# Comparative Analysis of Natural Gas Markets in the Far East: Japan & China

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Abstract *Natural Gas is considered by energy export to be the most promising fossil fuel for the 21st century. It is more environmental friendly since natural gas emits 22% less carbon dioxide than oil and 40% less than coal, and it can be safely stored and burned with high heating value of 24,000 Btu per pound. There are some geographical concerns in the global gas market, not only because the most important reserves are concentrated in a limited number of countries, but also the "desegmentation" (Figure 1) of natural gas market which cause by the cost of gas transportation over large distances around the world. This paper focus on the highlighting Asia region: Japan & China, presents an updated and thorough overview of demand/supply market in Japan & China, performs a comparative analysis of natural gas market based on statistical & historical data, and also provides some valuable potential findings for future development.*

Key Words: Natural gas, LNG, electricity, Japan, China, demand, supply, import, analysis, projection.

## I. Introduction

There are three regional natural gas markets could be identified in the world: America, Europe, and Asia with limited trade between them because of the cost of gas transportation over large distances, which resulting large price differences. One of the reason is that Japan is the world's largest importer of liquefied natural gas (LNG), accounting for 36 percent of worldwide imports (?). However, the proven reserves of gas per region is pretty comparable between Asia and America.

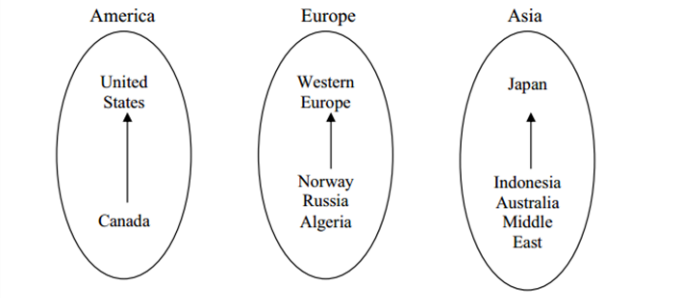



Figure 1

# II. Background

## 2.1 Analysis of Major Electricity Generation Sources in Japan

EIA states that in Japan, between 1987 and 2011, nuclear generation accounted for an average of 30% of Japan's total generation. As a result of the nuclear outages after Fukushima nuclear disaster in 2011, the proportion of nuclear power in the energy mix dropped dramatically to 0.9%, fossil-fueled generation of electricity rose to 90% of Japan's total electricity output during 2013, shown in Figure 2 with natural gas contributing 38.68%, 16.91% more than the worldwide average. In comparison, natural gas only accounted for 27.12% of power generation in the U.S. in 2013 despite that the U.S is a major natural gas export country in the world.

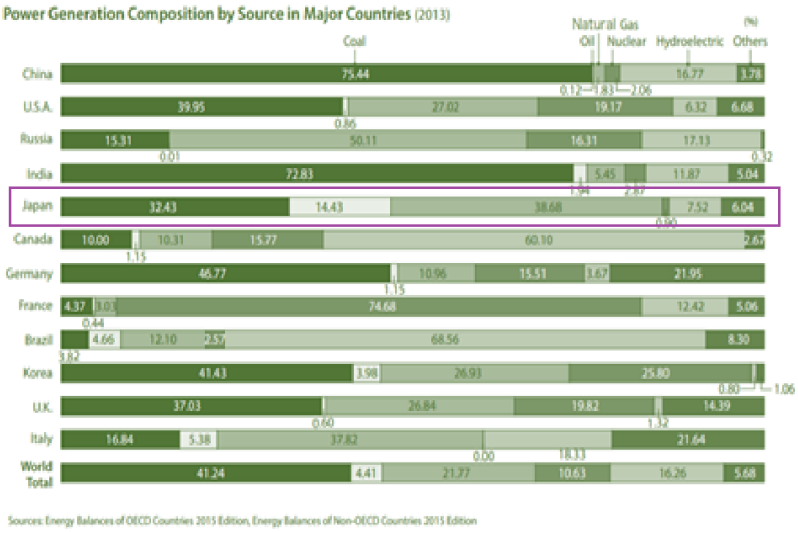



Figure 2

## 2.2 Analysis of Major Electricity Generation Sources in China

From the power generation composition by sources in major countries (2013), China' s major source for electricity production is coal which takes up 75.44% in 2013 while natural gas only contributes 1.83%.

