Natural Gas Price Report Update

Introduction

The development of horizontal drilling and hydraulic fracturing has allowed the U.S. to capture significant amounts of natural gas from shale formations, where it was previously uneconomic. The result has been a transformation of the characteristics of natural gas prices.

This document is intended to be a brief update to the November 2013 report entitled *Natural Gas Market Study* by the State Utility Forecasting Group[i]. It specifically looks at the level and volatility of natural gas prices since that report was prepared and how long-term projections of natural gas prices have changed.

Natural Gas Prices

With the exception of a brief spike in early 2014 that was related to an extreme cold spell (commonly referred to as the polar vortex), natural gas prices have remained low since the previous report was prepared. As can be seen in Figure 1, the period of low prices began around 2009, which corresponds with the development of shale resources. Five notable price spikes have occurred in the time period shown: the winter of 2000/2001, 2003, 2006, 2008, and 2014. The spikes of 2006 and 2008 were associated with supply disruptions in the Gulf of Mexico due to hurricane activity. The price spikes of the winter of 2000/2001 and February 2003 resulted from a combination of low levels of natural gas storage and high demand from colder than typical weather. The 2003 spike was exacerbated by well freeze-offs[1] that halted production in the deep South. It should be noted that the 2014 spike associated with the polar vortex was less extreme than the previous ones despite the severity and widespread nature of the event.

[1] A well freeze-off occurs when the ambient temperature drops below freezing at an unprotected well and water in the natural gas freezes, blocking the flow of gas.

