INSIGHT OUT

Expert Voices on China's Energy and Environmental Challenges

Clearing the Air

Is Natural Gas China's Game Changer for Coal?

Wilson Center

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Clearing the Air: Is Natural Gas China's Game Changer for Coal?

Managing Editor: Luan (Jonathan) Dong

Change is nothing new for China. This vast country has in recent history transformed its economy, urban and rural landscapes, education system, and demography and more at an unprecedented speed. One equally critical change underway today is the government's efforts to reduce China's reliance on coal and shifting to cleaner energy sources. On this path, natural gas has emerged as a potential game changer.

China's drive to natural gas is ignited by the imperative to reduce air pollution that has significantly intensified in most of its eastern cities over the past two years. This shift, however, is bound to require costly investments, raise energy prices, and dampen economic competitiveness in the short term. Moreover, the government's rapid and extensive expansion of new energy sources also can create new environmental and social challenges.

The China Environment Forum invited three experts—one from the United States, two from China—to discuss whether China will be able to achieve its monumental shift to natural gas. First off, **Hengwei Liu** from Harbin Institute of Technology lays the groundwork on China's current natural gas supply and demand. **Xizhou Zhou** from IHS CERA then argues optimistically that China's energy market still has room to incorporate expansive natural gas, even if institutional reforms are absent. And finally, World Resources Institute's **Sarah Forbes** elaborates on how U.S.-China natural gas cooperation can benefit both countries.

This is the first issue of CEF's new *Insight Out* series, designed to tap on-the-ground expertise to understand the complex energy and environmental challenges facing China. As with much of our work, we cast an eye on opportunities for collaboration between American and Chinese researchers, business, NGOs, and governments.

Sarah Forbes has been a Senior Associate at the World Resource Institute since 2008 and she leads the technology consortium within the climate and energy program, managing the WRI initiatives on shale gas and carbon dioxide capture and storage (CCS) in China.

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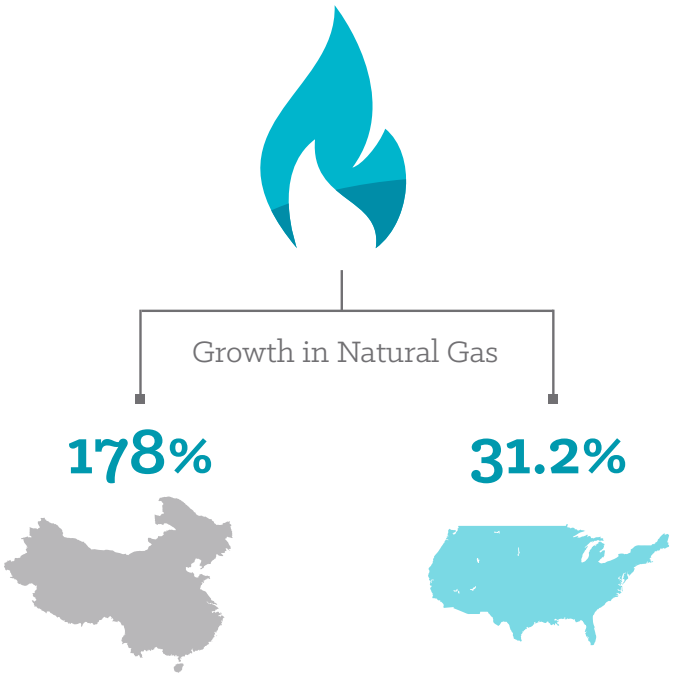
China's Growing Appetite for Natural Gas

By Hengwei Liu

Chinese leaders have embarked on a war against pollution and the chief enemy is coal fired power plants, which are a major source of the smog shrouding Chinese cities. A central part of the battle includes capping coal use to below 65 percent of total energy consumption by 2017, down from 69 percent in 2012. To help fill the gap left by this desired drop in coal use, the central government plans to boost the share of natural gas in the energy mix from 4.7 percent in 2012 to 10 percent by 2020. This represents a 178 percent increase in production volume—144 billion cubic meters (bcm) to 400 bcm—in only eight years. To put this in perspective, U.S. natural gas production over the past eight years—with the help of shale gas revolution—only increased 31.2 percent.



COAL CAP

usage below

65%

HUGE RESERVES YET SHORT SUPPLY

China is devoting great efforts to step up domestic production of both easily extractable conventional and more expensive unconventional gas. Conventional natural gas has, to date, supplied most of the demand. But continued reliance on this resource will be difficult, as China has only 1.7 percent of the world's proven conventional gas reserves, and production has outpaced new reserve discoveries.

