Current and Future Natural Gas Demand in China and India

Executive Summary

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April 2017

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EXECUTIVE SUMMARY

In recent years China and India have been viewed as potentially large markets for ***future*** natural gas consumption. In this paper we examine the historical drivers of natural gas demand in both countries and analyze the potential direction and impact of these drivers and possible new drivers on realizable natural gas demand in the future. As part of our analysis, we reviewed several public and private forecasts of natural gas demand in China and India in light of our demand driver analysis. We also compare the key features of both markets and discuss their possible impact on the future evolution.

Table 1. Snapshot of China and India Energy Markets

Indicator	China	India
Primary Energy Use 2015 (MMTOE)	3,014	701
• Oil	• 19%	• 28%
• Natural Gas	• 6%	• 7%
• Coal	• 64%	• 58%
• Nuclear	• 1%	• 1%
• Hydro	• 8%	• 4%
• Renewables	• 2%	• 2%
Primary Energy Use Growth Rate 2005-2015	5%	6%
Natural Gas Use 2015 (BCM)	197	51
Natural Gas Use Growth Rate 2005-2015	15%	4%
Electric Generation 2015 (TWh)	5,811	1,305
Electric Generation Growth Rate 2005-2015	9%	7%

Source: BP 2016 Statistical Review of World Energy. Growth rates are annual averages.

Table 2. Composition of 2014 Gross Domestic Product in China and India

Indicator	China	India
GDP Growth Rate 2005-2015	10%	7%
2014 Value Added as Percent of GDP:		
• Manufacturing	• 36%	• 17%

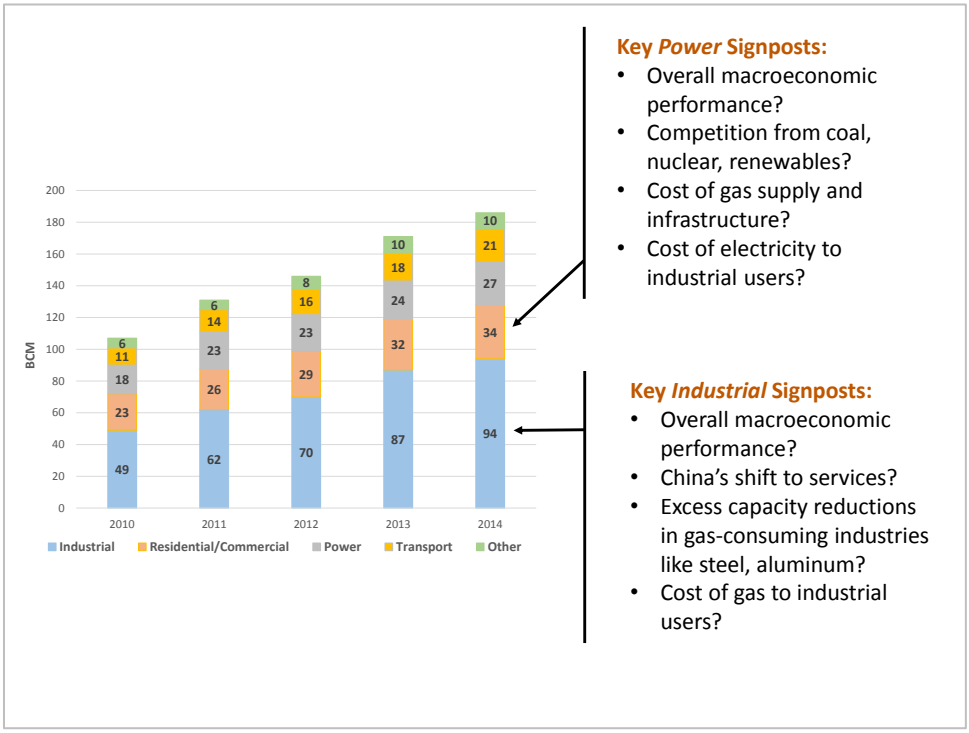
Indicator	China	India
• Power	• 7%	• 13%
• Services	• 48%	• 53%
• Agriculture	• 9%	• 17%

Source: World Bank World Development Indicators. Growth rates are annual averages.

China's primary energy, natural gas and electric generation markets are about four times the size of India's. The energy market sizes reflect the difference in the size of their economies: $10 trillion GDP for China and $2 trillion GDP for India in 2015. The primary energy markets in both countries are dominated by coal and, to a lesser extent, oil. The use of non-fossil fuels is greater than the use of natural gas in China and equal to gas use in India. Natural gas demand growth outpaced the growth in primary energy use and electric generation in China but lagged behind these measures in India.

