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Five years on
The outlook and
impact of American
LNG exports

Deloitte Center
for Energy Solutions





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Executive summary

In the last five years, Deloitte MarketPoint (“MarketPoint”) published two research papers analyzing the impact of US liquefied natural gas (“LNG”) exports on both the domestic and global gas markets. The first, **“Made in America: The economic impact of LNG exports from the United States,”** was published in 2011 and analyzed the impact of 6 billion cubic feet per day (bcfd) of exports on US natural gas prices. In 2013, Deloitte MarketPoint followed up with **“Exporting the American Renaissance: Global impacts of LNG exports from the United States,”** looking at the exports from a different angle, their impact on global prices across multiple scenarios. Both reports used Deloitte MarketPoint’s World Gas Model¹ (WGM) to build out scenarios to evaluate the opportunity and assess the impacts of US LNG exports. The studies concluded that large volumes could be shipped with minimal impact on US prices due to a flat supply curve driven by the success of horizontal drilling and hydraulic fracturing to develop economically large quantities of shale gas.

In fact the supply curve has not only been flat, but it has also shifted downward over the last five years. In hindsight, the shale gas revolution has been unprecedented, production volumes from horizontal wells have been increasing despite a reduction in drilling over the past five years.² Industry expectations were surpassed by the resiliency of shale gas and the eventual growth was not captured in models in early stages. With record storage along with ample undrilled acreage, US LNG exporters are taking advantage of a low cost of supply despite the global LNG price slide. And while the 2013 Reference Case predicted that Asian and European spot prices would converge once increasing exports eased the sellers’ market, the impact of changes in oil prices on indexed contracts was outside the scope of the analysis. The result is not only a dampened market today, but also the potential for sustained low prices in the medium term due to excess liquefaction capacity relative to the demand forecasted by the MarketPoint model.

That market slack is driven by a number of factors, including the construction of multiple liquefaction facilities in Australia and the US that are beginning shipments just as demand growth in the emerging markets is beginning to wane. Other factors playing out in the short and medium terms are the number of potential brownfield liquefaction trains at existing facilities, the large number of unsanctioned but permitted projects, and the potential for gas being piped into major markets like India and China. MarketPoint’s most recent Reference Case, published Q4 2015, indicates significant market slack continuing into the early 2020s followed by moderate tightening. It suggests that growing demand will likely be met by a multitude of sources including both traditional players in the Middle East and Africa as well as the relative newcomers in North America and Asia.

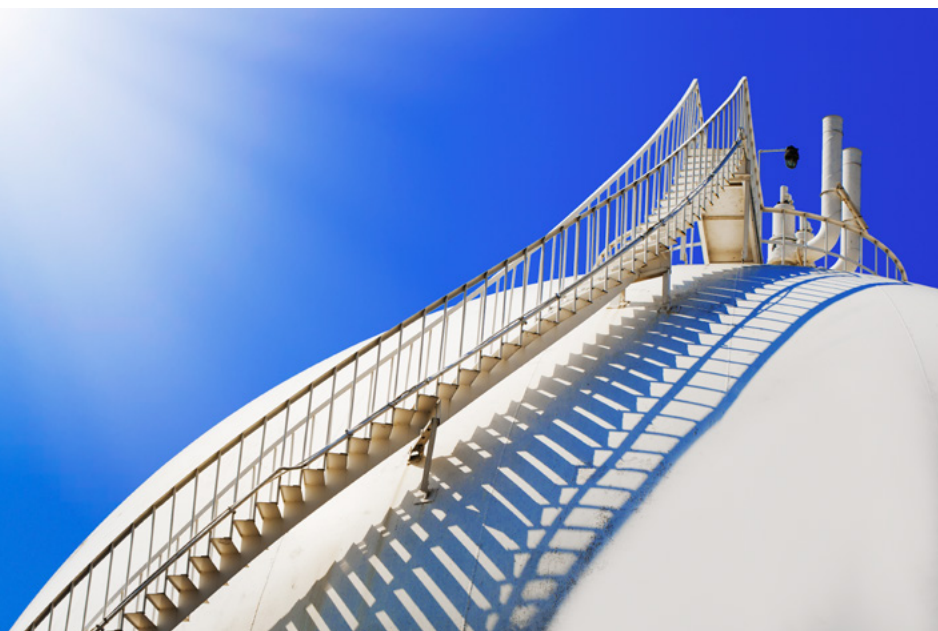
From famine to feast

LNG is a multi-purpose fuel traded globally between 19 exporting countries and almost 30 importing countries. Additionally, it has potential for further expansion as demand continues to grow.³ LNG's viability in the US is based upon a complex supply chain involving upstream operations to produce the natural gas, an intricate network of pipelines to transport the natural gas to LNG terminals, liquefaction plants to cryogenically liquefy and reduce its volume by a factor of 600, and a specialty shipping sector with tankers to transport the fuel while it remains in liquid form. In the US, development and operating costs have shifted throughout the value chain due to an abundance of low-cost gas supply from shale gas combined with brownfield liquefaction capacity built upon existing import terminals. This, combined with increased shipping capacity leading to lower overall shipping rates,⁴ means the US will likely shift from a net natural gas importer to an exporter by the end of 2016.