Similarly, India is a country which relies on coal as a major source of power generation. Coal is the cheapest fossil fuel for generating electricity, but at the same time it is the dirtiest.

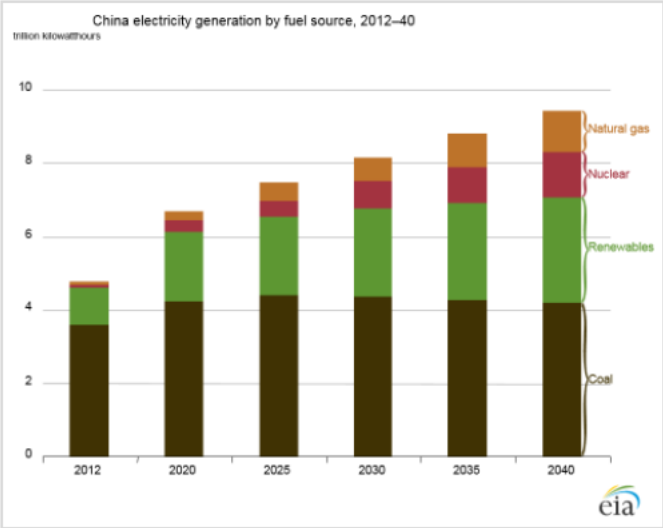



Figure 3

In 2012, coal's share of China's total electricity generation was estimated at 75%. Assuming the phase-in of various government policies through 2030 in the IEO2016 Reference case, the coal share declines to an estimated 53% in 2030 and to 44% in 2040. Overall, although natural gas previously has not played a significant role in China's electric power sector, natural gas-fired generation grows at a comparable rate of around 9.9% per year from 2012 to 2040 in the Reference case Figure 3. As a result, the natural gas share of total electricity generation increases from 2% in 2012 to 12% in 2040. A major factor in the expanding role of natural gas in electricity generation is an increase in sources of natural gas supply, including contracts with Russia for large-scale construction of natural gas pipelines between the two countries, financed by China, with the first stage calling for a pipeline with the capacity to carry 1.3 trillion cubic feet per year (will be discussed more in next section).

## III. Demand & Supply Analysis

### 3.1 Demand of Natural Gas in Japan Market

New legislation concerning air pollution control may lead to increased demand for clean fuel. Energy Information Administration (EIA) forecasts that Japan's natural gas consumption is going to increase by an average of 0.9%. They estimate that Japan's natural gas share of total energy consumption is going to increase from 25% in 2020 to 30% in 2040, while it estimates that its oil and coal consumption is going to decline. It appears that environmental concerns favoring natural gas consumption after Fukushima and expansion of LNG terminals have influenced this forecast. It is also possible that Japan's LNG demand may decline in the long run due to a declining population, slower economic growth, nuclear power plants restarting, and solar capacity increasing.

### 3.2 Supply of Natural Gas in Japan Market

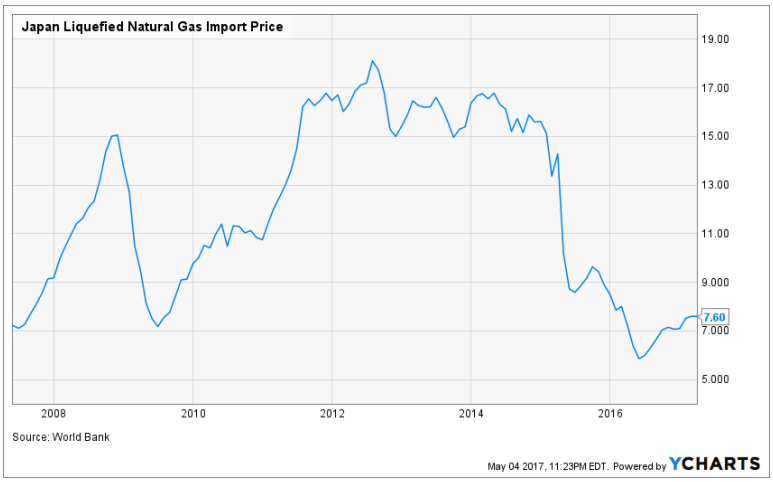
Japan relies on LNG imports for nearly all of its natural gas supply and ranks as the world's largest LNG importer. According to the Oil & Gas Journal (OGJ), Japan had 738 billion cubic feet (Bcf) of proved natural gas reserves as of January 2017, which is small compared to other natural gas-producing countries. Because Japan is one of the top global natural gas consumers and has minimal amounts of production, the country relies on imports to meet nearly all of its natural gas demand.

