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CHINA'S QUEST FOR BLUE SKIES

The Astonishing Transformation of the Domestic Gas Market

Sylvie CORNOT-GANDOLPHE

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Executive Summary

China's gas industry has been moving into a new era. China's natural gas demand has skyrocketed amid a state campaign that encourages coal-to-gas switching. In just two years, China added 75 billion cubic meters (bcm) to global gas demand, the equivalent of the UK gas market, the second largest European market. Despite steadily rising, Chinese gas production has not been able to cope with such a huge increase and gas imports have also surged, with strong global repercussions. In just two years, China has become the world's largest gas importer and is on track to become the largest LNG import market.

The boom in gas demand is policy driven. The fight against air pollution and the acceleration of coal-to-gas switching in the industrial and building sectors have been the key drivers of the rapid increase in gas demand. Climate change has not been a direct driver of the gas demand boom, but coal-to-gas switching has also helped to reduce China's carbon intensity. Looking ahead, the growing recognition of the role of natural gas to tackle poor air quality and climate change provides the foundations for a bullish outlook for China's gas demand. In its move to a clean, low-carbon, secure, and efficient modern energy system, the Chinese government has set a clear goal of making natural gas a key source of energy. It is expected to be the third largest energy supply source after coal and oil, with a 10% share in the domestic energy mix by 2020 and 15% by 2030, against 7.8% in 2018.

China's gas market has entered **a golden age** that can propel gas demand to some 600 bcm by 2030, from 280 bcm in 2018. The nation will lead the growth in global gas demand and become the second-largest gas market already by 2025. Yet the spectacular annual gas demand growth rates seen in the past two years are expected to be slightly more moderate in the medium term. The longer term demand outlook is brilliant, provided domestic natural gas production steps up, alongside storage capacity and that import dependency remains at an acceptable level for policy makers.

Seasonality of Chinese gas demand is a major challenge. Despite rising production and surging imports, a major gas shortage affected northern China in winter 2017-18. This has exposed the key bottlenecks of the Chinese gas market: an underdeveloped gas transport and storage system and the lack of adequate incentives for investment in

the gas industry. The gas crisis has not derailed the coal-to-gas switching policy but it has changed the pace and way of its implementation, with strict planning. The promotion of natural gas is changed from "coal-to-gas" to "**change with gas**". Clean heating plans now integrate specific local conditions and affordability of gas supplies. This new policy highlights the high stakes for successful switching to gas, both to provide winter heating and improve air quality. A disruption of supplies could raise risks for social stability on both counts.

The gas shortage has been a catalyst for adopting short-term measures to alleviate winter gas supply/demand imbalances, accelerating the construction of key infrastructure and reinforcing and improving security of gas supply. The short-term measures combined with a milder winter than the previous one helped China's gas market to balance smoothly in winter 2018-19. Looking ahead, higher storage capacity and better interconnectivity of the transmission network will enhance winter security of supply and smooth out the seasonality of China's LNG imports. In the short term, the implementation of a compulsory peak shaving mechanism will create additional LNG demand.

The gas shortage has also been a catalyst for intensifying gas market reforms to improve market competition and security of gas supply. Reforms have been particularly successful on the consumption side. The downstream market of the gas industry has been liberalized and full market competition has begun to emerge. Chinese policy makers have adopted new gas pricing for residential users to solve cross-subsidization between customers and better reflect procurement costs. Trading on exchanges is encouraged.

However, in the upstream and midstream segments, the degree of competition is still low. Growing gas demand has put more pressure to rapidly reform these segments. A fundamental step has been taken with the creation of the national pipeline company, an independent oil and gas transmission system operator. The move will facilitate utilisation of the transmission pipeline network by third parties, allowing more and more players to enter the market and fostering competition. As a result, it will facilitate the growth of gas supplies, unlocking the potential for new upstream suppliers and possibly have a downward pressure on prices, making natural gas more affordable to end users and further boosting gas demand in the long run. But there is still a long way to go before the system is fully liberalised. NOCs' strategic role in the gas supply chain is expected to remain dominant despite anticipated growth in non-NOC players.

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Introduction

In a bid to tackle air pollution and "turn China's skies blue again," Beijing has adopted a bold policy plan. Part of this initiative is an extensive government-led switch from coal to natural gas for heating and industrial purposes. The switch was accelerated in the last two years, leading to a spectacular growth in gas demand. Natural gas is also part of the government's plan to transform its energy mix, thus responding to climate change challenges. The use of gas is expected to increase significantly in the future. Given that gas makes up only 7.8% of the country's total fuel mix—compared with 23% on average in the world—the shift towards natural gas is just the start of a new era for the Chinese gas industry.

The objective of this report is to give a better understanding of the profound repercussions of China's quest for blue skies on its domestic gas market. The report is structured into five parts:

- The first part reviews recent gas market developments in China;
- The second part analyzes the main drivers of the robust growth in gas demand;
- The third part assesses the implications of rising and seasonal demand on infrastructure and short-term security of gas supply;
- The deepening of gas market reforms is reviewed in the fourth part;
- The final part gives an overview of gas demand outlooks by key international and Chinese institutions.

This report is followed by a related analysis focusing on the repercussions of the transformation of the Chinese gas market on the global gas market.[1]

1. S. Cornot-Gandolphe, "China's Quest for Gas Supply Security: The global implications", *Etudes de l'Ifri*, Ifri, September 2019.

A new era for China's gas market

Fast growth in gas demand

For the second consecutive year, natural gas consumption in China registered a dramatic growth in 2018. With **280 bcm consumed**, natural gas demand increased by 18.1%.[2] This follows a 15.3% increase in 2017. In just two years, China has added 75 bcm to global gas demand, the equivalent of the UK gas market, the second largest European market. It should be noted that gas shortages restricted gas demand during the heating season of 2017-18 (15 November-15 March).[3] Without these restrictions, gas demand would have been even higher.

These strong growths are policy-driven: the central government has accelerated **coal-to-gas switching** to an unprecedented level as part of its policy drive to "make China's skies blue again." There has been a strong push to phase out small, inefficient coal boilers in **industrial sectors** (especially those in and around major cities) as well as to substitute coal use for **residential heating** in northern China. The sustained economic growth also supported higher gas demand by the industrial sector. Weather-related events (a very cold winter in 2017-18 and a heat wave in summer 2018) also increased demand for heating and cooling. The central and local governments have **lowered gas prices for non-residential customers**, thus increasing the competitiveness of natural gas against competing fuels, although the effect on gas consumption is less evident than the coal-to-gas switching policy.[4]

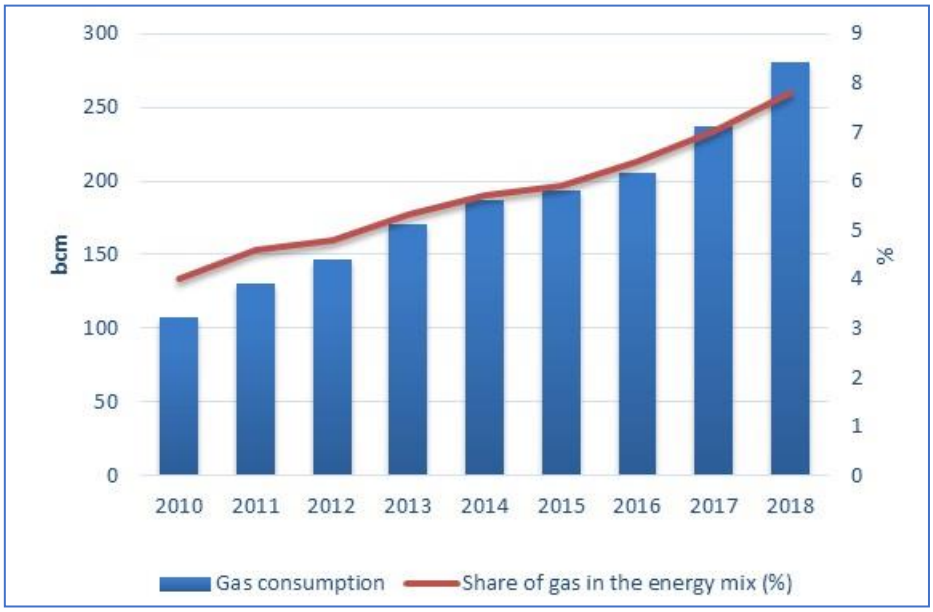
These growths mark a new stage of expansion for gas demand. They follow three years of 'modest' growth, as demand plummeted mainly due to the high price of natural gas compared with

2. National Development and Reform Commission (NDRC), "2018 natural gas operation profile" (in Chinese), 31 January 2019, available at: www.ndrc.gov.cn.
3. China's heating system is very different from other countries in the world. Back in the 1950s, the central government drew a line across the country, stipulating places located above the line (North China) can enjoy a central heating system with subsidies from the government, whereas no heating systems would be provided to places below the line (South China).
4. See S. O'Sullivan, "China's Long March to Gas Price Freedom: Price Reform in the People's Republic", Oxford Institute for Energy Studies (OIES), November 2018, available at: www.oxfordenergy.org.

competing fuels. Thus, gas demand has resumed the double-digit growth that characterized the period 2000-2013 when gas consumption rose at an average annual rate of 16%. **Projections for 2019 indicate a growth of 10% to 14% (totalling 310 bcm to 320 bcm)**.[5]

Despite the dramatic increase in gas consumption, natural gas is still under-represented in China's energy mix, accounting for only **7.8% of total energy consumption in 2018**, compared with 23% worldwide. The energy mix remains dominated by coal (59% of the energy mix in 2018, down 1.4 percentage points from 2017), but clean energy sources (natural gas, nuclear power, hydropower and other renewables) are increasing their share continuously (22.1% in 2018, 1.3 percentage points higher than in 2017).

Graph 1: Evolution of natural gas consumption in China



Source: National Development and Reform Commission (NDRC), National Bureau of Statistics (NBS).

