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# ENERGY LAW JOURNAL

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Volume 35, No. 2

2014

## **BREAKING RULES AND CHANGING THE GAME: WILL SHALE GAS ROCK THE WORLD?**

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**Synopsis:** This article explores the evolution of shale gas impacts on global LNG markets and evaluates the implications for future change in terms of LNG trade, pricing, economics, environment, and geopolitics. The article is organized into three periods of evaluation: historical, near-term through 2020, and longer-term after 2020. It first evaluates the early historical impacts on LNG trade and markets as North American shale production has boomed in the period from 2006 through 2013. North America has not yet begun to export LNG and yet, trade and price impacts have already registered through the elimination of most of North America's previously expected import needs. Next, the article explores how the early effects may have been a harbinger of greater trade and pricing impacts to come as North American LNG exports ramp up for the period between 2015 and 2020, considering the likely evolution of global supply and demand, critical commercial developments already underway, as well as potential constraints and impediments on the near horizon. Finally, the article explores the potential long-term impacts if foreign LNG buyers are successful at importing not only North American LNG but also the underlying shale gas revolution—in terms of the technology and know-how—and industry conditions needed to achieve the sort of large scale, low cost production achieved in North America. It addresses the question of how global proliferation of shale gas production, if replicated in several shale-resource provinces worldwide, would compound the initial market, price, commercial, economic, geopolitical, and environmental impacts expected from North American LNG exports.

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\* BRG Co-Chair & Director, Energy & Natural Resources. The opinions expressed in this presentation are those of the individual author and do not represent the opinions of BRG or its other employees and affiliates. The information provided is not intended to and does not render legal, accounting, tax, or other professional advice or services, and no client relationship is established with BRG by making any information available in this presentation. The article was prepared with the assistance of Rick Chamberlain, Rebecca Honeyfield, Li Li, and Kevin Hyzak at BRG.

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## I. INTRODUCTION

North American shale gas production is changing the game for regional exploration and production, and having wide-ranging market, economic, and commercial impacts. The prospective export of North America’s new gas surpluses as Liquefied Natural Gas (LNG) under hub-indexed pricing is also breaking the historical rules of the game for LNG trade, contracts, and pricing—prospectively adding substantial surplus supply to global markets and aiding buyers to break down the historical, seller-driven pricing mechanisms for LNG sales. But the extent and timing of shale gas’ impacts on global markets is uncertain and complex.

*A. Breaking the Rules & Changing the Game*

General Douglas McArthur, the United States military leader tasked to manage the post-war occupation of Japan, once said, “rules are mostly made to be broken and are too often for the lazy to hide behind.”<sup>1</sup>

Some people never play by the rules. By breaking, bending, or ignoring established rules of the game, great entrepreneurs and innovators have redefined the way we live our lives. Over the last several decades, innovators like Bill Gates, Steve Jobs, and Ted Turner have changed the way we communicate, receive and share information, enjoy music and entertainment, obtain news, and ultimately perceive and interact with the world around us. They did this, in part, by marrying their radical ideas about how to do things better with cutting edge technological innovation. In their respective industries, each broke the rules, made new ones, and changed the way the game is played.

North American shale gas has become another industry “game changer,” and prospective LNG exports promise to “break the rules” that prevail for global LNG trade. In the United States and Canada, independent energy producers have successfully developed and refined technological solutions for oil and gas production, primarily through horizontal drilling and hydraulic fracturing (fracking), tapping into vast unconventional resources and bringing large volumes of new production to market in a highly cost-effective fashion. In so doing, these producers and technologies have already changed the game for exploration and production, at least in North America. Proposing to export North American shale resources as LNG, export terminal developers and sponsors are “breaking the rules” of global LNG trade by bringing new low-cost, hub based pricing to market. The evolving results of this disruptive activity could be revolutionary in the United States and worldwide. It positions the United States to transform itself from a net importer to a net exporter of natural gas by the end of this decade, with oil perhaps soon to follow, and it threatens to fundamentally alter global LNG commercial and pricing practices.

However, with North America’s shale revolution still less than a decade old, serious questions remain as to the future trajectory of change and the nature and magnitude of global impacts and implications. Will the fracking innovations live up to current expectations for a global “energy revolution,” or will they provide more gradual, evolutionary change? What will be the market and commercial impacts and their economic, geopolitical, and environmental implications? These are the relevant critical questions being asked throughout North America and worldwide.

The evolution of global markets during the initial years of the shale boom since 2006 provides some insight into what we should expect over the coming several years. Looking ahead as North American LNG export capacity ramps up, the remainder of this decade will provide a global testing ground for North America’s shale gas revolution, offering a preview of the ultimate impact it could have on global markets.

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1. WILLIAM A. GANOE, *MACARTHUR CLOSE-UP 137* (Vantage Press, N.Y. 1st ed. 1962).

### B. *Genie in a Bottle—Exporting Shale as LNG*

In prior presentations and publications, I have compared the export of North American shale gas as LNG to a powerful genie that is being summoned by global LNG buyers and could soon be unleashed on global markets to fulfill their wishes for lower prices, improved or reduced price indexation, and greater flexibility among other benefits.<sup>2</sup>

In fact, the expected commercial tumult threatened by this genie is already sending shock waves through LNG trade and downstream gas markets worldwide. Among other impacts, Australian LNG projects have been cancelled;<sup>3</sup> Japanese and other Asian buyers have initiated a review of pricing levels and indexation formulae that have been used in Australian LNG contracts;<sup>4</sup> Qatari suppliers have cut LNG prices for Asian buyers in response to new competition from the United States, Australia, and East Africa;<sup>5</sup> and natural gas spot prices have fallen significantly in Europe.<sup>6</sup>

But there are still significant questions about how powerful and sustained the North American LNG genie's impact will be. On the supply side, the questions regard the potential for sustained rapid growth in shale gas reserves and production in North America, and eventually worldwide, and the outlook for shale production costs. On the demand side, the crucial issue is whether demand will grow fast enough to absorb the substantial additional supply coming to market. Above all, this will depend upon the evolution of demand in Japan and Korea and the velocity of demand growth in China, India, and other emerging LNG markets in Southeast Asia, Eastern Europe, and South America.

### C. *The LNG Buyers' Wish List*

When North American shale gas is unleashed on world markets in the form of LNG, how will the genie work its magic? Increasing the supply of LNG and natural gas has the potential to produce global LNG surpluses that could yield a buyer's market in which purchasers would enjoy new supply options and enhanced negotiating power. The list of buyers' hopes and wishes is long, and not short on ambition:

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2. Christopher Goncalves & Anthony Melling, *Genie on the Loose*, LNG INDUSTRY, 1, 18 (May 2014); Christopher Goncalves, Presentation to CWC Conference: Genie in a Bottle: Introducing Henry Hub (Nov. 19, 2013) (on file with author).

3. Ross Kelly, *Woodside Shelves Browse LNG Project*, WALL ST. J. (Apr. 12, 2013), <http://online.wsj.com/news/articles/SB10001424127887323741004578417272261186816>; see also Michael Stothard, *GDF and Santos Pull Plug on Australian Floating LNG Project*, FINANCIAL TIMES (June 19, 2014), <http://www.ft.com/cms/s/0/9fc97498-f78e-11e3-b2cf-00144feabdc0.html>.

4. Ben Potter, *Japan seeks price cuts on Australian gas*, FINANCIAL REVIEW (Apr. 18, 2013), [http://www.afr.com/p/business/resources/japan\\_seeks\\_price\\_cuts\\_on\\_australian\\_Qsu6gLmWbG6HQ4vS6Z4XrK](http://www.afr.com/p/business/resources/japan_seeks_price_cuts_on_australian_Qsu6gLmWbG6HQ4vS6Z4XrK).

5. Oleg Vukmanovic, *Qatar cuts gas prices to keep competition at bay*, REUTERS (Nov. 8, 2013), <http://uk.reuters.com/article/2013/11/08/uk-qatar-lng-asia-idUKBRE9A708Z20131108>.

6. U.K., *European Natural Gas Prices Dropped Further in June*, PLATTS (July 3, 2014), <http://www.platts.com/pressreleases/2014/070314/no>.

### 1. Lower and stable prices

With increasingly ample and robust expectations for growing shale gas reserves and production, U.S. market prices have held to levels hovering around \$4 per million British Thermal Unit (MMBtu) for Henry Hub,<sup>7</sup> and in the mid-term are not expected to exceed \$5 per MMBtu.<sup>8</sup> Combined liquefaction and international shipping costs effectively match the current commodity input price and thus double the delivered ex-ship (DES) price of North American LNG to major markets in Europe and Asia.<sup>9</sup> Over recent years, European and Asian prices have respectively ranged from two to three and three to four times the level of Henry Hub prices.<sup>10</sup> Therefore, the opportunity to use a shale-driven LNG surplus to reduce future LNG procurement prices is promising for buyers and troubling for many sellers. Further, buyers expect the increased supply and higher traded volumes of LNG and natural gas in downstream markets to enhance the liquidity and stability of international gas markets; much like shale gas has already done in North America.<sup>11</sup> This increased stability and liquidity could foster critical contracting changes of interest to many buyers.

### 2. New price indices

A large volume of LNG trade is transacted under long- and mid-term, bilateral contracts in which LNG prices are indexed to oil benchmarks and products.<sup>12</sup> Shale-driven LNG surpluses could foster and deepen new LNG and natural gas hubs in Asia and Europe, leading to greater ability for buyers and

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7. The Henry Hub is a natural gas distribution hub located at the intersection of nine interstate and four intrastate pipelines. The price of natural gas is denominated in dollars per MMBtu and sets the price for natural gas commodity prices listed on the New York Mercantile Exchange (NYMEX).

8. U.S. ENERGY INFO. ADMIN., *AEO2014 EARLY RELEASE OVERVIEW 7* (Dec. 2013), available at [http://www.eia.gov/forecasts/aeo/er/pdf/0383er\(2014\).pdf](http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2014).pdf).

9. Unless otherwise referenced, the analysis provided in this article was developed by use of the author's and BRG's proprietary research, analytic methods, and forecast models, including the LNG Global Balance model (GloBal), which analyzes international supply and demand for LNG; the Shale Resource Potential model (ShaRP), which calculates shale gas production and economics in North America; and the Gas Industry Equilibrium model (GIEq), which forecasts long term North American natural gas supply, demand, pipeline and storage flows, prices, and basis differentials based on GPCM architecture [hereinafter CHRISTOPHER GONCALVES]. These models incorporate a variety of inputs for prices, volumes, contracts, demand, and supply data from several data subscription sources including: Bloomberg Professional, Waterborne LNG flows, Global LNG Info, International Energy Agency (IEA) natural gas monthly statistics, IEA Annual Reports (WEO Outlook and Natural Gas information), ICIS Heren Global LNG Market, LNG Journal, Natural Gas Intelligence (NGI shale gas daily and gas daily), SNL Energy, Energy Velocity and the GPCM® Natural Gas Forecasting Model." The underlying proprietary research and analysis is also based on public filings and information from the U.S. Federal Energy Regulatory Commission (FERC), the U.S. Department of Energy (DOE), the U.S. Energy Information Administration (EIA), the Canadian National Energy Board (NEB), the Province of British Columbia (BC Gov) and the International Group of Liquefied Natural Gas Importers (GIIGNL).

10. *Energy prices and costs in Europe*, at 168, COM (2014) 21 final (Jan. 1, 2014), available at [http://www.eerstekamer.nl/europeesvoorstel/swd\\_2014\\_20\\_part\\_3\\_commission/document/f=/vjpgj112qeqd.pdf](http://www.eerstekamer.nl/europeesvoorstel/swd_2014_20_part_3_commission/document/f=/vjpgj112qeqd.pdf).

11. "Recent developments allowing for the economic extraction of natural gas from shale formations reduce the susceptibility of gas markets to price instability and provide an opportunity to expand the efficient use of natural gas in the United States." BIPARTISAN POLICY CTR. & AM. CLEAN SKIES, TASK FORCE ON ENSURING STABLE NATURAL GAS MARKETS 9 (2011), available at [http://www.eenews.net/assets/2011/03/22/document\\_gw\\_01.pdf](http://www.eenews.net/assets/2011/03/22/document_gw_01.pdf).

12. WARNER TEN KATE, LÁSZLO VARRÓ, & ANNE-SOPHIE CORBEAU, INT'L ENERGY AGENCY, DEVELOPING A NATURAL GAS TRADING HUB IN ASIA 12 (Figure 2) (2013).

sellers to rely on spot market prices. This could provide a better reference for term contracts and a better price signal for investment and transaction decisions that would be based on the balance between supply and demand, even though this would not necessarily guarantee consistently lower prices.<sup>13</sup> Most of the new supply coming from North America will be tied to North American natural gas hub prices, primarily the U.S. Henry Hub price or the AECO Hub price for Alberta, Canada.<sup>14</sup> The ultimate importance of these natural gas hub prices for LNG contracting will depend upon the eventual volume of North American LNG exports relative to current and incremental LNG trade worldwide. I estimate that North American LNG exports could grow to represent between 15% and 20% of global LNG trade by 2020. As such, over the next half decade, the North American hub-priced supplies should dominate the incremental market for new LNG supply. Combined with the emerging LNG surpluses they would foster, they have the potential to disrupt oil-indexation practices in and stimulate preferences for hub pricing. As addressed below, however, many questions remain about which new hubs may develop in Asia and whether they, and certain existing hubs in Europe, will have the depth and liquidity needed to support global LNG trade over the longer-run.