It is not just the US value chain that is shifting. The underlying structure of the global LNG trade is shifting as well. Increases in market liquidity—partially based on increased liquefaction capacity and the ability to deliver LNG to alternate destinations—has the potential to make markets more efficient by reducing unnecessary shipping miles. One of the major US companies engaging in this more open trade, Cheniere Energy, shipped its first LNG cargo out of Sabine Pass in February 2016.⁵ This marks a major milestone in the LNG industry, the first commercial LNG export from the US lower 48 states.

The emergence of shale gas available in large quantities in several supply basins across the US has provided an extensive, low-cost gas resource base. When prospects for US LNG exports were gaining momentum as a result, Deloitte MarketPoint published two articles on global LNG market analysis and the interplay of the LNG export and US domestic gas markets.

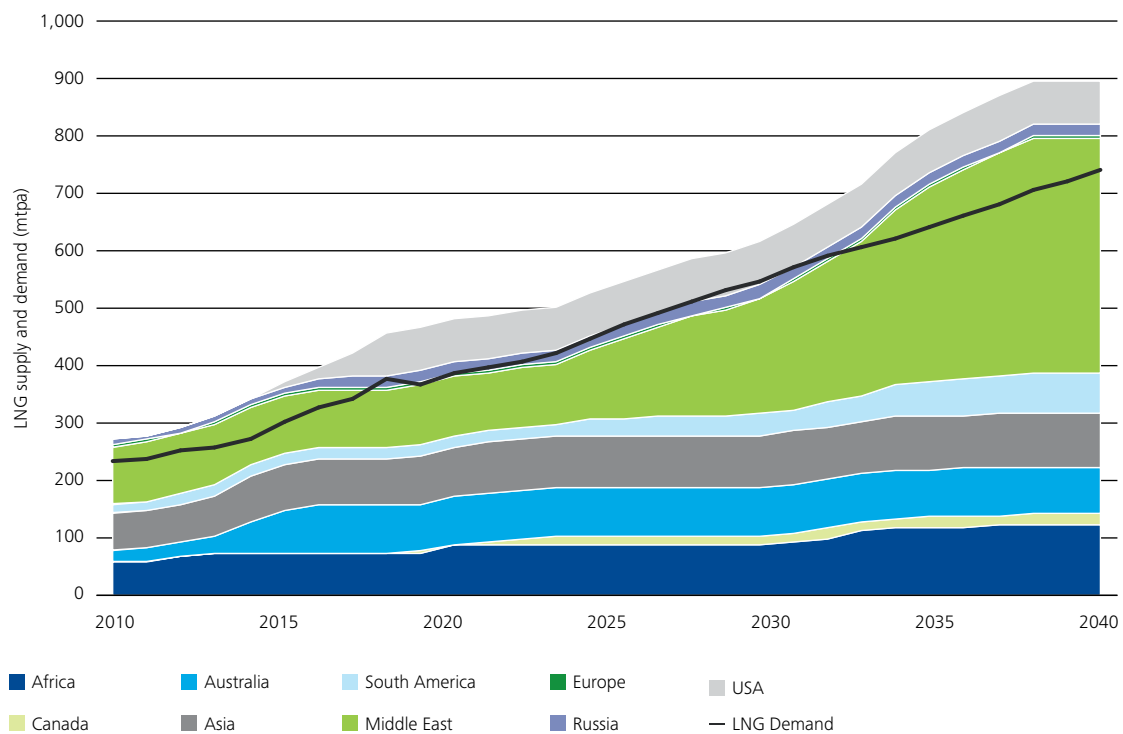
“Made in America: The economic impact of LNG exports from the United States,” published in 2011, analyzed the impact of 6 billion cubic feet per day (bcfd) of natural gas, equivalent to roughly 46 million tonnes per annum (mtpa) of exports on the LNG from the US. In 2013, the group published the follow-on report, **“Exporting the American Renaissance: Global impacts of LNG exports from the United States,”** which looked at the impact of US exports on international gas prices as indicated by the UK National Balancing Point (NBP) and Japanese import prices. The reports highlighted the opportunity for the US to export LNG into a profitable market at competitive prices, with minimal impact on US prices. Essentially, the cost of natural gas supply would remain relatively flat even after considering the increase in demand stemming from LNG exports.



The flat supply curve for natural gas is driven by extensive horizontal drilling and hydraulic fracturing in the Barnett, Haynesville, and Marcellus shales. These techniques have led to a nearly 50 percent increase in natural gas production in ten years, reaching roughly 75 bcf/d in 2015.⁶ During this period, Henry Hub prices dropped precipitously from US\$8.86 per million British thermal units (Btu) in 2008 to under US\$4 million Btu in 2009, and prices have remained low. With higher production and lower demand, prices have continued to decrease in 2015 and even fell below \$2 by the end of the year.⁷ US prices are expected to remain low in the near term. Anticipated El Niño weather has kept winter temperatures on the warmer side in the Northeast, which is the major gas consuming region for winter heating demand. Storage continues to remain above the five-year average and, barring major supply disruptions or a severe winter ahead, stocks are expected to remain high.

