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A Natural Gas Giant Awakens: China's Quest for Blue Skies Shapes Global Markets

By David Sandalow, Akos Losz and Sheng Yan*

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Introduction

"When China awakes, she'll shake the world." Those words have been attributed to Napoleon Bonaparte, although some historians are skeptical.[1] Whoever said them first, the words have proved prophetic in describing much of the global energy sector in recent years, from coal (China leads the world in production and consumption) to solar panels (China leads the world in manufacturing and deployment) to oil (China leads the world in imports). Yet in natural gas China remained almost a bit player, with a far more modest role in global markets.[2]

No more. In 2017, China was the world's fastest-growing natural gas market. Consumption grew by 15%, more than twice the rate of economic growth. Liquid natural gas (LNG) imports grew by a staggering 46%.[3] Government targets imply strong natural gas demand growth for at least the next decade—although infrastructure constraints could limit consumption in the short and medium terms.

In this paper, we look at factors behind China's thirst for natural gas and recent natural gas shortages. We then explore implications for China's LNG demand, US-China trade and global climate goals.

Blue Skies, Big Ambitions

In 2017, natural gas accounted for roughly 7% of China's primary energy consumption. This was much lower than in other major economies, including the United States (28%), the European Union (24%) and Japan (22%). More than two-thirds of natural gas in China is used in industry

and buildings (mainly for heating). Very little natural gas is used in power generation, the primary gas-consuming sector in most major economies.[4]

In winter 2013, a long period of especially severe air pollution in China gained widespread attention and was labeled an "airpocalypse." This experience led the Chinese government to dramatically increase the priority it gave to fighting air pollution. The National Action Plan on Air Pollution Prevention and Control, adopted in late 2013, set ambitious goals for reducing particulate emissions and other air pollutants. President Xi Jinping promised to "make China's skies blue again."[5]

Natural gas quickly became a central part of the Chinese government's plan for fighting air pollution. The Chinese economy relies heavily on coal, which produces far more particulate matter and other pollutants per unit of energy than natural gas. Transitioning from coal to natural gas offers huge benefits in reducing soot and smog, as well as significant benefits in reducing greenhouse gas emissions.

Owing mainly to air quality objectives, China's 13th Five-Year Plan (2016–2020) set ambitious goals for increasing the use of natural gas, including almost doubling the share of gas in China's primary energy mix in five years. The 13th Five-Year Plan calls for natural gas to provide up to 10% of China's primary energy by 2020 and 15% by 2030.[6]

Ministries, provincial governments, local governments and state-owned enterprises (SOEs) followed up with a range of policies and measures. That included China's first clean winter heating plan, which required 28 cities in the Beijing-Tianjin-Hebei region known as the "2+26" cities to clean up small coal-fired boilers, primarily by replacing them with natural gas–fired units. As a result of the push, an estimated 4 million households switched from coal to natural gas in the "2+26" cities. China's latest clean heating plan, adopted in December 2017 for the period through 2021, targets the replacement of "dispersed coal boilers" in a wider area across northern China.[7]

Chinese President Xi Jinping has called for the market to play a "decisive" role in allocating resources. Consistent with that, the Chinese government has undertaken a process of gradual price liberalization for natural gas. Gas prices for nonresidential customers were liberalized starting in 2015. In 2017 the government announced that third parties would receive access to pipelines and LNG import terminals. These reforms and others should help in meeting the government's natural gas consumption and related clean air goals in the years ahead.

Cold Weather, Gas Shortages

During the winter of 2017–2018, much of northern China experienced significant natural gas shortages. With demand surging owing to the government's ambitious coal-to-gas switching programs, supply was unable to keep up. Millions of homes were temporarily left without heat. One provincial capital suspended heating in government offices, hotels and shopping malls. Natural gas–fueled taxis and buses had to wait in long lines to fill up. Industrial output was scaled back to divert natural gas to emergency heating in homes and office buildings.[8]

Several factors contributed to China's natural gas shortage last winter.

