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CHINA'S ENERGY CROSSROADS

Forging a New Energy and Environmental Balance

By Philip Andrews-Speed, Mikkal E. Herberg, Li Zhidong, and Benjamin A. Shobert

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China has emerged as the world's single largest energy consumer, and the country's phenomenal economic growth has increased global demand across the spectrum of fuel choices, particularly coal, oil, gas, and nuclear power. Surging demand has not only dramatically reshaped world energy markets but also raised new and more complex questions for stakeholders concerned with developments in China's domestic energy infrastructure, environmental policy, and global energy diplomacy. China is struggling to reshape its domestic economy to address energy and environmental concerns. Two critical parts of this effort are decreasing the economic role of heavy, energy-intensive industries and reducing the enormous fossil-fuel requirements currently necessary for sustaining economic growth.

With these issues in mind, the National Bureau of Asian Research (NBR) held its tenth annual Energy Security Workshop—"China's Energy Crossroads"— in Washington, D.C., on June 5, 2014. Building on NBR's long-standing program to bring together policymakers, industry leaders, and specialists on energy security, the annual workshop convenes senior stakeholders for high-level discussions on developments in Asian energy markets and the implications for geopolitics. Over the course of the year, the arguments presented are then tested and explored through further dialogue with leading experts in both the United States and Asia. As a culmination of these efforts, this final report presents the program's findings and highlights how stakeholders on both sides of the Pacific can strengthen their cooperation on a common goal of promoting energy security in the Asia-Pacific.

In this NBR Special Report, four senior energy and geopolitical specialists examine major shifts underway in China's energy security strategies and assess how the country is affecting market, geopolitical, and environmental outlooks for the Asia-Pacific more broadly. The first two essays explore a range of issues that are more traditionally associated with energy security in China: Philip Andrews-Speed examines the dynamics of China's energy policymaking, while Mikkal E. Herberg details the country's expanding impact on global oil and gas markets. The second half of the report then explores the increasingly important question of how environmental security factors into energy security discussions. In the third essay, Li Zhidong discusses the prospects for peak coal demand in China, the policies and strategies in place for making peak demand a reality, and continuing uncertainties in the country's energy and environmental outlook. Next, Benjamin A. Shobert explains why China's environmental concerns are growing in importance as a driver of the country's public policy and considers the impact of Beijing's approaches to environmental challenges on governments and citizens across the Asia-Pacific. Finally, a conclusion by Mikkal E. Herberg offers overarching insights into China's efforts to achieve a balance between energy and environmental security.

Overall, the four essays in this report paint a picture of an increasingly complex energy landscape within China. As several authors so aptly highlight, while only a few years ago China was focused on the challenge of securing energy supplies to promote economic growth, today it also faces the much more nuanced challenge of sustaining growth while addressing the country's very real—and very pressing—environmental concerns. At the same time, China's growing energy diplomacy and presence in markets ranging from Central Asia to the Middle East and Africa to North America confirm its emergence as an energy superpower, and Beijing now faces questions about its potential for leadership in the global arena. As a result, how China pursues its energy security goals has significant implications not only for Chinese citizens but for the environmental, economic, and geostrategic outlooks of Asia and the rest of the world.

There are a number of individuals and groups deserving of both our recognition of their invaluable contributions and our deep thanks for making this program possible. First and foremost, we are grateful for the generous support of our sponsors—the Asian Development Bank, Chevron, ConocoPhillips, ExxonMobil, and the Henry M. Jackson Foundation—whose contributions enable us to examine the central energy-security challenges facing the United States and the Asia-Pacific today. We are also appreciative of the Woodrow Wilson International Center for Scholars for cohosting this program's June workshop and to the Ronald Reagan Building and International Trade Center for cosponsoring that event. Finally, we are grateful to the dozens of leading scholars and practitioners who informed and sharpened this year's research by sharing their time and insights. We look forward to continuing to work with these wonderful partners and collaborators over the next ten years.

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China's Energy Policymaking Processes and Their Consequences

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EXECUTIVE SUMMARY

This essay examines the dynamics of China's energy policymaking and how differences in the context and processes for various initiatives ultimately shape their implementation and potential for success.

MAIN ARGUMENT

China faces a number of severe energy challenges, relating notably to energy supply security and environmental cost, as well as to investment efficiency and social equity. With this in mind, the Xi Jinping government has inherited or launched several important policy initiatives that aim to reshape the country's energy portfolio and that directly affect the energy sector. These initiatives include efforts to advance the continued reduction of energy intensity and carbon emissions, the radical reduction of air pollution, the reform of state-owned enterprises (SOE), and the reform of the pricing systems for energy products. Considered collectively, these policy initiatives involve quite different sets of strategies to achieve their ultimate goals. Such differences ultimately shape how various programs are implemented and suggest likely intended (and unintended) consequences based on observations of past efforts.

POLICY IMPLICATIONS

- China's Action Plan for the Prevention and Control of Air Pollution outlines a series of ambitious goals for the industrial sector, and addressing air pollution is a high priority for the Xi government. To be successful, this plan will need to be supported by a number of measures, including strategies for the power sector, for identified industries, and for key regions. Yet success will also require longer-term structural and policy shifts inside China, which will be more challenging for policymakers to achieve.
- To date, China's energy sector reforms have had the desired consequences of raising money, transforming management incentives, improving technical and commercial performance, and creating the basis for international expansion. However, the government has undertaken only limited steps to develop competition within domestic oil and gas markets, which will be needed to further advance the sector's reform.
- While the Chinese government's ambition to introduce carbon trading is to be applauded, effective implementation faces a number of serious obstacles. Ultimately, these trading experiments are unlikely to bring about significant emissions reductions without a concurrent loosening of state controls on SOE ownership and energy pricing.

China faces a number of severe energy challenges, relating notably to energy supply security and environmental cost, as well as to investment efficiency and social equity. With this in mind, the Xi Jinping government has inherited or launched a number of important policy initiatives that aim to reshape the country's energy portfolio and that directly affect the energy sector. These initiatives include efforts to advance the continued reduction of energy intensity and carbon emissions, the radical reduction of air pollution, the reform of state-owned enterprises (SOE), and the reform of the pricing systems for energy products. Considered collectively, each of these policy initiatives involves quite different sets of strategies to achieve its ultimate goals. The initiatives also possess differing characteristics relating to the role of policymaking, methods of implementation, and likely intended (and unintended) consequences.

This essay seeks to show how different types of energy policy initiatives in China emerge from different contexts and processes and assesses how these differences shape the initiatives' implementation and their potential for success or failure. The first section examines the historical considerations that have shaped China's energy policies, how these considerations are changing, and what views remain constant. The essay next outlines an analytical framework that parses Beijing's energy strategies into four core types of programs. The following section then applies this framework to five high-level policy programs—focusing on air pollution control, oil and gas production, renewable energy, industry reform, and carbon markets—to better understand what we can expect to see in terms of future developments and prioritization. The essay concludes by arguing that our analysis of these select efforts suggests that the outcomes of ongoing policy programs to change the energy mix, reduce pollution, and reform the state-owned energy companies are extremely uncertain.

The Prevailing Policy Paradigm and Changing Policy Priorities

In China, as in many countries, the government formulates national energy policy in the context of a prevailing paradigm—that is, a set of shared beliefs, values, ideas, and principles relating to the world or to a particular sector. This paradigm can ultimately shape how challenges are identified and addressed.[1] For the purposes of this essay, three key elements of China's energy paradigm are discussed: a preference for self-reliance in energy supply, growing attention to environmental security, and a strong view on the role of the state in sector governance.

Preference for Self-Reliance in Energy Supply

Since 1949, a constant concern of the Chinese government has been securing an adequate supply of energy to support a growing economy. A traditional preference for self-reliance was a necessary response to the diplomatic isolation of the Communist government, especially after the break in relations with the Soviet Union in 1960. Until the early 1990s, the focus of the government was on the need to exploit domestic sources of energy.[2] This led to the dominance of coal and, secondly, oil in the nation's energy mix.

This emphasis on domestic sources changed in 1993 when China became dependent on imported oil for the first time in its history as oil demand surged ahead of domestic production.

[1] Dieter Helm, "The New Energy Paradigm," in *The New Energy Paradigm*, ed. Dieter Helm (Oxford: Oxford University Press, 2007), 1–35; and Catherine Mitchell, *The Political Economy of Sustainable Energy* (Basingstoke: Palgrave MacMillan, 2008).

[2] James P. Dorian, *Minerals, Energy, and Economic Development in China* (Oxford: Clarendon Press, 1994).

Growing dependence on oil imports since then and high international oil prices since 2003 have caused oil to rise steadily up the agenda of the central government. But the continued ability of international markets to supply these imports and China's ability to pay for them meant that this increasing vulnerability did not bring security of oil supply to the top of the agenda. In contrast, when Chinese policymakers realized that the country faced a major shortfall in domestic energy supplies of all types, including coal (particularly for increasing the availability of electricity), energy security became a national priority. Policymakers at the national level, led by Wen Jiabao, believed that immediate and radical action was needed to ensure that the economy and people's livelihoods were not seriously damaged by a shortfall in energy supply. As a result, policy and industry attention switched from the production of energy to its consumption, as well as to the challenge of reducing waste in all parts of the energy supply chain. Thus, in 2004 the government issued its first Medium and Long-Term Energy Conservation Plan, and three years later it revised the Energy Conservation Law of 1997, which had proved ineffective. This concerted attempt to reduce national energy intensity was soon followed by efforts to address the environmental impacts of energy production and use.

Growing Attention to Environmental Security

At the same time as the government was formulating new policies to reduce national energy intensity, it also realized that climate change was an urgent challenge and issued its first Climate Change Program in 2007. This came in response to a surge in carbon dioxide emissions in China, which had surpassed the United States to become the largest emitter in the world. In addition, there was a growing awareness that large areas of the country were vulnerable to the impacts of global climate change. Coupled with broader concerns about energy supply security, the growing prioritization of climate change led the government to make a more concerted attempt to boost the deployment of renewable energy; to that end, in 2009 it revised the Renewable Energy Law of 2005. Additionally, since 2012, pressure has mounted on the government to combat the frighteningly high levels of atmospheric pollution across the country, which are caused primarily, but not solely, by the ever-increasing quantities of coal burned. This issue has stimulated a renewed push by the Xi government to enhance the share of natural gas and renewable sources in the energy mix—an initiative that is exemplified by the Action Plan for the Prevention and Control of Air Pollution issued by the State Council in September 2013. **Table 1** highlights the rising frequency of legislative and policy initiatives to support the transition to a low-carbon economy.

The Strong Role of the State

A third element of China's energy policy paradigm—the strong belief in the role of the state in the energy sector—has played a critical role in constraining the way in which the sector is governed. In particular, the government continues to prefer direct state control over the energy sector, despite the privatization that has occurred in many other sectors of the economy.

While initially Chinese government involvement in the energy sector was implemented through the Ministries for Petroleum, for Coal, and for Electrical Power, more recently its involvement has been through the less direct method of state-owned energy companies. Yet despite commercialization, these companies, especially those owned at the central government level, remain under relatively tight government control concerning senior appointments and strategy.

TABLE 1 Selected laws and policies relating to the low-carbon energy transition in China

Year	Laws	Programs and policies
1996	–	• Brightness Program (solar PV)
1997	• Energy Conservation Law	–
2002	–	• Township Electrification Program (solar PV)
2003	–	• First concession bidding round for onshore wind power projects
2004	–	• Medium and Long Term Energy Conservation Plan
2005	• Renewable Energy Law	–
2006	–	• Catalogue of High Technology Products for Export
2007	• Revised Energy Conservation Law	• National Climate Change Program • 11th Five-Year Plan for Energy Development
2008	–	• 11th Five-Year Plan for Renewable Energy Development
2009	• Revised Renewable Energy Law	• First feed-in-tariff scheme for onshore wind energy • First concession bidding round for onshore solar PV projects • Rooftop subsidy and Golden Sun programs (solar PV)
2011	–	• First feed-in-tariff scheme for solar PV
2012	• Draft Climate Change Law	• 12th Five-Year Plan for Renewable Energy Development
2013	–	• 12th Five-Year Energy Development Plan • State Council Opinion on Promoting the Healthy Development of Photovoltaic Industry • Action Plan for the Prevention and Control of Air Pollution

The State-owned Assets Supervision and Administration Commission and the Communist Party determine the senior appointments in the centrally owned enterprises.

While the energy companies are generally free to pursue their corporate and commercial objectives, the government can and does intervene when national interests are at stake. For instance, direct pressure from the government was needed to overcome PetroChina's reluctance to embark on shale gas development in China, which did not appear commercially attractive. As noted above, this contrasts with enterprises in most other sectors of China's economy, which have been largely released from government control and, in many cases, fully privatized. The energy sector thus remains an exception to a general trend of liberalization.

Although China has to date escaped the disastrous effects of badly implemented energy sector liberalization, ongoing reliance on strong state involvement in the energy sector has shaped the institutional environment and generated its own problems and challenges. These include the ability of the state-owned energy companies to influence government policy and constrain and distort government efforts to reform the energy sector.[3] The national oil companies (NOC) have

[3] Erica S. Downs, "Business Interest Groups in Chinese Politics: The Case of the Oil Companies," in *China's Changing Political Landscape: Prospects for Democracy* (Washington, D.C.: Brookings Institution Press, 2008), 121–41.

been very effective at securing sustained government support for their overseas investments, and SOEs across the energy sector have succeeded in slowing the process of structural reform and constraining its impact on their market power. This influence is enhanced by the government's industrial policies, which explicitly identify energy industries ranging from oil and gas to wind and solar as being strategically important as "pillar industries" or "new energy technology industries," respectively.[4] In these ways, China's policy paradigm for energy governance is premised on the leadership and direct intervention of the state, with only a limited role for market forces.

This section has highlighted the manner in which the prevailing policy paradigm shapes the national energy policy processes in China. Key components of this paradigm are the preference for self-reliance in energy supply, growing attention to environmental security, and the strong role of the state in governing the energy sector. Together, these values and priorities shape the energy policy agenda and the nature of consequent energy policies and strategies.

Framework for Understanding Energy Policy in China

The above analysis of China's energy paradigms suggests several critical points related to how policymakers and industry leaders are thinking about the country's energy challenges. Yet it offers only brief glances into the key drivers, tactics, and other considerations that shape individual programs. With this in mind, it is helpful to examine whether energy policymaking in China follows observable patterns, which may influence thinking about how policy and industry approach certain kinds of efforts and what expectations we should have for recently announced plans.

A number of published analyses of China's energy policymaking and implementation are strongly rooted in theory and draw on various ideas relating to more abstract concepts such as the nature of the state, the interests of actors, the role of institutions, and the nature of strategies.[5] However, a limitation of such approaches is that they are rarely sufficiently comprehensive to satisfactorily address a wide range of energy policy issues. As an alternative, this essay takes a more empirical approach by clustering a number of specific energy strategies developed over the last twenty years on the basis of certain observed characteristics (see **Table 2**). Although the scheme fails to embrace every type of national energy policy initiative, it does include most of the important ones, which can be broadly categorized into four types: strategic programs, investment programs, sector reforms, and policy experiments.

Strategic Programs (Type I)

Type I initiatives seek to change behaviors in the energy sector across the country and are possibly the most important of the four categories on account of their high strategic importance to the central government. The best recent example of a type I program was the bundle of strategies designed to reduce national energy intensity by 20% between 2005 and 2010 and

4 Peter Nolan, *China and the Global Business Revolution* (Basingstoke: Palgrave MacMillan, 2001); and Joanna I. Lewis, *Green Innovation in China: China's Wind Power Industry and the Global Transition to a Low-Carbon Economy* (New York: Columbia University Press, 2013).

5 See, for example, Philip Andrews-Speed, *The Governance of Energy in China: Transition to a Low-Carbon Economy* (Basingstoke: Palgrave Macmillan, 2012); Tim Wright, *The Political Economy of the Chinese Coal Industry: Black Gold and Blood-Stained Coal* (Abingdon: Routledge, 2012); and Øystein Tunsjø, *Security and Profit in China's Energy Policy: Hedging Against Risk* (New York: Columbia University Press, 2013).

TABLE 2 Simplified characterization of different types of Chinese energy strategies

	Type I: Strategic programs	Type II: Investment programs	Type III: Sector reform programs	Type IV: Policy experiments
Consultation time frame	Limited	Limited	Wide	Variable
Policy debate time frame	Months	Months	Years	Years
Implementation time frame	3–5 years	3–5 years	Many years	2–5 years
Policy instrument	Targets	Targets	Incremental adjustment	Pilot projects
Political support	Very strong	Strong	Moderate to strong	Weak to moderate
Financial support	Large	Large	Focused	Small to none
Beneficiaries	• National economy • Some industries	• Energy SOEs • Local governments	• National economy • Certain industries	Unclear
Sources of resistance	• Local government • Companies	• Few (local society)	• Industries • Society	Few
Reporting and monitoring	Extensive	Moderate	Variable	Little to moderate
Probability of success (short-term)	Moderate to high	High	Variable	Low
Probability of success (long-term)	Low to moderate	N/A	Moderate to high	Variable
Unintended consequences	Moderate to high	Moderate to high	Variable	Variable
Examples	• Energy efficiency • Air pollution	• Large dams • Nuclear power	• Price reform • Sector reform	• Power pools • Carbon markets

which succeeded in a reduction of 19.1%, according to official announcements.[6] As several analysts have noted, such results were achieved not by investment alone, but through efforts to reshape behaviors by setting energy intensity targets for SOEs and local governments, by raising standards for energy-using appliances, and by introducing a number of measures to promote the purchase of energy-efficient appliances.

While they have deep, long-term significance, China's strategic programs are often formulated in a relatively short time and usually in response to a national crisis such as a shortage of energy, extreme pollution, or dire safety statistics. The energy intensity initiative mentioned above emerged in response to a nationwide shortage of energy in 2004, and the recent program of measures to combat air pollution arose from the public outcry at the quality of the air in China's cities, which surged in 2012. Additionally, in most cases, enterprises and local governments stand to lose in

6 "China Announces 16% Cut in Energy Consumption Per Unit of GDP by 2015," Xinhua, March 5, 2011.

the short term, as these strategic programs usually require the closure of outdated plants, the loss of jobs, and a fall in revenue; this has been the case in both the energy intensity and air pollution programs. As a consequence, the central government has to expend considerable political capital implementing the strategy, and this commonly occurs through the imposition of quantitative targets, which are rigorously monitored.

Ultimately, these programs tend to last three to five years (that is, roughly the duration of a five-year plan). They have a relatively high probability of success but frequently trigger undesirable, unintended consequences. For instance, in an effort to meet their energy intensity targets shortly before the 2010 deadline, some local governments ordered power stations to suspend output, thus interrupting electricity supplies to factories, hospitals, and other users. In the case of the various campaigns to close small-scale coal mines, these measures not only have led to local unemployment but have, on occasion, resulted in a short-term shortfall of coal supplies.

Investment Programs (Type II)

Type II initiatives focus on enabling investment to strengthen energy policy. Their view of the energy sector stems from a belief that if more energy is needed, or if more of a certain type of energy is needed, the government should make large-scale funding available and let industry determine how to best invest in new production capacity. Investment programs have for years been the favored energy policy strategy for China's government because funds have been ample and few actors resist such policies. In the energy sector, the industry vehicle is usually SOEs. The history of China's energy sector under the Communist Party is replete with examples of this second type of program. These include programs with government-led funding yet industry-led development, such as the programs for the exploration of the Daqing oil field in the 1950s, construction of the Three Gorges Dam in the 1990s, development of numerous long-distance oil and gas pipelines over the last ten years, and ongoing construction of nuclear power stations.

Such investment programs have strong political support from China's leadership, and the state-owned energy companies are generally willing to take the funds and invest because this allows them to enhance their production capacity and domestic market power. Targets for production or new infrastructure capacity are usually met unless natural conditions, such as geology, are strongly unfavorable. Resistance to the strategy on the part of powerful actors is low because of the large amount of money made available.

However, the scale of funds available and the way in which they are dispersed can lead to unintended consequences. Examples include the alleged misuse of funds related to the construction of the Three Gorges Dam and the uncoordinated manner in which the rapid expansion of wind power was managed, leading to a low level of dispatch from this new capacity. Finally, it should be noted that any losers tend to be communities directly affected by the projects, which rarely have the power to obstruct the projects for more than a temporary period (though this is changing as civil society gains in confidence and capacity). Still, the relatively high degree of success of investment programs contrasts with the rather slow rate of implementation of sector reform programs discussed in the next section.

Sector Reform Programs (Type III)

The third type of policy initiative, sector reforms, aims to broadly reshape the energy sector and tends to have a long time frame, measured in years or even decades. Two prominent examples of reform programs in China's energy sector are the long-standing efforts to reform the energy industry and energy prices.