Classified as a conventional resource in China but unconventional in the rest of the world, **tight gas** is widely found in China's large sedimentary basins and represents country's most accessible and reliable gas resource. Tight gas development has been transforming the country's gas market in similar ways as shale gas did in the United States. The tight gas output hit a record high of 30 bcm in 2012, nearly one-third of China's total gas output. It is projected that China's tight gas output will reach 50 bcm by 2015 and 80 bcm by 2020. But even this breakneck pace of expansion is not enough to meet China's gas demand and move the needle on reducing coal dependence.

UNCONVENTIONAL DREAMS

The U.S. shale gas revolution has sparked hopes that unlocking China's massive shale resources could help meet the country's skyrocketing natural gas demand and ease its heavy reliance on coal. But China's revolution in **shale gas** is more a distant dream than an upcoming miracle due to extraction obstacles—most reserves are locked in complex geological conditions in the southwest or reside deep in the arid west. So far fewer than 200 shale gas wells have been drilled, compared with around 40,000 wells in the United States. China's shale gas production in 2013 reached a mere 200 million cubic meters, far short of the central government's goal of 6.5 bcm by the end of 2015 and 60-100 bcm by 2020. The Chinese oil industry currently intends to focus on perfecting expertise in conventional and tight gas and then to transplant these skills to shale gas extraction.

Sitting on the third largest **coalbed methane** (CBM) reserves in the world, China's leadership hoped these reserves could produce 10 bcm of gas per year by 2010. The actual production, however, was only 1.5 bcm/y. Despite this marked shortfall, the central government set even more ambitious 2015 targets of 16 bcm/y (~100% utilization) for CBM and 14 bcm/y (> 60% utilization) for coal-mine methane. The lack of sufficient subsidies for these unconventional gas reserves, the overlap of mining rights between these gas resources, and the continued dominance of coal have slowed methane production considerably.

China is rapidly emerging as a global leader in converting coal to gas—typically referred to as **synthetic natural gas** (SNG). The possibility of carbon emission capture during the conversion process makes it a "clean coal technology" to many policymakers. The central government has targeted a rise in China's SNG output to 50 bcm/y by 2020. As of 2013, Beijing has approved nine large-scale SNG plants with a total capacity of 37.1 bcm/y. Many more facilities are in the planning phases, but the associated high carbon emissions, extensive water needs, and wider environmental impacts could limit their potential.

NATURAL GAS IMPORT SURGE

To meet its rapidly growing demand, China has been establishing four strategic energy corridors to boost gas imports and diversify its gas supplies. The **China-Central Asia gas pipeline** is China's first international gas pipeline, which transports natural gas through twin parallel pipelines from Turkmenistan, Uzbekistan, and Kazakhstan to China's western border. These countries are currently expanding the pipeline capacity (currently 30-40 bcm/y) in order to transport more gas to China, particularly from gas-rich Turkmenistan. Overall, Central Asia gas exports to China could reach 100 bcm/y by 2020.

China-Myanmar gas pipeline, which came online in 2013, links Yunnan Province with Kyaukphyu, a port city in northwest Myanmar. The initial gas import is a modest 4 bcm/y but will likely be ramped up to a full capacity of 12 bcm/y as Myanmar develops adjacent gas fields.

This gas deal represents a major step forward for both countries as China secures a major new source of the clean-burning fuel while Russia diversifies its gas sales to Asia and away from stagnant European markets.

After more than a decade of tough talks, in mid-2014 China signed a long-awaited **30-year natural gas supply deal with Russia** to build a 38 bcm/y pipeline to deliver gas from East Siberian fields to China starting in 2018. The reported volume is less than the 68 bcm/y that Russia would have exported under an earlier agreement that envisaged shipment from both East and West Siberia. Nevertheless, the final gas deal represents a major step forward for both countries as China secures a major new source of the clean-burning fuel while Russia diversifies its gas sales to Asia and away from stagnant European markets.

Accounting for over six percent of the global **liquefied natural gas** (LNG) trade, China became the world's third largest LNG importer in 2012. Its import regasification capacity reached 42.5 bcm/y by 2013, and will continue to grow to 54.4 bcm/y by 2015 and to 82~136 bcm/y by 2020. Though import volume is expected to increase, LNG's higher market-based prices have failed to compete with price-regulated domestic sources and even pipeline imports.

MORE DOWN THE PIPELINE

Despite having huge untapped unconventional reserves, China is unlikely to satisfy its fast-growing demand by itself. The policy to accelerate gas development in China will not easily materialize as it requires both technical breakthroughs and tough institutional reforms.

The country faces a more complex geology, inadequate or lack of access to water and infrastructure, as well as more complex mineral rights ownerships than the United States. Moreover, the large state-run companies heavily dominating the Chinese oil and gas sector hold vertical market monopoly, controlling almost everything from upstream to downstream. In such an environment, the pricing of natural gas cannot possibly reflect the real balance between supply and demand.