With the expected commissioning of multiple LNG liquefaction plants in both the US and Australia, the global gas market will open up considerably. This is in stark comparison to the tightened market of the last few years, which was driven by high demand due to multiple factors including the closure of Japanese nuclear facilities following the Fukushima disaster and ongoing delays at multiple vertically integrated gas projects in Australia. The purpose of this paper is to re-establish a dialogue on LNG and reflect on what MarketPoint's model and analysis got right, what it missed, and what unanticipated structural changes occurred in the market. To put it more colloquially: the good, the bad, and the ugly. The paper discusses several points raised in the previous reports and provides an update on shifts in market trends and the emergence of new trends in the current environment.

Figure 1.1 Deloitte MarketPoint Reference Case LNG supply and demand projection



Source: Deloitte MarketPoint analysis

Revisiting the 2011 and 2013 assumptions and conclusions

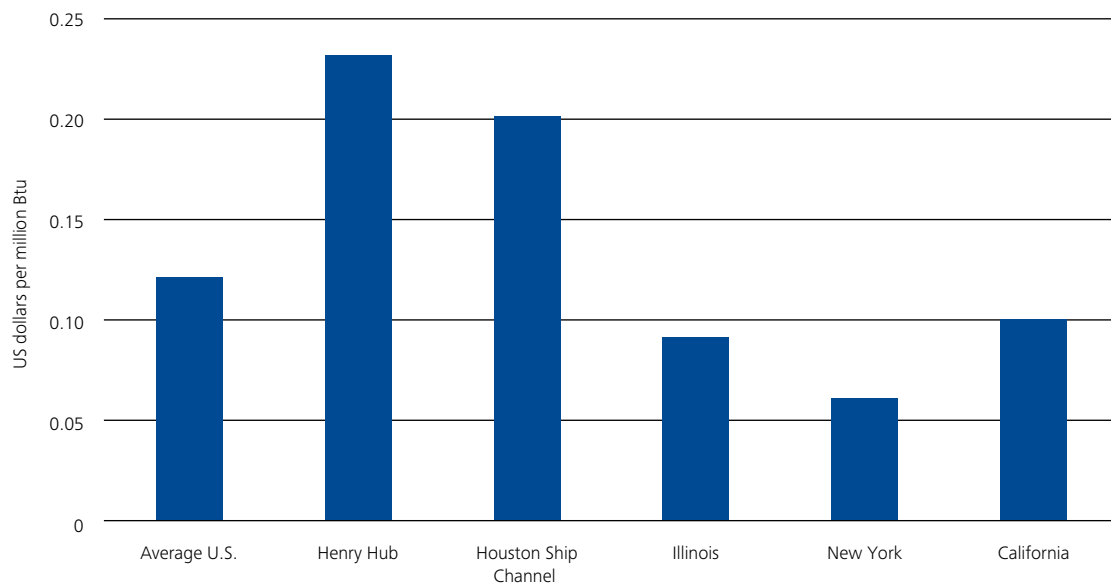
Both papers analyzed the short- and long-term trends in US natural gas supply and demand. For all practical purposes, demand growth in the lower 48 states has been, and is expected to continue to be, driven by power generation. Demand is expected to continue to grow with a number of coal-fired units likely to shut down in the next few years. Supply comes from a handful of regions, with roughly two-thirds of production coming from shale including gas plays like the Marcellus, Haynesville, and Barnett shales as well as from associated gas from unconventional oil plays like the Eagle Ford.

In 2011's "**Made in America: The economic impact of LNG exports from the United States**" the model considered two cases. The first assumed no exports and the second assumed 6 bcfd of LNG to be exported from the US Gulf Coast, in line with the potential capacity expected at the time in region. The model predicted that not only could shale gas meet domestic power needs, but it could also provide sufficient low-cost feed gas for LNG exports. This was due to the fact that total assumed exports over 20 years would be roughly 48 tcf, less than four percent of MarketPoint's estimate at the time of 1200 tcf of US gas resource producible under \$6 per million Btu.

The 2011 export case projected that the Gulf Coast exports would have only minor effects on production and marginal impacts on US gas prices, with fluctuations because of the geology and geography of the US shale boom. As shown in Figures 2.1 and Figure 2.2, the model estimated that average city gate prices could potentially rise \$0.12 per million Btu as a result of exports, roughly 1.2 percent over the timeframe analyzed, with city gate prices averaging US\$7.09 per million Btu from 2016 to 2035. The impact, however, varied by geography. Henry Hub's proximity to the LNG terminals led to a US\$0.22 per million Btu increase, almost twice the impact on the citygate price. On the opposite side of the country, areas like New York were forecasted to see increases on the order of only US\$0.05 per million Btu due to the adjacent Marcellus shale. The impact of exports could become increasingly muted with technological advances and increased acreage exploration that would potentially cause a further flattening of the North American gas supply curve.