### 3. Greater delivery flexibility

Many LNG contracts limit the buyer's ability to adjust or re-sell supplied volumes through "take-or-pay"<sup>15</sup> contracts with "destination clauses."<sup>16</sup> By fostering a shift toward more flexible arrangements, shale-driven LNG surpluses tied to U.S. Henry Hub spot prices could alter common practices for international LNG and natural gas contracts. As with most liquefaction investments, the new North American LNG terminals require long-term contracts with firm supply and offtake obligations. So far, however, these obligations have been assumed by LNG aggregators and traders (including a mix of large oil companies, leading LNG producers, and large LNG buyers) who are interested in global trade and arbitrage as well as direct supply routes.<sup>17</sup> This could enhance opportunities for delivery flexibility for the ultimate buyers.

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13. Natural gas prices tend to vary seasonally, more so in Europe without developed storage infrastructure; oil prices largely do not. JULIAN WIECZORKIEWICZ, CTR. FOR EUROPEAN POLICY STUDIES, ABOLISHING OIL INDEXATION IN GAS CONTRACTS: IS IT THE CURE-ALL? 3 (Mar. 2013), *available at* <file:///C:/Users/nas953/Downloads/JW%20Oil%20Indexation%20in%20Gas%20Contracts.pdf>.

14. The AECO price is the Canadian counterpart to the Henry Hub price in the United States. It is quoted in gigajoules and trades on the National Gas Exchange as opposed to the Henry Hub price, which is traded in MMBtu and trades on the NYMEX.

15. "Take-or-pay" contracts require buyers to commit to a minimum level of off-take or pay for any minimum volumes not taken. HOSSEIN RAZAVI, FINANCING ENERGY PROJECTS IN EMERGING ECONOMIES 130 (1996).

16. "Destination clauses" stipulate and typically limit the ultimate market destination of the gas, restricting a buyer's ability to re-sell the gas. GRAHAM D. VINTER & GARETH PRICE, PROJECT FINANCE: A LEGAL GUIDE 410 (3d ed., 2006).

17. Oleg Vukmanovic and Edward McAllister, *Exclusive: World buyers line up to buy U.S. natural gas*, REUTERS (Jan. 24, 2014), <http://www.reuters.com/article/2014/01/24/us-lng-sales-idUSBREA0N0XS20140124>.

#### 4. Increased supply security and diversification

The potential emergence of shale-driven LNG surpluses on the global market would create a cushion that offers buyers greater confidence in backup supply solutions and the overall security of LNG and natural gas supply. Such enhanced supply security would be a critical improvement for East Asian buyers, who historically have placed a high premium on the security of supply into their supply-constrained markets.<sup>18</sup> The new North American LNG would enhance supply diversification for buyers and reduce the market power and influence currently wielded by large volume supplier nations.

#### 5. Improved air quality and lower carbon emissions

Natural gas is the cleanest fossil fuel that, when combusted, emits only 54.0% and 72.5% the carbon of coal and oil, respectively, and none of the particular matter or sulfur oxide.<sup>19</sup> LNG buyers in high-growth, carbon challenged countries, such as China and India or the neighboring countries that share their air,<sup>20</sup> hope that increased access to LNG will support substantial air quality improvements and carbon reductions.

But how soon will the shale genie's magic produce results in global LNG trade and markets, or will it yield a more gradual evolutionary change? How real and how lasting is the promise of shale-driven LNG trade? What will the shale revolution actually accomplish in the LNG markets commercially, economically, and geopolitically? What will be the environmental implications?

In the United States and Canada, fourteen LNG projects with a combined total capacity of 171 billion cubic meters (Bcm) are already in the advanced stages of permitting and commercial development,<sup>21</sup> but there are several potential bottlenecks that still could stall or impede LNG exports and delay or soften the genie's market impact. As addressed below, potential bottlenecks include policy challenges, environmental concerns, financing hurdles, or disruption to trade

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18. POTEN & PARTNERS, 2015-2035 LNG MARKET ASSESSMENT OUTLOOK FOR THE KITIMAT LNG TERMINAL 4 (2010), available at <http://www.arcticgas.gov/sites/default/files/documents/km-lng-10-10-poten-partners-lng-mkt-assess.pdf>.

19. *Natural Gas*, ENVTL. PROT. AGENCY, <http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html#footnotes> (last updated Sept. 25, 2013). Some environmental groups argue that the entire life cycle emissions of shale gas exports needs to be compared to use of local coal. The DOE has published a report showing that the difference between the two is negligible. OFFICE OF FOSSIL ENERGY, U.S. DEPT. OF ENERGY, LIFE CYCLE GREENHOUSE GAS PERSPECTIVE ON EXPORTING LIQUEFIED NATURAL GAS FROM THE UNITED STATES (2014), available at <http://energy.gov/sites/prod/files/2014/05/f16/Life%20Cycle%20GHG%20Perspective%20Report.pdf>. The FERC has found that evaluating the impact of shale gas during the environmental assessment review for liquefaction terminals is too speculative and outside their jurisdiction. OFFICE OF ENERGY PROJECTS, FED. ENERGY REGULATORY COMM'N, ENVIRONMENTAL ASSESSMENT FOR THE COVE POINT LIQUEFACTION PROJECT 24, 163 (FERC issued May 2014), available at <http://www.ferc.gov/industries/gas/enviro/eis/2014/05-15-14-ea/ea.pdf>.

20. For example, due to prevailing weather patterns and proximity, the air pollution produced in Beijing has become a major contributor to air pollution in Seoul and Tokyo.

21. *Federal Approval Process for Liquefaction Natural Gas Exports*, U.S. GOV'T ACCOUNTABILITY OFFICE (Oct. 1, 2014), <http://www.gao.gov/products/GAO-14-762>; Chris Smith, *LNG UPDATE Global LNG supply, demand remain tight*, OIL & GAS JOURNAL (Apr. 7, 2014). Independent determination of project's status made after reviewing filings made with the FERC, DOE, and NEB.

routes, such as the risk of extended delay of the ongoing Panama Canal expansion project.

Over the next five years, the world market will serve as a laboratory for the North American shale gas and LNG experiment. If the remaining obstacles can be overcome, the experiment will provide a preview of the full long-term impacts shale gas could eventually have on world markets.

## II. EARLY TREMORS IN LNG TRADE FROM 2006 THROUGH 2013

Large-scale shale gas production in the United States did not begin to take off until 2006.<sup>22</sup> The evolution of global LNG markets during this period provided an early insight into the disruptive effects of shale production on global gas markets. The early impacts discussed below signal the potential for a substantial snowball of market and commercial change over the coming years.

### A. *Wagging the Dog*

From 2006 to 2013, U.S. shale gas production grew from 29 Bcm to 265 Bcm, representing an increase from 5.5% to 38.7% percent of total U.S. natural gas production.<sup>23</sup> Over these seven years, the U.S. shale revolution had a material impact on global LNG markets and trade, albeit indirect and partially offset by other major global events such as the Fukushima tragedy in Japan.

Before the shale boom became well-established in 2010, the United States was considered the global LNG import market “of last resort”<sup>24</sup>—the “tail” end of the global LNG markets (i.e., the “dog”). As the shale revolution took hold, the U.S. “tail” began to wag the global market “dog.”

As of 2006, global LNG trade remained limited, with only 221 Bcm of LNG traded annually between thirteen LNG producer countries and sixteen LNG importer nations (see Figure 1). The United States, with Alaska exporting to the Pacific Rim and the East Coast importing LNG from the Atlantic Basin, was the only nation that both imported and exported LNG.

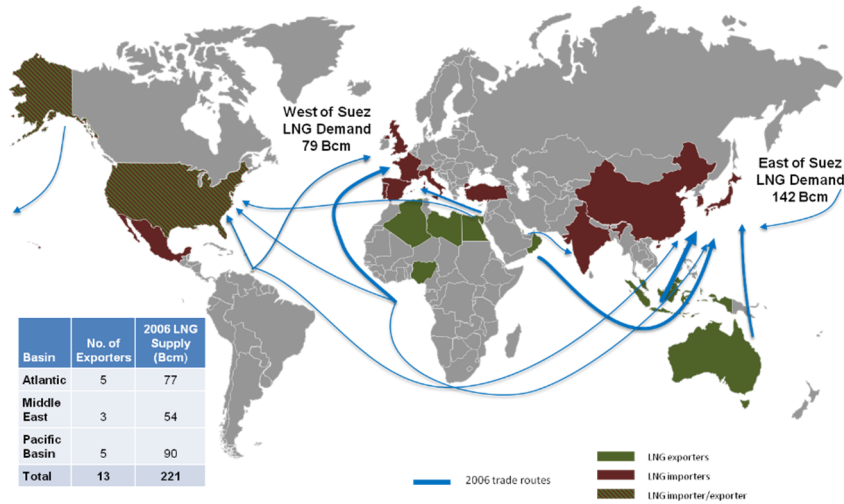
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22. IVAN SANDREA, OXFORD INST. FOR ENERGY STUDIES, US SHALE GAS AND TIGHT OIL INDUSTRY PERFORMANCE: CHALLENGES AND OPPORTUNITIES 2, (2014), available at <http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/03/US-shale-gas-and-tight-oil-industry-performance-challenges-and-opportunities.pdf>.

23. U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2014 WITH PROJECTIONS TO 2040, MT-23, FIGURE MT-44) (2014) (Figure MT-44) [hereinafter *Annual Energy Outlook 2014*], available at [http://www.eia.gov/forecasts/aeo/pdf/0383\(2014\).pdf](http://www.eia.gov/forecasts/aeo/pdf/0383(2014).pdf). 2013 shale production data represents EIA’s shale gas estimate in Trillion Cubic Feet (Tcf) which has been converted to Trillion Cubic Meters (Tcm) using 1 cubic meter equals 35.3147 cubic feet. *Interactive Units Converter*, EIA, <http://www.epa.gov/cmop/resources/converter.html>. This ratio has been used throughout the report to convert cubic feet into cubic meters.

24. U.S. ‘Last Resort Market’ for LNG, NATURAL GAS INTELLIGENCE (Nov. 12, 2007), <http://www.naturalgasintel.com/articles/17362-u-s-last-resort-market-for-lng>.





**Figure 1 Global LNG Trade in 2006<sup>25</sup>**

Over the following seven years, North American shale production indirectly contributed to a substantial reorientation of the global LNG market by removing almost all projected U.S. LNG demand from the market. It also fostered new plans by a small group of early developers to produce and export LNG from North America.

These developments have already had a material impact on LNG trade. Rapidly increasing shale production after 2006 progressively reduced the United States' appetite for imported LNG from Qatar and other supply sources. This occurred just as Qatari LNG production capacity grew to its peak,<sup>26</sup> Russia and Yemen joined the fleet of global suppliers,<sup>27</sup> and the global financial crisis and surging oil prices in 2008-2009 precipitated a global softening of energy demand.<sup>28</sup> As a result of the substantial increases in supply and weakened demand, the LNG market experienced a sustained glut in which the supplies originally earmarked for the United States had to be offloaded into Europe.<sup>29</sup> European customers were able to increase short- and mid-term LNG purchases at low spot traded hub prices to displace the flexible portion of their pipeline supplies under their long-term contracts that were subject to higher oil-indexed prices. Most recently, the tragic Japanese tsunami and Fukushima disaster of March 2011

25. CHRISTOPHER GONCALVES, *supra* note 9.

26. *Qatar*, EIA, <http://www.eia.gov/countries/cab.cfm?fips=qa> (last updated Jan. 30, 2014).

27. INT'L ENERGY AGENCY, THE IMPACT OF THE FINANCIAL AND ECONOMIC CRISIS ON GLOBAL ENERGY INVESTMENT: IEA BACKGROUND PAPER FOR THE G8 ENERGY MINISTERS' MEETING 24-25 MAY 2009 3 (May 2009), available at <http://www.iea.org/ebc/files/impact.pdf>.

28. *Id.*

29. Sook Ching Wong & Shahriar Fesharaki, *LNG Supply, Demand Weathered 2008-09, Will Recover in 2010-11*, OIL & GAS JOURNAL (Sept. 6, 2010), <http://www.ogj.com/articles/print/volume-108/issue-33/processing/lng-supply-demand.html>.

led to a significant re-tightening of global LNG markets that began to reverse these trends. As Japan's nuclear reactors were all idled by early 2012 to address security concerns,<sup>30</sup> LNG imports in that country grew a substantial 25% to support the thermal power needed to replace the lost nuclear generation.<sup>31</sup> The redoubled Japanese LNG demand has steadily absorbed the global surpluses.

By 2013, global LNG trade had increased to 327 Bcm sold by seventeen exporters, with effectively all of the incremental demand in the Pacific Basin after Fukushima (see Figure 2).