The industrial sector is the largest gas consuming sector in both countries accounting for 50 percent and 52 percent of total gas use in China and India in 2014, respectively. China's industrial gas use grew at an average annual rate of 18 percent between 2010 and 2015 while India's industrial gas use grew only slightly.

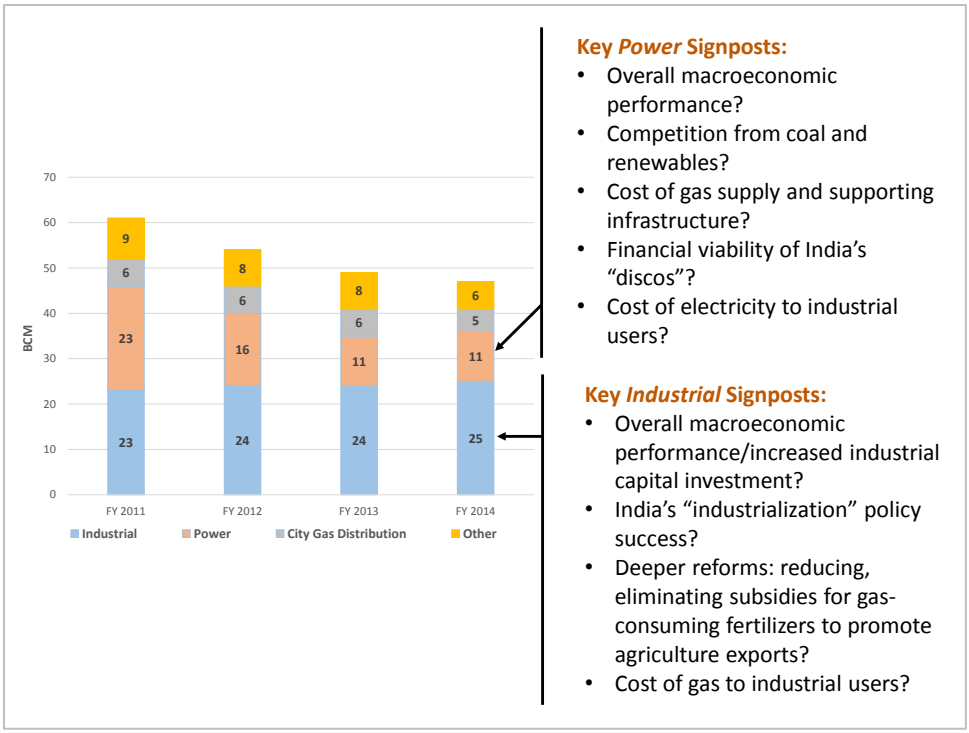
Figure 1. Chinese Gas Consumption by Sector 2010-2014 (BCM)



Source: NBSC as revised by CEE. See Appendix 2 of full report for revisions.[1]

[1] There are industrial sector categorization differences among historical data reporters (NBSC, MOPNG, EIA, IEA) which complicated the forecast analyses. We have revised the reported historical categorizations for this sector in order to make the historical consumption data more comparable among reporters and to gain insights into the gas

Figure 2. Indian Gas Consumption by Sector FY2011-FY2014 (BCM)



Source: MOPNG as revised by CEE. See Appendix 2 of full report for revisions. India's fiscal year is April 1-March 31. City gas distribution includes residential/commercial and transport. MOPNG gas use data prior to FY 2011 does not include LNG consumption.

An important factor influencing the differences in energy market size and growth rate between the two countries is the respective structure of the Chinese and Indian economies. Until very recent times, China has had an industry and investment led economy while India has had a services and consumption led economy. Agriculture plays a much larger role in India than China. According to the International Energy Agency's (IEA) 2015 World Energy Outlook (WEO 15) industry-led economic growth requires ten times more energy per unit of value added as compared with services-led growth.

Currently both countries have announced transitions to new economic structures which could reverse these historical trends: China is transitioning to a services-led economy while India plans to increase industrial value added as a percentage of GDP from 17 percent in 2014 to 25 percent by 2022 through "Make in India" policies. As a result, natural gas demand theoretically could slow in China and accelerate in India. The actual implementation and speed of these transitions will greatly influence future energy natural gas demand in both countries.

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use by the major individual industries within the sector. The details of these revisions are in Appendix 2 of the full report. Although there are data differences among reporters with respect to gas use by the other consuming sectors, these are not as significant and were not revised. Reported total gas use for each country was also not revised.