To overcome the technical and regulatory hurdles, Chinese oil and gas firms need to adapt the advanced technologies developed in the United States to China's geology. Moreover, the Chinese government needs to draft new rules to encourage private investment to the tightly state-controlled oil and gas sector. Monopoly-breaking reforms on China's gas market will be critical to ramp up private investment in the sector in order for the government to successfully utilize global gas resources and unlock its huge domestic unconventional gas reserves■

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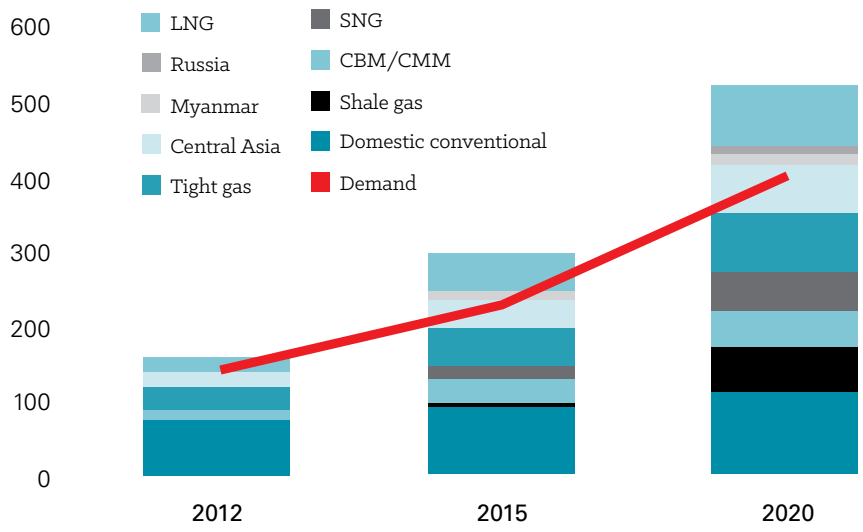
China's Natural Gas Balance



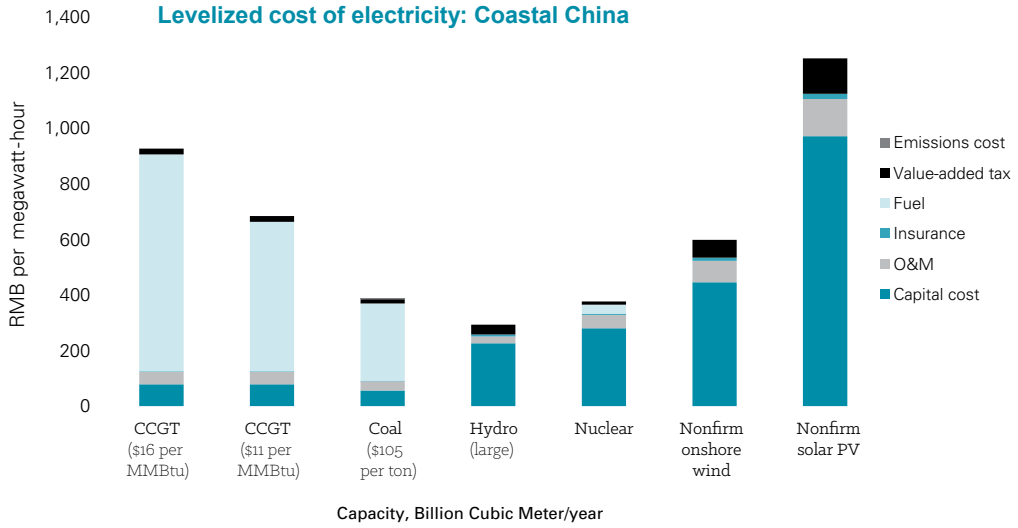
Sources: BP, NBS, NDRC, EIA, CNPC, SINOPEC, CNOOC, CAE, and author's estimates.

Ending Baobiao: Is China's Switch to Natural Gas Affordable?

By Xizhou Zhou

"Beyond index" (baobiao 爆表), is the watchword in Chinese urban households, describing times when air pollution is truly off the charts and prompts many to stay indoors or wear filter masks outside. Over the past year, baobiao has been announced with alarming frequency on hourly air quality index broadcasts in more than a hundred cities along China's east coast. This pollution—primarily from coal-fired power plants—is exacting a high cost on China. The cost of burning coal is falling in China, a trend that ironically could help one the most promising cleaner energy alternatives—natural gas—to expand.

