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CHINA'S QUEST FOR GAS SUPPLY SECURITY

The Global Implications

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Executive Summary

The major transformations that are occurring on the Chinese gas market have profound repercussions on the global gas and LNG markets, especially on trade, investment and prices. This is just the beginning of the "China's effect" on global gas markets as the government projects that the share of natural gas is to increase to 15% by 2030.

China has become a key driver of global LNG demand. China alone explained 63% of the net global LNG demand growth in 2018 and now accounts for 17% of global LNG imports. Driven by the fight against air pollution and the acceleration of coal-to-gas switching, the share of gas in China's energy mix increased from 6.4% in 2016 to 7.8% in 2018. This relatively small change at the Chinese level has had an oversized impact on global gas markets. In just two years, China has become the world's first gas importer and is on track to become the largest importer of Liquefied natural gas (LNG).

The pace and scale of China's LNG imports have reshaped the global LNG market. Over the past two years, fears of an LNG supply glut have largely been replaced by warnings that the lack of investments in new LNG capacity would lead to a supply shortage in the mid-2020s unless more LNG production project commitments are made soon. There is now a bullish outlook for future global LNG demand which has encouraged companies to sanction additional LNG projects, based on the anticipated supply shortage. The United States (US)-China trade war has not prevented US developers from investing in new liquefaction trains so far but without China's equity or contracts: out of the seven LNG export projects sanctioned between October 2018 and August 2019, three are in the US. However, since the imposition by China of a 10% tariff on US LNG in retaliation to US tariffs on Chinese goods, Chinese imports of US LNG have collapsed, a trend that has been reinforced by the imposition of a 25% tariff since 1 June 2019.

China also leads the global and Asian spot LNG purchases, and has become a key driver of the evolution of Asian spot LNG prices. In winter 2017-18, Chinese buyers' rush out to cover gas shortages with spot LNG cargoes led to a doubling of spot LNG prices from summer 2017. In winter 2018-19, lower Chinese LNG spot purchases, combined with weaker North Asian demand due to a warmer end of winter and ample LNG supplies, had

a commensurate impact on global prices and LNG trade flows. The Asian spot LNG price collapsed by 60% between September 2018 and March 2019, erasing the price spread between the Pacific and the Atlantic basins.

Europe has now become a premium market for Atlantic LNG suppliers. European LNG imports have surged, notably LNG imports from the US, but also from Russia's Yamal LNG. The surge in LNG imports has depressed European spot prices, which have collapsed to ten-year lows in June 2019. By extension, now that the US has become a leading LNG exporter, warmer temperatures in China have also reverberated on US spot prices.

The purchasing behaviour of China's LNG importers has also an indirect impact on the storage market, notably in Europe. In 2019, low LNG spot prices and weaker spot demand in Asia have helped Europe to fill its underground gas storage (UGS) to more than average summer levels. Currently, China's LNG imports peak in winter but the seasonality of China's LNG imports is evolving with a second peak in summer. This peak is expected to increase in the future with new UGS capacity commissioned in the country that will need to be refilled before the winter. The expansion of UGS will help stabilize seasonal demand and price fluctuations in China. In turn, this will impact the seasonality of global LNG trade flows. Furthermore, as China is becoming the largest LNG market, the country is also expected to have more pricing power. The recent decoupling between spot and oil-indexed LNG prices and China's political will to develop a China gas benchmark and eliminate the "Asian LNG price premium" could accelerate the move. Looking ahead, the Shanghai Exchange could become a key trading hub for China's domestic gas market, but also a reference for Asian and global LNG prices, as well as for China's imported gas by pipeline. It would reinforce the role of the renminbi on the energy market, which is Beijing's objective.

To tackle security of supply issues, China has diversified its gas supplies, routes and modes of deliveries. First pipeline contracts with Turkmenistan were signed in 2007 and China has now developed two strategic routes for importing natural gas by pipeline: the Central Asia pipeline from the west and the Myanmar pipeline from the south. But deliveries from both routes can hardly be expanded in the short term. The Power of Siberia pipeline will complement this strategy with a third import route from the northeast by the end of 2019. China has also diversified its sources of LNG supply and signed contracts with major LNG producing countries, neighbouring LNG exporting countries, new LNG exporters. Chinese buyers have also signed contracts with portfolio players, thus

ensuring diversification and flexibility of their LNG supplies, and insulating China from turmoil in a given country.

Despite a high level of diversification of gas supply, routes and modes of delivery, security of gas supply remains a major concern for Chinese policy makers. Growing gas import dependency, domestic winter supply tightness, but also the trade war with the United States (US) have led the Chinese government to reinforce and improve its security of gas supply policy.

- Stepping up domestic gas production has become a top-level priority. In response to government's call, the three national oil companies (NOCs) have allocated the largest investment on domestic drilling since 2016. Unconventional gas, including tight and shale gas, and offshore gas are the focus of the renewed efforts. In the short term, an acceleration in the growth of natural gas production is expected. Despite having the world's first shale gas resources, technical barriers, geological complexity, marketing issues and lack of investment have prevented Chinese shale gas production to take off. If these barriers are addressed correctly, shale gas production could finally take off. This would moderate the growth of Chinese gas imports and maintain gas import dependency at a level that Chinese policy makers are comfortable with.
- Further diversifying external gas supplies and strengthening cooperation with key natural gas exporting countries are the second pivot of the security of gas supply policy. China, as a buyer or an investor, has already been instrumental in several key gas/LNG export projects worldwide. It is involved in almost all new LNG exporting countries, such as Russia, Canada, Mozambique and Papua New Guinea, as well as floating liquefied natural gas (FLNG) projects in West Africa.

The US-China trade war, which has intensified since May 2019, could have the unintended effect of helping Russia to become a large LNG exporter and a major gas (and energy) partner of China. This is supported by the opening up of the Arctic as a frontier LNG export region, and the ability to export LNG through the strategic Northern Sea Route. This comes in addition to Russian pipeline gas supplies to China, which are going to start at the end of 2019.

The Belt and Road Initiative and China's policy on strengthening cooperation (and equity participation) with key gas exporting countries will have profound repercussions on future developments on the international gas scene. As a buyer or an investor, Chinese participation in key gas export

projects will shape future global gas trade, but also energy and economic development in the related countries. As a result, China's security of supply policy has implications that stretch well beyond the energy sector.

China's gas imports can be expected to continue to grow strongly, from 120 billion cubic meters (bcm) in 2018 to up to 300 bcm by 2030. Much will depend on whether the country is successful in developing its own production potential, or whether policy makers put a limit to the external gas dependency, or if they feel more comfortable with greater pipeline imports than LNG for example. That also means that China's imports will not grow endlessly and could reduce in pace, or have political limits. Hence major uncertainties on long-term Chinese LNG demand.

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Introduction

Driven by the fight against air pollution and the acceleration of coal-to-gas switching, the share of gas in China's energy mix increased from 6.4% in 2016 to 7.8% in 2018. This relatively small change at the Chinese level has had an oversized impact on global gas markets. In just two years, China has become the world's first gas importer and is on track to become the top LNG importer. Despite being lower than its oil dependency (70% in 2018), the surge in gas imports has led to a **significant increase in China's natural gas import dependency, rising from 39% in 2017 to 44.5% in 2018**.

Despite a **high level of diversification of its gas supplies, routes and modes of delivery**, **security of gas supply remains a major concern for Chinese policy makers**. On the pipeline side, deliveries from Central Asia have not always been reliable, with lower than contractual exports from Turkmenistan in the past two winters. Exports from Myanmar have been constrained by limited gas resources. Despite importing LNG from 25 countries, the top two LNG exporters to China, Australia and Qatar, account for 61% of its total LNG imports. The growing gas import dependency has raised security of supply issues, especially in a country which has little gas storage to handle potential gas supply disruptions and efficiently address the seasonality of gas demand. The trade war between the US and China has also reinforced the necessity to improve security of gas supplies. The government aims to reinforce security of gas supply based on two key pillars:

- stepping up domestic production;
- strengthening international cooperation in view of accelerating the implementation of key gas export projects and further diversifying external gas supplies.

The dual quest for blue skies and security of gas supplies will have profound repercussions on the global gas and LNG markets. Already in the last two years, China has become a key driver of global LNG demand, spot LNG and gas prices and a determining factor for LNG investment.

This report looks at the implications of China's quest for blue skies on its security of gas supply policy and the repercussions of the radical transformation of the Chinese gas market on global LNG markets. It includes three parts:

- The first part reviews Chinese efforts to speed up domestic gas production and includes outlooks for gas production by key institutions.
- The second part assesses China's diversification of gas supply and reviews China's LNG procurement strategy and major imported pipeline projects. It provides an outlook for gas and LNG import needs.
- The third part analyses the global implications of China's rising gas imports on LNG trade, prices, investment and strategic international cooperation.

Stepping up domestic gas production

Accelerated spending to tap Chinese significant resources

Raising domestic gas production has become a top political priority to boost national energy security. In August 2018, President Xi Jinping made a series of instructions, demanding the country's NOCs vigorous efforts to improve exploration and production (E&P) efforts and help safeguard national energy security.[1] In response to this call, NOCs are spending the largest investment on domestic drilling since 2016 to speed up natural gas production. PetroChina, the largest gas producer, boosted its capital spending to $38 billion in 2018, up 19% from 2017 and plans to raise it to $45 billion in 2019.[2] About 76% of the budget will go to upstream E&P, up 16% year on year. Combined, the three NOCs are raising combined capital expenditure to $77 billion in 2019, up 18% from 2018. The three NOCs are also strengthening their cooperation in E&P activities. PetroChina has signed a joint research framework agreement with Sinopec to work on the Tarim Basin, the Junggar Basin and the Sichuan Basin. CNOOC has also signed cooperation agreement with Sinopec to explore oil and gas offshore East China.

Increased E&P spending will help China tapping its significant gas resources, most of which fall into the unconventional gas category. BP estimates proven gas reserves at 6.1 trillion cubic meters (tcm) as of end of 2018, while the German Federal Institute for Geosciences and Natural Resources (BGR) estimates conventional gas resources at 20 tcm as of end 2016.[3] Tight gas resources stand at 12 tcm. The Chinese Ministry of Natural Resources (MNR) estimates shale gas resources at 21.8 tcm, while the International Energy Agency (IEA) and the US Department of Energy estimate them at 32 tcm, making China the

1. Ch. Aizhu "China state firms to expand domestic oil, gas exploration after Xi's call", *Reuters*, 8 August 2018, available at: www.reuters.com.
2. See "FACTBOX-China's oil majors tap new discoveries as they step up drilling", *Reuters*, 1 February 2019, available at: www.reuters.com.
3. BP, *Statistical Review of World Energy*, June 2019, available at: www.bp.com; German Federal Institute for Geosciences and Natural Resources (BGR), *BGR Energy study 2017*, December 2017, available at: www.bgr.bund.de.

world's largest resource holder. China has also large recoverable coalbed methane (CBM) resources (10.9 tcm), placing China second in the world after Russia.

So far, the exploration levels are relatively low (the exploration of most conventional gas basins is less than 20%) and the exploration of unconventional oil and gas has just started.[4] **With the priority given at the highest political level to domestic production, combined with increasing E&P spending by NOCs, gas production in China is expected to accelerate in the near term. Most of the efforts are concentrated on unconventional gas (tight and shale gas) and offshore gas.**

However, the challenge of increasing production should not be underestimated. More than 90% of the newly discovered natural gas reserves are tight gas from **low permeability and ultra-low permeability reservoirs**. In recent years, natural gas reserves with a **depth of more than 4,500 meters** accounted for more than 80% of new reserves, and some in the west have reached nearly 8,000 meters. The deep and complex underground geological conditions increase production costs, which is an important constraint to the continued development of reserves and production. China has to develop advanced technology and equipment for exploring and developing deep-strata and deep-water oil and gas, giant and complex gas fields and unconventional oil and gas, and to build a new generation of petroleum engineering service technology and equipment.[5]

Rising production of tight gas and offshore gas

Tight gas production is increasing, and this growth should continue, considering the recoverable resources and the proven technologies of production. In addition, the government has started to grant **subsidies to tight gas production**, which should accelerate its development. About 90% of the tight gas reserves lie in the Ordos, Sichuan, Tarim, Junggar and Songliao basins. PetroChina-owned and operated Changqing gas field in the Ordos basin is the country's top tight gas producer, with output accounting for almost a quarter of Chinese domestic gas production. In October 2018, CNPC and Equinor agreed to jointly explore unconventional

4. S. Li, B. Zhanga and X. Tang, "Forecasting of China's natural gas production and its policy implications", Pet. Sci. (2016) 13:592–603, DOI 10.1007/s12182-016-0101-x.
5. C. Jia, "Challenges and technological development trend of Chinese Upstream Petroleum Industry", CNPC, AAPG Geoscience Technology Workshop, Beijing, China, 26-28 October, 2018

gas opportunities in China and conventional oil and gas production internationally.[6] Equinor could use its tight gas technology in China's oil and gas fields. Already, Total (at South Sulige) and Shell (Changbei field) produce tight gas in partnership with PetroChina.

Offshore production is a new development area. But the production in the China Sea has been delayed by conflicts on maritime borders. Offshore E&P has been opened to participation by foreign companies, but CNOOC maintains at least a 51% stake in all offshore developments in China. CNOOC has made a large discovery in the Bohai Sea (Bozhong 19-6 gas field) that will help the company increase its offshore gas production.[7] Recently, CNOOC signed **strategic cooperation agreements with nine international companies**— Chevron, ConocoPhillips, Equinor, Husky, KUFPEC, Roc Oil, Shell, SK Innovation, and Total— for oil and gas exploration in the Pearl River Mouth Basin offshore China.[8]

Shale gas: first encouraging results, but still very challenging

As China has significant shale gas resources, the exploitation of shale gas has become **a strategic option to secure gas supply and reduce import dependency.** It is still in an early stage but has been progressing at a fast pace over the past five years. **In 2018, shale gas output reached 10.3 bcm,** produced in the Sichuan Basin, China's premier shale gas area. Shale gas resources are also found in other basins, such as the Tarim and Ordos Basins.

Shale gas production is dominated by NOCs. Sinopec, with its **Fuling** project, has the most advanced project (more than 6 bcm produced in 2018).[9] Sinopec plans to raise output there to 10 bcm by 2020. Sinopec also plans to develop a new shale block, Yongchuan-Rongchang in Southeastern Sichuan Basin, which has the potential to produce 2 bcm per year (bcm/y) by 2020. Petrochina produced 4.3 bcm of shale gas in 2018 in the Sichuan basin, up 40% from 2017.[10] The main producing area is the **Changning-**

6. T. Paraskova, "China's CNPC Boosts Global Oil, Gas Ties", *Oil Price*, 17 October 2018, available at: https://oilprice.com.
7. J. Wei and W. Yifan "Massive reserves of oil and gas found in Bohai Sea", *China Daily*, 25 February 2019, available at: www.chinadaily.com.cn.
8. T. Paraskova, "China's CNOOC Signs Oil, Gas Exploration Deals With 9 Foreign Firms", *Oil Price*, 18 December 2018, available at: https://oilprice.com.
9. Sinopec, "Fuling shale gas field output exceeds 6 bln cubic meters in 2018", 10 January 2019, available at: www.sinopecgroup.com.
10. Ch. Aizhu, "PetroChina's 2018 shale gas output up 40 pct vs 2017", *Reuters*, 7 January 2019, available at: https://af.reuters.com.

Weiyuan shale gas block. The other main contributing block to PetroChina's production is Zhaotong in southwest Yunnan province. According to PetroChina's strategic plan, the company will build the first 10-bcm/y shale gas capacity in the southwest region by 2020. Its shale gas production is expected to reach 12 bcm in 2020 and at least 40 bcm by 2035.[11]

In a move to encourage shale gas development, China has cut the resources tax on shale gas production to 4.2% from the previous 6.0% starting from 1 April 2018. The government also grants subsidies to the production of shale and tight gas via a special fund created in 2019, which replaces the previous fixed subsidy that applied to shale gas only.