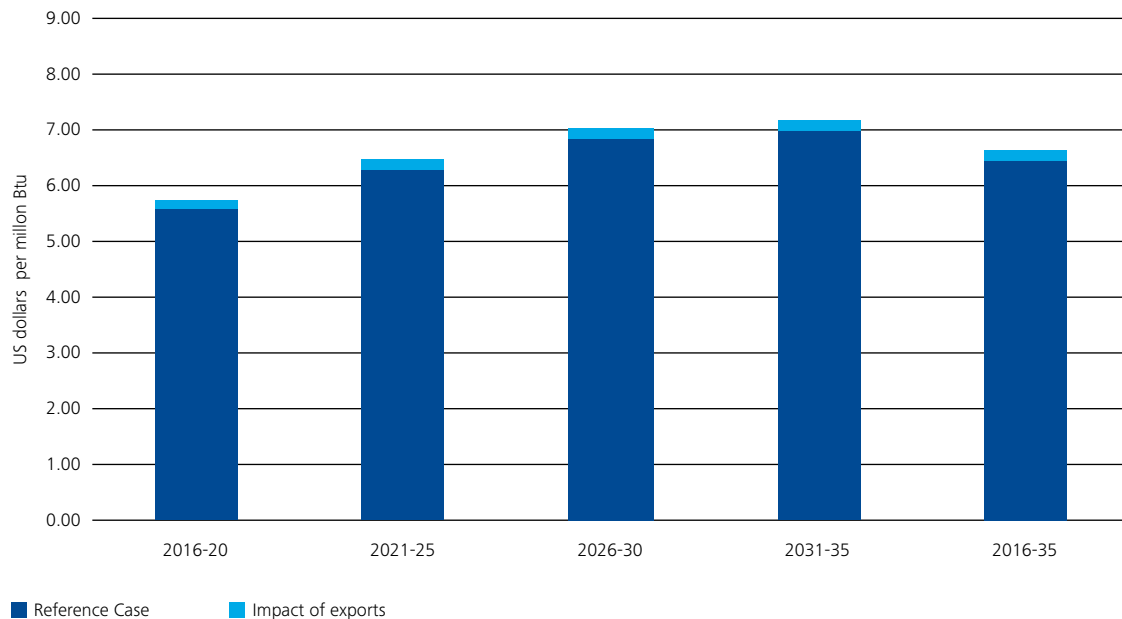


Figure 2.1 2011 Report: WGM estimate of changes in average (2016–2035) US city gate gas prices



Source: Deloitte MarketPoint analysis

Figure 2.2 2011 Report: WGM impact of LNG exports on average US city gate gas prices over time



Source: Deloitte MarketPoint analysis

“Exporting the American Renaissance: Global impacts of LNG exports from the United States,”

published in 2013, shifted focus from domestic to global markets and took stock of how various factors could narrow US, European, and Japanese spot gas prices. Table 2.1 identifies the three cases under two scenarios analyzed in the study. The three cases included various levels of LNG exports with no US exports, 6 bcf/d shipped to Europe, and 6 bcf/d shipped to Asia. For all three cases, MarketPoint considered two scenarios: a “business-as-

usual” scenario (BAU) in which leading exporters retain and renew traditional, oil-indexed contracts and a “competitive response” scenario (CR) where major exporters compete to retain or increase the proportion of their volumes in the global market. These scenarios were not specified to cover the range of all possibilities, but to test market impacts of various factors influencing the gas markets.