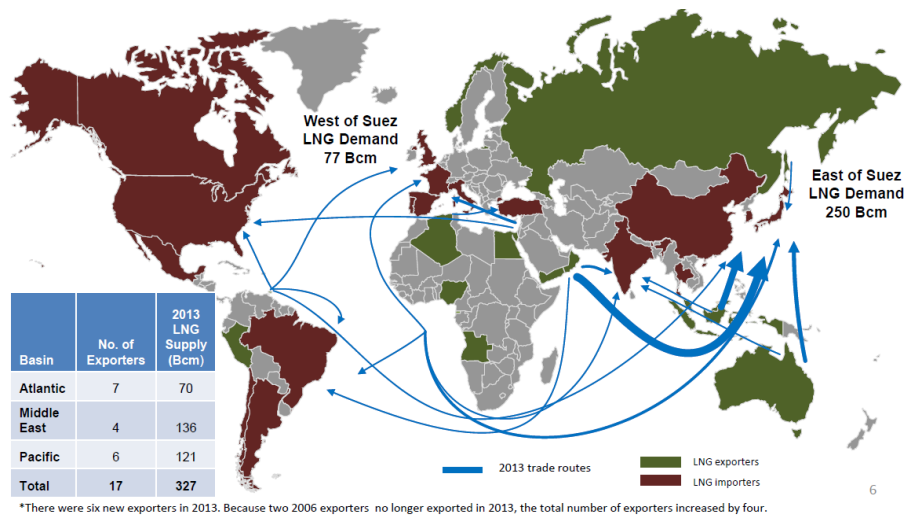


Figure 2 Global LNG Trade in 2013<sup>32</sup>

### B. Falling Prices & Volatility

In addition to re-orienting global LNG trade, the shale revolution also had indirect impacts on LNG prices. Prior to 2011, the LNG oversupply contributed to the decline of spot prices for natural gas in NW Europe and short-term prices for LNG in Asia.<sup>33</sup> Combined with sustained high oil prices and oil-indexed LNG prices (under long-term contracts), this provoked a substantial divergence between low U.S. natural gas prices and long-term LNG prices in Asia, with European prices falling in between these extremes.<sup>34</sup> The indirect effect of North American shale production on European prices appears to have been particularly strong (see Figure 3).

30. David Batty, *Japan shuts down last working nuclear reactor*, THE GUARDIAN (May 5, 2012, 7:35 AM), <http://www.theguardian.com/world/2012/may/05/japan-shuts-down-last-nuclear-reactor>.

31. Japan, EIA, <http://www.eia.gov/countries/cab.cfm?fips=ja> (last updated July 31, 2014).

32. CHRISTOPHER GONCALVES, *supra* note 9.

33. See *infra* Figure 3, *Prices for Oil, Natural Gas, & LNG*.

34. *Id.*

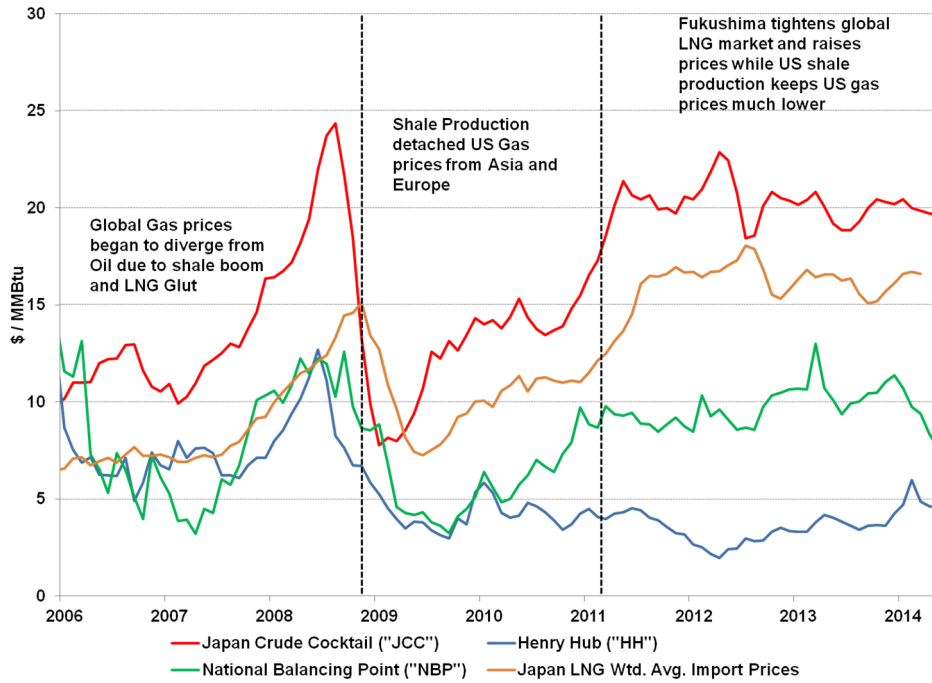
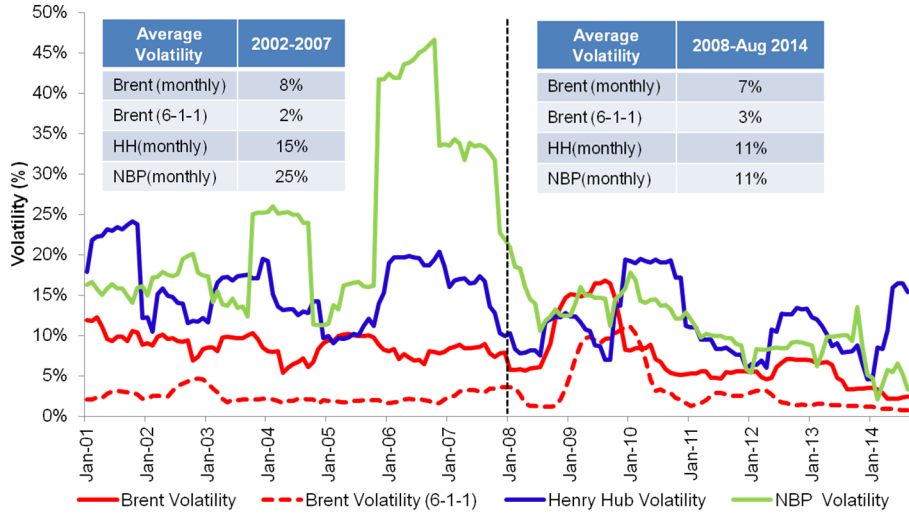


Figure 3 Price Evolution for Oil, Natural Gas, and LNG<sup>35</sup>

35. The Japan Crude Cocktail (JCC) price tracks Brent crude prices closely with a one-month lag. NBP is the liquid trading point for natural gas in the United Kingdom, which is the key price point often compared to Henry Hub (HH) in the United States. JCC was sourced from Argus Global LNG Monthly and other price data were sourced from Bloomberg.

Further, the increase in supply liquidity also improved price stability for natural gas and led to decreasing volatility in the United States and Europe (see Figure 4).



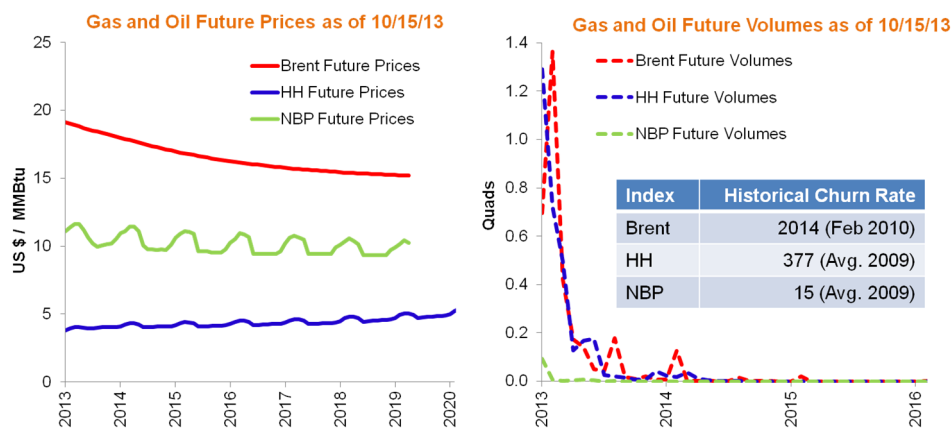
**Figure 4 Monthly Volatility based on 12-Month Moving Average<sup>36</sup>**

36. Gas and Oil Future prices and volumes are sourced from Bloomberg and ICE; volatility is calculated based on moving twelve-month of monthly returns; Brent 6-1-1 refers to rolling average Brent prices over a six-month period with a one month time lag prior to the month of application.

As natural gas price volatility has decreased and approached the lower levels associated with oil indices, such as Brent, natural gas price indices have become increasingly more compelling to international buyers as a reliable way to purchase natural gas and LNG under long-term contracts. This has been aided by market perceptions that:

(a) The divergence between oil and gas prices has become a sustainable long-term feature of global energy markets; and

(b) With U.S. LNG coming to market under Henry Hub pricing, the depth of the relevant futures markets is almost on par with major oil indices (see Figure 5), making it feasible to hedge hub priced LNG.



**Figure 5 Oil and Gas Futures Depth and Liquidity<sup>37</sup>**

### C. Reconsideration of Contracting & Indexation Practices

Another indirect impact of North American shale production on global markets has been to stimulate new thinking and creative solutions for how to contract and index prices for LNG and natural gas. As the sustainability of shale production has become increasingly more reliable, institutionalized practices have been questioned and new paradigms explored.

LNG and natural gas supply contracts have been largely oil-indexed since 1960, first in Europe where they originated and later spreading to Asia.<sup>38</sup> Indexing LNG and natural gas prices to oil price movements was initially considered a source of benefits for buyers and sellers. European sellers in Norway, Russia, and

37. Gas and Oil Future prices and volumes are sourced from Bloomberg and ICE; Historical churn rates are sourced from a presentation by Dr. Andrey Konoplyanik. Andrey A. Konoplyanok, Presentation at the European Gas Markets Summit, How market hubs and traded gas in European gas market dynamics will influence European gas prices and pricing, (Feb. 2011), available at <http://www.konoplyanik.ru/speeches/2011-4.pdf>.

38. ANTHONY J. MELLING, CARNEGIE ENDOWMENT FOR INT'L PEACE, NATURAL GAS PRICING AND ITS FUTURE: EUROPE AS THE BATTLEGROUND 9 (2010), available at [http://carnegieendowment.org/files/gas\\_pricing\\_europe.pdf](http://carnegieendowment.org/files/gas_pricing_europe.pdf).

Algeria were primarily oil producers with associated gas production.<sup>39</sup> As such, they required long-term contracts to support term investments needed to explore for, produce, and deliver natural gas. Buyers accepted oil indexation practices that guaranteed a moderate discount to the price of competing oil products, and as a way to reduce volatility—with oil markets far more liquid and less volatile than fledgling, shallow gas markets (where they even existed).<sup>40</sup>

Over recent decades, European reliance on oil-indexed contracts has substantially declined, but not disappeared.<sup>41</sup> The region's natural gas markets have become progressively deeper, more competitive, and more reliable through a combination of:

(a) Regulatory reform and increasing customer access to hub-traded prices for natural gas, especially in northwestern Europe; and

(b) Sustained efforts to diversify supply sources away from concentration on Russia, Norway, and Algeria toward sources of LNG from around the world and pipeline gas from other countries in North Africa and the Caspian region.

Meanwhile, oil prices have been substantially higher and subject to:

(a) Manipulation by the Organization of Petroleum Exporting Countries (OPEC)<sup>42</sup> and opaque trading practices;<sup>43</sup>

(b) Financial speculation;<sup>44</sup>

(c) Various forms of geopolitical risk associated with military conflict and/or political instability in major producing regions;<sup>45</sup> and

(d) A pronounced shift toward increasingly remote, difficult, and costly forms of exploration and production (deepwater, the arctic, etc.).<sup>46</sup>

There may also be a connection between shale production, global supply liquidity, and some of the geopolitical issues in gas supply contracting and delivery flexibility. European authorities have initiated an antitrust lawsuit to eliminate destination clauses in gas contracts, specifically the gas contracts of Russia's primary gas exporter, Gazprom.<sup>47</sup> In light of economic sanctions and

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39. *Id.* at 16.

40. *See generally id.*

41. *Id.* at 10-11.

42. *Crisis and Collusion: The 50 years under OPEC have been eventful*, *ECONOMIST* (Sept. 14, 2010), <http://www.economist.com/node/17031126>.

43. *Transparency and Integrity in Global Oil Markets Pricing*, PLATTS, available at <http://platts.com/IM.Platts.Content%5Caboutplatts%5Cmediacenter%5Cmediakits%5Cplattstransparencyintegritymarkets12.pdf>.

44. Luciana Juvenal & Ivan Petrella, *Speculation in the Oil Market*, (Fed. Reserve Bank of St. Louis, Working Paper 2011-027E, 2012), available at <http://research.stlouisfed.org/wp/2011/2011-027.pdf>.

45. Brad Plumer, *Nearly 4% of the world's oil supply is offline due to conflict*, *VOX* (Aug. 6, 2014, 2:56 PM), <http://www.vox.com/2014/8/6/5975157/how-conflict-in-the-middle-east-is-making-gasoline-more-expensive>.

46. Christopher Johnson, *Oil exploration costs rocket as risks rise*, *REUTERS* (Feb. 11, 2010), <http://www.reuters.com/article/2010/02/11/us-oil-exploration-risk-analysis-idUSTRE61A28X20100211>.

47. James Kanter, *Stalled Gazprom antitrust case may suggest unease for energy sanctions*, *N.Y. TIMES* (Aug. 10, 2014), <http://powersource.post-gazette.com/powersource/latest-oil-and-gas/2014/08/10/Stalled-Gazprom-Antitrust-Case-May-Suggest-Unease-for-Energy-Sanctions/stories/201408100236>.

ongoing negotiations and compromises between the parties, this lawsuit may be on the verge of resolution, although final agreement remains to be seen.<sup>48</sup> The developments in Ukraine, the further development of shale gas, and increasing global supply liquidity could have indirect implications for the prosecution of this litigation.