The government has also adopted a more favourable legal framework for shale gas than for conventional gas, with the opening of exploration to private companies in 2011. Since then, China has awarded around 50 shale gas mining licences, including 23 to non-NOCs. However, due to excessive commitments and lack of upstream experiences for some licensees, little exploration work was carried out. In 2014, the government enforced more stringent monitoring, so that companies that did not carry out exploration activity had to surrender their exploration blocks.[12] After several postponements since 2013, China cancelled its third national shale licensing round at the end of 2016, choosing instead to allow individual provinces to tender acreage themselves. In 2017, the first provincial tender was issued in the Guizhou province. Like Guizhou, other provinces such as Chongqing, Sichuan and Hubei are actively setting up their own dedicated plans to boost shale gas development. Since 2012, the government has also encouraged the **participation of foreign companies through joint ventures** with Chinese operators. But explorations and joint studies by global majors such as Shell, BP, Exxon and Total at Chinese shale blocks have yielded little success and foreign investors have all pulled out of Chinese shale gas exploration. This does not augur well for the shale gas development in China. However, most companies quitted shale gas exploration in China when the oil price collapsed in 2014.

Despite recent advancements, **shale gas development in China is still hampered by several geological, technological, regulatory and economic barriers**. China's shale formations tend to be deeper and more fractured than in North America and located in densely populated

11. Z. Xin, "Shale gas business firming up in China", *China Daily*, 14 February 2019, available at: www.chinadaily.com.cn.
12. "China Reforms Domestic Upstream Business", *Drillinginfo*, 30 January 2018, available at: https://info.drillinginfo.com.

mountainous terrains, leading to higher costs and complications in drilling. New entrants have had difficulties marketing any output to end-users via the existing pipeline networks, due to limited TPA. Water availability may also prove a constraining factor in Sichuan, given potential competition with agricultural needs; it will certainly be an issue if, and when, activity moves to the arid Tarim basin in the west. Despite reductions in well costs, shale gas production costs in China remain much higher than in the US. The IEA estimated production costs of shale production in China at $7-10/million British thermal units (MBtu) in 2017,[13] and subsidy levels appear inadequate to drive the necessary activity surge to reduce costs. Nevertheless, a drilling contract awarded in 2018 signals further potential reductions of 20% in well cost compared to 2017.[14]

The difficulty in producing shale gas has led the government to consistently **revise downwards its production targets**. In mid-2012, national targets were set at 6.5 bcm by 2015 and 60-100 bcm by 2020. In late 2014, slow progress in expanding shale output saw the 2020 target revised to 30 bcm, where it remains in the current Five-Year Plan (FYP) (2016-20), while shale gas production is projected to reach 80-100 bcm by 2030. According to Wood Mackenzie, **China's shale gas production will likely reach 17 bcm in 2020**, nearly double the 2017 level, but short of the government's goal of 30 bcm.[15] **Shale gas is only expected to become a leading driver for gas production growth in the long term**, and projections for shale gas production vary significantly between key institutions (see Table 1). Accelerating drilling activity, increasing well productivity and improving gas marketing conditions will be key factors for the future success of shale gas development in China.

CBM: coming slowly

Due to its large resources, CBM production could supplement natural gas supplies in China. However, **after almost 25 years of exploitation, CBM production is still at an early stage of development and its utilization rate is still low**. In 2015 (the latest official data with detailed information on CBM and coal mine methane (CMM) production and utilization), total methane production from coal was 18 bcm, but only 48% (8.6 bcm) was used in energy projects, such as distributed energy, use for

13. IEA, *World Energy Outlook 2017* (WEO2017), November 2017, available at: www.iea.org.
14. Wood Mackenzie, "Chinese shale gas production to almost double in two years", 17 April 2018, available at: www.woodmac.com.
15. Wood Mackenzie, *ibid*.

heating and as transportation fuel.[16] A lack of access to distribution networks is one of the reasons why much of the country's CMM is released into the atmosphere. CBM resources are located in three primary basins: the Junggar, Sichuan and Ordos Basins. The coal-rich Shanxi province (northern China) concentrates most of the CBM activity, with 96% of the production capacity of the country in two major CBM industrialization bases. The province produced 5.7 bcm of CBM in 2018 (5.4 bcm utilized) and plans to raise production to 6.6 bcm in 2019.[17]

The **significance of CBM/CMM development is multifaceted in China**. Accelerating the development and utilization of CBM/CMM helps safeguarding coal mine production safety and reducing methane emissions. As a result of its coal production, China is the world's leading emitter of CMM. The 13th FYP for the Development and Utilization of Coalbed Methane (Coal Mine Gas) targets a CBM/CMM production of 24 bcm by 2020, of which two thirds (16 bcm) are utilized.[18] Although the acceleration of the exploitation of CBM's reserves is underway, there are still many obstacles to its development, which makes the target challenging: technical and water resource problems, regulatory obstacles and transport constraints. The Shanxi province is trying to remove these obstacles, by resolving overlapping claims of CBM and coal exploration rights and developing local markets for these small and scattered resources. But coal seam permeability is low in most mining areas in China, making production costs high (in a range of $7.5-10.5/MBtu). In the long run, the IEA assumes that current obstacles are overcome and total CBM production reaches 19 bcm by 2030, while CNPC is more bullish with a projected production of 50 bcm.

SNG: a controversial contribution

At the beginning of the 2010s, China started to develop projects for the conversion of coal to synthetic natural gas (SNG), also called coal-to-gas (CTG). The NDRC approved 15 major CTG projects in 2013. These projects had a production capacity of 83.3 bcm/y. The contribution of SNG to gas supply was estimated at 50 bcm by 2020. However, the chaotic development of several projects at the local level and concerns about pollution risks, environmental footprint, water supplies as well as the

16. Surface production (CBM) was 4.4 bcm, of which 3.8 bcm was utilized. CMM production was 13.6 bcm, of which 4.8 bcm was utilized.
17. Ch. Aizhu, "China's Shanxi province plans higher coal seam gas output in 2019", *Reuters*, 19 February 2019, available at: https://af.reuters.com.
18. The surface CBM production is 10 bcm and its utilization rate is more than 90%, the coal mine gas drainage is 14 bcm, and its utilization rate is above 50%.

economic viability of the technology led Chinese regulators to suspend approval of new CTG plants and set stricter rules. The development of SNG production has therefore been very limited compared with plans established in the first half of the 2010s. As of June 2018, **five pilot SNG projects are operating in China**, with a total capacity of just under 6 bcm/y.[19] SNG production was 2.8 bcm in 2018.

In 2016, Chinese regulators approved **three new CTG projects** (4 bcm/y of capacity each), ending a suspension lasting more than two years. They are located in the coal-producing regions of Shanxi, Xinjiang, and Inner Mongolia. At the end of 2017, the NDRC approved the construction of a new pipeline (Northwest Inner Mongolia CTG Line) to deliver SNG produced in Inner Mongolia and Shanxi to the Hebei province, near Beijing.

The **13th FYP for Deep Processing of Coal**, published in March 2017, identifies five key demonstration projects, with an installed gasification capacity expected to reach 17 bcm/y by 2020.[20] Despite challenging economics, the projects aim to **demonstrate key gasification technologies at large-scale** and to provide clean gas to key air pollution control areas. However, there are several problems with such a strategy for cutting local air pollution.[21] CTG plants require enormous amounts of water and produce significant amounts of CO2 emissions. Producing SNG would therefore require capturing CO2 emissions from the CTG plants, making it an expensive option.[22]

Currently, there are some 80 CTG projects with a cumulative capacity of more than 300 bcm/y at different stages of development. The approval of the three projects in 2016 signals that the government supports a moderate development of SNG, under the strict control of environmental protection and water resources. **Due to its substantial environmental risk, the contribution of SNG to total gas supplies is likely to be limited in the future** (see Table 1). It is closely linked to the success of unlocking China's vast unconventional gas reserves. A shale gas boom in China alongside cheaper available imports would diminish the economic and policy rationale for coal gasification projects.

19. SIPA Centre on Global Energy Policy, "Guide to Chinese Climate Policy: SNG", Columbia University, available at: https://chineseclimatepolicy.energypolicy.columbia.edu.
20. National Energy Administration (NEA), "Notice of the "13th Five-Year Plan" for the Demonstration of Deep Processing of Coal", (in Chinese), 8 February 2017, available at: http://zfxxgk.nea.gov.cn.
21. SIPA Centre on global energy policy, "Guide to Chinese Climate Policy: SNG", *op. cit.*
22. See S. Cornot-Gandolphe, "Carbon Capture, Storage and Utilization to the Rescue of Coal? Global Perspectives and Focus on China and the United States", *Etudes de l'Ifri*, Ifri, June 2019, available at: www.ifri.org.

Green gas: high potential

Despite its huge biogas market, China's biomethane market is still marginal. However, this is changing rapidly. **The Chinese government is vigorously promoting the development of biomass energy**, including large-scale biogas and biomethane plants (designated in China as bio-natural gas, BNG). BNG has many environmental, economic and social attributes that makes it of strategic importance in China. It can improve China's energy structure, transform increasing waste into a valuable resource, facilitate rural energy revolution and increase income of rural farmers, eliminate urban smog and reduce CO2 emissions, alleviate gas shortage and enhance energy security. The biomass potential in China is huge and largely unexploited. According to a joint Sino-German report, the biogas potential amounts to 100 bcm/y (natural gas equivalent), of which two thirds from agriculture waste.[23]

The first biogas upgrading pants were built in China at the beginning of the 2010s. In 2015, the government launched an investment fund to support large-scale biogas projects and biogas upgrading. Currently, China is developing 200 large-scale biogas/biogas upgrading demonstration projects in 160 counties that could produce 10 bcm of biogas and biomethane by 2020. A new policy, launched in 2018 and further elaborated at the beginning of 2019, aims to **industrialize the biogas/biomethane market** through the support of national policies and financial subsidies. The aim is to increase domestic green gas supply and replace low-quality coal to control pollution and reduce CO2 emissions. The Chinese government plans to raise BNG production to 30 bcm/y by 2030, making China the biggest national producer in the world.[24]

Still high uncertainties on future production

The priority given at the top political level to accelerate E&P efforts gives a new momentum for China's gas production. In 2016, the 13th FYP targeted an increase in gas production to 207 bcm by 2020, of which 30 bcm of shale gas (unlikely to be reached) and 10 bcm of

23. Q. Mingyu, "Opportunity and challenge of Biogas market in China", China University of Petroleum (Beijing), Deutsches Biomasseforschungszentrum gGmbH (DBFZ), Universität Rostock, 2017, available at: www.oav.de.
24. CEDIGAZ, "Global biomethane market: green gas goes global", March 2019, available at: www.cedigaz.org.

CBM. **The State Council in 2018 reaffirmed the ambitious target of "above 200 bcm" by the end of 2020.**[25]

In the medium to long term, the growth depends heavily on the prospects for unconventional gas, notably shale gas, which, as seen above, are still uncertain. Table 1 shows projections for gas production by CNPC, the IEA (World Energy Outlook 2017, WEO 2017) and the US Energy Information Administration (EIA) (International Energy Outlook 2017, IEO 2017). It clearly shows that gas **production is expected to rise significantly** in the medium and long-term. But it also illustrates **a wide range of future production levels**, especially for shale gas. The EIA is bullish about shale gas prospects in China. In the reference case of the EIA's IEO 2017, shale resource developments are projected to account for nearly 50% (about 200 bcm) of China's natural gas production by 2040, making the country the world's largest shale gas producer after the US. The IEA is less bullish: it is only by the middle of the next decade that shale gas production accelerates, reaching nearly 100 bcm by 2040. Due to security of supply issues, the success of the development of shale and tight gas will be key to the rising contribution of gas in the energy mix.

Table 1: Outlook for China's gas production by key institutions

All data in bcm	2020		2025		2030			2040	
	13th FYP	CNPC	IEA WEO 2017 (c)	EIA IEO 2017	CNPC	IEA WEO 2017 (c)	EIA IEO 2017	IEA WEO 2017 (c)	EIA IEO 2017
Conventional gas	130	170	125	99	240	127	105	110	127
Tight gas	37		27	85		35	142	51	275
Shale gas	30	30	30		80	48		97	
CBM/CMM	10 (b)	16	16		50	19		32	
CTG	nd	4	24	nd	20	32	nd	46	nd
TOTAL (a)	**207**	**220**	**222**	**184**	**390**	**261**	**247**	**335**	**402**

Notes:

(a) Excludes biogas/biomethane production.
(b) The 13th FYP on gas refers to CBM production only.
(c) WEO 2018 projects slightly higher gas production in 2030 (263 bcm) and 2040 (343 bcm) but does not give a detailed breakdown by type of gas.

Source: NEA, CNPC, IEA, EIA.[26]

25. State Council, 30 August 2018, *op. cit.*
26. National Energy Administration (NEA), The 13th five-year plan (2016-2020) of natural gas development, Beijing, 2016; presentation by Duan Zaofang, "China natural gas status and outlook", CNPC, 8 November 2017, available at: https://eneken.ieej.or.jp; IEA, *World Energy Outlook 2017*, *op. cit.*, New Policy Scenario (NPS); US EIA, *International Energy Outlook* (IEO) 2017, Reference case, September 2017, available at: www.eia.gov.

Strengthening international cooperation and further diversifying external gas supplies

New security of gas supply policy: the external dimension

Even with ambitious goals on domestic production, the gap between China's rising demand and production will widen. To tackle security of supply issues, China has diversified its gas supplies, routes and modes of deliveries:

- China signed its first pipeline contract with Turkmenistan in 2007 and has now developed two strategic routes for importing natural gas by pipeline: the Central Asian pipeline from the west and the Myanmar pipeline from the south. The Power of Siberia pipeline will complement this strategy with a third import route from the northeast by the end of 2019.
- Since 2006, China has also diversified its sources of LNG supply and signed contracts with major LNG producing countries, neighbouring LNG exporting countries, new LNG exporters. Chinese buyers have also signed contracts with portfolio players, thus ensuring diversification and flexibility of their LNG supplies, and insulating China from turmoil in a given country.

However, despite **this high level of diversification**, **security of gas supply remains a major concern for Chinese policy makers**. In September 2018, the State Council issued the "**Several Opinions on Promoting Coordinated and Stable Development of Natural Gas**".[27] This key document, aiming at accelerating the development and use of natural gas in a coordinated and stable manner, **focuses on**

27. 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.

security of gas supply and recommends actions on the internal and external dimensions of security of gas supply.[28]

Regarding the external dimension, China is seeking to **strengthen the diversity of exporting countries (regions), modes and routes of transport (notably from its exposure to the straits of Malacca and Hormuz), import channels, contract models and participants.** In this context, pipeline imports from neighbouring countries (Central Asia, Myanmar and Russia) are key, but also Arctic development to open the strategic Northern Sea Route, through Russian waters in the Arctic Ocean.

Beijing is seeking to **strengthen international gas (and oil) cooperation** with key natural gas exporting countries in view of rising overseas gas (and oil) equity production and accelerating the implementation of key gas export projects.

China's LNG procurement strategy

In 2018, China's LNG imports again reached record volumes (53.8 million tons (Mt), +41.2% year-on-year), with Australia and Qatar accounting for 61% of total imports. LNG is the preferred supply option to cope with rising demand given the economic and technical constraints of pipeline imports and domestic gas production, as well as the extensive use of LNG as one of city gas supply sources. The rise in LNG imports has continued in the first half of 2019, although at a slower pace: LNG imports reached 28.4 Mt, up 19.3% year-on-year.