Contributing to the size differential between the Chinese and Indian natural gas markets are significant variations in the development of their gas resources and the size, integration and geographical reach of their gas infrastructure. Development of the natural gas resource base, gas import capacity and the associated gas delivery infrastructure is significantly more advanced in China than India (Table 3).

Table 3. Snapshot of Natural Gas Supplies and Infrastructure in China and India

Indicator	China	India
2015 Proved Gas Reserves TCM	3.8	1.5
2015 Gas Production BCM	138	29
2015 Gas Imports BCM/Percent of Total Gas Supply: • Percent Pipeline • Percent LNG	59/30% • 58% • 42%	22/43% • 0% • 100%
Miles of Major Gas Pipelines	35,498 (Jan. 2014)	10,825 (Mar. 2015)
LNG Regasification Terminals: • Operating • Under Construction • Planned/Proposed	 • 12 • 5 • 7	 • 4 • 2 expansions • 7
Storage Capacity (BCM) • Underground working storage • LNG tank storage	 • 7 • 32	
City Gas Distribution • 2014 Gas Sales (BCM) • Urban Population Access to Gas • Percent Urban Population Access to Gas	 • 56 • 241 million 34%	 • 5 • 3 million 0.6%
2015 Natural Gas Vehicles	4.5 million	2.5 million
2015 NGV Refueling Stations	7,000+	1,000
Gas-fired Generation 2014 • % Total Capacity • % Total Generation • Gas Use BCM	 • 2% • 4% • 27	 • 5% • 9% • 11

Sources: BP SR 2016, EIA China and India Country Analyses, BMI Research China and India Oil & Gas Reports, India Ministry of Petroleum and Natural Gas, India Petroleum and Natural Gas Regulatory Board, China National Bureau of Statistics, Stratus Advisors 2016, Andy Flower July 2016

China's gas production grew at an average annual rate of 14 percent between 2005 and 2015 and India's grew at less than 1 percent over the same period. Chinese conventional gas production is expected to grow at low rates with any significant future increases coming from shale gas and coal bed methane. However, shale production to date has been disappointing due to difficult geological and topographical conditions, relatively high costs and insufficient pipeline infrastructure, among others.[2] The outlook for meaningful growth in Indian gas production is even more uncertain given the lack of upstream

[2] Energy Insights, McKinsey, 2016.

incentives in the current pricing mechanisms, the slow pace of upstream energy reform and the difficult struggle to increase production at India's large KG D6 field.

China's gas pipeline infrastructure is much larger than India's it is not well integrated and is concentrated in four areas around Beijing and Bohai Bay, Shanghai and the Yangtze River delta and central west Chongqing. There are regional and local gaps, especially in the northeast and growing southeastern coastal areas as well as lack of delivery capacity between some gas import terminals and demand centers. China has a growing space heating market in the northern parts of the country but lacks the gas storage capacity necessary to manage seasonal swings in demand. China's gas infrastructure may not have the flexibility needed to perform peaking and other load balancing services for the power industry.

India's gas infrastructure is much less extensive and more highly fragmented than China's. India's domestic gas production has been declining since 2012 in part due to lack of investment in the upstream sector which in turn is partly due to a government administered natural gas pricing system that does incentivize upstream investment. Forty percent of India's gas pipeline and distribution infrastructure is in the two western states of Gujurat and Maharashtra. It is difficult to extend the gas delivery infrastructure in India and/or build new import terminals due to limited capital markets and significant land acquisition problems as well as the myriad of problems afflicting the expansion of any industrial activity in India

Exacerbating the infrastructure problems in both countries is the organization of the natural gas industry and the high degree of government intervention in the industry. In India all sectors of the natural gas value chain (upstream, midstream and distribution) are dominated by large state-owned companies. The same is true of the upstream and midstream sectors, and, to a lesser extent, the distribution sectors in China. In China, there are many more players in the city gas distribution sector than in India but many of these companies are owned by or associated with local government entities. The presence of powerful state owned enterprises in the natural gas sector together with the high degree of government intervention in natural gas pricing and supply allocation discourage private investment in the sector, especially private foreign investment, shutting out new sources of capital. This is an acute problem in India where access to abundant and affordable capital is very problematic. It is a growing problem in China where the heavily indebted and financially stressed state-owned companies operating in the gas sector are cutting capital expenditures.