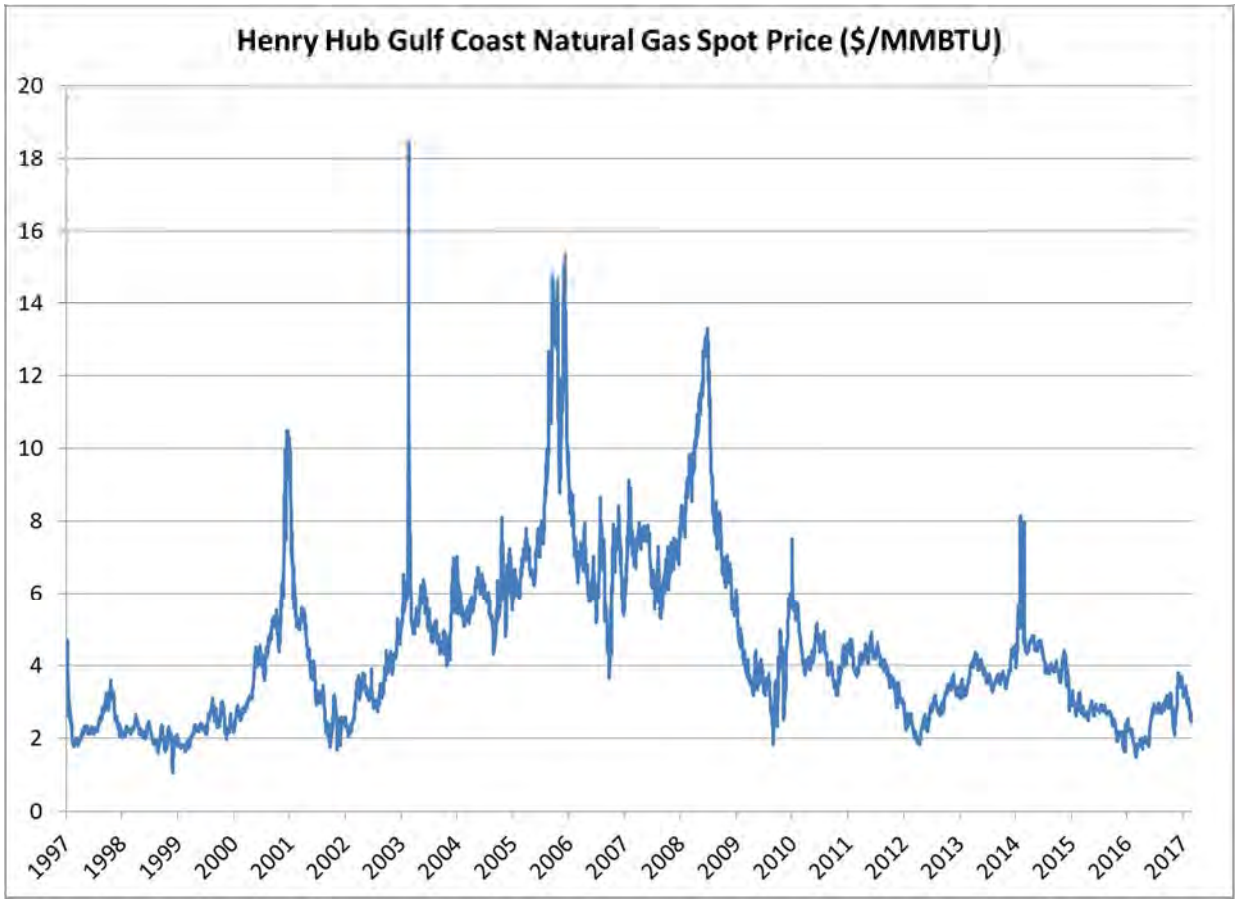
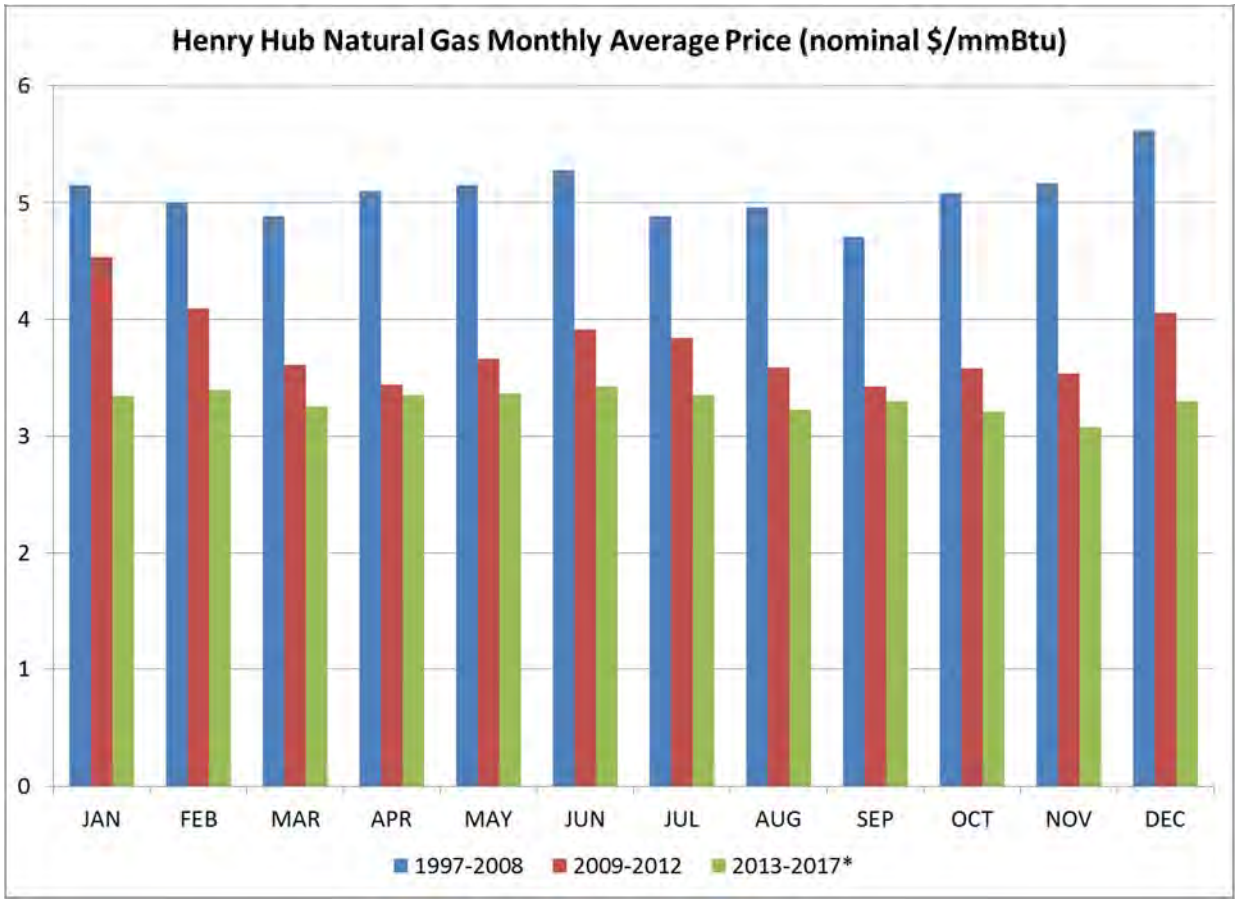


Figure 1. Historical Natural Gas Spot Prices (data source: Energy Information Administration (EIA))[ii]

Figure 2 shows the seasonal variation of natural gas spot prices for three different periods: 1997-2008 (pre-shale development), 2009-2012 (early shale development with higher crude oil prices), and 2013-present (primarily characterized by low crude oil prices). As can be seen in the figure, the most recent period has seen low prices but does not exhibit the seasonality marked by higher winter and summer prices of the two earlier periods.