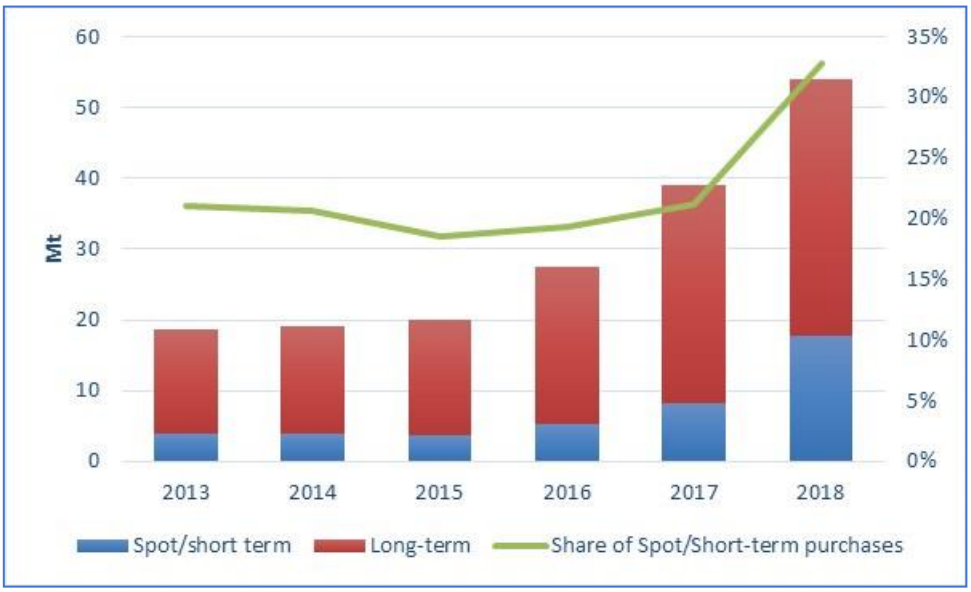
Most of Chinese supply is delivered through long-term contracts, supplemented by spot purchases. Since 2006, **China has** signed contracts with major LNG producing countries (Australia, Qatar), neighbouring LNG exporting countries (Indonesia, Malaysia), new LNG exporters (Russia, US, Papua New Guinea, Canada, Mozambique), and portfolio players (Shell, Total, BP, Chevron, Petronas, Woodside), thus **ensuring diversification and flexibility of its LNG supplies** (see Annex 1).

In 2018, LNG imports exceeded contractual volumes and led **Chinese companies to heavily resort to the spot market.** Their spot and short-term purchases (as defined by the International Group of Liquefied Natural Gas Importers (GIIGNL), so less than 4 years) more than doubled

28. The internal dimension of security of supply is covered in a previous report. See S. Cornot-Gandolphe, "China's Quest for Blue Skies: The astonishing transformation of the domestic market", *Etudes de l'Ifri,* Ifri, September 2019.

to 17.7 Mt, accounting for 33% of their LNG supplies.[29] Already in 2017, their spot and short-term purchases increased strongly (+56%), as NOCs replaced contracted volumes with cheaper and more flexible spot deliveries, especially in summer 2017, when spot LNG prices were below oil-indexed prices of long-term contracts.

Graph 1: China spot and short-term LNG purchases



Source: GIIGNL.

The strong growth in LNG demand in 2018 led NOCs to come back to the market for long-term LNG contracts, after three years of absence from 2015 to 2017. During that period, all contracts signed by China involved non-NOCs. In 2018, Chinese buyers have committed to new long-term LNG purchases or new LNG equity lifting totalling more than 12 million tonnes per annum (Mtpa).[30] There was a split between contracts from new projects (Corpus Christi Train 3, Woodfibre LNG, LNG Canada, Mozambique LNG and Mozambique's Rovuma LNG project) and projects and suppliers that exist or are under construction (Qatargas, Freeport, Papua New Guinea LNG), as well as contracts with portfolio players (see Annex 1).[31] The contract fever has continued so far in 2019, with a huge commitment by PetroChina and CNOOC to Novatek's Arctic 2 LNG project (see Part 3) and several contracts signed by NOCs and by private importers with global LNG suppliers.

29. GIIGNL, *Annual Report 2019 Edition*, available at: www.giignl.org.
30. Updated from: N. Tsafos "How is China securing its LNG needs?", Center for Strategic and International Studies (CSIS), 9 January 2019, available at: www.csis.org.
31. *Ibid*.

In February 2018, before the US-China trade war, **China signed its first-ever contracts with the US**. PetroChina signed two contracts with Cheniere to purchase a total of 1.2 Mtpa of LNG. The agreement was instrumental in helping Cheniere reach a final investment decision (FID) on the Corpus Christi Train 3. Several non-binding agreements were also signed mainly with Chinese independent buyers and Cheniere had signed a preliminary 20-year deal to supply 2 Mtpa of LNG to Sinopec from Sabine Pass Train 6 starting in 2023. The finalization of this deal has now been delayed following the US-China trade war.[32] Similarly, the agreement between ENN and Toshiba to purchase Toshiba's US LNG business, which included offtake obligations at the Freeport LNG export terminal (2.2 Mtpa) was terminated in April 2019 (the rights will finally be transferred to Total).

With the buoyant contractual activity in 2018 and during the first months of 2019, contractual commitments by Chinese buyers have increased significantly to almost **55 Mt by around 2020**, when only binding agreements (sale and purchase agreements, SPAs) are considered. In addition, there are several non-binding agreements (for about 15 Mtpa), which suggest that the contractual activity will continue in the next few months. Chinese buyers have also **offtake commitments** from Canada LNG (PetroChina will receive 2.1 Mtpa LNG sales share) and from the Rovuma LNG project in Mozambique (although the specific terms were not disclosed, based on CNPC share in Mozambique Rovuma Venture, CNPC would offtake 3 Mtpa). CNPC and CNOOC stakes in Arctic LNG 2 (20% combined) also translate into 4 Mtpa of LNG.

Australia and Qatar dominate current contractual commitment—but so do portfolio players. The new contracts (all kinds of contracts including Head of Agreements (HOA) and memorandum of understanding (MOU)) show a **diversification towards new LNG producing countries/projects**, with Mozambique, Russia and Canada leading the trend, but also a **growing share of agreements with portfolio players**, thus de-risking country supply risk.

A surge in LNG import capacity in the medium and long-term

China has stepped up construction of its LNG infrastructure facilities over recent years. China had 21 LNG terminals at the end of 2018 totalling 69 Mtpa receiving capacity, including 19 receiving terminals and two transhipment terminals.

32. Platts, "Cheniere, Sinopec In Talks For Long Term Lng Supply Contract: Source", 7 March 2019, available at: www.spglobal.com.

Table 2: Operating LNG terminals at the end of 2018

Terminal	Location	Region	Operator	Start-up date	Mtpa	Storage ('000 cm)
Dapeng LNG (incl. Expansion)	Guangdong	South	GDLNG (CNOOC, 33%, BP, 30%, other companies)	2006	6.8	640
Fujian LNG (or Putian LNG) (incl. Expansion)	Putian city, Fujian	South	CNOOC	2008/2018	6.3	640
Shanghai, Mengtougou (or Wuhaogou LNG) (transhipment only)	Shanghai	East	Shenergy (Shanghai Gas Group)	2008	(0.5)	320
Shanghai LNG (or Yangshan LNG)	Shanghai	East	CNOOC	2009	3	495
Rudong Jiangsu LNG (incl. Expansion)	Jiangsu	East	Petrochina	2011/2016	6.2	680
Dalian LNG (incl. Expansion)	Liaoning	North	Petrochina	2011/2016	6	640
Ningbo LNG	Zhejiang	East	CNOOC	2012	3	480
Dongguan LNG	Dongguan, Guangdong	South	Jovo Group	2013	1.5	160
Zhuhai Gaolan LNG	Zhuhai city, Guangdong	South	CNOOC	2013	3.5	480
Tangshan Caofeidian LNG	Tangshan city, Hebei	North	Petrochina	2013	6.5	640
Tianjin FSRU (Hoegh Esperanza)	Tianjin	North	CNOOC	2013/2018	3	230
Shandong LNG (or Qingdao LNG)	Qingdao, Shandong	North	Sinopec	2014	3	640
Heinan Yangpu LNG	Hainan	South	CNOOC	2014	3	480
Haikou LNG (transhipment only)	Hainan	South	Shennan Energy (CNPC)	2015	(1)	20
Guangxi Beihai LNG	Beihai city, Guangxi	South	Sinopec	2016	3	480
Yuedong LNG	Jieyang, Guangdong	South	CNOOC	2017	2	480
Qidong LNG (incl. Expansion)	Qidong, Jiangsu	East	Guanghui Energy	2017/2018	1.15	160
Tianjin LNG	North Binhai, Tianjin	North	Sinopec	2018	3	640
Diefu LNG	Shenzhen	South	CNOOC	2018	4	640
Zhoushan ENN LNG	Zhejiang	East	ENN	2018	3	320
Shenzhen Gas	Guangdong	South	Shenzhen Gas	2018	0.8	80
TOTAL					**68.75**	**9345**

Source: CEDIGAZ LNG Service, GIIGNL.

With three large-scale and one small-scale terminals commissioned in 2018 and two terminals expanded, LNG receiving capacity increased by 23% (13.2 Mt) in 2018. Sinopec's Tianjin LNG, ENN's Zhoushan LNG, CNOOC's Diefu LNG and Shenzhen Gas LNG import terminal in Guangdong province were commissioned in 2018. In addition, floating storage and regasification unit (FSRU) Höegh Esperanza replaced FSRU Cape Ann at CNOOC's Tianjin FSRU terminal and commenced operations in November 2018.

Overall terminal utilization rate increased to 80% in 2018 (70% in 2017). As a high share of LNG is received during the heating season, the capacity is still insufficient to meet peak demand. **Utilization rates are stretching infrastructure limits**, with some terminals running at or well above nameplate capacity.[33] For instance, CNOOC's Ningbo LNG terminal in Zheijang received 80 vessels in 2018 (5.47 Mt), well above its nominal capacity of 3 Mtpa. This is possible as not all imported LNG is regasified. In 2018, **13.2 Mt (+57%) of the country's LNG imports remained in liquid form** and were despatched from the terminals to the final customers directly by road thanks to the huge fleet of LNG trailers. Thus, LNG shipment by road represented 24% of total LNG deliveries. This gives some flexibility to the Chinese system.

Most of the receiving capacity is in the south (45% of the total), while most of import needs are concentrated in the north and the east. In winter 2017-18, receiving terminals suffered from a lack of pipeline capacity to transport regasified gas to the consumption centres to northern China. But the situation is improving as the NDRC has launched a series of projects to enhance south-north gas supply connectivity to Hebei and Shandong.

NOCs concentrate most of the import capacity. CNOOC had nine LNG import terminals in operation at the end of 2018 (34.6 Mtpa) and hold about half of the country's LNG import capacity. Sinopec and PetroChina each had three receiving terminals in operation (9 Mtpa and 18.7 Mtpa respectively). However, growing demand for natural gas have prompted smaller companies to invest in regasification terminals, encouraged by government policy (see Annex 2).

NOCs have ambitious plans to further increase their LNG receiving capacity. CNOOC is building new reception facilities in the northern province of Hebei, eastern provinces of Jiangsu, Fujian and Shandong, and expanding one existing facility at the northern port of Tianjin.[34] Additional CNOOC projects will boost its receiving capacity to 40 Mtpa by early 2022. Sinopec has plans for three new terminals at Wenzhou, Nantong and Longkou. By 2023, Sinopec plans to have an LNG receiving capacity of 41 Mtpa.[35] PetroChina plans to build more terminals in Shandong, Liaoning, Guangdong and Fujian provinces. In addition,

33. Platts, "Chinese LNG goes counter-seasonal: summer shortage, winter overdose", 6 March 2019, available at: https://blogs.platts.com.
34. M. Meng and A. Galbraith, "China's CNOOC plans new LNG terminals, 5.4 mln cubic metre storage tanks", *Reuters*, 2 April 2019, available at: https://af.reuters.com.
35. Sh. Sharma, "Sinopec to increase spot LNG purchases", *Natural Gas World*, 4 September 2018, available at: www.naturalgasworld.com.

PetroChina's operating import terminals in Rudong, Dalian and Tianjin are undergoing expansion to a combined capacity of 19 Mtpa.

In total, almost 40 Mtpa of new capacity will be added by 2022 (see Table 3), bringing total **LNG import capacity to 108 Mtpa by 2022, above the NDRC's target for 2025**. The increase in LNG receiving capacity will be limited in 2019, with **only 2.25 Mt of new receiving capacity** scheduled to enter operation during the year. Additional storage capacity at CNOOC's Tianjin terminal in northern China is also to be commissioned during the year. The company is engaged in an expansion of the terminal, where the capacity is being increased to 7.5 Mtpa by 2022, with the construction of six 220,000 m³ storage tanks.

Table 3: Main LNG terminals under construction at the beginning of 2019

Terminals	Location	Region	Operator	Start-up date	Mtpa	Storage ('000 cm)
New terminals						
Fangchenggang (no regasification facility)	Guangxi	South	CNOOC	2019	(0.6)	60
Yangcheng Binhai	Jiangsu	East	CNOOC	2021	3	880
Longkou LNG (CNOOC)	Shandong	North	CNOOC	2022	5	1320
Yantai	Shandong	North	CNOOC	2022		600
Tangshan	Hebei	North	CNOOC	2022		800
Longkou LNG (Sinopec)	Shandong	North	Sinopec	2022	6	810
Nantong	Jiangsu	East	Sinopec			
Wenzhou LNG	Zhejiang	East	Sinopec and Zhejiang Energy	2021	3	800
Zhangzhou LNG	Fujian	South	CNOOC	2021	3	480
Chaozhou Huaying LNG	Guangdong	South	Sinoenergy/Chaozhou Huafeng	2019	1	
SinoEnergy Jiangyin	Jiangsu	East	Sinoenergy	2020	1	160
Yangjiang LNG	Guangdong	South	Guangdong Energy and Pacific Oil & Gas		2	
Expansions						
Tianjin LNG (onshore expansion)	Tianjin	North	CNOOC	2019-2022	(2.2-7.5)	1320
Ningbo LNG	Zhejiang	East	CNOOC	2020	3	480
Tianjin North Bihai	Tianjin	North	Sinopec	2021		1100
Qingdao LNG (Shandong LNG)	Shandong	North	Sinopec	2021	4	320
Qidong LNG	Jiangsu	East	Guanghui Energy	2019	1.25	160
Rudong Jiangsu LNG	Jiangsu	East	Petrochina	2021		400
Zhoushan ENN LNG	Zhejiang	East	ENN	2022	7	
Shanghai LNG	Shanghai	East	CNOOC	2020		400
					39.25	**9,690**

Source: CEDIGAZ LNG Service, GIIGNL, Company's documents.

In the long term, according to a draft plan of the Ministry of Transport (National coastal and inland river LNG terminal layout plan (2035)), China may boost its LNG import capacity by nearly four-fold by 2035.[36] The Ministry of Transport envisages **34 coastal terminals with a total**

36. "China said to eye near four-fold LNG import capacity jump by 2035", *Gulf Times*, 15 January 2019, available at: www.gulf-times.com.

annual import capacity of 247 Mtpa by 2035. Additionally, there are six terminals planned inland along the Yangtze River. This highlights the key role LNG could play in the future, notably in coastal and river transportation.

Pipeline imports: diversifying routes

The strategic importance of Central Asia

Pipeline gas imports from Central Asia are made from the 1,833 km **Central Asia Gas Pipeline** (CAGP), built and operated by CNPC, along with domestic gas companies in Turkmenistan, Uzbekistan and Kazakhstan. The CAGP was China's first major effort to build **an alternative route to the maritime supply of LNG**, hence, increasing security of supply. It was also the project that **officially launched the Belt and Road Initiative (BRI).** China started importing Turkmen gas at the end of 2009. Exports from Uzbekistan started in 2012 and direct exports from Kazakhstan in 2017. **Central Asia exported 47.5 bcm to China in 2018, up 23% from 2017**, due to rising volumes from Kazakhstan and Uzbekistan.