Increased demand from the industrial, residential/commercial and power sectors have been the major drivers of gas demand growth in China (Figure 1), representing 57 percent, 14 percent and 11 percent, respectively of the total demand increase of 79 BCM between 2010 and 2014. Total gas demand in India declined 23 percent from 61 BCM in FY2011 to 47 BCM in FY2014 due to declining domestic gas supplies and relatively high prices for LNG. Like China, India's industrial sector is the largest gas consumer representing 52 percent of total gas use followed by the power sector at 23 percent of total gas use (Figure 2). In India, 86 percent of the 14 BCM gas demand decline between FY2011 and FY2012 occurred in the power sector because high LNG prices made gas-fired generation unaffordable for India's financially troubled electric distribution companies. Coal-fired generation accounts for 71 percent and 77 percent, respectively, of China and India's total electric generation with gas-fired generation

playing more of a peaking and load following role. Both countries have abundant domestic coal resources

The composition of the two countries' gas-consuming industrial sectors are quite different. In 2014 China's chemicals industry accounted for 34 percent of total industrial gas use followed by other industrial (25 percent), energy sector use for oil and gas extraction (17 percent), refining (15 percent), steel (five percent) and non-ferrous metals (four percent). China's other industrial category includes non-metallic minerals and non-energy intensive manufacturing businesses such as wholesale and retail trade, electronics, transport equipment, metals manufacturing, among others.

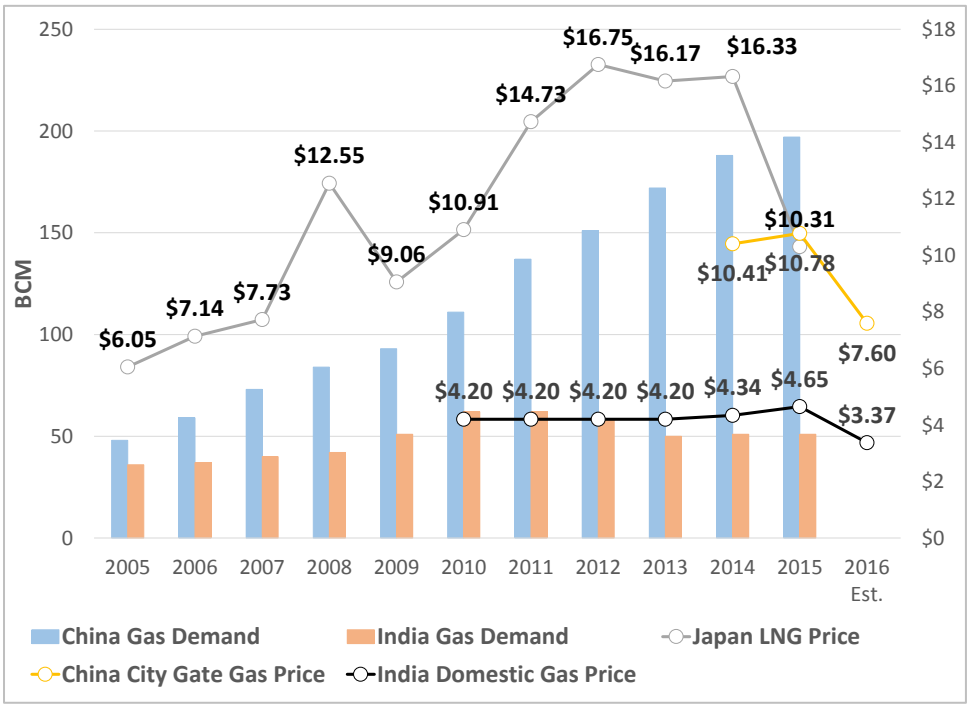
In India industrial sector gas consumption is dominated by the urea fertilizer industry at 61 percent of total sector gas use in 2014. The agriculture sector is still very important to the Indian economy and employs over 50 percent of the eligible voting population. India has a goal of self-sufficiency in urea production and the government thus far has been willing to support the industry with large subsidies. The fertilizer sector is followed by the refining and petrochemical sectors at 19 percent and 12 percent, respectively, of total industrial gas use in 2014.

India's city gas distribution (CGD) sector is much less mature and more infrastructure-constrained than CGD in China and accounted for 12 percent (5 BCM) of total gas demand in 2014 compared to 26 percent (55 BCM) in China. This large difference in market size can be explained by the following factors:

(1) Urbanization, which facilitates development of CGD systems, is more advanced in China (55 percent) than in India (30percent);
(2) There is a significant residential/commercial space heating market in China that does not exist in India;
(3) Electric units dominate the growing air conditioning market in India and the smaller, seasonal water heating market;
(4) More than 70 percent of Indian household energy use is for cooking and solid biomass accounts for about 85 percent and 25 percent of rural and urban cooking fuel, respectively;[3]
(5) In urban areas, subsidized LPG is the cooking fuel that is displacing kerosene and biomass;
(6) Diesel, which was subsidized until 2014, accounted for 70 percent of total transport oil demand;[4] and
(7) Presence of a larger NGV fleet and refueling station network in China.