Unlike in Europe, Asian markets depend heavily on LNG supplies and generally have not implemented similar market and regulatory reforms. In Japan, oil-indexation practices that guaranteed a moderate discount to oil prices were initially considered prudent because oil products were the incumbent competitors in the power and industrial sectors, and supply alternatives were limited.<sup>49</sup> The same was also generally true for the other major regional LNG markets in South Korea and Taiwan. These traditions are deep-rooted and the price of LNG in Asia continues to be dominated by long-term, oil-indexed contracts and use of regional or international gas hub benchmarks remains very limited.<sup>50</sup>

Since 2006, however, the growth in North American shale gas output and enhanced supply diversification and liquidity in the LNG markets have begun to affect how LNG is contracted. Despite continued uncertainty about the future impact of shale gas on LNG markets, many market participants have made increasing use of spot market supplies and short-term contracts, which provide greater amounts of current delivery flexibility, diversion options, and/or destination flexibility and also allow for future flexibility (through new contracts) as markets are expected to change. Buyers have not wanted to continue the historical practice of locking into mid- and long-term oil indexed supplies with destination restrictions.

Whereas short-term and spot supplies typically comprise a small portion of the supply portfolios for security-conscious Asian buyers, their preference for these supplies has become pronounced since 2010,<sup>51</sup> as the number and progress of North American LNG export projects has increased. In 2010, the East of Suez LNG markets fell into a significant supply deficit (after years of relative balance in 2006-2009).<sup>52</sup> This deficit situation was soon compounded by the Japanese tsunami and nuclear shutdowns of late 2011 and early 2012. Despite the deficit, most of the new supply during this period consisted of spot market supplies and short-term contracts, which increased by ~54 Bcm from ~17 Bcm in 2010 to ~71 Bcm in 2013, whereas the East of Suez long- and mid-term contracts only increased by ~5 Bcm, from ~174 Bcm in 2010 to ~179 Bcm in 2013.<sup>53</sup>

By comparison to Asia and the East of Suez markets, Europe and the West of Suez markets did not need incremental supply as they grew to have a material surplus. In 2010, there were over 22 Bcm spot LNG supplies and short-term contracts, but then demand declined as supply increased.<sup>54</sup> By 2013, long-term

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48. *Id.*

49. Warner ten Kate et al., *supra* note 12, at 17.

50. *Id.*

51. CHRISTOPHER GONCALVES, *supra* note 9.

52. *Id.*

53. *Id.*

54. *Id.*

contracts exceeded demand by ~16 Bcm,<sup>55</sup> so there was no need for incremental supply of any contract duration. Different from Asia, there was little need for short-term or spot LNG to bridge to future supplies from North America. Further, as most of the northwest European LNG contracts were already hub-priced and many of the southern European contracts indexed to Brent oil prices were well below Asian oil-indexed prices and closer to European hub price levels, European buyers had less commercial interest than Asian buyers to use short-term supplies to reduce supply costs.

Looking forward, both Asian and European buyers are keen to add U.S. hub-indexed supplies to their future portfolios. As of 2014, there has been approximately 86 Bcm LNG contracted with U.S. export terminals and approximately ~28 Bcm contracted with Canadian export terminals, including known long-term sales and purchase agreements (SPAs), memorandums of understanding (MOUs), and heads of agreement (HOAs).<sup>56</sup> The combined 114 Bcm of North American contracts includes ~62 Bcm for East of Suez buyers, ~21 Bcm for West of Suez buyers, and ~31 Bcm for LNG traders and aggregators who are using the new supplies for their global trading portfolios.<sup>57</sup>

The early impacts of North American shale gas production on LNG trade suggest a potential snowball of impacts once U.S. LNG exports commence and begin to grow.

### III. LIQUEFIED SHALE GAS—READY TO ROCK THE WORLD BY 2020?

Over the second half of this decade, several U.S. LNG export projects are poised to introduce large volumes of hub-priced LNG to the global market as their offtakers aim to take advantage of high “shale spreads”—the difference in price between low U.S. shale-driven gas prices and the delivered price of LNG in the Atlantic and Pacific markets.<sup>58</sup> This will test the initial impacts of North American LNG export on global LNG and natural gas markets.

These results, in turn, will provide further insights into what could occur over the longer term if the North American shale revolution can be expanded at home and/or replicated in other global markets such as China, the United Kingdom, Continental Europe (West and/or East), Australia, Argentina, and/or other key shale resource provinces worldwide.

#### A. *Increasing Global Supply*

Over the second half of this decade, most of the world’s incremental LNG supply is expected to come from Australian liquefaction projects already under construction and from new U.S. terminals under development due to a substantial

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55. *Id.* Spot LNG market supplies and short-term contracts are calculated to be equal to total historical LNG demand minus long-term and mid-term LNG contracted capacity under final contracts, excluding HOA and MOU preliminary agreements.

56. *Id.*

57. CHRISTOPHER GONCALVES, *supra* note 9.

58. The author previously coined the terms ‘shale spread,’ ‘Pacific shale spread,’ and ‘Atlantic shale spread’ at a CWC Conference in November 2011.



cost advantage.<sup>59</sup> Therefore, a critical question for global supply regards how much low-priced LNG the United States can export and for how long.

As the shale revolution has deepened, U.S. demand for natural gas has begun to grow rapidly. Low-priced natural gas is increasingly used to produce electricity, because it has become cost competitive with coal and also provides a reliable and flexible complement to intermittent renewable energy generation.<sup>60</sup> Natural gas has also stimulated the beginnings of an industrial renaissance because it provides a source of international competitive advantage for fuel-intensive industries such as petrochemicals, chemicals, and metals. Transportation uses for natural gas are also beginning to grow as short-range trucking fleets begin converting from diesel.<sup>61</sup> In my analysis, U.S. indigenous natural gas demand could reach 770 Bcm per year by 2020.<sup>62</sup>

In addition to satisfying these increasing demands for natural gas, shale gas must compensate for substantial declines in conventional natural gas production of approximately 50 Bcm by 2020.<sup>63</sup>

The economics of shale production suggests that high volumes of low cost output will be sustainable for several decades to come. In my analysis, approximately one-third of all resources in the lead plays are the most economic classes of shale wells (Class I and II wells). Additionally, many U.S. fields contain valuable Natural Gas Liquids (NGLs) that reduce the net costs of dry gas and LNG production. A recent BRG illustrative scenario analysis for the long-term, all-in production costs of these “sweet spots” in the major U.S. shale plays is provided in Figure 6.

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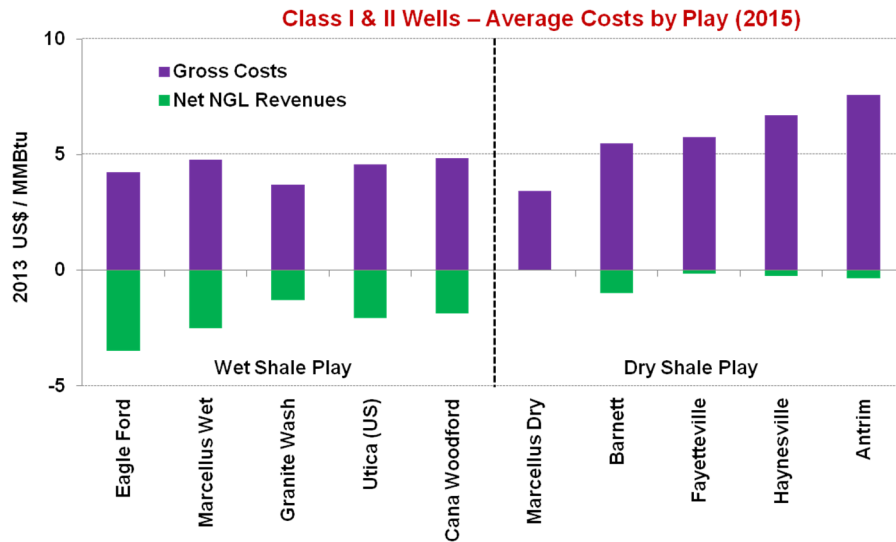
59. CHRISTOPHER GONCALVES, *supra* note 9.

60. *Natural Gas Consumption by End Use*, EIA, [http://www.eia.gov/dnav/ng/ng\\_cons\\_sum\\_dcu\\_nus\\_a.htm](http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm) (last visited Aug. 7, 2014).

61. *See generally United States, Overview data for United States*, EIA, <http://www.eia.gov/countries/country-data.cfm?fips=US&trk=m> (last updated May 30, 2013).

62. U.S. domestic gas demand includes commercial, electric, industrial, residential, and natural gas vehicle gas demand as well as lease and plant fuel and pipeline fuel. *See generally supra* note 56.

63. CHRISTOPHER GONCALVES, *supra* note 9.

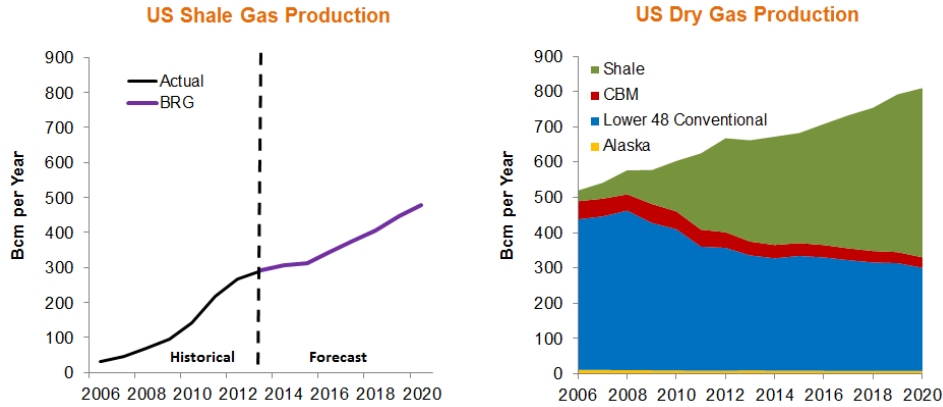


**Figure 6 Illustrative All-In Economics for Shale Play Sweet Spots<sup>64</sup>**

This recent winter (2013-2014), extreme bouts of cold demonstrated the resilience of shale gas production and delivery. The resulting price spikes were temporary and all supply outages were quickly alleviated. This provided an important indication of reliability as the United States transitions to reliance on shale gas for a majority of its natural gas demand.

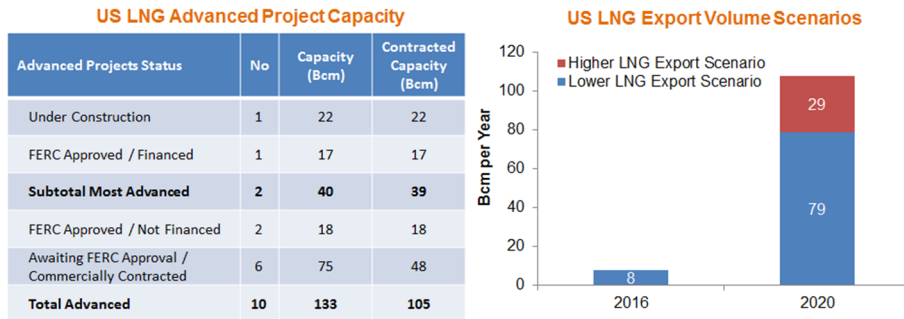
My analysis indicates that U.S. shale gas resources are more than adequate to support continued economic shale production. Already by 2020, I project that shale production will grow to 500 Bcm from current levels of 300 Bcm (see Figure 7), increasing from 43% of total U.S. natural gas production in 2013 to 59% by 2020.

64. *Id.*



**Figure 7 U.S. Shale and Dry Gas Production<sup>65</sup>**

In addition to supplying ~770 Bcm of domestic demand, this increased production will allow for the prospect of significant exports from the United States. It is likely that the level of U.S. LNG exports could reach 100 Bcm (or more) by 2020 (see Figure 8), representing between 20% and 25% of the global LNG trade. By comparison, Qatar currently accounts for approximately 35% of global LNG trade.<sup>66</sup>



**Figure 8 U.S. LNG Advanced Projects Status<sup>67</sup>**

My forecasts indicate that price impact from the higher LNG export scenario adds only tens of cents per MMBtu to lower export scenarios.

Additional new LNG production for the 2015 to 2020 period is under development and construction in Australia and East Africa. These new supplies

65. *Id.*; see also supporting data from *Annual Energy Outlook 2014*, *supra* note 23.

66. *FAQs: Natural Gas*, IEA, <http://www.iea.org/aboutus/faqs/gas/> (last visited Oct. 10, 2014).

67. See generally *supra* note 21.

could add 103 Bcm of new supply to global markets by 2020,<sup>68</sup> but their development has already been challenged by the success of North American shale production and LNG exports. Australia, for example, has already shelved planned liquefaction projects with a total capacity of nearly 10 Bcm.<sup>69</sup>

These sources also compete with each other. Australia is also facing competition from East Africa, where giant reserves of natural gas have been discovered in Tanzania and Mozambique and the cost to build new LNG export facilities is estimated to be about half the cost of similar plants in Australia.<sup>70</sup> Mozambique and Tanzania are ideally situated to supply gas to the Pacific market, especially the West Indian coast. Mozambique is aiming to start liquefaction terminal operations in 2018, with capacity to export approximately 14 Bcm of LNG annually, after an estimated two-year ramp-up period.<sup>71</sup> It is unlikely that Tanzania will be able to export any LNG before 2020.<sup>72</sup>

Because of the intensified global supply competition to Australian LNG from the United States and East Africa, Japanese buyers have been able to negotiate price reductions with Australian producers. This has dampened investor enthusiasm for the large capital outlays needed for Australia's large-scale, integrated exploration and production (E&P) and LNG export projects. A toxic brew of escalating costs,<sup>73</sup> public backlash,<sup>74</sup> lack of developed infrastructure to support production in remote areas,<sup>75</sup> and "relative uncertainty around geology and reserve estimations"<sup>76</sup> have escalated the investment risks for these projects and thereby reduced the outlook for expected LNG export volumes over the mid- to long-term.

