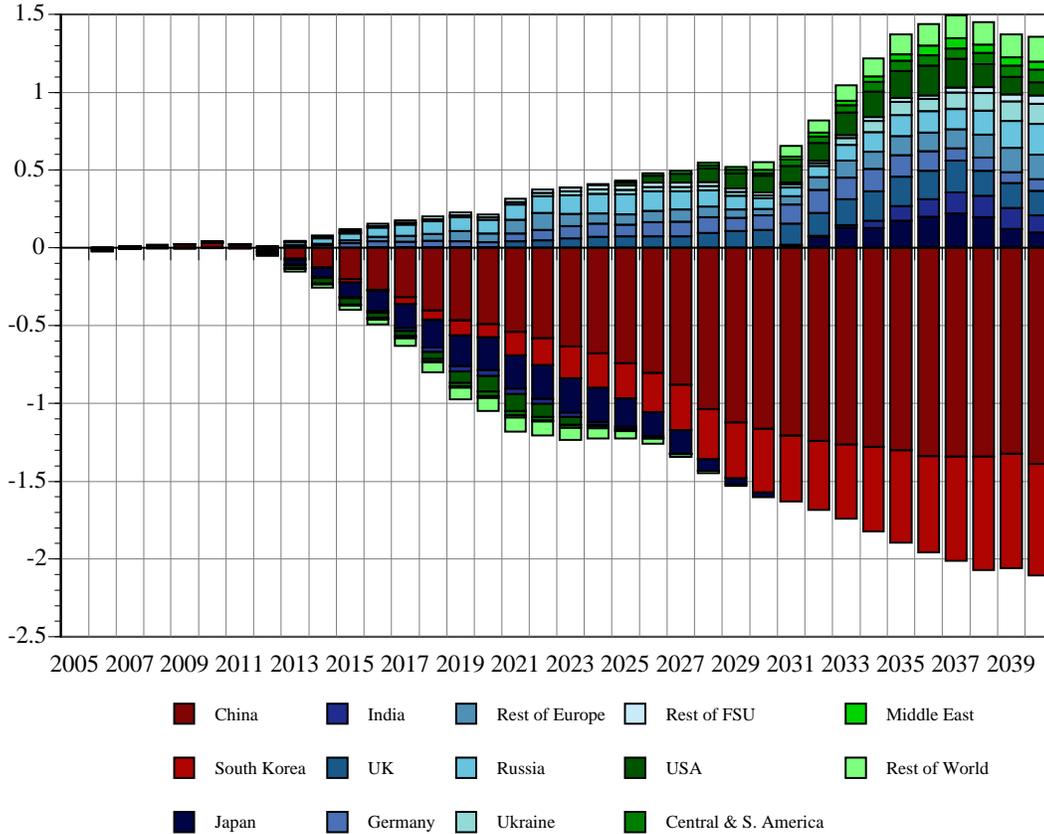


Figure 20 shows the effect on overall demand, not just the demand for LNG, of not developing pipeline infrastructure in Northeast Asia. The largest reductions in demand occur in China and South Korea as they can no longer benefit from the lower-priced Russian pipeline gas. Japan also suffers a smaller decline as the pipeline from Sakhalin is not developed. Countries that experience increased demand include Western Europe and countries of the FSU as more Siberian supply is shipped west instead of east. However, the United States also experiences a slight expansion of demand from the late 2020s as reduced demand for Atlantic Basin LNG from Europe lowers prices and allows U.S. imports to expand.