* Partial year through March 6, 2017

Figure 2. Historical Natural Gas Monthly Average Prices (data source: EIA)

Price Volatility

The low levels of price volatility experienced starting in 2009 has continued in the period since the previous report was produced. One measure of volatility, the statistical variance, indicates how spread out prices are from the average: a small variance indicates they are close to the average while a large variance indicates they are not. The variance for 1997-2008 is $7.05/mmBtu, the variance for 2009-2012 is $0.77/mmBtu, and the variance for 2013-present is $0.87/mmBtu. Figure 3 provides another indication of how price volatility has lessened. For each year, a line indicates the range between the minimum and maximum prices experienced in that year and a triangle indicates the average price. The high prices in the winter of 2000/2001 impact the spread for both years. The price spikes of 2003, 2005, and 2008 are also evident. Starting in 2009, both the average price and the spread are smaller, especially from 2011 onward, with the exception of the polar vortex year of 2014.

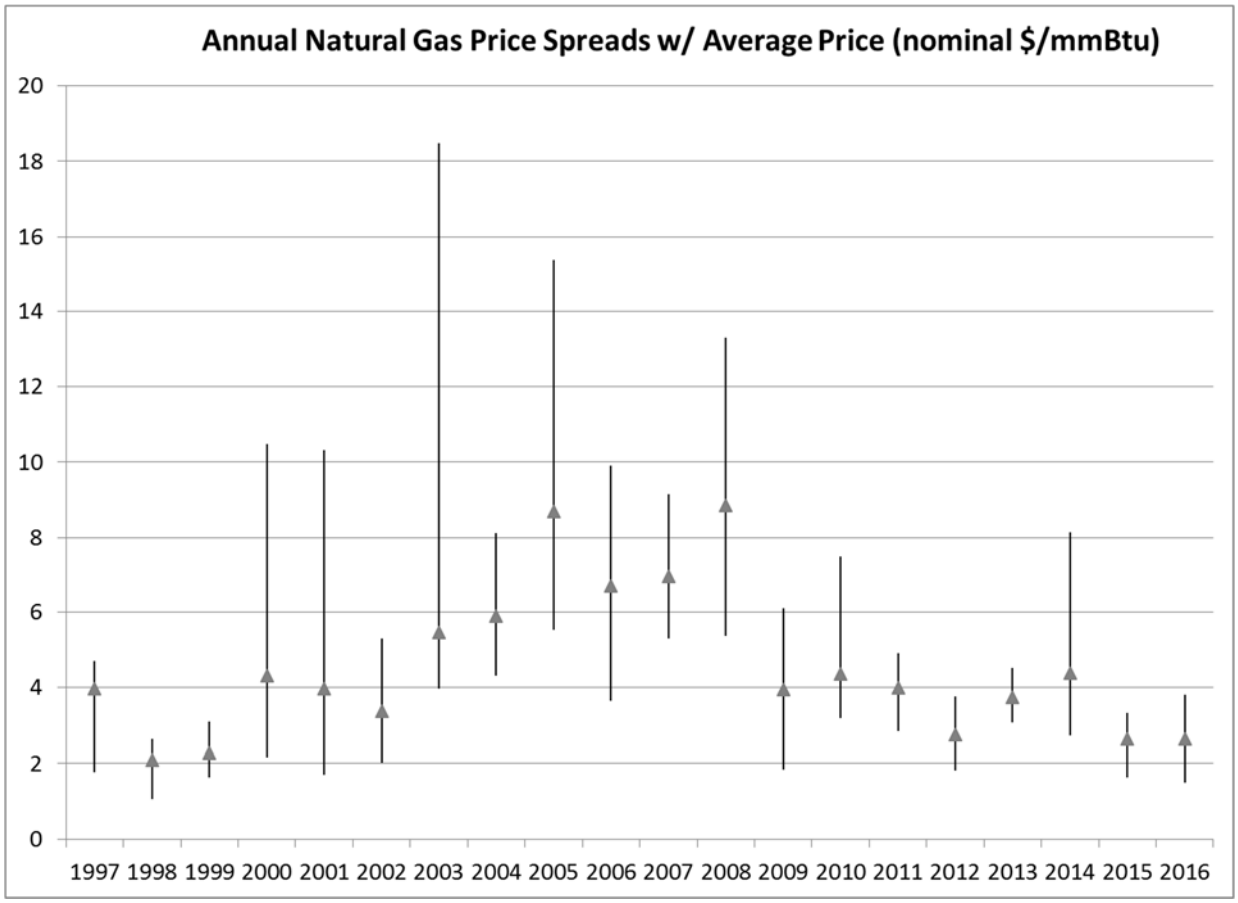


Figure 3. Historical Annual Natural Gas Price Spreads (data source: EIA)

