

Overview of China's Energy Transition 2022

Chapter on Natural Gas

BACKGROUND

Dear Reader,

The fossil energy crisis, coupled with the continuing COVID-19 pandemic, is accelerating major disruptions to traditional energy supplies, transport, and consumption. As the world's largest producer, importer and consumer of energy, China has attracted increased international attention focusing on the domestic energy system and its future.

The Chinese energy system is undergoing dramatic shifts, with a top-down mandate to transition from a carbon-intensive economy towards a peaking of emissions by 2030 and carbon neutrality by 2060. Notwithstanding growing concerns about energy security, China is expected to uphold this climate commitment, which was announced by President Xi Jinping in September 2020. As with the European Union (EU), although a short-term setback to its clean energy transition may occur, China is nevertheless doubling down on efforts to transform its fossil fuel-dominated economy towards a renewables-based system.

We have observed a growing interest in the Chinese energy system, which led us to draft an Overview of China's Energy Transition 2022. The purpose of this

publication is to deliver facts and background information, rather than address specific policy challenges or delve into possible solutions. Instead, we present fundamental data that should be helpful to gain a better understanding of the Chinese energy system.

This publication introduces the Chinese natural gas industry, with a focus on supply, imports, consumption, market reform, and the ongoing transformation of the sector. This first part of the publication will be followed by additional chapters dedicated to oil, coal, electricity and carbon-dioxide emissions from fuel combustion, among other topics.

A caveat: We strive to find and analyse available data. However, we recognise that errors occur, and statistics might not always be accurate.

I hope you find this chapter useful for better understanding the Chinese gas industry and its future.

Kevin Tu
Managing Director
Agora Energy Transition China

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1 | Overview of Natural Gas

The Chinese natural gas industry has undergone unprecedented growth in the past two decades. As a result, China has become the third largest gas-consuming country in the world, trailing only the United States and Russia. In 2021, apparent gas consumption in China reached 373 billion cubic meters (bcm), with the year-on-year (YOY) growth rate returning to double digits (13% in 2021). Gas consumption in 2021 totalled 827 bcm in the United States and 475 bcm in Russia; however, both countries are also major gas producers.

Boosted by the Chinese government's campaigns to improve air quality and encourage coal-to-gas switching, the gas industry has experienced a strong 'push' from Beijing to expand and is projected to grow further in the years to come.

China became the world's largest gas importer in 2018, overtaking Japan. In 2021, China's imports of liquefied natural gas (LNG) increased by 15.1% YOY and reached 81.4 million metric tons (equal to 110.7 bcm), thus also surpassing Japan as the largest LNG importer. China is a major player in both the international LNG market and the pipeline gas market.

China's gas imports have continued to grow because domestic production has not been able to keep pace with rising demand. As a result, China's dependency rate on gas imports has already exceeded 40%. Imports are diversified between pipeline gas and LNG trade. Due to supply security concerns and a desire to

hedge against commodity-price fluctuations on international markets, Chinese importers prefer signing long-term contracts to procuring from the spot market.

The Chinese government has been implementing market-oriented reforms in the gas industry. Its officially stated philosophy is "control the middle, and liberalize the two ends", meaning that both the downstream and upstream sectors should eventually be liberalized while the transmission segment will remain tightly regulated. In order to "control the middle" and encourage competition along the gas value chain, the government established the PipeChina corporation in December 2019 to accelerate third-party access to gas infrastructure. PipeChina has consolidated the majority of gas pipelines, storage facilities and LNG terminals from the "three big barrels of oil" (CNPC, Sinopec and CNOOC) and become the dominant operator of gas network infrastructure in China.

Despite its size, the Chinese gas industry has been playing a relatively marginal role in China's growing demand for energy so far. Further gas market development is challenged by the difficulties of ramping up domestic production and the high cost of imports, which make gas a very costly alternative to coal. Domestic resource constraints, international gas-price volatility, energy security concerns, insufficient infrastructure, institutional weaknesses and slow reform will continue to pose challenges to the Chinese gas industry.

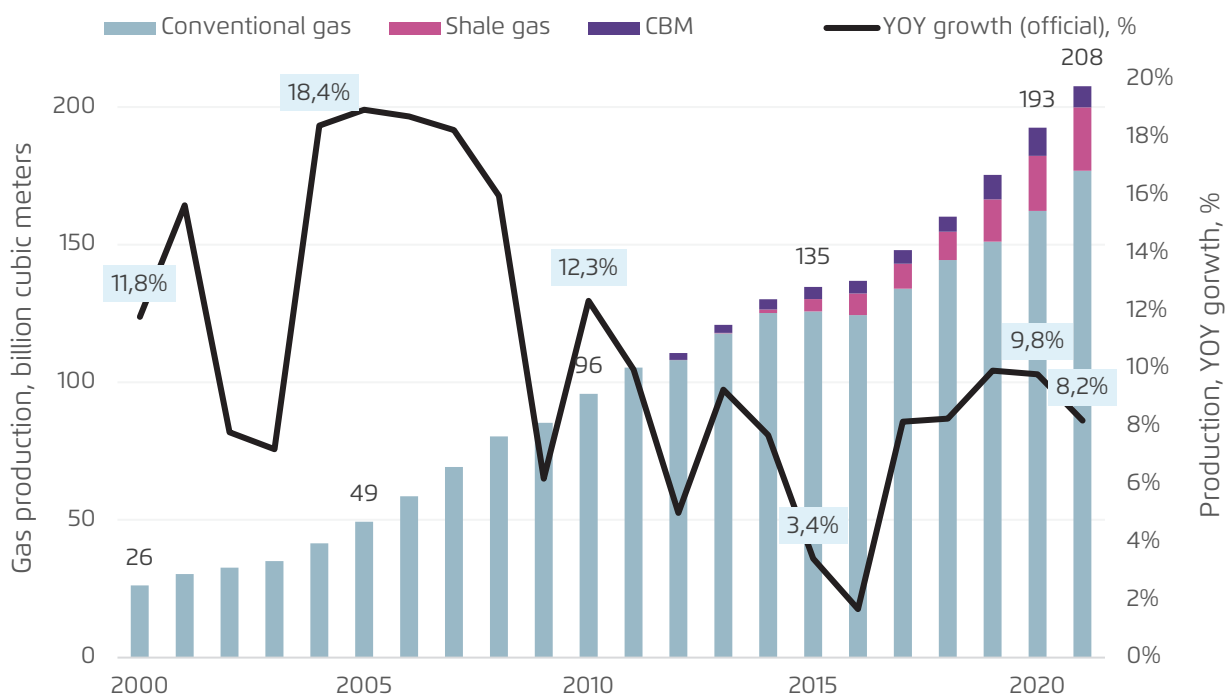
2 | Supply

2.1. How much natural gas does China produce?

According to the 14th Five-Year Plan (FYP) for energy-system development, China's annual gas production capacity should reach 230 bcm by 2025.