The country's lack of sufficient domestic hydrocarbon resources has led Japanese energy companies to actively participate in oil and natural gas projects. About 36% of Japan's LNG imports originated from regional suppliers in Southeast Asia such as Malaysia (18%) and Indonesia (8%), and these suppliers are becoming more constrained, while Japan is seeking to diversify its contracts and investment in other LNG ventures. 27% LNG imports originated from Australia in 2016, although the country has a fairly balanced portfolio with supplies coming from other regions. Qatar, the world's largest supplier of LNG, made up 15% of Japan's LNG trade. Russia became a new source of natural gas for Japan when it commissioned the Sakhalin-2 liquefaction terminal, located just north of Japan, in 2009.

Japan is the first country to import LNG as an energy source which has led and continues to lead the LNG industry. Back to 1969, Japan first imported LNG from Alaska, and since then, it has accumulated the technology to liquefy natural gas, keep it cold and liquid during transport and later gasify it.

Japan has experienced dramatic growth in LNG imports since the Fukushima nuclear disaster in early 2011, with total LNG imports in 2012 approximately 25% higher than in 2010. Beginning in 2015, there has been a gradual restart of Japan's nuclear capacity, and in the IEO2016 Reference case, those gradual restarts are assumed to continue and to lessen the country's need for LNG imports.

Japan Liquefied Natural Gas Import Price (Figure 4) is at a current level of 7.60 USD per Million Btu (Mar. 2017), unchanged from 7.60 USD per Million Btu the previous month and up from 7.23 USD per Million Btu one year ago. This is a change of 0.00 from previous month and 5.12% from one year ago.




**Japan Liquefied Natural Gas Import Price Summary**

| | |
|---|---|
| **Last Value:** | 7.60 |
| **Latest Period:** | Mar 2017 |
| **Updated:** | Apr 5, 2017, 20:15 EDT |
| **Frequency:** | Monthly |
| **Unit:** | USD per Million Btu |
| **Adjustment:** | N/A |
| **Value Previously:** | 7.60 |
| **Change From Previous:** | 0.00 |
| **Value One Year Ago:** | 7.23 |
| **Change From One Year Ago:** | 5.12% |
| **First Period:** | Jan 1977 |
| **First Value:** | 2.771 |
| **Notes:** | Import price, C.I.F, recent two months' averages are estimates. |

Figure 4

Japan imported 83.34 million mt of LNG in 2016, as compared to 85.05 million mt the year before, according to the provisional data released by Japan's Ministry of Finance. The average price of spot LNG for delivery into Japan that was contracted in March 2017 was at US$6.2 per mmBtu, dropping to the lowest level in five months. After rising for the previous four months, and reaching a contract-based price of $8.5 per mmBtu in February the price dropped over 27 percent, according to the monthly report from the Japanese Ministry of Economy, Trade and Industry (METI).

## 3.3 Demand of Natural Gas in China Market

Despite some moderation in its projected economic growth, China remains one of the world's fastest-growing economies in the IEO2016 Reference case. As a result, its total net electricity generation nearly doubles from 4.8 trillion kWh in 2012 to 9.4 trillion kWh in 2040, at an average annual growth rate of 2.5%.

China's central government promotes natural gas as a preferred energy source, and it has set an ambitious target of increasing the share of natural gas in its overall energy mix to 10% by 2020. In the IEO2010 Reference case, China's natural gas consumption grows at an average rate of 5.0% annually over the forecast period—the highest growth rate worldwide—to a total of 9.7 trillion cubic feet in 2035. Nevertheless, China does not achieve its targeted natural gas share, as coal continues to fulfill the country's largest share of energy demand with natural gas provides 5% of China's energy supply in 2020 in the Reference case.