[3] IEA WEO 15.
[4] Ibid.

Figure 3. China and India Gas Demand (BCM), Domestic Gas Prices (MMBtu) and Japan LNG Prices (MMBtu)



Sources: BP SR 16; Sen, A. April 2015; Paltsev, S., et.al., July 2015

The natural gas markets in both China and India are highly price sensitive and rely on LNG and, in China's case, pipeline imports range from around 30-43 percent of their gas supply respectively. In 2014 and 2015 gas demand growth declined markedly in China, from 14 percent in 2013 to 10 percent in 2014 and 5 percent for 2015. This decline in part was due to relatively high domestic gas prices in 2014 and 2015 (close to $11/MMBtu) and high LNG prices (roughly $10 to $16/MMBtu). Pipeline imports from Central Asia and Myanmar averaged $6.01/MMBtu in December 2015 compared to an average LNG price (contract and spot) of $7.64/MMBtu in the same month.[5]

In the first half of 2016, China's gas consumption increased almost ten percent compared to the first half of 2015 with LNG imports increasing 21.2 percent for the same period year on year.[6] In the first half of 2016 spot Asian LNG prices fell to $4.80/MMBtu in June and average domestic city gate gas prices fell from $11.00/MMBtu to $7.60/MMBtu.

[5] Russell, C., 2016, February 29, LNG needs new pricing, rules to realize its golden age, Reuters, http://www.reuters.com/article/us-column-russell-lng-asia-idUSKCN0W2174

[6] LNG World News, 2016, August 1, China boosts LNG imports, http://www.lngworldnews.com/china-boosts-lng-imports/

Chinese gas consumption growth moderated to 2.3 percent year on year to July 2016 reflecting sluggish economic growth and weakening seasonal consumption.[7] LNG imports in July 2016 declined 17 percent from those in July 2015 as LNG prices into China increased. July 2016 pipeline imports, primarily from Turkmenistan and Uzbekistan, rose 21 percent from those in July 2015.[8] The average price of pipeline gas was $4.77/MMBtu in July 2016 compared to $5.40/MMBtu for LNG.[9] Despite the fall in LNG and domestic gas prices in 2015 and the first half of 2016, coal-fired plants were still first in the dispatch order for baseload generation based on LNG prices into Guangdong in southern China.[10]

India saw natural gas demand increase nine percent for the three month period April-June 2016 compared to the same period in 2015. Indian LNG import prices declined from $13.10/MMBtu in 2014 to $7.50/MMBtu in 2015 and to about $4.85/MMBtu in the first half of 2016.[11] Domestic gas prices fell from $5.05/MMBtu in March 2015 to $3.15/MMBtu in April 2016.

These low gas prices may extend through the mid-term but could be difficult to maintain longer term. Forecasts we reviewed all expected imported Asian LNG import prices to range from $7.50/MMBtu to $15.00/MMBtu over the period 2020-2030. Indian and Chinese domestic gas producers say that prices need to increase substantially from current levels in order to increase domestic gas production.

Natural gas pricing in both China and India is complicated by government administered pricing mechanisms. Although the mechanisms in both countries include some market inputs, prices are not directly tied to relevant gas markets or alternative fuels. Natural gas prices do not respond to price movements in relevant gas markets and/or alternative fuels on a timely basis in either country. The timing of price adjustments is unclear in China and is every six months in India. The lack of clear and timely market price signals discourages private investment in all segments of the natural gas value chain and reinforces the dominance of state-owned enterprises.

As part of our analysis, we reviewed two public forecasts of Chinese and Indian natural gas demand: the IEA's WEO and the Energy Information Administration's (EIA) International Energy Outlook 2016 (IEO). In addition, we review forecasts provided to CEE of Chinese and Indian natural gas demand from BMI Research, a Fitch Group company; McKinsey Energy Insights; and ICIS. For India we include two additional forecasts: (1) Vision 2030 prepared for the Indian government and (2) a March 2016 forecast by ICRA, a Moody's Investors Service company.[12]

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[7] China Daily, 2016, August 29, China imports less natural gas amid weak consumption, China Daily, http://www.chinadaily.com.cn/bizchina/2016-08/29/content_26627793.htm. Bloomberg News, 2016, August 9, The world's energy engine is slowing, http://www.bloomberg.com/news/articles/2016-08-09/world-s-energy-engine-slowing-no-help-for-gluts-from-oil-to-coal

[8] Sikorski, T., Tertzakian, A., 2016, August 26, Global LNG fundamentals, Energy Aspects, https://www.energyaspects.com/publications/view/2016-08-26-fundamentals

[9] Ibid.