Limited storage capacity

China's limited natural gas storage capacity contributed substantially to the shortages in winter 2017–2018. In most countries with significant seasonal variation in natural gas demand, such as China, the United States and many members of the European Union, seasonal gas storage plays an important role in ensuring adequate supplies during peak winter months. In China, however, storage capacity is inadequate to play a meaningful role in meeting peak demand. At the end of 2017, China's underground natural gas storage capacity was 11.7 billion cubic meters (bcm), equivalent to about 5% of total consumption.[9] The same coverage ratio is around 17% in the United States and 27% in Europe.[10]

Overstretched LNG infrastructure

At the end of 2017, China had 16 operational LNG receiving terminals with 71 bcm of annual import capacity along the country's east coast.[11] These terminals became highly overstretched in the peak winter months of December and January, with an average nationwide utilization rate above 105% and utilization at some northern terminals exceeding 120%.[12] Although some southern terminals operated comfortably at utilization rates of around 70%, the pipeline infrastructure to move natural gas from southern terminals to northern demand centers proved inadequate. To bridge this infrastructure gap, Chinese companies—notably CNOOC and Sinopec—dispatched hundreds of trucks to deliver LNG from receiving terminals in the south to cities in the north at distances of more than a thousand miles.[13] These truck deliveries reportedly came at a cost of more than $30 per MMBtu during the winter peak demand, nearly three times the spot LNG price during this period.[14]

Pipeline gas shortfalls

The Beijing-Tianjin-Hebei region relies heavily on pipeline gas from Central Asia for natural gas supplies. In the second half of 2017, pipeline gas deliveries from Turkmenistan fell substantially. Possible causes included stronger-than-anticipated demand growth and cold weather in Turkmenistan (leaving less natural gas for exports), unplanned outages at a gas processing facility, and—as at least one Chinese newspaper suggested—an attempt to negotiate better pricing terms amid the looming gas supply crunch in China.[15]

Chinese buyers attempted to offset the reduced volumes from Turkmenistan with more supply from Kazakhstan and—to a much lesser extent—Uzbekistan. CNPC rushed to bring natural gas wells online ahead of schedule at its Amu Darya project in Turkmenistan.[16] However, pipeline gas imports from Central Asia remained largely flat during the months of peak winter gas demand. These lower-than-expected volumes put considerable pressure on the natural gas market in northern China.

Cold temperatures

Winter weather in northeast China was also a bit cooler than the average of the three prior winters. Aggregate heating degree days—a commonly used measure of heating demand—in Beijing, for example, was approximately 7% higher in the winter months of 2017–2018 than the previous three years' average during the winter heating season.[17]

Lack of market-based price signals

Despite several rounds of reform in recent years, China's natural gas prices remain semiregulated. The lack of market-based price signals holds companies back from investing in underground storage facilities and other natural gas infrastructure. In liberalized gas markets across Europe and North America, price increases help market participants avoid physical fuel shortages by incentivizing them to invest in additional infrastructure, cut consumption or bring additional supplies to the market. In the absence of such market-based pricing mechanisms, regulators must keep the system in balance. As China's winter gas shortage illustrates, that can be exceedingly challenging, especially during times of surging demand.

Lack of coordination

Before winter 2017–2018, the massive coal-to-gas switching initiative in northern China was led by the Ministry of Environmental Protection (MEP). Natural gas supply and infrastructure development was led mostly by the National Energy Administration and a number of state-owned enterprises. Provincial and local authorities played important roles as well. Coordination among these players and others appears to have been inadequate. This became especially problematic when coal-to-gas switching in the residential sector in northern China exceeded the planned rate by nearly 25%.[18] In March 2018 a new Ministry of Ecology and Environment (MEE) was established and given a substantially broader remit than MEP, reflecting the high priority that environmental issues have received in recent speeches by President Xi Jinping and others. This change may help address coordination challenges on some topics, such as water pollution and carbon emissions; however, MEE is not responsible for natural gas supply and infrastructure.[19]

Implications for LNG Demand

Global LNG markets are growing rapidly. Global LNG shipments grew by about 6.5% in 2016 and more than 10% in 2017.[20]

China's ambitious goals to increase natural gas consumption could create significant additional LNG demand. In this section we examine four factors that will play a central role in determining China's LNG requirements in the years ahead: domestic natural gas production, pipeline gas imports, natural gas storage capacity and LNG infrastructure constraints.