My analysis of future global LNG supply scenarios accounts for the supply dynamics and competitive risks described above. Under a range of scenarios for LNG production from North America, Australia, and East Africa, I estimate that

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68. CHRISTOPHER GONCALVES, *supra* note 9.

69. Ross Kelly, *Woodside Shelves Browse LNG Project*, WALL ST. J. (Apr. 12, 2013), <http://online.wsj.com/news/articles/SB10001424127887323741004578417272261186816>; *see also* Michael Stothard, *GDF and Santos pull plug on Australian floating LNG project*, FINANCIAL TIMES (June 19, 2014), [http://www.ft.com/intl/cms/s/9fc97498-f78e-11e3-b2cf-00144feabdc0,Authorised=false.html?\\_i\\_location=http%3A%2F%2Fwww.ft.com%2Fcms%2Fs%2F0%2F9fc97498-f78e-11e3-b2cf-00144feabdc0.html%3Fsiteedition%3Dintl&siteedition=intl&\\_i\\_referer=#axzz3FPy5EJJu](http://www.ft.com/intl/cms/s/9fc97498-f78e-11e3-b2cf-00144feabdc0,Authorised=false.html?_i_location=http%3A%2F%2Fwww.ft.com%2Fcms%2Fs%2F0%2F9fc97498-f78e-11e3-b2cf-00144feabdc0.html%3Fsiteedition%3Dintl&siteedition=intl&_i_referer=#axzz3FPy5EJJu).

70. Eduard Gismatullin & James Paton, *Africa Gas Rush Imperils \$100 Billion in Australian LNG*, BLOOMBERG (Apr. 30, 2012), <http://www.bloomberg.com/news/2012-08-29/africa-gas-rush-imperils-100-billion-in-australian-lng.html>.

71. Nadja Kogdenko, *East Africa: the newest LNG frontier*, LNG INDUSTRY (Oct. 3, 2014), [http://www.lngindustry.com/news/special-reports/articles/East\\_Africa\\_as\\_the\\_newest\\_LNG\\_exporting\\_frontier.aspx#.U\\_S\\_kPldW4I](http://www.lngindustry.com/news/special-reports/articles/East_Africa_as_the_newest_LNG_exporting_frontier.aspx#.U_S_kPldW4I).

72. *Id.*

73. Sonali Paul, *High-cost Australia may miss \$180 bln LNG expansion wave*, REUTERS (Apr. 10, 2014), <http://www.reuters.com/article/2014/04/10/australia-lng-idUSL3N0MZ1XB20140410>.

74. Andrew Carter, Embassy of Austl., Unconventional Energy & Hydraulic Fracturing in Australia 7, (2013) (on file with author).

75. *Id.*

76. *Id.*

global LNG supply could increase approximately 230 to 250 Bcm by 2020, representing an approximate 70% to 75% increase over total LNG trade in 2013.<sup>77</sup>

### B. Uncertain Global LNG Demand Growth

Whereas mid-term global LNG supply will largely be driven by North America, future global demand growth will be driven by the major markets in East Asia and a wide array of new LNG terminals throughout Southeast Asia, Eastern Europe, and Latin America.

In 2014, Japan, South Korea, and China comprised 62% of global LNG demand.<sup>78</sup> Japan and South Korea are both isolated markets with limited natural resources, so they are ideal markets for LNG. However, Japan is now working on programs to steadily restore some of the nuclear generation that was shut down after the 2011 tsunami<sup>79</sup> and South Korea is aggressively developing new nuclear capacity,<sup>80</sup> both of which would reduce future needs for LNG.

After the Fukushima disaster, Japan shut down 49 GW of nuclear capacity and replaced it with imported oil, coal and LNG, of which the additional LNG represented an increase of 25% or 23 Bcm (0.8 Tcf/yr) from 2010 to 2013.<sup>81</sup> In the short-term, the slow pace of Japanese nuclear restarts will have a marginal impact on global LNG demand. However, restarting all the idled reactors over the long-run (beyond 2020) could displace up to ~55 Bcm of imported LNG, assuming the same mix of fuels used to replace idled nuclear plants is displaced when they restart.<sup>82</sup>

Conversely, South Korea currently has 6.9 GW of new nuclear capacity under construction and an additional 8.7 GW planned for future construction.<sup>83</sup> Combined, the South Korean nuclear additions could reduce global LNG demand by 10-15 Bcm in the long run, depending upon the mix of LNG and other fuels displaced by the new nuclear capacity.<sup>84</sup>

Collectively, the nuclear developments in Japan and South Korea could help resolve the current supply deficit in the East of Suez markets, and thus reduce Pacific shale spreads by 50% or more toward pre-2010 levels that are more

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77. CHRISTOPHER GONCALVES, *supra* note 9.

78. Takayuki Kato, *China, Japan, South Korea gulp down 62% of global LNG production*, NIKKEI ASIAN REVIEW (May 2, 2014), <http://asia.nikkei.com/Markets/Commodities/China-Japan-South-Korea-gulp-down-62-of-global-LNG-production>.

79. *Nuclear Power in Japan*, WORLD NUCLEAR ASS'N, <http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Japan/> (last updated Sept. 30, 2014). A "high case" developed by Itochu has Japan restarting thirty-five reactors within five years. *Id.*

80. *Nuclear Power in South Korea*, WORLD NUCLEAR ASS'N, <http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/South-Korea/> (last updated Sept. 25, 2014).

81. "Japan's overall LNG imports rose about 25% between 2010 and 2013, from nearly 3.4 Tcf/y to 4.2 Tcf/y." *Japan*, *supra* note 31.

82. CHRISTOPHER GONCALVES, *supra* note 9. Nuclear energy displaces demand for a mix of energy resources that include but are not limited to LNG.

83. Andrew D. Paterson & Walter S. Howes, *Policy and Market Factors Shaping National Nuclear Strategies: Part II of 'Redefining Leadership in Global Nuclear Energy Markets'*, ENVTL. BUSINESS J., 1, 35 (2014).

84. CHRISTOPHER GONCALVES, *supra* note 9. Nuclear energy displaces demand for a mix of energy resources that include, but are not limited to, LNG.

consistent with the liquefaction and shipping costs need to move LNG from North America to Asia.

LNG suppliers are betting that China's overall economic and energy demand growth will yield enough additional LNG demand to more than offset decreased demand from Japan and South Korea. China's electric energy demand is expected to increase over 60% in less than ten years, from 4,476 Terawatt-hours (TWh) in 2011 to 7,295 TWh in 2020.<sup>85</sup> Further, China has made it a national priority to improve air quality<sup>86</sup> while meeting increasing demand, which bodes well for natural gas because it will require replacing coal with clean energy sources in the power generation, industrial, and home heating sectors. Among the key options, China is aggressively developing renewable energy and natural gas production, as needed to complement intermittent renewable energy sources. For natural gas supply, China is working to develop its own formidable shale gas resources as well as constructing pipelines to import natural gas from Russia, Central Asia, and Myanmar.<sup>87</sup> As a result, I expect natural gas demand in China to increase by 131-199 Bcm by the end of this decade, reflecting growth of 9%-12% a year.<sup>88</sup>

How much of China's natural gas demand growth will be met by LNG will depend on China's success with indigenous shale gas development and pipeline imports. Recent indications show China will not be able to rely on as much indigenous shale gas production as originally envisioned. The Chinese government recently has scaled back official projections for shale gas production from 80 Bcm to 30 Bcm by 2020,<sup>89</sup> which is much more consistent with my own conservative forecasts. As a result, my analysis indicates that Chinese demand growth will require additional LNG imports of between 25 and 54 Bcm by 2020.<sup>90</sup> This level of new LNG imports would partially, but not fully, offset the impact of nuclear policies in Japan and Korea.

In addition to China, new regasification terminals and/or new markets for LNG in Southeast Asia (including India), Eastern Europe, and South America could add multiples of the incremental demand expected from China. Overall, I expect these emerging LNG markets to account for between 90 and 143 Bcm of new demand by 2020, reflecting approximately 60% of global LNG demand growth.<sup>91</sup> Among the major emerging markets for LNG in Southeast Asia, India and Indonesia alone should be able to absorb approximately 40-50 Bcm of new supply. The remainder of incremental demand is scattered amongst a wide array of new terminals under various stages of development in numerous new or small LNG markets. This potential demand is subject to a variety of uncertainties and

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85. *Id.*

86. Jennifer Duggan, *Beijing to spend £76bn to improve city's air quality*, THE GUARDIAN (Jan. 23, 2014), <http://www.theguardian.com/environment/chinas-choice/2014/jan/23/china-beijing-authorities-measures-tackle-air-pollution>.

87. *China*, EIA, available at <http://www.eia.gov/countries/analysisbriefs/China/china.pdf> (last visited Oct. 4, 2014).

88. CHRISTOPHER GONCALVES, *supra* note 9.

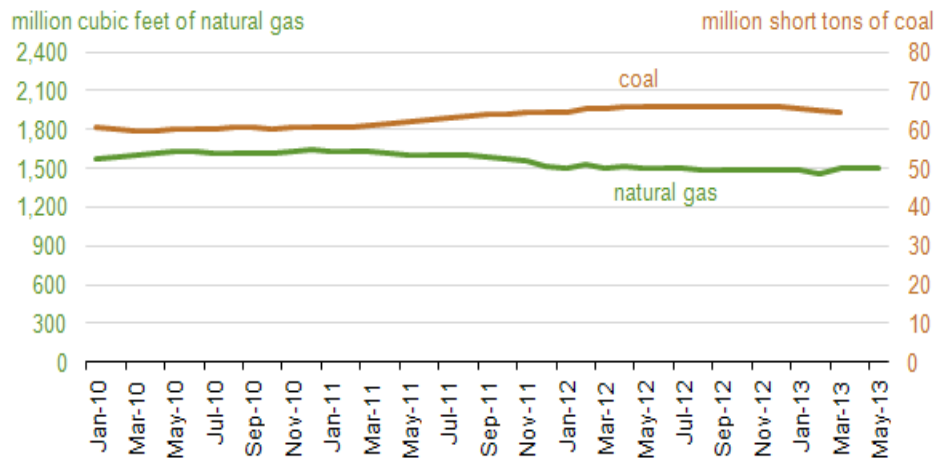
89. Chen Aizhu, Judy Hua, & Charlie Zhu, *China finds shale gas challenging, halves 2020 output target*, REUTERS (Aug. 7, 2014, 8:54 AM), <http://mobile.reuters.com/article/idUSKBN0G71FX20140807?irpc=932>.

90. CHRISTOPHER GONCALVES, *supra* note 9.

91. *Id.*

completion risks related to off taker credit, downstream market structure, natural gas pricing, sector regulations, takeaway and grid pipeline adequacy, and other issues. The speed with which this LNG demand can develop and the prices customers may require to switch to LNG and natural gas will be critical considerations.

In contrast to Asia, Europe's natural gas markets continue to be relatively stagnant due to sustained economic slowdown and higher gas prices relative to cheap coal available from the United States. Energy demand in Europe (EU-28) has declined since 2009<sup>92</sup> and further declines are more likely than increases in the near- to mid-term. For example, BP has forecast that "[e]nergy demand in the EU has peaked and is expected to fall by 6% by 2035."<sup>93</sup> In addition to the general decrease in European energy demand, natural gas consumption has been losing ground to cheap coal imported from the United States,<sup>94</sup> where it has been displaced by cheap shale gas production.



**Figure 9 Europe Natural Gas and Coal Consumption, 12-month moving averages<sup>95</sup>**

92. The EU-28 countries include: Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, and the United Kingdom. *EU-28 Final Energy Consumption*, EUROSTAT, available at [http://epp.eurostat.ec.europa.eu/statistics\\_explained/images/a/af/Final\\_energy\\_consumption%2C\\_1990%E2%80%932012\\_%28million\\_tonnes\\_of\\_oil\\_equivalent%29\\_YB14.png](http://epp.eurostat.ec.europa.eu/statistics_explained/images/a/af/Final_energy_consumption%2C_1990%E2%80%932012_%28million_tonnes_of_oil_equivalent%29_YB14.png).

93. *BP Energy Outlook 2035: EU*, BP PLC, available at [http://www.bp.com/content/dam/bp/pdf/Energy-economics/Energy-Outlook/Regional\\_insights\\_European\\_Union\\_2035.pdf](http://www.bp.com/content/dam/bp/pdf/Energy-economics/Energy-Outlook/Regional_insights_European_Union_2035.pdf).

94. *Multiple factors push Western Europe to use less natural gas and more coal*, EIA (Sept. 27, 2013), <http://www.eia.gov/todayinenergy/detail.cfm?id=13151>.

95. *Id.*

As a result, continental European LNG buyers and sellers have been diverting and reloading LNG cargoes for delivery to Asia.<sup>96</sup> This has continued recently despite lower seasonal demand in Asia during the summer of 2014. Conversely for the UK market meanwhile, Qatari suppliers have been redirecting Pacific-bound supplies due to the softening seasonal demand in Asia.<sup>97</sup> Over the mid-term, European markets anticipate little indigenous demand pull for LNG, but there could be increasing volumes of surplus supply put into the market if a global glut develops and prices drop.

Therefore, it appears that the only near-term development that could substantially increase European demand for LNG imports would be significant and/or sustained hostilities between Russia and Ukraine that cause an interruption of Russian pipeline deliveries of natural gas to Europe. Europe depends on Russia for approximately 162 Bcm or 30% of its natural gas supply.<sup>98</sup> Approximately half of this Russian supply transits Ukraine via pipeline.<sup>99</sup> Any disruption to the Ukraine delivery corridor could cause LNG import demand to spike to displace any loss of Russian supplies.