In China's sector reform programs, consultation is often wide and ongoing, as can be seen in the case of structural reform and price reform. This is not least because resistance to reform (either from SOEs or from government agencies at central and local levels) is strong and arises from the political and economic losses that powerful actors may incur. In addition, there may be other policy challenges that are more pressing in the short term and might be exacerbated if reforms were implemented at that time. For example, the shortage of electricity supply in 2003–5 stalled the initiative to undertake further structural reforms to the power sector, as such reforms might have exacerbated the power shortages. As such, these considerations can weaken the ability and the resolve of the leadership to push through with reforms, prompting policymakers to wait until political and economic conditions are appropriate. An illustration of this has been the government's approach to raising domestic gasoline prices. While prices broadly follow international trends, the government tends to wait until international prices are relatively low before implementing substantial hikes to prices or taxes. Reform programs are thus implemented incrementally over decades in a series of steps that are usually small but occasionally quite significant.

Although in the long term these reforms can meet with a high degree of success, in the short term they can produce unintended consequences. This is especially true if the partial reform process creates new opportunities for gaming, rent-seeking, and abusing monopoly power. In both the oil and the power-generation sectors, corporatization and commercialization have allowed SOEs to enhance their market power in the absence of competitive markets. This has enabled them to suppress actual and potential competitors as well as drag their feet over implementing central government decrees. An example of the latter has been the slowness of NOCs to upgrade their refineries to meet new fuel standards. In turn, the recent campaign to root out corruption, rent-seeking, and poor capital management in the NOCs provides the most prominent example of how such practices have become pervasive.

Policy Experiments (Type IV)

The fourth type of program involves policy experiments. Although the broad energy sector reform programs discussed above may have an experimental character, they are usually deliberate steps that are not easily reversible. In contrast, type IV programs are often a smaller component of a multiyear reform strategy for testing a new type of policy or market instrument. These programs are also usually confined to one or more specific geographic areas, and each area may be running the experiment under different conditions and applying different rules. Examples include the power pool experiments run at various times over the last fifteen years and the newly created carbon markets.

The political support for these experiments is variable, and in some cases they may only be tolerated to mollify a particular policy lobby. In the case of market experiments, for example, there may be tight constraints on price fluctuation. Moreover, in the short term these trials produce little tangible benefit, while in the long term they are often terminated with no follow-up, as has been the case with the competitive power pool experiments, in which no actual settlement has occurred.

Selected Recent Policies and Their Consequences

The previous section has described four types of energy policy programs in China. While these categories are neither comprehensive nor mutually exclusive, they provide a lens through which to examine national policy initiatives. This section reviews a selection of recent and current policy programs applying the framework just described in order to illustrate the main characteristics of the programs and to infer their likely significance. The examples have been chosen on the basis of their current or ongoing policy relevance and the clarity with which they illustrate each of the five categories. They are, in order, air pollution control (type I program), oil and gas production (type II program), renewable energy (type II program), industry reform (type III program), and carbon markets (type IV program).

Air Pollution Control (Type I Program)[7]

The measures introduced in 2013 to counteract air pollution provide a good example of a strategic program that has high national importance and that is ongoing today. In the winter of 2012–13 the air pollution in northern China reached the highest levels recorded and caused widespread anger across Chinese society. Tackling such pollution is a high priority for the Xi government, which took office in March 2013. To that end, in September 2013, after several months of internal debate, the State Council issued the Action Plan for the Prevention and Control of Air Pollution.

This document sets down a number of quantitative targets to be achieved by 2017 and proposes a range of measures to help achieve these targets. The headline targets relate to particulate matter (PM), while the main sectors targeted are energy, industry, and transport. The action plans seeks to reduce the concentration of PM10 in cities at the provincial and prefecture levels by 10% over the five years from 2012 to 2017. Certain regions have tougher targets explicitly aimed at PM2.5: a 25% reduction in the Beijing-Tianjin-Hebei region, 20% in the Yangtze River Delta region around Shanghai, and 15% in the Pearl River Delta region in Guangdong Province. On the question of China's evolving energy outlook, the plan reiterates the need to reduce the proportion of coal in the national energy mix to 65% by 2017, down from 67%–68% today, by reinforcing existing policies to replace coal use with greater use of electricity, natural gas, nuclear power, and renewable energy. The absolute consumption of coal in the three priority regions mentioned above is to be reduced in part by banning the construction of small-scale, coal-fired plants for generating electricity and only permitting the construction of coal-fired plants if they cogenerate heat as well as power. The share of non-fossil fuels in the energy mix is supposed to reach 13% by 2017, with the nuclear power capacity reaching 50 gigawatts.

Assessment. The action plan sets some ambitious goals for the industrial sector, especially energy- and pollution-intensive "key" industries such as metallurgy, cement, and chemicals. The energy intensity of these industries is to be reduced by 20% by 2017 and pollution intensity by 30%. The proportion of materials recycled by the metallurgical industries must be raised to 40%. In order to control pollution from motor vehicles, the plan exhorts Beijing, Shanghai, and Guangzhou to tightly constrain the number of cars on the road and sets staged targets to ensure that diesel and gasoline supplies in major cities meet the national V standard by 2017. Highly polluting old vehicles are to be removed from major cities by 2015 and from across the country

[7] This section draws on Philip Andrews-Speed, "China's New Pollution Control Plan: New Weapon or Paper Tiger?" web log, October 10, 2013.

by 2017. The public sector, including the transportation sector, will increasingly be required to use "new energy" vehicles and promote their use among the public.

Outlook. To be successful, the action plan will need to be supported by a number of measures. In the short term, these will include plans or strategies for the power sector, the identified industries, and the key regions. More challenging will be the steps needed to change the industrial structure, enhance the role of market instruments in pollution control, and improve the effectiveness of environmental regulation.

This plan demonstrates the commitment of the Xi government to tackling air pollution. The wide-ranging nature of the proposed measures reflects the scope of the challenge but also renders implementation very difficult. One of the major obstacles will lie with local governments, which will try to protect their enterprises in order to sustain employment and tax revenue. Nevertheless, significant progress should be possible by 2017, provided the central government pursues the implementation of delegated targets with the same rigor that it did in the earlier energy efficiency program. However, the need to combat air pollution is likely to remain a long-term challenge.

Oil and Gas Production (Type II Program)

Investment in new energy production capacity is the most common form of the type II investment program and can be seen across the energy sector—in coal mines, long-distance electricity grids, and wind and solar power, for example. Here we examine the case of oil and gas production because it has expression both overseas and at home.

As briefly suggested earlier, China's government has long supported NOCs in their quest to enhance the production of oil and natural gas on the basis of promoting supply security. On the international side, a key component of China's oil and gas strategy has been the investment in overseas oil and gas assets by NOCs. As a result of twenty years of expansion of their overseas activities, Chinese oil companies had a stake in more than two hundred projects in roughly 50 countries by the year 2013. Since 2008, the aggregate value of new acquisitions by China's NOCs has exceeded $100 billion; in 2013 alone they spent $32 billion on conventional oil and gas assets.[8]

Meanwhile, the domestic side of China's NOC strategies is re-emerging in importance. While it has become increasingly evident that the nation's remaining reserves of conventional oil and natural gas may be limited, expectation is growing that various forms of unconventional hydrocarbon may be available in large quantities, though commercial viability has yet to be demonstrated. As a result, in recent years the focus of attention of the government has been on unconventional gas. Tight gas is already being exploited in the Ordos Basin of northern China and in the Sichuan Basin, and these accumulations provide approximately 20% of the nation's domestic natural gas production.[9] Collaboration with foreign companies such as Shell and Total has been crucial for this success. The country's energy companies have been working jointly with foreign companies since the early 1990s to develop coalbed methane resources, which are abundant in some of the major coal basins of northern China. In recent years, these foreign players have tended to be small, independent companies such as Sino Gas and Energy, Pacific Asia Petroleum, Sino American-CBM, and Green Dragon Gas.

8 Yvonne Lee, "Chinese Energy Giants Refocus on Traditional Assets," *Wall Street Journal*, December 23, 2013, http://online.wsj.com/article/SB10001424052702304475004579275713155308116.html.

9 FACTS Global Energy, *A New Era for Natural Gas in China toward 2030—From Self Sufficiency to Import Dependency* (Honolulu: FACTS Global Energy, 2011).

Assessment. China's government has provided its NOCs with the capital and political support to continuously expand their portfolio of assets, both overseas and at home. Investment by NOCs in overseas oil and gas reserves is not considered to be a normal part of energy security policy in countries belonging to the Organisation for Economic Co-operation and Development (OECD), not least because most NOCs have been privatized and these privately owned companies are less beholden to their governments than NOCs are. There is also strong skepticism that access to oil and gas reserves and production in remote countries can indeed contribute to national security of supply in the event of an international supply crisis.[10] In China's case, not only does the belief persist in some quarters that these investments do indeed enhance national security of supply, but such investments are also seen as satisfying other national policy objectives, such as promoting national industrial champions, supporting employment, and advancing international diplomacy. Indeed, a close symbiotic relationship exists between these investments and China's increasingly active diplomacy on all continents.[11]

The implications of these policies are increasingly felt on the domestic side. New revelations suggest that China may have even larger resources of shale gas than the United States; yet successfully developing these resources will also require higher levels of investment. Coupled with an understanding of how the Chinese government typically approaches investment programs, this suggests a renewed emphasis on NOC activity at home. Systematic exploration for shale gas started in 2009, and the government originally set production targets of 6.5 billion cubic meters in 2015 and 60–100 billion cubic meters by 2020. Two licensing rounds have been held, which resulted in twenty blocks being awarded to Chinese companies other than the major NOCs. Although exploration by PetroChina and Sinopec on their own territories has met with some success, it is too early to assess the long-term significance of these discoveries. In response to the relatively slow progress, in August 2014 the government reduced the output target for 2020 to just 30 billion cubic meters.

Outlook. If China can even partially replicate the U.S. shale gas revolution, then this new source of gas supply could reduce its rising demand for imported gas. The main concerns at present relate to the likely high cost of this gas, the lack of suitable technology to maximize gas recovery, water supply in arid areas, and the management of social and environmental impacts—areas that will require breakthroughs and innovations in technologies, markets, and policies for successful management. However, as a consequence of prolonged and generous support for overseas investment, the NOCs have been less than rigorous in their commercial assessments of investment opportunities, thereby reducing the profitability of many projects. This, in turn, has been one of the factors that has triggered recent steps by the government to reform NOCs, as will be discussed in a later section.

Renewable Energy (Type II Program)

While the discussion above examines China's oil and gas policies and their significant impact on Chinese policymaking, it is important to note the extent to which investment programs have also focused on alternative energy supplies, such as the development of renewable energy technology. Over the last few years, China has developed the world's largest production capacity for wind and solar energy equipment and now has one of the largest outputs of these two sources of renewable

[10] Zha Daojiong, "Energy Interdependence," *China Security* (Summer 2006): 2–16.

[11] Philip Andrews-Speed and Roland Dannreuther, *China, Oil and Global Politics* (Abingdon: Routledge, 2011).

energy. Although the Chinese government has supported the development of renewable energy for decades, in part to promote rural electrification, it has only provided strong incentives since 2005 with the enactment of the Renewable Energy Law. The vast scale of Chinese exports of solar and wind energy equipment has driven down the price of these appliances across the world, but at the same time these renewable energy policies have burdened many of China's manufacturing companies with massive debt.

Assessment. The story of wind and solar energy in China provides an example of the application of state-led principles in a very particular institutional setting. It illustrates how energy is often subservient to other policies, such as social and industrial policy; how poor management of the interaction between industrial and energy policies can damage both sets of policies; and how the Chinese government can nonetheless learn from its mistakes and adapt its policies accordingly. Despite the rapid rise of wind and solar energy capacity, government policies between 2006 and 2010 laid the groundwork for two problems. The first was overcapacity in the manufacturing industry. The second was the disproportionately low level of output of wind and solar energy in China.

China's approach to renewable energies prioritized the development of the country's renewable manufacturing industry over the generation of renewable energy itself. Although China's eleventh five-year plan (2006–10) explicitly stated that the objectives of developing renewable energy were to encourage the production and consumption of this energy and increase its share in total primary energy consumption, the development target for each individual renewable source was set in terms of installed capacity rather than in terms of the share of total primary energy consumption. This focus on capacity-based targets led to the pursuit of capacity growth rather than generation growth of renewable energy over the years 2005–11. In the case of wind power, grid companies were required to provide grid connection and to purchase all the renewable energy generated. However, little consideration was given to technological and institutional barriers to grid connection, and few specific policies were enacted to provide economic incentives to grid companies to accommodate renewable energy. As a consequence, the dispatch of wind energy did not keep up with the construction of wind power capacity.[12]

Outlook. This excessive emphasis on building the scale and competitiveness of the renewable energy manufacturing industry, which has received generous support, sowed the seeds of a financial crisis in the industry. One of the responses has been the rapid expansion of overseas sales and investment by China's wind and solar companies.[13] In addition, state banks have stepped in to rescue bankrupt companies.

Industry Reform (Type III Program)[14]

One of the stated priorities of China's new government is to increase the role of market forces in those sectors where they are weak. Energy is one of these sectors, and the main target of government efforts so far has been the oil and gas industry. The NOCs, in particular PetroChina and Sinopec, are widely seen as having excessive market power, leading to accusations of weak capital controls, inefficiency, and rent-seeking. Over the last two years, the government has started to take a number of steps to bring the rigor of market forces to bear on the companies in order to

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12 Sufang Zhang, Philip Andrews-Speed, Xiaoli Zhao, and Yongxiu He, "Interactions between Renewable Energy Policy and Renewable Energy Industrial Policy: A Critical Analysis of China's Policy Approach to Renewable Energies," *Energy Policy* 62 (2013): 342–53.

13 Xiaomei Tan, "Clean Technology R&D and Innovation in Emerging Countries—Experience from China," *Energy Policy* 38 (2010): 2916–26.

14 This section draws on Philip Andrews-Speed, "Tentative Steps to Reforming China's National Oil Companies," web log, March 15, 2014, http://www.andrewsspeed.com/index.php/permalink/3273.html.

address these deficiencies. On the one hand, it is opening up more opportunities for other Chinese companies. On the other hand, the government has been raising the price of oil products and natural gas to provide appropriate economic signals to the producers and users of energy.

The program of wide-ranging industrial reforms launched in 1998 forced the restructuring of the two large NOCs. The government discussed the option of splitting the two companies into five companies—a measure applied in 2002 to the State Power Corporation—but chose a less radical approach. An asset swap created two vertically integrated oil companies, China National Petroleum Corporation (CNPC) in the north and west of China and Sinopec in the south and east, both with upstream and downstream assets. The second stage of reform involved the separation of productive assets into commercialized subsidiaries—PetroChina within CNPC and Sinopec within the Sinopec Group—that were then partially listed on international stock exchanges.

Assessment. To date, these reforms have had the desired consequences of raising money, transforming management incentives, improving technical and commercial performance, and creating the basis for international expansion. However, the government has undertaken only limited steps to develop competition within the domestic oil and gas markets. Instead, it has helped the NOCs drive many local oil refiners and retailers out of business. Since 1998, PetroChina and Sinopec have succeeded in reinforcing their dominant positions in the domestic market, in onshore oil and gas exploration and production, in the transport of oil and gas by pipeline, and in oil refining and retailing. In addition, performance gains have stalled.

This is not to say that the government has taken no action on introducing competition. One concrete step taken was to classify shale gas as an "independent mineral resource." This enabled the government to bypass certain regulations that cover oil and gas—in particular, by removing the requirement for investors to cooperate with an NOC and allowing Chinese private companies to participate. This paved the way for the second round of licensing for shale gas in 2012, which attracted bids from 83 companies and resulted in the awarding of nineteen blocks to 16 companies, none of which were NOCs.

Yet while this reform has opened up opportunities to companies other than NOCs, these companies lack the expertise to explore and develop the shale gas resources effectively. Meanwhile, although they have the choice of collaborating either with local subsidiaries of the NOCs or with foreign service companies, legal ambiguities have discouraged foreign oil companies from partnering with the winners of these blocks. Further, PetroChina and Sinopec will still retain the most prospective areas for shale gas unless the government forces them to relinquish their rights over large tracts of land.

Outlook. Chinese policymakers will need to undertake two key tasks to advance reforms. First, they must break up the monopoly control of NOCs over pipelines. This issue is of particular importance for natural gas given the priority the government places on gas production from shale gas, coalbed methane, and synthetic natural gas. Companies producing gas are obliged to sell their output to the NOCs, which then transport the gas in their pipelines and sell it to city gas companies or end users. This arrangement allows the NOCs to set the price paid to the gas producers and take much of the profit. In February 2014 the government issued the document "Measures for Regulation of Fair and Open Access to Oil and Gas Pipeline Networks." But the text is sufficiently ambiguous that pipeline owners may still be able to discriminate against other companies unless the government takes robust steps to enforce the spirit as well as the letter of the measures and regulate tariffs.

Another reform undertaken by Chinese policymakers is to force the NOCs to sell some of their assets to private companies. After being initiated, however, this measure has been diluted to encouraging NOCs to introduce private capital into some of their subsidiaries. Sinopec, for example, has announced that it plans to sell up to 30% of its oil retail business to either foreign or domestic parties. The sale would provide Sinopec with much-needed cash and a generous return on its investments in retail stations over the past decade. If foreign oil companies take a large stake in projects, they could help boost the performance of these assets. But by itself the sale of stakes in assets will do little to reduce the market power of the NOCs, which can only be achieved by forcing the NOCs to sell the assets themselves rather than only shares of assets.

Carbon Markets (Type IV Program)[15]

Finally, the Chinese government has pledged to reduce the intensity of carbon emissions by 40%–45% between 2005 and 2020. This will require an equivalent reduction in energy intensity, and the government sees it as necessary to introduce economic instruments to act alongside the regulatory instruments. To that end, the Draft Law on Addressing Climate Change, published in May 2012, includes mention of both cap-and-trade schemes and a carbon tax. In April 2013 the National Development and Reform Commission announced that seven pilot emissions trading schemes would be launched in 2013, with a focus on energy-intensive industries such as petrochemicals and power generation. The even more energy-intensive industries such as steel and cement do not appear to have been included, probably because they are critical for the construction sector and employ so many people.

The pilot schemes are to be held in five cities (Shenzhen, Beijing, Shanghai, Tianjin, and Chongqing) and two provinces (Guangdong Province and Hubei Province). In total, these markets will cover more than 700 million tonnes of carbon dioxide, or 7%–8% of the country's total energy-related carbon dioxide emissions. These seven experiments constitute a first step toward building a nationwide scheme by 2016.

Assessment. The governments in each of the seven locations have the authority to design the trading schemes so that they are suitable to local conditions and to allocate the permits. Such an approach allows them to choose options that are less likely to have serious negative impacts on the local economy. Yet it also carries the risk that local governments will allocate permits in excess of the number required, as has happened in Europe. Two features common to the schemes launched to date in China are that the permits are issued on the basis of emissions intensity rather than on absolute emissions and that the permits are issued free of charge.[16] If an enterprise exceeds its allowance, it must purchase permits from other permit holders. However, the penalties for exceeding an allowance are relatively small.

Each of the schemes has different floor prices, ranging from 60 renminbi ($9.90) per tonne in Guangdong Province to 25 renminbi ($4.10) per tonne in Shanghai. Most trading appears to have taken place close to the floor prices, with the exception of the Shenzhen market, where prices have risen to higher than 70 renminbi ($11.55) per tonne, well above the floor of 28 renminbi ($4.60). For comparison, carbon prices in Europe were between 4 euros and 5 euros ($5.20–$6.50) per

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15 This section draws on Philip Andrews-Speed, "China's New Carbon Trading Experiments," web log, January 12, 2014.

16 Regarding the latter feature, Guangdong was an exception in that 3% of the permits were auctioned.

tonne during 2013 and rose to a high of 8 euros ($11.00) in March 2014, whereas prices ranged from $11.00 to $15.00 per tonne during the first year of California's carbon market in 2013.[17]

Outlook. While the Chinese government's ambition to introduce carbon trading is to be applauded, effective implementation faces a number of serious obstacles. First, the major energy users are large SOEs, which have significant market power, soft budgetary constraints, a low cost of capital, and close relations with local or central government. Second, the limited capacity and authority of the governing agencies may constrain their ability to monitor actors, administer the scheme effectively, and impose penalties on offenders. Finally, most energy prices are still subject to direct or indirect government control, particularly in the electrical power sector, and the government continues to be reluctant to allow the prices of energy and industrial products to rise too rapidly. As a consequence, power generators may be unable to pass higher prices on to consumers.

At the heart of the problem lies the profound mismatch that exists between this economic policy instrument (emissions trading) and the administrative and political nature of the way in which China's government manages the energy sector. As a consequence, these trading experiments are unlikely to bring about significant and sustained emissions reductions until the major energy producers and consumers are further freed from state ownership and control and the government loosens its control over energy prices. And if these experiments do succeed in reducing emissions, it is unlikely to be in the most economically efficient manner. It thus remains to be seen whether these pilot trading schemes will be abandoned in a few years or lay the groundwork for a robust nationwide scheme.