Figure 21. Selected Price Differences in Scenario S3 Relative to the Reference Case

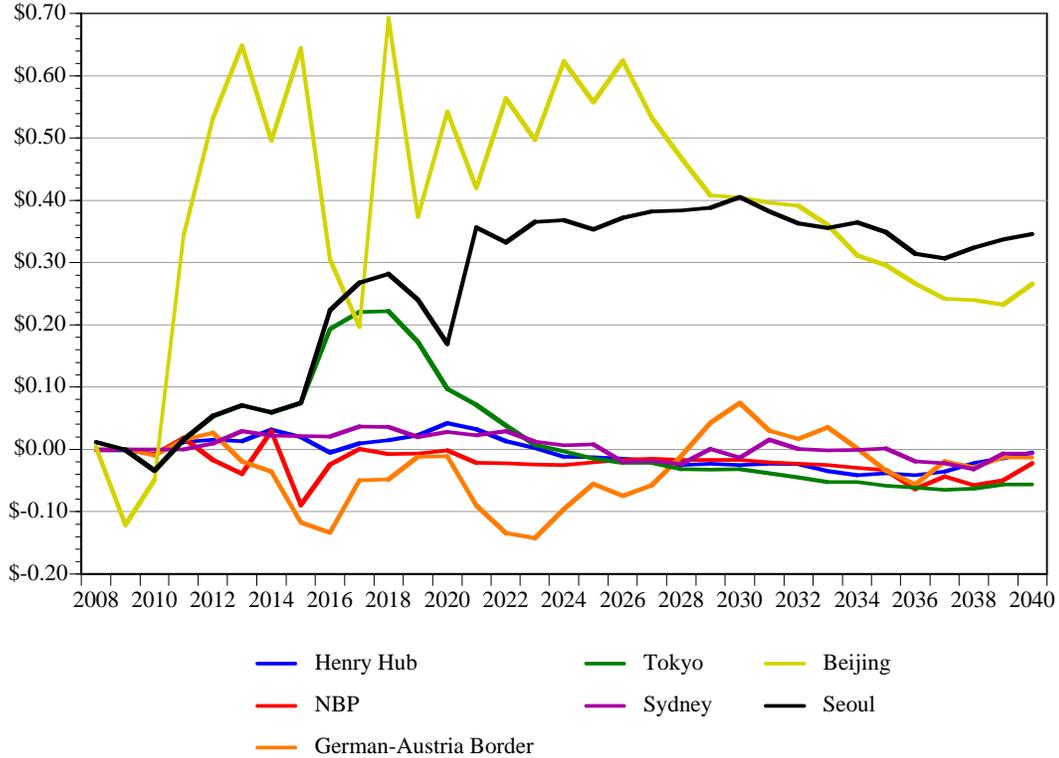


Figure 21 reinforces the conclusions from Figure 20. In particular, the largest increases in prices occur in Northeast Asia where the changes in demand also are largest. Conversely, European (and Former Soviet Union) locations experience the largest price declines as more Siberian supplies are shipped west instead of east.

V. CONCLUDING REMARKS

We began this essay by noting Russia’s apparently dominant status in the world natural gas market. It is currently the world’s largest natural gas producer and has extraordinary potential for developing new resources. Russia also has a long history of exporting natural gas to Western Europe and is well situated to satisfy the rapidly expanding demand for natural gas in East Asia.

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However, there is also some growing unease, especially in Western Europe, that Russia might be unable or unwilling to meet European demands—either for political reasons or because of insufficient investment into necessary infrastructure. The cut-offs of Russian supply to Ukraine during the pricing dispute in 2006 especially heightened West European concerns over Russia's future reliability as a major supplier. Russia's seemingly successful strategy in maintaining the dependence of Central Asian suppliers on Russian pipeline infrastructure to get their supplies to European markets has only added to Western concerns.

The general implication of our analysis, however, is that Russia's ability to adversely affect West European gas markets may be less than at first appears to be the case. The rapidly developing world market for natural gas implies that disturbances in any one location are spread out across the globe. In addition, the ability of alternative producers to substitute through time also helps reduce the effects of shocks in any one period by spreading the effects to other periods of time.

Our results also highlight the importance of the Middle East as a possible counterweight to Russia. In many cases, the Middle East has been able to at least partially offset the effects of various disturbances in Russian supply. Coordinated action by Russia and the Middle East could therefore be a much more significant threat to the energy security of the rest of the world. By the same token, our analysis highlighted the common interest that the countries of Western Europe, Northeast Asia and North America have in promoting the development of an efficient worldwide market for natural gas.

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