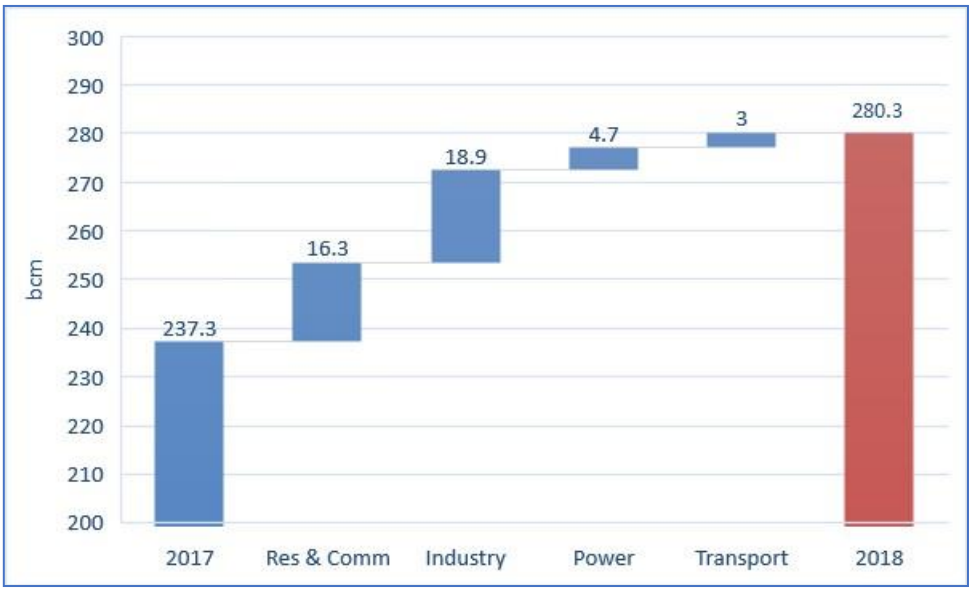
City gas use, the industrial sector, and to a lesser extent, the power sector, are driving the growth in natural gas consumption.

City gas consumption, which includes residential/tertiary customers, small industrial users and gas used as vehicle fuel, was 115 bcm in 2018, up 24% year-on-year.[6] The growth in city gas use has been driven by the fight against air pollution and the establishment of coal-free areas in Beijing-Tianjin-Hebei (BTH) and surrounding cities, rapid urbanization and expansion of pipeline coverage, as well as surging demand of LNG by

5. sxcoal.com, *China Energy Development Report 2018* (in Chinese), 29 April 2019, available at: www.sxcoal.com.
6. *Ibid.*.

heavy-duty trucks. China, the world's largest car market, is also the world's largest market for natural gas vehicles (NGVs) with a fleet of 6.7 million vehicles at the end of 2018, of which 400,000 LNG heavy trucks.[7] The strong growth of LNG heavy trucks is part of China's continued battle against air pollution that includes curbs on heavy-duty diesel vehicles.

Graph 2: Incremental gas demand by sector in 2018



Source: Shell, NDRC, estimates.

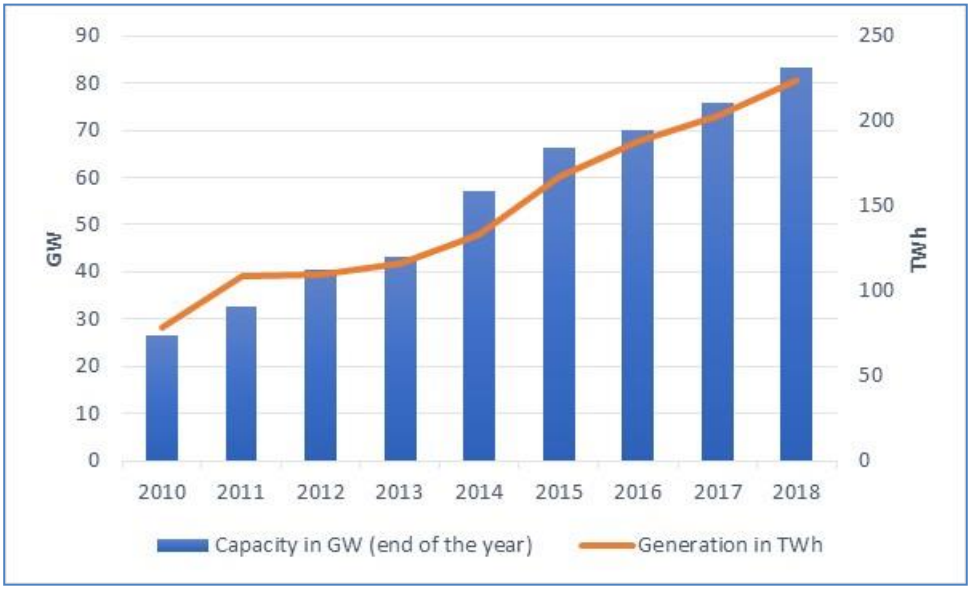
The industrial sector increased its gas demand by 21% to 91 bcm, boosted by coal-to-gas switching and the elimination of coal-fired boilers in the sector, especially in the eastern coastal areas.

In the **chemical industry**, production of chemical products increased, and gas consumption rose slightly, reversing the previous downward trend.

China's gas demand by the power sector was up 14% in 2018 to 47 bcm. Gas-fired electricity generation rose by 10.3%. Installed gas capacity rose from 76 GW at the end of 2017 to 83 GW at the end of 2018, that is less than 4% of total installed capacity but still, the equivalent of almost three times the installed gas power capacity of Germany.

7. NGVs Branch of CCTA, "Number of gas vehicles", 20 March 2019, available at: www.cngvs.cn.

Graph 3: Gas-fired power capacity and electricity generation



Source: China Electricity Council (CEC), NDRC.

Despite this increase, the share of gas in electricity generation is still very low, representing **3.6% of total power generation**. Natural gas can't compete with coal as environmental externalities are not priced. This will change with the full implementation of the Chinese carbon market launched at the end of 2017. The market is initially limited to the power sector (including combined heat and power (CHP) plants) and covers one-third of the country's carbon emissions (above 3 Gt), making it the world's largest carbon market. The market will grow to include eight key energy-intensive industrial sectors[8].

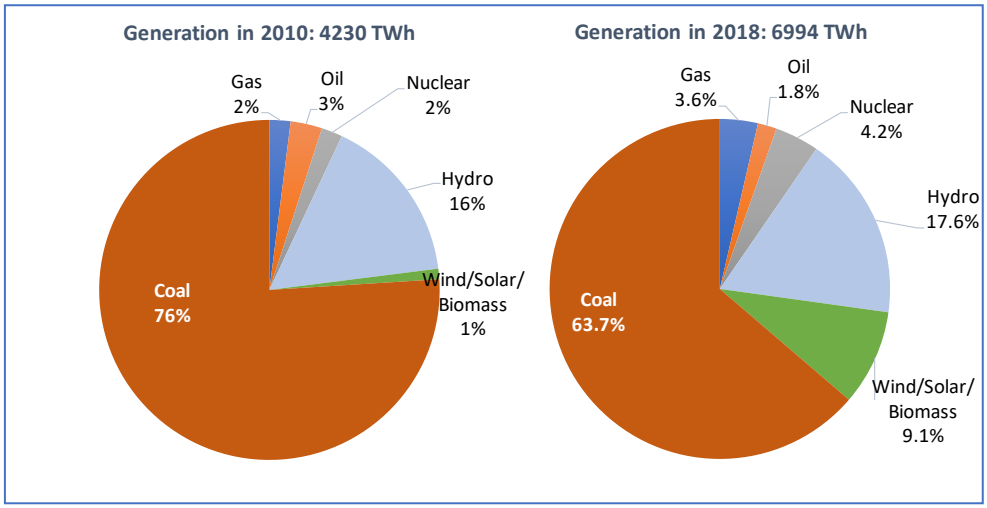
The carbon market is developed gradually. Since December 2017, China has implemented several low-carbon pilot areas at local and industry levels. The overall carbon intensity decline in these pilot areas is faster than the national average. From December 2017 to the end of May 2019, the national carbon market pilot quotas have accumulated 310 million tons (Mt) of CO2, with an accumulated turnover of about 6.8 billion yuan.[9]

China's electricity consumption rose strongly in 2018, with a growth of 8.5%, 1.9 percentage points higher than in 2017. Rising renewable generation was not sufficient to cover such an increase and coal generation increased by 6.5% in 2018. However, trends on a longer period clearly

8. T. Voita, "China's National Carbon Market: A Game Changer in the Making?", *Édito Énergie*, Ifri, 22 March 2018, available at: www.ifri.org.
9. sxcoal.com, "The cumulative turnover of the national carbon emission market reached 6.8 billion yuan. The Ministry of Ecology and Environment: the next step is to accelerate the construction of the carbon market", 20 June 2019, available at: www.sxcoal.com.

show that the share of coal in power generation is being reduced to the benefit of clean energy sources.

Graph 4: Electricity generation in China – 2018 vs. 2010



Source: China Energy Portal.

Steady increase of gas production

In 2018, China's natural gas production reached **160.3 bcm, an increase of 8.3% year-on-year**. Conventional gas production, as defined by China, and including tight gas,[10] increased by 7.7% in 2018, and production reached 141.6 bcm. Unconventional gas production increased significantly (+13.3%), with an output of 18.7 bcm. Unconventional gas includes shale gas, coalbed methane (CBM)[11] and coal-based natural gas production (synthetic natural gas or SNG). Shale gas production reached 10.3 bcm, an increase of 1.3 bcm from 2017.

Table 1: Natural gas production in China (2015-2018)

(data in bcm)	2015	2016	2017	2018	% change 2018 vs. 2017
Conventional gas (incl. Tight gas)	121.8	123.0	131.5	141.6	7.7%
Shale gas	4.5	7.9	9	10.3	14.4%
CBM	4.4	4.5	5.3	5.6	5.7%
SNG	1.6	2.2	2.2	2.8	27.3%
Total production	**132.3**	**137.4**	**148.0**	**160.3**	8.3%

Source: NBS, NDRC.

10. The Chinese government has not identified tight gas as unconventional gas (which therefore is included in conventional gas production in Chinese statistics) though it is explored and developed with unconventional techniques such as horizontal drilling and hydraulic fracturing.
11. Official production data seem not to include coal mine methane (CMM) despite efforts to recover CMM.

Despite the opening of part of the sector to private and foreign companies (offshore, CBM, shale gas), **production remains dominated by the three NOCs** (see Box 1).

China's main three onshore natural gas-producing basins are the Sichuan Basin (Sichuan province in the southwest), the Tarim Basin (Xinjiang province in the northwest) and the Ordos Basin (Shanxi province in the north). Together, the three basins make up 90% of the country's output. But each of them is beset with geological or technological difficulties.[12]

Conventional gas production (in the international sense, so excluding tight gas) has almost reached a plateau. Most of the deposits have been exploited for a long time and are entering their end of life cycle. The International Energy Agency (IEA) estimates that based on remaining resources, a slight increase in conventional gas output is achievable by 2020, but this production is expected to peak at the end of the 2020s.[13] Thus, **rising production in the future mainly depends on unconventional gas development** and offshore gas.

Box 1: The gas market is dominated by the three NOCs

The Chinese gas market is dominated by the three large NOCs: China National Petroleum Corporation (CNPC), through its subsidiary PetroChina, China Petroleum & Chemical Corporation (Sinopec) and China National Offshore Oil Corporation (CNOOC). The three NOCs dominate the production, transmission, storage and imports of gas.