The CAGP currently consists of three lines (A, B and C), which came into service in 2009, 2010 and 2014 respectively, and with a **combined annual capacity of 55 bcm/y**, since the addition of compressor stations on Line C in Kazakhstan in 2018. Deliveries from Lines A and B (30 bcm/y combined) are supplied by Turkmenistan.[37] Line C (25 bcm/y since 2018) was initially expected to be supplied by Turkmenistan (10 bcm/y), Uzbekistan (10 bcm/y), and Kazakhstan (5 bcm/y); yet more deliveries are coming from Kazakhstan since the beginning of 2019. In 2018, CNPC strengthened coordination with Turkmenistan, Uzbekistan and Kazakhstan to bring gas supplies to full capacity and invested in new production capacity in Turkmenistan and Uzbekistan to sustain exports.

Turkmen exports are to reach 65 bcm/y by 2020 according to agreements between CNPC and TurkmenGaz. But Line D has not been completed and export flows **are volatile especially during the past two winter periods**. One invoked reason was the technical failure of various equipment, while disagreement on gas prices also seemed to be a factor. A large part of the revenue from the sales to China is used to pay off

37. According to the contract signed by CNPC in 2007, 17 bcm/y would be supplied by TurkmenGaz, according to the Sale and Purchase Agreement, and the other 13 bcm/y from CNPC's share of gas production according to the Turkmenistan Amu Darya Right Bank Gas Production Sharing Contract.

the debt for the construction of the pipeline, which was financed by China. Uzbekneftegaz will supply up to 10 bcm/y of gas to CNPC via Line C of the gas pipeline and in 2018, the country exported 6.6 bcm to China. In October 2017, Kazakh gas started flowing through the CAGP, under the term of a short-term contract for 5 bcm in 2017-18 (5.9 bcm delivered in 2018). In October 2018, China and Kazakhstan signed a five-year contract to double gas volumes to 10 bcm/y starting in 2019.[38] Gas flows via the new 1,454 km long, 15 bcm/y **Beyneu-Bozoy-Shymkent pipeline**, running west to southeast Kazakhstan, then linking into the Kazakhstan-China pipeline, part of the CAGP.

The construction of a **fourth line (Line D) with a capacity of 30 bcm/y** and a length of 1,000 km has been planned since 2013 but has been subject to repeated delays and remains uncertain.

With the increase in Central Asian gas exports in 2018, **deliveries through the three existing lines are close to the maximum pipeline** capacity of 55 bcm/y.

China-Myanmar gas pipeline

China started receiving gas from Myanmar in 2013 through the Myanmar to China gas pipeline. The 2,520 km, 12 bcm/y gas pipeline is part of an integrated strategic infrastructure project that enables China to route oil and gas supplies to its southwestern provinces. The oil pipeline allows crude oil from the Middle East to bypass the Malacca Straits and go ashore on Made Island. The 30-year contract between Myanmar and China provides for deliveries of 10 bcm/y. But due to insufficient gas production from the offshore Shwe gas field, deliveries are limited to less than 4 bcm/y (3.1 bcm exported in 2018). The potential for increased natural gas deliveries appears to be limited in the short term. CNPC is investigating new gas sources which could come from new discoveries offshore Myanmar or through LNG imports. But these projects are still in the planning stage and the feeding of the export line is still limited.

Russian pipeline deliveries starting end 2019

The most important change in China's gas supplies over the next few years will be the start of deliveries from eastern Russia via Gazprom's **Power of Siberia pipeline, which has strategic significance both for Russia and China.**

38. N. Bisenov, "Kazakhstan to double gas exports to China in 2019", *Nikkei Asian Review,* 28 October 2018, available at: https://asia.nikkei.com.

Under a deal signed in May 2014, China will import 38 bcm/y of natural gas for 30 years via the eastern route. Yet the 38-bcm annual volume should be attained around 2025 only following a ramp-up period of six years (5 bcm are scheduled to be exported in 2020).

Gazprom announced that the laying of the first 2200 km section of the Russian part of the pipeline was completed in March 2019. First deliveries are now expected to begin on 1 December 2019. The 3,371-kilometer Chinese section starts in Heihe in northeast China's Heilongjiang province and ends in Shanghai, passing through nine provinces. The first phase of the pipeline linking Heihe and Changling in Jilin province will be completed by October 2019, with the rest of the domestic pipelines linking Changling to Shanghai by the end of 2020.

Map 1: Power of Siberia

Source: Gazprom.

Power of Siberia is only the first step for Gazprom towards building a strategic gas relationship with China. Gazprom is notably keen to develop the western route to China as well. In 2015, Gazprom and CNPC signed an agreement on the basic conditions of pipeline gas deliveries from Western Siberia to China via the western route (a pipeline known as the Altaï pipeline and renamed by Gazprom **Power of Siberia 2**). Supplies from the Yamal Peninsula were envisaged at 30 bcm/y. But talks over new Russian routes to China were stalled in 2017.[39] In the US-China trade war context, Russia and China have re-opened talks on additional gas deliveries

39. O. Astakhova and O. Kobzeva, "Russia-China talks over new gas routes stalled: sources", *Reuters*, 7 June 2017, available at: www.reuters.com.

by pipelines, with several opened alternatives: the western route (Power of Siberia 2), the Far Eastern pipeline (a new branch from the East Siberian Sakhalin gas fields to China with a capacity of 8 bcm/y) and increased deliveries through Power of Siberia. With these projects, Gazprom expects to capture 25% of Chinese gas imports by 2035 and to become the largest supplier on the Chinese market.[40]

For the time being, **Chinese buyers seem more interested in further increasing deliveries through the Power of Siberia pipeline**. An increase of up 10 bcm/y is reportedly under discussion.[41]

Future trends in pipeline gas and LNG imports

With its strong build-up of new pipelines and LNG terminals, China is increasing its gas import capacity and diversifying transportation routes and modes significantly. By the middle of the 2020s, import capacity could exceed 300 bcm/y, equally split between pipeline gas and LNG. This would largely be sufficient to cover future gas needs even in a high demand scenario. However, several pipeline projects are at the planning stage, and their realization is still uncertain.

Table 4: Import capacity and contracted volumes

	Annual contractual volumes (bcm/y)	Import capacity (bcm/y)	Comments
Pipelines			
Turkmenistan Uzbekistan Kazakhstan	65 10 10	55-85	The high range implies the building of Line D, for which no firm date has been confirmed yet. In the best case, the full capacity could be reached by end 2022.
Myanmar	10	10	Unsufficient supplies limit gas exports to below 5 bcm/y
Russia Power of Siberia 1 Power of Siberia 2 Sakhalin pipeline	38	48 (30) (8)	Deliveries starting on 1 December 2019. Increase of gas deliveries by up to 10 bcm/y currently under discussion Planned. No binding agreement yet Planned. No binding agreement yet
LNG	76	150	Contracted quantities at the beginning of the 2020s (only SPAs signed as of April 2019). Import LNG capacity expected to be reached by end 2022
TOTAL	**209**	**263-331**	

Source: Author.

In the short term, despite the ambitious plans to increase domestic production, the gap between domestic production and demand will continue to widen, resulting in a continuous surge in gas imports.

40. Gazprom, "2019 Gazprom Investor Day", February 2019, available at: www.gazprom.com.
41. RIA News, "Miller spoke about China's interest in gas supplies from Russia" (in Russian), 28 April 2019, available at: https://ria.ru.

Table 5: Scenarios for import needs to 2040

	2017	2018	2019	2020	2025	2030	2040
Gas demand (bcm) (a)	237	280	310-320	345-355	473	574	636
Gas production (bcm) (b)	148	160	174-176	190-195	222	263	343
Required imports (bcm)	**92**	**120**	**134-146**	**150-165**	**251**	**311**	**293**
Pipeline imports (bcm) (c)	42	50.5	52-55	58-61	98-113	98-155	98-181
Required LNG imports (bcm)	50	74.2	79-94	89-107	138-153	178-213	112-195
Required LNG imports (Mt) (d)	38	54	57-68	64-78	100-111	129-154	81-141

(a) 2019-2020: own estimates, 2025-2040: China State Council (high scenario)[42]
(b) 2019-2020: own estimates, 2025-2040: IEA (WEO 2018)[43]
(c) Range of possible imports based on existing and planned pipeline capacity
(d) The conversion between bcm and Mt is based on 1 bcm=1.38 Mt

Source: Author.

Until 2020 when Power of Siberia enters its first full year of operation (5 bcm expected to be delivered then) , the growth of gas imports by pipeline will be limited (an additional 5 bcm/y is expected from Kazakhstan in 2019, but transportation capacity could be a bottleneck), requiring growing LNG imports to rebalance the market. **LNG imports are expected to rise to some 64-78 Mt by 2020 (+10 Mt to 24 Mt compared to 2018).** The expansion is still pronounced but lower than the exponential growths registered in 2017 and 2018. The large range of LNG requirements translates the difficulty to evaluate **Chinese import needs even in the short term**, as the rates of increase in both gas demand and domestic production are difficult to assess, and in the case of gas demand, are highly dependent on weather conditions and economic activity.

The gap between China's natural gas consumption and domestic production is expected to substantially widen after 2020, as demand growth far outpaces domestic production growth. In the medium term, **Russian deliveries will reduce the growth in LNG requirements**. All things being equal and with continued uncertainty over Line D, there are 38 bcm/y less LNG to be delivered in the Chinese market. **China is expected to overtake Japan** (which imported 82.5 Mt of LNG in 2018) **as the world's largest LNG importing country at the beginning of the 2020s.**

42. 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.
43. IEA, *World Energy Outlook 2018* (WEO 2018), November 2018, available at: www.iea.org, New Policy Scenario (NPS)

In the long term, total gas imports could reach around 300 bcm/y. After 2025, there is a **huge uncertainty about the future contribution of gas imports by pipeline** (as shown in the range of imports by 2030 and by 2040), as Russian supplies could potentially add 48 bcm/y and Central Asia 30 bcm/y. **Another layer of uncertainty comes from the development of domestic gas production.** The long-term production data shown in Table 5 are those of the IEA's WEO 2018. By 2030, the supply-demand gap reaches some 310 bcm and gas import dependence reaches 54%. But according to CNPC high scenario for total gas production (390 bcm in 2030),[44] the supply-demand gap would be only some 180 bcm, drastically reducing import needs. The uncertainty about future gas production has been a recurrent issue in projecting China's gas pipeline and LNG import requirements, but one thing is clear: import dependency will have to stay at an acceptable level for Chinese policy makers.

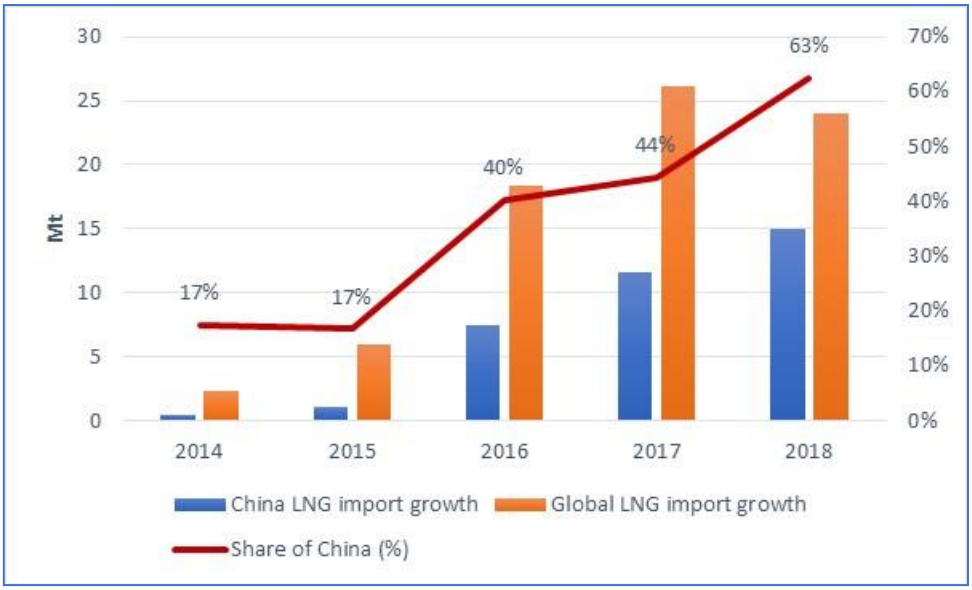
44. CNPC, presentation by Duan Zaofang, "China natural gas status and outlook", 8 November 2017, available at: https://eneken.ieej.or.jp.

The global implications: China will dominantly shape gas markets

China leads the world in LNG imports

As recently as mid-2016, LNG experts were not optimistic about the development prospects of the global LNG industry, forecasting a supply glut driven by the wave of new LNG supplies from Australia, the US and Russia. In just three years, LNG supply capacity (nameplate capacity) has grown by an impressive 26% to 383 Mtpa at the end of 2018, up almost 80 Mtpa.[45] However, the rapid rise of Chinese imports has largely erased talk of a global gas glut, notably in 2017 and 2018. In both years, **the growth in China's LNG demand was above market expectations** and surprised many analysts. Contrary to general thinking, the market was able to absorb all new LNG supplies, at least until the last quarter of 2018. China, and to a lesser extent South Korea, helped rebalancing the market.

Graph 2: Annual growth of global and Chinese LNG imports



Source: Data from GIIGNL.

45. International Gas Union (IGU), *2019 World LNG Report*, May 2019, available at: www.igu.org.

Box 1: Global LNG trade in 2018

The global LNG market has been changing fast in recent years driven by the rise in demand from emerging economies, especially in Asia, new import technologies (FRSU), lower prices since 2014 and the rise of new exporters – Australia, the US and Russia.[46]

World LNG imports rose by 50 Mt in the past two years to 314 Mt in 2018.[47] Almost 76% of the demand came from the Asian market, which imported 239 Mt (an increase of 13%). China stood as **the world's fastest growing LNG market.** Alone it explained 63% of the net global LNG demand growth in 2018. Overall, the trio of Japan, China and South Korea continued dominating the LNG import scene, accounting for 57.5% of overall deliveries in 2018. Europe imported 49 Mt, an increase of 6.4%.

On the supply side, Australia (+11.1 Mt), the US (+8.4 Mt) and Russia (+7.3 Mt) contributed the bulk of growth in 2018. Qatar remained the largest LNG supplier (77 Mt), followed by Australia (67 Mt). Both the US and Russia expanded their LNG supplies tremendously: the US is now the fourth largest LNG exporter (21 Mt exported in 2018, +69%) and Russia the sixth (18.3 Mt, +72%).

On the global gas market, LNG is strengthening its position and now accounts for 32% of global gas trade.

China raised its share in global LNG imports from 8% in 2015 to 17% in 2018 at unprecedented speed and pace, shaking up the industry. China overtook South Korea in 2017 to become the second largest LNG importer and is well on track to surpass Japan as the world LNG importer in the next few years. Fears of oversupply have largely been replaced by warmings that the lack of investments in new LNG capacity would lead to a supply shortage in the mid-2020s unless more LNG production project commitments are made soon.

China has also been the main driver of spot LNG purchases. Global spot and short-term volumes[48] jumped to 99.3 Mt in 2018 (+28%) and accounted for 32% of total LNG imports. **China alone explains 43% of this growth.** China increased its spot LNG purchases to 17.7 Mt in 2018 and accounted for 18% of global spot imports and a quarter of Asian spot purchases. Due to the size of China on the spot market, China has become a key driver of Asian spot LNG prices (see next section).

[46] See S. cornot-Gandolphe, "New and Emerging LNG Markets: The Demand Shock", *Etude de l'Ifri*, Ifri, June 2018, available at: www.ifri.org.
[47] GIIGNL, *Annual Report 2019 Edition*, *op. cit.*
48. As defined by GIIGNL, i.e. cargoes delivered under contracts of a duration of 4 years or less.