[10] Sikorski, T., Tertzakian, A., 2016, August 31, Hard times: global LNG outlook, Energy Aspects, https://www.energyaspects.com/publications/view/2016-08-31-hard-times

[11] Sikorski, T., Tertzakian, A., Hard times: global LNG outlook, Energy Aspects, https://www.energyaspects.com/publications/view/2016-08-31-hard-times

[12] A more in-depth analysis of these forecasts is contained in Appendix 2.of the full report.

We supplement these projections, where possible, with insights gained from other public forecasts such as ExxonMobil's 2016 Outlook for Energy, BP's 2016 Energy Outlook, and other public analyses of future Chinese and Indian natural gas demand. Many of these sources also look at future gas demand by end-use sectors but do not publish the details of their analyses in a manner comparable to the IEA and EIA.

For China, the forecasts we reviewed see 2016 gas consumption increasing slightly to 200 BCM as a result of lower prices and growing to 300 BCM in 2020. In 2025, the forecasts begin to diverge resulting in a range of gas demand estimates for 2030 from a low of 407 BCM to a high of 529 BCM.[13]

The higher gas demand forecasts expect significant growth in China's industrial and/or power sector gas use. Gas demand growth in these forecasts is predicated on continued expansion of the industrial sector and timely implementation of Chinese government environmental policies, including carbon taxes, which discourage coal use and encourage fuel-switching to natural gas in the power and industrial sectors. The more moderate forecasts of gas demand growth also depend to some extent on government environmental policies that encourage gas use.

Despite its environmental issues, we expect coal to remain a formidable competitor to gas in the industrial and power sectors. In our view, it is difficult for environmental policies to trump the economic advantages of coal without the imposition of measures that advantage gas economically to coal such as a meaningful carbon penalty. It seems unlikely that the government will burden an already slowing economy with a penalty that is high enough to trigger the desired fuel switching. The government could rely more upon renewables to meet environmental goals than large-scale industrial fuel-switching, except in the most polluted urban areas. Alternatively, China could foster greater development and more competitive pricing among gas supply sources (a version of the U.S. gas market situation). To date, government commitment to renewable energy sources has been greater than its support for gas and several forecasts expect nuclear and non-hydro renewables to have a greater share of total generation than natural gas. A complication for gas use in China is a more complex picture for supply sources. Outside of domestic production growth, for which the success case is not clear, Russia pipeline delivery and LNG imports constitute the major supply options. Given the likely continued price disadvantage of gas relative to coal, the pace of industrial fuel-switching to gas may be slower than that envisioned in the forecasts we reviewed. Moreover, in light of the massive investment in coal and methanol-to-olefins technologies we expect usage of those fuels to grow in the large and rapidly growing chemicals sector.

We expect limited gas demand growth in the refining, steel and non-ferrous metals industries due to the massive overcapacity in those sectors and ultimate rationalizing of excess capacity. We do think gas demand growth will occur in the non-energy-intensive manufacturing industries, especially where coal is not a dominant competitor, as the economy becomes more consumer-oriented. However, it is difficult to predict the significance of that growth.

[13] A recent chapter on global LNG potential demand posits China's total natural gas demand in a range of 400 BCM to about 475 BCM in 2030. Honore, A., Rogers, H., D'Apote. S., Corbeau, A., 2016, September, "LNG Demand Potential," in LNG Markets in Transition: The Great Reconfiguration," edited by A. Corbeau and D. Ledesma, Oxford Institute for Energy Studies, Oxford University Press.

Significant growth in natural gas use in the power sector is problematic. Coal, together with nuclear, will dominate baseload generation. China's modern gas-fired power fleet has been utilized mostly for load-following and peaking purposes, leading to a nationwide utilization rate of about 30 percent. We expect renewables to be used more than natural gas in meeting the environmental goals of the power sector. Gas supply factors, as discussed above, play a significant role in affecting price fundamentals. Increased usage of existing gas-fired generation capacity could occur but overall we expect gas-fired generation to continue to play a peaking and load balancing role.

City gas distribution in China has the potential to be a growth market for natural gas. The residential/commercial sector is the second largest gas consuming sector in China. All the forecasts we reviewed expect residential/commercial sector gas use to triple from 34 BCM in 2014 to around 70 to 80 BCM in 2030. To realize this growth potential, we think that continued reform of residential gas pricing and expansion of gas infrastructure, especially storage, are required. New distribution infrastructure is required to penetrate markets with limited access to gas.