Figure 1: Combined Cycle Gas Turbine Power Substantially More Expensive



Notes: CCGT excludes heat generation; "nonfirm wind" and "nonfirm solar PV" do not include costs related to grid integration of intermittent renewable; CCGT: RMB 2,940 per kilowatt (kW) capital expenditure (capex) 44% efficiency, 38% utilization. Coal: RMB 3,375 per kW capex, 37% efficiency, 55% utilization. Hydro: RMB 10,000 per kW c apex, 42% utilization. Nuclear: RMB 20,100 per kW, 89% utilization. Onshore wind: RMB 7,500 per kW, 19% utilization. Solar PV: RMB, 153 per kW, 15% utilization. Source: IHS Energy

NATURAL GAS IN POWER: KEY FUEL SUPPLY AND PRICE CONSTRAINTS

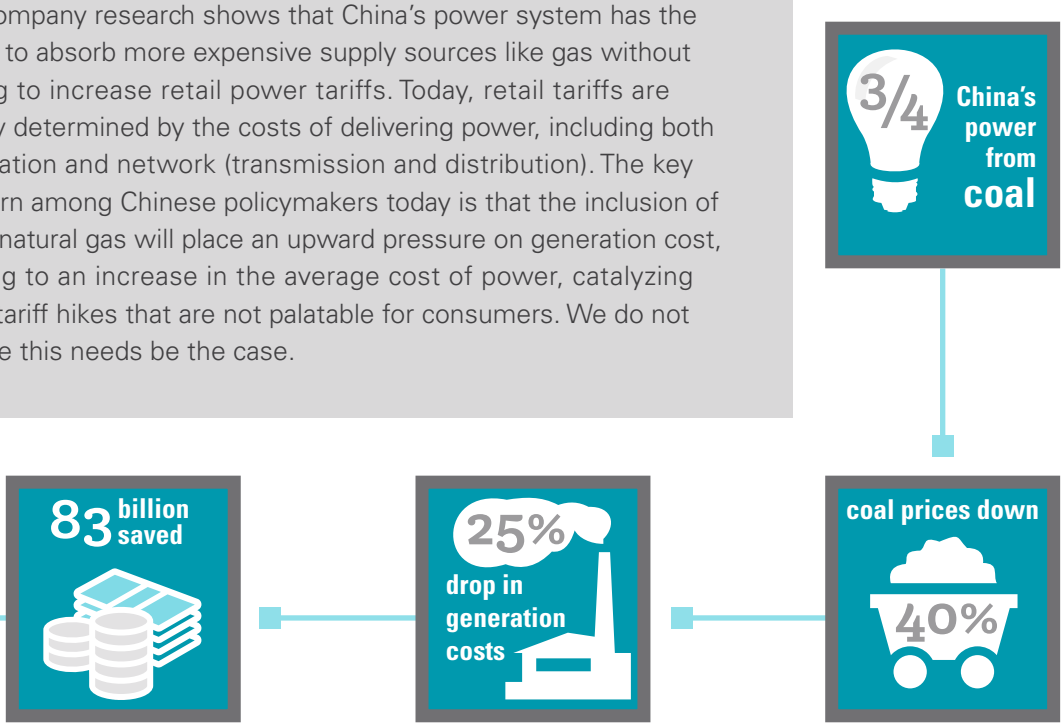
The biggest obstacles to China's switch to gas are limited supply availability and high prices. One-third of China's gas supply is already from imported sources, including liquefied natural gas from Qatar and Australia and pipeline gas from Central Asia and Myanmar. Natural gas imports to China are priced significantly above the levels that prevail in North America and Europe. To encourage supply, the Chinese government has implemented reforms to increase domestic gas prices to import levels.

Burning gas for power in combined cycle gas turbines (CCGT) in coastal China is therefore costly, easily twice as expensive as production of coal and many other fuels and technologies. (See Figure 1). Electricity price escalation is a highly sensitive issue for the Chinese government, which has in the past restricted the pass through of fuel cost increases to consumers. It is thus doubtful whether the country has the appetite for more gas in its power generation mix if it comes at a high price.

1/3 Natural gas imported from Australia, Qatar, and Central Asia

CAN CHINA AFFORD GAS FOR POWER?

IHS company research shows that China's power system has the ability to absorb more expensive supply sources like gas without having to increase retail power tariffs. Today, retail tariffs are largely determined by the costs of delivering power, including both generation and network (transmission and distribution). The key concern among Chinese policymakers today is that the inclusion of more natural gas will place an upward pressure on generation cost, leading to an increase in the average cost of power, catalyzing retail tariff hikes that are not palatable for consumers. We do not believe this needs be the case.