Conclusions

China faces a number of severe energy challenges, notably relating to security of energy supply and environmental damage. Each of these challenges requires a distinct set of policy programs. These programs in turn arise from different policy contexts and through different policymaking processes. This essay has shown how these different contexts and processes play a strong role in determining the degree of success and the consequences of the policy programs.

Two key issues will warrant future examination. The first issue is the role of environmental security in China's energy strategies. One of the top priorities of the Xi government is reducing air pollution. In the energy sector, this will require an improvement in efficiency and the promotion of cleaner forms of energy production and use. The pollution-control measures announced in 2013 will require the vigorous enforcement of administrative measures, which, to judge by the track record of past energy efficiency programs, may go a long way to achieving success. But this success will be tempered by the poor scientific understanding of the processes that create this pollution as well as by local resistance to these policies. After early teething problems, the deployment of wind and solar programs should be able to move ahead rapidly in a sustained manner, though these forms of renewable energy will continue to provide a relatively small share of China's total energy consumption. In contrast, the newly launched carbon markets are unlikely to significantly reduce emissions, at least in the short term.

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[17] World Bank, *State and Trends of Carbon Pricing 2014* (Washington, D.C.: World Bank, 2014).

The second issue in need of further examination is the impact of the country's evolving energy outlook on more traditional energy policy priorities and whether this may lead to a broader paradigm shift in China. In the oil and gas industry, NOCs will be under pressure to find and produce unconventional oil and gas wherever these resources may exist within China, but the future level of output is still quite uncertain. Although NOCs will continue to invest in overseas oil and gas assets, they are likely to become more judicious in their selection of projects and may soon start to rationalize their portfolios by selling off some assets. Finally, the measures announced to reform NOCs are unlikely to lead to any significant reduction of their market power within China, though these measures may stimulate better management and increase profitability.

Ultimately, as highlighted above, a number of factors shape—and will continue to shape—China's potential success in implementing its energy policy initiatives. These include the context of the energy policy challenge, the nature of the available policy instruments, and the actors involved. Yet even when closely monitored and carefully implemented, selected policies can lead to unintended consequences. As a result, the outcomes of ongoing policy programs to change the energy mix, reduce pollution, and reform the state-owned energy companies are extremely uncertain.

China's Search for Oil and Gas Security: Prospects and Implications

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EXECUTIVE SUMMARY

This essay explores China's impact on global markets for oil and gas and highlights implications for policy and industry.

MAIN ARGUMENT

China's transformation into an energy superpower means that its strategies and goals now have far-reaching implications. The rapid growth in Chinese energy demand has long had major impacts on world oil markets and prices. But more recently, the country's enormous drive to expand natural gas use has begun to have added important regional and even global impacts on gas and LNG markets. The continuing quest for energy security is thus accelerating China's emergence as a regional and global power. Decisions by Beijing influence not only the country's domestic trajectory but regional and global outlooks for energy supply availability, environmental security, and geopolitics. These trends are adding complexity to what is already a highly interconnected global picture for energy and environmental security. They are increasing the importance of China's strategic and economic relationships with its neighbors and major producer countries as it seeks to promote supply security and as other powers seek to adapt to China's global rise as a crucial strategic and economic player.

POLICY IMPLICATIONS

- Almost all of China's incremental oil consumption will need to be imported, and such growth will inevitably drive China to enlarge its presence abroad. Ultimately, this will further accelerate the country's emergence as a regional and global power, yet also intensify its diplomatic dilemmas and challenges.
- China's growing dependence on maritime oil supplies will be an additional "multiplier" in animating Chinese leaders' interests in territorial claims in the South and East China Seas. It will also increase attention to questions related to the control of Asia's vital energy sea lanes. These issues are already highly contentious, and the heightened focus on them will bring with it new questions for policymakers across the Asia-Pacific.
- China is on target to raise its domestic gas consumption enormously, but this will mean depending on imports for roughly one-half of its gas needs. This trend is driving China to rapidly expand its energy reach across Central Asia and increasingly to Russia through large pipeline deals that will link China to these suppliers for the long term. Hence, gas is also driving China's growing regional power and influence.

China's historic transition from a small player in global energy markets to an energy superpower means that its strategies and goals now have far-reaching implications. The rapid growth in Chinese energy demand has long had major impacts on world oil markets and prices. But more recently, the country's enormous drive to expand natural gas use has begun to have important regional and even global impacts on gas and liquefied natural gas (LNG) markets.

As China's global footprint in oil and gas markets continues to expand, decisions by Chinese policymakers influence not only the country's domestic trajectory but regional and global outlooks for energy supply availability, environmental security, and geopolitics. These trends are adding complexity to what is already a highly interconnected global picture for energy and environmental security. They are also increasing the importance of China's strategic and economic relationships with its neighbors and major producer countries as it seeks to promote supply security and as other powers seek to adapt to China's global rise as a crucial strategic and economic player.

With these issues in mind, this essay explores China's impact on global markets for oil and gas and highlights implications for policy and industry. Section one briefly examines the similarities and differences in China's impact on these two different fuel markets. Section two then examines China's oil prospects, highlighting expectations for continued demand growth and drawing implications for Chinese and international strategic and energy interests. Next, section three examines the increasingly important role of natural gas in China's energy security calculus and discusses the implications for regional and global gas markets and prices, as well as for China's expanding geopolitical presence. Section four raises questions that will be increasingly important for policymakers in light of China's oil and gas demand trends. The essay concludes with a discussion of the broader geopolitical implications of China's booming oil and gas demand.

China's Oil and Gas Realities

The respective impacts of evolving oil and gas market realities on thinking in Beijing could be considered two sides of the same coin. Investments in both markets are driven by China's desire to increase its sense of energy security and involve a complex network of regional and global ties that will inevitably lead the country to expand its geopolitical reach. Yet the particulars of oil and gas markets also affect China in very different ways.

On the oil side, the rapid pace and enormous scale of China's oil demand and import growth have been a central driver in global oil markets and the geopolitics of oil. China has been one of the major factors behind rising global oil prices and heightened concerns among large importing countries over a potential future of very tight and precarious oil supplies. Meanwhile, oil has also been a key driver of China's emergence outward as a regional and global power. This is largely because the country's buying power and enormous new oil investments are inevitably accompanied by efforts to strengthen diplomatic ties with major energy suppliers and countries where China's national oil companies (NOC) have large investments. Hence, the outlook for oil demand in China is inevitably interlinked with its regional and global outlook and thus has important implications for global energy markets and geopolitics.

Alternatively, China has been a much more modest factor in regional and international natural gas markets up until the last five years. However, the country's traditionally limited interest in gas supplies is rapidly changing. China has discovered natural gas both as a cleaner domestic alternative to environmentally damaging coal use and as a source of supply diversification that can strengthen energy security. Beijing has ambitious plans for the development of its own domestic gas supplies, but as Damien Ma and others have noted there are significant limits on the near-term potential of these projects.[1] For example, the government has recently revised downward its ambitious 2020 targets for domestic shale gas production, while raising targets for the consumption of natural gas and its share of overall energy use. Beijing's intensifying push to enhance the role of natural gas in China's energy mix is leading rapidly toward increased reliance on large-scale natural gas imports. As China boosts pipeline gas imports from Central Asia and looks to Russia, Australia, Qatar, and other countries in the Middle East to secure future supplies, this quest is further raising the diplomatic profile of China in regional and global energy markets as it is pushed to develop and deepen its international ties.

Three important similarities can be observed from this overview. First, despite the fact that China has substantial domestic oil and gas resources, the outlook for its consumption needs for both fuels will increasingly outrun what can be domestically produced. Second, the scale of China's potential impact on international markets is enormous, with this impact already being felt in oil markets and likely to grow in the near feature for gas markets. This suggests that China's energy needs will be an important consideration not only for policymakers in Beijing but also increasingly for leaders in Washington, Tokyo, and Doha. Finally, as will be discussed below, there is a complex interrelationship between China's market needs for oil and gas and the country's strategic and political relationships in the Asia-Pacific and other regions. Thus, with these points in mind, the following sections explore China's oil and gas prospects in greater detail, before drawing broader conclusions for both.

China's Oil Prospects

As suggested above, China's oil demand outlook is strongly connected to its regional and global strategic outlook. China has been the most important source of growth in global oil demand over the last decade as a result of industry expansion, urbanization, and motorization.[2] Between 2000 and 2012 the country was responsible for over 40% of growth, having added roughly 5 million barrels per day (mmbd) of new demand to the global oil market. To put this in relative terms, China contributed an amount of demand growth equivalent to more than the annual oil consumption of Japan, the world's third-largest oil-consuming nation.

This powerful growth in oil demand, combined with relatively modest growth in domestic oil production, led to a rapid expansion in dependence on imported oil. Between 2000 and 2012, China's imports of oil quadrupled, increasing from 1.5 mmbd to 6.0 mmbd. Meanwhile, its import dependence rose from 31% to 60%.[3] To find sources able to meet this need, China has seen its dependence on Middle East supplies rise to 50% of the country's oil imports. Additionally, maritime supplies now account for over 80% of China's oil imports, with supplies transported

[1] See Damien Ma, "China's Coming Decade of Natural Gas?" in "Asia's Uncertain LNG future," National Bureau of Asian Research, NBR Special Report, no. 44, November 2013, 23–35.

[2] Early demand growth was for industrial diesel, boosted by surges in demand during severe power shortages in 2004, 2008, and 2010. Growth has more recently been driven by intensifying gasoline demand for light-duty vehicles.

[3] In 2000, demand of 4.8 mmbd and domestic production of 3.3 mmbd led to imports of 1.5 mmbd. In 2012, domestic demand of 10.2 mmbd and domestic production of 4.2 mmbd led to imports of 6.0 mmbd. All statistics in this paragraph are derived from BP plc, "BP Statistical Review of World Energy 2014," June 2014.

through the sensitive sea lanes of the Indian Ocean, Malacca Strait, and South and East China Seas, among other routes.

Revisiting Self-Sufficiency in a Global Context

For Chinese policymakers who have traditionally been focused on self-sufficiency as a critical aspect of energy and resource security, rapidly rising import dependence has had a cathartic impact on Beijing's policy orientation. In the early 2000s, China's grudging recognition of its inevitable reliance on global markets drove a "go out" strategy of supporting the global expansion of the three Chinese NOCs to increase the country's role and influence in the development of supplies. The large investments in oil fields abroad, combined with new crude supply contracts with all the major oil exporters, drove China's growing presence across the energy export world. Supported by ample financing by state banks and an active energy diplomacy, China and its NOCs have become a larger factor in the Middle East, Central Asia, Africa, South America, and North America.

This strategy has also brought new challenges and entanglements for China and its NOCs. Attempts to invest in the U.S. oil patch have been highly charged politically and added to bilateral tensions. The attempt by the China National Offshore Oil Corporation (CNOOC) to buy Unocal in 2005, for example, led to a firestorm of controversy in Washington, D.C., and ultimately the withdrawal of the offer. Even in 2012, there was significant political concern when CNOOC acquired some operations in the United States as part of its acquisition of Canada's Nexen, and the investment was only approved with important limitations on CNOOC's U.S. activities. Meanwhile, Chinese investments in a number of "pariah states" in the Middle East and Africa have drawn Beijing into unwanted diplomatic disputes, attracted criticism, and exposed China to political violence and instability that have threatened its investments and the safety of Chinese citizens. When the Libyan uprising led to widespread and worsening violence, Beijing organized the evacuation of 35,000 Chinese nationals. Finally, heavy dependence on maritime oil supplies flowing through the Malacca Strait and the South China Sea exposes China's energy lifeline to the naval power of the United States. This is something that Chinese planners view as a potentially critical vulnerability if there were ever a military confrontation between China and the United States. Thus, they see the dependence on sensitive sea lanes as a potential source of unintended tension that must be managed.

Oil in China's Energy Mix through 2040

Looking forward, Beijing's oil-driven influence and supply dilemmas both seem likely to intensify. China already surpassed the United States in 2013 as the world's largest net oil importer, although most forecasts suggest that China's oil demand growth will slow somewhat as the Chinese economy is gradually reshaped toward a consumer-driven economy. However, while demand growth is expected to slow to 3%–4% annually (nearly half the previous rate of 5%–7%), oil consumption is still expected to rise overall. Between 2013 and 2035, oil consumption is projected to increase from 10 mmbd to 16–17 mmbd, with motorization taking over from industry as the driver of oil demand growth.[4] As of 2014, China is already the world's largest light-duty vehicle market by annual sales, and despite a range of recent policies intended to slow the growth

[4] Institute of Energy Economics, Japan (IEEJ), "Asia/World Energy Outlook 2013: Growing Uncertainty over International Energy Trends and the Future of Asia," October 2013, 20.

of motorization and steer consumers toward more fuel-efficient vehicles, gasoline-driven oil demand continues to rise strongly.[5] Looking ahead to 2040, Japan's Institute of Energy Economics forecasts that China's light-duty vehicle fleet is likely to increase nearly fourfold, from 94 million in 2011 to 363 million in 2040.[6]

While domestic oil output may grow modestly, almost all of China's incremental oil consumption will need to be imported to respond to the phenomenal growth described above. This suggests that by 2040 China's dependence on oil imports will rise to roughly 70%, with imports reaching 12–13 mmbd.[7] At least two-thirds of these import needs will likely be met by maritime supplies and at least half will come from the Middle East.

To the extent that China remains on this trajectory, oil demand growth seems likely to boost its impact on oil markets. Such growth will inevitably drive China to enlarge its presence abroad, accelerating the country's emergence as a regional and global power as it purchases, develops, and invests in new supply options. This trend will also intensify diplomatic dilemmas and challenges, as it encourages China to expand its diplomacy in the key energy-exporting regions of the world—most importantly in the Middle East but also in Central Asia, Africa, South America, and even North America. Equally important, the geographic regions supporting this growth suggest that China's quest for oil will also be a key factor in Sino-U.S. relations as each side bumps up against the other in pursuing its energy security and strategic goals. The Middle East and Persian Gulf will potentially be a key area of either cooperation or competition. China will also become an increasingly important factor in global energy governance due to the scale of its impact and reach. In all these ways, the country is becoming simply too big to stand on the sidelines.

A New Golden Age for Gas?

Natural gas has historically constituted a very small share of China's energy mix, which has been dominated by coal use in the power sector. As recently as five years ago, natural gas made up just 4% of total energy use, whereas coal constituted two-thirds.[8] But as energy security has moved up the strategic agenda of the Chinese leadership at the same time that air pollution and carbon emissions, largely driven by coal and electricity consumption, have become critical issues, the role of natural gas in China's energy mix is changing. The environmental and strategic benefits of expanding natural gas use have become profoundly clear to policymakers and leaders.

With policy support, China's gas consumption nearly doubled in a period of four years, rising from 80 billion cubic meters (bcm) in 2008 to 144 bcm in 2012. Gas now makes up 7% of China's energy mix, which, while still a very low share compared with countries in other regions of the world, is nearly double what it was five years ago.[9] Gas-fired power generation is now being encouraged in regions where gas supplies are available as a way to slow growth in coal consumption and reduce air pollution. This is the case around major cities in the east that have natural gas infrastructure and also along the route of three large natural gas trunk lines running from west to east. These three major pipelines have been built to bring gas from western China to the eastern

5 IEEJ, "Asia/World Energy Outlook 2013," 13–14.

6 Ibid., Appendix 25.

7 Ibid., 20, 36.

8 BP plc, "BP Statistical Review of World Energy 2014."

9 Ibid.

coastal cities and will enable expanded access across the country. Domestic gas production has also grown substantially, increasing by 33% from 2008 to 2012 to reach 107 bcm, but consumption has rapidly outrun production. As a result, China has witnessed rising gas imports, which accounted for 25% of its gas use in 2012.[10]

China's Dash for Gas

China is thus engaged in a major "dash for gas." Plans to rapidly increase gas consumption to reduce environmental pressures mean that gas imports will continue to grow, which will produce rippling effects through regional markets. China's 2011 natural gas plan targeted consumption to essentially triple from 107 bcm in 2010 to 220 bcm in 2015 and 330 bcm by 2020. In mid-2014 the target for 2020 was raised to 420 bcm, which would constitute an astounding fourfold rise over just ten years.[11]

While domestic gas production is also forecast to rise strongly, much of the expected incremental demand still will need to be met by imports because of limits on domestic options. China is on target to raise its domestic conventional and unconventional gas production substantially, but the outlook remains unclear due to uncertainty about long-term supply development and domestic pricing for gas. Although China potentially has the world's largest shale gas resources, developing those resources will require successfully navigating a complex geology, continuing technology development, making major investments in new pipeline infrastructure, and addressing a range of other near-term barriers. With the higher 420 bcm target for gas use in 2020, imported gas will likely constitute 40%–50% of China's gas use by 2025, depending on developments in domestic gas production.[12]

With this in mind, China has developed a robust and diversified set of potential sources to meet growing demand for gas imports. First, three large pipelines have been built from Central Asia to bring supplies of Turkmenistan gas to China's western border and on to eastern markets, and a fourth pipeline is planned. More gas from Kazakhstan and Uzbekistan will be added to expand the volumes provided by these four pipelines. Current plans are for 65 bcm of gas to come from Central Asia to China by 2020, with potential expansion to as much as 100 bcm. Second, a new gas pipeline has been built to bring 12 bcm of gas from Myanmar to southern China. Third, China now has seven LNG receiving terminals along its east coast, and many others are planned, which could raise LNG imports to 60–70 bcm by 2020. Finally, after a decade of negotiations, Russia and China signed a gas pipeline deal in May 2014. The deal will bring 38 bcm of gas from the Russian Far East to northeastern China by 2023, further diversifying the country's imported gas options.

Such developments and the huge expansion in Chinese gas imports are already beginning to have important impacts on Asia's regional gas trade, LNG markets, and gas pricing. China has now become a major factor in potentially knitting together Eurasia's fragmented gas trade as the country draws in large supplies from Central Asia, Russia, and Myanmar. Eventually these overland supplies could meet imported supplies of LNG along the Chinese coast and become the fulcrum of gas pricing across the region. LNG suppliers and developers in Qatar, Australia, Russia, offshore East Africa, and even the United States and Canada are expecting large-scale Chinese LNG imports to help support Asia's high, oil-linked LNG prices in the future. Alternatively, competition for a place in the Chinese

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10 BP plc, "BP Statistical Review of World Energy 2014."

11 Colin Shek, "China Targets Gas Supply of 420 bcm by 2020," *Natural Gas Daily,* April 25, 2014.

12 Although forecasts for China's gas-import prospects vary, most suggest import levels in the 40%–50% range after 2020, consisting of mainly imports by pipeline from Central Asia and Russia but also LNG supplies along the eastern coast. See, for example, BP plc, "Energy Outlook," 2014, slide 26.

gas market could be a key driver reducing Asia's high LNG and pipeline gas prices. In a decade, China could rival Japan as the largest LNG importer in the world.

China's Emerging Geopolitics of Gas

Geopolitically, China's increasing presence in gas markets is leading the country to expand its diplomacy and development efforts across Eurasia. Enormous gas imports from Central Asia, for example, are reinforcing China's influence in that region. The quest for new gas supplies also provides a foundation for closer relations with Russia by supplying an outlet for Russian Far East gas and creating a base load of demand that makes LNG and other pipeline gas exports from the Russian Far East to Northeast Asia more commercially viable. Another gas pipeline to western China based on existing West Siberian gas supplies also appears to be in the works.[13] In the wake of U.S. and European sanctions and pressure to reduce dependence on Russian gas amid the Ukraine crisis, the pipeline agreements with China give Russia a key alternative market for its gas, add gas-export revenues, and allow President Vladimir Putin to boast that Russia has other options for its energy exports. But the agreements are a double-edged sword. China's forays into Central Asia have substantially reduced Russian control over Central Asian gas supplies (specifically in Turkmenistan) and eroded Russia's influence in the region.

Hence, natural gas has become a key ingredient in China's energy security calculus as well as an important element of efforts to diversify its energy mix and move the country toward a more environmentally sustainable future. Domestic gas production is expected to rise strongly, although the pace and scale of growth inevitably remain uncertain. Huge domestic shale gas resources could significantly change China's energy outlook, but over a longer time horizon beyond 2020. In the meantime, gas is becoming a key factor in China's growing regional and global geopolitical footprint in ways similar to the impact of oil on the country's geopolitics.

Key Questions for Policymakers

China's growing imports of oil and gas supplies have significant implications both for regional markets and for geopolitics. Oil and gas investments abroad by Chinese NOCs, oil and gas supply contracts, oil-backed loans, pipeline connections to Central Asia and Russia, and the imperative of protecting Chinese citizens on the ground all will drive China's diplomatic presence in key regions. This means that China will occupy more and more strategic space currently occupied by the United States. As one example, the two countries will increasingly bump up against each other in places like Iran, Saudi Arabia, and Iraq as a result of China's quest for oil.

For both the United States and China, this outlook raises a number of increasingly important questions. Will the two countries manage their intersecting interests cooperatively or competitively? Can the United States and China find common ground on managing political challenges and instability in the Persian Gulf? Another key question is whether the relationship between China and its NOCs will continue to follow the mercantilist model of "China Energy Inc." or evolve into a more market-driven approach that might reduce the diplomatic sensitivities and complications that tend to accompany the overseas investments of Chinese NOCs. Each of these questions has implications for geopolitics in key oil-exporting regions as well as for Sino-U.S. bilateral relations.