Together, they accounted for 91% of national production in 2018, and PetroChina alone for almost 70%. The national transmission gas network totalled almost 80,000 km in 2018, of which two thirds (51,750 km) are currently controlled by PetroChina. Gas storage is also dominated by CNPC (10 UGS facilities) and Sinopec (2 UGS).

The three NOCs dominate gas imports and operate most of the import infrastructure. CNPC operates the transmission pipelines from Central Asia and Myanmar and is the only importing company for pipeline gas. The three big companies also dominate LNG imports and infrastructure, although new private investors have entered the LNG market.

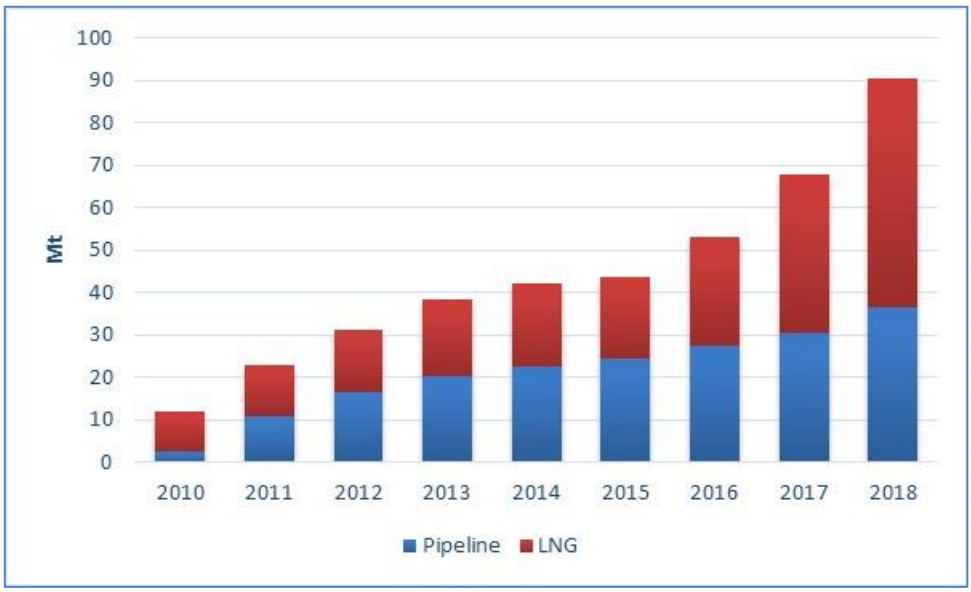
12. C. Aizhu, "China's soaring natural gas output unable to meet demand set loose in pollution fight", *Reuters*, 5 February 2018, available at: www.reuters.com.
13. International Energy Agency (IEA), *World Energy Outlook 2017* (WEO 2017), November 2017, available at: www.iea.org.

China has become the world's largest gas importer

For the second year in a row, 2018 was a record-breaking year for Chinese natural gas imports. **China's imports of natural gas surged by 32%** year-on-year to 90.4 Mt (124.7 bcm).[14] **China surpassed Japan to become the world's first gas importer**, although Japan remains the top LNG importer (82.5 Mt). China now accounts for 10% of global gas trade by pipeline and LNG tanker.

In value terms, China's gas import bill surged by 62% in 2018 to 255.2 billion yuan ($38.48 billion). That translated into an average import price of $8.17/million British thermal units (MBtu),[15] rising 25% year on year, according to data from the Chinese General Administration of Customs (GAC).[16]

Graph 5: Evolution of China's gas imports



Source: CEDIGAZ, GAC.

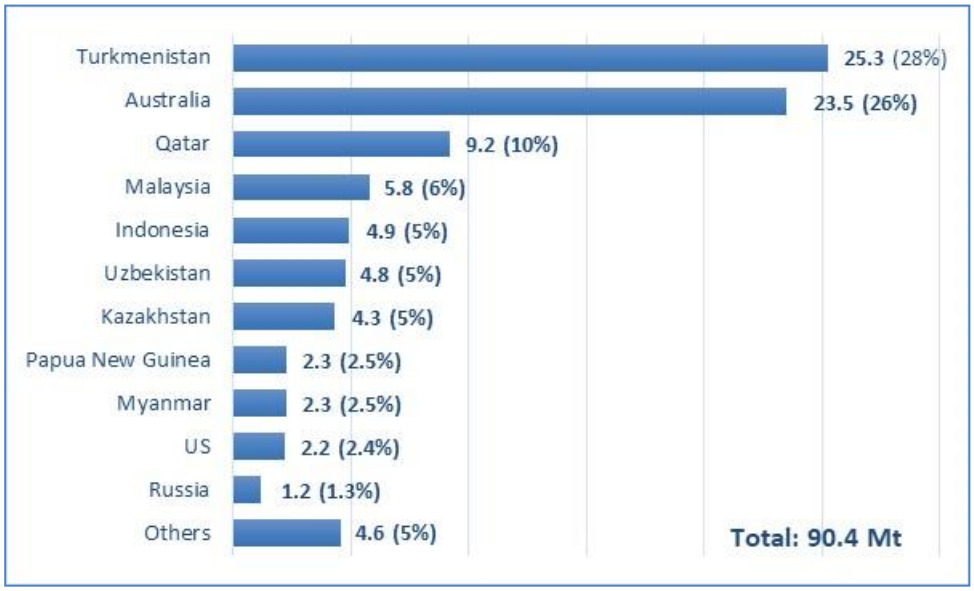
China imported 53.8 Mt of LNG, up 41.2% year-on-year. In just two years, its LNG imports have doubled, making **China the largest growth market**. The average import price of LNG was $9.6/MBtu. Pipeline imports totalled 36.6 Mt, up 20.4% year-on-year. The average import price was $6.2/MBtu. For the second year in a row, **LNG imports**

14. Based on 1 Mt = 1.38 bcm (source: NDRC).
15. Based on 52 MBtu/t of LNG.
16. Sxcoal, "China's natural gas imports hit record high in 2018", 15 January 2019, available at: www.sxcoal.com.

outpaced gas imports by pipeline and accounted for 60% of total imports.

China began gas imports in 2006, with the first deliveries of LNG from Australia to the Dapeng (Guangdong) regasification terminal. Since then, China has pursued its import strategy by diversifying its sources and modes of importation. Since 2010, China has been importing gas by pipeline from Central Asia (Turkmenistan, Uzbekistan and Kazakhstan) and since 2013 from Myanmar. Turkmenistan remained the main supplier in 2018, but its share in total imports dropped to 28%, while that of Australia increased to 26%.

Graph 6: China's gas imports in 2018 by supplier (Mt and share in total)



Source: CEDIGAZ, GAC, GIIGNL.

China imported LNG from 25 countries in 2018, but four countries - Australia, Qatar, Malaysia and Indonesia - provided most of the supply. The bulk of the additional LNG demand in 2018 was provided by Australia (+6 Mt), Indonesia (+1.8 Mt), Qatar (+1.6 Mt) and Malaysia (+1.5 Mt). Australia has become the largest LNG supplier since 2015, outpacing Qatar. Imports from the US reached 2.2 Mt in 2018, but they collapsed after September 2018, when the trade war between the US and China escalated and China imposed a 10% tariff on US LNG.

The surge in gas demand is policy driven

The fight against air pollution is the key driver

The fight against air pollution and the associated restructuring of the energy mix are key drivers of the rapid increase in gas demand. The year 2013 started with a severe air pollution episode that covered one-sixth of China's territory and affected more than 600 million people in 17 provinces, municipalities, and autonomous regions in most of northern and eastern China. Air pollution is a major threat to public health and wellbeing and reducing air pollution has therefore become a matter of priority for the Chinese government. In 2014, Premier Li Keqiang declared "war" on pollution at the National People's Congress. To reduce air pollution, the government has aggressively advocated **coal-to-gas switching on a large scale**, notably in North China. Coal-to-gas switching involves the replacement of coal for the production of heat in residential, commercial and industrial uses and the production of heat and power in CHP plants.

The Action Plan for Air Pollution Prevention and Control

The State Council, China's top administrative authority, issued an **Action Plan for Air Pollution prevention and control (APAP)** in September 2013. This first plan set the road map for air pollution prevention and control for the period 2013-2017 and **focused on three key regions** presenting the highest pollution levels: the BTH region, the Yangtze River Delta (Shanghai, Jiangsu, and Zhejiang provinces), and the Pearl River Delta (Guangdong province). The plan aimed to improve air quality in China through a comprehensive reduction of emissions of particulate matters, PM10 and PM2.5.[17] Measures employed to achieve the

17. The plan set a 10% reduction in inhalable PM10 levels by 2017 relative to 2012 across all regions, and tougher targets for reductions in PM2.5 concentrations for the three key regions: BTH (25%), the Yangtze River Delta (20%), and the Pearl River Delta (15%). Beijing was further assigned a specific target to keep the annual average concentration of PM2.5 at or below 60 micrograms per cubic meter (μg/m^3).

goals included effectively reducing production capacity in energy-intensive industries, capping coal consumption within the regions, and speeding up the adjustment of the energy mix structure by increasing the supply of clean energy.

2017 was the final and target year of the APAP and China was under pressure to meet politically important 2017 air quality targets. While significant progress had been achieved, efforts by provincial governments were insufficient to fulfil the goals of the APAP. This led the Ministry of Environmental Protection (MEP)[18] to intervene with more stringent plans in March and August 2017.[19] The new plans strengthened air pollution measures in 28 cities, including two municipalities and 26 cities, known as the "2+26 cities".[20] Notably, the **2+26 cities were the focus of a pilot program to convert heating systems powered by coal to clean fuels in northern China**. The MEP also raised the clean heating targets in the 2+26 cities. Some cities, Beijing, Tianjin, Langfang, and Baoding, had to complete the construction of "**forbidden coal zones**" by the end of October 2017.

Overall, **3.94 million households** in the 2+26 cities **switched** to gas or electricity in 2017. Most local governments opted for gas over electricity, as it is cheaper and quicker to lay gas pipelines than setting up power grids. Provincial governments overshot the conversion target that was agreed upon by the central government and major gas suppliers: out of the almost 4 million households that switched to gas or electricity in 2017, 795,000 houses were initially not included in the plan.[21] The implementation of environmental protection policies also resulted in the **large coal-to-gas conversion of industrial enterprises** in Shandong, Sichuan, Jiangsu, Hebei, Qinhuangdao and other provinces.