CHEAPER COAL: GOOD NEWS FOR GAS-FIRED POWER IN CHINA

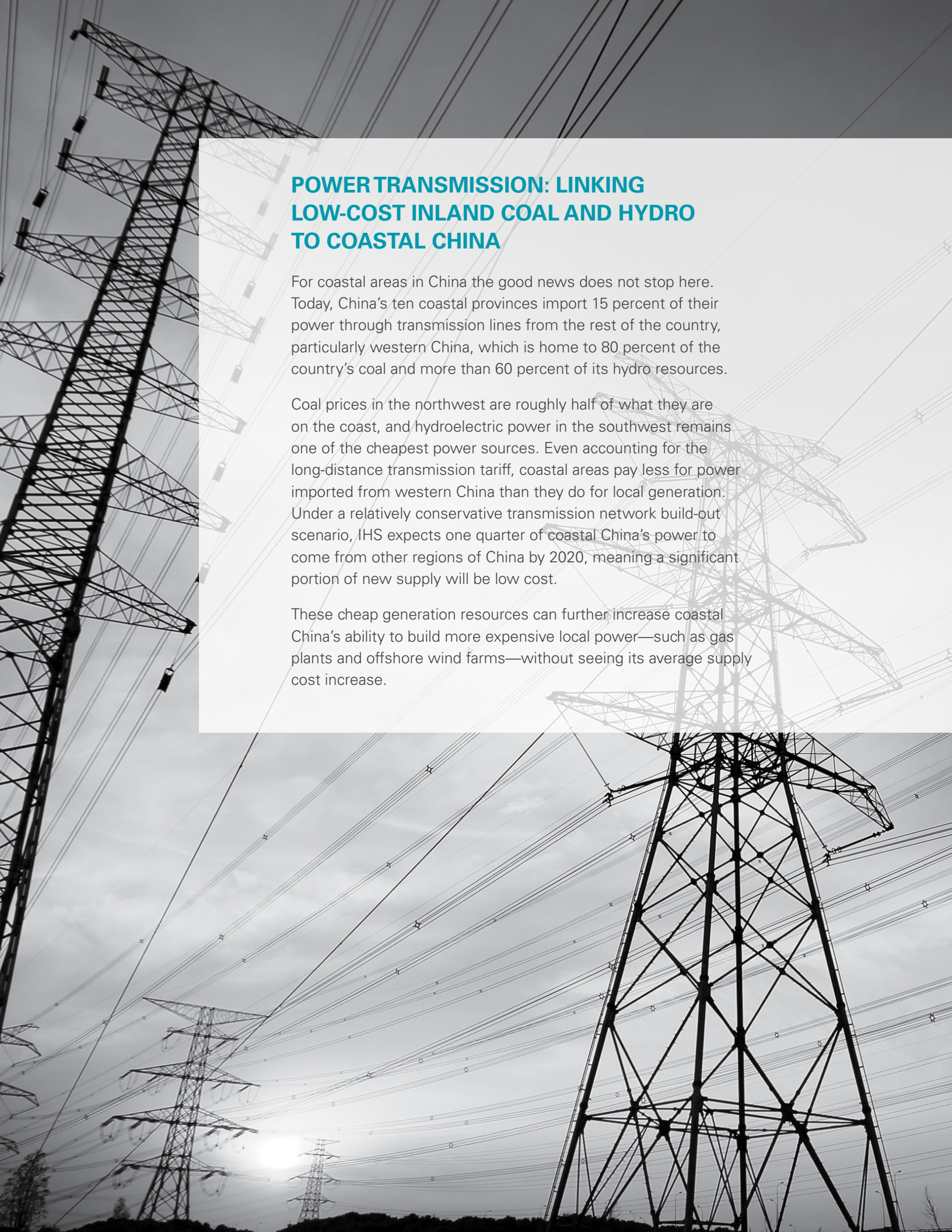
A key factor shaping the average cost of power generation in China is that coal is becoming cheaper, even as expensive new generation technologies are added to the mix.

Coal currently accounts for roughly three quarters of China's power generation, and coal prices have dropped 40 percent over the past two years. Since the bulk of the cost of running a Chinese coal-fired unit is paying for fuel, any drop in coal prices leads to a significant drop in the cost of power.

IHS estimates that the cost of coal-fired power generation in coastal China on average has dropped by almost one quarter between 2011 and 2013. Nationally, the reduction in coal prices has saved utilities more than RMB 500 billion ($83 billion) over that two-year period. By comparison, the total cost premium paid to add new gas-fired power is estimated at about only RMB 10 billion ($1.6 billion), over the past two years.

In other words, the decreasing cost of coal-fired power can offset the incremental cost of more gas-fired power in the future. In a counterintuitive twist, the drop in coal prices has been very good news for gas-fired power in China.