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[13] Lucy Hornby, "Putin Snubs Europe with Siberian Gas Deal That Bolsters China Ties," *Financial Times*, November 10, 2014.

In addition, China's growing dependence on maritime oil supplies will also be a "multiplier" in animating Chinese leaders' interests in territorial claims in the South and East China Seas, where there may be substantial oil and gas resources. It will also increase attention to questions related to the control of Asia's vital energy sea lanes. These issues are already highly contentious, and the heightened focus on them will bring with it new questions as well. Can the United States and China find common ground in securing the energy sea lanes that will be vital to China's economic prosperity and that are also key to U.S. efforts to ensure reliable flows of oil to global markets and stable oil prices? Related to this question, how will China approach the broader issue of global energy governance? Beijing has been cool so far to the idea of an association with the International Energy Agency (IEA). It sees the IEA as a U.S.-dominated group reflecting Western and U.S. interests rather than those of new oil importers like China and India. There are indications that Beijing may prefer the idea of global energy governance through the Group of Twenty (G-20) or regional groupings that exclude the United States, such as the Shanghai Cooperation Organisation. In terms of global energy governance, China is increasingly a central factor in cooperation or fragmentation.

The energy security of China and the broader Asia-Pacific would be strengthened if the United States and China could find common ground on more collaborative ways to ensure reliable access to energy supplies for the region. Stability in the Middle East, secure energy sea lanes from the Middle East to Asia, and more effective global energy governance are all vital interests for both countries. To date, these important public goods have largely been supplied by the United States and U.S.-led institutions. But China is now too big a global energy factor to stand on the sidelines. A partnership between the United States and China would serve Asian and global energy security, but this will require astute diplomacy and a common vision of the energy future.

Conclusion

China's widening quest for imported oil and gas to meet its enormous future energy needs is accelerating and reshaping the country's regional and global presence and influence. This search will be a key driver of the growing gravitational force of China's expanding economic and diplomatic footprint. But it will also complicate Chinese diplomacy and bring new entanglements in places where China has never been involved. In addition, this quest will have large impacts on the future of global oil prices as well as on natural gas and LNG prices in Asia.

This evolution of China's energy strategy could support greater cooperation with other Asian and Eurasian powers and the United States on more integrated, competitive energy markets and a more productive, multilateral approach to energy security. China's growing stake in the stability of global energy markets and secure transportation routes should give the country strong incentives to collaborate with other importers and producers on ensuring stable oil and gas supplies and more competitive prices.

However, China's greater demand for oil and gas supplies also has the potential to lead to competition. If China, the United States, and other major importers and suppliers choose to see energy sea lanes, secure energy supplies, and control of pipeline routes as elements of a nationalistic, mercantilist platform for political and economic competition, there is a significant risk of a zero-sum outcome. The energy diplomacy of both the United States and China and their ability or inability to collaborate will be critical to determining which path is chosen.

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Peak Coal in China: Rethinking the Unimaginable

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EXECUTIVE SUMMARY

This essay explores the prospects for peak coal demand in China and details implications for public policy.

MAIN ARGUMENT

Coal is the dominant form of energy used in China, but its role in the country's overall energy mix has been progressively reduced since 2011. A number of factors have contributed to this slowing growth in demand—including major shifts in China's economy, rising levels of energy efficiency, and the continuing substitution of coal with other fuels—and policy and market evidence suggests that these trends will continue to check new growth. Yet how and to what extent China will be able to reshape its use of coal has been the subject of great debate. A number of prominent studies conducted by different Chinese and international organizations show that China's coal demand will peak in the near future, but these studies diverge significantly in their assessments of when and at what level. A comprehensive reassessment of the market, technological, and policy factors that shape our understanding of when peak demand will occur suggests that China's coal use is very likely to peak before 2020, yet achieving this goal will require ongoing leadership from industry and policy.

POLICY IMPLICATIONS

- Without a clear estimate of when China will reach peak coal demand, it is difficult to make an objective evaluation of China's strategies and actions toward addressing energy-related issues such as reducing air pollution and lowering carbon dioxide (CO_2) emissions. A clearer understanding is critical for strengthening public policy and requires revisiting common assumptions.
- In order to make the peaking of coal and reduction of CO_2 emissions feasible, more comprehensive strategies should be adopted by stakeholders in China. These include the promotion of greater energy efficiency, the deployment of alternative fuels, and the imposition of a carbon tax.
- A joint effort by China and the United States is imperative for addressing global climate change. The most important objective in the near future is that each country prepare ambitious long-term targets for reducing CO_2 emissions and secure approval for these plans.

The possibility that China will reach peak coal demand is attracting worldwide attention. Currently, China is the largest consumer, producer, and importer of coal. The country is also the world's largest emitter of carbon dioxide (CO_2), and a number of studies have noted that by energy source coal is the country's largest driver of CO_2 emissions (accounting for about 80% of total emissions).[1] Yet as policymakers and industry leaders seek to reshape China's economic development model and also address environmental concerns, there are signs that efforts to reshape the use of coal are taking effect and limiting new demand. According to preliminary statistics, in 2013 coal consumption in China increased by only 1.9% from the previous year, and the ratio of coal in primary energy consumption dropped by 0.9 points to 65.7%.[2] Meanwhile, the government is aiming to lower the coal ratio in the country's energy mix in 2014 and to control (and ultimately reduce) total coal consumption as soon as possible.

How and to what extent China will be able to reshape its use of coal has been the subject of great debate, with critical implications for the energy and environmental outlooks for both China and the Asia-Pacific. A number of prominent studies conducted by different Chinese and international organizations show that China's coal demand will peak in the near future, but these studies diverge significantly in their assessments of when and at what level. To date, recent predictions have ranged from a period between 2015 and 2030 and at the level of 3.9–4.8 billion tons, an unbelievably broad range.[3] Without greater certainty about our expectations for developments in China, it is difficult to assess whether the country is on track to meet its national-level energy policy goals. Similarly, such unclear expectations also complicate our ability to evaluate to what extent moving forward on addressing urgent environmental concerns requires greater attention among leading representatives from industry, policy, and research.

To explore these issues, this essay assesses the prospects for peak coal demand in China. The first section outlines the role of coal in China's energy mix and examines the market and policy factors shaping its use. Next, this study details the broad range of assessments for when peak coal will occur in China and assesses their methodology. The following section then offers an alternate framework for assessing peak coal and highlights key driving factors related to policy, technology, and market transformation that should shape our understanding of when and at what level this peak will occur. Based on this framework, this study ultimately suggests that China's raw coal use is very likely to peak at about 3.9 billion tons in 2015, while coal use in heat content terms is very likely to peak at about 2.55 billion tons of coal equivalent (tce) in 2019.[4] The essay concludes by outlining key metrics for assessing whether China is on track to reach these goals and providing recommendations for public policy.

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1 For more on Chinese CO_2 emissions, see International Energy Agency (IEA), *World Energy Outlook 2013* (Paris: IEA, 2013); and Ken Koyama, "Asia/World Energy Outlook 2013: Analyzing Changes Induced by the Shale Revolution, " Institute of Energy Economics, Japan, October 31, 2013.

2 Wu XinXong, "Zhuanfangshi tiaojiegou cugaige, qiangjianguan baogongji huiminsheng, zhashi zuohao 2014nian nengyuan gongzuo" [Completing Well the Energy-Related Works in 2014, through Transiting Development Model, Adjusting Industrial Structure, Strengthening Reform, Enforcing Management, Securing Supply and Improving People's Livelihood], National Energy Administration, February 11, 2014, http://www.nea.gov.cn/2014-02/11/c_133105714.htm.

3 For more on these predictions, see China Academy of Engineering, *Zhongguo nengyun zhongchangqi (2030, 2050) fazhan zhanlue yanjiu* [The Study Report on China's Medium- to Long-term Energy Development Strategies (2030, 2050)] (Beijing: Science Publishing, 2011); Citi Research, "The Unimaginable: Peak Coal in China," September 4, 2013; and Zhang Lei, "Meitan xiaofei de tianhuaban zaina?" [Where Is the Peaking Level of Coal Demand?] *China Coal News*, March 17, 2014.

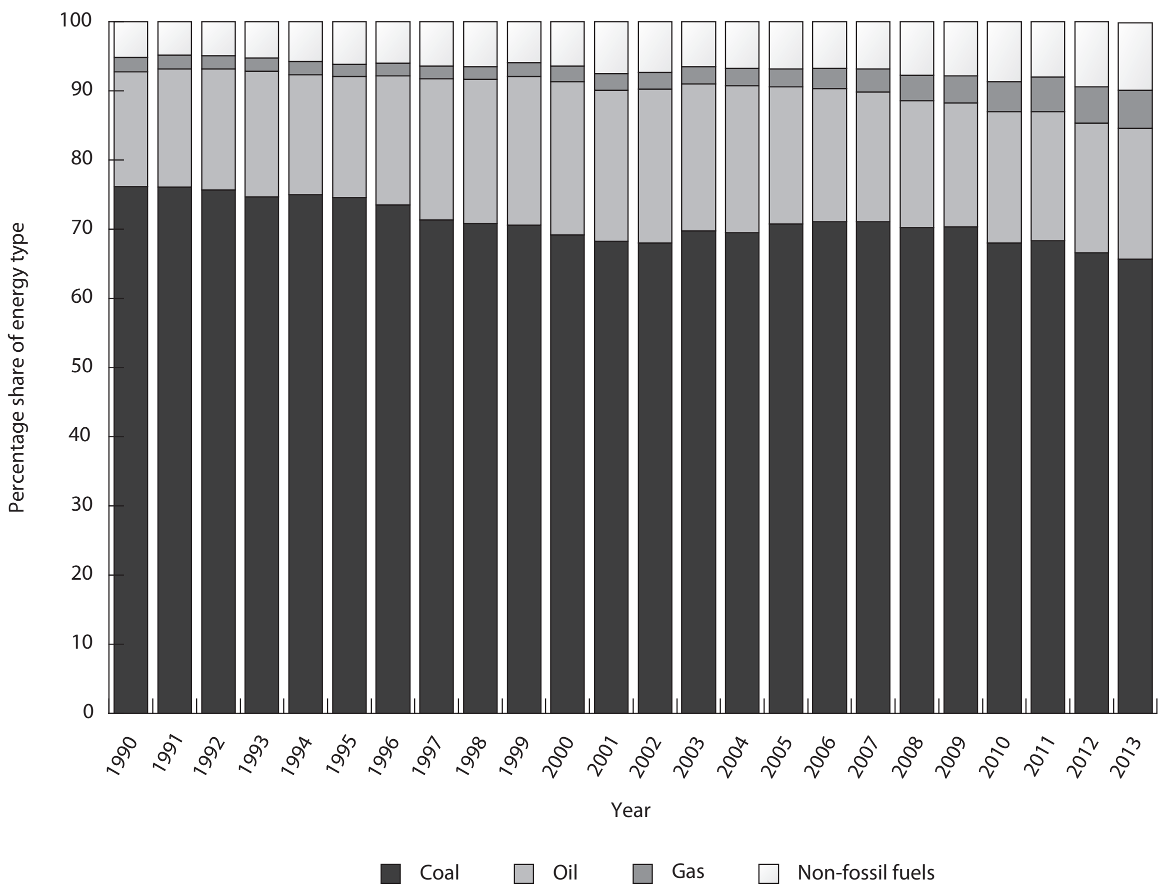
4 A ton of coal equivalent (tce) equals 7 million kilocalories (kcal), and the heat content of a ton of raw coal is about 4.5–5.5 million kcal, with an average of 5.0 million kcal. For more on Chinese coal use, see National Bureau of Statistics of China, *China Statistical Yearbook 2013* (Beijing: China Statistics Press, 2013), http://www.stats.gov.cn/tjsj/ndsj/2013/indexeh.htm; and Wu, "Zhuanfangshi tiaojiegou cugaige, qiangjianguan baogongji huiminsheng, zhashi zuohao 2014nian nengyuan gongzuo."

Coal in China's Energy Mix

The Current Situation

Coal is the dominant form of energy used in China, but its role in the country's overall energy mix has been progressively reduced since 2011. Although China's coal use reached 3.74 billion tons in 2013—accounting for about one-half of coal use worldwide—the country's growth rate for coal consumption also shrank to its lowest level since 2001. According to preliminary statistics, the annual growth rate of coal use dropped from 9.0% in the decade over 2001–11 to 6.9% in 2012 and to 2.0% in 2013. As a result of this decline, and coupled with other policy measures to promote greater reliance on alternative energy sources such as hydropower and natural gas, China succeeded in decreasing the ratio of coal in primary energy consumption from 68.4% in 2011 to 65.7% in 2013 (see **Figure 1**).

FIGURE 1 The makeup of China's primary energy demand since 1990



SOURCE: National Bureau of Statistics of China, *China Statistical Yearbook 2013* (Beijing: China Statistics Press, 2013), http://www.stats.gov.cn/tjsj/ndsj/2013/indexeh.htm; and Wu XinXong, "Zhuanfangshi tiaojiegou cugaige, qiangjianguan baogongji huiminsheng, zhashi zuohao 2014nian nengyuan gongzuo" [Completing Well the Energy-Related Works in 2014, through Transiting Development Model, Adjusting Industrial Structure, Strengthening Reform, Enforcing Management, Securing Supply and Improving People's Livelihood], National Energy Administration, February 11, 2014, http://www.nea.gov.cn/2014-02/11/c_133105714.htm.

To date, three major drivers have contributed to the slowdown of coal use in terms of immediate, causal factors (as opposed to underlying questions about the influence of national policy debates, which will be discussed at length later in this essay). First, China is in the midst of several economic shifts that affect its energy needs. In 2012 and 2013 the country's GDP growth rate fell to 7.7%—its lowest level in more than a decade—and generally such slowdowns in GDP growth also correspond with a dampened demand for coal.[5] Meanwhile, China's economic development has also been entering into a new era of service-oriented growth. Since secondary industry (that is, mining and quarrying; manufacturing; production and supply of electricity, gas, and water; and construction) consumes over 70% of China's electricity, the country's transition away from a focus on these energy-intensive industries toward a service-based economy is also curbing electricity demand, and thus new demand for coal. Related to this point, as the manufacturing sector alone is the country's second-largest coal consumer, decreasing emphasis on this sector will also more directly reduce new demand for coal (see **Figure 2**).

A second driver of China's slowdown in coal demand has been that energy efficiency continues to improve. In China's twelfth five-year plan, the national government set a binding target for energy conservation, aiming to reduce energy consumption per unit of GDP by 16% between 2010 and 2015. Since this plan took effect, energy-GDP intensity has decreased by 9.0%,[6] placing the plan's overall target possibly within reach. Additionally, industry efforts to deploy more modern technologies and require higher standards for newly constructed plants have strengthened efforts to advance more efficient use of coal. Results from these efforts can be seen in the fact that the average gross thermal efficiency rose from 39.4% in 2010 to 40.7% in 2013, and that the average net thermal efficiency rose from 36.9% to 38.3%,[7] which was equivalent to a reduction of 54.6 million tons of coal consumption and a lowering of CO_2 emissions by 99.7 million tons in 2013.

The last driver is that some progress has been made in substituting other energy sources for coal. China has pledged to raise the ratio of non-fossil fuels in its total primary energy consumption to 11.4% by 2015, and policy and industry leaders have been making great strides in fulfilling this target. As a result, in the past three years installed power-generation capacity for a range of alternatives has increased—by 64.0 gigawatts (GW) for hydropower, 45.9 GW for wind power, 14.5 GW for solar power, and 3.8 GW for nuclear power—making China a world leader in the development of non-fossil fuels.[8] Correspondingly, the share of coal-fired power in total electricity

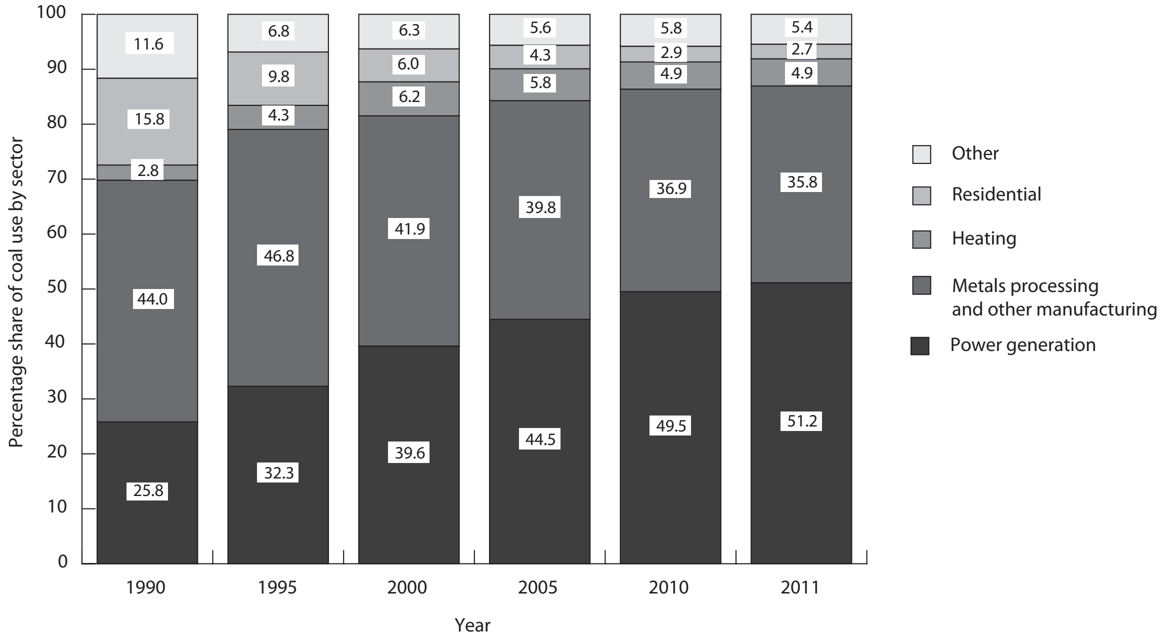
5 National Bureau of Statistics of China, "2013nian guomin jingji he shehui fazhan tongji gongbao" [Statistical Bulletin on National Economy and Social Development in 2013], February 24, 2014.

6 Author's calculation based on data in National Bureau of Statistics of China, *China Statistical Yearbook 2013*; and National Bureau of Statistics of China, "2013nian guomin Jingji he shehui fazhan tongji gongbao."

7 For more on gross thermal efficiency, see China Electricity Council, "2011nian dianli gongye tongji jichu shuju yilanbiao" [Basic Statistical Data of Electricity Industry in 2011], April 19, 2013, http://www.cec.org.cn/guihuayutongji/tongjxinxi/niandushuju/2013-04-19/100589.html; and National Energy Administration, "Quanguo dianli gongye tongji shuju" [Statistical Data of Electricity Industry], January 14, 2014, http://www.nea.gov.cn/2014-01/14/c_133043689.htm. Gross thermal efficiency for 2013 is estimated by assuming that the own use ratio in plants improved to 6.00%, up from 6.08% in 2012.

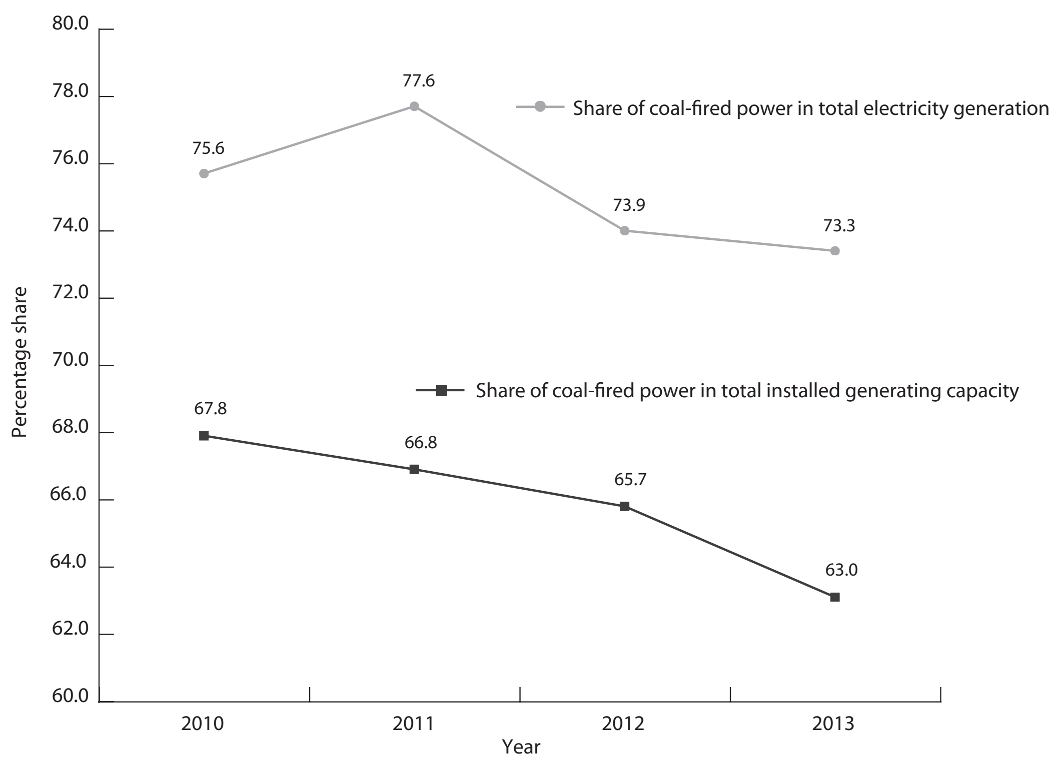
8 For more on China's development of non-fossil fuels, see National Energy Administration, "Quanguo dianli gongye tongji shuju"; and Wu, "Zhuanfangshi tiaojiegou cugaige, qiangjianguan baogongji huiminsheng, zhashi zuohao 2014nian nengyuan gongzuo." Since China's per household electricity consumption in 2013 was estimated at 1,528 kilowatt hours, 1 GW hour (GWh) of electricity can supply 655 houses for one year. According to preliminary statistics, 1 GW of power-generating capacity in 2013 generated electricity of 2,080 GWh for wind, 3,592 GWh for hydropower, and 7,893 GWh for nuclear power. If we assume that 1 GW of solar power generates 1,200 GWh per year, then the electricity generated in 2013 by the increased capacity of the four non-fossil power sources from 2010 is estimated at 372,753 GWh, which could provide electricity for about 244 million houses for one year. This is equivalent to reducing coal consumption by 170.9 million tons and lowering CO_2 emissions by 312 million tons.