The 2013 report identified three factors that limited price volatility in the more recent period: greater geographic diversity of supply regions reduces the impact of a single event, the ability to drill new wells more quickly in response to price increases, and the ability to switch between coal and natural gas for electricity generation. While the first two factors appear to still be significant, the generation surplus that facilitates fuel switching may be shrinking. A comparison of the most recent surveys by the Midcontinent Independent System Operator (MISO) and the Organization of MISO States (OMS) show a reduction in reserve surplus from 1.6 gigawatts (GW) to 0.9 GW[iii] [iv]. While the 2017 survey results have not been released, it should be noted that in MISO's March 20 presentation to the Market Committee of the Board of Directors, preliminary numbers indicated an increase in reserve surplus this year due in part to increased levels of demand response[v].

The geographic diversity of the supply of natural gas in the U.S. has continued to increase. The 2013 report noted that in 2011, nine states produced at least 2.5 percent of the total U.S. natural gas for the first time ever. By 2015, the addition of Ohio and West Virginia has increased that number to eleven. Furthermore, the reliance on offshore natural gas production continues to fall (see Figure 4); with the offshore share of total U.S. production declining from 21.6 percent in 2003 to 8.5 percent in 2011 to 5.5 percent in 2015.

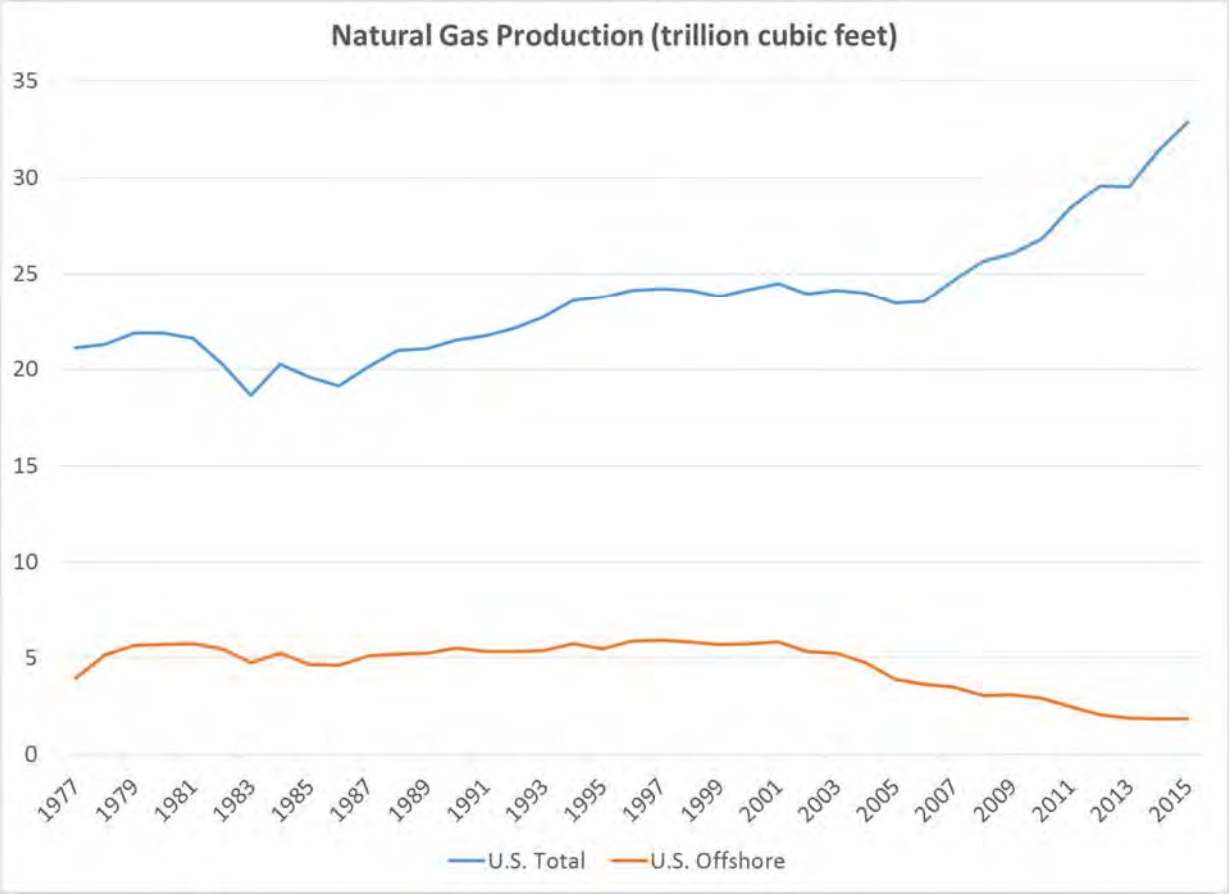


Figure 4. Historical Natural Gas Production (data source: EIA)[vi]