Additional money now available to invest in developing natural gas



POWER TRANSMISSION: LINKING LOW-COST INLAND COAL AND HYDRO TO COASTAL CHINA

For coastal areas in China the good news does not stop here. Today, China's ten coastal provinces import 15 percent of their power through transmission lines from the rest of the country, particularly western China, which is home to 80 percent of the country's coal and more than 60 percent of its hydro resources.

Coal prices in the northwest are roughly half of what they are on the coast, and hydroelectric power in the southwest remains one of the cheapest power sources. Even accounting for the long-distance transmission tariff, coastal areas pay less for power imported from western China than they do for local generation. Under a relatively conservative transmission network build-out scenario, IHS expects one quarter of coastal China's power to come from other regions of China by 2020, meaning a significant portion of new supply will be low cost.

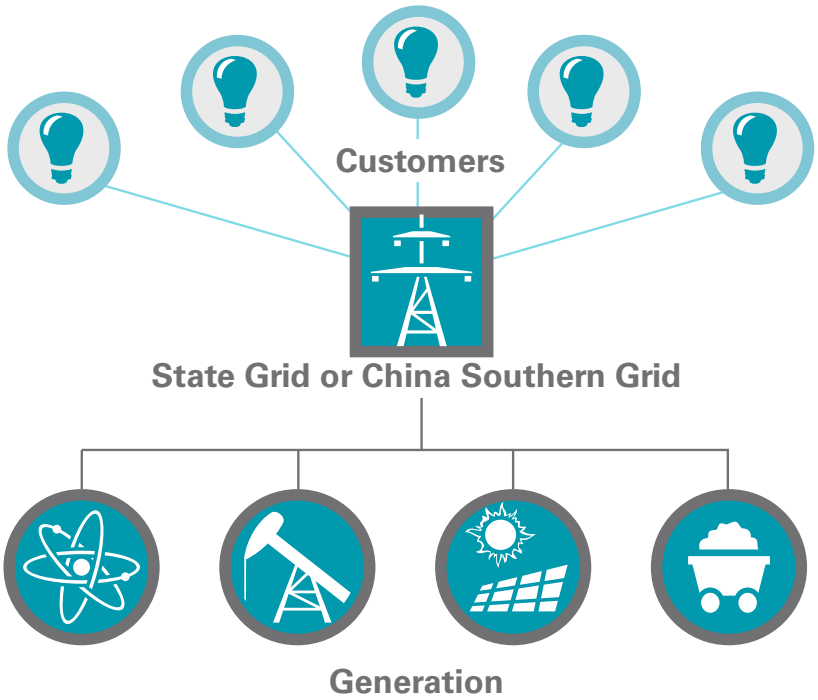
These cheap generation resources can further increase coastal China's ability to build more expensive local power—such as gas plants and offshore wind farms—without seeing its average supply cost increase.

FURTHER TRANSPARENCY REQUIRED TO FULLY REFLECT MOVEMENTS IN COSTS

A study recently completed by IHS, *Solving the Tangram: China Regional Gas and Power Scenarios* quantifies the changes in power generation costs at a provincial level and paints a future where China's gas-fired power fleet can continue to expand—alongside renewables—without asserting upward pressure on the average cost of power generation in China. This is also a future where gas-fired generators will be fairly compensated for the higher cost power production (just like wind and solar power), and one in which gas suppliers will not lose money by procuring gas from the global market.

But how much institutional change does this great future require? Here is one more piece of good news: it does not require any significant market reforms like the kinds the Chinese government has proposed, but barely implemented during the last decade—e.g., separation of transmission and distribution, full opening of a wholesale energy market. In fact, the current single-buyer model of China's power market, whereby a regional utility (either State Grid or China Southern Grid) is the only purchaser from generators, allows the utility to pool power generated from different sources—some of which are more expensive while others are cheaper—and balance their supply portfolio.

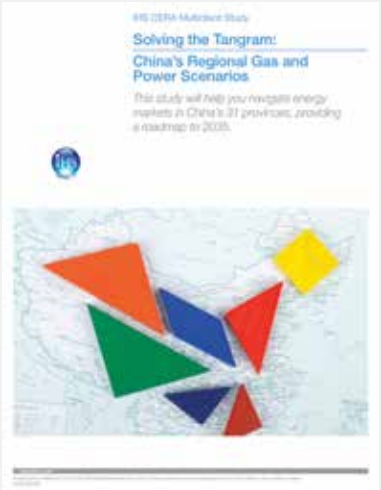
China's Electric Grid... From Generation to Customer



> Transparency will allow all parties involved to agree on costs and prices and honor the associated energy market transactions that can help China clear its air.