FIGURE 2 Structure of coal use by sector



SOURCE: National Bureau of Statistics of China, *China Statistical Yearbook 2013*.

FIGURE 3 Switching from coal-fired power



SOURCE: National Bureau of Statistics of China, *China Statistical Yearbook 2013*.

generation dropped from 75.6% in 2010 to 73.3% by 2013, and its share in total generating capacity fell to 63.0%, down 4.8 points in these three years (see **Figure 3**).[9]

Government Planning

The slowdown in coal use is very likely to persist, particularly given the trajectory of government policy. From a national policy perspective, the government aims to lower the coal ratio in China's energy mix to below 65% and to limit coal use to 3.8 billion tons in 2014, as outlined in the "Guiding Opinions on Annual Energy Development in 2014" released by China's National Energy Administration. As for 2015, the target for coal use is 3.9 billion tons in the Twelfth Five-Year Plan for Coal Industry Development.

To achieve these targets, the National Energy Administration has outlined a series of recommendations for policy and industry. It plans to increase the ratio of natural gas in China's energy mix to an ambitious 6.5% and additionally make gains in expanding the total power capacity of non-fossil fuels (by 8.64 GW of nuclear power, 18.00 GW of wind power, and 10.00 GW of solar power). These targets, if achieved, will raise the ratio of non-thermal power in total power generation capacity to 32.7% and the ratio of non-fossil energy in primary energy to 10.7%.[10]

At the same time, the National Energy Administration is looking to manage the demand side of the equation as well. It has decided to reduce coal consumption in Beijing, Tianjin, Hebei Province, and Shandong Province to 17 million tons and shut down 2 GW of inefficient small thermal power plants across the country. Additionally, the construction of new coal thermal plants, except cogeneration plants, will be prohibited in the Beijing-Tianjin-Hebei belt and the Yangtze and Pearl River Deltas, where air pollution is severe. Coal thermal power for the populous eastern provinces will also be replaced by nine large-scale coal thermal power bases in the coal-rich west and supplied through building twelve west-east electricity transmission routes.[11]

Preliminary statistics from the first half of 2014 show that the growth rate of China's GDP was only 7.4% but that the share of tertiary industry reached 46.6%, up 0.3 points on a year-on-year basis. Electricity consumption increased by only 5.3%, and the average net thermal efficiency increased to 38.8%, up 0.4 points from the first half of 2013.[12] These figures illustrate that all the factors contributing to the slowdown of coal use are working.

The Broad Range of Projections on Peak Coal Demand in China

Despite a growing consensus that China's coal demand will peak in the near to medium term, the question of exactly when and at what level remains debated. Recent studies conducted by different international and Chinese institutions show that coal demand in China will peak or plateau between 2015 and 2030, at the level of 3.9–4.8 billion tons, which is an unbelievably broad

[9] For more on coal's share of total energy generation, see China Electricity Council, "2011nian dianli gongye tongji jichu shuju yilanbiao"; and National Energy Administration, "Quanguo dianli gongye tongji shuju."

[10] Since non-fossil energy is almost exclusively used for power generation in China, the higher the ratio of non-thermal power is, the more non-fossil energy will be consumed, and then the share of non-fossil energy in primary energy will increase.

[11] National Energy Administration, "2014 Nian Nengyuan Gongzuo Zhidao Yijian" [Guiding Opinions on Annual Energy Development in 2014], 2014.

[12] See National Bureau of Statistics of China, "2014nian shangbannian woguo GDP chubu hesuan zingkuang" [Preliminary Statistics of GDP in the First Half of 2014], July 17, 2014, http://www.stats.gov.cn/tjsj/zxfb/201407/t20140717_582698.html; China Electricity Council, "2014nian shangbannian dianli gongxu xingshi yuce baoguo" [Forecasting Report on Electricity Supply and Demand in the First Half of 2014], July 30, 2014; and National Energy Administration, "2014nian shangbannian dianli gongye tongji shuju" [Statistical Data of Electricity Industry in the First Half of 2014], July 15, 2014, http://www.nea.gov.cn/2014-07/15/c_133483853.htm.

range. **Table 1** surveys the key findings of the major studies of peak coal to date. This section discusses several of these studies in greater detail to highlight their key strengths and raises additional questions for consideration.

TABLE 1 Current assessments of peak coal in China

Organization (year of outlook)	Peaking or flattening year		Amount of coal use			Assumed heat content of raw coal
	Peaking	Flattening	Billion toe	Billion tce	Billion tons	kcal/kg
Chinese Academy of Engineering (2011)	2030	–	1.85–2.00	2.64–2.85	3.70–4.00	4,995
Citigroup (2013): **• "Transition scenario"** **• "Deep transition scenario"**	• 2016–17 • 2015	–	• 1.88 • 1.86	• 2.69 • 2.66	• 3.92 • 3.88	• 4,800 • 4,800
IEA (2013): "New Policies Scenario"	–	2025	2.17	3.10	–	–
China National Coal Association (2014)	2020	–	2.28	3.26	4.76	4,794
China's joint team on "The Outlook and Response to Peak Coal" (2014)	2020	–	1.96	2.80	4.10	4,780

SOURCE: China Academy of Engineering, *Zhongguo nengyun zhongchangqi (2030, 2050) fazhan zhanlue yanjiu* [The Study Report on China's Medium- to Long-term Energy Development Strategies (2030, 2050)] (Beijing: Science Publishing, 2011); Citi Research, "The Unimaginable: Peak Coal in China," September 4, 2013, available at https://archive.org/details/801597-citi-the-unimaginable-peak-coal-in-china; International Energy Agency (IEA), *World Energy Outlook 2013* (Paris: IEA, 2013); Li Ziqin, "Yuji 2050nian woguo jiang shixian yi qingjie fadian weizhu" [Clean Electricity Is Forecasted to Dominate China's Power Generation in 2050], China Energy Net, March 18, 2014, http://www.ccchina.gov.cn/Detail.aspx?newsId=43271&TId=57; Zhang Lei, "Meitan xiaofei de tianhuaban zaina?" [Where Is the Peaking Level of Coal Demand?] *China Coal News*, March 17, 2014; and author's own calculations.

Research by the Chinese Academy of Engineering

In 2011 the Chinese Academy of Engineering (CAE) published *The Study Report on China's Medium- to Long-term Energy Development Strategies*.[13] The report estimated that China's coal use would peak at 3.7–4.0 billion tons around 2030, mainly driven by changes in the country's macroeconomic structure, wider use of coal alternatives, and tougher measures for environmental

[13] China Academy of Engineering, *Zhongguo nengyun zhongchangqi (2030, 2050) fazhan zhanlue yanjiu.*

protection and climate change prevention. This conclusion was achieved through a comprehensive assessment using both top-down and bottom-up methods.[14]

Although the CAE report was very reliable upon release, the unpredicted slowdown in economic growth and coal demand growth since 2011 may require a reassessment of its prediction for peak coal demand. For example, a net thermal efficiency of 37.8% in 2020 was assumed in the best case (scenario 3), but that rate was already reached in 2012. This suggests that a more current, realistic assumption should move up the peaking year while also lowering the peaking level.

Research by Citigroup vs. Research by the China Electricity Council

In its 2013 report "The Unimaginable: Peak Coal in China," Citigroup argued that China's coal use is very likely to peak in 2015 at 3.88 billion tons in its "deep transition scenario" or in 2017 at 3.92 billion tons in its "transition scenario."[15] The study's findings are driven by four core assumptions: (1) China will continue its efforts to reduce air pollution, especially those related to pollutants derived from coal, (2) current structural downward shifts in GDP growth and energy intensity will continue, (3) the energy sector will see robust growth of renewables and nuclear capacity, along with increased availability of nature gas, and (4) policy and industry will continue to make strides in improving coal plant efficiency and lowering overall energy demand. The report also suggested that peaking coal demand in the power-generation sector would result in the peaking of total coal demand in China.

Although the report's general conclusion that China's coal use will peak before 2020 is acceptable, whether coal-fired power generation will peak before or around 2020 requires further discussion (as does the assumption that coal demand in power generation will peak earlier than coal demand in the non-power sector). For example, the China Electricity Council (CEC) issued a report in March 2014 on the development trends of new energy that alternatively indicated that coal-fired power generation will not peak before 2020 and instead will continue to increase its ratio in total generation between 2013 and 2020, ultimately peaking by 2030.[16] From the perspective of an observer of these two studies, the CEC's conclusions on coal-fired generation appear more acceptable than Citigroup's study. Given that the share of alternatives in the power sector remains quite small, it will be very hard to increase these supplies enough to otherwise meet the incremental demand in Citigroup's narrower window.

Research by Chinese Coal-Related Institutions

In March 2014, two sets of peak coal predictions were released by Chinese coal-related institutions. The first set of predictions, authored by a joint team initiated by the Planning and Design Research Institute of Coal Industry to study the outlook for and response to peak coal, suggests that coal use will peak at 4.1 billion tons in 2020.[17] This conclusion is supported by a top-down method and makes the following key predictions by source: (1) total primary energy

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14 Using a top-down method means that the total primary energy demand will be estimated first and then broken down into energy sources and sectors. By contrast, using a bottom-up method means that energy consumption by sources and sectors will be estimated first and then summarized to get the total primary energy demand. Checking the results of one method against those of the other is likely to improve the feasibility of the final results.

15 Citi Research, "The Unimaginable: Peak Coal in China," September 4, 2013, available at https://archive.org/details/801597-citi-the-unimaginable-peak-coal-in-china.IEA.

16 Li Ziqin, "Yuji 2050nian woguo jiang shixian yi qingjie fadian weizhu" [Clean Electricity Is Forecasted to Dominate China's Power Generation in 2050],China Energy Net, March 18, 2014, http://www.ccchina.gov.cn/Detail.aspx?newsId=43271&TId=57.

17 Zhang, "Meitan xiaofei de tianhuaban zaina?"

demand will increase to 4.76 billion tce in 2020 and 5.65 billion tce in 2030, (2) oil demand will reach 0.63 billion tons in 2020 and 0.70 billion tons in 2030, (3) natural gas demand will increase rapidly to 437.10 billion cubic meters in 2020, (4) non-fossil fuels will also expand fast to 0.71 billion tce in 2020, and (5) coal demand, calculated as the residual, will be 2.80 billion tce (or 4.10 billion tons, based on an average heat content of 4,780 kilocalorie/kilogram [kcal/kg] for raw coal). This conclusion seems very close to the one given by Citigroup, yet its consistency with findings about coal use by sector needs to be analyzed further. Without showing coal use by sector, it is hard to evaluate the reliability of the study. Alternatively, the second report, by the China National Coal Association, suggests that coal use will peak at 4.76 billion tons by 2020. This conclusion is achieved by a bottom-up method and includes the following detailed predictions by sector for coal: (1) coal use in power generation will flatten at 2.62 billion tons in 2020, (2) coal use in the iron and steel sector will peak at 0.62 billion tons in 2015, (3) coal use in the non-metallic mineral sector will peak at 0.60 billion tons in 2015, (4) coal use in the chemical sector will increase by 16.5% annually before 2020 and by 0.96% over 2020–25, peaking at 0.75 billion tons by 2025, and (5) coal use in other sectors will decrease gradually to 0.28 billion tons by 2020.[18]

These detailed findings suggest that the China National Coal Association sees peak coal demand as occurring in the near future, yet also imply a somewhat dramatic increase in demand before this point is reached—a more than 25% increase within the next seven years. While these predictions could inspire the coal industry, whether this increase would be viewed as acceptable needs to be carefully discussed, as it would have an impact on aims to address urgent environmental concerns. Although there are ways that China's coal consumption could increase, while policy and industry ensure that rises in air pollutants and CO_2 are also checked—for example, through completely adopting cleaner coal technologies such as flue gas desulfurization and carbon capture and storage (CCS) in all sectors of coal use—it is unlikely that these measures could take effect in the narrow seven-year window for such a dramatic rise as proposed by the association. Consequently, such a dramatic rise in coal consumption almost certainly means more serious air pollution and greater CO_2 emissions. Both of these outcomes are at odds with the national consensus and are almost certain to be met with public and policy opposition.

In sum, the studies examined in this section offer a broad range of assessments as to when and at what level coal demand will peak. Although this can largely be explained in terms of the different methods these studies employ and the different assumptions they make about the factors influencing coal demand, the broad range of predictions may confuse policymakers, energy suppliers, and consumers—not only in China but also around the world. Without a narrower range of assessments, it will be difficult to make an objective evaluation of China's strategies and actions toward addressing energy-related issues such as reducing air pollution, lowering CO_2 emissions, and strengthening energy-supply security.

[18] Zhang, "Meitan xiaofei de tianhuaban zaina?"

The Reassessment of Peak Coal Demand for China

With the studies discussed above in mind, this section reassesses prospects for peak coal demand in China using a top-down approach, combined with a rough linkage to an integrated econometric model.[19] Three main factors and assumptions support this reassessment.

First, a national consensus on the urgent need to address the challenges of air pollution and climate change has formed, and the government has started to take action. For addressing air pollution and climate change, political will is to a great extent more important than economic capability and technological feasibility, Without sufficient political will, there will be no way to address these challenges. This is true not only for China, a highly centralized nation, but also for all the countries in the world.

Since 2011, the Chinese government has established addressing climate change as a key priority, and there is evidence of real, measurable efforts that will affect the country's demand for coal. In terms of its international commitments to address this issue, China submitted a voluntary plan to the United Nations in January 2010, setting targets to reduce CO_2 emissions per unit of GDP by 40%–45% from 2005 levels by 2020 and raise the ratio of non-fossil fuels in the primary energy demand from 7.5% to 15.0%.[20] Further, at the UN Climate Summit in New York in September 2014, China declared its intention to achieve the peaking of CO_2 emissions as early as possible and also decided that it will contribute significantly to the adoption of a long-term framework beyond 2020, to be discussed at the 21st Conference of the Parties on Climate Change in Paris in 2015.

At the same time, China has also launched a robust series of domestic efforts. The low-carbon society experiment launched in 2010 has now been expanded to 42 areas covering 6 provinces, 4 direct-controlled municipalities, and 32 cities. According to the targets set for these experiments, carbon emissions are expected to peak by 2020 in 15 of those areas—including Beijing and Shanghai, where fine particle pollution is severe—and by 2030 at the latest in the other areas. Further, China launched regional CO_2 emissions trading experiments in 7 regions and hopes to establish an integrated domestic emissions trading market by around 2020. In order to fit the allocated emissions cap, almost all the enterprises need to control or reduce fossil fuel use, especially use of coal, and expand the use of non-fossil fuels. Those who can not meet their cap by making their own cost-effective reductions must buy emissions permits in the market. "Cap and trade" is theoretically a cost-effective system for reducing emissions. Because coal consumption accounts for about 80% of CO_2 emissions in China, a cap-and-trade program will result in the decrease of coal consumption. In February 2014, the National Development and Reform Commission issued a notice requiring that those entities that as of 2010 produced greenhouse gas emissions of 13,000 tons or more (CO_2-equivalent) or that had energy consumption of 5,000 tce or more must report their annual

[19] An integrated econometric model, named the 3Es-model, consists of three submodels. The macroeconomic submodel is designed to consistently provide indicators influencing energy supply and demand and related pollutant emissions. The energy submodel, which serves as the core of the 3Es-model, is designed to determine the energy flow from final energy consumption by sector and energy source to the required input for the output of transformed energy sources, and then to primary energy consumption and energy trading position. Finally, the environmental submodel is designed to generate the production matrices and emissions matrices of energy-related pollutants such as sulfur dioxide and CO_2. For a detailed analysis, see Li Zhidong, "An Econometric Study on China's Economy, Energy and Environment to the Year 2030," *Energy Policy* 31, no. 11 (2003): 1,137–50; Li Zhidong, "Quantitative Analysis of Sustainable Energy Strategies in China," *Energy Policy* 38, no. 5 (2010) 2,149–60; and Li Zhidong, "An Econometric Study on the Vision of Low-Carbon Society in China," in *Economic Analysis on Efficiency and Justice* [Kouritsu to Kousei no Keizaibunnseki], ed. Reiko Aoki and Asako Kazumi (Tokyo: Minerva Publishing, 2012), 299–327.

[20] Yang Jun, "Woguo xiang Lianheguo tongbao yindui qihou bianhua zizhu jianhuan xinxi" [Chinese Government Submitted a Voluntary Plan for Addressing Climate Change to the United Nations], Xinhua Net, February 2, 2010, http://www.ccchina.gov,cn/cn.NewsInfo.asp?NewsId=22484; and National Development and Reform Commission, "Zhongguo yingdui qihou bianhua de zhengce he xingdong: 2013 nian baogao" [China's Polices and Actions for Addressing Climate Change: 2013], 2013.

greenhouse gas emissions. At the same time, a group for guiding the collection of statistics on climate change countermeasures—consisting of eighteen government offices, including the National Bureau of Statistics, and three industry organizations—was launched to gather the necessary statistics for the nationwide introduction of total volume control measures and the emissions trading system. All these measures are targeted for the post-2020 framework negotiations.

While the above policies on climate change specifically target reducing CO_2 emissions, there is an important point to be made about China's efforts to address air pollution more generally. The State Council announced the Action Plan for the Prevention and Control of Air Pollution in September 2013. The plan sets the target of reducing the concentration of PM10 (particulate matter of 10 micrometers or less) by 10% from 2012 levels in cities nationwide by 2017, while reducing PM2.5 concentration by 25% in the Beijing-Tianjin-Hebei belt, 20% in the Yangtze River Delta, and 15% in the Zhujiang Delta. The plan also actively promotes the use of new energy vehicles.

Because coal is the largest emitter of PM10 and PM2.5, fulfilling these targets requires reducing coal consumption in non-power-generation sectors and promoting the diffusion of cleaner coal technologies in the power-generation sector. Additionally, as the general consensus is that both oil and natural gas demand will not peak in the near future (at least not before 2030), reducing coal use is the only option to alleviate air pollution and reduce carbon emissions. That is because oil is mainly used in sectors such as transportation where substituting is more difficult in the narrow window, and natural gas is treated as one major fuel to substitute for coal in the household and commercial sectors as well as in distributed boilers. Thus, the Chinese government has begun not only to decrease the coal ratio in the country's energy mix but also to control and then reduce total coal consumption. For example, the government has decided to reduce coal consumption in 2017—compared with 2012 levels—by 13 million tons in Beijing, 10 million tons in Tianjin, 40 million tons in Hebei Province, and 20 million tons in Shandong Province. These efforts are expected to be further strengthened in the future.

Second, China is transitioning away from energy-intensive industry and exports toward a service-based economy and high-value-added exports and is tolerating a gradual slowdown in economic growth. Policymakers have recognized that both of these are requirements for realizing sustainable development in the long term and will reduce industrial coal use directly and thermal coal use indirectly through curbing electricity demand in industry. Reflecting this new thinking and political will on macroeconomic strategy, we assume that the current trends and policies influencing economic shifts and growth will keep working in the future. Because the labor-absorbing capability per GDP in tertiary industry is about 20% higher than that in secondary industry, a slowdown in GDP growth, combined with the expansion of tertiary industry, can also help the country absorb new labor in urban areas.