Relationship with Crude Oil Prices

Prior to the development of shale gas, crude oil and natural gas prices tended to move together as they acted as substitutes for each other for various energy demands, such as space heating, electricity generation, and industrial processes. With the development of wet gas[2] fields, that relationship has changed. Figure 5 shows how natural gas and crude oil spot prices have changed through time. The prices are normalized so that the prices on January 7, 1997 (the first date for which both prices are available) are equal to 1. The prices follow the same general trajectories, with the exceptions of the previously mentioned natural gas price spikes, until 2009, at which point they diverge. With the more moderate oil prices in the past couple years, the positive correlation of the two prices has returned.

There appear to be two competing factors affecting the relationship between natural gas and oil prices. On the demand side, they act as substitutes for each other in various processes and end use. Thus, an increase in oil prices results in an increase in natural gas demand and a corresponding increase in natural gas price. On the supply side, they are co-products in wet gas production. High oil prices spur increased drilling activity, which results in more natural gas supply and lower natural gas prices. From the onset of the shale boom until the drop in crude oil prices, the co-production effect was more significant and the price diverged. With lower oil prices, drilling activity is reduced and the demand

[2] Wet gas refers to natural gas mixed with oil or petroleum liquids.

substitution effect is more pronounced. The combined effect has been to keep natural gas prices relatively low and stable under both high and low oil prices.