In other words, the current market structure is suitable for achieving a cleaner energy future without tariff hikes. Certain aspects of market reforms, however, do need to continue. In particular, further reduction in market opaqueness is urgently needed to ensure that the costs at each part of the value chain are clearly accounted for, and that the public and regulators have a timely and honest view on any changes in these costs. Transparency will allow all parties involved to agree on costs and prices and honor the associated energy market transactions that can help China clear its air■

Xizhou Zhou is Director of IHS CERA Beijing Office.



Acknowledgments

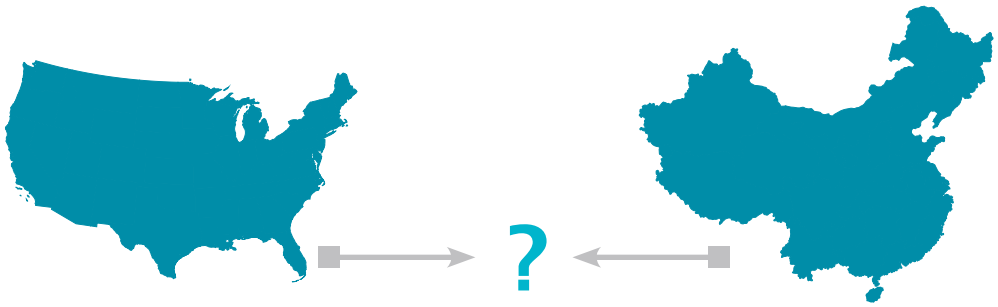
This Op-Ed piece draws on *Solving the Tangram: China Regional Gas and Power Scenarios*, a groundbreaking new study that builds on IHS's 15 years on-the-ground research on China's energy sector. The study provides regional-level gas and power market analysis, with long-term outlooks for China's 31 provincial-level regions.

Can Collaboration Reduce Uncertainty in China's Shale Future?

By Sarah Forbes

Many parallels exist in the U.S. and Chinese energy profiles. Both are continent-sized countries with geographically dispersed energy resources and with energy demand centers (cities) that are often far from energy supplies. Both countries currently rely heavily on fossil fuels to power their economies, primarily drawing on coal, natural gas, and imported oil. Both countries seek to increase energy independence by diversifying the energy mix and ramping up domestic energy production, particularly unconventional fossil fuels such as shale gas. If shale gas can provide a significant substitute for coal, it could result in a net reduction of carbon emissions for China, the world's largest emitter.

Yet these similarities belie the challenges unique to China in the context of shale gas development. If China were to simply replicate U.S. R&D programs and incentives for shale gas development, it would likely be unsuccessful in addressing the specific key barriers and questions central to the sector's successful development. Moreover, if China were to replicate the regulatory exemptions for the industry seen in the United States, it would likely result in costly environmental degradation that affects people, ecosystems, and the economy. Despite the unique context of shale gas in China, U.S. experience with technological development and policy design can contribute to responsible development of shale gas in China and foster opportunities for U.S. researchers, academics, and industry interested in cooperating on shale gas development in China.



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THREE E's ON WHY THE UNITED STATES AND CHINA SHOULD COLLABORATE ON SHALE GAS

Here are three reasons for why and how international cooperation between the United States and China can help.

Environmentally Smart Development

Unlocking China's large shale gas reserves requires serious attention to managing fugitive methane emissions. It will also be necessary to effectively address other risks, including competition for water resources, along with other significant air quality problems and water pollution threats. Bilateral collaboration offers one promising avenue for achieving the environmental benefits while meeting China's growing energy demand, in part by sharing information and building on the U.S. experience with regulating production.

Energy Security

From a global geopolitical perspective, increased domestic energy security in China decreases dependence on energy imports from unstable regions. Expected rising gas demand in China could provide opportunities for U.S. exports at some point if Chinese domestic production proves insufficient.

Economic Development

U.S.-China collaboration on shale gas can also create opportunities for U.S. companies looking for new market opportunities overseas (providing oilfield services, for example) and benefit Chinese companies seeking to enter a new market, either at home or abroad. While there can be beneficial spillover effects to economic development associated with energy development, the external costs to society and the environment must be mitigated through sound environmental policy.

Moving Forward

MOVING FORWARD

Here are the three simple approaches to help ensure U.S.-China collaboration yields a legal and regulatory framework for shale gas in China that promotes responsible development:

1

Substantive work on environmental regulations for air, water, and climate impacts. Comprehensive, lifecycle environmental concerns regarding shale gas development should be addressed much more in future energy collaboration. The U.S. experience with shale gas development has generated an increased understanding of the environmental impacts associated with development and how to avoid them with thorough regulatory actions as well as adoption of best practices. This new area of collaboration should not be relegated to engagement among environmental regulators in both countries but should also include cooperation between academics and think tanks, as well as ministries and cabinets such as the China's National Development and Reform Commission and U.S. Departments of Energy and State. This collaboration should involve both technical and policy aspects of environmentally sound shale production. One way to accomplish this would be to initiate a platform for multi-agency/ ministry dialogue between the countries that is focused specifically on environmental policies needed for safe shale gas deployment in China. Such a platform could be a part of the already existing shale gas initiative and should involve industry, NGOs, academia, and government entities.