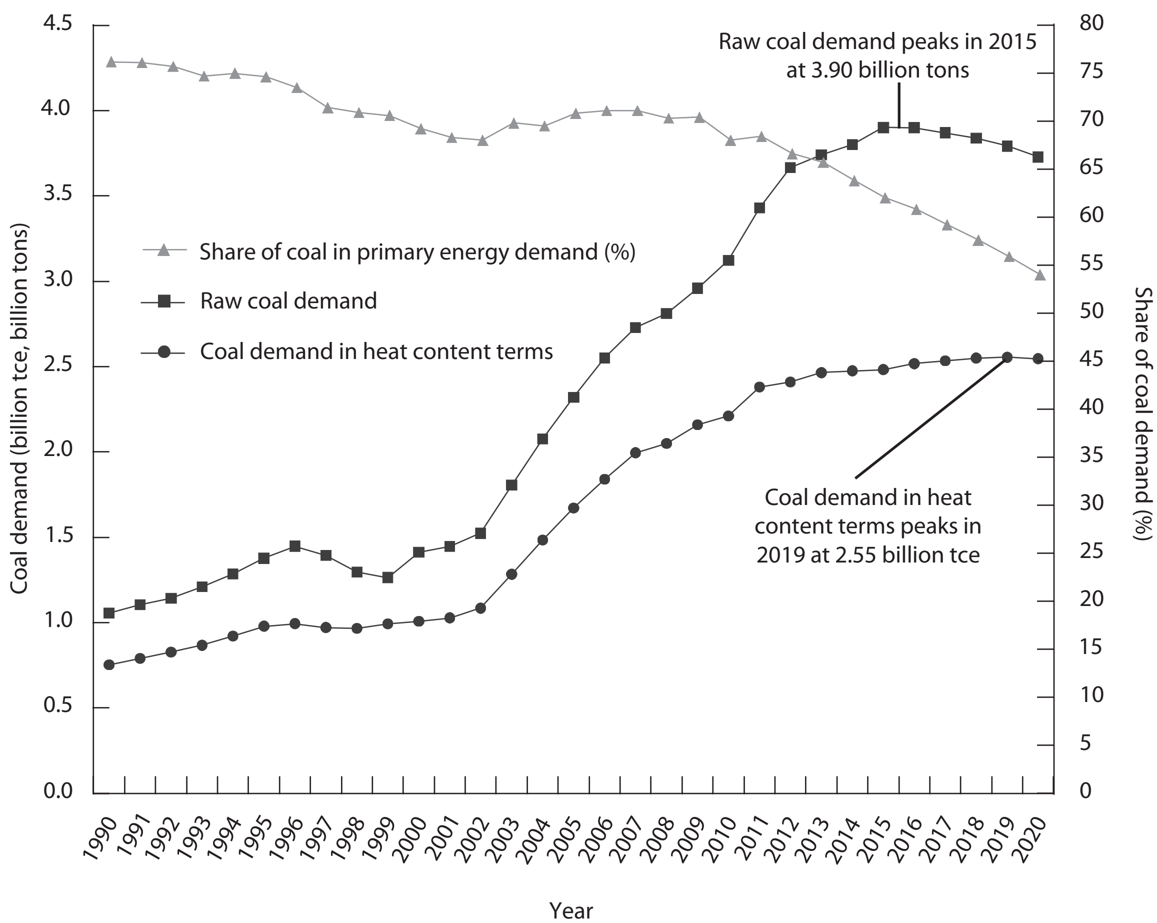
Finally, in thinking through the developments in policy and technology we should anticipate in the near future, there is a clearly observable roadmap for how the government intends to advance efforts to both reshape the use of coal and promote the greater use of alternative supplies in the electricity sector. On this point, the Chinese government has adopted a package of comprehensive energy and environment strategies, which will be strengthened in the future. These include improvements in energy efficiency; the development of natural gas and shale gas; the promotion of the deployment of non-fossil fuels, especially renewable energy; and the imposition of a carbon tax. This study assumes that these efforts will take effect progressively and assist China in realizing the targets for 2020 that it submitted to the UN, such as to reduce CO_2 intensity by about 19% between

2015 and 2020. However, expectations for some of the country's more ambitious strategies should be limited, at least in the near term. Although factors such as the development of CCS technology and coal-substituting technologies like coal-to-liquid and coal-to-gas—as well as a possible lower coal price—may make coal more attractive and spur demand, these effects will be too limited to offset the slowdown in demand. This is due to the fact that CCS still faces universal issues such as high cost, high energy intensity, and poor safety, and that coal substitution may aggravate the air pollution and water shortage issues facing northwestern China. Additionally, coal-substituting technologies may also not contribute to CO_2 emissions reductions.

Main Findings and Key Considerations

Based on these assumptions, the prospects for peak coal demand in China can be reassessed. The main findings based on this author's own analysis are shown in **Figure 4** and **Table 2**. This examination suggests four key points.

FIGURE 4 Outlook for China's coal demand through 2020



SOURCE: National Bureau of Statistics of China, *China Statistical Yearbook 2013*; Wu, "Zhuanfangshi tiaojiegou cugaige, qiangjianguan baogongji huiminsheng, zhashi zuohao 2014nian nengyuan gongzuo"; and author's own calculations based on data in this essay.

First, China's economic growth rate will be sustained at 7.5% over 2013–15. Then it will drop by 0.7 points to an average of 7.0% over 2016–20. This is because a number of potential drivers are slowing down—in the increase in capital input (due to economic saturation), in the growth of the labor pool (due to strict birth control and rapid aging), and in the rate of technological progress (due to diminishing technological disparities between China and the world). On the other hand,

TABLE 2 Main findings on China's coal demand through 2020

	2013	2014	2015	2016	2017	2018	2019	2020	Rate of change from 2013 to 2020 (%)
GDP growth rate (%)	**7.7**	**7.7**	**7.3**	**7.2**	**7.1**	**7.0**	**6.9**	**6.8**	**–**
Primary energy demand (million tce)	**3,750**	**3,880**	**4,000**	**4,141**	**4,283**	**4,426**	**4,569**	**4,713**	**25.7**
Coal	2,464	2,475	2,482	2,517	2,533	2,549	2,554	2,546	3.3
Oil	709	738	762	787	813	840	867	896	26.4
Gas	206	252	300	333	380	434	495	564	173.7
Non-fossil fuels	368	415	456	504	557	603	653	707	92.3
Shares by source in primary energy demand (%)									–
Coal	*65.7*	*63.8*	*62.0*	*60.8*	*59.2*	*57.6*	*55.9*	*54.0*	-17.8
Oil	*18.9*	*19.0*	*19.1*	*19.0*	*19.0*	*19.0*	*19.0*	*19.0*	0.6
Gas	*5.5*	*6.5*	*7.5*	*8.0*	*8.9*	*9.8*	*10.8*	*12.0*	117.8
Non-fossil fuels	*9.8*	*10.7*	*11.4*	*12.2*	*13.0*	*13.6*	*14.3*	*15.0*	53.1
Total coal demand in heat content terms (million tce)	**2,464**	**2,475**	**2,482**	**2,517**	**2,533**	**2,549**	**2,554**	**2,546**	**3.3**
Power-generation sector	1,195	1,264	1,325	1,380	1,436	1,492	1,550	1,609	34.7
Non-power-generation sectors	1,269	1,211	1,157	1,137	1,098	1,057	1,004	936	-26.2
Shares by sector in total coal demand (%)									–
Power-generation sector	48.5	51.1	53.4	54.8	56.7	58.5	60.7	63.2	30.4
Non-power-generation sectors	51.5	48.9	46.6	45.2	43.3	41.5	39.3	36.8	-28.6
Raw coal demand (million tons)	**3,740**	**3,800**	**3,900**	**3,899**	**3,870**	**3,839**	**3,792**	**3,728**	**-0.3**
Power-generation sector	1,813	1,941	2,082	2,137	2,193	2,247	2,302	2,356	29.9
Non-power-generation sectors	1,927	1,859	1,818	1,762	1,677	1,592	1,490	1,371	-28.8

the outputs of energy-intensive goods, such as raw iron and steel and cement, will peak around 2015; the share of secondary industry in China's GDP will decline to about 40% in 2020; and in order to offset this decline the share of tertiary industry will increase to over 50%.

Second, China's primary energy demand will increase by 3.3% per annum in 2013–20, compared with 6.0% in 2005–13. It will rise to 4.71 billion tce in 2020 from 3.75 billion tce in 2013.

Table 2 continued.

	2013	2014	2015	2016	2017	2018	2019	2020	Rate of change from 2013 to 2020 (%)
Total power generation (TWh)	**5,398**	**5,802**	**6,180**	**6,537**	**6,910**	**7,299**	**7,704**	**8,125**	**50.5**
Coal-fired power generation	3,959	4,210	4,436	4,642	4,854	5,072	5,296	5,525	39.6
Non-coal-fired power generation	1,439	1,592	1,744	1,895	2,056	2,227	2,408	2,600	80.7
Shares by source in power generation (%)									–
Coal-fired power generation	*73.3*	*72.6*	*71.8*	*71.0*	*70.2*	*69.5*	*68.7*	*68.0*	-7.3
Non-coal-fired power generation	*26.7*	*27.4*	*28.2*	*29.0*	*29.8*	*30.5*	*31.3*	*32.0*	20.1
Gross thermal efficiency (%)	**40.7**	**40.9**	**41.1**	**41.3**	**41.5**	**41.8**	**42.0**	**42.2**	**3.6**
Total CO_2 emissions (million ton of CO_2)	**8,568**	**8,732**	**8,878**	**9,078**	**9,252**	**9,437**	**9,605**	**9,753**	**13.8**
Coal	6,830	6,860	6,880	6,977	7,023	7,066	7,079	7,056	3.3
Oil	1,399	1,456	1,504	1,554	1,605	1,657	1,712	1,768	26.4
Gas	339	415	494	548	625	713	814	929	173.7
Shares by source in CO_2 emissions (%)									–
Coal	*79.7*	*78.6*	*77.5*	*76.9*	*75.9*	*74.9*	*73.7*	*72.4*	-9.2
Oil	*16.3*	*16.7*	*16.9*	*17.1*	*17.3*	*17.6*	*17.8*	*18.1*	11.0
Gas	*4.0*	*4.8*	*5.6*	*6.0*	*6.8*	*7.6*	*8.5*	*9.5*	140.4
Energy-GDP intensity (tce/million yuan)	**65.9**	**63.4**	**60.9**	**58.8**	**56.8**	**54.8**	**53.0**	**51.1**	**-22.4**
CO_2-GDP intensity (tce/million yuan)	**150.6**	**142.6**	**135.1**	**128.9**	**122.7**	**116.9**	**111.3**	**105.8**	**-29.7**

SOURCE: Author's calculations based on data in this essay.

This slowdown of energy demand comes from the combination of the above-mentioned slowdown in GDP growth and the continuation of energy efficiency improvement. Energy-GDP intensity is expected to improve by 22.4% from 2013 levels by 2020.

Third, China's coal-GDP intensity is expected to improve by 36.2% from 2013 levels by 2020, and coal use is very likely to peak at 3.9 billion tons in raw coal base in 2015 and at 2.55 billion tce in heat content terms in 2019. Although non-coal-fired generation will grow faster than total power generation, it will not be large enough to meet growing electricity demand and therefore will not lead to the peaking or flattening of coal-fired power generation before 2020. That is because the share of non-coal-fired generation is too small, accounting for only 26.7% of China's total power generation in 2013. At the same time, the average gross thermal efficiency will improve from 40.7% in 2013 to 42.2% in 2020, but this will not lead to the peaking of coal demand for power generation before 2020, as the improvement rate of thermal efficiency of just 3.6% will be much lower than the expanding rate of coal-fired power generation, which will reach 39.6% (see Table 2). On the other hand, coal use in non-power-generation sectors will keep declining, and this reduction is expected to surpass the increase of coal use for power generation and then drive the peaking of total coal consumption before 2020. Additionally, the government's September 2014 decision to prohibit the production, import, and use of low-quality coal will lead to significant improvements in the heat content of raw coal, thus resulting in a peaking of raw coal demand by as early as 2015.

Finally, it should be noted that the peaking of coal demand is a requirement for a peak in CO_2 emissions but is not a sufficient condition. As shown in Table 2, by 2020 China's CO_2-GDP intensity is expected to decline by 29.7% from 2013 levels, but total emissions will increase from 8.6 billion tons to 9.8 billion tons. Although emissions are unlikely to peak before 2020, peak coal demand will result in a peaking of emissions as early as the first half of the 2020s or at least around 2030.

In order to make the peaking of coal and reduction of CO_2 emissions feasible, more comprehensive strategies should be adopted, including the promotion of greater energy efficiency, the development of natural and shale gas resources, the deployment of non-fossil fuels, and the imposition of a carbon tax. A concern in the near term is whether the carbon tax included in the twelfth five-year plan will indeed be introduced by 2015, and whether the total CO_2 emissions control will be included in the next five-year plan, which starts in 2016. A carbon tax (a typical incentive measure) can contribute to emissions reductions through increasing the emitting cost, and the total emissions control (a typical regulative measure) can require emitters to reduce emissions directly through imposing a cap.

On the other hand, CCS will contribute to reducing CO_2 emissions, and coal liquefaction will contribute to ensuring the security of oil supplies. In addition, coal gasification will not only help secure China's gas supply but also help improve air quality in the Beijing-Tianjin-Hebei belt and southeastern coastal China. At the same time, because CCS still faces a number of issues, which were discussed in the previous section, proponents need to explain the position and role of these technologies in long-term comprehensive energy strategies for working toward an environmentally friendly and low-carbon society.

In sum, this study suggests that coal use in China is very likely to peak at 3.9 billion tons in raw coal base in 2015 and at 2.55 billion tce in heat content terms in 2019. Yet achieving this peaking of coal demand is not an easy task. To continue on this path, the government also needs to adopt more comprehensive strategies focusing on energy conservation and the substitution of non-fossil fuels and natural gas for coal.

Conclusion

China has declared war on air pollution and pledged to achieve the peaking of CO_2 emissions as early as possible. Since coal is the largest emitter of both air pollutants and CO_2, switching away from coal is imperative for China not only to decrease the share of coal in primary energy consumption but also to control and then reduce coal consumption overall.

This study assesses the prospects for reaching peak coal demand and discusses public policy options. The main findings and suggestions can be summarized as follows. First, China's raw coal use is very likely to peak at about 3.9 billion tons in 2015, while coal use in heat content terms is very likely to peak at about 2.55 billion tce in 2019. Such a level of peak coal demand will result in CO_2 emissions peaking as early as the first half of the 2020s, or at least around 2030. Second, as part of China's own efforts, more comprehensive strategies should be adopted. They include improvements in energy efficiency; the development of natural gas and shale gas; the promotion of non-fossil fuels, especially renewable energy; the imposition of a carbon tax; and deeper industrial restructuring and institutional reform.

Yet while the intent of this study has been to look at Chinese policymaking in a domestic context, there is also an important point to be made about China's impact on world markets and its opportunity to demonstrate real leadership on the global stage. Looking at China's efforts to reduce carbon emissions in a wider regional context, greater international cooperation, such as stronger practical cooperation between China and the United States to reduce greenhouse gas emissions and air pollutants, is vital.

As of October 2014, the two countries have taken opposing positions, with the United States refusing to participate in the UN Framework Convention on Climate Change without concessions by the major carbon-emitter, China, and China arguing that the United States should join the framework with a high total volume reduction target. However, in April 2013, in the early months of the new leadership of Xi Jinping and Li Keqiang and the second Obama administration, the countries released a joint statement on climate change. The statement recognizes that collaboration in multilateral negotiations on preventing global warming and the adoption of specific actions to address this issue could become key for deepening bilateral relations. Additionally, in February 2014 the two governments released another joint statement confirming that they will steadily collaborate in five areas.[21] The countries also decided to enhance the sharing of information regarding their respective post-2020 plans to limit greenhouse emissions and reaffirmed their commitment to contribute significantly to the adoption of a long-term framework at the 21st Conference of the Parties on Climate Change scheduled for 2015. Further, in July 2014 the countries issued the "Report of the U.S.-China Climate Change Working Group to the 6th Round of the Strategic and Economic Dialogue" in Beijing. This document outlines the progress made on five initiatives and highlights new possible areas for cooperation.

A joint effort by the world's two largest carbon-emitting countries is imperative for addressing global climate change, and there are high expectations for solid progress from this collaboration. The most important objective in the near future is that each country should move forward with ambitious long-term targets for reducing CO_2 emissions and secure approval for these plans in its own legislative body as well as from the other country. Ambitious targets

[21] These include (1) the reduction of emissions from heavy-duty and other vehicles, (2) the creation of a smart grid, (3) CCS, (4) the collection and management of data on greenhouse gas emissions, and (5) the promotion of energy efficiency in buildings and industry.

would also provide a huge market for CO_2-reducing business, such as energy conservation and non-fossil energy development, and further promote cooperation between the two countries based on each holding comparative advantages. As a result, Sino-U.S. cooperation would finally accelerate the process of peaking coal use in China.

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The Key Drivers of China's Environmental Policies

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EXECUTIVE SUMMARY

This essay examines the key drivers of China's environmental policies and analyzes how environmental considerations are increasingly shaping China's decisions on economic, energy, and public health issues.

MAIN ARGUMENT

China's environmental policies historically have been a distant second priority to the country's pursuit of economic growth. In recent years, however, environmental problems—specifically those that involve air, water, and food supply—have become politically sensitive subjects, inciting growing social unrest and protests. The Chinese government's response to these problems has been to increasingly invest in a number of strategic renewable energy and clean-technology sectors, most notably clean coal. At the same time, the country has made massive investments in its strained healthcare system. Environmental considerations are also among the key drivers of China's emphasis on higher-technology manufacturing and service-sector opportunities as part of the twelfth five-year plan. Nonetheless, despite these positive moves, questions remain about China's ability to adapt its current environmental regulatory system in ways that might constrain key industries during a time when two things are happening: the country's economic development model is transitioning, and overall economic growth is slowing.

POLICY IMPLICATIONS

- U.S. policymakers should not underestimate the priority that their Chinese counterparts will continue to put on economic matters over all else. In this way, China is likely to continue to resist adopting either energy or pollution standards that are perceived as restrictive to the country's conventional growth model.
- China's energy policies are designed to ensure that the country can maintain cost-effective and timely access to key resources such as coal, oil, and natural gas. While the central government has taken great steps to incentivize the development of a renewable energy and clean-technology sector domestically, these priorities reflect economic goals more so than purely environmental priorities.
- The primary vulnerability that China's environmental damage has created is political and is best seen through the country's strained healthcare system. This means that China's healthcare reforms will continue to be a critical measure of how the government believes it can best balance the need to address the damage its economic growth model has caused to people's health with the political risks attached to shutting down the country's worst polluters.

February typically marks the worst time of the year for Beijing's enveloping air pollution, especially for an egregious type known as PM2.5 (particulate matter of 2.5 micrometers or less). These particulates are roughly 30 times smaller than the width of a human hair and gradually accumulate in a person's respiratory and vascular systems—leading to premature death in the form of lung cancer, heart disease, cerebrovascular problems, and other respiratory ailments. In February 2014, the U.S. embassy in Beijing's now-infamous Beijing Air Quality Index indicated that the city's air quality had been at or above the "unhealthy for sensitive group level" for 70% of the month and that the same index had registered at "hazardous" or "beyond index" 25% of the time.[1]

For people aware of these measurements and the implications for their own and their family's health, this meant that for 95% of February 2014 residents of Beijing needed to stay indoors, preferably in an environment with purified air. For those lucky enough to have the options to stay home or to work, go to school, or shop in artificial indoor environments with scrubbed air, a livable solution could be seen through the haze. But for the average citizen of Beijing, these were not options. The formerly white respiratory masks tucked neatly around people's noses as they made their way around the city grew rapidly gray and dingy. These masks may provide solace but do little to protect one's health.[2]

China's environmental concerns have reached a critical inflection point, and these issues are increasingly driving national policy in ways that have key implications for public health, energy outlooks, and efforts to address global climate change. With this in mind, this essay examines the key drivers of environmental policy in China. Section one discusses the scale of China's environmental concerns—detailing levels of air, water, and soil pollution across the country and the impact that this is having on public health—while the following section examines the root causes of these concerns. Next, section three highlights rising industry and public pressure on the Chinese government to address environmental concerns. The following sections then assess the impact of this pressure on public policy and how the Chinese leadership is adapting in response to these pressures. Finally, section six examines where China fits into growing international debates on climate change and the environment and suggests key considerations for moving forward on urgent policy goals. The essay concludes by arguing that environmental concerns are beginning to compete with the economic development model that China has embraced over the last 30 years because these environmental problems are contributing to one of the fundamental political vulnerabilities China's central government faces: a deeply inadequate healthcare system.

Assessing the Damage

How bad are China's environmental problems? An academic study published in July 2013 evaluated pollution and morbidity data across China and concluded that people living north of the Huai River, where China's air pollution is most extreme, should expect to live on average five years less than their counterparts who lived south of the same river.[3] Meanwhile, Beijing's smog

1 See the Twitter account BeijingAir, https://twitter.com/BeijingAir.

2 Richard Saint Cyr, "Pollution Masks: Which Are Best? Consider Totobobo," MyHealth Beijing, September 13, 2010, http://www.myhealthbeijing.com/children/pollution-masks-which-are-best.