## 3.4 Supply of Natural Gas in China Market

During the past decade, China's proved natural gas reserves almost doubled from 1.4 tcm (or 48.3 tcf) in 1999 to 2.5 tcm (or 86.7 tcf) in 2009, with the acceleration in exploration and the consistent discovery of new natural gas reserves, according to BP Statistical Review of World Energy (Figure 5).

From 2007 to 2035, China has the largest projected increase in natural gas production in non-OECD Asia [1], from 2.4 trillion cubic feet in 2007 to 5.6 trillion cubic feet in 2035, for an average annual increase of 3.0%. Increases in natural gas supplies that are easily accessible account for most of the total production growth between 2007 and 2020 (Figure 6). After 2020, continued growth in natural gas production in China comes from more expensive tight gas, shale gas, and coalbed methane resources, which in 2035 provide more than three times as much production as the same three resource types in OECD Europe [2].

Note: [1] non-OECD Asia: countries not in The Organization for Economic Co-operation and Development in Asia
[2] OECD Europe: The Organization for Economic Co-operation and Development in Europe

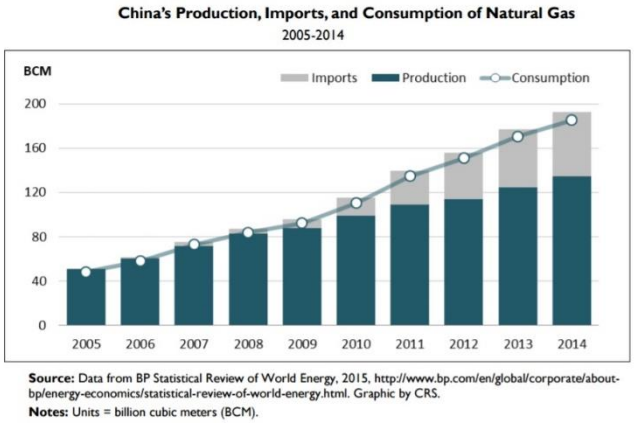



Figure 5

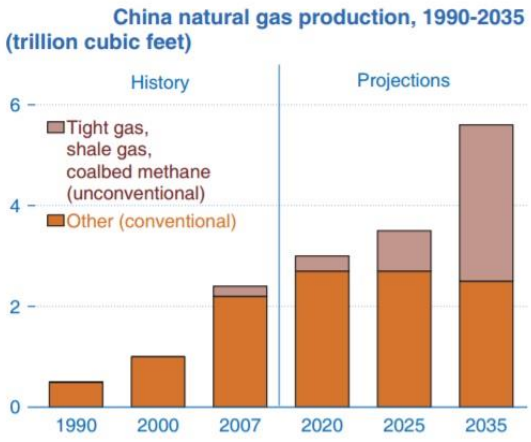



Figure 6

In 2014, China ranked third in global liquefied natural gas (LNG) imports behind Japan and South Korea, which are both relatively established markets compared to China. China ranked sixth for pipeline imports. Central Asia, especially Turkmenistan, is China's main source of pipeline imports of natural gas. Chinese companies signed contracts to increase imports from Australia, Qatar, and Malaysia, but Australia is likely to remain China's main LNG supplier because of its geographic proximity and its large and growing list of upcoming LNG export projects.

On July 1, 2015, China launched the Shanghai Oil and Gas Exchange, which trades both pipeline gas and LNG. China's diversified natural gas market, with expanding pipeline infrastructure and gas-on-gas competition, offers a more liquid Asian natural gas price index, but high levels of government regulation make it less attractive as a regional benchmark.

## IV. Comparative Analysis

Generally in Asian countries, the trend of gas/power "Marketization" has some progress made, but also has weak institutions or tendency to backtrack with facing political risk.

## 4.1 Transportation of Natural Gas

Transporting natural gas requires construction of physical pipelines, while transporting LNG requires building factories to transform it from gas to liquid and ships to keep it liquid. It is generally accepted in the industry that 3,000 km is the threshold beyond which LNG is cheaper option than gas, but it also depends on the price negotiations with many interested parties.