The transport sector is the one sector where the Chinese government has actively supported natural gas demand growth with infrastructure subsidies and favorable consumption tax policies. The government appears to see natural gas vehicles as a key component in its efforts to limit urban air pollution. The most aggressive of the forecasts we reviewed incorporate 2030 transport sector demand ranging from 45 to 63 BCM. In order to realize this potential, we think significant expansion of the refueling network and piped gas distribution systems are needed, especially in the northeast and the rapidly growing southeastern coastal areas.

For India, most forecasts we reviewed indicate total gas demand for 2016 growing to 55 BCM as a result of lower prices. The bullish ICRA outlook for gas demand growth in the industrial and power sectors results in total gas demand of 92 BCM in 2020 compared to the about 70 BCM estimates from other forecasters. The ICRA forecast depends on continued low domestic and international gas prices, more rapid and significant expansion of gas infrastructure than seen to date, and rapid resolution of long-standing structural issues in the electric power industry. Although India is making progress on the gas infrastructure and electric power industry fronts, all of the other forecasters (excluding the Indian government) expect slower near term progress consistent with that experienced in recent years. The ranges in the total gas demand forecasts for 2025 and 2030 are 85-104 BCM and 112-118 BCM, respectively.

These forecasts for gas demand growth in the industrial sector appear to be predicated on an energy-intensive industrial expansion that will increase the use of all fuels. Progress in the "Make in India" initiative has been muted to date. Nevertheless, if growth in manufacturing accelerates from current levels, forecasters see significant expansion of the traditional energy-intensive industries like steel, cement, refining and chemicals alongside continued growth in non-energy intensive industries such as textiles, food and beverages, transport equipment and electronics. However, most forecasters see coal as the dominant fuel in the industrial sector. According to the IEA, coal's share of industrial total energy use will expand from 50 percent currently to 56 percent by 2040. India's environmental goals and commitments will be met with renewables rather than significant industrial fuel switching from coal to gas.

India's gas demand is highly price sensitive; its two largest gas consumers, the fertilizer and power industries, require significant government subsidies in order to survive. The outlook for growth in domestic gas supplies is subdued at current low price levels. At present, India relies on imported LNG supplies to meet gas demand growth and the forecasters do not see LNG import prices continuing at the extremely low levels seen in 2016 (about $4.85/MMBtu for the first half of 2016)[14] over the forecast period. McKinsey indicates that a delivered Asian LNG price of $7.50 to $8.50/MMBtu is required to cover full project costs of the new LNG capacity that will need to be built by 2030.[15] The IEA expects the natural gas price for imported gas in Japan to range from $11.00 to $15.00/MMBtu from 2020 to 2030.[16]

Although there could be increased gas demand from the fertilizer industry, we expect the pace of gas demand growth to be slow due to rising uncertainty about new capacity additions in an industry that requires significant government support to survive. With respect to non-fertilizer industrial demand growth, our view is closer to that of the IEA. We think industrial gas demand growth will be muted due to infrastructure and supply impediments; limited duration of current low LNG import prices; limited progress in the push for manufacturing growth to date; constrained access to affordable capital for investment as well as overall impediments to industrial activity.[17]

The forecasts we reviewed project significant growth in power sector gas demand although not as large as the projected increases in Chinese power sector demand. The most aggressive power sector gas demand forecasts foresee carbon penalties that will favor gas and allow displacement of coal in the power sector. More conservative forecasts see renewables and nuclear fueling most of the total energy demand growth in the power sector and those two energy sources will be relied upon to meet environmental goals.

If low LNG prices persist, we think power sector demand will increase enough to have adequate utilization of existing gas-fired generation capacity. However, given the limitations of India's gas infrastructure natural gas is not likely to play a baseload power role in the future or increase its share in total generation significantly. Given the uncertainties surrounding potential increases in domestic gas production, and the inability of the sector to tolerate high LNG prices (e.g., the inability of India's electric distribution companies or EDCs to charge electric rates high enough to cover costs), our interpretation for power sector demand is sympathetic to the low end of the forecasts.

The CGD sector in India is currently small. Some forecasts predict significant growth in gas demand from the sector as a result of favorable government reforms which prioritize household gas consumption over gas use in other sectors and/or growth in gas demand for natural gas vehicles as the fleet expands in order to reduce air pollution in major cities. Our view of sectoral gas demand growth is more modest. We think the largest impediments to robust CGD gas demand growth are:

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[14] Sikorski, T., Tertzakian, A., Hard times: global LNG outlook, Energy Aspects, https://www.energyaspects.com/publications/view/2016-08-31-hard-times

[15] Energy Insights, 2016, June.