3 Yuyu Chen, Avraham Ebenstein, Michael Greenstone, and Hongbin Li, "Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy," *Proceedings of the National Academy of Sciences of the United States of America*, May 28, 2013, http://www.pnas.org/content/110/32/12936.

has become symbolic of similar problems around the country: for example, 70% of China's water is too polluted for drinking.[4] A 2002 national study on cadmium levels in China's rice showed that 10% of the country's supply exceeded national maximums for this heavy metal that is linked to cancer; moreover, a 2013 Chinese government evaluation of rice in Guangdong, one of China's agricultural centers, found 44% of the rice sampled exceeded nationally mandated maximum cadmium levels.[5] These various data points reinforce the simple but chilling message that the inputs on which human life depends (food, water, and air) have become toxic to Chinese citizens in numerous ways.

Quantifying China's environmental damage is not easy, particularly given the political sensitivities among Chinese policymakers. The U.S. embassy's data stream mentioned above provoked an obvious firestorm, in part because it presented a real-time and measurable reality that reflected the cloying ache in people's throats and the heavy breaths Beijing's population anecdotally knew to be a problem. Meanwhile, China's own attempts to measure environmental pollution have run into internal political resistance over publicizing the actual data. The best example of this was a July 2007 study initiated by the Ministry of Land and the National Bureau of Statistics. While the data was ready for publication roughly eighteen months after the study was initiated, the results were not published until December 2013, and then only in limited form, as the full scope of the findings and the associated data sets were not publicly released.[6] It is now obvious why the results were held back: they created a very real political liability for China's central government. According to He Guangwei, a 2012 winner of the Environmental Press Award given by chinadialogue.net, these results showed that "about 16.1 percent of China's soil and about 19.4 percent of farmland were contaminated."[7] Parsing even the limited collected data remains politically charged. He further noted that in 2013 "a Beijing lawyer Dong Zhengwei requested the data [on soil pollution], including information on causes, and methods for dealing with it, from the Ministry of Environmental Protection. The request was refused on the grounds that the data was a 'state secret.'"[8]

Yet understanding the scale of China's problems is increasingly important to strengthening decision-making in both the public and private sectors. For example, the soil pollution mentioned above is widely believed to be the cause of China's growing number of cancer clusters (also referred to as cancer villages), which today is estimated to include over 450 unique locales across the country.[9] One of the most likely factors leading to the proliferation of these cancer clusters is the pervasive heavy-metal pollution of arable land. Thus, reliable data on this pollution is important for better understanding the resources required to address associated health challenges.[10] However, as Jennifer Holdaway and Wang Wuyi have pointed out, soil pollution is only one factor among many environmental considerations. A more sophisticated

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4 Rylan Sekiguchi, "Water Issues in China," Freeman Spogli Institute for International Studies, September 2006, http://spice.fsi.stanford.edu/docs/water_issues_in_china.

5 "Cadmium Rice: Heavy Metal Pollution of China's Rice Crops," Greenpeace East Asia, April 24, 2014, http://www.greenpeace.org/eastasia/publications/reports/toxics/2014/cadmium-rice-heavy-metal.

6 He Guangwei, "The Victims of China's Soil Pollution Crisis," in "Pollution and Health in China: Confronting the Human Crisis," ChinaFile, September 7, 2014, 16.

7 Ibid.

8 Ibid.

9 Jonathan Kaiman, "Inside China's 'Cancer Villages,'" *Guardian*, June 4, 2013, http://www.theguardian.com/world/2013/jun/04/china-villages-cancer-deaths.

10 M. Sim, "The Toxic Rice Fields of China's Cancer Villages," Blacksmith Institute, Pollution Blog, June 11, 2013, http://www.blacksmithinstitute.org/blog/the-toxic-rice-fields-of-chinas-cancer-villages.

means for evaluating the mechanisms at work in China's cancer villages would need to look at a confluence of other factors in addition to soil pollution, such as water and air pollution in the same areas. Yet pulling all of these various factors together in a scientifically rigorous manner has been difficult. The lack of political will to complete such a study is a significant obstacle, but perhaps more importantly the unfortunate reality that China's current public health system is not equipped to accurately or consistently measure and report back to government authorities this sort of broad public health data is also a consideration.[11]

The Root Causes of China's Environmental Challenges

China's current environmental situation did not emerge overnight, but it is in many ways a direct result of the country's rapid industrialization, which happened at a pace and on a scale without precedent. Looking at the country's challenges holistically, China's environmental problems have a threefold root cause, stemming from separate yet interrelated issues. These causes are China's lack of funding for its environmental regulatory agency, significant reliance on conventional coal-fired power, and single-minded emphasis on economic growth.

An Underfunded Regulatory Agency

One of the root causes of China's environmental challenges is that the country's environmental regulatory agency (the Ministry of Environmental Protection) is badly underfunded. In its current form, this ministry does not have the funding to provide the sort of industry oversight that would have any chance to monitor, report, and penalize environmental polluters. While cynics are quick to suggest this underfunding is intentional, that is an unfair accusation. No country in the history of mankind has modernized its economy at the pace or scale of China. In addition, China's modernization took place using industrial technologies that were an order of magnitude larger in their environmental footprint than what the Western countries had at their disposal during their more gradual periods of historical economic growth. To put China's development in perspective, a March 2011 report by McKinsey's Global Institute compared, among other things, the speed and scale with which China has modernized its industrial infrastructure.[12] The report found that when China's modernization was compared with that of the British Empire during the latter's Industrial Revolution, China's ran at "ten-times the speed and 100-times the scale of Britain's."[13]

These realizations lead to an uncomfortable truth: that to a great extent, the environmental damage caused by China's rapid industrialization surprised everyone—both in China and across the Asia-Pacific—catching officials unprepared and leaving the country without sophisticated and government-funded regulatory systems with the administrative and legal ability to act. China's own policymakers are gradually coming to grips with their need to invest new resources and add new teeth to the Ministry of Environmental Protection. This is true not only for domestic reasons but for international ones as well. China's pollution has been linked to new smog problems in neighboring countries such as Japan. In addition, U.S. coastal cities such as Los Angeles and

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11 Jennifer Holdaway and Wang Wuyi, "Fixing China's Environmental and Health Woes," in "Pollution and Health in China: Confronting the Human Crisis," ChinaFile, September 7, 2014.

12 Richard Dobbs, Sven Smit, Jaana Remes, James Manyika, Charles Roxburgh, and Alejandra Restrepo, "Urban World: Mapping the Economic Power of Cities," McKinsey & Company, March 2011, http://www.mckinsey.com/insights/urbanization/urban_world.

13 Tong Wu, "China's Industrial Revolution Is Happening on a New Planet," Conversation, September 18, 2013, http://theconversation.com/chinas-industrial-revolution-is-happening-on-a-new-planet-18204.

Seattle have pointed out that their air quality suffers as a result of polluting smog that crosses the Pacific Ocean, leading to a new potential source of tension in Sino-U.S. relations.

Reliance on Conventional Coal-Fired Power

The second root cause of China's environmental problems is the country's reliance over the last 30 years on conventional coal-fired power. Coal has been not only extensively employed in the power sector but also traditionally used in tandem with lower-standard plants. It is perhaps not surprising, then, that an October 2014 study by a broad consortium of leading Chinese institutes and government agencies found that more than half of China's air pollution can be attributed to coal use alone. The numbers are even more staggering for PM2.5 in particular, with the study finding that coal is responsible for an average of 50%–60% of these concentrations and highlighting a direct correlation between the rise of China's coal consumption and the rise of PM2.5 levels across the country.[14]

The good news is that China appears to be moving away from its highest-polluting sources of energy, both through its pursuit of cleaner supplies and its efforts to promote the more efficient, cleaner use of fossil fuels. In many ways, China is leading the world not only in developing alternative energy but in developing cleaner versions of existing technologies as well. James Fallows wrote in December 2010 that with respect to clean coal "China is now the leader in this area, the Google and Intel of the energy world."[15] Additionally, his analysis points out the leadership position China has carved out for itself in this realm, suggesting that its actions can be seen as "an area of achievement that is objectively good for the world as a whole."[16]

Today, the most efficient and lowest-emission clean-coal plants in the world are not found in Europe or the United States but are instead found in China. In 2009, Keith Bradsher of the *New York Times* wrote about clean-coal plants in China that "while the United States is still debating whether to build a more efficient kind of coal-fired power plant that uses extremely hot steam, China has begun building such plants at a rate of one a month."[17] Fallows quoted an anonymous U.S. government official working in China on energy policy who said that China "can go from concept to deployment in half the time we can, sometimes in a third. We have some advanced ideas. They have the capability to deploy it very quickly. That is where the partnership works."[18] China's success in bringing this sort of clean-coal capacity online more quickly than other developed economies is positive proof of the government's ability to respond to environmental and energy problems constructively. The speed of this response also provides hope to the Chinese people and their global peers that Beijing could address equally urgent challenges specific to public health with similar success.

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14 National Resources Defense Council (China Program), "Coal Utilization's Contribution to Air Pollution," China Coal Consumption Cap Plan and Policy Research Project, October 20, 2014, http://www.nrdc.cn/coalcap/index.php/English/project_content/id/448.

15 James Fallows, "Dirty Coal, Clean Future," *Atlantic*, December 2010, http://www.theatlantic.com/magazine/archive/2010/12/dirty-coal-clean-future/308307.

16 Ibid.

17 Keith Bradsher, "China Outpaces U.S. in Cleaner Coal-Fired Plants," *New York Times*, May 10, 2009, http://www.nytimes.com/2009/05/11/world/asia/11coal.html.

18 James Fallows, "Dirty Coal, Clean Future."

Emphasis on Economic Growth

The third root cause of China's environmental problems is also the most nuanced, which means it only presents itself as obvious in hindsight: China's emphasis on economic growth as the only source of the central government's viability. Ironically, the single-minded emphasis on economic growth, absent adequate safeguards on unrestrained development, has resulted in healthcare problems and unmitigated environmental damage that could severely constrain the Chinese economy. China's leadership now understands the need to address these challenges.

In some ways, the government's original single-minded focus is the primary lens through which it is coming to terms with the need to change its environmental policies. Yet this realization has come on the other side of a policy and regulatory environment that encouraged businesses to do whatever possible to capture export markets. In many cases, this created working conditions unacceptable to the modern environmental regulatory system. One of the best examples is the disposal of industrial waste—such as solvents, unreacted chemicals, and compounding materials—by simply directing it away from the manufacturing process into either the ground or nearby rivers and lakes.

Just as China's economic development model now must become more sophisticated—that is, less reliant on traditional, low-value-added manufacturing—so too will its environmental regulatory system need to develop to reflect the country's new insights into how unfettered economic development can actually create future economic liabilities. China's twelfth five-year plan reflects the central government's awareness of these problems, with specific goals set for reducing the levels of chemical oxygen demand, ammonium nitrogen, and five heavy metals related to industrial pollution.[19] These pollutants not only have been tied to health problems but also are the byproducts of key industries that have historically played an important part in China's growth. China's need to create an alternative economic development model, to develop renewable and clean energy sources, and to modernize its healthcare system are all inexorably interrelated in ways that make solutions difficult to carry through successfully.

Changing Public Expectations

For the last 30 years, China's political system has benefited from an understandably simple tenet: the government's most important role is to ensure economic growth. All other societal factors come a distant second. This in part explains why China's political liberalization has not progressed as stakeholders in Washington, D.C., anticipated. Yet, as discussed in the preceding section, the focus on economic growth also explains why China's healthcare system is so poorly equipped to deal with the downstream effects of pervasive environmental damage and the related impact on public health.

Conventional wisdom has been that Beijing's population begrudgingly puts up with a trade-off between environmental and economic health; that is, in some increasingly difficult calculus, people have agreed to live with deteriorating environmental conditions in order to remain close to the country's center of political power and its engine of economic growth. But for a narrower slice of Beijing—specifically multinational headquarters and the expatriates who

[19] "With Overall Water Quality Significantly Affected by Pollution, the 12th Five Year Plan (2011–2015) Adds New Water Quality Targets to Lower Pollution," China Water Risk, http://chinawaterrisk.org/big-picture/pollution-indicators.

populate their executive ranks—the city's environmental problems have become untenable.[20] For example, in April 2014, Bloomberg reported that multinational companies were offering hardship packages to their expatriate executives in Beijing in order to keep them and their families in China. Despite such incentives, in many cases executives reported they were sending their families back overseas prior to the end of their assignments simply to ensure that the pollution did not cause long-term health problems for their families.[21]

Popular expressions of concern are spreading beyond Beijing as well. In 2007, several thousand protesters picketed the announced plans to expand a petrochemical facility in Xiamen.[22] In previous years the local government would have likely stifled the protests and allowed the plant's expansion to move forward. This time the response was different, reflecting a growing awareness on the part of municipal and provincial leaders that environmental concerns have become a political liability that must be weighed against the central government's broader economic development and energy policies. Similar stories have emerged around China, where concerned citizens have brokered compromises on planned expansion of known heavy-polluting industries. In 2012, three days of protests culminated in clashes between civilians and Chinese authorities and ultimately led to the cancelation of a Sinopec petrochemical plant.[23]

While none of these more constructive responses by local government address the environmental damage that has already been done, they do reflect a political realization on the part of China's leaders that economic growth is no longer the single mediating principle around which people want policy decisions made. The central government is keenly aware of the need to address civil unrest before it spreads, and Beijing's responsiveness to public backlash against the expansion of polluting industries is an important indication of the government's heightened awareness that the traditional emphasis on economic growth alone is inadequate to maintain a satisfied populace.

The Rise of Environmental Considerations in China's National Policymaking

These escalating levels of environmental damage, coupled with rising public concern, have led Chinese policymaking to a crossroads. Viewed collectively, China's environmental problems add new complexities to at least four policy areas that were already facing challenges. First, they place additional pressure on the country to reform its internal economic development model and reduce the role of heavy manufacturing. Evidence of this pressure can be seen in the emphasis on greater economic growth in higher-technology and service industries. However, it is important to note that even if the country succeeds in making this transition into higher-value-added sectors, environmental problems will not necessarily decrease. For example, several of China's newly emphasized higher-technology industries, such as photo vitalic (PV) cell manufacturing, create

[20] Frank Langfitt, "Beijing: From Hardship Post to Plum Assignment and Back Again," NPR, June 25, 2014, http://www.npr.org/2014/06/25/325217677/beijing-from-hardship-post-to-plum-assignment-and-back-again.

[21] "Foreign Workers in Beijing Leaving Their Families at Home to Protect Them from Smog," Bloomberg, April 8, 2014, http://www.scmp.com/news/china/article/1469700/chinas-pollution-takes-toll-families-and-companies-bottom-lines.

[22] Edward Wong, "In China City, Protesters See Pollution Risk of New Plant," *New York Times*, May 6, 2008, http://www.nytimes.com/2008/05/06/world/asia/06china.html.

[23] Andrew Jacobs, "Protests over Chemical Plant Force Chinese Officials to Back Down," *New York Times*, October 28, 2012, http://www.nytimes.com/2012/10/29/world/asia/protests-against-sinopec-plant-in-china-reach-third-day.html.

very specific and difficult to handle pollutants.[24] PV cell manufacturing utilizes lead, mercury, and cadmium, which do not pose a problem if handled correctly. However, in markets such as China's, where regulations are lacking or not enforced, these materials are often improperly handled, which only accentuates one part of the problem that renewable energy is supposed to solve. Thus, in the absence of adequate government regulations and sufficiently funded oversight capabilities, these new high-technology industries will only add to China's pollution problem.

Second, environmental concerns are injecting new energy into efforts to buttress China's struggling healthcare system, which are taking on even greater urgency as a result. As highlighted by the examples above, economic growth has come at a cost to public health in the form of decreased life expectancy as a result of increased disease rates related to environmental factors.[25] The last 30 years have seen China chronically underinvest in its public health system. This trend is particularly noticeable in China's lagging primary care and diagnostic capabilities. What this means practically is that cardiovascular, respiratory, and oncology problems, which are directly related to pollution, are likely to be discovered late, thereby increasing the cost and complexity of care within the context of an already overburdened and underfunded system.

Third, China's environmental problems are influencing the types of energy policy the country will pursue domestically. As pollution levels increase and are understood to be closely related to coal-burning power plants (China's predominant source of electrical power), the country has come under pressure to do more than simply build additional coal-fired plants, even if these plants can be built to meet high standards for efficiency and air quality. This in no small part explains China's increased appetite for risk in pursuit of clean technology and renewable energy. Where clean-technology investments in more developed countries reflect global concerns, in China these investments largely reflect local problems that do not require a particularly sophisticated sense of the dangers of global warming or natural-resource depletion. These concerns quite literally assault Chinese citizens every day, which explains the appetite for alternative energy sources and more efficient versions of existing systems.

Last, China's environmental problems influence the country's energy policies in the global arena. These energy policies go beyond simple choices about clean coal, solar power, or nuclear power: they also have repercussions for foreign policy. While China continues to make significant and, in some ways, best-in-class investments in renewable energy and clean-technology industries, the country's leadership is acutely aware that many of these investments remain speculative in terms of their scalability and economics. Consequently, China will need to continue to ensure access to oil and natural gas as well as coal. This is best evidenced by its emphasis on maintaining sea lanes in the Strait of Malacca, building pipelines in Myanmar, and pursuing drilling rights in contested waters in the South China Sea. The protection of these interests will require positioning hard-power assets in strategic areas and using soft-power assets to gain privileged access to geographic pinch points where vulnerable oil pipelines must traverse.[26]

Seen as a whole, these four policy areas err on the side of being reactive rather than proactive. This is true not only for problems surrounding resource scarcity and environmental degradation but also for issues that increasingly manifest themselves through civil unrest and deteriorating

24 Yingling Liu, "The Dirty Side of a 'Green' Industry," Worldwatch Institute, 2013, http://www.worldwatch.org/node/5650.

25 C. Arden Pope III and Douglas W. Dockery, "Air Pollution and Life Expectancy in China and Beyond," *Proceedings of the National Academy of Sciences of the United States of America*, August 6, 2013.

26 David H. Shinn, "Africa, China, the United States, and Oil," Center for Strategic and International Studies, http://csis.org/story/africa-china-united-states-and-oil.

healthcare outcomes. The new prominence of environmental considerations in China's policymaking process comes at a particularly unique moment in the country's transformation from a manufacturing and infrastructure-based economy to one built around services and higher-technology sectors. Just as the success of this transition is not certain, neither is the ability of the central government to balance these competing priorities and the funding collectively required for their realization.

Adapting to a New Environmental Era

Overall, these adjustments in priorities suggest a significant change in views among the national leadership, with implications for public policy, industry developments, and the public. Importantly, these shifts are among the first indications that China's leadership understands the need to end its single-minded focus on economic growth at all costs. The Chinese government now understands that it must do more than just promote economic growth: it must also deal with the negative downstream externalities that the country's environmental pollution has created.

On this point, the distinction between policies that emphasize managing the aftereffects of environmental pollution and those addressing their causes is essential. Today, most of China's national policies for responding to an environmental crisis are not only reactive but primarily focused on mitigating the downstream effects of contaminated air, water, and soil on human life and longevity rather than the root causes of such pollution. As an example of this approach, much of China's twelfth five-year plan has been directed at spending on new hospitals, expansion of the national insurance plan, and greater funding for essential drugs. However, the country's healthcare system does not simply need new widgets but needs greater reform and innovation. As part of the reform of China's *danwei* worker units in the 1980s, government-provided healthcare was largely eliminated, leaving public hospitals in tier-one cities as the only places where individuals could hope to access complex care necessary to treat overexposure to environmental pollutants. Today, this has created a top-heavy and inefficient system oriented toward big hospitals to which people flock when they have a healthcare problem, regardless of the distance from their hometowns. As the burden on China from higher disease rates increases, this pattern will break the back of the country's public hospitals.[27]

If China is to address the healthcare problems stemming from environmental pollution, changes to where and how healthcare is consumed are essential. But success on this will require more than simple new investments in clinics and diagnostic equipment. In order to provide adequate care for people negatively affected by environmental pollution, China will need to ensure that oncology therapeutics, cardiovascular interventions, and associated surgeries do not bankrupt families. Given the World Health Organization's 2012 estimate that up to 50% of China's rural poor find themselves in "entrenched poverty" because of healthcare expenses, and that 56% of urban Chinese avoid following up on their doctors' recommendations because they cannot afford to pay, the affordability of healthcare remains problematic.[28] Deeper changes in how hospitals are funded, specifically the formal severing of prescription drug sales as a source of revenue for

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27 Because of this issue, the country's Ministry of Health is investing heavily in community care that is designed to supplement public hospitals by offering more local diagnostic and primary care services.