The outcome of the large and rapid conversion of households and industries has allowed **significant reductions in pollution levels.** All

18. The MEP has been transformed into the Ministry of Ecological Environment (MEE) since March 2018 after the NDRC's climate change and carbon emission responsibilities shifted to the new ministry.
19. In March 2017, the MEP issued the 2017 Air Pollution Prevention and Control Work Plan in the Beijing-Tianjin-Hebei and the Surrounding Region. In August 2017, the MEP published a new action plan to cut PM2.5 concentrations by at least 15% year-on-year in the 28 northern cities from October to March to meet smog reduction targets.
20. Beijing, Tianjin, Shijiazhuang, Tangshan, Langfang, Baoding, Zhangzhou, Hengshui, Xingtai, and Handanin, Hebei Province; Taiyuan, Yangquan, Changzhi, and Jincheng in Shanxi Province; Jinan, Zibo, Jining, Dezhou, Liaocheng, Binzhou, and Heze in Shandong Province; Zhengzhou, Kaifeng, Anyang, Hebi, Xinxiang, Jiaozuo, and Puyang in Henan province.
21. C. Chi-Yuk, "Can China switch 70 per cent of northern cities to clean heating by 2021 in bid to tackle pollution?", *South China Moring Post*, 17 December 2017, available at: www.scmp.com.

targets set in the APAP were exceeded.[22] But as of end of 2017, only 107 of China's 338 cities of prefectural level or higher had reached the World Health Organization (WHO)'s interim standard (35 micrograms per cubic meter (µg/m³)) for PM2.5 concentration. The government has therefore announced new plans for the period to 2021, that cover more regions. But the rapid switch to natural gas increased winter gas demand significantly and led to **serious gas shortages** during an unusual cold winter (see next part). The gas supply deficit has not derailed the government determination to accelerate the contribution of natural gas to a cleaner energy mix. But the government has adopted **a more orderly expansion of gas demand** in successor plans.

The Winter clean heating plan for northern China (2017-2021)

In December 2017, the NDRC issued **the Winter clean heating plan for northern China (2017-2021)**.[23] The plan extends the coverage of air pollution reductions to **northern China**, which includes 14 provinces.[24] According to the plan, 70% of northern China will have converted to clean heating by 2021, reducing bulk coal burning by 150 Mt. The plan promotes the replacement of loose coal (low quality coal with high ash and high sulphur content) by **clean heating, which has a wider definition than coal-to-gas or coal-to-electricity switching**. Clean heating includes several methods to replace the burning of loose coal, based on local conditions, such as natural gas, electricity, geothermal, biomass, solar energy, industrial waste heat, nuclear energy, but also "clean coal", defined in Chinese plans as high-efficient and ultra-low emission coal. Therefore, while the plan implements a large-scale coal-to-clean heating switching, the various alternatives proposed mean that **the burden of coal replacement will not fall entirely on natural gas.** "Clean coal" heating has, in fact, the largest growth target by 2021. Recognising the difficulty to meet peak gas demand in winter, coal-to-gas switching has to be implemented in an orderly manner under the precondition of **ensuring gas supply**.

22. S. Yinglun, "China's air quality improves, top legislature inspection report", *Xinhua*, 10 July 2018, available at: www.xinhuanet.com.
23. NDRC, "Northern Region Winter Clean Heating Plan (2017-2021)", 5 December 2017, available at: www.ndrc.gov.cn.
24. Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong, Shaanxi, Gansu, Ningxia, Xinjiang and Qinghai, as well as some parts of Henan Province.

In the industrial sector, the switch to natural gas will continue unabated. There will be over 150,000 t/h of coal-fired boilers capacity to be eliminated and upgraded to gas-fired boilers.

The **2+26 cities are prioritized for coal-to-gas switching** and new construction of natural gas heating. Between 2017 and 2021, an additional 1.8 billion m² of floor area in the region will be heated with natural gas-fired heating (1.4 billion m² at end 2016), leading to **an additional consumption of 23 bcm during the period, or 4.5 bcm/y**. By 2021, the government targets 12 million households shifted to gas and approximately 15 million households shifted to heat pumps and direct electric heating. In 2018, a total of **4.8 million Chinese households made the switch**, of which 3 million switched to gas.

Table 2: Natural gas heating development targets in the 2+26 cities (2017-2021)

Measures	Incremental gas demand in bcm/y (2021 targets)
Coal-to-gas switching (12 million households)	9
Newly built and retrofitted gas-fired cogeneration (additional capacity 11 GW)	7.5
Newly built and renovated gas-fired boilers (additional capacity 50,000 steam t/h)	5.6
Gas-fired distributed energy (additional capacity 1.2 GW)	0.9
Total	**23**
of which urban areas	14.5
of which rural areas	8.5

Source: NDRC.

The Three-year Action Plan for Winning the Blue Sky Defence War (2018-2020)

After the expiration of the APAP in 2017 a more comprehensive plan was issued in July 2018: the **Three-year Action Plan for Winning the Blue Sky Defence War (2018-2020)** (hereafter the Blue Sky Action Plan),.[25] The Blue Sky Action Plan **extends the focus of air pollution control to all 338 cities at prefectural or higher level.** It therefore significantly expands the scope of PM2.5 restrictions to 82 cities that were not covered previously and will be forced to improve their air quality.

25. State Council, Three-year Action Plan for Winning the Blue Sky Defence War (2018-20), 3 July 2018, available at: www.gov.cn.

Notably, the plan includes a new targeted region for air pollution control, the **Fen-Wei plains**, which include Xi'an and parts of Henan, Shaanxi and Shanxi provinces (two major coal provinces).

The Blue Sky Action Plan takes **more detailed measures on structural pollution issues** and pushes forward the restructuring of energy consumption, industrial layout and transport means. It **speeds up the adjustment of the energy structure**. The regions of BTH, Shandong and Henan will be required to **cut coal consumption** by 10% over the 2016 to 2020 period, while the Yangtze River Delta region will have to cut coal use by 5% over the period. The Fen-Wei Plains have to achieve negative growth in coal consumption.

The Blue Sky Action Plan also addresses the issue of gas imbalances. It is set to slow down the penetration of natural gas in CHP plants as **natural gas will be channelled into other sectors (buildings and industrial uses)** where coal-to-gas switching has a higher impact on air pollution.

Restructuring of the energy mix and climate change challenges

Rising gas demand is also part of the government's plan to restructure its energy mix away from coal, thus responding to climate change challenges. Accelerating the use of natural gas is led by China's commitment to reduce its carbon intensity by 40-45% by 2020 from 2005 levels, under the 13th Five-Year Plan (2016-2020) for national economic and social development. China is currently by far the world's largest emitter of CO2, accounting for 30% of global CO2 emissions. Despite ongoing efforts, its CO2 emissions rose in 2018 due to increased fossil fuel consumption. Nevertheless, China has already met and even exceeded its 2020 carbon intensity target. In 2018, China had cut carbon emissions per unit of GDP by 46% from 2005 levels. Overall, China's efforts to improve air quality by choosing gas provide important indirect benefits for carbon emissions.

Under the Paris Agreement, China has committed to peak its CO2 emissions by 2030 or sooner, to reduce its carbon intensity by 60-65% by 2030, against a baseline of 2005, and to increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030. With coal still accounting for 59% of China's energy mix, 52% of industrial consumption and 17% of residential/commercial consumption, there is still a large potential for coal-to-gas switching. Looking ahead, the fight against air pollution will continue unabated, and the reduction of China's carbon intensity will also favour **the continuous expansion of gas demand**.

China's emerging carbon market may offer an opening for natural gas to gain market share against coal.[26]

The role of economic activity

Gas demand, notably industrial demand, is also driven by the increase in economic activity, although the coal-to-gas switching factor has been more important in driving gas demand. The recovery of industrial demand was a key driver of rising gas demand in the past two years. Combined with the large-scale coal-to-gas conversion of industrial boilers in the eastern coastal areas, the sector increased its gas use significantly.

In contrast, a slowdown in Chinese economy may weaken the growth of gas demand by industrial users. While the economy grew by 6.6% in 2018, the rate of increase is projected at 6-6.5% in 2019, impacted by softer domestic demand and a more challenging international context for Chinese goods. Decrease in tax rates and infrastructure spending are expected to sustain economic growth. But some analysts have revised downward their projections for gas demand in 2019 and 2020 (for instance Credit Suisse projects a rate of 11% in 2019 and 10% in 2020 amid an economic slowdown).[27] In the first half of 2019, China's total gas consumption was 146.5 bcm, an increase of 8.9% year-on-year, which was 9 percentage points lower than the growth rate in the same period of 2018. The deterioration of the operating environment of industrial enterprises has reduced their gas demand.

Over the long run, fundamentals for the Chinese economy and prospects for growth are expected to remain strong, especially as domestic Chinese consumer incomes and consumption patterns increase.

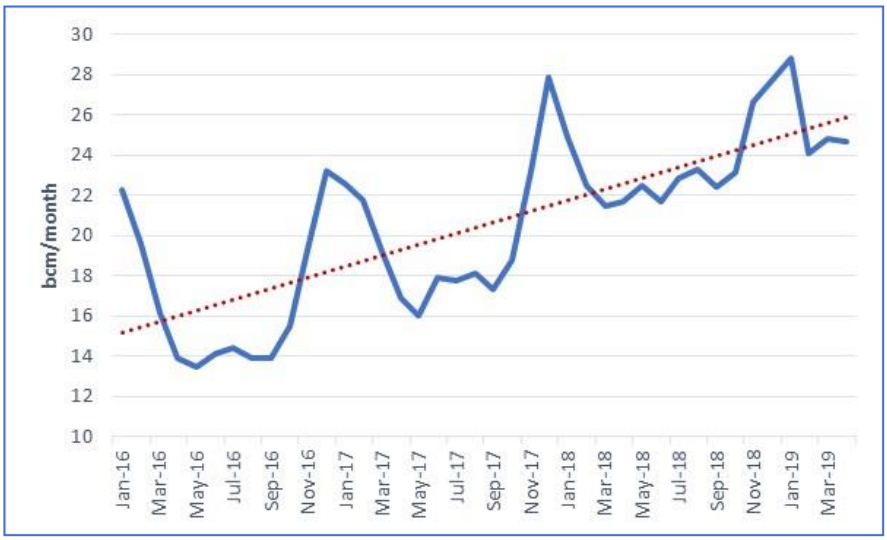
26. IEA, *The Role of Gas in Today's Energy Transitions*, 2019, available at: https://webstore.iea.org.
27. Energy China Forum, "China's 'Game Changer' Pipeline Reform to Supercharge Gas Demand", 6 May 2019, available at: http://en.energychinaforum.com.

Infrastructure is lagging behind

Seasonality of gas demand is a key issue

China's natural gas demand is highly seasonal with a pronounced peak in December/January due to heating demand. The average monthly ratio between winter and summer demand is as high as 1.7. In Beijing alone, monthly winter gas demand is five times higher than summer demand. The coal-to-gas switching policy reinforces gas demand during the heating season.

Graph 7: Seasonality of gas demand



Source: NDRC[28] (apparent gas demand).