Domestic natural gas production

Historically, most of China's natural gas supply has come from domestic production, almost all from conventional wells. In 2017, roughly 60% of China's natural gas consumption came from domestic sources. Chinese natural gas production grew by an impressive 9% last year yet failed to keep up with the 15% annual growth in natural gas consumption. That gap is likely to continue in the years ahead. China's conventional natural gas production could grow modestly in the near term, but not as much as consumption. In addition, the ability of conventional fields to deliver sustained growth over the longer term is probably limited.[21]

Unconventional gas—particularly shale gas—has significant long-term growth potential in China, but ramping up production from shale formations has been challenging. The government's 2020

target for shale gas production was scaled back from 100 bcm per year in 2012 to 30 bcm per year in 2014.[22] Wood Mackenzie, a prominent energy consultancy, now predicts that only about 17 bcm per year of production from shale seems realistic by 2020, and even this would require a near doubling of current production in less than three years.[23] The challenges facing China's shale producers—including difficult terrain, high costs, poor geology, long distance to markets and an SOE-dominated industry structure—remain formidable. The prospects for significant increases in Chinese shale gas production in the short and medium terms are moderate at best.

China's other sources of unconventional natural gas production—coalbed methane (CBM) and coal gasification (CTG)—are less material over the long run. They depend on provincial subsidies (in the case of CBM) or come at a heavy cost to the environment (in the case of CTG).

China's domestic supply of natural gas over the medium and long terms may be driven more by shale gas production than other sources. But the experience so far suggests that the growth of shale in China will not be nearly as rapid or transformational as in the United States. The gap between China's natural gas consumption and domestic production is expected to substantially widen in the medium term, as demand growth far outpaces domestic supply growth in any plausible scenario.[24]

Pipeline gas imports

China currently imports natural gas through two pipeline systems: the Central Asia gas pipeline (from Turkmenistan, Kazakhstan and Uzbekistan) and the China-Myanmar pipeline. A natural gas pipeline from the Russian Far East is currently under construction.

The potential for increased pipeline gas imports from Central Asia appears limited in the short term and highly uncertain over the long term. Last year 39 bcm of natural gas was delivered,[25] well below the system's 55 bcm per year capacity. Turkmenistan's inability or unwillingness to increase deliveries last winter—notwithstanding repeated pleas by Chinese officials—suggests that prospects for additional supplies may be poor, owing in part to Turkmenistan's own growing domestic requirements.[26] Kazakhstan and Uzbekistan have some potential to increase pipeline gas deliveries to China, but ramping up natural gas production in those countries will take time. Incremental volumes in the next few years will likely be small.

A fourth pipeline from Central Asia, known as Line D, is under discussion, but its prospects are uncertain. Line D would add another 30 bcm per year import capacity from Turkmenistan to

China via Uzbekistan, Tajikistan and Kyrgyzstan. Construction started on the pipeline in 2014, but the project was delayed in 2016,[27] and then eventually suspended altogether in 2017.[28] Although earlier this year reports started to emerge that CNPC intended to speed up the project and that construction on the pipeline's Tajik and Kyrgyz sections could soon resume, progress toward reviving the Line D project on the Turkmen and Uzbek sides of the border have been limited.[29] Given the remaining uncertainties around construction and timing, as well as the technical difficulties due to the mountainous terrain, the Line D project is expected to start deliveries in 2023 at the earliest,[30] if the project is ultimately completed at all.

The potential for increased natural gas imports through the China-Myanmar pipeline also appears to be limited. Deliveries have fallen short of the 5.2 bcm annual contract volume, owing in part to rising demand in Myanmar and the limited availability of natural gas for exports. Pipeline gas from Myanmar is also among the highest-cost supply options for China at the moment.[31] A material increase of imports from this direction seems unlikely.

Perhaps the most important change in China's natural gas supply mix over the next five years will be the start of deliveries via the Power of Siberia pipeline, which will connect Russia's largely untapped gas reserves in Eastern Siberia with China's northeastern provinces.[32] Work on the project progressed slowly in the period leading up to 2017, when Russian pipeline gas seemed expensive and the LNG market appeared to be heading for a long period of oversupply. But last year CNPC decided to accelerate construction on the Chinese side of the border.[33] The Power of Siberia pipeline is now back on schedule, with deliveries projected to start by the end of 2019.[34]

Although the 38 bcm per year of contracted volume on the Power of Siberia line is significant, the ramp-up to full capacity could stretch well into the mid-2020s. Moreover, as Russia's eastern gas fields will most likely have limited ability to adjust production seasonally, the role of providing seasonal gas supply flexibility for China will continue to fall primarily on LNG, even after the start of Russian pipeline gas deliveries.