Table 2.1 2013 Report: Market scenarios and export cases

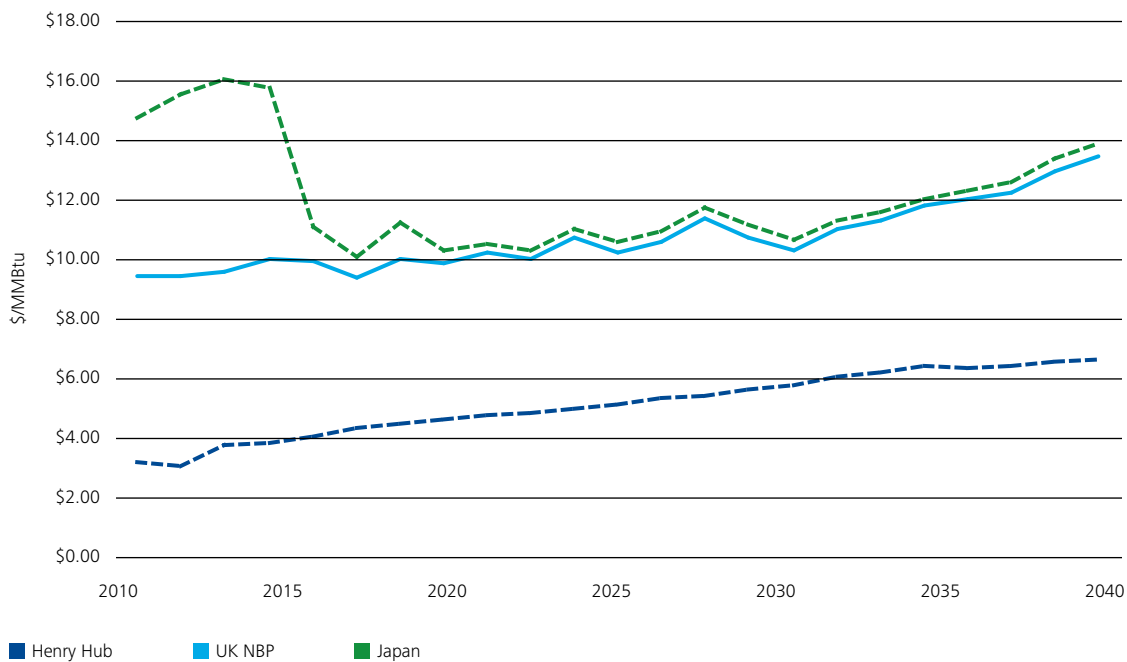
	Business-as-usual scenario	Competitive response scenario
No exports case	<ul style="list-style-type: none"> • No LNG exports from the US • Prolonged oil-price indexation 	<ul style="list-style-type: none"> • No LNG exports from the US • More competitively priced supplies
Asia export case	<ul style="list-style-type: none"> • 2 bcf/d each to Japan, Korea, and India • Prolonged oil-price indexation 	<ul style="list-style-type: none"> • 2 bcf/d each to Japan, Korea, and India • More competitively priced supplies
Europe export case	<ul style="list-style-type: none"> • 3 bcf/d each to UK and Spain • Prolonged oil-price indexation 	<ul style="list-style-type: none"> • 3 bcf/d each to UK and Spain • More competitively priced supplies

Source: Deloitte MarketPoint analysis

In all cases, the price of Japanese LNG imports was projected to decrease and converge with European prices, indicated by the UK NBP, a virtual trading hub for pricing futures contracts. The model, shown in Figure 2.3, predicted an upward slope in nominal US prices irrespective of export capacity, with the NBP price following a similar trend. The increase in US prices resulted from the impact of demand increases on the expected marginal supply in an effectively closed market. The European prices include the cost to regasify LNG from both major (that is, oil-indexed) and smaller (opportunistically priced) suppliers as well as

constrained domestic resources. The high initial Japanese price, together with Southeast Asian prices in general, resulted from the spike in demand from Fukushima in a restricted, illiquid spot market combined with sustained, high oil prices. The onset of new capacity from Australia, irrespective of US exports, were projected by the model to provide sufficient slack in supply to cause a convergence in Asian and European prices.

Figure 2.3 2013 Report: Projected prices in key markets (BAU scenario with no US exports)



Source: Deloitte MarketPoint analysis

Back to the future—How did the 2011 and 2013 Reference Cases fare?

The WGM is an approximation of the intricacies of the global gas supply and demand network. On a micro level, it relies on a group of key assumptions to project the supply, demand, and price balances in different regions, with or without LNG exports and imports. Like the 2015 Reference Case, the analyses in the 2011 and 2013 reports reflect a high level of uncertainty over the costs to produce shale gas, directly impacting the total economically producible reserves in the US. Due to this uncertainty, the 2011 report—and to some extent, the

2013 report—did not anticipate the drop in oil and gas prices seen today. Rapid change in technologies increased the level of shale gas production. The collapse in oil price combined with a slow erosion of potentially anticipated high demand in Asia caused an excess of supply and resulted in very low gas prices. Slowdowns in European and Asian economies and the resulting weaker demand was not anticipated during the 2011 and 2013 report timelines. This abrupt change caused low prices that were not anticipated in the earlier reports.

For example, in 2011 the EIA estimated total US production of close to 58 bcf/d, rising to 61.5 bcf/d by 2015 with more than half of all production from unconventional sources.⁸ In a scenario assuming roughly 71 bcf/d of demand, MarketPoint projected a Henry Hub price averaging close to US\$6.50 per million Btu through 2016. The total US production in 2015 was close to 75 bcf/d, with Henry Hub prices averaging US\$3.50 per million Btu. Not only that, spot prices dropped below US\$2.50 by the end of the year, where they have remained.⁹ This large change is largely due to the new economics of shale gas driven by horizontal drilling, fracturing, and advanced technology in the development and production phases. However, this reinforces the conclusions of the 2011 paper, the economic potential of US shale gas supply is substantial and is more than capable of supplying LNG exports with minimal to no impact on domestic end users, even as prices remain low. In the case of the Marcellus shale, it continued to produce over 15 bcf/d by the end of 2015, roughly seven times its output at the beginning of 2011.¹⁰ Further technological advances, combined with a leaner service sector, could continue to drive production costs down, leading to continued robust drilling and production activity.