Despite rising production and imports, the surge in gas demand led to **widespread gas shortages in North China during the heating season 2017-18.** To cope with the situation, several urgent measures had to be taken to ensure gas supplies to residential users. The government ordered restrictions on gas supplies to non-residential users such as LNG plants, chemical fertilizers, power plants, and industries, to prioritize the supply of gas for heating of residential users in North China. Chinese LNG

28. NDRC, "Monthly gas situation" (in Chinese), available at: www.ndrc.gov.cn (monthly editions)

buyers rushed out to buy spot cargoes, making Asian spot LNG prices skyrocket. After only six months of coal-free power generation, Beijing restarted the Huaneng coal-fired generating units to ease the natural gas tension. Due to lack of gas transport connectivity, CNOOC had to rent over 100 tank trucks to deliver LNG from South China LNG receiving terminals to North China to help to deal with the supply deficit.

The gas supply deficit is due to several factors that combined each other: a higher coal-to-gas switching than planned, an earlier and colder-than-usual winter, lower Turkmen gas exports than contracted, transportation bottlenecks and insufficient storage capacities.[29]

Above all, the gas crisis has exposed **the key bottlenecks of the Chinese gas market**: the **underdeveloped gas transport and storage systems** and the **lack of adequate incentives for investment** in the gas industry.

China crucially lacks gas storage:at the beginning of winter 2017-18, China had 12 UGS, with a total capacity of 10.5 bcm, according to the International Gas Union (IGU).[30] This represented only 4.4% of gas consumption. China's gas pipeline network lacks interconnectivity impeding gas to flow where it is the most needed. LNG import capacity is more adequate, but it suffers from lack of connectivity with the gas transmission network. Geographic bottlenecks also arise due to the concentration of LNG import terminals in south provinces, rising demand in northeast China and lack of south-to-north transmission capacity. Due these limitations, Chinese infrastructure cannot ensure an appropriate level of security of supply.

Similar to the gas crisis that hurt the country in 2009 (also provoked by a very harsh winter), the gas shortage has been the catalyst for **accelerating the construction of key infrastructure and deepening gas market reforms.** The government has also adopted **a more orderly expansion of gas demand**. The gas crisis has triggered the adoption of **short-term measures** to alleviate winter shortages and **new approaches for dealing with security of gas supply** with the construction of an intensive and efficient production, supply and marketing system. These short-term measures and new policies have already had a positive effect on the rebalancing of gas supply and demand in winter 2018-19 and will have more profound implications on China's gas supply and demand balance in the medium and long term.

29. See D. Sandalow, A Losz and S. Yan, "A natural gas giant awakens: China's quest for blue skies shapes global markets", Center on Global Energy Policy, 27 June 2018, available at: https://energypolicy.columbia.edu.
30. IGU, Working Committee 2 - Underground Gas Storage Database, June 2018

The adoption of these new policies highlights the **high stakes for successful switching to gas**, both to provide secured gas supplies and improve air quality. A disruption of supplies could raise risks for social stability on both counts.

Short-term measures to prevent winter gas shortages

Although the winter 2018-19 was warmer than the previous one, gas demand increased to 109 bcm between 15 November 2018 and 15 March 2019, up 17% over the previous winter.[31] Daily peak demand rose 20% to 1.037 bcm. Despite the strong growth, China did not encounter gas shortages. **The balance of gas supply and demand in winter 2018-19 was prepared well in advance at all levels of the gas chain**. Chinese NOCs have been directed to further increase domestic natural gas production, as well as to step up development of critical gas infrastructure. Pipeline interconnectivity was improved with key inter-connections built during the year. UGS capacity was increased to 13 bcm with two new UGS facilities commissioned in 2018. Three large-scale LNG receiving terminals were commissioned in 2018, adding 10 million tons per annum (Mtpa) of import capacity. NOCs also stockpiled LNG well ahead of the winter and signed new short-term LNG contracts, including higher deliveries in the winter season. They also signed a new contract with Kazakhstan to increase Central Asian gas imports. Directed by the NDRC, NOCs had also to sign annual supply contracts with major gas users by the end of April 2018. The coal-to-gas switching was done in a more orderly way. Conversion of industrial coal-fired boilers to natural gas had to secure a matching supply source before proceeding.

These measures allowed a smoother gas supply/demand balance in winter 2018-19, also helped by mild temperatures in February and March 2019, effectively reducing heating needs. This translated into lower spot LNG cargoes requirements, leading to a sharp drop in Asian spot LNG prices. It's worthy to note that **the seasonality of gas demand was less pronounced in 2018 than the years before** (see Graph 7). Demand by industrial users, which was restricted during the winter season, started to rise again at the end of the winter. Higher gas requirements to fill UGS and LNG tanks sustained gas demand in summer 2018. It can be expected that this new pattern for gas demand will be the new normal (except in case of extreme temperatures in winter).

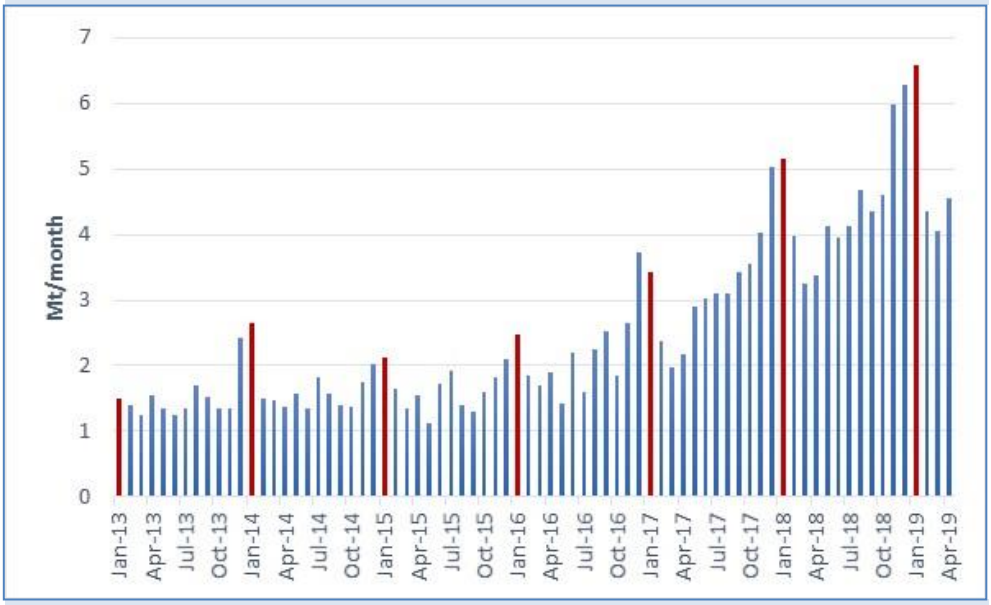
31. "China's natural gas production, supply and marketing system has achieved remarkable results" (in Chinese), *Polaris*, 19 April 2019, available at: http://news.bjx.com.cn.

Box 2: Chinese LNG imports are highly seasonal

LNG has been the main tool to cover seasonal gas demand, as production and imports by pipeline have little flexibility and storage capacity is still insufficient.

Chinese LNG imports rose 51% year-on-year to 21.4 Mt in winter 2017-18 (based on imports from November 2017 to March 2018), as China struggled with gas shortfalls and brought in more spot cargoes to cover surging winter heating demand. In winter 2018-19, Chinese LNG imports again rose significantly, reaching 27.3 Mt (+27% year-on-year). They reached a record in January 2019. But after large purchases in the early winter, the Chinese market was well supplied with LNG, and its LNG imports declined in February and March 2019 when temperatures eased.

Graph 8: China monthly LNG imports



Source: CEDIGAZ LNG Service, GAC.

Construction of a production, supply and marketing system

In September 2018, the State Council issued the "**Several Opinions on Promoting Coordinated and Stable Development of Natural Gas**" (hereafter the "opinions") in order to accelerate the development and use of natural gas in a coordinated and stable manner.[32] The opinions are a key document. **This is the first guidance document issued by the State**

32. State Council, "Several Opinions of the State Council on Promoting the Coordinated and Stable Development of Natural Gas" (in Chinese), 30 August 2018, Guo Fa [2018] 31, available at: www.pkulaw.cn.

Council to promote the development of the natural gas industry. The State Council **focuses on security of gas supply** and recommends actions on the internal and external dimensions of security of gas supply.[33] With this document, **China adopts a security of gas supply policy which covers all typical tools to safeguard supply**.

The State Council reaffirms the key role of natural gas in Chinese energy transformation. Natural gas, a premium low-carbon energy source, should be better developed and utilized. Natural gas production is a mainstay of constructing a modern energy system as well as advancing the restructuring of energy production and consumption, the document says. But there is an array of pressing matters that the industry faces, such as domestic output falling short of consumption, insufficient supply diversification, unbalanced consumption structure, and infrastructure facilities lagging behind.

The sustainable development of natural gas production and marketing is to be strengthened under a set of principles, with emphasis on **overall planning** of the supply, storage and sale of natural gas, **adherence to the market-oriented mode, and orderly implementation** of related policies. The promotion of natural gas is changed **from "coal-to-gas" to "change with gas"**.

The State Council basically requires provincial governments and enterprises to:

- Accelerate efforts to increase the supply of natural gas and build a multi-gas supply sources pattern.
- Strengthen the construction of natural gas pipeline network, gas storage facilities, and LNG receiving terminals and reinforce the interconnection of gas pipelines.
- Expand natural gas utilization in a coordinated way.
- Build a multi-level reserve system.

In addition, **specific mechanisms featuring natural gas supply and demand balance are highlighted**, to forewarn supply and demand imbalances, to regulate demand, and to provide contingent support in case of short supply. For the marketing of natural gas, the opinions suggest the establishment of a comprehensive coordination mechanism and recommend the full implementation of the natural gas sale and purchase contract system, the signing of medium and long-term

33. The external dimension of security of supply is covered in a second report: S. Cornot-Gandolphe, "China's Quest for Gas Supply Security: The global implications", *op. cit.*

contracts, and the active promotion of the signing of inter-annual contracts — the same marketing policy has been followed on the coal market to stabilize coal prices within a reasonable range. Power utilities have been encouraged to sign medium/long-term contracts with coal producers to secure and stabilize supply (long-term contracts on the Chinese market are five-year contracts).

The State Council proposes to establish a **multi-level gas reserve (storage) system**, which mainly includes UGS and coastal LNG receiving terminals, supplemented by large-scale inland LNG storage tanks in key areas and pipeline network interconnections. In accordance with a Notice issued by the NDRC in April 2018,[34] a **compulsory peak shaving mechanism** for meeting peak demand in colder months is established (see Box 3). Gas suppliers — mainly NOCs — are required to have storage facilities to meet at least **10% of their contracted sales by 2020**. City gas distributors must have storage equal to 5% of their annual supplies within the same time frame and local governments will need to have sufficient storage to cover three days of consumption in their administrative regions. The opinions also propose to establish and improve demand side management and peak shaving mechanisms.