Overall, pipeline deliveries have limited room to grow until 2020. Larger volumes—mainly from the Russian Far East—will ramp up only gradually between 2020 and 2025.

Natural gas storage

China urgently needs more natural gas storage to manage significant seasonal demand variations. Government plans call for increasing natural gas storage capacity from roughly 12 bcm today to 15

bcm by 2020 and 35 bcm by 2030.[35] In order to achieve those goals, the Chinese government last year began requiring Chinese natural gas companies to build and maintain storage facilities. Upstream companies are required to build storage capacity equal to 10% of their annual contracted sales volume and midstream companies (including city gas distributors) are required to provide storage equal to 5% of annual consumption in their respective service areas. Companies have several years to meet these requirements.[36]

The financial returns on natural gas storage facilities in China are low. Regulated city-gate prices suppress the seasonal price signals that could incentivize private companies to invest in gas storage. In part for that reason, plans for increasing natural gas storage rely mainly on state-owned enterprises fulfilling the requirements discussed above.[37]

Although work is underway to expand China's natural gas storage as a matter of priority, expansion to European or US levels of demand coverage seems unlikely even in the longer term.[38] China's geology is an obstacle. Depleted oil and gas fields, the most commonly used geological features for seasonal storage, are less prevalent in China than in North America, for example. Many potential natural gas storage sites in China are located deep underground, close to densely populated areas or in mountainous regions, which raises safety risks and technical complexity.[39] Technical expertise in building new facilities in complex formations is reportedly also in short supply.[40]

If government targets for both natural gas storage capacity and natural gas consumption are met, storage will reach 6% of consumption in 2030, by one estimate,[41] as compared to just over 5% today.[42]

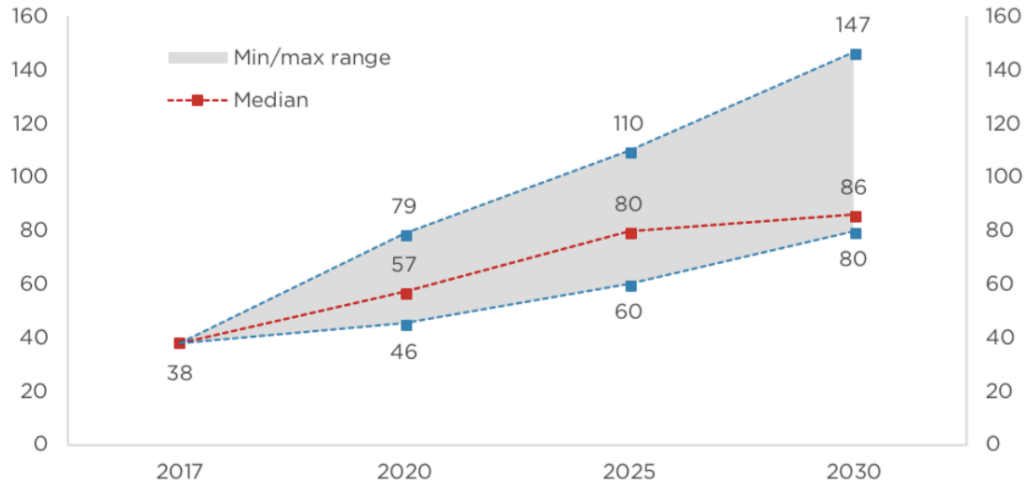
LNG infrastructure

Chinese natural gas demand is surging. Government targets call for significant increases in consumption (from 7% of primary energy today to 10% in 2020 and 15% in 2030).[43] Domestic production and pipeline imports are unlikely to provide sufficient supply. The lack of adequate storage capacity will require flexible supply for times of peak demand. The combination of these factors suggests a substantial growth of Chinese LNG demand.

A survey of recent industry forecasts indicates that analysts generally expect China's LNG demand to reach 80 to 147 mtpa (109 to 200 bcm per year) by 2030—roughly two to four times greater than the 38 mtpa consumed in 2017 (see figure 1). In the majority of forecasts, China overtakes Japan

(which imported 84 mtpa of LNG last year) as the world's largest LNG importing country in the mid- to late 2020s, although this happens much sooner in some forecasts.