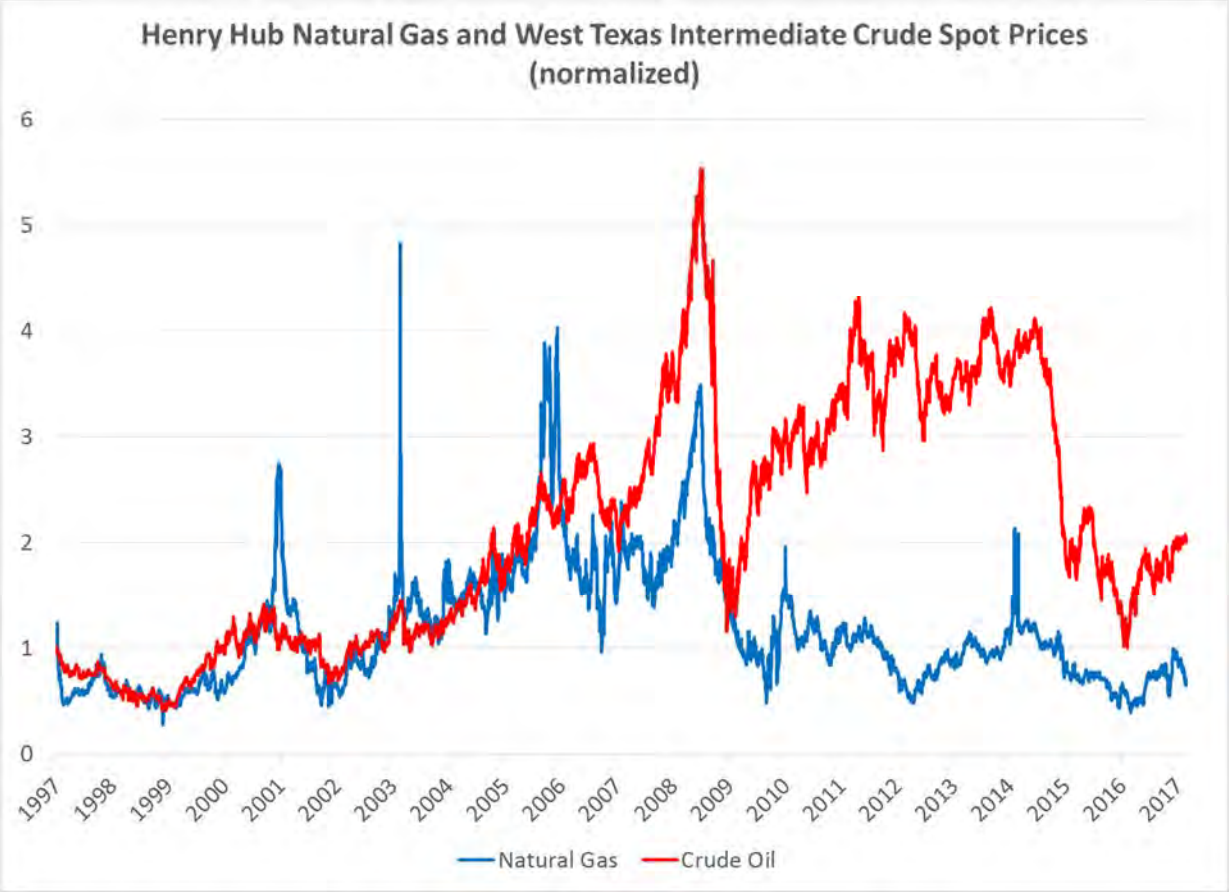


Figure 5. Historical Natural Gas and Crude Oil Prices (data source: EIA)[vii]

Price Forecasts

The more recent long-term projections from EIA show significantly lowered long-term forecasts of natural gas prices. Figure 6 shows the natural gas price projections from the five most recent Annual Energy Outlooks.

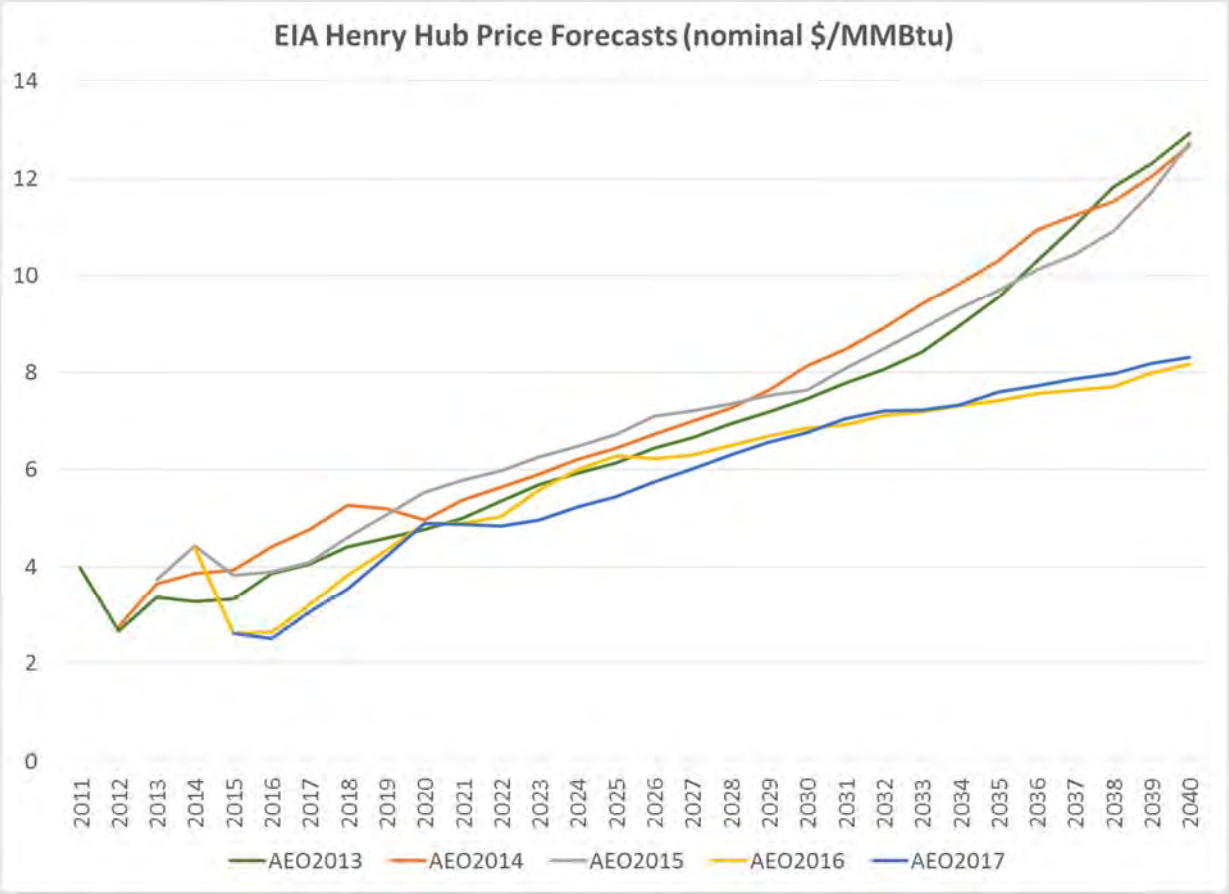


Figure 6. Natural Gas Price Forecasts (data source: EIA)[viii] [ix] [x] [xi] [xii]

EIA's March 2017 *Short-Term Energy Outlook* projects natural gas spot prices to increase from $3.03/mmBtu in 2017 to $3.45/mmBtu in 2018 due to "new natural gas export capabilities and growing domestic natural gas consumption"[xiii]. This is slightly below the projection in the *Annual Energy Outlook 2017* of $3.55/mmBtu.