The continued strong production in the US has had a large impact on the Canadian gas markets and the 2011 report predicted that Canadian gas production would decline as US demand for imported gas decreased but would ramp up by the end of the decade. That model projected that continued US demand and potential for export would be an incentive for increased Canadian production by the end of the decade, particularly from the Horn River and Montney Shale plays. And in reality, Canadian gas production peaked in the mid-2000s, declined through 2014, and has begun to increase moderately,¹¹ though continued low prices challenge Canadian shale economics.

The 2011 and 2013 reports also assumed strong global demand growth as seen in Asia with China, India demand growing at a faster pace than in other Asian countries. Demand in China was anticipated to grow at an annual rate of over ten percent. This growth has not materialized as strongly as expected, weighing on both European and Asian gas prices. For example, the WGM projected UK NBP prices of roughly US\$9 and US\$10 per million Btu in 2013 and 2014 respectively. The prices actually averaged US\$10.60 and US\$8.20 per million Btu, with 2014 having a notably higher share of warm days than previous years.¹² This warm winter, combined with underwhelming Asian LNG demand growth, led to increased inventories that continue to hang over the market even as additional supply comes on stream. The MarketPoint model accurately identified this as a factor driving the elevated Asian prices downwards.

Despite a conservative North American supply estimate and an upward demand trend in Europe and Asia, the 2013 report projected that the increase in LNG supply would put pressure on Japanese import prices and that this pressure would lead to a decrease in Asian import prices in line with UK NBP by 2015. This prediction was based on the ability of LNG buyers to demand flexibility in their contracts and take advantage of gas market prices that would be lower than oil-indexed LNG prices. As seen last year, the prices did drop, with import prices decreasing 20% year on year,¹³ though this decrease is partly driven by the oil price crash on oil-indexed LNG contracts. Combined with weakened demand, the lower contracted price has led to a similar drop in the spot LNG market.

The 2013 model included both the BAU and CR scenarios, with recent events indicating the market is trending towards that CR scenario. In light of the current demand picture, the upcoming arrival of new cargoes will likely cause a sustained narrowing of the European and Asian LNG markets with a more competitive spot market and buyers renegotiating contracts. There has already been some evidence of contracts being reworked to delay delivery or adjust pricing. For example, the recent discussion between Petronet and RasGas will change the benchmark from a five-year Japanese Customs Cleared (JCC) basis to a three-month Brent basis.¹⁴



Head to head: LNG moving from a seller's to a buyer's market

The potential shift to a competitive market—where existing suppliers cut prices below pre-negotiated contracts to remain in line with other, cheaper contracts—was outlined as one of the key scenarios in MarketPoint's 2013 **"Exporting the American Renaissance: Global impacts of LNG exports from the United States"** report. This CR scenario forecasted a seven to eight percent drop in the European and Japanese prices on average from 2016 to 2030. This drop was solely from the impact of current major exporters' pricing in response to competitive pressures with existing planned liquefied volumes. The increased number of cargoes and lower than expected demand growth will likely exacerbate the impact, potentially leading to lower LNG prices for longer, with various market price differentials outside North America driven by shipping cost variance. Further, charter costs are likely to decrease because of an oversupply of LNG transport vessels. Although the 2016 market faces headwinds, this is not the first time a rapid increase in LNG supply has significantly impacted pricing. Through much of its 40-year history, LNG has been a niche market with a limited number of participants on either side of the transaction. It is prone to large swings of pricing and availability along with renegotiation of contracts. During the 1980s, newly available piped gas led to a decline in demand for LNG in both Europe and the US. In one case a Belgian Utility, Distrigaz, attempted to exit a 1975 long-term contract with Sonatrach, the Algerian national oil company.

Today's market is similar to the 1980s, with a large glut of supply linked to older contracts at odds with excess spot capacity and competition for potentially more flexible contractual terms. In the case of RasGas and Petronet, a five-year JCC average index for the contract provided long-term stability of pricing. Only sustained shifts upward or downwards could materially affect the pricing, which essentially reduced volatility. Lower volatility is generally a benefit for both an LNG liquefier and the utilities served by an importer like Petronet. In this case, the large and unexpected slide in crude prices has led to renegotiations without lengthy disputes via arbitration or similar legal proceedings. Going forward, these kind of agreements should prove much more common. Unlike the 1980s, there is a larger number of exporting countries and facilities, allowing for more competitive bidding for future contracts than in the past. The risk that lawsuits could alienate actual and potential buyers, as well as negatively impact goodwill, may exceed the revenue benefit of holding onto out-of-the-money contracts. This is particularly true for sellers whose contract prices are well above both the short-term spot price and the cost of supply. Future renegotiations of existing contracts should be expected, particularly for those that have either long lag periods or long averaging periods for oil price indexation.