Over the longer term, an interruption of Russian supplies via Ukraine could also stimulate efforts to develop shale gas throughout Europe, as discussed below in Section IV.

### C. Potential for LNG Surpluses

On balance, our global market analysis indicates a high probability for the development of a material market surplus by the end of this decade. As the new U.S. and Australian LNG volumes come to market by 2020, LNG supplies will probably grow more quickly than demand. This will soon resolve the prevailing tight market conditions that emerged after the Japanese tsunami. It is also likely to yield substantial market surpluses by the end of the decade.

Figure 10 provides a range of possible market scenarios, with the most likely outcome somewhere between the two.

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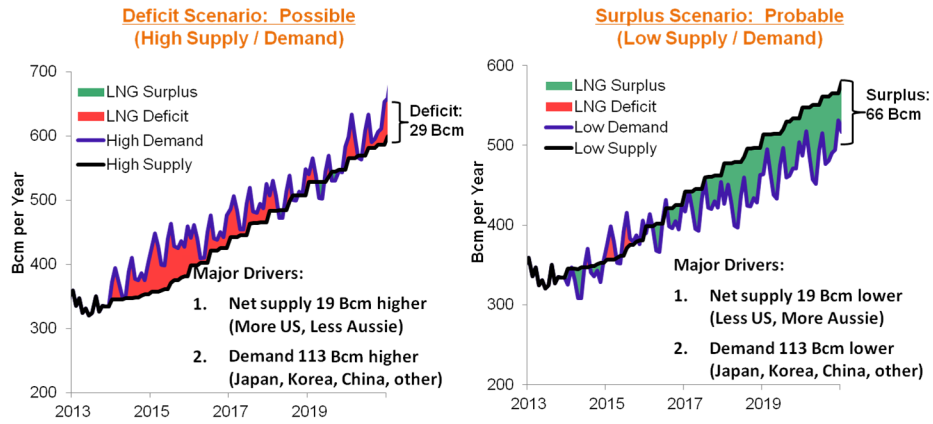
96. Florence Tan, *GDF Suez says diverts 25 pct of Europe LNG to Asia*, REUTERS (Sept. 25, 2010), available at <http://asiapacific.cwlng.com/wp-content/uploads/2013/10/25.9.2013-Reuters-GDF-Suez-says-diverts-25-pct-of-Europe-LNG-to-Asia.pdf>.

97. Isis Almeida & Anna Shiryaevskaya, *LNG Shipments Diverted From Asia Drive U.K. Price Drop*, BLOOMBERG (July 17, 2014), <http://www.bloomberg.com/news/2014-07-16/lng-shipments-diverted-from-asia-drive-u-k-price-drop.html>.

98. *Russian Gas Imports to Europe and Security of Supply—Factsheet*, CLINGENDAEL INT'L ENERGY PROGRAMME (Mar. 7, 2014), available at <http://www.clingendaelenergy.com/files.cfm?event=files.download&ui=9C1DEEC1-5254-00CF-FD03186604989704>.

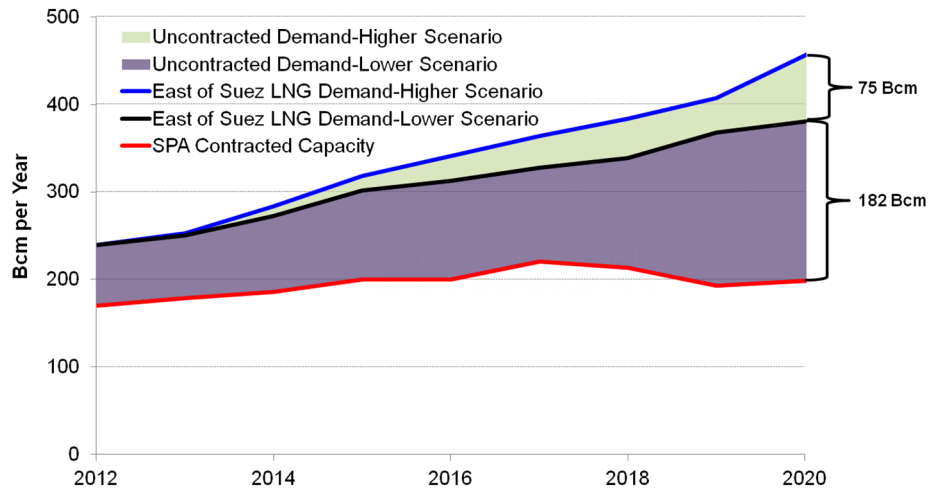
99. *Id.*





**Figure 10 Global LNG Supply-Demand Balance<sup>100</sup>**

Even after Asian buyers signed a series of new U.S. LNG supply agreements in recent years, there is still a large volume of future demand that remains uncontracted. By my estimate, this could range from 182 to 257 Bcm (as presented in Figure 11 below), representing a mix of new demand growth and existing demand subject to contract expiry and replacement.

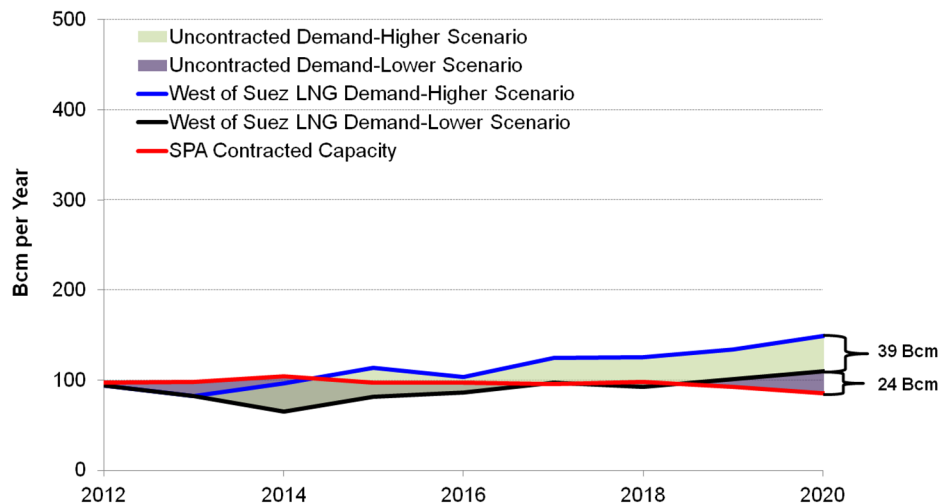


**Figure 11 Uncontracted Demand East of Suez<sup>101</sup>**

100. CHRISTOPHER GONCALVES, *supra* note 9.

101. *Id.* SPA Contracted Capacity excludes short-term SPAs and aggregator contracts for short-term trade.

By contrast to Asia, European LNG demand has weakened and the West of Suez markets probably will be over-contracted for several more years. This should continue to support European cargo diversions and re-loadings to supply East of Suez markets in the short-term. By 2020, however, this over-supply should be corrected and, in my analysis, Europe could add 24 to 63 Bcm of uncontracted demand to the global balance (see Figure 12 below). This assumes no increase in European LNG demand due to the Ukraine conflict and potential interruption of the flow of natural gas through Ukraine.



**Figure 12 Uncontracted Demand West of Suez<sup>102</sup>**

In short, the historical surplus West of Suez will be compounded and a new commercial surplus could emerge East of Suez due to the substantial new Australian LNG and the U.S. capacity that is contractually destined to Asian clients. The new East of Suez LNG surpluses will come at a time that presents buyers with substantial opportunity for commercial change.

#### *D. Potential Buyers' Market for LNG*

The timing of these developments is proving favorable for buyers. The new demand growth and contract expiry are bringing buyers to market for new supplies at the same time as the emerging market surpluses are likely to mount. Some of the negotiations for new LNG supplies toward the end of the decade are already well underway so the commercial impacts are already beginning to take shape.

In the current market, new contract negotiations present buyers with new opportunities to adjust pricing levels and practices, flexibility and destination provisions, diversion rights, term of supply, and other critical commercial provisions. Buyers are gaining traction on the terms and conditions they seek for

102. *Id.* SPA Contracted Capacity excludes short-term SPAs and aggregator contracts for short-term trade.

mid-to long-term LNG contracts and beginning to close supply deals with Henry Hub indexation, lower slopes to oil, greater flexibility provisions, and so forth.

As compared to historical conventions for international LNG supply contracts and fully oil-indexed prices, the new U.S. contracts typically offer more delivery and destination flexibility, lower price levels and greater price stability through a greater fixed price component (for liquefaction costs), and reduced variable price component (for hub price pass through).

New contracts and re-contracting allow for substantially more commercial change than can be accomplished through traditional price review procedures—under which buyers and sellers can periodically review and adjust price levels, and occasionally indexation practices, through bilateral negotiation, or failing that, international arbitration. As a result of these benefits, large Asian and European buyers are snapping up increasing volumes of U.S. LNG for commercial diversification and negotiation leverage purposes. These purchases are primarily commercial and opportunistic in nature and do not always reflect a physical need for more supply. By replacing their expiring high priced, oil-indexed international contracts with new, low priced, hub-indexed U.S. contracts, buyers hope to use the new U.S. LNG supplies to extract greater price and volume flexibility from incumbent suppliers. This commercial interest in the new LNG supplies will yield physical surpluses, forcing incumbent suppliers to quickly find new markets for existing production or yield to reduced competitive pricing requirements.

The arrival of U.S. LNG and LNG surpluses on the near horizon is also stimulating and/or accelerating critical Asian initiatives to establish the traded price references and hubs needed to move away from oil-indexation:

(1) Platts began publishing a price benchmark for natural gas, the Japan Korea Marker (JKM), in February 2009 based on its evaluation of the prices paid for physical cargoes.<sup>103</sup> So far, the JKM lacks liquidity and transparency but is nevertheless used for short-term transactions and, recently, at least one term contract.<sup>104</sup> Current efforts aim to deepen this market.

(2) An over-the-counter (OTC) market for LNG futures—the Japan OTC Exchange (JOE)—has also been established, given official permission to open on May 20, 2014.<sup>105</sup> Although this does not provide a proper hub trading platform, it could pave the way for regional pricing. Also, combined with U.S. futures contracts for Henry Hub prices, a Japanese LNG futures contract could eventually enable North American LNG sellers and buyers of supplies to Asia effectively to hedge the “shale spreads” that are so critical to this new trade.

(3) Singapore is also developing the infrastructure and platforms to become East Asia’s LNG hub. Singapore is attempting to create a virtual hub based on shipping and liquefaction rather than pipeline junctions, as pipeline networks are

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103. Warner ten Kate et al., *supra* note 12, at 67.

104. *Id.*

105. *Japan OTC Exchange Receives Regulatory Permission to Open Market*, JAPAN OTC EXCHANGE, INC. (Mar. 20, 2014), available at [http://www.j-otc.com/en/pdf/Release\\_140520\\_Permission.pdf](http://www.j-otc.com/en/pdf/Release_140520_Permission.pdf).

limited in the Pacific.<sup>106</sup> Currently Singapore's shipping ports have annual capacity of nearly 9 Bcm, which is being expanded to 13 Bcm.<sup>107</sup>

Unlike Asia, European LNG imports and pipeline border pricing practices have already evolved to reflect a broad mix of:

(1) On the one hand, hub-pricing and indexation—primarily to the National Balancing Point (NBP) in the UK and the Transfer Title Facility (TTF)<sup>108</sup> in the Netherlands—above all in the UK and northwestern European markets, and

(2) On the other hand, the continued use of oil indexation (to Brent crude or other products) in most of the markets of Southern and Eastern Europe.

The United Kingdom's NBP has long been the dominant gas hub for Northern Europe,<sup>109</sup> but most recently has been losing substantial trading volumes to the TTF for two reasons: (1) The Netherlands is closer to Germany, the largest natural gas importer in Europe; and (2) the British hub trades in Pounds sterling while many European utility companies prefer to hedge in Euros.<sup>110</sup>

Over the second half of this decade, the likely synchronous emergence of uncontracted demand and global LNG surpluses should further stimulate the expanded use of hub pricing in Continental Europe. Depending upon the volume of LNG supply and price pressure, and other developments regarding Russian supply via Ukraine, it is also possible that increasing volumes of hub-priced LNG could accelerate the transition away from oil-indexation in Europe.

### *E. Potential Bottlenecks*

The emerging commercial benefits to global consumers of North American shale production and LNG exports promise to be substantial, but they are not guaranteed and several potential bottlenecks could get in the way. Despite the number of U.S. and Canadian LNG export projects that are already in the advanced stages of commercial development and permitting (see The LNG Buyers' Wish List above), a series of potential bottlenecks could still stall or impede LNG exports.

#### 1. Political delays and challenges

The Department of Energy (DOE) recently finalized and implemented a new review process that intends to expedite the processing of non-Free Trade Agreement (non-FTA) export applications.<sup>111</sup> But permitting and approval delays could persist. On August 12, 2014, for example, the Cove Point LNG facility

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106. Press Release, Singapore LNG Corp., Prime Minister Lee Hsien Loong Officially Opens the Singapore LNG Terminal (Feb. 25, 2014), <http://www.slng.com.sg/newsroom-press-release-20140225.html>.

107. *Id.*

108. TTF is the hub for ICE Exend, the independent Dutch gas exchange established in 2005.

109. *Quarterly Report on European Gas Markets*, 6 DG ENERGY 1 (2013), available at [http://ec.europa.eu/energy/observatory/gas/doc/20130611\\_q1\\_quarterly\\_report\\_on\\_european\\_gas\\_markets.pdf](http://ec.europa.eu/energy/observatory/gas/doc/20130611_q1_quarterly_report_on_european_gas_markets.pdf).