Liquified Natural Gas (LNG) Exports

The Sabine Pass facility in Louisiana completed construction and commenced operation on two liquefaction units, or trains, in 2016[xiv]. Three more trains are under construction there with two estimated to be in service later this year and one in 2019. Additional facilities are under construction at the Corpus Christi (Texas) facility (two trains to be in service in 2018)[xv], the Cameron (Louisiana) facility (three trains to be in service in 2018)[xvi], the Freeport (Texas) facility (one train to be in service in 2018 and two in 2019)[xvii], and the Cove Point (Maryland) facility (one train to be in service in late 2017)[xviii].

Exports from these and potentially additional terminals are expected to put upward pressure on natural gas prices. It should be noted, however, that the profitability of LNG exports relies on a difference in price between the U.S. and the overseas markets. As Figure 7 shows, the price of natural gas in Europe and Asia has dropped significantly in recent years. This drop has coincided with the drop in global crude oil prices. The projects currently under construction were all started prior to the drop in crude oil prices. Development of additional LNG export facilities has slowed recently. For instance, the Lake Charles

(Louisiana) project received federal regulatory approval in 2015, but the developers delayed the final investment decision prior to commencing construction[xix]. Furthermore, the cost of liquefying, transporting the LNG overseas, and regasifying means that the overseas price must be higher than the domestic price. NERA Economic Consulting in the "*Macroeconomic Impacts of LNG Exports from the United States*" report for the Department of Energy estimated those costs to be $6.30/mmBtu for shipment to Europe, $7.14/mmBtu for shipment to Korea and Japan, and $8.39/mmBtu for shipment to China and India[xx].