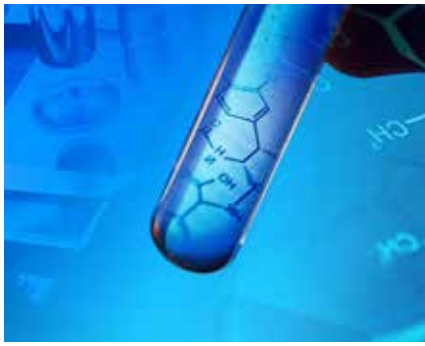
2

Small company involvement, personnel training, and more transparency. Business-to-business collaboration around shale gas will continue to be important, but there are barriers that must be addressed for it to be effective. They include inadequate involvement of smaller companies on both sides, insufficiently trained Chinese engineers to drill wells, difficulty in investing in shale assets in both countries, and sensitivities surrounding information and technology sharing.

To remedy these issues, both governments could initiate an industry forum—perhaps as an offshoot of the oil and gas industry forum—focused on the interests and needs of the small(er) shale gas companies. A new workforce training program could provide exchange opportunities for young professionals from both countries to have extended stays in shale gas companies. This would help to cultivate a group of trained reservoir engineers, ready to support shale gas development anywhere in the world. Leaders in both governments should jointly discuss the barriers to data and finance, and could begin by commissioning a joint report from industry, government, and academic stakeholders in both countries.

3

Facilitate opportunities for joint R&D. While existing technical collaboration is important, it should evolve into deeper efforts that include exchanges of researchers and dialogues aimed at solving the unique challenges of shale production in China. Both governments should fund researchers in academia and industry to partner bilaterally and co-develop novel approaches for conserving water use (e.g., waterless fracking) and to develop new approaches for reducing air emissions and other environmental impacts associated with shale gas development.



Taking this recommendation seriously means prioritizing extended exchange programs over short workshops and meetings. It also means expanding beyond questions around geology and technology and including joint research on the economic and policy aspects of shale gas development. A collaborative research and demonstration program, similar to what has been established under the Sino-U.S. Clean Energy Research Center program would be one way to encourage joint technology development and demonstration■

This piece was adapted and embellished from a paper Sarah drafted recently for the Brookings Institution, "The United States and China: Moving Towards Responsible Development of Shale Gas." Sarah Forbes is a Senior Associate at the World Resource Institute and she can be reached at sforbes@wri.org.

The Price to Pay

A central message in all of the above essays is that even without monumental institutional reform in China's energy sector, a significant shift to natural gas is happening. Getting the pricing set right will be an essential component to making natural gas marketable and cost-competitive with other energy sources. Encouragingly, the central government has embarked on gas price reforms, using market pricing to replace price controls in pilot schemes in Guangdong and Guangxi provinces. Other advances in market access, price transparency, financing, technology innovations, and beyond will be important to catalyzing domestic production.

These steps could help the country decrease its reliance on coal—but only so much. Even if China reaches its aggressive natural gas target of supplying 400 bcm by 2020, coal's share in the nation's primary energy consumption would most likely still be above 50 percent. Nevertheless, natural gas is the first potential game changer to coal's reign, and may be an important bridge fuel before truly zero-emission renewables become a substantial portion in China's energy mix. With lessons learned and reforms achieved in the gas sector, it may be much easier for other forms of energy to follow suit and get a bigger cut of the pie. Perhaps more importantly, China's slow and steady progress in expanding natural gas is bound to have a much bigger impact in global markets and geopolitics.

China's change in natural gas will not happen overnight, neither will its reduction of air pollution. But the suffocating smog in Beijing and the difficult reforms around the sector may very well be the necessary price to pay for the country to start changing the way it is powered and heading down the path to a cleaner energy future ■



China Environment Forum's Role as Convener and Catalyst for Action

For 17 years the Wilson Center's China Environment Forum has carried out research and exchange projects on a broad range of energy and environmental issues in China—from U.S.-China clean energy cooperation and water-energy choke points in China to food safety and the ecological impact of China's overseas investment.

Insight Out is a new publication series that is supported by the blue moon fund, as part of CEF's Cooperative Competitors Initiative, which creates dialogues and publications for policy, business, research and NGO professionals to understand energy trends in China and explore opportunities for U.S.-China energy collaboration.

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