Figure 1: LNG demand projections for China (mtpa)



Source: CGEP, summarizing projections in 15 reports by banks, consultancies and forecasting agencies released between November 2017 and June 2018.

Will China's LNG import infrastructure be sufficient to accommodate this demand?

LNG receiving terminals are the first bottleneck. Many were running at significant overcapacity in the winter of 2017–2018. To address this problem, the National Development and Reform Commission (NDRC) is giving priority to approvals of LNG import terminals and Chinese companies are adding new LNG import capacity at a rapid pace. Five new or expanded regasification terminals are scheduled to enter service in 2018 alone. Several additional terminals are under construction or expanding capacity, with projected online dates between 2019 and 2021. In all, China's LNG import capacity could increase by half through the early 2020s.[44]

Pipelines are the second bottleneck. Only about a quarter of China's new import capacity is in the most overstretched northern regions, which means that the parallel development of the domestic gas pipeline network remains a key enabler of substantially higher LNG imports in the winters to come. NDRC plans call for an expansion of China's natural gas pipeline network by 99,000 km

(or about 60,000 miles) between 2015 and 2025. Integrated LNG terminal and pipeline planning is a growing trend, in particular to facilitate movement of natural gas from south to north.[45]

China's LNG import capacity constraints are being removed. Challenges may persist for the next year or two, but many market participants believe that new regasification capacity and pipelines will be sufficient to accommodate growing LNG import volumes in the near future.[46]

Implications for US-China trade

In 2017, the United States' trade deficit with China was $375 billion.[47] President Trump has identified reducing that deficit as a priority. Could natural gas exports from the United States to China play a material role in reducing the US-China trade deficit?

The short answer is no. In 2017, the total value of US LNG exports to China was $424 million according to US Census data and $644 million according to Chinese customs data—between 0.1% and 0.2% of the bilateral trade deficit.[48] US-China LNG trade could grow substantially in the years ahead, delivering considerable benefits for both countries, but could not exceed 10% of the current US-China trade deficit during the next five years as an extreme upper bound. Actual amounts will likely be much smaller.

The math is straightforward. US LNG export capacity today is 3.1 Bcf per day. That figure will increase to roughly 9.1 Bcf per day by 2020 and perhaps to 9.7 Bcf per day by 2022. (LNG export terminals take three to five years to build, so maximum potential LNG export capacity through 2022 is known with high confidence.) As of early June, LNG prices in the Asian market are roughly $10 per MMBtu.[49] Even if *all* US LNG exports went to China and Asian prices remained at $10 per MMBtu (which would be nearly 50% higher than the previous three years' average), total annual LNG exports to China would be in the range of $35 billion in 2020 and $37 billion in 2022 (or about 9%–10% of last year's US-China trade deficit).[50] However, most US LNG exports will not go to China, so the actual figures will likely be much lower. The impact on the US-China trade deficit will be modest at most.

That is not to say US-China LNG sales are insignificant from a commercial standpoint. To the contrary, these sales could provide substantial commercial benefits to companies in both countries.

For US LNG exporters, China is an important market. Indeed, China is the third-largest destination for US LNG, receiving one in every seven cargoes over the past two years. With China

projected to become the world's largest LNG importer in the next decade,[51] Chinese companies will continue to be important potential customers.

In addition, long-term contracts with Chinese companies could play an important role in financing new US LNG export projects. Raising billions of dollars for such projects typically requires long-term contracts for a significant portion of the planned capacity to secure project finance debt.[52] Chinese companies are important prospects for long-term LNG contracts in the years ahead. The first such contract between a US supplier and a Chinese buyer was signed by Cheniere Energy and CNPC earlier this year. The two companies contracted for a total volume of 1.2 mtpa (1.6 bcm per year) of LNG, with some deliveries starting in 2018 and some in 2023 for a period of 25 years and 20 years, respectively.[53] The agreement was instrumental in helping Cheniere Energy reach a final investment decision (FID) on the Corpus Christi Train 3 expansion project,[54] the first FID on a US LNG project since 2015.