110. Henning Gloystein & Jason Neely, *Britain's gas trading crown at risk as euro boosts Dutch appeal*, REUTERS (Aug. 19, 2014), <http://www.reuters.com/article/2014/08/19/gas-trade-britain-idUSL5N0QO1C720140819>.

111. Nick Snow, *DOE finalizes LNG export national interest review reforms*, OIL & GAS JOURNAL (Aug. 15, 2014), <http://www.ogj.com/articles/2014/08/doe-finalizes-lng-export-national-interest-review-reforms.html>.

unexpectedly had its zoning exemption overturned.<sup>112</sup> This could increase costs and extend delays, but the specific project impacts remain unclear.<sup>113</sup> Other LNG export projects could face similar opposition and delays as U.S. firms in energy intensive industries and environmental groups continue to lobby against large-scale export of LNG.<sup>114</sup>

## 2. Financing

The proposed North American liquefaction terminals are huge capital intensive investments that can cost several billions of dollars and the major lenders' appetite for LNG export risk exposure is not unlimited. Regardless of how credit-worthy the LNG off-takers may be, the long-term financial viability of these projects ultimately depends on continuing high shale spreads. Most lenders understand that when markets shift even iron-clad capacity contracts with credit-worthy off-takers run the risk of breach and/or commercial dispute. If LNG prices and shale spreads collapse to levels that no longer support profitable export and trade of North American LNG, then the exports could lose appeal in some markets and terminal utilization would eventually decline. Only three projects—Cheniere's Sabine Pass, Dominion's Cove Point LNG, and Sempra's Cameron LNG—have secured the project financing needed to begin construction.<sup>115</sup> Lenders to these first projects have been comfortable with the long-term sustainability of LNG terminal usage and revenue based on expectations for high shale spreads over the term of financing. Future lenders are expected to require increasingly rigorous analysis to evaluate the sustainability of shale spreads and terminal utilization levels over the term of financing.

## 3. Environmental

Public and environmental group concerns about carbon emissions and the environmental impact of fracking have stimulated opposition to LNG exports in the United States. Although substituting coal consumption in Europe or China with natural gas from U.S. LNG would reduce carbon emissions substantially, critics argue that the full supply chain for the export of LNG to foreign markets (including fugitive methane from U.S. shale production and fuel combustion for U.S. pipeline transportation compressors, U.S. liquefaction terminals, LNG

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112. Timothy B. Wheeler, *Cove Point zoning exemption overturned*, THE BALTIMORE SUN (Aug. 12, 2014), <http://www.baltimoresun.com/features/green/blog/bs-md-cove-point-ruling-20140812,0,133476.story>.

113. *Id.*

114. Ed Crooks, *Opposition mounts to US gas exports*, THE FINANCIAL TIMES (Mar. 25, 2013), <http://www.ft.com/intl/cms/s/0/1958a1e0-949d-11e2-b822-00144feabdc0.html#axzz3Ay9DygpN>.

115. Michael Sanserino, *FERC gives final approval to Cove Point LNG project*, POWERSOURCE (Sept. 30, 2014), <http://powersource.post-gazette.com/powersource/companies-powersource/2014/09/30/Coal-struggles-to-keep-its-place-in-rail/stories/201409300025>; *Cheniere reaches final investment decision on Trains 3, 4*, OIL & GAS JOURNAL (May 30, 2013), <http://www.ogj.com/articles/2013/05/cheniere-reaches-final-investment-decision-on-trains-3--4.html>; *Final Investment Decision Reached for Cameron LNG Liquefaction-Export Project*, PR NEWSWIRE (Aug. 6, 2014), <http://www.prnewswire.com/news-releases/final-investment-decision-reached-for-cameron-lng-liquefaction-export-project-270229331.html>; *Dominion Midstream Partners*, PROFUNDO (Sept. 10, 2014) at 7 ("limited financing options"), available at <http://chesapeakeclimate.org/wp/wp-content/uploads/2014/09/Dominion-Midstream-IPO-Risk-Report-9-10-2014.pdf>.

shipping, foreign regasification, and so forth) produces an equivalent amount of carbon as combusting domestically produced coal.<sup>116</sup> Another primary area of concern is the contamination allegedly caused by shale production flowback water (i.e., the water recovered after the process of fracking), which can include brine, metals, and other contaminants.<sup>117</sup> Existing water treatment facilities are typically not well equipped to treat this water and new recycling and treatment solutions are required.<sup>118</sup> Further, increased seismic activity in some areas, especially Texas, has been linked to fracking.<sup>119</sup> Some groups oppose the export of LNG on these grounds, but so far the Federal Energy Regulatory Commission (FERC) has rejected claims that shale gas production should be factored into the environmental review of LNG terminals because they are too speculative and not subject to FERC jurisdiction.<sup>120</sup> As a result of these concerns and others, some townships and states have put a moratorium on fracking, or in some cases banned it altogether. In June 2014, the New York Court of Appeals ruled that townships have the right to restrict fracking within their borders<sup>121</sup> and New York's general assembly recently passed a three-year fracking moratorium.<sup>122</sup> There have also been contentious fights over moratoriums in California<sup>123</sup> and Colorado,<sup>124</sup> and many more states are now considering political or legal action. The legality of these bans and moratoriums is being tested in courts across the United States. At a minimum, the speed with which shale gas production can continue to grow remains subject to continued environmental dispute and effective resolution of key environmental concerns about fracking. Even where bans or moratoria are not implemented, the evolving body of shale gas health, safety, and environment (HSE) regulations will be a critical factor in the overall cost of shale gas production, and therefore the price of U.S. natural gas and LNG exports.

#### 4. Renewed Delays with Panama Canal

Expansion of the Panama Canal is required for LNG vessels from the United States Gulf and East Coast to deliver cargoes into the Pacific Basin. So far,

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116. *Stop LNG Exports, Exporting Liquefied Natural Gas (LNG) to Overseas Markets is a Dirty, Dangerous Practice that lets the Industry make a Killing at the Expense of Human Health*, SIERRA CLUB, <http://content.sierraclub.org/naturalgas/stop-lng-exports> (last visited Oct. 8, 2014).

117. Bill Chameides, *Fracking Water: It's Just So Hard to Clean*, NATIONAL GEOGRAPHIC ENERGY BLOG (Oct. 4, 2013), <http://energyblog.nationalgeographic.com/2013/10/04/fracking-water-its-just-so-hard-to-clean/>.

118. *Id.*

119. *Legislative Subcommittee Addresses Growing Concerns Over Fracking and Seismic Activity in Texas*, SIERRA CLUB LONE STAR CHAPTER, <http://texas2.sierraclub.org/news/legislative-subcommittee-addresses-growing-concerns-over-fracking-and-seismic-activity-texas> (last visited Oct. 4, 2014).

120. *Environmental Assessment for the Cove Point*, *supra* note 19, at 23-24, 163.

121. Kate Taylor & Thomas Kaplan, *New York Towns Can Prohibit Fracking, State's Top Court Rules*, N.Y. TIMES (June 30, 2014), [http://www.nytimes.com/2014/07/01/nyregion/towns-may-ban-fracking-new-york-state-high-court-rules.html?\\_r=0](http://www.nytimes.com/2014/07/01/nyregion/towns-may-ban-fracking-new-york-state-high-court-rules.html?_r=0).

122. Press Release, N.Y. State Assembly Speaker Sheldon Silver, Silver, Sweeney Announce Moratorium On Hydrofracking Approved (June 16, 2014), available at <http://assembly.state.ny.us/Press/20140616a/>.

123. Patrick McGreevy, *Calif. Senate vote falls short for moratorium on oil fracking*, L.A. TIMES (May 28, 2014), <http://www.latimes.com/local/political/la-me-pc-calif-senate-votes-on-moratorium-on-oil-fracking-20140528-story.html>.

124. Ernest Scheyder, *Oil producers undaunted as Colorado mulls fracking restrictions*, REUTERS (Mar. 2, 2014), <http://www.reuters.com/article/2014/03/02/us-ceraweek-colorado-idUSBREA210M820140302.124>.

however, the expansion effort has grappled with construction cost overruns and delays. Work was halted for a month in February 2014 due to a contract dispute between the Panama Canal Authority (PCA) and its contractor, Grupo Unidos por el Canal, over \$1.6 billion in cost overruns that represent a 30% increase in total project cost.<sup>125</sup> A labor dispute also stopped construction between April 23 and May 8, 2014.<sup>126</sup> Re-opening of the expanded canal is now scheduled for January 2016, six months after the original completion target of July 2015.<sup>127</sup> But if past disputes resurface or new ones materialize, completion could be delayed several years and the transit tolls now under discussion increasing with canal shippers could be increased.<sup>128</sup> If the toll fees are raised proportionately to the increased project cost, then the actual toll fees could increase by 30% or more. Further, despite expansion, the Panama Canal may prove more of a physical bottleneck than expected. Consider that only six ships of any type (including LNG vessels, oil and product tankers, container vessels, etc.) will be able to enter the canal in each direction,<sup>129</sup> and that delivering all the 43 Bcm of U.S. LNG capacity already contracted to East of Suez markets<sup>130</sup> in 2020 via the Panama Canal in 150,000 cm vessels would require approximately 1.3 LNG vessels per day on average, and perhaps double that traffic in winter.<sup>131</sup> The scheduling challenges will be material and global swap solutions could become necessary.

#### IV. GLOBALIZING SHALE PRODUCTION & EXPORTING THE REVOLUTION

Even if U.S. LNG exports become constrained by the bottlenecks described above, over the longer term global gas consumers may be able to obtain the benefits of shale gas more directly by developing production closer to home. This will take time because initial experience with shale production programs around the world suggests a variety of unique challenges that will need to be surmounted.

Over the remainder of this decade, no other major shale production successes are likely and North American shale production and LNG exports will be the primary driver of increased global LNG supply. Beyond 2020, however, the magnitude and duration of shale productions impacts on global markets could be substantially compounded if the North American revolution can be effectively imported by other countries.

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125. *Panama Canal chief says new locks will be working by January 2016*, REUTERS (June 11, 2014), <http://in.reuters.com/article/2014/06/11/panama-canal-idINL2N0OR2QG20140611>.

126. *Id.*

127. *Id.*

128. *Panama says still targeting canal expansion by end 2015*, PLATTS (Mar. 3, 2014), <http://www.platts.com/latest-news/shipping/tokyo/panama-says-still-targeting-canal-expansion-by-26745221>.

129. *LNG carriers to undergo modification to transit Panama Canal*, LNG INDUSTRY (Apr. 7, 2014), [http://www.lngindustry.com/news/lng-shipping/articles/LNG\\_carriers\\_to\\_undergo\\_modification\\_to\\_transit\\_Panama\\_Canal\\_919.aspx#.VDFyqBZHF](http://www.lngindustry.com/news/lng-shipping/articles/LNG_carriers_to_undergo_modification_to_transit_Panama_Canal_919.aspx#.VDFyqBZHF) XE.

130. Includes final SPAs as well as known preliminary agreements (HOAs and MOUs).

131. CHRISTOPHER GONCALVES, *supra* note 9.

Shale resources are widely dispersed throughout all regions of the world<sup>132</sup> (see Figure 13). Several countries with substantial resources are eager to develop production to minimize the need for imported LNG and natural gas. Rather than import U.S. LNG, these countries would prefer to import the underlying shale revolution into their own markets.



**Figure 13 World Shale Resources<sup>133</sup>**

Among other shale provinces, China (~31 Tcm), the U.K. (~1 Tcm), Eastern Europe<sup>134</sup> (~10 Tcm), Argentina (~23 Tcm), Australia (~12 Tcm), India (~3 Tcm), and Indonesia (~1Tcm) all have substantial technically recoverable shale reserves.<sup>135</sup> By comparison, the United States has a reported 19 Tcm of reserves according to EIA<sup>136</sup> (although other estimates are significantly higher). China and some European countries appear to have the most advanced shale development programs, but many of the other markets have struggled with a variety of impediments and delays.

Based on a multi-attribute approach that considers public and policy opinion, commercial terms, service and infrastructure availability, water, and regulatory issues, the United States has the best conditions for sustained unconventional gas

132. ADVANCED RES. INT'L, INC., U.S. ENERGY INFO. ADMIN., EIA/ARI WORLD SHALE GAS AND SHALE OIL RESOURCE ASSESSMENT 1 (June 2013), available at [http://www.adv-res.com/pdf/A\\_EIA\\_ARI\\_2013%20World%20Shale%20Gas%20and%20Shale%20Oil%20Resource%20Assessment.pdf](http://www.adv-res.com/pdf/A_EIA_ARI_2013%20World%20Shale%20Gas%20and%20Shale%20Oil%20Resource%20Assessment.pdf).

133. U.S. ENERGY INFO. ADMIN., TECHNICALLY RECOVERABLE SHALE OIL AND SHALE GAS RESOURCES: AN ASSESSMENT OF 137 SHALE FORMATIONS IN 41 COUNTRIES OUTSIDE THE UNITED STATES 5 (June 2013), available at <http://www.eia.gov/analysis/studies/worldshalegas/pdf/fullreport.pdf>.

134. Including, above all, Bulgaria, Romania, Poland, and Ukraine.

135. *Technically Recoverable Shale Oil and Shale Gas Resources*, *supra* note 133, at 6-7.