However, gas trade via pipeline has a drawback, as it does not allow buyers and sellers to change their counterparts without constructing another expensive, time consuming pipeline. Thus, LNG offers better potential to apply market-pricing mechanism, which will stabilize price and help expand trade.

Cost of the gas transportation from Indonesia, Australia, and Middle East to Japan. The cost of transportation of gas over long distances is 5 to 10 times higher than in the case of oil.

## 4.2 Domestic Industry Concern: Monopoly or Oligopoly?

The Japanese trading company, Mitsubishi, a key natural gas supplier to Japanese utilities, has owned capacity in liquefaction terminals, mostly in Southeast Asia, Australia, and Oman, for four decades. JX Nippon and Inpex are developing several production and export projects throughout Southeast Asia, Australia, and the UAE, and more recently, in North America. In the past few years, Japanese utilities have also acquired small stakes in the upstream supply and operations of LNG projects to secure LNG contracts from emerging and growing LNG markets such as Australia, the United States, Canada, and Russia.

However, in China, the gas extraction and distribution industries are widely considered to be highly concentrated and oligopolistic. China National Petroleum Corporation (CNPC) dominates the natural gas industry and claims to produce roughly 80% of the country's total in four provinces alone.

Earlier, China had been expected to take more time before purchasing LNG on a full-fledged basis as gas price had been controlled by the government at lower level than the international LNG price. However from 2007 to 2008, PetroChina as well as the CNPC that earlier joined the international LNG market, began to aggressively buy LNG at international price.

At the end of 2014, the firm reported that it owned 50,836 kilometers of gas pipelines in China, or 78% of the country's total. A 2013 joint study by Harvard University and China's Central Party School calculated

a market concentration ratio for the big three of 99.7%—indicating "almost total dominance" of the natural gas industry by these SOEs [3].

Analysts suggest that long-standing monopoly control over the gas pipeline industry has led to significant inefficiencies. An analysis by Radio Free Asia in December 2015 estimated that for the stake sold in November 2015, pipeline construction costs far exceeded the market value suggested by the sale price. The analysis suggested that this lack of profitability may also have been exacerbated by government regulation of gas prices.

### 4.3 Japan Korean Marker

Japan Korea Marker is a spot assessment price published daily by the energy consultant Platts. Launched in February 2009, it provides a spot price for traded LNG in the Asia-Pacific market and the facilitates swap and spot deal making. Platts JKM™ reflects delivered ex-ship spot LNG prices for cargoes delivered into Japan and South Korea, the world's two largest LNG importers, which, combined, account for nearly 50% of global LNG demand. The JKM has become the main alternative Asia pricing indicator for parties engaged in the global LNG trade. In June 2012, Platts launched a JKM-swap assessment derived from JKM, which is assessed for the three months into the future. The JKM-swap is effectively the first LNG derivatives with size that are set at a standard of 10,000 MBtu. There is another JKM swap index as shown in Figure 7: JKMSGM1 Index 11/16/2012 - 10/16/2014 LNG Swap JKM 1 month Index, ICAP JKM swaps number are the brokers assessment of the spot price for un-contracted cargoes of LNG delivered into the markets of northeast Asia, the primary consumers of the fuel globally.

Note: [3] SOEs: state-owned enterprises, also known as national oil companies (NOCs)