US-China LNG sales offer important benefits for Chinese companies as well. Flexible spot LNG purchases from US exporters are well suited to fill seasonal supply gaps in China, as the increased deliveries in the winter of 2017–2018 indicate. US LNG purchases under long-term contracts could also help China meet its growing structural demand for natural gas. Although the full cost of new US LNG delivered to Asia is slightly higher today than the cost of LNG from other major suppliers, the transparent Henry Hub–based pricing of US LNG is a significant benefit for Chinese buyers, helping reduce reliance on traditional oil-linked LNG contracts. US LNG offers supply diversification and energy security benefits for China as well. (Last year two-thirds of China's LNG came from just two suppliers—Australia and Qatar.)[55]

Although commercial fundamentals suggest there is potential for growing US-China LNG trade, political risks could slow that growth. As of this writing, US-China LNG sales have not been directly limited by broader US-China trade tensions. However, in response to the Trump administration's June 15, 2018, announcement of tariffs on $50 billion of Chinese goods, the Chinese Foreign Ministry announced it will impose tariffs on other US energy products, including crude oil, gasoline, naphtha, fuel oil and liquefied petroleum gas (LPG).[56] President Trump's statement that "trade wars are good and easy to win" and the Chinese government's tendency to respond to tariffs with retaliatory measures suggest a real risk that US-China trade tensions could significantly escalate in the months and years ahead. US-China LNG trade could be adversely affected by such tensions.

Another set of political risks comes from the Trump administration's willingness to reverse US policy on international agreements (such as the Iran nuclear deal and Paris climate accord) and disrupt longstanding alliances (such as with members of the G7). Before signing long-term LNG purchase contracts, importers evaluate the dependability of an exporting country's government, assessing the risk that the government will interfere with those contracts. Although the Trump administration has been full throated in support of LNG exports to China to date, its lack of respect for prior US agreements and alliances raises concerns in many countries about the durability of US government support for any policy. A recent commentary described one of the main advantages of Canadian LNG as providing "the stability of North America without the [...] complex politics of the United States, which could [...] entangle [US LNG] projects with broader trade and geopolitical considerations."[57]

Implications for Global Climate Goals

Natural gas can play an important role in helping China meet its climate goals. The Chinese government is firmly committed to the Paris climate agreement and has pledged to peak carbon dioxide emissions by 2030, making best efforts to peak earlier. It has also pledged to cut carbon emissions per unit of GDP by 60%–65% from 2005 levels by 2030. Replacing coal with natural gas can help significantly in meeting these pledges, since natural gas produces about half the carbon dioxide per unit of energy as coal when burned. Natural gas is an especially good substitute for coal in many applications, including in particular for generating heat in industrial processes and in buildings. The growth and development of China's natural gas sector can play an important role in meeting China's climate goals and contributing to global climate change mitigation.

There is one caveat: leaks in the course of production and distribution of natural gas could significantly diminish the climate change benefits of using natural gas to replace coal. Methane—the principal component of natural gas—is itself a powerful greenhouse gas. As a rough rule of thumb, if more than 3%–8% of the natural gas consumed as an energy source leaks, that would cancel the greenhouse gas benefits of switching from coal to natural gas. Leaking natural gas infrastructure is also economically wasteful, giving many market participants a direct financial incentive for avoiding it. As China scales up its natural gas infrastructure, attention to detecting and managing methane leaks will be important.[58]

Conclusion

Natural gas will play a growing role in China's energy mix in the years ahead, as a core part of the Chinese leadership's strategy for responding to serious environmental challenges, including urban air pollution and climate change. Domestic production and pipeline imports will be unable to keep up with rapidly growing demand, leaving LNG imports to fill the gap. Infrastructure constraints may limit LNG imports in the short term but will likely be resolved within several years.

The impact of LNG trade on the US-China bilateral trade deficit will be modest at most. Nevertheless, that trade could offer benefits to companies in both countries if trade tensions do not interfere.

China is shaking up natural gas markets as it emerges as the world's leading LNG importer in the next decade. Chinese LNG demand will be instrumental in investment in LNG supply around the world, including—potentially—the United States. Chinese natural gas could also deliver significant environmental benefits both in China and globally, although there are risks with respect to methane leakage that must be addressed.

As in other parts of the energy sector, as the giant awakens, the world will notice.

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At the Center on Global Energy Policy David Sandalow is the Inaugural Fellow and Founding Director of the US-China Program, Akos Losz is a Senior Research Associate, and Sheng Yan is Deputy Director for China. *The views represented in this commentary represent those of the authors. This work was made possible by support from the Center on Global Energy Policy. More information is available at* http://energypolicy.columbia.edu/about/mission.

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