On the supply side, the opinions urge to reinforce security of gas supply based on two key pillars: stepping up domestic production and strengthening international cooperation. The State Council recommends efforts to promote institutional reforms in the **upstream segment** to facilitate the step up of domestic gas production. Specifically, the competitive system of block transfer should be fully implemented, and the transfer of mining rights are encouraged to be conducted in a market-oriented manner. **Domestic gas production has to be raised to more than 200 bcm by the end of 2020**. Even with ambitious goals on domestic production, the gap between China's rising demand and production will widen. Thus, Beijing is **strengthening international gas (and oil) cooperation** in view of rising overseas gas (and oil) equity production, implementing key gas export projects and further diversifying gas imports.

34. NDRC, "Opinions on Accelerating the Construction of Gas Storage Facilities and Improving the Market Mechanism for Ancillary Services for Gas Storage and Peak Shaving", April 2018, available at: www.ndrc.gov.cn.

Gas infrastructure enters a period of rapid development

China has embarked on a huge investment programme to expand its LNG, pipeline and storage infrastructure.[35] By 2025, the NDRC aims to expand:

- LNG receiving capacity to 100 Mtpa, a target that is likely to be reached earlier.
- Pipeline capacity for natural gas imports to 150 bcm/y.
- Gas transmission network to 163,000 km (104,000 km by 2020 and a capacity of 400 bcm/y). The NDRC envisages all Chinese cities with more than 500,000 residents will have access to gas pipelines.
- Storage capacity of natural gas, including LNG, to 40 bcm, of which 32 bcm for UGS (see below).

The targets are ambitious considering the slow rate of transmission and storage development in recent years, but the government has promulgated specific regulations to facilitate investments in gas transportation and storage by all kind of capital. The creation of a national pipeline company (see below) is also aimed at boosting investment in transmission lines thanks to private capital's injection.

These projects will secure and diversify supply sources for demand centres. **Meeting the ambitious targets requires huge investment which depends on the attractiveness of the gas market for a variety of players, including non-NOCs, and therefore on the success of gas market reform policies.**

Box 3: Storage, a vital asset

The gas shortage in winter 2017-18 has demonstrated that investment in storage is not only necessary, but it has to be made rapidly. UGS capacity represented only 4.6% of 2018 gas demand, which is not compatible with China's rapidly developing natural gas demand and imports. This means there is very limited ability to respond to changes in demand or to supply issues. For comparison, the ratio between working gas capacity and annual consumption in European countries with a high import dependency and a large heating market is about 25%. The lack of UGS in China is only partly offset by storage capacity at LNG import terminals (equivalent to 5.6 bcm at end 2018) as well as by peak shaving LNG facilities.

35. D. Patton, "China expects LNG receiving capacity to reach 100 mln T by 2025", *Reuters*, 12 July 2017, available at: https://af.reuters.com.

Today, the storage market is dominated by CNPC and Sinopec. At the end of 2018, UGS working capacity was increased to 13 bcm (13 UGS in 26 reservoirs) from 10.5 bcm a year earlier,[36] thanks to the commissioning of Sinopec Wen 23 UGS (Henan province), the expansion of CNPC Hutubi UGS (Xinjiang), and the commissioning of the first private gas storage: the first phase of a salt cavern site at Jintan (Jiangsu), owned by Hong Kong and China Gas Company (Towngas). In winter 2018-19, storage contributed 100 mcm/d to the average winter demand of 900 mcm/d.

The growth in gas storage capacity is accelerating. CNPC plans to raise its total working gas storage capacity to 15 bcm by 2025 (11 bcm by 2020), enough to meet 10% of China's peak seasonal demand. CNPC will invest over $10 billion to build seven new gas storage clusters and improve existing storage bases. **Sinopec has also announced a huge development of its storage capacity**.[37] The company plans to build 16 UGS facilities in depleted oil and gas fields in central Henan province. The total designed capacity has been reported at 55.6 bcm. Sinopec plans to start building five more storage units in the province before 2020 in addition to Wen 23 UGS.

The expansion of UGS will help stabilize seasonal demand and price fluctuations in China and the wider Asian LNG markets. However, due to the long lead time necessary to develop UGS, **the new sites will not solve the immediate seasonal imbalance between supply and demand**. In the meantime, the government is promoting **a compulsory peak shaving mechanism.**

In April 2018, the NDRC and the NEA jointly issued the "Opinions on Accelerating the Construction of Gas Storage Facilities and Improving the Market Mechanism for Ancillary Services for Gas Storage and Peak Shaving".[38] The aim is twofold: 1) to accelerate and incentivise the construction of gas storage facilities and that of a peak shaving mechanism, and 2) to develop an ancillary service market for gas storage.

The Opinions put forward the construction of a **multi-level natural gas reserve system** and divide this reserve system into four levels: "main, auxiliary, supplementary and support". The first level consists of UGS and LNG receiving tanks; LNG and natural gas emergency gas storage in key regions are the second level; flexible gas production, interruptible gas volumes, alternative energy, etc. constitute the third level

36. China Gas, "China's natural gas market analysis" (in Chinese), 24 January 2019, available at: www.chinagas.org.cn.
37. Platts, "Sinopec to build 55.6 Bcm natural gas storage in northern China", 7 August 2018, available at: www.spglobal.com.
38. NDRC, April 2018, *op. cit.*

(supplementary) and the network interconnection is the fourth level (support).

As mentioned above, the NDRC has required **suppliers, distributors and local governments to build gas storage facilities for peak shaving purposes by 2020** to guarantee supply during the heating season and emergency situations. The responsibilities for specific gas operators have been well established and will be controlled after 2020. The deadline (2020) is very short and requires huge building of LNG tanks, as well as filling these tanks. **In the short term, it will create additional demand for LNG.**

The government also wants to **encourage the development of a storage market**, by which companies/local governments can fulfil their gas storage obligations by building their own gas storage facilities, purchasing leased gas storage facilities, or purchasing gas storage services. At the same time, it insists on the market-based pricing of gas storage services and encourages the implementation of differentiated price policies such as seasonal gas prices and interruptible gas prices. The government has issued support policies to **subsidize the construction of gas storage facilities**. The NDRC will also expedite the approval and construction procedures for gas storage projects.

After 2020, with the priority given to the development of gas storage capacity, the implementation of the peak shaving mechanism and the broader multi-level gas reserve system, China will be in a better position to ensure secure and stable supplies during the heating season.

The lack of storage capacity is the basis of market views that **China will drive an increase in global seasonal LNG demand swings over the coming years.** In the absence of adequate storage, China's ability to meet peak winter demand depends largely on LNG imports. However, while LNG imports are seasonal and peak in winter (see Graph 8), their impact on spot gas prices may be limited as seen in winter 2018-19. It will take time, but **LNG imports will be more balanced all over the year** and could even peak during the summer season when UGS are refilled.

Deepening of gas market reforms

Despite significant progress achieved since 2010 when gas pricing reforms started, the Chinese gas market is still very concentrated and lacks competition. In addition, distorted gas price mechanisms and lack of flexibility of regulated gas prices have impeded investment in key infrastructure. **The government has launched a number of reform policies to address the aforementioned issues and recently accelerated and deepened market reforms.** Reforming the pricing mechanism, ensuring efficient third-party access (TPA) to infrastructure and breaking down the monopoly of the three NOCs have been the top priorities of China's reform policy agenda.[39] The reform plan for the country's oil and gas industry aims better efficiency and competitiveness by giving the market a decisive role in allocating natural resources. In this move, Chinese policy makers need to solve a dilemma as the gas market reform aims at lowering gas prices to stimulate growth in gas demand. But low prices disincentivise upstream activity, especially for unconventional gas.

Gas pricing reforms are intensified

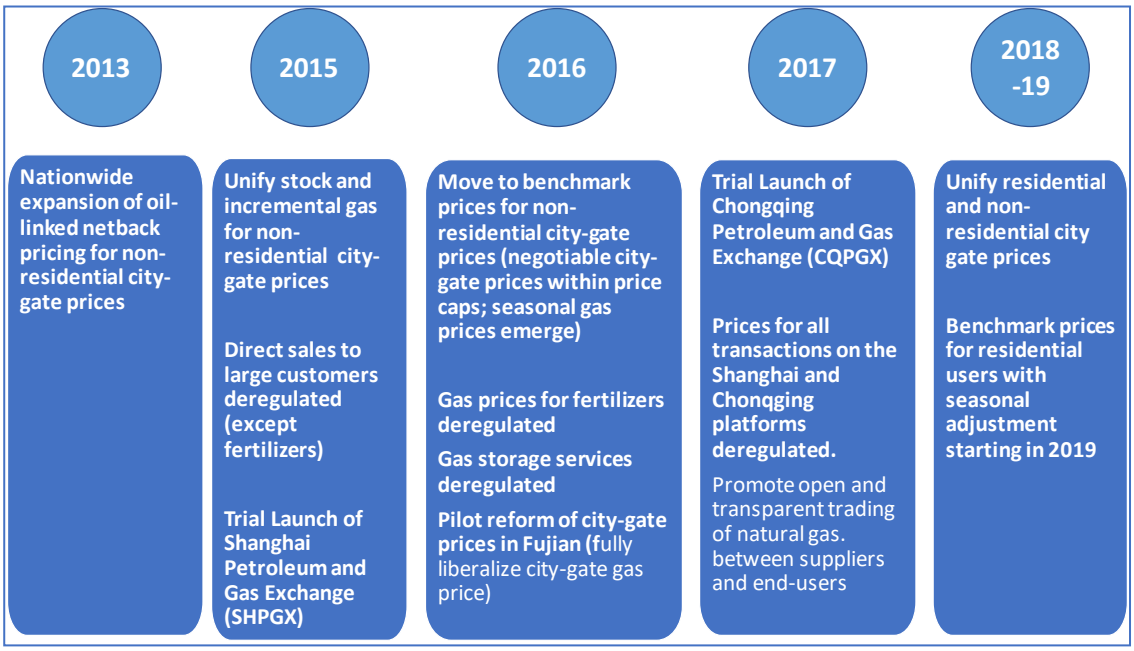
Since 2010, China has worked towards **greater market-based pricing and the gas pricing reform was intensified in 2018.**

Until 2018, the gas pricing reform focused on non-residential users. It culminated in 2015, when a single price cap was set for city-gate non-residential consumers in each province. In addition, in November 2016, the NDRC introduced "benchmark city-gate prices" for non-residential users, which replaced the rigid "ceiling city-gate prices". The benchmark prices can move up as much as 20% and drop to whatever level decided by suppliers and purchasers. In the meantime, China has gradually allowed the market to determine the prices for a variety of gases: offshore production, domestically-produced and imported LNG (unless delivered via regional pipeline networks), unconventional gas, sales to direct users, gas for the production of fertilisers, gas storage services. Since September

39. Central Committee of the Communist Party and the State Council, "Several opinions on deepening oil and gas sector reform", Beijing: The State Council, 2017.