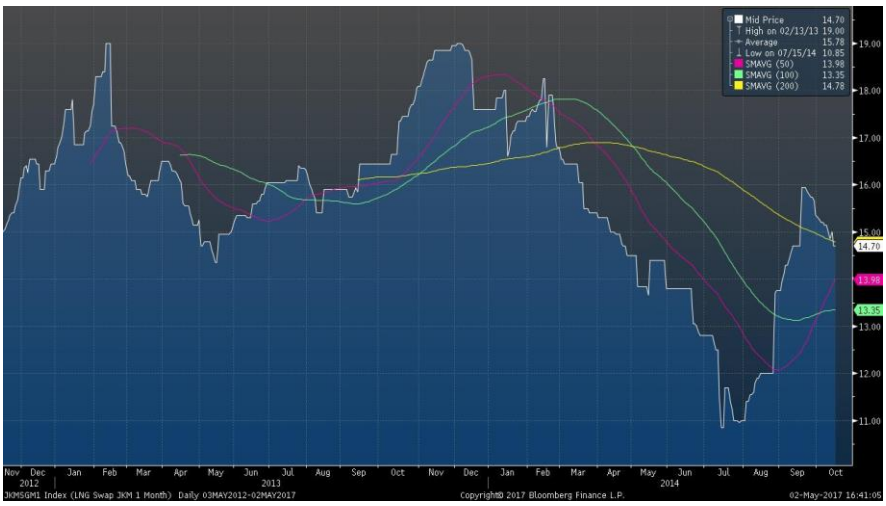


Figure 7

JKM is an important addition to the available international price indices and as such, supports the emergence of an efficient global LNG market. However, the method used to assess the JKM price can not be considered transparent when compared to a possible wholesale market, as JKM price discovery does not envolve entire demand/supply on a spot market or exchange.

The major demand factors are weather and economic activity. The relationship between spot markets has changed dramatically since March 2011 especially the JKM spot price, appearance totally different trend direction with US price benchmark (Henry Hub) as shown in Figure 8.

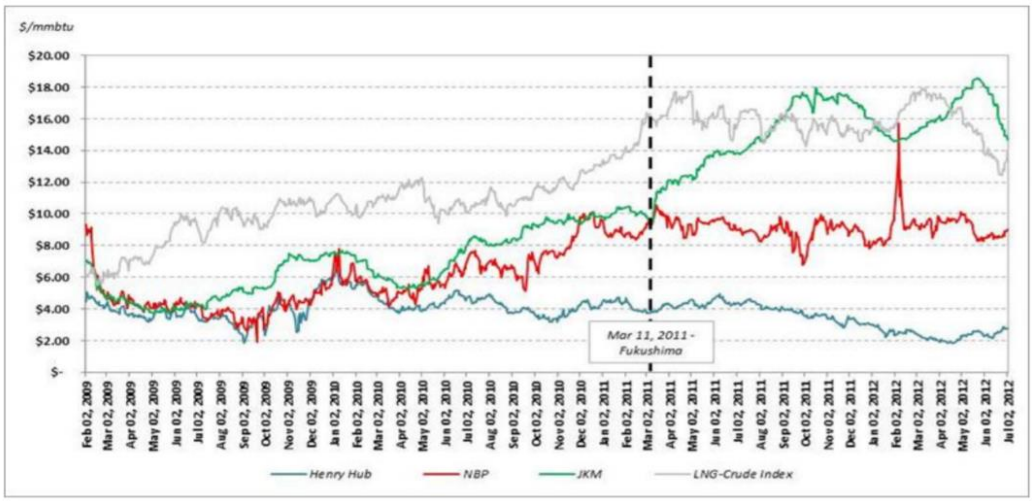


Figure 8

## 4.4 Natural Gas Pricing

In most regions of the world, gas prices reflect competition with alternative sources of energy such as oil. Japan is the level of a country – competition between gas and imported oil implies that gas prices are defined in terms of crude oil prices.

Asian LNG prices traditionally have been linked to international crude oil prices, which rose sharply between 2008 and 2014. Japan's higher natural gas demand for power, a tighter LNG global supply market, and higher oil prices led to a significant increase in Japan's LNG import prices, climbing from an average of $10 per MMBtu before the Fukushima crisis to more than $17 per MMBtu in 2012. International oil prices have decreased by more than half since the first half of 2014, and oil-linked Asian LNG prices followed the trend. Japan's average LNG import price plummeted to below $7 per MMBtu by 2016 (HIS 2017).