[16] IEA WEO 15.

[17] Including, but not limited to, land acquisition difficulties, complex bureaucratic and administrative requirements, time-consuming procedures, local and central government differences, regulatory ambiguity and retroactive taxes.

(1) The large capital requirements to expand an infrastructure that is considerably less developed than China's;
(2) The dominant role of electricity in the growing air conditioning market; and
(3) The difficulty of displacing biomass for cooking in rural areas.
(4) There are a number of security issues affecting the natural gas systems in both China and India including security of affordable gas supplies; security of international gas shipping and pipeline transportation routes; the security and adequacy of domestic gas system infrastructure and the ability of the natural gas system to accommodate demand fluctuations.

As both countries are importers of significant natural gas volumes, international gas supply and transportation security are important concerns. The current gas import infrastructures of both countries (pipeline and LND) are shown in Appendix 1- Maps and Table 21 of the main report. Both countries have attempted to address these security issues, with varying degrees of success, by increasing domestic gas production; expanding and diversifying international gas suppliers; expanding and diversifying transport options; building redundancy in import terminals and increasing global gas supplies through upstream investment in other countries. To date, China has a more expansive and diversified gas import structure than India possibly reflecting India's lack of financial resources and the serious difficulties in building significant infrastructure in that country. China has had more success in increasing domestic gas production than India but significant gas imports are expected to continue in both countries in the foreseeable future. The upstream gas sectors in both countries suffer from disincentives to investment, particularly around pricing, that are discussed in the body of this paper.

The governments of both countries have encouraged upstream oil and gas investment in foreign countries as a way to protect against price volatility and supply shortages. China has been more aggressive in this arena than India, frequently outbidding Indian investors. Currently China and India do not have sufficient gas storage to help them respond to supply and demand disruptions. This is of special concern in China which has a growing residential heating market with significant seasonal demand swings. There has been discussion about the relative riskiness of gas imports by pipeline versus gas imports via LNG. It has been reported that some Chinese policy makers favor oil and gas imports by land from Central Asia, Russia and even Iran in order to lessen China's reliance on seaborne energy.

The governments of both countries have policies supporting the development of non-fossil fuel energy sources for power generation, especially wind, solar and nuclear. Although energy security may not be the primary driver of these policies and mitigating reliability could be a challenge, wind, solar and nuclear are domestically-controlled resources and do not have the security disadvantages associated with imports. We note that promotion of renewables may also have a dampening effect on natural gas demand growth given the rapid pace of non-hydro renewable capacity growth relative to gas-fired generation.

In sum, we expect growth in industrial energy demand in China to slow as it struggles with massive overcapacity in the energy intensive industries. The uncertainty surrounding the ultimate success of the "Make in India" initiative clouds the prospect of robust industrial energy demand growth in India. The continuation of current low domestic gas and LNG prices could result in short-term demand increases in both China and India but we discount continuation of current price levels over the longer-term. We

expect cheap and abundant coal to continue dominating energy use among price-sensitive industrial and power sectors in both China and India absent the imposition of a meaningful carbon penalities, which we view to be unlikely, or meaningful. We expect natural gas to play a peaking and load balancing role in both countries' power sectors with baseload generation coming from nuclear and supercritical, clean coal plants. We think there will be continued strong policy support for renewables in power generation to achieve environmental goals. As a result, our expectation of natural gas demand growth in those two sectors is at the lower end of the forecasts we reviewed. If there are difficulties in accommodating renewables in power sector transmission grids, there may be a possibility for gas to play a greater role in generation.

In our view, there is gas demand growth potential in the city gas distribution sector of China which could be realized if there is continued strong investment in the expansion of distribution and transport infrastructure. We expect more modest growth in the gas demand from this sector in India given the large infrastructure challenges, slower urbanization and the competition from alternatives.

Although India's population is forecast to exceed China's around 2022[18]and its GDP growth is expected to outpace China's in the medium term, we think, consistent with the forecasts we reviewed, that India's gas market will still be about one-quarter the size of China's gas market in the foreseeable future.

Access the full report, Current and Future Natural Gas Demand in China and India at http://www.beg.utexas.edu/energyecon/GlobalGas-LNG/. For details please contact CEE.

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[18] *The Globalist*, 2015, November 5, Population growth at the top: China vs. India, http://www.theglobalist.com/population-growth-at-the-top-china-vs-india/