136. *Id.* at 6.



development. Other countries that have significant technically recoverable shale reserves are behind or lacking in key areas needed to support successful shale gas investment. Australia and Eastern European countries appear to be close behind the United States, but other countries in Asia, Western Europe, and South America have less promising conditions.<sup>137</sup>

These other countries with substantial shale resources have not achieved large-scale commercial production and many remain in the initial stages of developing the policies, programs, incentives, and regulations needed to support low cost shale production. The slow progress has led to questions about whether the North American revolution can be effectively imported by other countries. Unlike the United States, most countries control subsoil mineral rights and do not share them with individual landowners. In those countries, individual incentives to allow production are constrained; whereas individual landowners in the United States are incentivized to act in their own best interest. Further, the environmental regulations and approvals needed are largely localized in the United States (although this is also the case in Australia).<sup>138</sup> In some locations, U.S. state and local regulations are less restrictive and can be conducive to hydraulic fracturing. Shale production in other countries remains constrained by environmental regulations, water supply, and other factors.

China has the world's largest estimated shale gas reserves and is intent on developing them.<sup>139</sup> The fact that mineral rights are controlled by the state may be a benefit, but substantial obstacles have confronted the development of China's shale resource:

- (a) The development costs remain high;<sup>140</sup>
- (b) The quality and geology of the resource is technically challenging, especially for the well-situated Eastern shale plays;<sup>141</sup>
- (c) The remote location and long distances between China's best shale resources in the Western provinces and the major population and demand in the Eastern provinces requires the development of costly pipeline infrastructure;<sup>142</sup>
- (d) There is a lack of domestic engineering expertise to develop the plays, which will require either partnerships with, or outright purchase of, shale development firms;<sup>143</sup>
- (e) There have been conflicts between governing bodies in assessing mineral and land rights;<sup>144</sup> and

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137. *Id.* at 6-7.

138. Carter, *supra* note 74, at 6.

139. Jack Perkowski, *Shale Gas: China's Untapped Resource*, FORBES (June 13, 2013, 9:37 AM), <http://www.forbes.com/sites/jackperkowski/2013/06/13/shale-gas-chinas-untapped-resource/>.

140. *China*, *supra* note 87.

141. *Id.*

142. *Id.*

143. *Id.*

144. *Id.*

(f) Water scarcity is already an issue in many of the areas with shale gas potential, and hydraulic fracturing would put an additional strain on water resources.<sup>145</sup>

As a result, China has drilled only has 100 shale wells and any dramatic increase in production is not likely until after 2020.<sup>146</sup> The Chinese government recently lowered the shale production target for 2020 to 30 Bcm, which is far more realistic than the original target of 60-80 Bcm set two years ago.<sup>147</sup> Still, regardless of what it is able to produce at home despite these challenges, China will likely remain a net importer of LNG for the foreseeable future.

In Europe, any substantial new shale production could enhance energy security and economic competitive advantage for the region, but “opposition is particularly fierce.”<sup>148</sup> The U.S. shale revolution may not be feasible in Europe for several reasons:

(1) Mineral rights are controlled by states rather than individual landowners, reducing individual incentives to provide land access and making public opposition more likely;<sup>149</sup>

(2) The population is more dense—100 to 200 habitations per square kilometer as compared to 30 habitations per square kilometer in the United States<sup>150</sup>—and open land more scarce;

(3) So far, there are not as many tax and fiscal incentives for producers;<sup>151</sup> and

(4) Environmental regulations are more stringent and centralized, as compared to more variable from state-to-state in the United States, and environmental groups have more political power in Europe as compared to the United States<sup>152</sup> Additionally, some anti-shale environmental groups in Eastern Europe have allegedly obtained funding from Russia to oppose fracking (to discourage this diversification away from Russian supply),<sup>153</sup>

(5) Limited experience and availability of the services needed to support fracking;<sup>154</sup>

(6) Limited availability of fresh water for fracking;<sup>155</sup> and

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145. *Id.*

146. *Id.*

147. Chen Aizhu, Judy Hua, & Charlie Zhu, *China finds shale gas challenging, halves 2020 output target*, REUTERS (Aug. 7, 2014, 8:54 AM), <http://mobile.reuters.com/article/idUSKBN0G71FX20140807?irpc=932>.

148. Keith Johnson, *Russia's Quiet War Against European Fracking*, THE WEEK (June 20, 2014), <http://theweek.com/article/index/263786/russias-quiet-war-against-european-fracking>.

149. Bart J. A. Willigers, *Shale Gas in Europe: A Myth or a Reality?*, OIL & GAS FINANCIAL J. (Aug. 1, 2011), <http://www.ogfj.com/articles/print/volume-8/issue-8/features/shale-gas-in-europe-a-myth-or-a-reality.html>.

150. *Id.*

151. *Id.*

152. *Russia's Quiet War Against European Fracking*, *supra* note 148.

153. *Id.* Bulgaria, Lithuania, and Ukraine are cited as examples of countries where organized opposition to shale has materialized in countries that previously seemed receptive to shale gas production. Bulgaria banned fracking shortly after announcing a deal with Chevron for exploration and production.

154. *Shale Gas in Europe*, *supra* note 149.

155. Nick Leiber & Todd White, *Foreign Frackers Now Find Comfort in Water-Hungry Spain*, BLOOMBERG (Apr. 3, 2014), <http://www.bloomberg.com/news/2014-04-02/foreign-frackers-now-find-comfort->

(7) The shale geology is not as conducive to fracking as it is in the United States.<sup>156</sup>

Despite these risks and impediments, the geopolitical and energy security motivations to stimulate a European shale gas industry may prove more compelling. For example, Germany has begun phasing out its nuclear power plants, which had accounted for a quarter of its electric generation,<sup>157</sup> making it increasingly dependent on Russian natural gas. Although Germany, like France, had essentially banned fracking, it is now reconsidering the ban to allow for accelerated shale development to enhance energy supply security in light of developments in Ukraine.<sup>158</sup> Despite entrenched public and environmental opposition, France is also considering reversing its ban for similar reasons.<sup>159</sup>

Over the remainder of this decade, global LNG surpluses could provide a counter-balance to intensified energy security concerns and risks derived from events in Russia and Ukraine. If these risks persist over the longer-term, however, it is likely European policy makers will feel compelled to pave the way for shale gas production as a more enduring solution.

## V. A WORLD OF IMPACTS

Over the mid- to long-term, the shale revolution has the potential to fundamentally redefine the way LNG and natural gas are priced, purchased, and sold worldwide. The extent of market and commercial impact will depend upon the volume and velocity of U.S. LNG exports and how far and how fast the U.S. shale revolution may proliferate to the world's other leading shale provinces.

Among the key long-term impacts, I expect the most prominent to include:

### A. Price Levels

North American prices are expected to remain quite low into the next decade, and my analysis and forecasts indicate that the price increases from most moderate scenarios are limited to tens of cents per MMBtu, and even the high export case is limited to just over a dollar. These prices will form a global floor price. By contrast, Asian LNG and natural gas prices have already fallen a few dollars per MMBtu and could well decline several dollars more toward the delivered price of U.S. LNG, as the world's new marginal source of supply. This could be compounded if oil prices also fall, dragging remaining oil-indexed LNG prices down. Asian prices will form a global cap. European prices will continue to be range-bound and fluctuate between the United States floor and Asian cap prices.

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in-water-hungry-spain.html; see also *Fracking: The New Global Water Crisis*, FOOD AND WATER WATCH EUROPE (Mar. 2012), [http://documents.foodandwaterwatch.org/doc/FrackingCrisisEU.pdf#\\_ga=1.268211207.803743727.1412727859](http://documents.foodandwaterwatch.org/doc/FrackingCrisisEU.pdf#_ga=1.268211207.803743727.1412727859).

156. *Shale Gas in Europe*, *supra* note 149.

157. *Nuclear Power in Germany*, WORLD NUCLEAR ASS'N, <http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Germany/> (last visited Oct. 4, 2014).

158. *Russia's Quiet War Against European Fracking*, *supra* note 148.

159. *Id.*

As these regional floor and ceiling prices converge due to enhanced global supply liquidity, the range of European price fluctuations will be moderated.

### *B. Pricing Practices*

The ongoing trend toward greater utilization of hub pricing in European supply contracts could be accelerated by the diversification of supply fostered by the emergence of LNG surpluses and/or the eventual development of indigenous shale resources. In Asia, there is already a groundswell of activity to develop new trading hubs for LNG as well as internal markets for natural gas that, if sustained over time, eventually could provide new hub benchmarks and indices as a replacement for oil-indexation in long-term contracts. The elimination of oil-indexation would also reduce the need for price review provisions in supply agreements.

### *C. Contractual Delivery Flexibility*

In addition to improved pricing terms, buyers could also achieve increased flexibility of supply and deliveries. This could include a variety of developments, such as relaxed take-or-pay provisions and/or enhanced downward quantity tolerances, increased buyer diversion rights and/or improved sharing of diversion benefits, and elimination of destination clauses. But as observed by the IEA, future attempts to enhance delivery flexibility and/or modify destination “must properly incorporate aspects that preserve investment security.”<sup>160</sup>

These market and commercial impacts, in turn, could have a variety of secondary national and regional implications for supply security, economic welfare, geopolitical influence, and potentially also climate change. These are outlined below.

#### 1. Supply Security

An increase in supply security for buyers is likely to be reflected in an increasing number of supply sources and options available to buyers. The establishment of the United States as a swing supplier of LNG that, like Qatar, is able to supply markets both East and West of Suez, should provide buyers with another global swing supply option from a commercially reliable and politically stable producer.

#### 2. Economic Welfare

For heavily gasified economies throughout Asia, Europe, and Latin America, access to abundant supplies of LNG and/or new indigenous shale production at lower prices should have a tremendous economic benefit. As a leading fuel for power generation and industrial production, natural gas prices have a significant impact on energy inputs costs throughout such economies and, as such, can have substantial impacts on competitive advantage, export competitiveness, and thus economic growth. So far, the United States stands alone in enjoying these

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160. *Developing a Natural Gas Trading Hub in Asia*, *supra* note 12, at 7.

benefits, but the export of U.S. LNG and/or proliferation of shale production could serve to extend these benefits into new markets.

#### 4. Geopolitical Influence

With increased supply and improved supply security, the political power and influence of large natural gas and LNG producing nations should be reduced. In particular, the diversification of supply will tend to reduce the market and political influence derived from natural gas and LNG supply by Russia and Qatar. Over the longer-term, the potential proliferation of shale gas production worldwide could compound the impact.

#### 5. Air Quality/Climate Change

If in the future the proliferation of shale gas production leads to lower cost LNG and natural gas and development of a Pacific natural gas hub, then competitive gas prices could support national and global policy imperatives to clean up the air and reduce carbon emissions. The increasing availability of LNG could support the reduction of carbon dioxide emissions in markets where delivered natural gas prices are competitive with coal (also considering the impact of carbon mitigation policies such as carbon trading and taxes), or where fuel switching is mandated by environmental policies and regulations. This has already begun in the United States, where low cost shale gas has significantly reduced coal-fired generation and reduced carbon emissions by nearly 9% between 2007 and 2011.<sup>161</sup> For similar developments to proliferate to other major coal consuming markets of Europe and Asia, it is critical that natural gas prices become competitive with coal (when adjusted for combustion technology efficiency and any carbon taxes or trading values).

For example, coal use in Europe has actually increased in the last couple years due to cheap coal imports from the United States (where coal has been displaced by cheaper shale gas). This will need to be reversed through a substantial increase in the supply of natural gas (either through domestic production or LNG imports) or political action to increase the price of carbon.

In Asia, long-term pricing comparisons between natural gas and coal are complicated by uncertainty regarding whether hub pricing will be developed, and if so what level of natural gas and LNG prices will prevail in the future. Development of national or regional hubs would not guarantee lower natural gas prices, but would ensure that prices reflect the fundamentals of supply and demand more quickly than with the current regulated or controlled pricing. If new hub prices do become competitive with coal, then natural gas demand growth could be substantial.

However, in some Asian countries competitive gas prices may not be needed as environmental imperatives have begun to trump economics. For example, the Chinese government has begun to unilaterally replace coal plants with natural gas

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161. *United States, Overview data for United States*, EIA, <http://www.eia.gov/countries/country-data.cfm?fips=US&trk=m> (last updated May 30, 2014).

plants, despite lower coal prices and generation economics.<sup>162</sup> In the near term, it is doing so primarily for air quality and not economic reasons, even though the higher cost energy from natural gas (as compared to coal) is expected to erode China's international competitive advantage in manufacturing.<sup>163</sup>

On balance, the mid-term outlook through 2020 appears to be increasingly beneficial for LNG buyers' efforts to reduce prices, revise pricing practices, and improve the flexibility provisions of supply contracts. The subsidiary benefits for consumer nations could also be substantial in the areas of economic welfare, energy security, geopolitical influence, and air quality/climate change.

Nevertheless, the long-term future of shale gas production and its impact on LNG markets is subject to substantial uncertainty. The sustainability of North American shale gas production in the emerging environment of high demand and high LNG exports appears to be promising, but the ability of other countries to import and replicate the North American shale revolution is much less clear. Here again, the words of General MacArthur may be relevant, "[t]here is no security on this earth; there is only opportunity."<sup>164</sup>

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162. *Taking Stronger Action on Climate Change: China and the United States*, CHINA FAQs (May 13, 2014), available at [http://www.chinafaqs.org/files/chinainfo/ChinaFAQs-Taking\\_Stronger\\_Action.pdf](http://www.chinafaqs.org/files/chinainfo/ChinaFAQs-Taking_Stronger_Action.pdf).

163. *Exports of goods and services (% of GDP)*, THE WORLD BANK, <http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS> (last visited Oct. 7, 2014).

164. COURTNEY WHITNEY, MACARTHUR: HIS RENDEZVOUS WITH HISTORY (1956) (quoting General Douglas MacArthur).