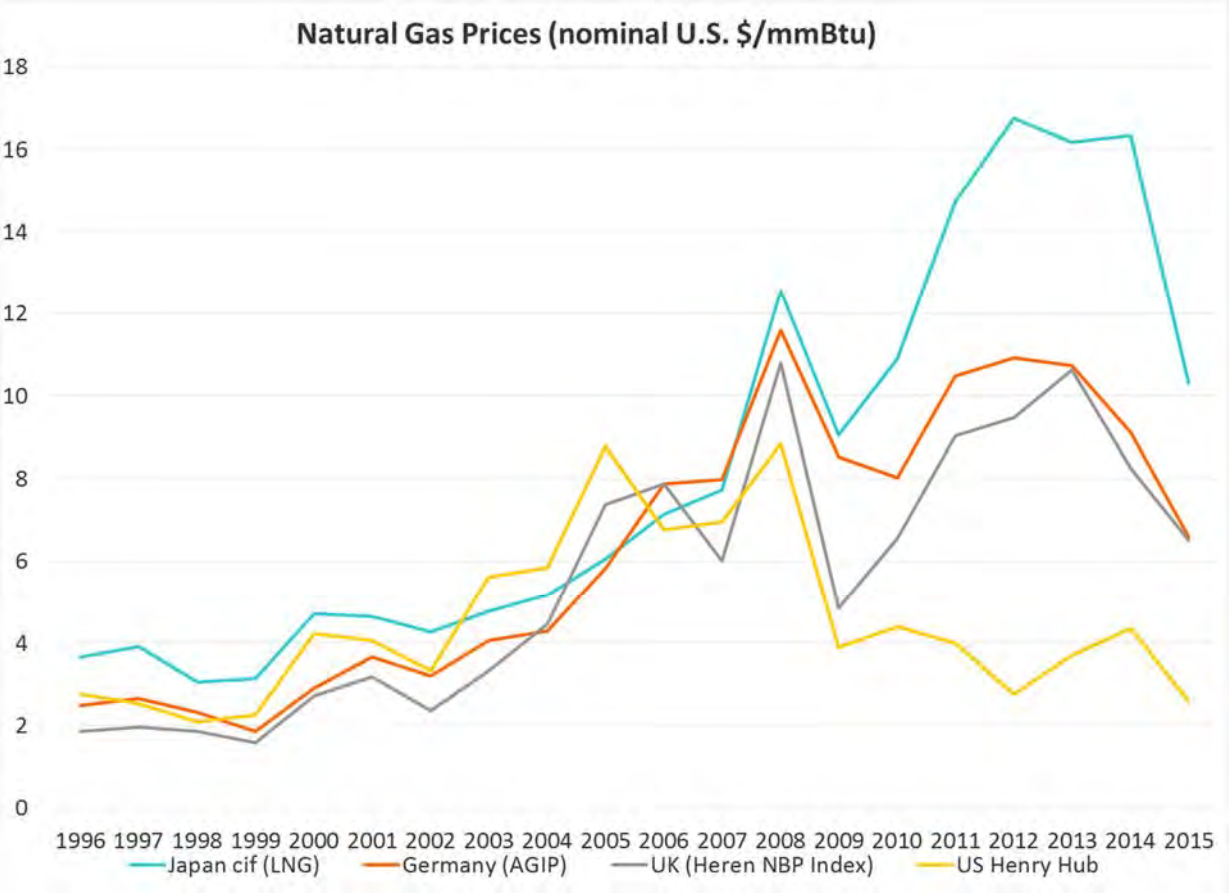


Figure 7. Historical International Natural Gas Prices (data source: British Petroleum (BP))[xxi]

Another factor that could limit LNG export opportunities is the development of shale gas resources in other countries. To date, overseas shale development has been quite small compared to U.S. standards, but there are signs of growth. EIA reported in June 2015 that ten countries had joined the U.S. and Canada in exploring shale gas and tight oil, led by Argentina and China[xxii]. Chinese shale gas production produced 3.76 billion cubic meters (about 130 billion cubic feet, or bcf) in the first 9 months of 2016 with plans to bring production capacity to 10 billion cubic meters (about 350 bcf) in 2017[xxiii]. By way of comparison, this would equal approximately one percent of total U.S. natural gas production.

Risk Factors

The most significant risks to continued low, stable natural gas prices are new environmental regulations and increased demand. While the current political environment does not indicate that environmental

regulations will present a significant burden to continued shale gas development, it remains a possibility in the longer term. This could be especially true if a hydraulic-fracturing related disaster were to occur in the future.

Increased demand is a more likely scenario, both through increasing exports and through increased domestic use as an energy source or as an industrial feedstock. However, the evidence in the past few years indicates that supply is more elastic and prices are more resistant to change than they were before the development of shale gas.

Conclusions

Natural gas prices have remained low and relatively stable since the development of shale gas production about eight years ago. While prices can be affected by extreme events (such as the polar vortex), the impact of such events has been moderated. A number of factors, such as the geographic diversity of supply, the ability to rapidly construct new wells, and the co-production status with petroleum products in wet gas, suggest that this is the new normal. The most recent projections from EIA reflect an expectation of continued low prices in the long term.

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[ii] EIA. https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm

[iii] MISO, "2015 OMS MISO Survey Results," June 2015. https://www.misoenergy.org/Events/Pages/SurveyResults20150619.aspx

[iv] MISO, "2016 OMS MISO Survey Results," June 2016. https://www.misoenergy.org/Events/Pages/2016OMSMISOSurvey.aspx

[v] MISO, "2017 Summer Operations Preview," March 2017. https://www.misoenergy.org/Events/Pages/MCBOD20170321.aspx

[vi] EIA, https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FGW_mmcf_m.htm

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[viii] EIA, "Annual Energy Outlook 2013,' May 2013. https://www.eia.gov/outlooks/archive/aeo13/

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[x] EIA, "Annual Energy Outlook 2015," April 2015. https://www.eia.gov/outlooks/archive/aeo15/

[xi] EIA, "Annual Energy Outlook 2016," September 2016. https://www.eia.gov/outlooks/archive/aeo16/

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[xiii] EIA, "Short-Term Energy Outlook," March 2017. https://www.eia.gov/outlooks/steo/

[xiv] http://www.cheniere.com/terminals/sabine-pass/trains-1-6/

[xv] http://www.cheniere.com/terminals/corpus-christi-project/liquefactions-facilities-trains-1-3/cc-schedule/

[xvi] http://cameronlng.com/project-timeline.html

[xvii] http://www.freeportlng.com/Project_Status.asp

[xviii] https://www.dom.com/covepoint

[xix] LNG World News, "Lake Charles LNG FID delayed," July 2016. http://www.lngworldnews.com/lake-charles-lng-fid-delayed/

[xx] NERA Economic Consulting, "Macroeconomic Impacts of LNG Exports from the United States," December 2012. https://energy.gov/sites/prod/files/2013/04/f0/nera_lng_report.pdf

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[xxii] EIA, “Argentina and China lead shale development outside North America in first-half 2015,” June 2015. https://www.eia.gov/todayinenergy/detail.php?id=21832

[xxiii] Oil & Gas Journal, “China’s shale gas production outperforms expectations,” November 2016. http://www.ogj.com/articles/2016/11/china-s-shale-gas-production-outperforms-expectations.html