The 2015 outlook—Increasing supply into saturated markets

In the next five years, MarketPoint projects an LNG glut overhanging the markets. Major project deferrals and growing LNG demand in Europe and Asia will be needed to before justifying new greenfield projects. In 2012 and 2013, Qatar remained the largest global LNG supply country, with around 32% of LNG exports, while Australia built up its share. This is in line with the MarketPoint forecast that as US and Australia increase their exports and market share, Qatar may have to cut down on its exports or lower its price to remain competitively priced in the market, based on current demand expectations.

Beyond countries like Qatar restricting shipments, lower LNG prices did and will continue to require LNG suppliers to curtail their capital budgets. According to *Moody's Investor Service*, almost 30 proposals in the US and 22 in Canada are expected to be deferring their plans to build an LNG facility.¹⁶ Examples include Veresen Inc.'s Jordan Cove project and Cheniere's Sabine Pass Train six in the US. *Moody's* also noted that greenfield projects are at higher risk of cancellation or deferrals so projects in remote areas or those facing regulatory hurdles in areas like East Africa or Pacific Canada are less likely to reach sanction in the current environment. Even with these projects being delayed, the WGM forecasts that the global markets will likely be oversupplied into the early 2020s, reducing cargo prices and therefore project returns. Portfolio players and other who maintained spare capacity for sale into the spot market will likely be hardest hit.

MarketPoint also expects increased competition from piped gas in several regions. Bulgaria has announced that it intends to revive the Nabucco pipeline after Russia announced its plans to shelve the plans for the South Stream pipeline, which would have supplied gas to Bulgaria via Europe. There are also discussions that the Trans-Adriatic pipeline ("TAP") and Nabucco could be united to transport Azeri gas into Europe. In other parts of the world, we anticipate that pipeline flows will materialize from Russia to China and from Iran to Turkey, Pakistan, Afghanistan and India.

Pipelines require significant upfront investment in both financial and political capital. However, once commissioned they can deliver large quantities of gas at relatively low per-unit operating costs. Even in higher demand scenarios, pipelines could restrict growth avenues

for LNG, particularly in Europe. In all likelihood, large pipeline projects in Asia remain a more remote possibility. But with the potential lifting of sanctions on Iran, there is growing optimism on potential natural gas pipelines transporting natural gas from Iran to India directly by a planned undersea pipeline¹⁷ or a pipeline via Pakistan.¹⁸ These developments could potentially undermine LNG imports into India.

Ultimately, continued exports by the traditional large players like Qatar and Australia, and new entrants like the US, will likely lead to excess spare capacity that will sustain lower prices through the end of the decade and possibly into the early 2020s. Additional brownfield developments at large facilities with access to large gas resources (like the US Gulf Coast) could bring additional LNG cargoes to market despite the limited marginal demand, possibly undermining a price recovery. Another factor is the advent of small-scale and floating liquefaction and regasification facilities that are made possible by new technology. These will likely mushroom in response to regions with smaller demand that have so far been overlooked by the large facilities.

These smaller facilities, combined with small-scale ships, are expected to begin to supplement the large liquefaction and regasification facilities. They can provide a quick turnaround response to regional markets such as the Caribbean Islands. Construction of the smaller facilities should also be smoother and less uncertain than the large facilities seen today. Financing and obtaining the regulatory permits for the smaller facilities should be an easier process compared to geopolitical and financial issues faced by most facilities currently in planning and construction phases. However, by the mid-2020s, new large-scale liquefaction capacity will be needed to meet the growing demand across the globe. If those facilities are not sanctioned by the end of the decade, the near-term feast could become a famine leading to a sharp increase in LNG prices over the course of the following decade.