2017, prices for all volumes traded at the Shanghai and Chongqing gas exchange centres are set by the market and producers and users are encouraged to trade on the trading platforms. In 2017, China launched a pilot price reform program in coastal Fujian province, which fully liberalizes city-gate gas prices to introduce competition between gas supplied by pipeline and LNG.

Graph 9: Gas pricing reforms – Main steps



Following these gas pricing reforms, **prices for about 50% of natural gas consumption are now determined by market factors**, while the other half falls under the city-gate price regime (compared to 29%/71% in 2015).[40] For this later half, only residential users (about 40%) were still subject to rigid city-gate prices in 2017, while the city-gate price for the remaining 60% was set by a flexible mechanism of reference prices supplemented with fluctuation ranges.

Despite the significant progress, gas prices have remained high in China. According to the IGU, China is among the countries in the world with the highest average wholesale price, at above $8/MBtu in 2018.[41] In addition, the pricing structure left a number of unresolved market distortions. **Prices for residential customers were capped at substantially lower levels than deregulated prices for industrial**

40. Shell, "China's gas pricing evolution", presentation by Xianfang Ren at the World Gas Conference, Washington, June 2018
41. IGU, *Wholesale gas price survey 2019 Edition*, May 2019, available at: www.igu.org.

users – the opposite pricing structure than in developed countries. At 1.4 yuan/m³ on average in 2017 (around $8/MBtu), **residential city-gate prices were lower than import costs**, and their rigidity distorted the market. With this system, PetroChina, the largest gas importer in China, occurred huge financial losses on its gas import segment. These price differentials led to cross-subsidization between various demand sectors. The gas shortage of winter 2017-18 has clearly exposed the inefficiency of this gas pricing system.

In May 2018, for the first time since 2010, the government took a major step towards reforming residential prices and solving cross-subsidization issues:

- The NDRC announced that it would **unify residential city-gate price with non-residential city-gate price** so that residential, industrial and commercial users would all pay the same city-gate price. The harmonization of city-gate prices will occur gradually, with a maximum upward price adjustment for residential city-gate prices of 0.35 yuan/m³ ($2/MBtu) in the first year (starting 10 June 2018) in regions where there is a substantial gap between residential and non-residential prices**.**
- **The government has also adopted a flexible gas pricing for residential users**, which will be based on a **benchmark** price (instead of the rigid ceiling price), subject to upward adjustment of up to 20%.

The policy represents a major reform to the residential pricing system, with an attempt to better reflect procurement costs, while incentivizing suppliers to boost both gas imports and domestic production. The policy is also aimed at more-efficient use of natural gas to avoid gas shortages during winter. **Its impact on gas demand remains to be seen**.

The next step in the gas pricing reform is to achieve market-oriented gas prices and create a **price benchmark** adapted to the Chinese gas market. To facilitate this move, the **Shanghai Oil and Gas Exchange (SHPGX)** was launched in November 2016 after trial operations since 2015. A second natural gas trading exchange in Chongqing, the **Chongqing Petroleum and Gas Exchange (CQPGX)**, was established in January 2017 and officially started operations in May 2018. Both platforms are backed by NOCs and local governments. The two trading centres focus on two different regions in China, the eastern and south eastern markets for Shanghai and western markets for Chongqing. Other provinces and cities are also planning to build natural gas trading centres,

for instance Karamay in Xinjiang province and Shenzhen in Guangdong Province.

The Shanghai Exchange handled more transactions of pipeline gas and LNG in 2018 than it did in 2017, but sales volumes as a share of Chinese gas consumption slowed. Altogether, trading volumes (bilateral) rose to 60 bcm, of which 55.5 bcm for pipeline gas and 3.33 Mt for LNG.[42] However, total volumes at 30 bcm, represented 10.5% of China's natural gas consumption, down from 10.9% in 2018. On the Chongqing Exchange, unilateral trading volume of pipeline gas was 6.3 bcm and that of LNG 38,000 t.

The Shanghai Exchange is gradually becoming an important reference for domestic contracts. The NDRC publishes monthly prices for LNG and pipeline gas based on the Shanghai Exchange. The government hopes at least one of the trading schemes will develop into a **benchmark to price gas supplies across China, or even Asia**. But **with 13% of Chinese gas demand traded on the two exchanges in 2018,** it will be a long way to go before the bulk of China's gas demand is met by supplies purchased via domestic trading platforms.

Creation of a national oil and gas pipeline group

China has also taken several steps towards **gas infrastructure reform** this decade, from trial TPA to regulation of rates of pipeline companies and gas distributors. But the TPA measures were difficult to implement because the three NOCs, which dominate midstream infrastructure, could decide pipeline capacity utilization and turn down usage requests. Thus, this initiative did not gain much traction. In a further step, **in May 2019, the NDRC issued new regulations to ensure TPA to the country's oil and gas infrastructur**e.[43] The rules require the opening of the infrastructure to third parties under transparent (published) and non-discriminatory terms and establish rules for the independence of infrastructure operators. Operators are required to separate their pipeline business from other segments such as upstream production and sales. As part of this resolution, China has also decided to adopt thermal units of measurement instead of volumetric units, as the standard units for measuring and pricing domestic gas by end-May 2021.

42. Xinhua, "Natural gas trading on Shanghai exchange posts new high", *China Daily*, 6 February 2019, available at: www.chinadailyhk.com.
43. Platts, "ANALYSIS: China's latest energy liberalization policy set to break oil and gas monopolies", 7 June 2019, available at: www.spglobal.com.

In an additional step, in March 2019, the government announced the creation of **an independent national oil and gas pipeline company**.[44] First proposed in 2015, the reform has taken years to be adopted as it is a complex one involving a massive restructuring of assets worth as much as 500 billion yuan ($78 billion). The new pipeline network company – which unusually gathers oil and gas pipelines – is taking over the control of all transportation pipelines from the three NOCs.[45] Some LNG import terminals and gas storage facilities are likely to be included in the new company. Then, the new company is expected to attract approximately 50% of social capital, including government investment funds and private capital. These new **funds will be used to expand the pipeline network**. In a third step, the new company will seek an initial public offering on the capital market.

The move is designed **to open access to China's pipeline infrastructure to private and foreign energy producers** as a way to spur oil and gas production and boost competition in the market. The reform is expected to reduce gas prices to end-users and **further boost gas demand**.

The establishment of the new company is **one of the most significant and fundamental reform measures in recent years**. It will have a far-reaching impact on the Chinese gas market. The creation of the new company breaks a monopoly that the three NOCs have over downstream users. It will help reform the energy sector by separating transmission and sales businesses. It will be a game changer for the Chinese gas industry. Gas distributors will be winners from better demand and improving margins.

Opening up the upstream sector

The Chinese government is committed to reform the upstream oil and gas sector and unveiled its plan in May 2017 ("Several Opinions on Deepening Oil and Gas Sector Reform", the 2017 Opinions). The document highlights opening up more acreage to qualified companies to diversify investment and participation in E&P of conventional oil and gas, and **ultimately create a market that is led by NOCs but with the participation of diversified investors**. Currently the sector is dominated by the three NOCs and the provincial state-owned company, Yangchang Petroleum. Non-NOC enterprises were only granted E&P licences in the field of shale

44. C. Yingnan, "Government greenlights national oil and gas pipeline network company", Broad & Bright, 8 April 2019, available at: www.lexology.com.
45. D. Murtaugh, "China's 'Game Changer' Pipeline Reform to Supercharge Gas Demand", *Bloomberg*, 4 June 2019, available at: www.bloomberg.com.

gas and CBM development. For foreign companies, the Production Sharing Contract structure with qualified Chinese state-owned enterprises (SOEs) was the only possible co-operative structure. Under the new scheme, eligible companies will be able to apply for licenses to develop oil and gas reserves, thus breaking the dominance of the three NOCs in the upstream E&P. A new granting mechanism will require that upstream block rights be subject to tender, and winning bidders will have to give up their blocks once the exploration period expires. In addition to requiring competitive tenders, the 2017's Mineral Rights Granting System Reform program also imposes strict restrictions on the granting of mineral rights via agreements. In January 2018, China offered five blocks in Xinjiang in a first oil and gas tender round, three were sold to non-NOCs.

The "Several Opinions on Promoting the Coordinated and Stable Development of Natural Gas" of September 2018 reiterates that efforts will be made to promote upstream institutional reforms. The effective implementation of these measures will help to change past barriers, such as lack of competition, insufficient investment, no fulfilment of exploration commitments.

According to Deloitte, three main types of oil and gas companies could benefit from the upstream reform: provincial SOEs in oil and gas resource-rich provinces; private oil and gas companies with overseas assets and exploration experience; and oilfield service companies with domestic experience.[46] Also, foreign oil and gas companies may be expected to participate in E&P of conventional resources by means of setting up joint ventures with domestic players beyond the current collaborative model.

Creating a competitive upstream environment is a precondition for stimulating the innovation (both technological and commercial) needed to bring down costs and tap unconventional gas deposits that are geologically challenging. **The upstream reform, when fully implemented, is expected to accelerate the growth of natural gas production, notably unconventional gas production, and improve security of supply.**

46. Deloitte, "Unfolding the upstream reform", 2018, available at: www2.deloitte.com.

Brilliant outlook for gas demand

Policy targets

The government has issued several strategic plans for the period 2016-20 and beyond that clearly define its **strategic positioning towards natural gas** that will become **one of the main energy sources in China** (see Table 3). With the recent implementation of favourable policies, the use of gas is expected to increase significantly for a long time to come. Given that gas makes up only 7.8% of the country's total fuel mix—compared with 23% on average in the world—the shift towards natural gas is just the start of a new era for the Chinese gas industry.