In 2021, gas production in China increased 8.2% YOY to 205.3 bcm. It consists of mostly conventional gas, with shale gas accounting for 11% and coal bed methane for 4%.

Figure 1 | Annual gas production in China and gas production growth in 2000-2021.



*CBM – coal bed methane

Source: National Bureau of Statistics of China (NBS)

2.2. How big are domestic natural gas reserves in China?

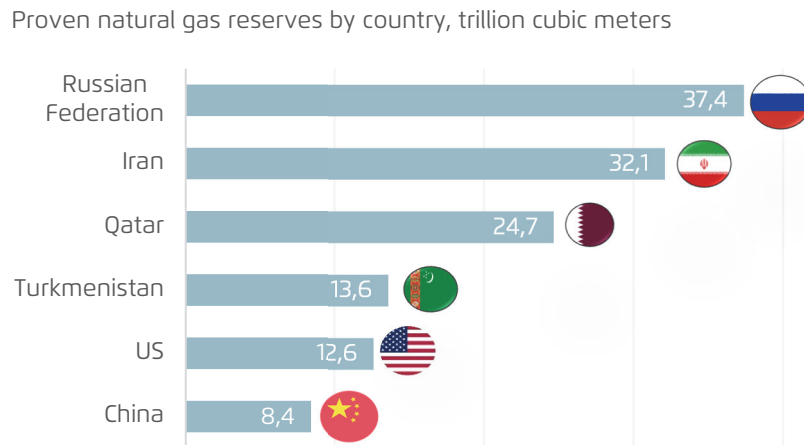
China ranks sixth in the world in proven natural gas reserves. However, the quality of these reserves is relatively low - and the gas becomes increasingly difficult to extract.

China also has the largest shale gas deposits in the world and is the 3rd biggest shale gas producer (after the United States and Canada). Despite the rapid growth of shale gas production (+15% in 2021, +30%

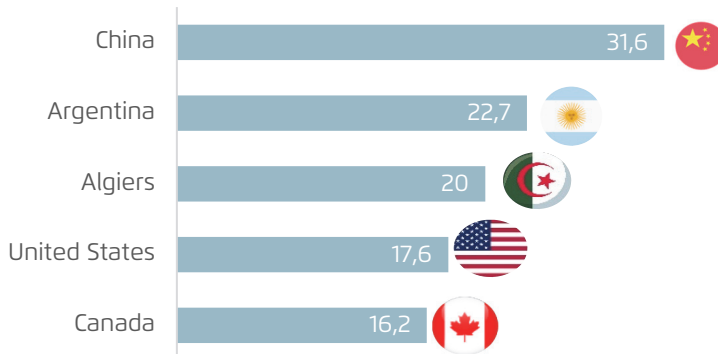
in 2020), these deposits are deep (e.g., 2600-3000 metres in the Sichuan basin) and hard to extract.

Hence, Chinese shale gas has high production costs, which are approximately four to five times greater than in the United States. Another reason why a shale gas revolution is unlikely in China is that many reserves are located in water-scarce areas. As a result, except for major domestic oil companies, all the international players have exited shale gas development projects in mainland China.

Figure 2 | China's proven natural gas reserves in the international context



Technically recoverable shale gas reserves by country, trillion cubic meters



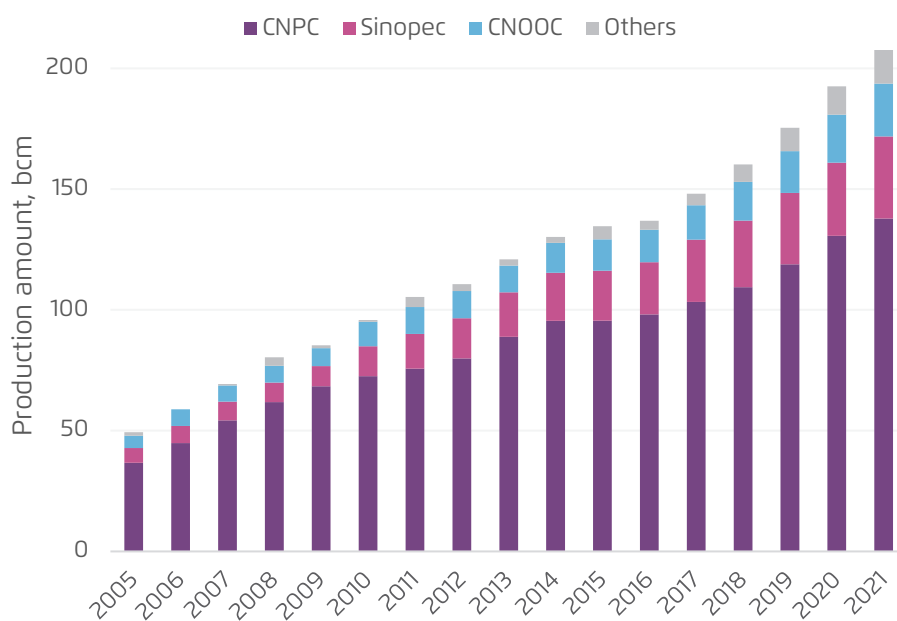
Source: National Bureau of Statistics of China (NBS)

2.3. Which companies are the major gas producers in China?

Natural gas production is dominated by the 'three barrels of oil' – China National Petroleum Corporation (CNPC), China Petroleum & Chemical Corporation (Sinopec), and China National Offshore Oil Corporation (CNOOC). Together, these companies account for 95% of gas output in China.

There is a further 'division of labour' between Chinese majors: CNPC focuses mainly on developing conventional gas resources, Sinopec develops large shale gas deposits in the Sichuan Basin and CNOOC specializes in the development of offshore gas reserves in the South China Sea and Bohai Basin.

Figure 3 | Gas Production by Chinese Companies in 2005–2021



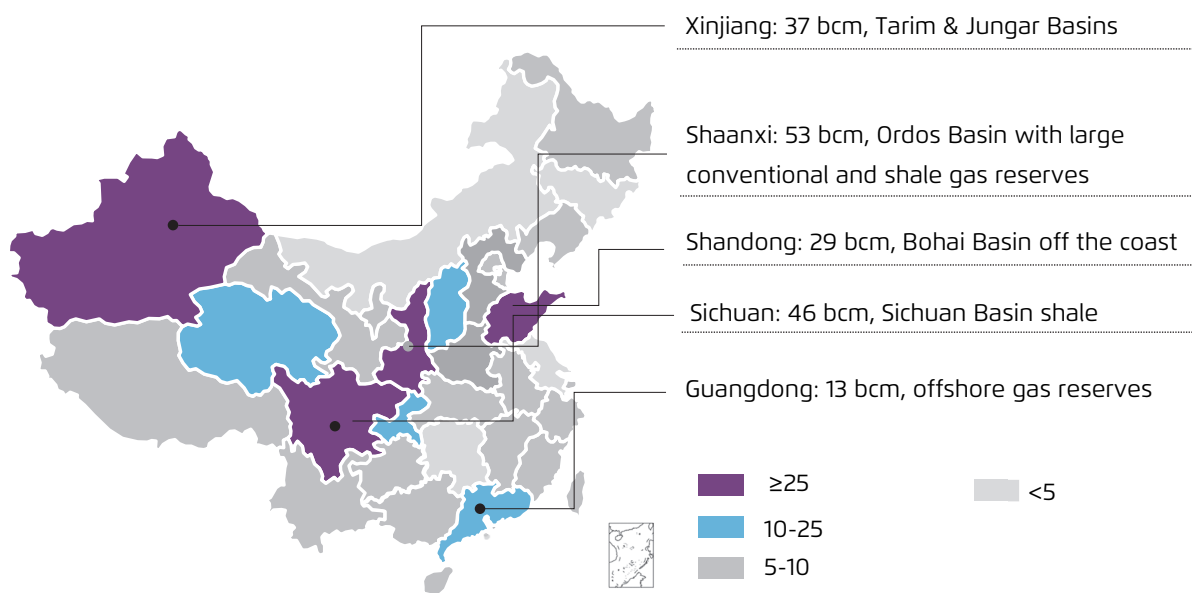
Source: National Bureau of Statistics of China (NBS), corporate annual reports

2.4. What are the major gas-producing regions in China?

Shaanxi, Xinjiang and Sichuan account for 71% of total gas production in China. The Northern Shaanxi province makes up the southeastern portion of the

Ordos Basin with large conventional and shale gas reserves. The Xinjiang autonomous region deposits mostly traditional gas reserves in the Tarim and Jungar Basins. The Sichuan province is rich in shale gas reserves.

Figure 4 | Gas production in China in 2020 by provinces



Source: China Energy Statistical Yearbook, 2020

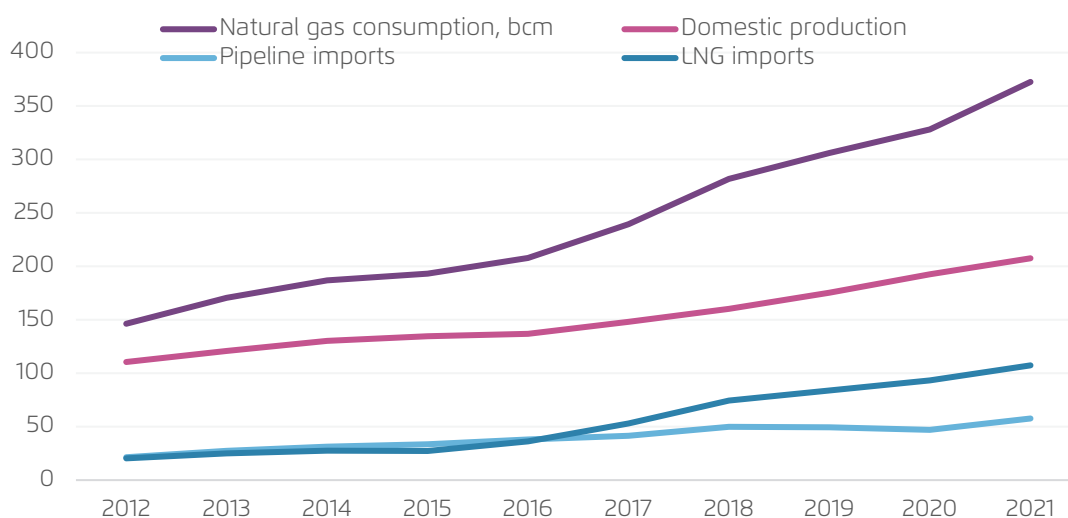
3 | Imports

3.1. China's natural gas import dependency and energy security concerns

China's gas production and imports follow the demand trajectory. Imports (especially, LNG) are more sensitive to gas demand growth compared with domestic production, and therefore fluctuate more widely (as shown in the graph below).

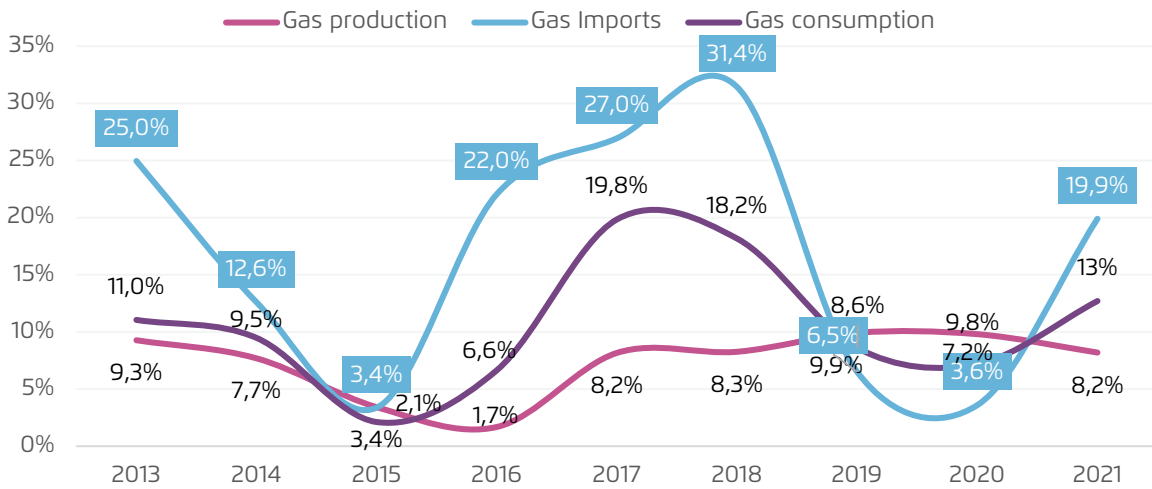
Consequently, in periods of strong demand growth, imports meet most of the incremental consumption and rise much faster than domestic production, which in general cannot ramp up speedily enough. The highest YOY growth in gas production stands at only 9.9% in the last decade, in sharp contrast to the often double-digit spike in gas imports during the same period.

Figure 5 | Natural gas consumption, production, PNG and LNG imports in 2012–2021



Sources: National Bureau of Statistics of China, NDRC, General Administration of Customs of China

Figure 6 | Comparison of natural gas production, imports and consumption growth in 2012–2021

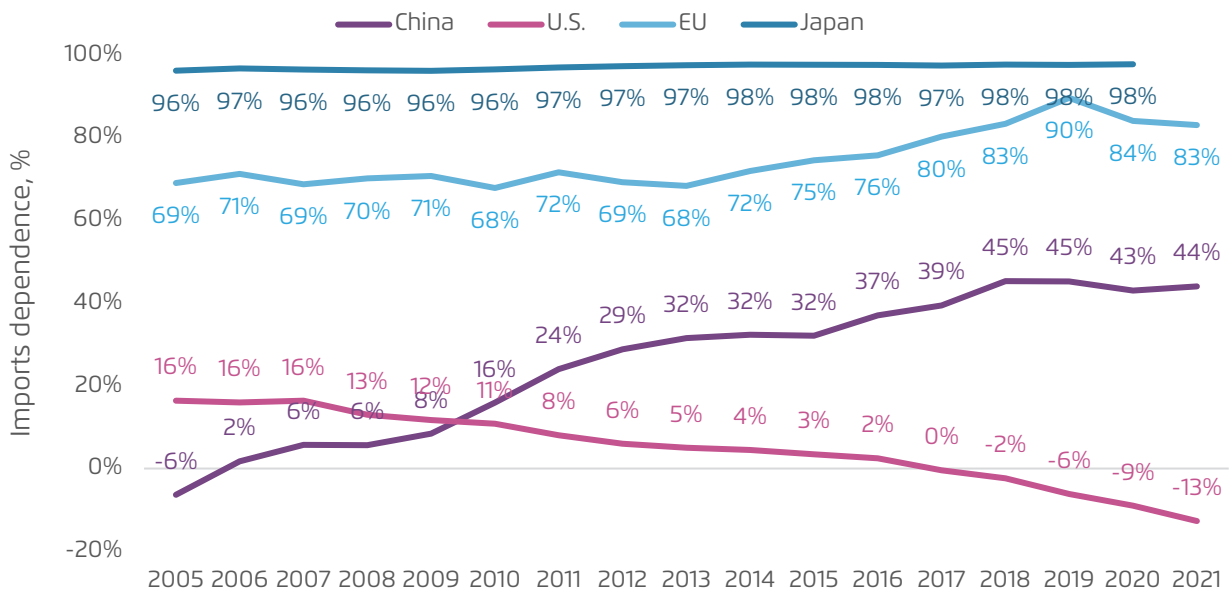


Sources: National Bureau of Statistics of China, NDRC

In 2021, China's imports of natural gas rose 20% YOY to 165 bcm. China's dependency on gas imports has steadily grown and exceeded 40% as early as 2018. This has raised concerns about China's energy supply

security and made it a priority. However, it is worth noting that China's dependency on gas is much lower than that of either Japan or the EU.

Figure 7 | Comparison of gas import dependence of China, U.S., Japan and EU



Source: BP Annual Statistical Review 2021, Eurostat, EIA, China stats

3.2 China’s pipeline gas imports

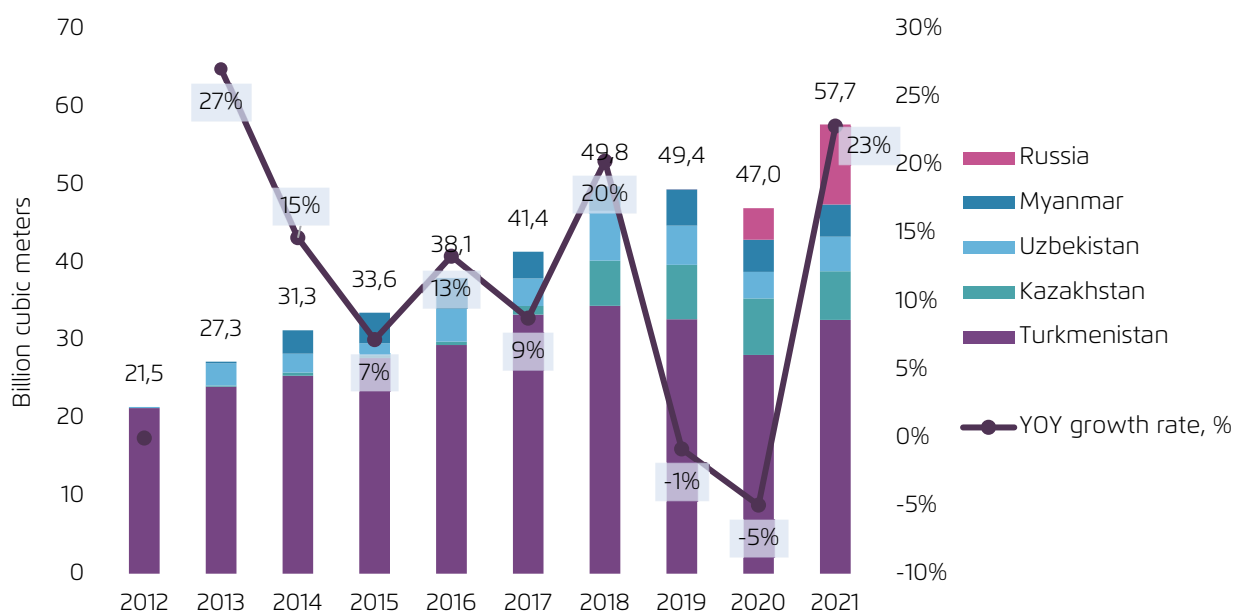
Currently, China imports most of its pipeline gas from Central Asia, namely from Turkmenistan, Uzbekistan and Kazakhstan. These supplies flow through the Central Asia – China pipeline (connected to China’s West to East pipeline network). Since the end of 2019, CNPC has also imported pipeline gas from Russia via the Power of Siberia pipeline, with annual contracted supply volume scheduled to reach 38 bcm. Since 2013, small amounts of pipeline gas have also entered southern China from Myanmar.

Turkmenistan has long served as China’s largest foreign supplier of pipeline gas, accounting for 57% of Chinese pipeline imports in 2021.

Total pipeline gas imports in 2021 rose 23% YOY to 57.7 bcm. Pipeline imports are projected to grow as Russian supplies via the Power of Siberia connection continue to ramp up and a new supply route from the Far East of Russia comes online.

However, the share of pipeline supplies has decreased as LNG plays a bigger role in meeting China’s demand. Between 2015 and 2021, the share of pipeline supplies in China’s gas imports declined steadily from 57% to 35%.

Figure 8 | China’s pipeline gas imports in 2012–2021



Source: General Administration of Customs of China

Table 1 | Long-term pipeline gas supply contracts to China

Contracting parties	Supply country	Contract period	Annual supplies, bcm	Pipelines
CNPC-Turkmengazi State Consortium	Turkmenistan, Samandepe fields	30 years, started in 2012	40	Central Asia-China (lines A, C)
CNPC- Uzbekneftegaz	Uzbekistan,	30 years, started in 2012	10	Central Asia-China (line B)
CNPC-Kazmunaygaz	Kazakhstan, Karachaganak, Kashagan and Tengiz	5 years, started in 2018	10	Central Asia-China (line C)
CNPC-Gazprom	Russia, East Siberia	30 years, started in 2019	38	Power of Siberia
CNPC-Gazprom	Russia, Far East	30 years	10	–
CNPC-Myanmar Oil and Gas	Myanmar	30 years, started in 2013	4*	Myanmar-China

*Pipeline capacity is estimated at 12 bcm/year, however the actual annual pipeline gas imports haven't exceeded 5 bcm/year yet.

Source: Companies' info

Total contracted pipeline imports into China (once Power of Siberia ramps up to its contracted capacity) exceed 110 bcm a year, with Russia potentially becoming the major supplier. Following an agreement between Gazprom and CNPC in February 2022, Russian gas deliveries to China are poised to reach

48 bcm, which would lead Russia to leapfrog Turkmenistan as the top pipeline supplier to the Chinese market. At the same time, China might also consider developing Turkmenistan's giant Galkynysh gas field and building the long-stalled line D of the Central Asia-China Gas Pipeline.

3.3 China's LNG imports

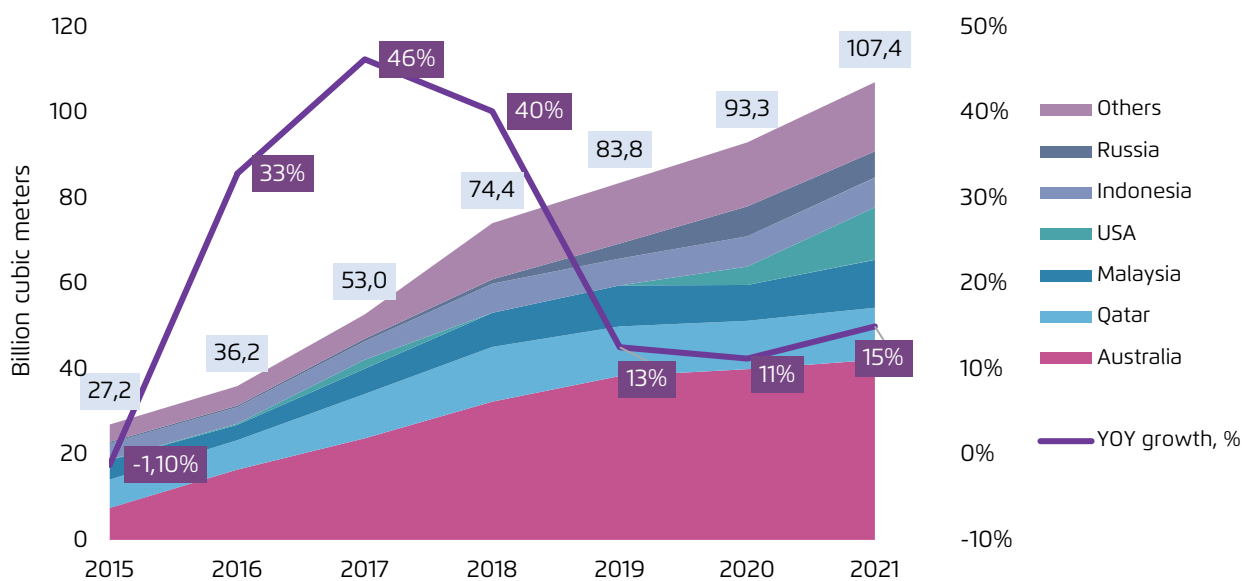
With a diversified portfolio, China imports LNG from more than 20 countries. Australia ranks as the largest supplier with a 40% market share, followed by Qatar with 11%. LNG imports from the United States are growing the fastest, almost tripling YOY in 2021 alone.

Despite strong volatility and price increases in international LNG markets in 2021, China's imports increased 15% YOY and reached 81.4 mt (million metric tons).

Chinese companies have also rushed to sign new mid- and long-term LNG import contracts as spot prices hit record levels after an almost full 'shop-stop' in 2020 (New contracts amounted to 25 mmtpa in 2021).

By the end of 2021, PipeChina and several private companies operated 22 LNG terminals with an aggregate capacity exceeding 80 mmtpa (million metric tons per annum). There are 17 LNG terminals under construction in China with a total estimated capacity of 72 mt a year.

Figure 9 | China's LNG imports in 2015–2021



Source: General Administration of Customs of China

3.4 China's gas sector reform and the establishment of PipeChina

In December 2019, the Chinese government established a new 'major' in the petroleum industry: the China Oil & Gas Pipeline Network Corporation (PipeChina). The company was formed through the transfer of assets and personnel from the three major national oil producers - CNPC, Sinopec and CNOOC.

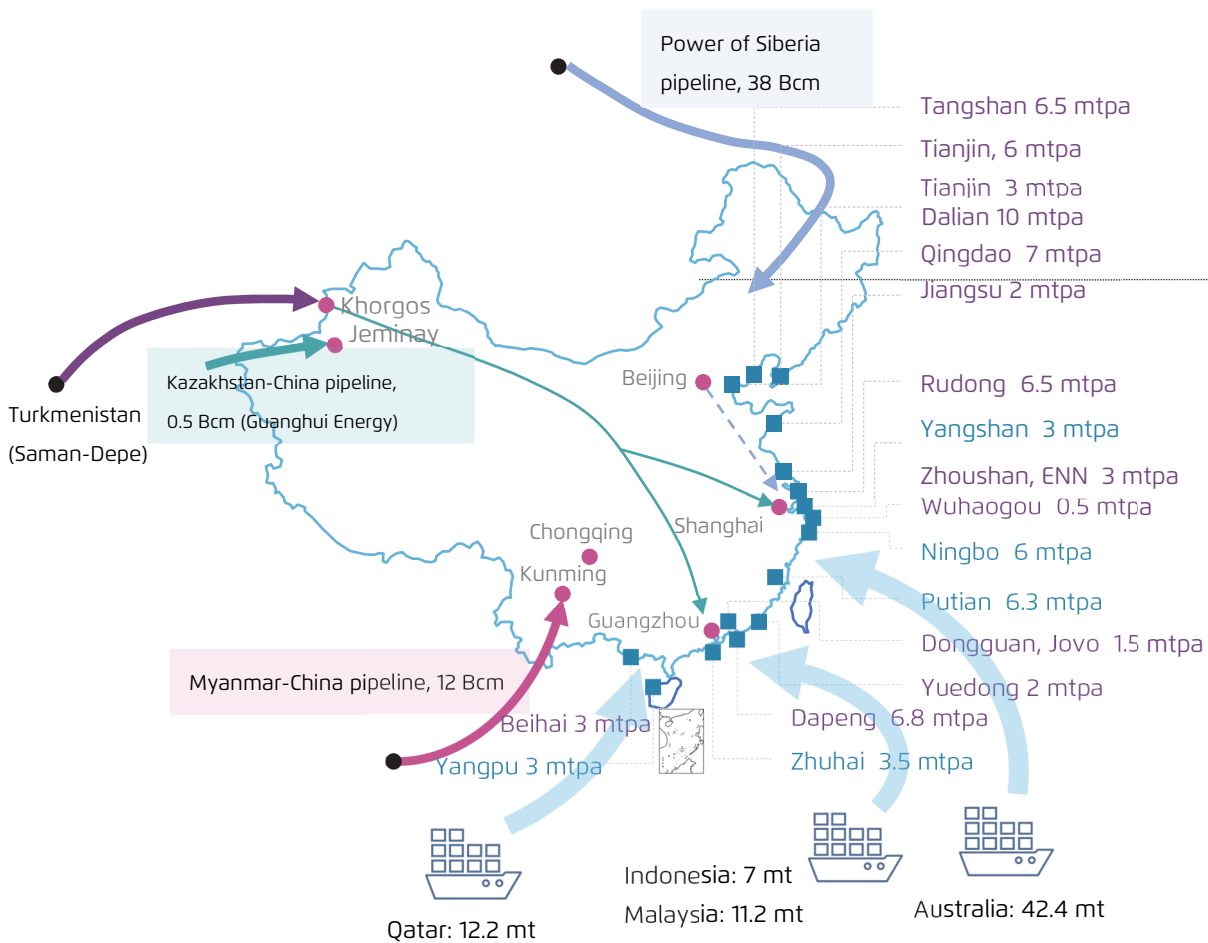
PipeChina began operations in September 2020. Since then, it has consolidated the majority of gas pipelines, storage facilities and LNG terminals from the "three barrels of oil" and become the top operator of gas network infrastructure in China.

PipeChina is part of an ongoing reform of state-owned enterprises (SOEs). This involves reallocating state-owned assets among SOEs by merging central ones and forming new conglomerates and industry leaders.

The major goals of establishing PipeChina are:

- ▶ To attract and direct more investment into gas infrastructure;
- ▶ To open access to gas transmission infrastructure and LNG terminals, increasing competition in the industry.

Map 2 | Operational gas import pipelines and LNG import terminals in China



Source: PetroChina, Sinopec, CNOOC corporate reports

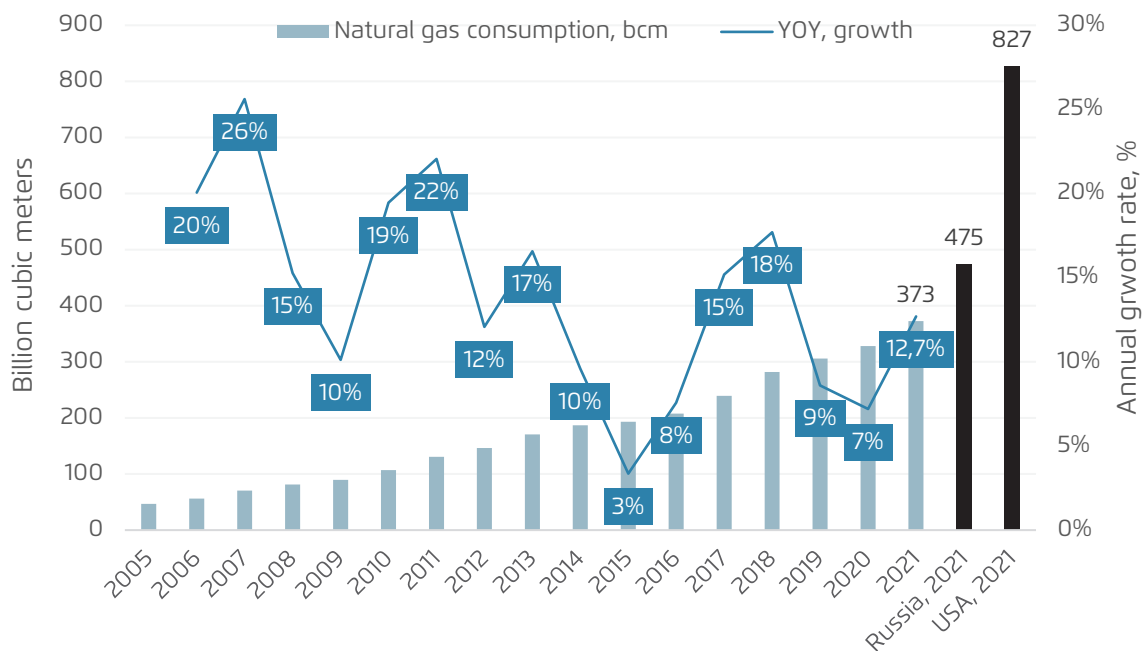
4 | Consumption

4.1 Natural gas consumption in China

China is the third-largest gas consumer in the world. Chinese gas consumption has undergone rapid growth over the past 15 years. Despite the pandemic

and high LNG spot prices in 2020, gas consumption in China in 2021 grew 12.7% YOY to more than 373 bcm. In 2021, China accounted for 9.4% of global gas consumption, lagging behind only the United States and Russia.

Figure 10 | China's Apparent Natural Gas Consumption, 2005–2021.



Source: NDRC, Rosstat, BP Annual statistical review 2022

The major factors stimulating gas consumption growth in China:

- ▶ Government policies to shift away from coal and diversify national energy structure;
- ▶ Government measures to control air pollution especially in urban centres ('blue sky campaign').

China's 'coal-to-gas' campaign in 2016–2018 was a major tool to implement this strategy.

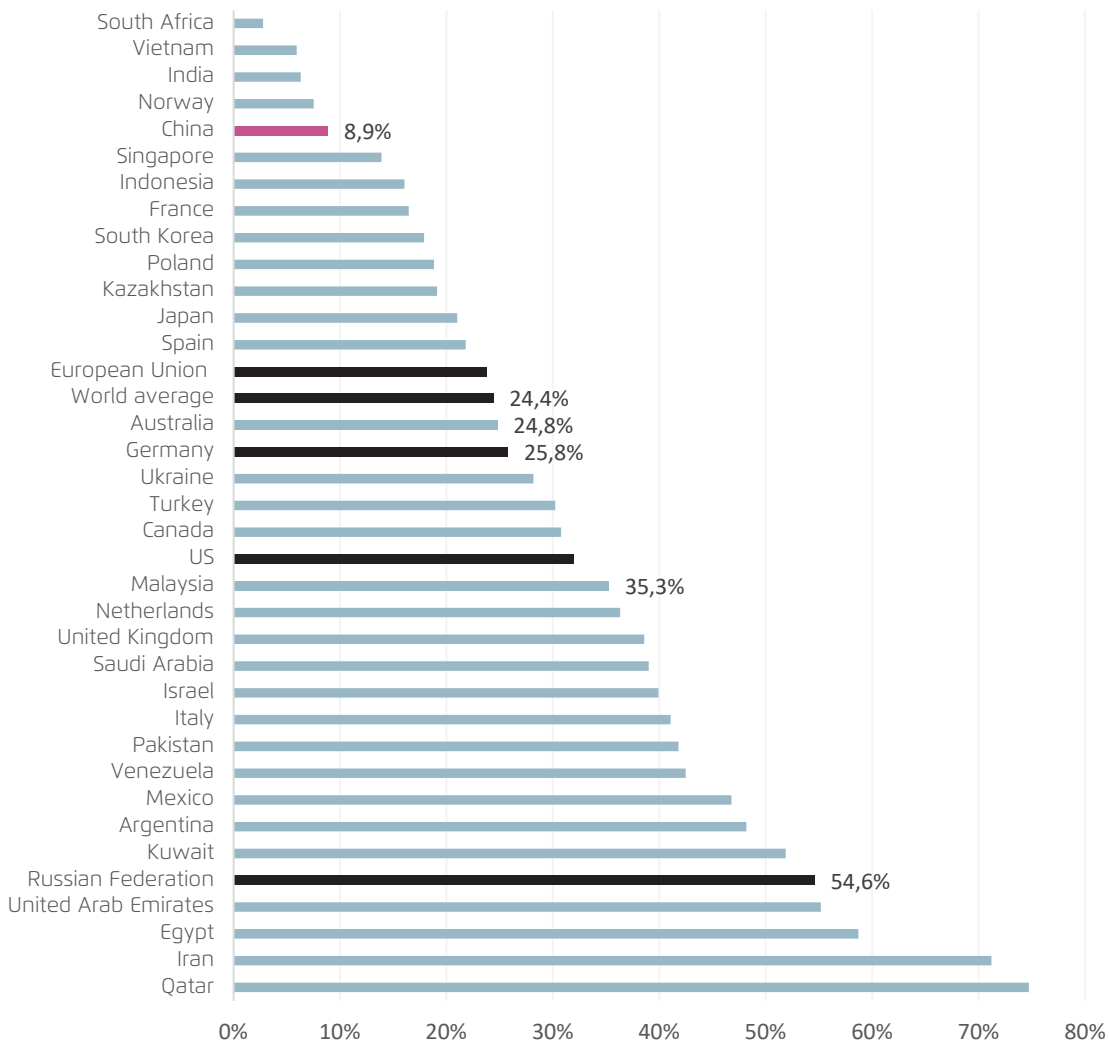
The use of gas as a heating fuel has been promoted in "2+26" cities with a campaign to increase the use of 'sustainable' heating fuels.

4.2 Will China's natural gas consumption continue to grow?

The share of natural gas in China's energy mix is relatively low – 8.9% in 2021 (according to the National Bureau of Statistics of China) compared with the world average of 24.4% the same year (BP).

However, the share of gas in China's energy mix is projected to continue growing and reach 12% by 2025. By then, China is expected to overtake Russia and become the second-largest gas-consuming country in the world.

Figure 11 | International comparison of the share of natural gas in energy mix



Sources: BP Annual Statistical Review 2022, NBS

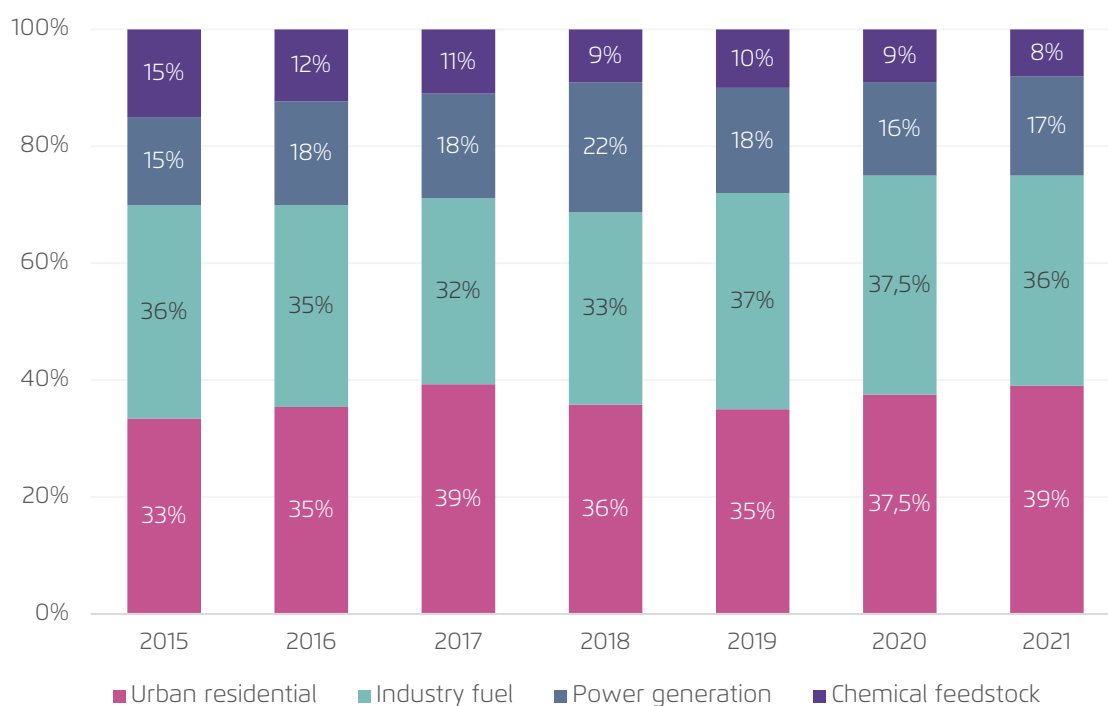
Natural gas consumption in China is projected to increase to:

- ▶ 430–450 bcm by 2025
- ▶ 540–550 bcm by 2030
- ▶ more than 600 bcm by 2040

4.3 Structure of natural gas consumption in China

Natural gas consumption is being driven by the industrial and residential sectors, whereas it is declining in chemicals production and remains relatively weak in power generation.

Figure 12 | Gas consumption by sector in China in 2015–2021



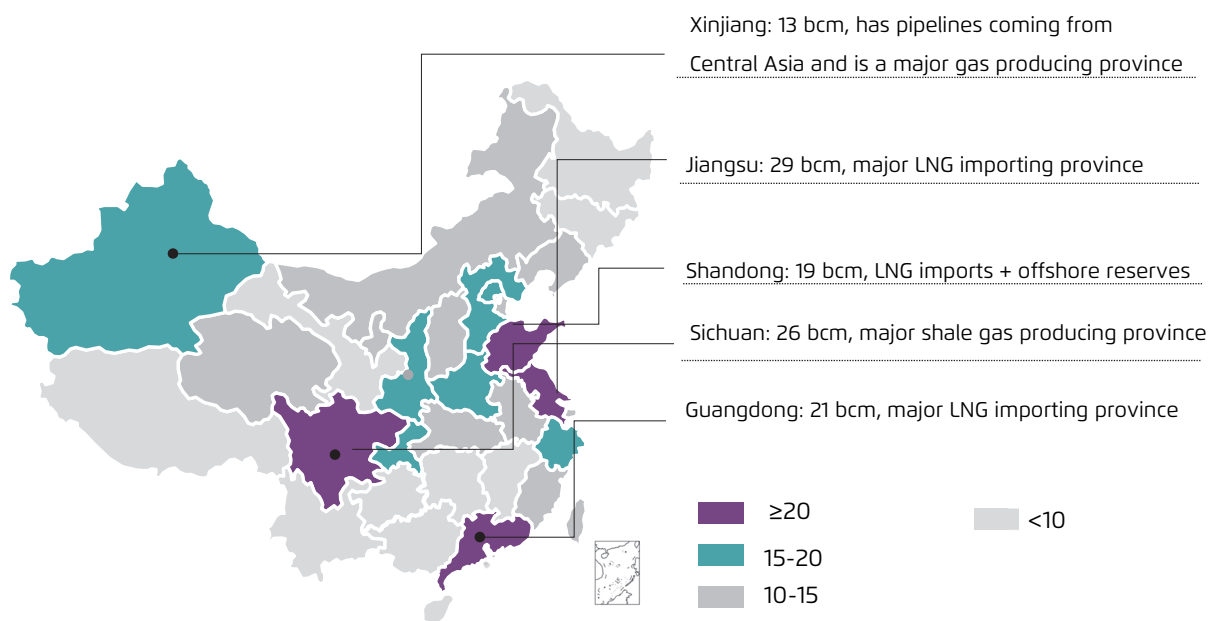
Source: CNPC Research Institute of Economics and Technology

4.5 What are the major gas consumption centres in China?

Four provinces – Jiangsu, Sichuan, Guangdong and Shandong – account for almost one-third (32%) of national gas consumption in China. The three

provinces that demonstrated the highest growth (above 20%) in gas consumption in 2019 were Hebei, Shandong and Shanxi.

Map 3 | Gas consumption in China in 2019 by provinces



Source: China Energy Statistical Yearbook, 2020

5 | Market Reform

The Chinese government has been enacting market-oriented reforms in the natural gas industry. Its officially stated philosophy is “control the middle, and liberalize the two ends”, meaning that the downstream and upstream sectors should eventually be liberalized while the transmission segment will remain tightly regulated. The establishment of PipeChina was part of the reform with the focus on “controlling the middle”.

So far, the upstream sector is largely monopolized by the “three barrels of oil” (CNPC, Sinopec and CNOOC). Lowering entry barriers could improve market competition and allow new players to enter both upstream and downstream businesses.

At present, wellhead, citygate and retail gas prices are set by the government. LNG prices are fully liberalized and LNG is sold according to the supply-

demand balance of the gas market. Wholesale prices for unconventional gas resources (offshore, shale gas, CBM) have also been liberalized.

The major goal of gas market reform is to liberalize the upstream and downstream segments, and only set the pipeline tariffs on a cost-plus basis. As part of the changes, several trading platforms have been established to promote market-based gas pricing mechanisms. The main platform is the Shanghai Petroleum and Gas Exchange. Apart from pipeline gas and LNG, market players can also use this platform to sell free terminal capacities as well as gas storage volumes. However, so far, the scope of trading activities has been limited and the trading platform has been mostly used to test various pilot schemes. Additional trading platforms have been established in the major gas hubs in Chongqing, Tarim (Xinjiang region) and Shenzhen (Guangdong province).

6 | Summary

Although the Chinese natural gas market has undergone rapid development in the past two decades, it still plays a relatively marginal role in meeting China's growing demand for energy. The share of gas in China's energy balance has reached only 8.4% in 2020 (missing a 10% target in the 13th FYP set by the central government) and is projected to grow to 12% by 2025 (according to NEA).

Due to persistent concerns over energy security, the Chinese government has long emphasized the importance of ramping up domestic gas production, but it still failed to keep pace with demand. The main reasons for this are the worsening conditions of domestic conventional gas reserves and the high extraction costs of unconventional gas reserves. As a result, imports have become the major source for meeting rising gas demand in China. China's dependency rate on gas imports has grown from just 16% in 2010 to 43%–44% in the last four years. However, it is still much lower than oil imports and is well diversified with several pipeline supply routes and multiple LNG suppliers.

In 2021, China became the largest LNG importer in the world, overtaking Japan. LNG imports have exceeded pipeline gas supplies to China since 2017. To secure supplies, Chinese gas companies largely rely on long-term LNG contracts that are less prone to price fluctuations, especially in recent years. China is also actively developing its LNG import terminals, which currently have 80 mmtpa capacity in operation and 165 mmtpa due to come online under the latest government plans. The Chinese LNG industry has attracted a number of independent players in recent years, but their role has been limited as a result of problems with access to terminals, which were operated until recently by the "three barrels of oil" (CNPC, Sinopec and CNOOC).

To open third-party access to gas-importing infrastructure and attract investment in the midstream sector, the government established

PipeChina in December 2019. The company has consolidated the majority of gas pipelines, storage facilities and LNG terminals from CNPC, Sinopec and CNOOC, and has become the major operator of gas network infrastructure in China. The establishment of PipeChina follows the logic of China's gas market reform – "control the middle, liberalize the two ends", meaning that the downstream and upstream sectors should eventually be liberalized while the transmission segment will remain tightly regulated. In this context, the government has been seeking to liberalize gas prices by establishing several trading platforms across China, but progress in price reform has so far been limited.

Gas will continue to play a role in China's energy mix due to a variety of supportive government policies. Unlike coal and oil, whose consumption is projected to peak before 2030, demand for gas will very likely continue to grow with support both at the top echelons of the Chinese government and the corporate level, with a strong emphasis on gas development at the three major petroleum companies. Nevertheless, a host of factors – domestic resource constraints, LNG price volatility, energy security concerns, insufficient infrastructure development, institutional weaknesses and slow market reform – will continue to suppress the potential of the Chinese gas industry.

Therefore, gas will not become a substitute for coal as the major fuel in China and will play an auxiliary role in the country's energy transition. Rather, it can help contribute to the phase-down of some amount of coal in the mid-term. Eventually, it needs to be replaced by cleaner energy sources. Otherwise, China may risk falling into the trap of infrastructure lock-ins.

Last but not least, against the backdrop of rising energy security concerns and the net-zero carbon agenda, the development of the Chinese gas industry will need to be observed in the coming years.

About Agora Energiewende

Agora Energiewende develops scientifically sound, politically feasible ways to ensure the success of the energy transition – in Germany, Europe and the rest of the world. The organization works independently of economic and partisan interests. Its only commitment is to climate action.



Agora Energiewende
Anna-Louisa-Karsch-Straße 2
10178 Berlin, Germany
P +49 (0)30 700 14 35-000
F +49 (0)30 700 14 35-129
www.agora-energiewende.de
info@agora-energiewende.de

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