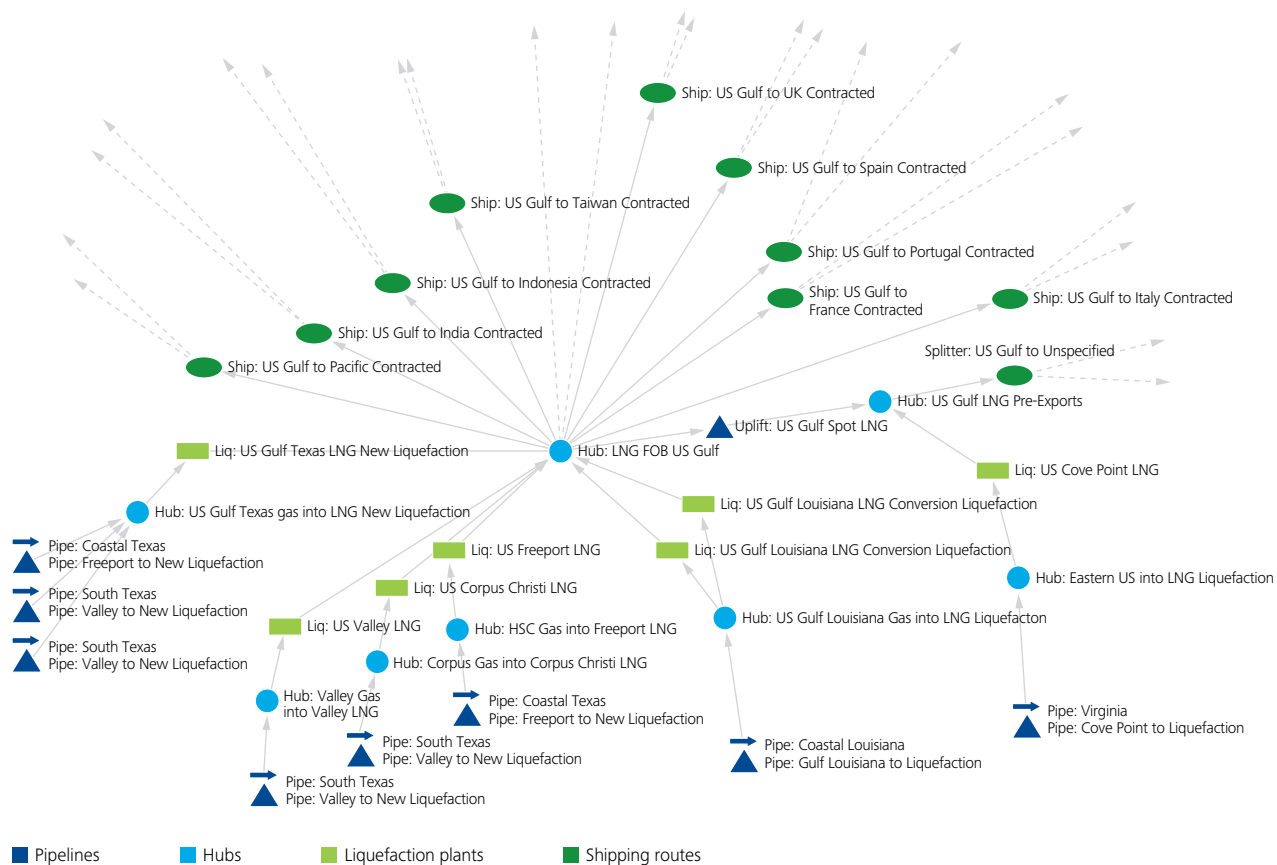
Appendix: The Deloitte MarketPoint analytical framework

The WGM is a proprietary economic model that looks at the long-term trends impacting the economic value of natural gas. It consists of disaggregated representations of the major global markets, North America, Europe, and Asia, and their linkages to other regions including LNG and piped gas. Figure 3.1 illustrates the regional structure of the model including the nodal interface between regions and sub-regions.

Each region is comprised of multiple sub-regions (e.g., countries) connected via inbound and outbound natural gas flows to surrounding sub-regions including the

international markets. The WGM includes the supply basins, gas processing facilities, pipelines, storage, LNG liquefaction or regasification infrastructure, contractual and spot market transportation, and demand for natural gas by sector in each region. The model iteratively calculates the price and flow based on market interactions until markets clear at each region and at each time period based upon self-interested agents' actions. This equilibrium determines an effective gas price, including certain non-fundamentals factors such as long-term contracts.

Figure 3.1 Regional WGM LNG structure



Source: Deloitte MarketPoint Analysis

In many cases, LNG imports and exports represent the marginal cubic foot (or million Btu), only a small percentage of the domestic gas produced or consumed. In major exporting countries or in importing countries whose imports are only seasonal, the natural gas supply curve follows the marginal cost of production for each country plus the cost of intra-country transport. For example, 9.8 bcf/d increase in US demand via LNG exports requires an increase in North American domestic production but may only lead to a marginal US\$0.05 per MMBtu increase in price due to availability of low cost of supply.

Additionally, the price of imports will likely be influenced by a region's domestic overall cost of supply as well as access to infrastructure including LNG regasification terminals and import pipelines from other regions. Europe, a net importer, supplements its own domestic production with LNG imports from multiple countries including Algeria and Qatar along with piped gas from Russia via three pipelines running through Belarus, Ukraine, or under the Baltic Sea. In this case, the overall cost of supply consists of multiple distinct regimes based on the higher costs of imported gas versus domestic production, all of which contribute to meeting demand.

The WGM represents the US as a partially closed system, with extensive pipeline infrastructure connecting the US to Canada and Mexico. The model also includes linkages to the European, African, Latin American, and Asian markets through LNG starting in 2016 with the start-up of the aforementioned Sabine Pass liquefaction plant. MarketPoint's most recent Reference Case assumes that roughly 9.8 bcf/d capacity in total will be built in the medium term, with the model developing long-term capacity growth as a function of global pricing equilibrium. This pricing equilibrium is based upon prevailing prices in the three major markets, North America, Europe, and Asia, as well as estimated shipping costs.



Endnotes

1. The World Gas Model is a configured database representing global gas markets. It is built on Deloitte MarketPoint's MarketBuilder software platform. This is a microeconomic model that analyzes supply, demand, transportation, and other aspects of the global gas and LNG markets.
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Let's talk



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Deloitte Services LP



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