Table 3: Main strategic energy and gas development plans

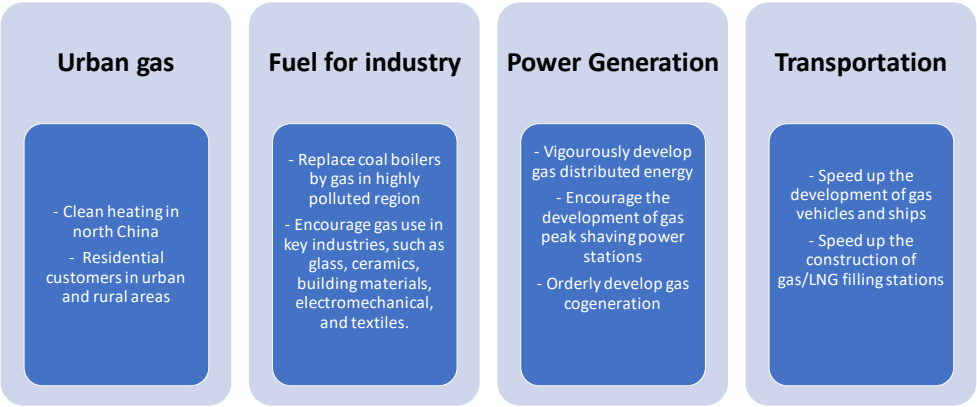
Date	Policy document	Main objectives
December 2016	**13th Five-Year Plan for Natural Gas Development (2016-2020)**	Highlights the key role of natural gas in the ongoing energy revolution in China. Actively promotes the use of natural gas and increase the share of gas in the energy mix to 8.3%-10% by 2020. Gas supply capacity is raised to 360 bcm by 2020.
April 2017	**Energy Supply and Consumption Revolution Strategy (2016-2030)**	Sets out the main overall targets and strategies of Chinese energy sector for 2030 and its vision to 2050. From 2021 to 2030, natural gas consumption will usher in rapid development and its share will account for more than 15% of total primary energy supply.
June 2017	**Notice on Accelerating the use of natural gas**	Highlights the importance of accelerating the use of natural gas in China. Natural gas is seen as a fuel of choice to reduce air pollution and respond to climate change. Reaffirms a 10% share of gas in primary energy consumption by 2020. Prioritizes four segments of gas consumption: city gas, industrial fuel, gas power generation and transportation.
September 2018	**State Council's Several Opinions on Promoting Coordinated and Stable Development of Natural Gas**	Promotes the coordinated and stable development of the natural gas industry. The promotion of natural gas is changed from "coal-to-gas" to "change with gas", with strong efforts to accelerate and diversify gas supplies, build midstream infrastructure and better interconnections. Emphasizes security of gas supply. Includes measures to ensure gas supply and demand balance.

China has set a goal of **increasing the share of gas to 10% in 2020 and 15% by 2030**. To achieve a 10% share in the energy mix by 2020 (equivalent to 360 bcm),[47] consumption will have to increase by an average 13.2% per year in 2019 and 2020, while the 15% share (about 600 bcm) would require an average growth rate of 5.2% (provided demand reached 360 bcm in 2020). A slowdown of China's economy may, however, reduce the growth in the near term, in the context of escalating trade tensions.

The **Notice on Accelerating the use of natural gas**, issued in June 2017, highlights the importance of accelerating the use of natural gas to facilitate the transformation of China's energy mix, reduce air pollution and respond to climate change. Compared to solar, wind and biomass energy, natural gas is seen by Chinese policy makers as a green and clean energy, which is more mature in terms of production, storage and transportation technologies than renewables. It is also more economic and feasible than other forms of new energy. The replacement of traditional coal, heavy fuel oil and other highly polluting fuels with natural gas is therefore one of the effective methods to solve the air pollution problem and can efficiently reduce pollutants and CO2 emissions. Natural gas is also seen as a strategic fuel to complement the development of renewable energy sources. It can also drive the development of related equipment manufacturing industries and contribute to the growth of the new economy.

Four segments of gas consumption are prioritized: city gas, industrial fuel, gas power generation and transportation.

Graph 10: Accelerating the use of gas in four key sectors



Source: NDRC.

47. Based on an energy consumption of 4.8 billion tons of standard coal equivalent (btce) in 2020 (13th FYP target) and 1 bcm = 1.33 Mtce.

Outlooks by key institutions

Table 4 compares recent outlooks for Chinese gas demand by key institutions (the IEA World Energy Outlook 2018 (WEO 2018), the US Energy Information Administration (EIA) International Energy Outlook 2017 (IEO 2017)[48]) and by China's State Council.[49] While there are differences in the speed of growth in gas demand, all outlooks indicate that **China's gas demand has entered a new development phase**. After the strong growth registered in the past two years, projections have been revised upward. The IEA, for instance, has raised its 2040 demand outlook for China by 100 bcm compared to WEO 2017, mainly due to the coal-to-gas switch policy. In all outlooks, **China leads the growth in global gas demand** and accounts for 25% to 30% of all global natural gas consumption growth by 2040. China becomes the second largest gas consumer in the world already by 2025, only surpassed by the US.

Table 4: Outlooks for China's gas demand by key institutions

All data in bcm	2015	2017	2020	2025	2030	2035	2040	2045	2050
IEA WEO2018, Nov. 2018									
New Policies Scenario (NPS)		248		464	559	637	708		
Sustainable Development Scenario (SDS)		248		463	577	661	698		
EIA IEO2017, Sep. 2017									
Reference Case	195		252	340	416	498	589	697	801
China's State Council, Jun. 2018									
Low case	193		300	392	476	498	525	552	580
Medium case	193		323	425	524	550	590	600	600
High case	193		357	473	574	603	636	665	695

Source: IEA WEO 2018, EIA IEO 2017, State Council of China.

All consuming sectors will increase their gas demand, but two sectors will contribute for the largest part of the growth: the industrial and power sectors.

Growing demand by the industrial sector results from two major trends: the substitution in many urban areas of coal-fired boilers largely

48. The EIA International Energy Outlook 2018 presents sensitivity cases related to transition paths for the Chinese economy but does not give detailed gas trends. So, we present here the projections published in 2017.

49. International Energy Agency (IEA), *World Energy Outlook 2018* (WEO 2018), November 2018, available at: www.iea.org, New Policy Scenario (NPS) and Sustainable Development Scenario (SDS); US Energy Information Administration (EIA), *International Energy Outlook (IEO) 2017, Reference case*, September 2017, available at: www.eia.gov; Development Research Center (DRC) of the State Council, "Making Natural Gas a Major Fuel", as presented by Li Yalan, CEO Beijing Gas at the IGU World Gas Conference, Washington, June 2018.

with gas-fired alternatives and rising gas demand by the light industry as China transitions to a service-led economy.

In the power sector, the role of gas in facilitating the integration of a larger share of variable renewables and reducing CO2 emissions will drive the rise in gas demand. In the short term, the current coal over-capacity and the lack of competitiveness of gas generation limits the construction of gas-fired power plants to some prosperous regions and to some cities where no-coal zones are implemented. For instance, Beijing has replaced its four coal-fired power plants by gas-fired cogeneration plants and similar policies have been adopted in some south and eastern provinces.

In the long term, the key issue is not so much replacing existing coal power plants but rather displacing coal power plants that might otherwise have been built to meet rising demand. There are strong indications that the coal capacity will reach a peak by 2025 (although the peak level remains subject of debate). Gas additions will not only ensure China can meet rising electricity demand but will lower the average emissions intensity of electricity generation. Thanks to their flexibility, gas-fired power plants will also facilitate the development of renewable energy sources. It remains that gas-fired generation, although rising, will be limited considering the size of the Chinese power market. The IEA projects gas generation to more than triple by 2030 (to 722 TWh), but still accounting for only 7.5% of total generation. Renewable generation accounts for 35% by 2030, in line with the new target set by the government.

The residential/commercial sector will be the third-largest contributor to gas demand growth driven by continued coal-to-gas switching policies, rapid urbanization, and expansion of pipeline coverage. The level of urbanization in China continues to increase, and the development of urban gas will continue to advance steadily. In 2017, China's urbanization rate reached 58%, and it is expected to reach 60% in 2020 and 70% in 2030.

The transportation sector will also be a key driver of gas demand in the medium/long term to reduce oil import dependency and GHG emissions of the sector. Electric vehicles are developing rapidly in major cities. But natural gas development in the sector focuses on the use of LNG for long-distance transportation of passengers and goods, and as bunker fuel in river and coastal transportation. According to the 13th Five-Year Plan (FYP) (2016-2020), there will be about 10 million NGVs by the end of 2020, of which 500,000 LNG vehicles. Gas demand by the sector will accelerate in the 2020s with the building of river and coastal LNG terminals and the greening of coastal and river transportation. LNG bunkering vessel is one of important mobile bunkering models that the

central government is strongly promoting. LNG as a marine fuel will also be promoted on the waters of the Beijing-Hangzhou Canal, Yangtze River trunk line, Xijiang shipping trunk line, Yangtze River Delta water network and Pearl River Delta water network.

According to the IEA's New Policies Scenario (NPS), by 2040, gas demand at 708 bcm is 460 bcm higher than in 2017. The **IEA's Sustainable Development Scenario (SDS)** leads to an even higher rise in natural gas demand in the medium term as coal is displaced more rapidly than in the NPS. Overall, by 2040, coal-to-gas switching abates nearly 1 Gt CO2 in the SDS.

China's State Council projects gas demand to reach slightly above 320 bcm in 2020 (medium case scenario). In the longer term, after a period of rapid growth to 524 bcm in 2030, the growth slows down before natural gas demand reaches a plateau (600 bcm) as energy demand enters its final phase of development, characterized by controlled energy consumption and a high share of non-fossil energy. In the higher case scenario, gas demand rises more rapidly (357 bcm in 2020) and continues its expansion in the long term to 700 bcm by 2050.

The recent implementation of favourable gas policies makes the high range of the outlooks very likely, provided security of gas supply is reinforced and import dependency remains at an acceptable level for policy makers.

Conclusion

The gas market in China is policy driven. Changes in Chinese policy and regulation can have a high impact on its gas supply and demand balance, and therefore on the international gas market. In the short term, economic activity and weather can move gas demand rapidly and therefore China's gas supply needs. The main structural trend is towards a continued increase in gas demand boosted by the need to restructure the energy mix away from coal and reduce local air pollution. However, the coal-to-gas switching policy is now implemented under strict planning and local considerations to avoid gas shortages and ensure affordability of gas supplies to end users.

Climate change has not been a direct driver of the gas demand boom yet, but coal-to-gas switching has also helped to reduce China's carbon intensity. Today, addressing climate change challenges is more and more associated with the fight against air pollution. While the building and industrial sectors have been the two priorities of the coal-to-gas switching policy, there are numerous signals that coal generation may reach a peak at the middle of the 2020s, creating more room for renewables and natural gas in the power sector. The need to reduce air pollution, carbon emissions and oil import dependency also adds a strong potential for gas and LNG use in the transportation sector.

Looking ahead, natural gas will remain an essential part of China's response to air pollution and climate change. The acceleration of infrastructure investment and a successful implementation of gas market reforms will facilitate the further increase of gas demand while keeping natural gas affordable to end users. Stepping up domestic gas production and strengthening diversification of gas imports will be key determining factors of the extent and speed of gas demand growth.

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