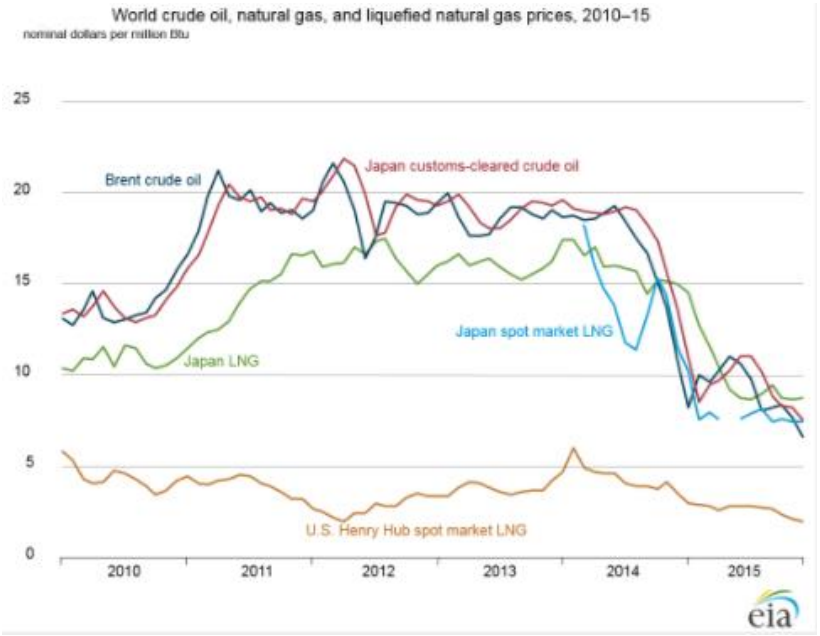



Figure 9

Although long-term contracts indexed to crude oil prices remain Asia's predominant pricing mechanism, natural gas is beginning to be traded in one-time transactions on the spot market, or under short-term contracts that more closely reflect international natural gas supply and demand balances. Short-term and spot LNG trade in the Asia Pacific market almost tripled from 2010 to 2014 when it represented 21% of global LNG trade and 7% of natural gas trade as Figure 9.

China's natural gas prices are regulated by the National Development and Reform Commission (NDRC) and have been kept below international market rates. China's natural gas market has become more complex as relatively expensive gas imports began to compete with domestic production in recent years. In order to bolster investment in the natural gas sector, to create more transparency in the pricing system and responsiveness to market fluctuations, and to make domestic natural gas competitive with other fuels and imported gas, the NDRC implemented a new system linking gas prices more closely to higher international oil prices.

### 4.5 Future Development & Potentials

Japan operates more than 30 LNG import terminals, including expansions and satellite terminals, with a total natural gas send-out capacity of 9.7 Tcf/y as of 2016. Soma LNG, which has 75 Bcf/y of capacity, is the only terminal under construction, and it is slated to come online by 2018 (EIA 2017). The present regasification capacity exceeds the country's demand, and the average terminal utilization rate is below 50%. Japan also has the largest LNG storage tank capacity in the world, holding 590 MMcf, which serves as a buffer during seasons of higher LNG demand. Most of the LNG terminals, which are located in the main population centers and near major urban and manufacturing hubs of Tokyo, Osaka, and Nagoya, are owned by local power companies, either alone or in partnership with natural gas companies. Japan lacks extensive gas pipeline infrastructure and relies on LNG imports in many coastal demand centers and uses LPG in other areas.


Figure 10

China's potential as a natural gas producer has been constrained by government policies. China has made significant strides in diversifying its natural gas supplies. Domestic production has risen 164% in the last ten years, to 135 BCM in 2014 (BP 2015). Natural gas imports, which did not begin until 2006, have grown from 1 BCM to over 58 BCM in 2014. In 2014, imports were split 46% from LNG and 54% from pipelines, with Turkmenistan being the single largest supplier (44% of imports). Figure 10 highlights the dispersion of China's natural gas resources and its infrastructure constraints. The existing pipeline, West-East Natural Gas Pipelines has been a good performer with an annual delivery capacity of 77 billion cubic meters total length of more than 20,000km. However, natural gas deposits do not have pipelines in place to bring that gas to market such as northeastern provinces of Jilin and Heilongjiang. With the first framework agreement signed in 1997, Russia's Gazprom and the China National Petroleum Corporation (CNPC) continue to negotiate terms for a pipeline linking Russian gas production with Chinese demand. The pipeline to deliver the gas is targeted to be completed in 2018, which is proposed to enter China in the northeastern Heilongjiang Province. The proposed Russian Pipelines is a valuable trade in term to meet the increasing demand of Chinese natural gas market. Significantly, there are some in development LNG import terminals

located at East China Sea and South China Sea as developments of the U.S- China cooperation on natural gas and international joint ventures. International oil and gas firms have been involved, mainly with CNPC and Sinopec, in several gas extraction projects in China, particularly focused on the shale gas sector.