28 Financial pressures explain the growth of China's Essential Drug List, which is a list of foreign and domestically manufactured pharmaceuticals that are not only available through the public hospital system but also provided at lower cost to consumers by the *yia bao*, China's national health insurance program. For more on this program, see "China's Health Sector Development," World Health Organization Western Pacific Region.

hospitals (which led to all manner of abuse in prescribing and pricing), hold the promise that pervasive problems around healthcare affordability can be addressed in the next decade. China's economic success is unassailable. But this success has a cost that could well create long-term economic liabilities in the form of chronic and acute disease management that will strip China of much of its hard-earned economic wealth.

Implications for China's International Collaboration

Given how China is approaching both the care and cause of its problems specific to environmental pollution, the question of how the growing recognition of these problems will affect China's international collaborations on critical policy goals must be asked. A core element of this question is how China will seek to revisit its energy policies and what this might mean for the country's energy security strategies as well as its trade relations. As part of this process, China's leadership has made a significant investment in a domestic clean-tech industry. Admittedly, this is for two reasons: China wants to capture higher-technology manufacturing, and it recognizes that clean technology could offer a very real set of solutions to the country's pollution and energy problems. No one knows better than China's leadership that the country cannot forever compete with the United States and Europe for limited natural resources like oil and gas. Outside of rising environmental concerns, no single issue has traditionally loomed as large in Chinese thinking on energy as the goal of self-reliance, and clean technology offers policymakers one way to pursue this objective.

The difference between the U.S. and Chinese responses to the realization that clean-tech and renewable energy sectors will be vital to promoting economic growth and addressing core societal problems in the 21st century is this: China believes these issues point toward the ways in which a purely market-oriented signal is inadequate. Short-term price decreases on energy commodities that coincide with lower overall economic activity around the world or the discovery of new oil reserves take the world's attention away from the longer-term strategic problem of limited fossil fuels. China believes that its system of top-down economic planning can identify long-term threats to economic growth and proactively work toward resolving them, even if the market might not believe that such an allocation of society's capital today is justified. In this way, China's environmental problems and emphasis on clean technology create problems for its international collaborations, specifically in how China complies with World Trade Organization (WTO) standards on domestic subsidies for clean-tech manufacturing.[29]

Yet as difficult as questions regarding China's WTO habits in clean-tech matters might appear to be, the challenges specific to creating international engagement on climate change and other public commons problems are even more profound. Provoking China has proved to be a vexing challenge on issues such as binding international legislation on climate change, an area where China's domestic concerns have trumped those of the United States. China's willingness and ability to participate in this sort of international collaboration becomes likelier as the country grows more stable and secure economically and politically. This is again why the emphasis on economic growth has played such a central role for China in ordering its priorities: domestic policies and the

[29] Arunabha Ghosh, "Governing Clean Energy Subsidies: Why Legal and Policy Clarity Is Needed," International Centre for Trade and Sustainable Development, November 9, 2011, http://www.ictsd.org/bridges-news/biores/news/governing-clean-energy-subsidies-why-legal-and-policy-clarity-is-needed.

country's orientation toward global rules and international expectations should become more, not less, responsive as the Chinese economy grows.

However, many critics of China's policies will be quick to note that the country has not proved willing to take on extra global responsibilities, even after several decades of extraordinary economic growth. These critics would point toward the intransigence of China's delegation during the 2009 negotiations in Copenhagen on a climate change treaty as proof that economic growth has only resulted in China becoming more difficult to deal with, not less.[30] During these negotiations, it became very clear that while China is aware of its pollution problems, its leadership also believes that developed economies went through similar periods without having their economic growth complicated or restrained by outside actors, especially those motivated by environmental concerns.

Still, such cynicism may misread the Chinese response. This is particularly true in the context of the Copenhagen conference and with regard to China's interactions with the world's second-largest emitter of carbon dioxide: the United States. The cause of global climate change is one of the most politically vexing issues, even within the United States. In 2012, during a heated GOP presidential primary, the need to test the orthodoxy of Republican candidates required a denial of the existence of climate change or that man-made activity could be the cause. Developed economies should not be surprised that Chinese politicians and policymakers have similarly complicated attitudes toward the question of the culpability on man-made climate change. China's perspective is informed less by a group of policymakers who deny that climate change is real and more by a larger group of policymakers who acknowledge its reality but equally point toward China's very recent encounter with modernity. They suggest instead that few inside or outside the country understood the great environmental damage set in motion as the country rapidly industrialized. At their best, these Chinese leaders have asked for ways to manage the need to continue modernizing China's economy at breakneck speeds while also finding ways to clean up Chinese industries.

The enlightened view on how industry affects the environment is something the developed world has only recently embraced. The expectations from developed economies for how China will approach this question need to reflect the country's relative maturity, sophistication, and political stability. To deny these realities would impair the world's ability to negotiate with Chinese policymakers on the basis of agreed-on facts.

China does pose a free-rider problem to the world's governments as the United States and European countries move forward with plans to address what most countries agree are shared global problems such as climate change. While the West introduces regulations designed to curb carbon emissions, businesses must bear additional costs—unless, of course, they happen to locate their most polluting production facilities in China or other less-developed economies, where environmental regulations are less stringent than what exist in the West today. For Western companies that maintain production capabilities in their home markets, these regulations create short-term costs that increase domestic operating expenses.

Obviously, the longer-term vision of Western policymakers is that global warming and climate change will be one of the most destabilizing influences the world has ever experienced. As such, it is the developed economies that must assume leadership on these matters. In some ways, the challenge for China to enter this group as a responsible stakeholder will require that it adopt

[30] "China's Thing about Numbers: How an Emerging Superpower Dragged Its Feet, Then Dictated Terms, at a Draining Diplomatic Marathon," *Economist*, December 30, 2009, http://www.economist.com/node/15179774.

policies that reflect more than its own provincial concerns. It remains unclear how to translate some of these more mature realizations into the context of the Chinese economic and political system. The more U.S. policymakers acknowledge and accommodate China's burgeoning desire to participate in the establishment of global rules, the more Chinese leaders will appreciate the costs and difficult choices that come with striking a balance between their international aspirations and domestic politics.

In the same way that Beijing's air pollution is a harbinger of broader and more pervasive environmental, social, and political problems within China, so too are China's environmental problems indicative of unresolved questions within a global context. If these questions are to be answered constructively, the world will need China's participation. To the extent that smog-filled skies, contaminated food, and tainted water point toward inadequacies in China's approach to its own economic modernization, so too do these problems point to questions about the sustainability of modern industrialization and the integrity of policies that assume new natural resources lie everywhere for extraction, absent any mediating sense of the related environmental consequences.

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Forging a New Energy and Environmental Balance: Conclusions and Implications for the Asia-Pacific

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The essays, discussion, and analysis that emerged from the National Bureau of Asian Research's 2014 Energy Security Program provide rich insight into China's many energy challenges and the domestic and regional impact of the country's rising energy demand. China's emergence as the world's single largest energy consumer over the past two decades and the country's phenomenal growth mean that these issues are now a question not just of how supply can meet demand but of what role China will play in the global arena as it adapts to its emerging role as an energy superpower. Growing reliance on imported oil and gas over the past two decades has catalyzed a far more active energy diplomacy that is accelerating China's emergence as a global power. This trend has been further magnified by the environmental impact of China's rising coal and oil consumption, which has led to an enormous increase in global carbon emissions and thrust China uncomfortably to the center of the global climate change debate. Altogether, Beijing's energy choices and strategies reverberate through global energy markets, creating numerous geopolitical and environmental challenges.

The analysis and discussion of the program converged around several major themes that will go a long way toward determining China's future impacts on global energy and environmental outlooks. First, discussants overwhelmingly agreed that China is in the midst of a historic and extremely difficult domestic energy transition. The two-decade surge in consumption has become the source of new and more complex challenges for the country's energy policy, energy infrastructure development, and environmental policy. In particular, both the authors of this report and the discussants at the June workshop noted that dramatically rising air pollution is forcing the leadership to move more decisively on addressing the negative environmental and public health consequences of the country's clearly unsustainable energy mix. Beijing is simultaneously struggling to, on the one hand, slow the pace of economic growth in order to reduce the dominance of heavy, energy-intensive industries and, on the other hand, reduce the enormous amount of energy required to sustain the current model of economic growth. Hence, the sheer scale of China's energy and environmental challenges is truly daunting. Beijing's success in addressing these challenges will have significant implications not only for China but for the environmental, economic, and geostrategic outlook for Asia and the world.

With the goal of addressing these concerns, China's current government has continued or launched a number of major policy initiatives that aim to reshape the country's energy portfolio. These initiatives include efforts to reduce energy intensity, reduce carbon emissions and air pollution, reform state-owned enterprises, and reform the pricing systems for energy products. As Philip Andrews-Speed's insightful analysis aptly highlights, different energy policies in China emerge from different contexts that shape their potential for success or failure. As a result, some of China's extant energy reforms are more likely to succeed, while others are more likely to fail based on expectations derived from past efforts. Participants at the June workshop concurred that overall progress is likely to be slow, with prospects for success varying tremendously across a range of key policy initiatives. For example, efforts to address energy-related air pollution in major Chinese cities have a reasonably good chance of near-term progress. Air pollution has become a major concern for the leadership, and a comprehensive program of reforms to limit coal use, slow the rapid expansion of motorization in large cities, and improve tailpipe emissions, among other measures, has strong support from the central government. On the other hand, progress on introducing carbon markets—another important government initiative—is likely to be slow due to the complexity of the issue, local opposition, and industry resistance. Reform of the monopoly power of state energy enterprises also seems likely to be very slow due to industry resistance and low leadership commitment. Overall, a mixed picture emerges in China of gradual but variable progress toward meeting many of its energy transition challenges. In most cases, delays are caused by resistance from existing state enterprises, opposition from local and provincial interests, and inconsistent and episodic leadership attention.

A second theme that emerged focused on the geopolitical implications of China's expanding global and regional energy presence as a result of its search to secure oil and gas supplies. As I noted in my essay for this report, rising dependence on oil imports is at the core of China's energy security anxieties and has shaped the country's strategies to increase control of overseas oil supplies and transport routes. As a result, China has pursued a "go out" strategy focused on the rapid international expansion of its national oil companies (NOC), supported by a wide-reaching energy and financial diplomacy. The NOCs' equity investments, negotiation of long-term supply contracts, construction of new oil pipelines, and employment of Chinese nationals have boosted China's economic and diplomatic presence across the key energy-exporting regions, including the Middle East, Central Asia, Africa, and Latin America. Looking ahead, virtually all forecasts suggest that Chinese oil demand will continue to grow strongly, and with China's reliance on imported oil. This is likely to drive the continued expansion of the country's energy interests globally and reinforce its emergence as a global diplomatic player.

At the same time, China's global energy and diplomatic presence will be further strengthened by its rapidly expanding investments in overseas natural gas and negotiation of long-term contracts to secure regional gas imports. China has discovered natural gas as a cleaner fuel than coal and has begun a huge drive to expand gas use—a "dash for gas." New government targets calling for gas demand growth to quadruple from 2010 to 2020 mean that large imports of gas will be needed. This strategy is boosting China's diplomatic and economic footprint across the Eurasian landmass and into South and Southeast Asia. For example, China has developed a very diversified portfolio of overland pipelines to import gas, including large pipelines from Central Asia and Myanmar, and concluded a deal with Russia in May 2014 to build a large new gas pipeline from East Siberia (and possibly a second pipeline from West Siberia). China is also investing in new receiving terminals along the coast to increase its capacity to import liquefied natural gas (LNG).

Yet workshop participants were mindful that a critical challenge for China is addressing its long-standing dependence on coal. A third key theme that emerged from the workshop revolved around the prospects for limiting and possibly reducing China's coal use, which currently accounts for one-half of all the coal burned every day globally. As several discussants noted, China's leadership recognizes that it must reduce the enormous growth and dominance of coal in the country's energy mix in order to tackle critical air pollution and climate goals. In his essay for this report, Li Zhidong makes the case that China could cap its coal consumption by around 2017 with the implementation of a new range of policies on coal and electricity use along with ongoing economic changes. He argues that this initiative will be driven by a strong new "national consensus on the urgent need to address the challenges of air pollution and climate change," a theme that is echoed by Andrews-Speed and Benjamin Shobert. Many observers now agree that such a consensus is officially driving fundamental changes in electricity demand and coal use. Yet key to this effort will be continually improving energy efficiency, reshaping the Chinese economy to become less energy-intensive and more consumer-driven and service-based, directly mandating reductions in coal burning in the major eastern cities, and substituting lower-carbon energy sources like natural gas and renewables for electricity generation. Li cites a long list of new policies to achieve these changes that have the strong backing of the Chinese leadership and discusses several studies that suggest that a cap on coal use is possible by 2020.

Discussants suggested that while Li's scenario for capping coal use is plausible, many of the associated developments and policies required for this cap seem likely to progress slowly. For example, although the use of coal-generated electricity is being reduced around the highly polluted eastern cities, there are plans for large new coal-fired power-generation centers in the western half of China that would then move the power to the east via long-distance transmission lines. This would simply displace carbon emissions and pollution from east to west rather than reducing the overall levels. Although there are planned restrictions to reduce coal use in the east, the western provinces where coal burning is expected to grow have no such restrictions. Some discussants also cited the limited implementation and follow-through that often affects the success or failure of key energy policies. Although the workshop discussions on the whole raised hopes that China's coal use could be capped in the relatively near future, a number of questions remain about the pace of progress. Many suspect it will take until 2025 or 2030 to cap China's coal use.

Finally, a fourth and closely related theme focused directly on the growing air, water, and other pollution that is driving Beijing's efforts to reduce carbon emissions. An important development is that Chinese leaders must increasingly respond to public pressure to address pollution problems and the worsening impact on public health. With daily updates on the Internet about the levels of air pollution in Beijing and other major cities and a long list of highly publicized cases of water pollution from chemical and industrial leaks, the leadership can no longer ignore these problems. The root causes of China's worsening pollution include a weak and underfunded regulatory system, historically heavy reliance on coal, and the single-minded focus on high economic growth. Nonetheless, Benjamin Shobert's essay suggests that there is progress in addressing all three causes. Furthermore, workshop discussions considered evidence that stronger Chinese efforts to reduce carbon emissions and craft a more responsible climate policy seem to be encouraging greater Sino-U.S. cooperation on climate change.

Ultimately, workshop participants noted that whether the issue at hand is analyzing the shifts in China's traditional energy policy in light of its structural transitions or understanding the role of environmental politics, the growing geopolitical footprint of China's energy policy has important implications for Sino-U.S. relations and China's role in Asia and key energy-exporting regions. For participants, this in itself raised new questions. How will the United States and China manage their increasingly intersecting diplomacy and interests in these regions: cooperatively or competitively? In particular, can the United States and China find common ground on managing political challenges and political instability in the Middle East and Persian Gulf? Additionally, China's growing dependence on maritime oil supplies will be a further multiplier in animating its drive to secure vital energy sea lanes from the Middle East to Asia and defend territorial claims in the South and East China Seas. Can the United States and China cooperate to secure the energy sea lanes that will be vital to China's economic prosperity and that are also key to U.S. efforts to ensure stable prices through the reliable flow of oil to global markets? Will China participate in existing global energy governance institutions like the International Energy Agency, or will it choose to create alternative institutions with less Western and U.S. influence? And as the two largest emitters of carbon dioxide, can China and the United States strengthen their common leadership on environmental security—and could such engagement serve as a model for moving forward on other issues of strategic trust? These questions remain largely unanswered, yet will be critical to address if the two countries are to move forward collaboratively.

Overall, the essays in this report and the broader discussions during the 2014 Energy Security Program present a positive but mixed picture of China's historic transition from an economy largely dominated by coal and plagued by worsening air pollution and carbon emissions to a more diversified, efficient, and environmentally sustainable energy future. China's leaders increasingly recognize the unsustainable nature of the country's recent economic and energy model and are moving gradually toward a new policy mix. Nevertheless, this transition is likely to be slow due to ingrained resistance to certain types of new policies, uncoordinated government initiatives, and inconsistent support from the leadership. But pressure from both the Chinese public and international community is growing in the face of daily reminders of the need for fundamental change, which bodes well for global climate change negotiations.

NBR's Trade, Economic, and Energy Affairs Group

Fostering collaborative solutions to shared challenges in the Asia-Pacific

NBR's Trade, Economic, and Energy Affairs Group collaborates with a broad range of U.S. and Asian specialists from industry, research, and policy to conduct innovative research and convene high-level dialogues. Guided by an in-house research team and a select group of senior advisors, the group's research focuses on three broad areas: (1) energy security and policy, (2) energy and the environment, and (3) trade, investment, and economic engagement.

Highlighted initiatives include:

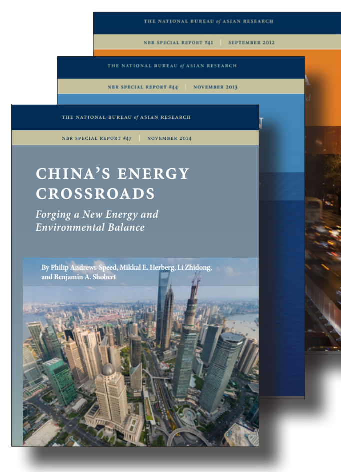
Pacific Energy Summit

As economies in the Asia-Pacific region continue to grow at astonishing rates, the Pacific Energy Summit aims to foster economic and energy security in the Asia-Pacific by developing practical solutions to the dual challenges of rising energy demand and global climate change. The annual, invitation-only Summit convenes 200 global leaders to articulate practical and tenable policy solutions to energy and environmental challenges.

PACIFIC
ENERGY SUMMIT

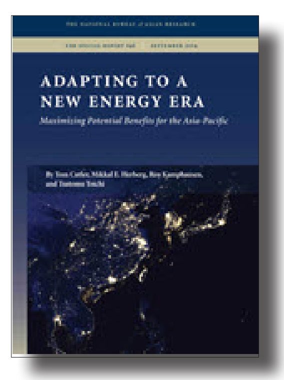
Energy Security Program

Dramatic developments are taking place in Asian energy markets, and these changes will affect the geopolitical situation in the Asia-Pacific region. Rising demand has led to increasing dependence on energy imports and a growing sense of energy insecurity among the major Asian powers. To address these issues, this initiative convenes senior policy and industry leaders and Asia energy specialists from across the region for high-level discussions on Asia's energy policies and their geopolitical implications. Experts share insights and recommendations through an invitation-only spring workshop; NBR's annual Energy Security Report, which compiles expert essays on each year's specific topic; and a public fall launch event.



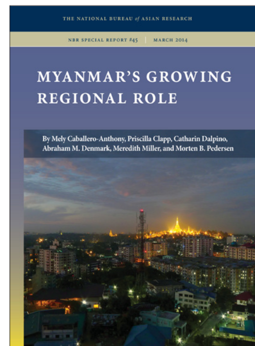
Adapting to a New Energy Era

An unexpected boom in U.S. and Canadian production of shale gas and tight oil has accelerated an already steady decline in U.S. imports of Middle East oil and gas. At the same time, China, Japan, and the rest of Asia have emerged as major importers of oil and natural gas from the Persian Gulf. This initiative aims to provide in-depth and academically rigorous research into how the United States, Japan, and other countries can craft stronger diplomatic, strategic, and economic tools to support common energy security interests.



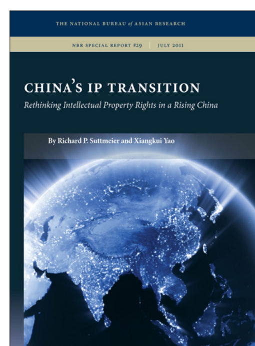
"NBR does a terrific job at getting great people, with great ideas, and making it into a process of dialogue and interaction that leads to recommendations that are very useful in the policymaking process."
— **Robert Hormats,** *Former Under Secretary of State for Economic Growth, Energy, and the Environment, Department of State, United States*

Myanmar's Growing Regional Role



Myanmar's recent domestic reforms and improved relations with the United States, European Union, Japan, and the Association of Southeast Asian Nations have opened the door for the country to be an important regional player. To better understand the challenges and opportunities presented by these shifting dynamics, this multi-year project brings together top experts from the United States, Myanmar, and the Asia-Pacific to deepen regional understanding. NBR's Myanmar initiative seeks to develop a comprehensive framework for the future of the country's engagement with partners in the region.

Innovation and IP Policy



Economies in the Asia-Pacific have shown unprecedented growth rates in recent years, and the United States aims to engage with the many burgeoning economies in the region. As India, China, and others work to further develop their economies, intellectual property and innovation policies have increasingly appeared in national and international discussions. To assess these key issues, NBR has developed projects looking at intellectual property protection and innovation policy development in the Asia-Pacific and how emerging players in the region continue to shape global discourse on the future of these policies.

Pacific Energy Forum

PACIFIC ENERGY FORUM

Broad and fundamental global energy shifts, along with rapidly evolving technologies and capabilities, suggest that Asia and North America need to fundamentally reconsider their current energy relationship. The Pacific Energy Forum gathers experts and leaders from Asia, the United States, and Canada to assess the key policy questions that will shape the future trans-Pacific energy relationship and enhance energy and environmental cooperation among key actors in the region.

For more information on these programs, please contact the Trade, Economic, and Energy Affairs group at eta@nbr.org.

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