Both the surge of China's total LNG imports and its spot purchases have reshaped the international LNG market and industry. China could account for 30% of global LNG trade flows by 2040 and for 36% of global LNG demand growth by 2040.[49]

China is a key driver of Asian spot LNG prices

Chinese influence on Asian LNG spot prices depends on the scale of its spot purchases, but also on buyers' strategies, as clearly illustrated over the past two years. Furthermore, as China is becoming the largest LNG market, the country is also expected to have **more pricing power in the LNG market**.

Between October 2017 and February 2018, Chinese buyers were at the forefront of the market procuring winter spot LNG cargoes amid tight global supply and colder-than-expected weather in North Asia. Chinese LNG imports rose 55% year-on-year to 21.7 Mt. **This boom and the large recourse to the spot market contributed to a doubling of the Asian benchmark for spot LNG supplies (Japan Korea Marker, or JKM)**[50] **between June and December 2017 to $11.2/MBtu**, their highest level since November 2014. They even peaked at $11.7/MBtu on 15 January 2018.

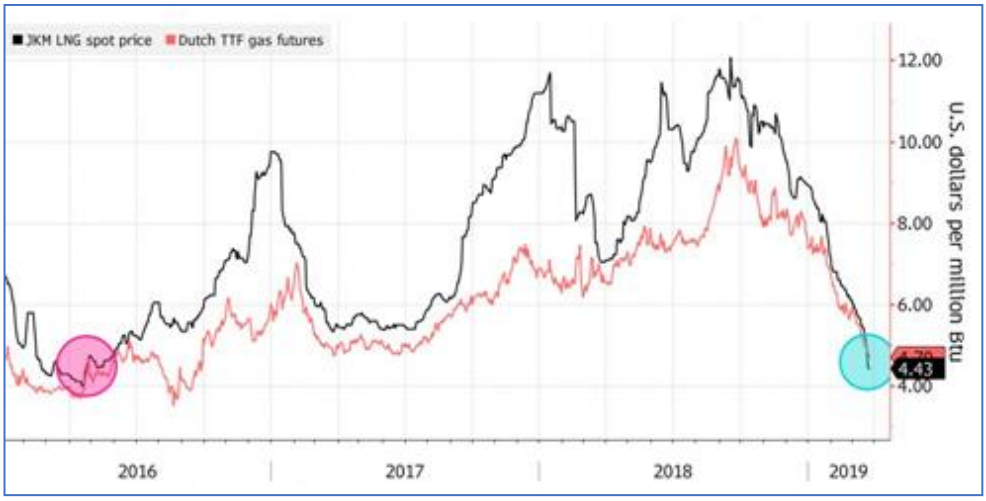
China again surprised the market in 2018 with a counter-seasonal conundrum of summer shortage and winter oversupply.[51] Thus, **Asian spot prices were more erratic in 2018, as were Chinese LNG spot purchases, driven by operations to fill storages and to a lesser extent, by consequences of a heat wave**. **Asian spot LNG prices rose to record levels in summer 2018:** they reached a peak of $11.6/MBtu, a doubling of 2017 summer levels. Such a rise in summer is unusual. The retreat in spot LNG prices was very brief in fall 2018 as Chinese and North Asian buyers anticipated winter demand. This supported prices which rose to a peak of $11.9 in mid-November 2018. However, the sustained rise in Chinese LNG imports in October and November 2018 was not sufficient to prevent spot LNG prices from falling. The surge in LNG supply and the collapse of oil prices from 81$/b in October 2018 to $57 in December turned the market and Asian spot LNG

49. IEA, WEO 2018, *op. cit.*
50. JKM is Platts benchmark price assessment for spot physical cargoes delivered ex-ship into Japan, China, South Korea and Taiwan.
51. Platts, "Chinese LNG goes counter-seasonal: summer shortage, winter overdose", 6 March 2019, available at: https://blogs.platts.com.

prices started to fall in the second half of November 2018. They retreated from highs of $11.9/MBtu in mid-November to $8.9 at the turn of 2018.

The decrease in prices in the fourth quarter of 2018 (Q4 2018) occurred despite strong rise in LNG imports by China, Japan and Korea. But **on the spot market, both Chinese NOCs and independent buyers embarked on a selling spree,** in an attempt to clear away unwanted yet expensive LNG.[52] On the supply side, most of the new LNG capacity commissioned in 2018 (37.5 Mtpa)[53] entered the market in Q4 2018, contributing to the tight supply in the summer and the relaxed one in winter.[54]

Graph 3: Spot LNG prices in Asia and Europe



Source: Intercontinental Exchange, S&P Global Platts.

When Chinese imports started to fall in February and March 2019 due to warmer temperatures and healthy LNG storage levels, **JKM collapsed from $8.9/MBtu at the start of January to $4.5 at the end of March**. JKM briefly touched a low of $4.38/MBtu on 27 March, below European spot prices (the UK National Balancing Point (NBP) traded at around $4.5), the second time only in three years (see Graph 3). Overall, Chinese strategy to manage winter supply and demand balance, as well as a milder winter than the previous one, has had a strong effect on the Asian spot LNG price. **JKM collapsed by 60% between September 2018**

52. Platts, 6 March 2019, *op. cit.*
53. IGU, *op. cit.*
54. Commercial starts were reached at both trains of Wheatstone LNG in Australia (8.9 Mtpa total), the first two trains of Yamal LNG in the Russian Arctic (11 Mtpa total), Cove Point in the US (5.25 Mtpa), and Kribi FLNG offshore Cameroon (2.4 Mtpa). In addition, commissioning cargoes were exported by Ichthys LNG T1 (4.45 Mtpa) in October 2018 and Yamal LNG T3 (5.5 Mtpa) in December, with commercial start at both trains in early 2019. Prelude FLNG offshore Australia also reported initial gas production in December, with commercial exports targeted for 2019. US Sabine Pass LNG T5 and Corpus Christi T1 also send commissioning cargoes in Q4 2018.

and March 2019. Since the end of March, it has oscillated between $4.5-5.5 (at the time of writing).

LNG capacity growth will accelerate again in 2019. The IGU indicates a total supply of 41.3 Mtpa scheduled to enter commercial operation during the year.[55] New facilities are expected to add substantial production mainly from the second half of the year. Most of the new capacity will be in the US, which is expected to become the world's third largest LNG exporter after Australia (now the first LNG exporter in terms of capacity) and Qatar. While the demand outlook over the next few years suggests that the new LNG supply will be absorbed, the problem for the industry is 2019, and possibly part of 2020. Overall, it seems unlikely that China and Asia will be able to absorb all the new LNG capacity coming to the market this year, leading to a **temporary oversupply in the global LNG market**.

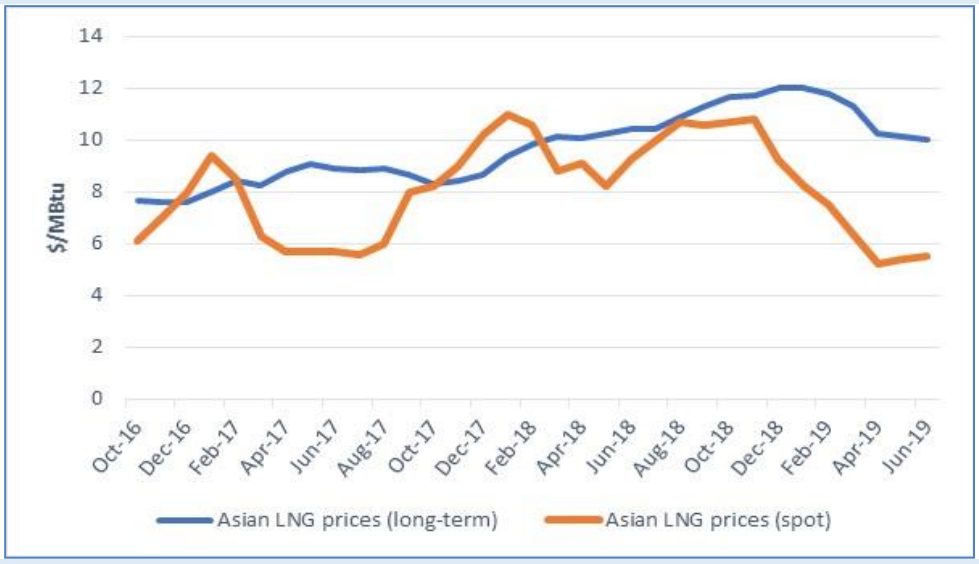
Box 2: Towards more China's power on gas pricing

At present, the pricing of LNG trade in Asia is mostly linked to oil prices. Oil-indexed long-term contracts make up around two-thirds of supply in Asia. However, as the LNG market is evolving into a true commodity market, the Asian market will gradually form a more transparent pricing mechanism.

Oil-indexed prices followed an upward trend in 2018, influenced by rising oil prices and strong LNG demand in Asia. They settled at $10.7/MBtu on average in 2018 and have oscillated between $10-12 in the first half of 2019. With the collapse of Asian spot LNG prices to around $5/MBtu since March 2019, there is a current decoupling between spot and long-term contract prices in Asia. The price gap is not expected to disappear any time soon with elevated oil prices and a flood of new LNG supplies entering the market.

55. US liquefaction will lead the way in the addition of new capacity (29.1 Mtpa in total). Corpus Christi LNG T1 and T2 (9 Mtpa total), Elba Island LNG T1-T10 (2.5 Mtpa total), Cameron LNG T1 and T2 (8 Mtpa total), Freeport LNG T1 (5.1 Mtpa), and Sabine Pass LNG T5 (4.5 Mtpa) are all targeted for 2019 commercial start-up, more than doubling existing US Atlantic Basin capacity (Sabine Pass LNG T5 and Corpus Christi T1 had already commissioning cargoes in Q4 2018). Outside the US, additional capacity to be added in 2019 includes new liquefaction trains in Russia (Vysotsk LNG T1, 0.66 Mtpa, Portovaya LNG, 1.5 Mtpa and Yamal LNG T4, 0.94 Mtpa) Australia (Ichthys LNG T2, 4.45 Mtpa and Prelude FLNG, 3.6 Mtpa), Indonesia (Senkang LNG T1, 0.5 Mtpa) and Argentina (Tango FLNG, 0.5 Mtpa).

Graph 4: Recent evolution of Asian LNG prices. Spot vs. Long-term



Source: World Bank, METI.

This decoupling may accelerate the move towards more market-based pricing. The gap between spot prices and oil-indexed contracts will pressure gas buyers to try to renegotiate contracts with producers. This is already driving Asian buyers locked into term deals to try to delay shipments or look to adjust contracts.[56]

Although Asia lacks liberalised and interconnected gas markets which could stimulate gas-to-gas competition and traded gas/LNG hub development, there is a strong willingness in Asia, and notably in China, to establish a benchmark price for natural gas and to reduce the spread between global gas prices and Asian LNG prices (the "Asian price premium"). **In this development, the Shanghai Exchange has a strategic importance for China** not only to promote gas market reforms in China, but also **to raise the influence of China in the international gas market**.[57] Similar initiatives are developed by Singapore and Japan. Like the Chinese initiative, these trading centres are still under development, lack liquidity, and in the case of China and Japan, still lack fully deregulated markets.

In the race towards an Asian gas price benchmark, Shanghai offers the advantage of being a hub for both LNG and pipeline gas, as well as having access to storage sites in China, an asset that has been key for the

56. J. Jaganathan, "Warp factor: Asia's LNG markets distorted by oil price surge", *Reuters,* 25 April 2019, available at: www.reuters.com.
57. See for instance: SHPGX, "Hou Qijun: I hope Shanghai Oil and Gas Trading Center will better serve the national energy strategy" (in Chinese), 13 April 2019, available at: www.shpgx.com.

development of hub prices in the US and Europe. China is Asia's largest demand centre, has large domestic production and various sources of imports, both pipeline and LNG. The strong willingness of the Chinese government to establish a China gas benchmark and ongoing efforts to liberalize the gas market, combined with the decoupling of spot and long-term prices, could be the catalysts for China and Asia to evolve towards more market-based pricing. As stressed at LNG 19 in Shanghai, LNG will continue to face competition from other fossil fuels and renewables if the industry cannot work together on commercial challenges.[58]

However, despite significant progress achieved by the Shanghai Exchange in 2018, it will take time before it becomes a benchmark on the international scene. But as observed on the coal market, if Chinese indices are not used as international benchmarks - one major drawback is their denomination in yuan, while international coal trading, as gas trading, is denominated in dollars – **Chinese coal indices have become key for coal exporters and international coal trading**. As coal imports in China are driven by price arbitrage between domestic and international prices and done on a spot basis, the main Chinese coal index (benchmark Bohai-Rim Steam-Coal Price Index, or BSPI) clearly puts a ceiling on international coal export prices. In addition, due to the size of China on the international steam coal trade (20% of global imports), China has become the price setter of the international coal market. This evolution took only a few years after China entered the international coal market and became the largest coal importing country. The Chinese gas market is not liberalised yet compared with the coal market. However, **pricing on the coal market provides an interesting experience on how gas pricing in China and its relationship with the global market may evolve in the future.**

Global linkage of LNG markets: High impact on European supply and prices, as well as on US prices

European LNG imports are surging

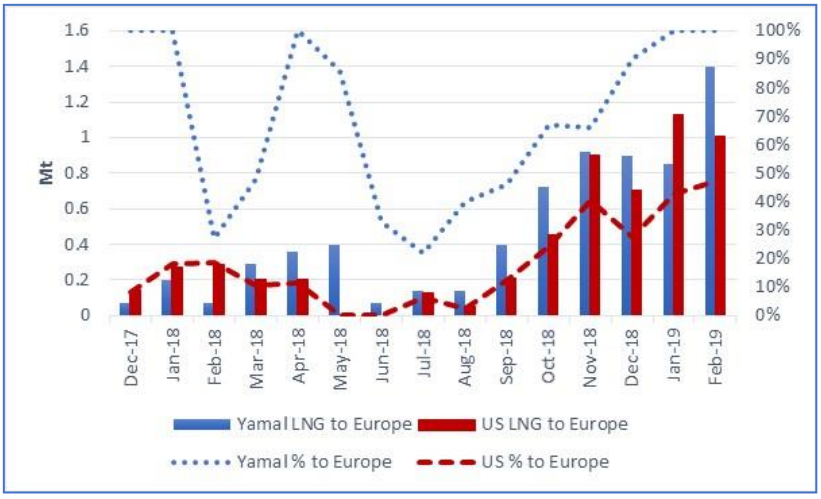
LNG has finally come back to Europe. Lower Asian prices have wiped out the economics of sending Atlantic LNG to Asia and raised the attractiveness of the European market. The US-China trade war has also played a role. European LNG imports reached 18.2 Mt in

58. C. Guthrie, "China urges LNG industry to deepen collaboration", *Petroleum Economist*, 2 April 2019, available at: www.petroleum-economist.com.

Q4 2018 (up 50% over Q4 2017) and **they even almost doubled in the first half of 2019 compared to the same period in 2018** (to 42.8 Mt, +86%). European LNG terminal send-outs are reaching record volumes, clearly illustrating the role of liquid North West European hubs as a sink for surplus LNG cargoes amid ample LNG supply and lower Asian demand. North West Europe now accounts for more than half of European LNG imports compared to 20% in winter 2017-18.

Europe is now the top buyer of US LNG after a near fivefold spike in US LNG sales to the continent in winter 2018-19, overtaking South Korea and Mexico. Profit rather than politics is driving the increase, despite pressure from President Trump for Europe to wean itself off Russian gas.[59] US LNG exporters have switched sales to Europe after prices in Asia fell sharply in November 2018. European prices held firm at the beginning of winter 2018-19: in contrast to Asian spot LNG prices, in December 2018 and January 2019, the benchmark for gas delivered to continental Europe (the Dutch Title Transfer Facility, TTF), had been at the highest level since the winter of 2013-2014 at around $7.7/MBtu. Rising coal and carbon prices as well as expectations of cold weather drove the price up. Thus, North West European markets offered higher netbacks than Asia to US LNG exporters (see Graph 3). In addition, Novatek's Yamal LNG also sent its production to Europe, even becoming the second LNG supplier to Europe in the first half of 2019, behind Qatar.[60]

Graph 5: US and Russian LNG deliveries to Europe



Source: CEDIGAZ LNG Service, EIA.

59. E. Kravtsova and S. Zawadzki, "Exclusive: Europe tops buyers for U.S. LNG with winter cargo influx", *Reuters,* 25 January 2019, available at: www.reuters.com.
60. Novatek-led Yamal LNG project delivered 19 cargoes totalling 1.41 Mt to Europe. LNG World News, "Russia becomes Europe's top LNG supplier in February", 1 March 2019, available at: www.lngworldnews.com.

The flood of LNG cargoes has depressed European spot prices and increased competition between LNG and gas imported by pipeline. European spot gas prices collapsed from around $8 in December 2018 **to 10-year lows in June 2019** (**$3.6/MBtu**). The jump in European LNG imports has reduced the market share for pipeline gas. Gazprom's gas deliveries to Europe amounted to 95.3 bcm in the first half of 2019, down by 5.9% compared to the same period in 2018.[61] Gazprom has indicated its willingness to maintain its record 2018 level of gas exports to Europe, targeting 200 bcm in 2019.[62] However, the group will have difficulties to maintain record level of exports given the surging LNG flows. Gazprom will not only have to compete with US (and Qatar) LNG, but also with Russian LNG. Similarly, Norwegian gas exports have decreased and Norway has seen its market share of the European market falling. The drop in Norwegian flows, meanwhile, was seller-driven, with Equinor conducting extensive maintenance on its production and also reducing output, probably for commercial reasons.[63]

Europe has also absorbed the surging LNG flows thanks to coal-to gas switching in the power sector and rising storage filling. As European gas hub prices has fallen, gas-fired power plants have become more competitive relative to coal plants, boosting **coal-to-gas switching in the power sector**. High CO2 prices (around €25/tCO2 since the end of 2018) also encourage the switch. **European UGS** has also helped rebalancing the global LNG market. European UGS has already absorbed a large part of the increase in LNG supplies. At the beginning of July 2019, European UGS were replenished at 73% of their working gas capacity, the highest level over the past five years.

The coming back of LNG in Europe arrives at the best timing:

- **It helps refilling UGS ahead of winter 2019-20**, while there are high uncertainties about the renewal of the gas transit contract between Russia and Ukraine. If no deal were reached before the beginning of 2020, storage withdrawals and higher LNG imports would help to smooth out the impact of a possible interruption of Russian deliveries through Ukraine.

61. *LNG World News*, "Gazprom hits first six-month gas production high since 2011", 2 July 2019, available at: www.lngworldnews.com.
62. Gazprom exports to Europe and Turkey reached a record 201.9 bcm in 2018, raising Russia's share of the European gas mix to 36.7%, up from 34.7% in 2017. N. Witkop, "Gazprom to maintain record exports to Europe this year", *Montel*, 30 April 2019, available at: www.montelnews.com.
63. *Pipeline and Gas Journal*, "LNG Steals Euro Market Share from Pipeline Gas, Breaking 4-Year Trend", 9 August 2019, available at: https://pgjonline.com.

- **It helps EU policy towards the US**. On 25 July 2018, President Juncker and President Trump agreed to strengthen EU-US strategic cooperation with respect to energy. The EU would import more US LNG to diversify and render its energy supply more secure. Since the joint statement, EU LNG imports from the US have increased 272% (up to 24 April 2019).[64] The figures speak for themselves, even if imports are driven by market economics, and not by EU policy. The EC has also recently promised to double its US LNG imports to 8 bcm by 2023, if priced competitively.[65] Poland and Lithuania are ready to increase their US LNG imports for diversification and security of supply reasons. The Polish oil and gas company PGNiG (which has indicated that it would not renew its long-term contract with Gazprom when it expires in 2022) recently concluded three long-term import contracts with US LNG developers. Portfolio players, European traders and utilities have also long-term contracts with US LNG developers, with some starting this year. Depending on Asian demand and netbacks to Europe and Asia, these new supplies, which have free destination, will flow to Europe. However, the surging import of US LNG does not seem sufficient by itself to move the US-EU trade talks on a positive conclusion.[66]
- **It helps the decarbonization of the EU electricity mix,** pushing coal out of the power electricity mix.

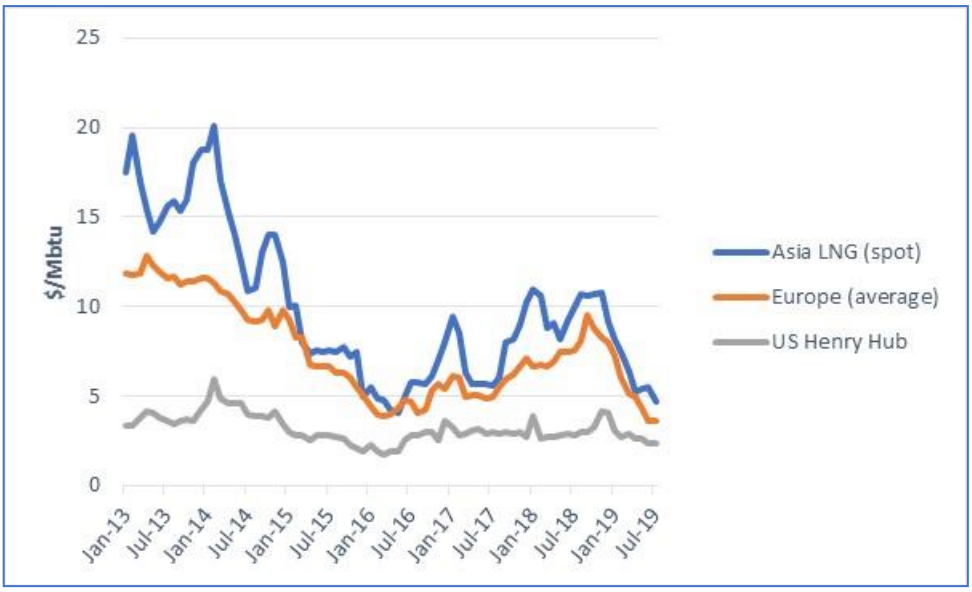
Convergence of regional spot gas prices

The fall of Asian and European spot prices leads to a **convergence between regional spot prices**.

Over the course of Q4 2018, differentials in regional spot prices decreased, as US prices increased, while spot Asian LNG and European gas became cheaper. The decline in regional price spreads accelerated in the first half of 2019 as spot Asian and European prices collapsed. The price spread between Henry Hub and TTF was $4.5 in Q4 2018 and narrowed to $3.2 in Q1 2019. In Q2 2019, the spread was only $1.7. Low European and Asian prices have started to pressure US spot prices, but also the margins of suppliers of US LNG.

64. European Commission, "U.S. liquefied natural gas exports up by 272% as EU and U.S. host High-Level Business-to-Business Energy Forum 2 May 2019", *Press release,* available at: http://europa.eu.
65. I. Slav, "EU Promises To Double U.S. LNG Imports Within 5 Years", *Oil Price,* 6 May 2019, available at: https://oilprice.com.
66. Atlantic Council, "US-European Trade Talks Stall", 7 June 2019, available at: www.atlanticcouncil.org.

Graph 6: Regional spot prices convergence



Source: EIA, World Bank, METI.

A warmer weather in China pushes down US spot prices

In a globalised LNG market, the recent sharp drop in gas prices in Asia and Europe has reverberated on US prices.

US gas prices are determined by domestic supply and demand balance, and set at liquid trading hubs, the largest and most important of which is Henry Hub in Louisiana. With the rise of the US as a major LNG exporter, **the US supply and demand balance is increasingly connected to the rest of the world.** The sharp drop in LNG prices in Asia and Europe has reverberated on the US market. It has also connected the price of gas in Louisiana to the weather in China—a development that is adding pressure on already low US prices.

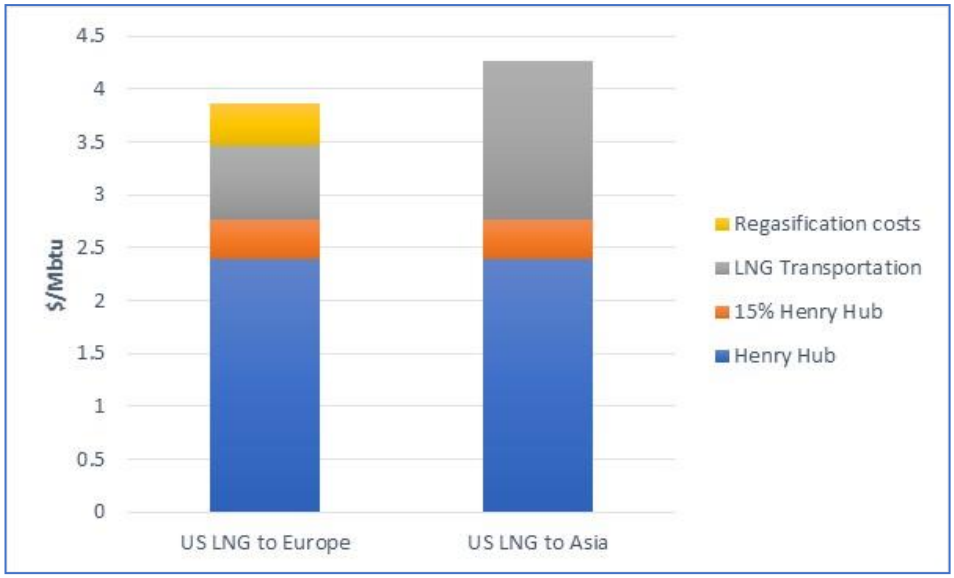
US gas production is rising rapidly, driven by associated gas. In 2018, US marketed gas production reached a record of 772 bcm, or +11.5% compared to 2017. Since most of the new natural gas production is a by-product of oil extraction, many domestic producers are unlikely to cut production in view of elevated crude oil prices. The EIA expects strong growth in US natural gas production in 2019 and 2020. **The role of LNG exports in absorbing production growth makes it key to support US prices**.

The EIA projects that US LNG export capacity will reach 8.9 billion cubic feet per day (bdfd) or 68 Mtpa by the end of 2019, doubling US

export capacity compared to the end of 2018.[67] The EIA expects LNG exports to continue to rise in 2019 and in 2020 as new liquefaction plants come online. However, the narrowing price spreads may challenge the competitiveness of US LNG exporters after adding the cost of liquefaction and transport.[68]

The US LNG projects coming on stream and ramping up in 2019 have supply contracts for a large portion of the volumes. The vast majority of the new contracted capacity is based broadly on the model pioneered by Cheniere, typically structured at 115% of the Henry Hub price plus a fixed fee of around $3/MBtu. As buyers are committed to paying the $3 fixed fee whether they take a cargo or not, it may be viewed as a "sunk cost". Thus, the short-run marginal cost will determine the competitiveness of US LNG exports. Paying 115% of Henry Hub to purchase and liquefy US gas, plus around $0.7 for transport across the Atlantic and $0.4 of regasification cost gives a short-run marginal cost of $3.9 for LNG delivered and regasified in Europe at $2.4/MBtu Henry Hub prices (their level in June 2019).[69] The same calculation for Asian market gives a short-run marginal cost of $4.3 for LNG delivered in Asia (assuming transportation cost of $1.5).

Graph 7: Short-run marginal costs of US LNG exports to Europe and Asia



67. EIA, "U.S. liquefied natural gas export capacity to more than double by the end of 2019", 10 December 2018, available at: www.eia.gov.
68. EIA, *Short-term energy outlook* (STEO), 6 August 2019, available at: www.eia.gov.
69. Regasification costs is added for LNG delivered in Europe as US LNG has to compete with gas delivered by pipeline. It is not added for LNG delivered in Asia as US LNG competes with other LNG suppliers.

As European and Asian prices have fallen below the marginal cost of US LNG supplies, American exporters may be forced to shut in their LNG trains as they could not cover their marginal cost. The US therefore would play the role of a swing producer in an oversupplied global LNG market. In practice, this may be difficult as US projects have different buyers which may have diverging buying interests and economic calculations. In the meantime, US LNG producers appear to be bringing forward their fall maintenance to capture stronger netbacks in fall and winter 2019 when prices are expected to recover.

If lower Asian prices help European policy, the fall in Asian and European prices comes at a very bad timing for US LNG exporters. The market is collapsing just as more US Gulf Coast terminals are poised to start up. **This should have the indirect effect of maintaining Henry Hub prices at low level.**

A new wave of sanctioned LNG projects

The surge in Chinese demand has helped **a new wave of LNG projects taking FIDs.** The growing number of LNG importers (42 in 2018), higher energy prices in 2018 and a rebound in long-term LNG contracting (led by China) have also made LNG exporters confident in future demand. The bullish outlook for LNG demand (see Box 2) has encouraged companies to sanction additional LNG plants, **based on the anticipation of a supply shortage by mid-2020.**[70]

While only 9.7 Mt of LNG capacity were sanctioned in 2016 and 2017,[71] **FIDs on 21.5 Mt of new capacity were taken in 2018**.[72] Much of the capacity sanctioned in 2018 came from the 14 Mtpa **LNG Canada** first phase. The $31 billion project became the first major project approved since 2015, and the first ever not to be underpinned by a long-term supply agreement as its sponsors agreed to market the LNG themselves. Only one train to reach FID in 2018, Corpus Christi LNG T3 (4.5 Mtpa), is a brownfield addition. The remaining sanctioned projects were both smaller floating proposals in frontier regions, with the 2.5 Mtpa Greater Tortue FLNG on the Mauritania-Senegal border and the 0.5 Mtpa Tango FLNG in Argentina.

70. See S. Cornot-Gandolphe, "The Next Wave of Global LNG Investment Is Coming", *Edito Energie*, Ifri, October 2018, available at: www.ifri.org.
71. IGU indicates 13.3 Mt and includes pre-FID decision on Woodfibre LNG, Canada (2.1 Mtpa) and Russia's Portovaya LNG (1.5 Mtpa), which did not announce FID, but announced a contract with an equipment supplier in 2017.
72. IGU, *op. cit.*

The trend has continued so far in 2019, with **four LNG projects with a nameplate capacity of almost 44 Mtpa sanctioned as of August 2019**:

- US **Golden Pass LNG** (15.6 Mtpa), based on equity offtake by its developers.
- Cheniere's **Sabine Pass Train 6 (4.5 Mtpa)**. Offtake agreements with Petronas and Vitol will support Train 6, as the contract with Sinopec has now been delayed.
- Anadarko-led Area 1 **Mozambique LNG** project (12.88 Mtpa). The project has successfully secured an aggregate 11.1 Mtpa of long-term LNG sales with key LNG buyers in Asia and in Europe.
- US Venture Global LNG's **Calcasieu Pass LNG** export facility (10.8 Mtpa), which has long-term offtake agreements with portfolio players and European buyers.

2019 is to set new records for LNG projects sanctioning. In total, promoters of more than 200 Mtpa of new LNG capacity have announced their intention to reach FID in 2019 (see Table 6, Annex 3). Clearly, not all projects will reach FID in 2019. They will be winners and losers. Political factors will play their role. The US-China trade war will make its toll on US projects relying on long-term contracts with Chinese buyers (see next section). **The collapse in spot LNG prices may delay new FIDs**, at least for projects relying on long-term contracts as buyers may postponed the signing of new contracts in view of the current LNG oversupply.

International LNG supply in the past has been quite concentrated, dominated by Qatar and Australia. **Supply in the future looks increasingly diverse and competitive**.

China has been instrumental in a growing number of LNG projects, even when China was not a buyer of the produced LNG. Since 2010, to secure its supply, China has embarked on a vast upstream acquisition program, involving strategic investments in major LNG export projects (see Annex 4). Chinese investment has been key for developing some LNG export projects, such as Yamal LNG.

The US-China trade war complicates the global LNG equation

The US-China trade war has escalated since the beginning of May 2019. China has increased tariffs from 10% to 25% from 1 June on

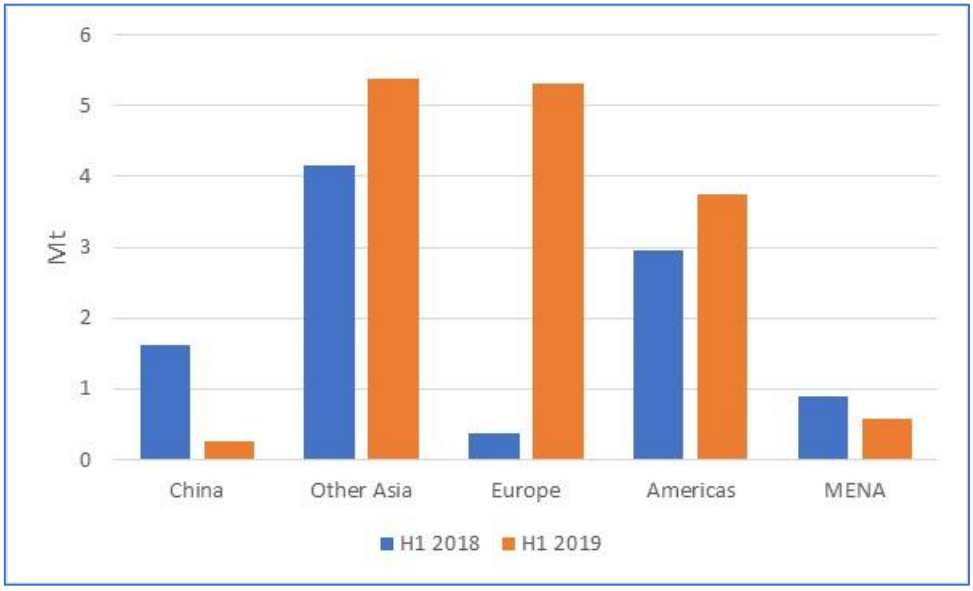
$60 billion of US goods, **including LNG**, retaliating against Washington's increase in tariffs on $200 billion of Chinese goods. In August 2019, China announced US$75 billion in tariffs on US goods from September 1, 2019, in retaliation to additional tariffs on $300 billion of Chinese goods.

The US and China started imposing tariffs on each other's goods in July 2018.[73] As the dispute heated up, China imposed a 10% tariff on LNG in September 2018. With China being the fastest LNG growth market and the US becoming the third largest LNG exporter, the needs and goals of these two future LNG giants could clearly be on a path to converge. LNG was originally one of the commodities (with crude oil) that could effectively reduce China's trade surplus with the US. But since the trade war has begun, among all energy products, LNG has been hit severely. **Chinese imports of US LNG have collapsed since the imposition of the initial 10% tariff on US LNG in September 2018**. With the tariff on US LNG being set at 25% since June 2019, Chinese buyers are seeking to completely avoid US cargoes.

Before the imposition of the tariff, China was taking nearly 11% of US LNG cargoes and above 20% in winter. In contrast, in the first half of 2019, only three US cargoes were exported to China and China accounted for only 1.7% of US LNG exports. Similarly, **the US share in China's total LNG imports dropped to 1% in the first six months of 2019**, well below the 7% registered over the same period in 2018 and the 4% over the full year of 2018. It was easy for China to replace the missing cargoes in the well supplied LNG market. The US was also able to replace the missing outlet. Since the 10% tariff applied, and even more so since Asian spot prices have fallen, **LNG trade flows have been redrawn with more US LNG going to Europe**. In the first half of 2019, US LNG exports rose by 53% year-on-year: other Asian markets (mainly Japan, South Korea and India) increased their US LNG imports by 30%, while Europe increased them fourteen times year-on-year.

73. See S. Cornot-Gandolphe and J.-F. Boittin, "The Trump-led Trade War with China: Energy Dominance Self-destructed?", *Etudes de l'Ifri,* Ifri, September 2018, available at: www.ifri.org.

Graph 8: US LNG exports in H1 2019 vs. H1 2018



Source: Cedigaz LNG Service.

The trade war has different implications on US LNG exports between the short-term and the long-term.

In the short term, most of the existing and under construction capacity in the US (the US first wave of LNG projects) has been backed by long-term agreements, mostly with non-Chinese firms. So, the impact of the LNG tariff is marginal for current US LNG exporters. However, their spare capacity is sold on the spot market. Any effect from the tariff on US LNG exports depends on global LNG demand. In the first half of 2019, LNG demand increased by 12.5% to 171 Mt, but the growth was mainly concentrated in Europe and China. If European LNG demand weakens, the US may have more difficulties to maintain full export capacity utilization without Chinese customers. Portfolio LNG players and traders are affected as they have acquired cargoes from US-based projects to sell them onto markets where demand and prices are the strongest. The arbitrage options for US LNG cargoes have become more limited. So far, the European market has been able to absorb surplus US LNG cargoes, but with new US LNG capacity coming into the market in 2019, the impact of the trade war could be more severe.

In the medium/long-term, the impact of the trade war will be felt by US LNG developers (the 'second wave' of US LNG projects) with exposure to China to finance their projects (e.g. Alaskan LNG, Delfin LNG, Texas LNG). These projects will have to find new financing sources/customers at a time when competition is fierce between LNG suppliers. As seen above, the US-China trade war has not prevented US developers to take FID.

China is not the only rapidly growing market. Over the past decade, an increasing number of emerging markets has joined the LNG import club. From 7 countries in 2010, they were 19 in 2018. The European market is back with rising LNG demand and new terminals being built (Croatia, Germany, Poland's expansion). But China remains the largest growth market in the medium and long term. The longer the trade war lasts, LNG projects outside of the US could potentially appear more attractive to Chinese importers. The trade war may also have a lasting undermining effect, in the case Chinese buyers lose confidence in US LNG as a secure source of LNG, due to government interference. Thus, US LNG developers risk losing a solid market if the trade war continues, slowing down the expansion of US LNG projects. The global market may also lose flexibility as US LNG projects offer flexible offtake contracts and price indexation on US gas hubs. On the Chinese side, with all LNG suppliers looking at the Chinese market, China will not have a hard time finding alternative supplies, but the trade tariff on US LNG will deprive the country from a flexible supplier, both in terms of volumes and pricing, and may make China more vulnerable to LNG price spikes.

Closer cooperation with Russia

The trade war between the US and China has opened the door further to gas cooperation between China and Russia, now seen as a direct competitor to the US in global gas markets. The recent announcement of a strategic partnership between China and Russia will reinforce links between the two countries, even if, in the long term, the two countries are strategic rivals.[74]

The US-China trade war, that President Putin qualified as 'a window of opportunity for Russia',[75] could well have the unintended effect of helping Russia to become a large LNG exporter and a major gas (and energy) partner of China. **LNG exports from Russia are poised to grow significantly** and perhaps challenge Australia, Qatar and the US for global leadership in liquefaction capacity.[76]

The opening up of the Arctic as a frontier LNG export region, and the ability to export LNG through the strategic Northern Sea Route (NSR) mean LNG from Russia can now reach more markets. Already, China is the

74. Xinhuanet, "China, Russia agree to upgrade relations for new era", 6 June 2019, available at: www.xinhuanet.com.
75. *RIA News*, "Russia replaces America in the Chinese markets" (in Russian), 30 November 2018, available at: https://ria.ru.
76. IGU, *op. cit.*

largest non-Russian user of the NSR.[77] China is looking at the Arctic as an addition to its Belt and Road Initiative, which stretches from Asia to Europe. The NSR, which links Asia to Europe, utilizing Russian waters in the Arctic Ocean, is about two weeks shorter than the Southern Shipping Route (through Suez Canal). But part of the NSR is free from ice only a few months a year. This window is expected to widen over the coming years as a consequence of global warming, prompting a shift in bilateral trade between European and Asian countries is expected in the future.

Russia intends to strengthen its position on the global LNG market, increasing its share in global LNG supply to 20% by 2035, increasing its LNG production four times to 120-140 Mtpa.[78] Russia has long been an LNG exporter, although before the end of 2017 it had just one terminal—the 9.6 Mtpa Sakhalin 2 project operated by Gazprom with Shell, Mitsui and Mitsubishi as partners. China has been instrumental in the development of the 16.5 Mtpa Yamal LNG project, fully operational since end of 2018. After the West enacted economic sanctions against Russia over its annexation of Crimea, it was China that stepped up to provide vital funding for Yamal LNG,bankrolling 60% of the project when taking into account credit lines extended by the Export-Import Bank of China and the China Development Bank.[79]

Novatek has aggressive plans to command a tenth of the global LNG market by 2030 and position Russia as one of the world's largest exporters alongside the US, Qatar and Australia. Novatek has attracted CNPC and CNOOC with a 10% stake each, in addition to Total, for its second Arctic plant, Arctic LNG 2, which is expected to come online in 2023. Novatek is also considering commissioning a third Artic LNG facility (Ob LNG)[80] and may **increase its LNG production target for 2030 by about 20%, to as much as 70 Mtpa**.[81] In another partnership, Novatek has created a joint venture in China with Sinopec and state-owned Russian bank Gazprombank to market LNG and natural gas to end-customers in China.[82]

77. *The Arctic Today*, "Russia's Northern Sea Route Sees Record Cargo Volume in 2018", 20 February 2019, available at: www.arctictoday.com.
78. *sxcoal*, "Russian Energy Minister Novak says Russia plans to increase LNG production by 4 times" (in Chinese), 25 June 2019, available at: www.sxcoal.com.
79. T. Kumon, "China thinks big in backing Russian Arctic LNG project", *Nikkei Asian Review*, 18 December 2017, available at: https://asia.nikkei.com/Economy/China-thinks-big-in-backing-Russian-Arctic-LNG-project2
80. A. Staalesen, "Novatek announces 3rd LNG project in Arctic", *The Barents Observer*, 23 May 2019, available at: https://thebarentsobserver.com.
81. *LNG World News,* "Novatek to bump 2030 LNG production target to 70 mtpa", 26 February 2019, available at: www.lngworldnews.com.
82. *LNG World News*, "Novatek, Sinopec, Gazprombank form LNG marketing JV in China", 6 June 2019, available at: www.lngworldnews.com.

Gazprom has been slow to join the global LNG boom as it has focused investment on pipeline supplies to Europe and China. To defend its position on the broader energy market, Gazprom has muscled its LNG strategy. In addition to the operating Sakhalin 2 project, the group has several projects under construction and planned (Portovaya LNG, Sakhalin Train 3 and Ust-Luga LNG) and is actively conducting trading operations.

If all new projects proceeded (most of them have announced their intention to reach FID in 2019), a new wave of Russian LNG would hit the market around 2024/25.

A potential constraint for further LNG export development from Russia may come from Russia's international trade in pipeline natural gas. Russia's pipeline projects to China may develop into gas-to-gas competition within the Russian export market and slow further LNG project activity.[83] Also western sanctions against Russia may slowdown the building of new LNG projects, despite efforts by Russia to master its own technology.

The Belt and Road Initiative and natural gas

The Belt and Road Initiative (BRI) provides a platform for Chinese oil and gas operators to "go out" and expand their activities in the related countries, and in many cases "bring in" natural resources. It was initiated with **cross-border gas pipelines in Central Asia**, the most difficult projects to align interests between the various parties

The BRI receives a lot of criticism before and during the second Forum of BRI countries in Beijing at the end of April 2019, especially its lack of transparency, political risks and the non-sustainability of financed projects. In the energy field, most of the international focus has been put on the brown side of the BRI and the many coal power plants built or planned in the related countries. However, **cooperation in the gas field has achieved fruitful results** since the initiative was first proposed, with a large number of landmark energy projects successfully implemented, including the Yamal LNG project and the China-Kazakhstan natural gas pipeline project.

Chinese oil and gas companies are actively developing their activities in the BRI countries, such as Russia, Central Asia and Myanmar. POLY-GCL, which is developing gas resources in Ethiopia for its LNG project in

83. IGU, *op. cit.*

Djibouti, provides another example of how private Chinese companies extend their activities overseas under the BRI framework.

The record level of gas import dependency has accentuated China's strategic need to acquire assets overseas to enhance energy security. In the energy field, **the BRI facilitates Beijing's call to strengthen cooperation with major gas exporting countries and implement major projects for cooperation.** The three NOCs are planning to step up cooperation with countries and regions participating in the BRI to further major project investments, oil and gas trade, engineering services, and new deepened cooperation.[84]

The BRI also serves **Beijing's will to raise its global governance in the energy field**, and notably have a stronger voice in international LNG trade. As a buyer or an investor, Chinese participation in key export gas projects will shape future global gas trade, but also energy and economic development in the related countries. As a result, China's security of supply policy has implications that stretch well beyond the energy sector.

84. Z. Xin, "Oil majors expand alliances and investments in Belt, Road economies", *China Daily,* 30 April 2019, available at: http://global.chinadaily.com.cn.

Conclusion

China's dual quest for blue skies and security of gas supply is becoming a key driver of global gas markets. Over the last two years, China has become the largest gas importer in the world and is on track to become the largest LNG market. This has economic, commercial and political implications not only in the gas market.

The government projects natural gas share to increase to 15% by 2030, meaning that **the "China's effect" on global gas markets has just emerged**.

The gas market in China is policy driven. The fight against air pollution and the acceleration of coal-to-gas switching have driven the boom in gas demand. Any changes in Chinese gas policy and regulation can have a high impact on its gas demand and in turn, its gas supply and demand balance and import needs (either on the upside or the downside).

Chinese gas supply is also policy driven, influenced by security of supply issues and geopolitics. Despite the increasing share of LNG, LNG is still a supplement to domestic production and pipeline imports in China's supply mix.

Steeping up domestic production is key to meeting the ambitious gas demand projections by 2030 and beyond to provide the level of security of supply that Chinese policy makers are comfortable with. As China is endowed with large gas resources, and given the top priority put on E&P and the dramatic increase in E&P spending by NOCs, domestic production should enter an accelerated phase of growth. If unconventional gas production does not take off, the contribution of natural gas to a low-carbon economy may be revised. **In all cases, this will impact future gas and LNG import needs.**

The share of LNG imports has increased tremendously in the past two years. The opening of the Power of Siberia pipeline will moderate the growth in LNG imports. Contractual gas imports through the pipeline correspond exactly to the increase in Chinese LNG imports during the past two years. In other words, by 2025, Power of Siberia has the potential to erase two years of growth in LNG imports. **China has several options to increase gas imports by pipeline from its gas-rich neighbours,** although plans for additional imports by pipeline are yet to be confirmed.

This leads to major uncertainties on long-term Chinese LNG demand.

The rise of China as an LNG superpower will strongly influence LNG trade flows and prices on the Asian and global market and make the global LNG market more dependent on China's policy. The global LNG market has currently entered an era of oversupply. The number of sellers has increased, and the market competition has become more intense. Asian oil-indexed LNG prices and spot prices have decoupled. This gives a timely opportunity for Asian LNG buyers to renegotiate LNG prices to eliminate the "Asian price premium". The stakes are enormous for China as natural gas faces competition from coal and oil. The cost of natural gas needs to be reduced to fully unleash the demand growth potential in the Chinese market and to reduce the carbon intensity of the energy mix. Due to the size of its market and strong political will, **China is expected to play a fundamental role in determining global gas prices,** not only spot prices, but more fundamentally the way gas is priced. Chinese policy makers are eager to develop a China benchmark for natural gas price. Even if this benchmark is not adopted in international contracts, it will play a fundamental role in global LNG trading, as seen on the coal market.

China is stepping up its governance in the energy field, including natural gas and LNG. Beijing's security of supply policy has a key focus on strengthening cooperation with BRI countries in the oil and gas field. Due to the size of its financial commitment and market, China will be in a strong position to shape future global gas trade, but also energy and economic development in the related countries. As a result, China's security of supply policy has implications that stretch well beyond the energy sector.

The US-China trade war has a huge impact on the global LNG scene. It has the unintended effect of warming relationships between Russia and China, a move reinforced by the strategic development of the Arctic region and the NSR. The trade war could have a long-lasting impact if US LNG becomes a less reliable supply for Chinese buyers due to government interference.

Annex 1: Main Chinese LNG import contracts (as of April 2019)

Buyer	Seller	Export Country	Type of contracts	Terms	Volume (Mtpa)	Start	Duration
CNOOC/GDLNG	North West Shelf LNG	Australia	SPA	FOB	3.30	2006	25
CNOOC	Tangguh LNG	Indonesia	SPA	FOB	2.60	2009	25
CNOOC	Petronas (MLNG Tiga)	Malaysia	SPA	DES	3.00	2009	20
CNOOC	Qatargas (Qatargas 2)	Qatar	SPA	DES	2.00	2011	25
CNOOC	Total (a)	Portfolio	SPA	DES	1.50	2010	20
CNOOC	QCLNG (Queensland Curtis LNG)	Australia	SPA	DES	3.60	2014	20
CNOOC	Shell	Portfolio	SPA	DES	5.00	2015	20
CNOOC	PNG LNG	Papua New Guinea	SPA	DES	0.30	2019	4
CNOOC	Petronas	Portfolio	SPA	DES	0.40	2019	5
CNOOC	BP	Portfolio	SPA	DES	1.00	2019	20
CNOOC	BP	Portfolio	SPA	FOB	0.50	2019	20
CNOOC	Anadarko (Mozambique LNG)	Mozambique	SPA	Unknown	1.50	2023	13
CNOOC	Pacific Oil & Gas (Woodfibre LNG)	Canada	HOA	Unknown	0.75	2023	13
CNOOC	New Age	Congo	HOA	Unknown	1.00	2021	
CNOOC	BP (Freeport LNG)	United States	HOA		1.50	2019	20
Total CNOOC					**27.95**		
Petrochina	Qatargas (Qatargas 4)	Qatar	SPA	DES	3.00	2011	25
Petrochina	ExxonMobil (Gorgon LNG)	Australia	SPA	DES	2.25	2016	20
Petrochina	Shell	Portfolio	SPA	DES	2.00	2016	20
Petrochina	Yamal LNG	Russia	SPA	DES	3.00	2018	20
Petrochina	Cheniere Energy (Sabine Pass)	United States	SPA	FOB	0.60	2018	25
Petrochina	Cheniere Energy (Corpus Christi)	United States	SPA	FOB	0.60	2023	20
Petrochina	PNG LNG	Papua New Guinea	SPA	FOB	0.45	2018	3
Petrochina	Qatargas (Qatargas 2)	Qatar	SPA	DES	3.40	2018	22
Total PetroChina					**15.30**		
Sinopec	PNG LNG	Papua New Guinea	SPA	DES	2.00	2014	20
Sinopec	APLNG (Australia Pacific LNG)	Australia	SPA	FOB	7.60	2016	20
Total Sinopec					**9.60**		
ENN	Total	Portfolio	SPA	DES	0.5	2019	10
ENN	Total	Portfolio	SPA	DES	0.25	2018	3
ENN	Origin Energy	Portfolio	SPA	DES	0.28	2019	5
ENN	Chevron	Portfolio	SPA	DES	0.65	2019	10
ENN	Mexico Pacific Ltd	Mexico	HOA	Unknown	1		15
ENN	Next Decade	United States	HOA	FOB	1	2023	20
ENN	Venture Global	United States	HOA	FOB	1	2024	20
ENN	Woodside	Portfolio	HOA	DES	1	2025	10
Total ENN					**5.68**		
Huadian Corp (CHD)	BP	Portfolio	SPA		1	2021	20
Huadian Corp (CHD)	Chevron	Portfolio	HOA		1	2020	10
Huadian Corp (CHD)	Petronas	Portfolio	HOA		0.5		20
Total CHD					**2.5**		
Jovo Group	Petronas	Portfolio	SPA	DES	0.5	2013	10
Jovo Group	SCT&E (Monkey Island)	United States	MOU	Tolling	2	2022	20
Jovo Group	Chevron	Portfolio	SPA	DES	0.5	2018	5
Total Jovo					**3.00**		
Zhejiang Energy	ExxonMobil	Portfolio	SPA		**1.00**		20
China Gas Holdings	Delfin LNG	United States	MOU	DES	**3.00**	2021	20
Guanghui Energy	Total	Portfolio	SPA		**0.70**		10
Guangzhou Gas	Pacific Oil & Gas (Woodfibre LNG)	Canada	HOA	FOB	**1.00**	2020	25
Total contracts (SPA, HOA, MOU)					**69.73**		
TOTAL SPA					**54.98**		

(a) Contract modified in 2018

Source: CEDIGAZ LNG Service, GIIGNL, various company's documents.

Annex 2: Chinese independent players in the LNG business

Many private and provincial companies (the second-tier LNG buyers) are involved in LNG imports and are building their own receiving terminals. At the end of 2018, four LNG receiving terminals were held by private companies, with an import capacity of 6.45 Mt (9% of China's receiving capacity). The **Jovo** group, which specializes in LPG, was the first privately-held company to import LNG at its own terminal. In September 2013, the company opened a small LNG terminal at Dongguan (Guangdong), and since then has imported LNG cargoes, initially sold by PetroChina, and now directly negotiated with Malaysia. **Guanghui Energy**, a Xingjiang company specialized in the sale and infrastructure of CNG and LNG for transportation, started LNG imports in 2017 at a new terminal at Qidong (Jiangsu). The terminal, with an initial capacity of 0.6 Mtpa, is to be raised to 3 Mtpa. Guanghui has signed an SPA with Total for 0.7 Mt/y for 10 years. The company plans to build a second terminal with China Huadian in Yueyang city on the Yangtze River, 830 km inland from Shanghai and the East China Sea. The first phase (0.5 Mtpa) is scheduled to commence operations in December 2020 and will be supplied from Qidong. In December 2014, **ENN** was the first Chinese private company to take delivery of an LNG cargo at a state-owned major's import terminal (PetroChina's Rudong LNG terminal). Now, ENN has opened a 3 Mtpa terminal in Zhoushan (Zhejiang), to be expanded to 10 Mtpa by 2022. ENN has SPA contracts with Total, Origin Energy and Chevron and several other non-binding agreements. **Shenzhen Gas**, a Guangdong distributor, opened its own small-scale import facility in Dapeng. Shanghai's main energy company **Shenergy Group** plans to build a second LNG terminal in the city to ensure the availability of long-term gas supplies. **Zhejiang Energy** buys LNG imported at Ningbo terminal from CNOOC. The group has invested in the expansion of the Ningbo terminal and is building a new terminal at Wenzhou (3 Mtpa), together with Sinopec. Zhejiang Energy has a 20-year agreement for 1 Mtpa with ExxonMobil. **Chaozhou Huafeng Group** is building a new terminal in Guangdong (Chaozhou Huaying LNG terminal) with a planned total capacity of 6 Mtpa, built in several phases. In February 2018, local power

utility **Guangdong Energy** (ex-Yudean Power) with Pacific Oil & Gas started building the Yangjiang LNG terminal in Guangdong (2 Mtpa). **China Huadian Corp. (CHC)**, one of the nation's biggest power generators, has proposed the construction of two LNG import terminals. However, these projects are still at the planning stage. The company, which has LNG SPAs with BP and Chevron, with sales starting in 2020, will utilise existing Chinese import terminals as a third-party user. **Beijing Gas** is planning to construct an LNG receiving terminal near the city of Tianjin.

These are only some examples of the dynamism of independent players on the Chinese LNG market. Overall, more than 30 companies, most of which are provincial pipeline companies, power generators, city-gas companies and investment corporations, have indicated interests in building LNG receiving terminals. These independent players add competition and new supplies to the market. Long-term contracts by non-NOCs (SPAs only) amounted to 5.38 Mtpa at the beginning of 2019, or about 10% of contracted LNG import volumes by the beginning of the 2020s. In 2018, they imported 3.2 Mt, i.e. 6% of total Chinese LNG imports.

There is also **improvement in TPA to NOC's terminals**. PetroChina has been the first among the three majors in opening its terminals to TPA on a fee-paying basis. CNOOC opened its three LNG receiving terminals in Guangdong province to third parties during the peak season of winter 2018-19 on a trial basis. The group is now offering access to its facilities to independent companies over a 10-year period, with a specified number of slots each year.[85]

85. Reuters, China's CNOOC explores opening up LNG terminals under reform pressure -sources, 12 March 2019, available at: https://af.reuters.com.

Annex 3: LNG export projects looking to take FID in 2019

Table 6: Liquefaction projects sanctioned recently and those aiming for FID in 2019 (as of August 2019)

Exporting country	Project	Lead sponsors	Type of project	Date of FID	Start-up	Capacity (Mtpa)
2016						
Indonesia	Tangguh Train 3	BP	Brownfield	Jul-16	2020	3.8
United States	Elba Island LNG	Elba Liquefaction	Brownfield	Nov-16	Q4 2019	2.5
TOTAL 2016						**6.3**
2017						
Mozambique	Coral FLNG	ENI	FLNG	Jun-17	2022	3.4
TOTAL 2017						**3.4**
2018						
United States	Corpus Christi Train 3	Cheniere	Brownfield	May-18	2023	4.5
Canada	LNG Canada Phase 1	Shell	Greenfield	Nov-18	2023	14
Mauritania/Senegal	Tortue FLNG Phase 1	BP, Kosmos Energy	FLNG	Dec-18	2022	2.5
Argentina	Tango FLNG	YPF	FLNG	Dec-18	Q2 2019	0.5
TOTAL 2018						**21.5**
2019						
United States	Golden Pass LNG 2	ExxonMobil, Qatar Petroleum	Brownfield	Feb-19	2023	15.6
United States	Sabine Pass Train 6	Cheniere	Brownfield	Jun-19	2023	4.5
Mozambique	Mozambique LNG	Anadarko	Greenfield	Jun-19	2024	12.9
United States	Calcasieu Pass LNG	Venture Global	Greenfield	Aug-19	2022	10.8
TOTAL 2019 (up to August)						**43.8**
LNG Projects Seeking an FID in 2019						
Qatar	Qatargas expansion	Qatargas	Brownfield	2019	End 2023/2024	31.2
Russia	Arctic LNG 2	Novatek, Total, CNPC, CNOOC	Greenfield	2019	2024/2026	19.8
Russia	Sakhalin 2, Train 3	Gazprom, Shell	Brownfield	2019	2023	5.4
Russia	Ust-Luga (ex-Baltic LNG) (a)	Gazprom, RusGazDobycha	Greenfield	2019	2023	13
United States	Driftwood LNG	Tellurian	Greenfield	2019	2023	27.4
United States	Freeport LNG, train 4	Freeport LNG Development	Brownfield	2019	2023	5.1
United States	Port Arthur LNG	Sempra LNG	Greenfield	2019	2023	11
United States	Magnolia LNG	LNG Limited	Greenfield	2019	2022	8.8
United States	Plaquemines LNG, Phase 1	Venture Global	Greenfield	2019	2023	20
United States	Rio Grande LNG	NextDecade	Greenfield	2019	2023	27
Mexico	Energia Costa Azul, Phase 1	Sempra LNG	Brownfield	2019	2023	2.4
Canada	Woodfibre LNG	Pacific Oil & Gas	Greenfield	2019	2023	2.1
Canada	Goldboro LNG	Pieridae Energy Canada	Greenfield	2019	2023	10
Mozambique	Rovuma LNG	ExxonMobil, ENI, CNPC	Greenfield	2019	2024	15.2
Nigeria	NLNG Train 7	Nigeria LNG	Brownfield	Q4 2019	2023	8
TOTAL						**206**

(a) Final implementation decision taken in April 2019

Source: Author from various companies' announcements.

Annex 4: Chinese equity participation in LNG projects

As other major importing countries (Japan, South Korea), Chinese NOCs have taken equity stakes in liquefaction projects. The first two long-term contracts that CNOOC signed in the early 2000s came with equity participation in Tangguh (Indonesia) and in the upstream of Northwest Shelf (NWS, Australia).[86] From 2006 to 2009, Chinese buyers signed long-term SPAs with various LNG developers, but with no equity stake. Since 2010, to secure its supply, China has embarked on a vast upstream acquisition program, involving strategic investments in major LNG export projects.

Australia: Sinopec owns 25% of Australian Pacific LNG (APLNG). In addition to its 5.3% of NWS gas reserves and right to process its gas through the NWS infrastructure, CNOOC has a 50% equity stake in Queensland Curtis LNG (QCLNG) Train 1.

Russia: Chinese companies and banks are actively developing Russian Arctic LNG projects. CNPC acquired a 20% interest in Novatek's Yamal LNG project, from which CNPC will receive 3 Mtpa of LNG. The Silk Road Fund, a Chinese state-owned investment fund, holds another 9.9% stake in the project. CNPC and CNOOC each have a 10% stake in Novatek's Arctic 2 LNG.

Canada: China is also active in developing Canadian LNG projects. PetroChina has a 15% equity stake in Shell-led LNG Canada. Woodfibre LNG, privately owned by Singapore-based RGE Pte. Ltd, has non-binding offtake agreements with Chinese gas-distribution companies Guangzhou Gas Group and Beijing Gas Group, and recently signed a HOA with CNOOC. China had also been an active participant in Canada's planned LNG export projects (notably, Pacific NorthWest LNG and Aurora LNG), but these projects have now been shelved.

Mozambique: China is engaged in the three projects developed in Mozambique. China is not a buyer of Coral FLNG, but CNPC holds a 28.6% stake in the upstream development of Area 4, which is also feeding ExxonMobil-led Rovuma LNG. Like its partners in the project, CNPC has

86. CSIS, *op. cit.*

agreed to offtake its equity share of the LNG produced. CNOOC has a long-term contract to buy 1.5 Mtpa from Anardako-led Mozambique LNG.

Papua New Guinea: China has no equity in the current and under development PNG LNG projects. But Chinese NOCs (PetroChina and Sinopec) are long-term buyers.

Indonesia: CNOOC has a 13.9% stake in Tangguh LNG. CNOOC is not a buyer of the Tangguh Train 3 but hold a 13.9% in the upstream development.

Ethiopia/Djibouti: Chinese POLY-GCL Petroleum Group is developing an LNG export project in Djibouti, feed from Ethiopia (3 Mtpa initially). The project is financed under the Belt and Road Initiative.

Cameroon: For the Hilli Episeyo, the first ever FLNG conversion, Golar received initial financing from Chinese sale and leaseback provider, CSSC (Hong Kong) Shipping Co., in the form of $700 million in construction financing. Of this, $640 million was drawn down and then repaid, at which point CSSC provided a $960 million sale and leaseback facility.

China is not only a lender to **FLNG projects in Africa**, but is also aiming to become the lowest cost seller of the floating plants.[87] China's Wison Offshore & Marine completed its first-ever FLNG ship (Caribbean FLNG) in 2017. Wison Offshore & Marine has also a FEED contract for a proposed FLNG facility in British Colombia (Western LNG).

United States: Sinopec, China Investment Corp and Bank of China are involved, at the feasibility stage, in the Alaskan LNG project that Alaska's state gas corporation, Alaska Gasline Development Corporation (AGDC) plans to develop. However, the recent escalation of the US-China trade war may stop Chinese investment in US LNG.

87. O. Vukmanovic and C. Leopold, "China pumps cash into African floating LNG projects in strategic push", *Reuters,* 27 June 2017, available at: www.reuters.com.

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