## V. Conclusion

Overall, the demand of natural gas market is likely to pick up in the long run amid the global sentiment of reducing reliance on nuclear power in the long run. While many countries are investing to strengthen renewable energy by building solar panels and windmills, it will take some time for renewables to reach sufficient production levels to satisfy energy demand. This makes natural gas a good alternative, as it is cleaner than both oil and coal and more efficient than renewable energy.

Japan's natural gas consumption grows modestly, by an average of 0.2 percent per year, from 3.7 trillion cubic feet in 2007 to 4.0 trillion cubic feet by 2035. A declining population and aging labor force limit the country's natural gas demand in the long term. Moreover, new nuclear generation capacity projected for Japan limits the need for additional natural-gas-fired generation after 2015.

In China, natural gas currently is a minor part of the overall energy mix, accounting for only 3% of total energy consumption in 2007. However, those shares nearly double in the projection to 12%.

The impact of China's continued rapid economic development on the environment has become a primary concern among environmental policymakers and also for the general public. In particular, China recently introduced a number of policies and proposals to address heightened concerns about air quality. China is moving to generate more electric power from nuclear power, renewables, and natural gas to address environmental concerns and to diversify its electricity generation fuel mix toward energy sources with lower or zero emissions of greenhouse gases.

Despite the growing importance of LNG, long-distance pipelines remain an important component of world gas trade. The major factor in the growth of piped gas (west-east pipeline, Russia-China pipeline) is rising natural gas demand in Asia, particularly China. Natural gas use in China may increase for several reasons: the implementation of environmental policies promoting use of natural gas in the power, industrial, and

transportation sectors; the availability of imported global LNG supply at relatively low prices; and growing capacity of LNG regasification.

As JKM is an important addition to the available international price indices and as such, supports the emergence of an efficient global LNG market. Although there exist the oligopoly concern in domestics industries, Japan & China markets have large potentials for pricing natural gas and trading with swaps/ futures necessary as the spot price is not as liquidity and transparent comparing with American or European market.

**Reference**

U.S. Energy Information Administration - EIA - *Independent Statistics and Analysis*
https://www.eia.gov/todayinenergy/detail.php?id=10391

The Federation of Electric Power Companies of Japan, *ELECTRICITY REVIEW JAPAN 2016*

Japan Liquefied Natural Gas Import Price:
https://ycharts.com/indicators/japan_liquefied_natural_gas_import_price

EIA, *International Energy Outlook 2016*, http://www.eia.gov/forecasts/ieo/nat_gas.cfm.

*Oil & Gas Journal*, Worldwide Look at Reserves and Production, December 7, 2015.

International Energy Outlook 2010

BP Statistical Review ofWorld Energy June 2016, #BPstats 65th edition, bp.com/statisticalreview

World Resources Institute, "CAIT Climate Data Explorer: China" (last updated July 1, 2015), http://cait.wri.org/indc/#/profile/China

CNPC, "Natural Gas & Pipelines," 2015,
http://www.cnpc.com.cn/en/naturalgaspipelines/naturalgas_index.shtml.

IHS Energy, LNG Market Data Sheet: Japan, January 4, 2017; Japan's Ministry of Economy, Trade, and Industry, Statistics: Spot LNG Prices webpage (accessed January 2017) and Newsbase NRG, "Japan India Will See Lower LNG Prices, Just Not Through Consortium", September 2014.

Peijun Duan and Tony Saich,

"Reforming China's Monopolies," Harvard University and the Central Party School, 2013, http://ash.harvard.edu/files/reforming_chinas_monopolies.pdf.

9 Michael Lelyveld, "*China Pipelines Sold Far Below Cost*," Radio Free Asia, December 28, 2015, http://www.rfa.org/english/commentaries/energy_watch/pipelines-12282015104204.html.

BP, *BP Statistical Review of World Energy*, June 2015, p. 22, http://www.bp.com/content/dam/bp/pdf/energyeconomics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf.