

MARCH 2018

# A Tale of Three Coal Markets

Common Challenges and Unique  
Attributes of U.S., Chinese,  
and Indian Markets

AUTHORS

Jane Nakano  
Sarah Ladislaw

**CSIS** | CENTER FOR STRATEGIC &  
INTERNATIONAL STUDIES

A Report of the  
CSIS ENERGY AND NATIONAL SECURITY PROGRAM



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# Executive Summary

The United States, China, and India together constitute about 70 percent of global coal consumption and 64 percent of global coal production. Each country is an important contributor to the global coal supply and demand picture and yet each stands at a very different stage in its relationship with coal.

The history of coal in the United States is predicated on a long-term decline in its share of the electricity fuel mix, but deep regional socioeconomic ties give the fuel an outsized role in national energy politics. Coal makes up 15 percent of the total U.S. energy mix and 30 percent of the electric power mix while the power sector accounts for about 90 percent of coal use in the United States. Over the years, electricity demand has flattened thanks to strong efficiency gains. Moreover, the abundance of inexpensive natural gas and rapid decline in renewable energy costs have significantly diminished the competitiveness of coal-fired power generation. Unlike in China and India, the U.S. coal fleet is in contraction as a wave of retirements is underway, with little evidence of reversal, indicating that **the current downturn appears structural and not cyclical**. After a recent period of decline and bankruptcy for the U.S. industry, a political movement to revitalize the coal sector has emerged from the current presidential administration. Notwithstanding the renewed political support, however, **the regulatory uncertainty clouds a future pathway for a coal power resurgence**. The notion of economic and energy security benefits long associated with the use of coal has effectively disappeared in one of the largest producer and consumer markets for coal in the world.

China is far and away the largest coal consumer and has built coal-fired power generation capacity at an unprecedented rate over the past couple of decades. As it enters a new phase of development, China seeks to reduce the role of coal in its economy both to mitigate the environmental impacts of coal production and use but also to harness its domestic power consumption to drive its competitive advantage in things like solar, wind, and nuclear power generation. China has concrete targets to reduce greenhouse gas emissions and ambitious plans, such as a nationwide emissions trading system, that can influence the pace and scope of shift in its power supply mix. Despite these government targets and the ongoing industrial structural reform that can reduce coal's dominance in the electric power sector, **the trajectory for coal use remains significantly subject to the future of state-owned enterprises and economic liberalization**.

In contrast to the United States and China, India is a fast-growing market for coal where economic development and universal energy access goals often override concerns about environmental pollution and climate change. India also sees enormous opportunity in renewable energy development—for the positive environmental attributes, the potential commercial opportunities, and the ability to lessen reliance on imported sources of energy like oil, gas, and coal. The Indian central and state governments have set up ambitious policies to foster a greater share of renewable energy in the electric power mix. The growth in renewable power-generation capacity shows early indications that **renewables as an indigenous resource have the potential to**

**challenge not only coal's economic advantage but also its energy security value propositions as an indigenous resource**, warranting close attention for some potentially valuable lessons for power-sector management in other developing economies where renewables increasingly beat out coal. **How India will calibrate its desire to phase out coal imports despite the quantitative and qualitative issues its domestic supply has is another issue with major implications for both global coal markets and the future of its power supply mix**, particularly solar and wind.

Even as each market navigates a unique set of circumstances surrounding the role of coal-fired power generation, **the availability of midstream infrastructure looms large as a universally important determinant of the competitiveness of coal resources**, and thus the fuel hierarchy. Railways are the dominant mode for transporting coal in China and the capacity constraints continue to intensify, disadvantaging domestic resources to imports. Midstream is also a major topic in the United States, where a lack of west coast export terminals limits the U.S. ability to take advantage of continued demand growth in Asia.

**Low utilization rates also reflect the headwinds facing coal-fired power generation in all three countries.** For example, U.S. coal-fired power generation experienced a 20 percent decrease in coal fleet utilization rates and a 12 percent decrease in the generation capacity from 2015 to 2016. Also, while China is expected to add another 200 GW of new coal-power capacity by 2020, the utilization rate of 47.5 percent for the thermal power fleet in 2016 indicates a complex nexus between capacity investment and power demand in the country, where the capacity growth does not give a solid indication of electric power output or fuel consumption.

**The local air pollution and climate implications of coal-fired power generation in each country also depend on the age of their fleet and capital stock turnover. The perceived future direction of coal in each country impacts the willingness of investors to upgrade or build new, more efficient plants.** Whereas the ever-weakening coal-power demand in the United States is diminishing investor appetite for new coal plants with higher efficiency, lower emissions (HELE) technology, the capacity expansion in China is enabling the modernization of its fleet that includes more HELE plants. The pace and scope of modernization for India's coal fleet, which is much younger yet remains low efficiency and high emissions today, will be an important indicator for its future emissions profile.

Lastly, **various noneconomic forces at play can generate a tension between the needs of a changing electricity market and the political-economic pressures of expanding coal-power capacity.** The coal sector enjoys a powerful narrative on its socioeconomic benefits like jobs and tax revenues for coal-mining communities, but enabled by technology advancements, the emerging focus on values like flexibility in the power sector has elevated attributes of many alternative sources of electricity, including renewables and natural gas in the United States. Likewise, the Chinese expansion of coal capacity appears to be misaligned not only with the projected level of power demand growth but also with government efforts to expand alternative sources of electricity, thus raising **the risk of stranded or severely underutilized coal plant assets.**





# A Tale of Three Coal Markets

## Common Challenges and Unique Attributes of U.S., Chinese, and Indian Markets

### Introduction

Coal has long been a cheap and abundant fuel in many parts of the world. For many countries, coal has served as a vital energy resource fueling their economic growth and development and, for coal-producing countries, providing jobs and becoming part of the social fabric of local communities. Managing the negative impacts of coal production and use, such as local air, water, and land pollution as well as safety issues and climate change considerations, has also been the source of a great deal of economic, technological, social, and political attention in many countries around the world. The future of coal in the United States, China, and India warrants particular attention as the power-sector transition underway in these markets illuminates the dynamic interaction among economic, energy security, and environmental/climate priorities and the role of coal along various stages of economic development. This report underscores key economic, policy, technology and environmental/climate forces affecting the role of coal for power generation in the three markets, and highlights important signposts—some are unique to a market while others are shared across the three markets—that can help clarify the nature of power-sector transition and the future of coal power in that process. The analyses presented in this report were highly informed by a series of workshops conducted throughout 2017 with experts from academia, environmental community, financial sector, government, and industry that explored the three markets, combined with additional independent research.

### Market Close-up: Key Takeaways

#### United States: Reviving an Industry against the Irreversible Current?

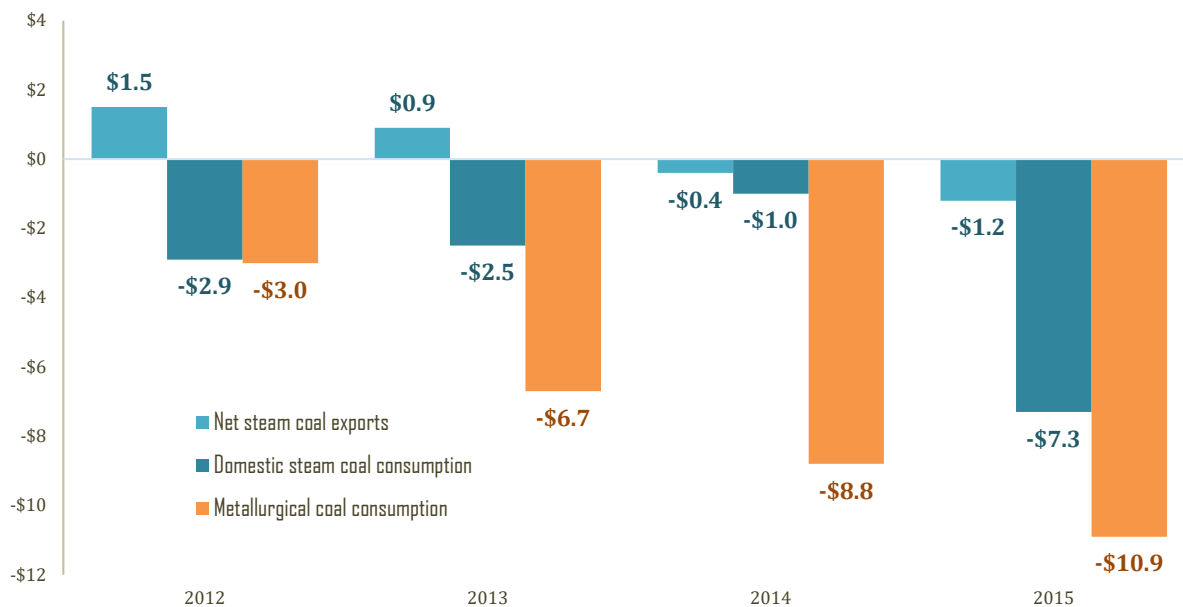
The United States has long been one of the largest producers and consumers of coal and benefited not only from its production and use domestically but also through coal exports to other parts of the world. The economics of coal has faltered in the recent decades due to a number of market and policy dynamics. The robust production of shale gas, combined with the rapid deployment of renewable energy, has significantly transformed the U.S. power sector, challenging the competitiveness of coal-fired power generation. Coal, which had long met about half of U.S. power demand, ceded its dominance to natural gas in 2016. Coal production and use were further constrained by environmental regulations seeking to manage the local environmental and health impacts and reduce emissions as part of an effort to combat climate change. Many existing coal plants closed or announced plans to close as a result and virtually all new coal-fired power generation capacity plans were scrapped. At the same time, the international market for coal, particularly metallurgical coal, collapsed, rendering many U.S. coal producers bankrupt. Although

the United States does not have state-controlled coal companies like China and India, coal still plays an important role in American politics. The death of the coal industry and the manufacturing jobs that went with it has come to symbolize the economic stagnation and dislocation that many in the United States feel are brought on by overregulation and a liberalized trade environment.

*The fate of U.S. coal sector is intertwined with the fate of its coal-fired power demand.*

Power-sector consumption has accounted for about 92 percent of the total domestic coal consumption for a decade, but it is not the only key revenue source for U.S. coal producers. In fact, metallurgical coal, which commands a higher price than steam/thermal coal, plays a bigger role in U.S. coal-export profile as well as in revenue creation for the U.S. coal sector.<sup>1</sup> As such, the weaker-than-expected foreign coal demands and attendant market collapse have driven more than half of the decline in the value of U.S. mines.<sup>2</sup> Yet, annual exports range between 4 to 13 percent of U.S. production since 2005, with current exports representing 13 percent of production in 2016.<sup>3</sup> It therefore remains highly uncertain whether increased export opportunities would be able to make up for the weak demand for coal-fired power generation and help revitalize the U.S. coal sector.

**Figure 1: Change in Revenue for U.S. Coal Producers (billion USD)**



Source: Rhodium Group, 2017.

<sup>1</sup> U.S. Energy Information Administration, "Quarterly Coal Report Data Tables," <https://www.eia.gov/coal/production/quarterly/>.

<sup>2</sup> Trevor Houser, Jason Bordoff, and Peter Marsters, "Can Coal Make a Comeback?," Columbia University, April 2017, 31, <http://energypolicy.columbia.edu/sites/default/files/Center%20on%20Global%20Energy%20Policy%20Can%20Coal%20Make%20a%20Comeback%20April%202017.pdf>.

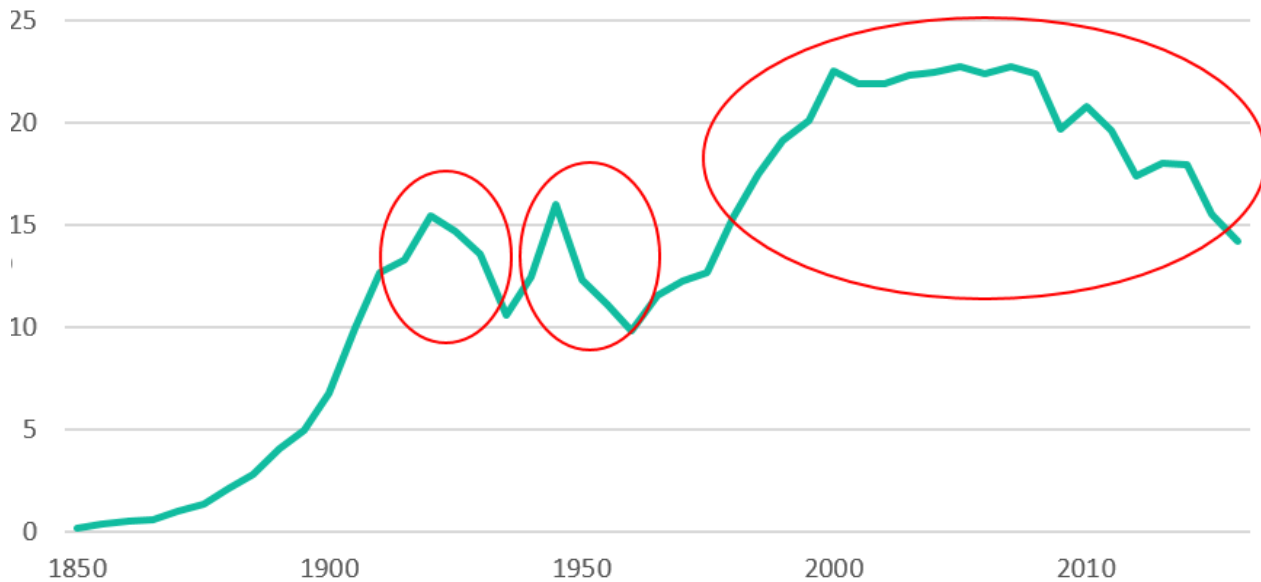
<sup>3</sup> U.S. Energy Information Administration, "Total Energy—Coal Overview," <https://www.eia.gov/totalenergy/data/browser/?tbl=T06.01#/?f=A&start=2004&end=2017&charted=0-4>.

The rapid increase in natural gas supply together with the availability of preexisting underutilized gas capacity at existing power plants, a well-developed network of pipelines, along with environmental regulations has pushed natural gas to become the single-largest source of fuel for power generation in the United States, overtaking coal in the process. In just over 10 years, coal went from a position of accounting for three times the level of generation in the electric power sector to an approximately equal level of natural gas consumption today. What further distinguishes this instance in the decline of coal from historical examples is that electricity sales have been stagnant for over a decade. As such, a loss in market share in a market facing an overall downward trend is a very different scenario from one facing the same situation in a market that is experiencing overall growth.

*The industry downturn seems structural, not cyclical, this time.*

Over the course of the past century coal consumption in the United States has seen three major consumption cycles since 1900. The current cycle reached a peak around 2005 and was followed by a notable rate of decline since then. The question now is whether coal can rebound like it did in the last two cycles or if demand for coal will continue to decrease. Over the longer run a compelling case has emerged that suggests that this cycle will be different from the previous two cases and that coal consumption will see a long-term decline due to inter-fuel competition at home and U.S. coal's lack of economic advantage over other supplies to growth markets.

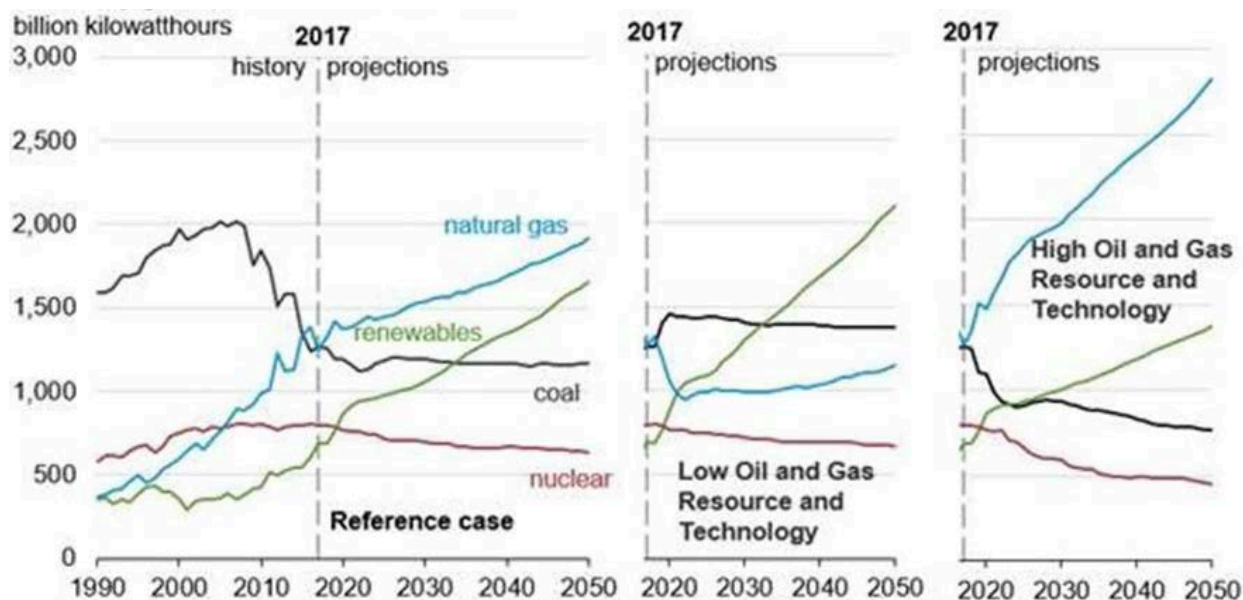
**Figure 2: Coal Consumption in the United States, 1850–2016 (quadrillion British thermal units)**



Date source: U.S. Energy Information Administration.

The U.S. Energy Information Administration (EIA) sees coal consumption declining out to the early 2020s, and then leveling off to 2050 after a modest rebound in the early 2020s in its reference case scenario but the availability of oil and gas resources, technology, and a carbon constraint

Figure 3: Electricity Generation from Selected Fuels



Source: U.S. Energy Information Administration.

creates differences in the outlook for coal. For example, in the EIA scenario with high oil and gas resources and lots of technological progress, coal will continue to see significant levels of decline in power generation, whereas in the low oil and gas resource and technology scenario, coal is projected to jump up in the next few years and level out to 2050.

*Coal quality and access have had varied influence on coal-producing regions during the current downturn.*

Twenty-five U.S. states produce coal but the role coal production plays in a given state's economy varies, as does the quality of the coal resource and ease of access (both to the resource and to export markets), affecting each state's ability to withstand economic and regulatory pressure. Take the Appalachian Basin (mostly West Virginia, Kentucky, and Pennsylvania) and the Powder River Basin (PRB) (mostly Wyoming and Montana), for example. Unlike the Appalachian region, where the readily accessible mines have already been exploited and current and future mining opportunities tend to be deep underground, surface mines produce over 90 percent of the coal in the PRB, rendering greater profit margin. PRB coal companies can extract more than 10 times as much coal per employee hour as their counterparts operating in the Appalachian Basin.<sup>4</sup> Also, although the calorific value of PRB coal is generally lower, the sulfur content is also lower than in the Appalachian or Interior (e.g., Illinois basin) coal.<sup>5</sup> With tightening environmental regulations, lower sulfur content is increasingly a favorable characteristic.

<sup>4</sup> Alison Cassady, "Complex Market Forces Are Challenging Appalachian Coal Mining," Center for American Progress, October 2014, 2, <https://cdn.americanprogress.org/wp-content/uploads/2014/10/CoalMiningEmployment-brief.pdf>.

<sup>5</sup> Sylvie Cornot-Gandolphe, "US Coal Exports," Oxford Institute for Energy Studies, March 2015, 13, <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2015/03/CL-21.pdf>.

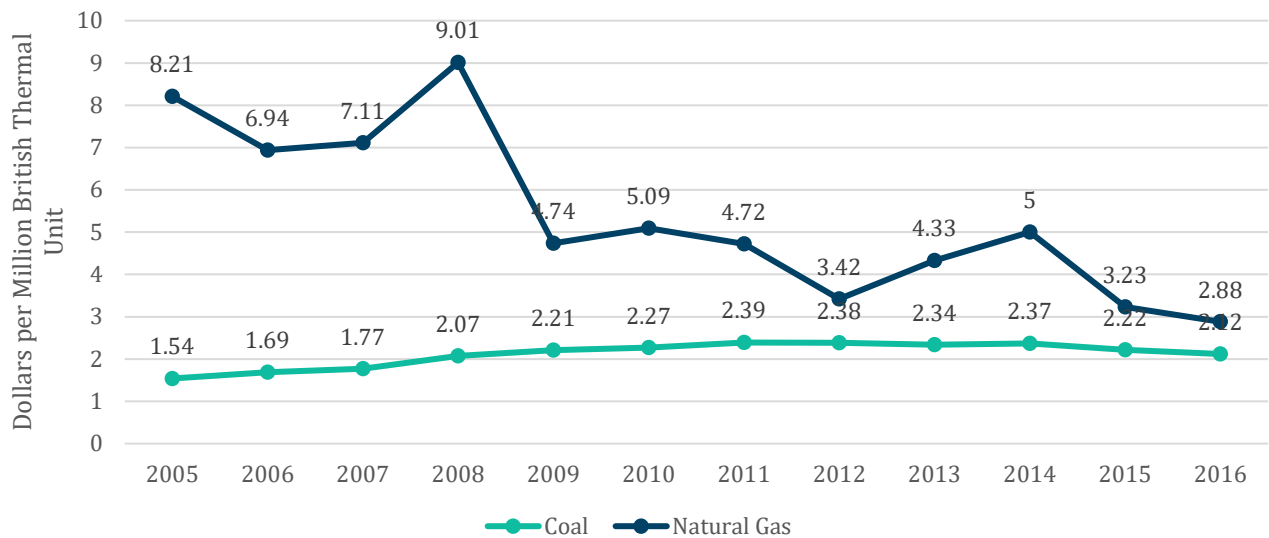
While the western region has a production cost advantage, it has seen its production level decline because, unlike the Appalachian region, it has very limited access to export facilities and therefore to foreign markets. There is sustained business interest in building coal-export terminals in the Pacific Northwest in hopes to capture growing markets in Asia; however, most of the planned coal-export projects in the Pacific Northwest have stalled, primarily due to strong local opposition.

*The cost advantage of coal-fired power generation became muted by noneconomic considerations such as flexibility, fixed and variable operational and maintenance costs, and environmental compliance costs.*

While coal saw a rapid rise in the average delivered cost to generators over the period 2006–2008, the fuel maintained its significant cost advantage over natural gas and saw only a minor decline in terms of its share in power generation. However, even though increasing delivered coal costs began to level out in 2011 and in fact began a gradual decline thereafter, significantly lower gas prices, which fell by nearly a half in 2008, have significantly reduced coal’s cost advantage more recently. Throughout this entire period, the average delivered cost of coal remained below that of natural gas, but other considerations such as flexibility, fixed and variable operational and maintenance costs, and environmental compliance costs have largely favored the use of gas-fired over coal-fired generation.

Approximately 60 GW of coal-fired generation retirement occurred in the period between 2005–2016, but was offset by an addition of 20 GW in new capacity resulting in a net coal capacity retirement of 40 GW. The decline of coal-fired power generation is evident in both the low utilization rates and plant retirements. Over 2006–2016, utilization rates fell by about 20 percent while actual capacity decreased by about 12 percent. While low utilization rates could provide a room for output rebound, it may also indicate further decline for coal-fired power generation demand.

**Figure 4: Average Delivered Cost of Fuels to Generators**



Data source: U.S. Energy Information Administration.

### *Deregulatory efforts add to coal market uncertainty.*

While technology and fuel markets have played and will continue to play a significant role affecting the level of coal-fired power generation, environmental policies and regulations have also had an undeniable impact on coal-fired power-generation assets. Some of these regulations, which have already come into effect, have both directly caused retirements of certain coal plants and affected investment decisions in the building of new facilities in tandem with other regulations that have yet to be enforced.

Many of these regulations affecting coal-fired power generation were created or tightened during the Obama administration and are subject to review and change by the Trump administration. While the majority of the regulations outlined below are currently under review and the Trump administration has further made clear its intention to rewrite or rescind several of these regulations, for the most part they will face an arduous and protracted process in achieving these goals. Changes to prior rules by agencies are made possible by administrative law but the process requires notice-and-comment and any changes must be permissible under statute to reflect reasoned decisionmaking, which will likely make any efforts to fully eliminate certain regulations defective.

While the deregulatory efforts on the part of the Trump administration are meant to alleviate pressure on coal-fired power generation and coal production more generally, the net result has yet to create overwhelming confidence in the sector's future because of previously mentioned market dynamics and the perception that a future administration may reinstate more stringent environmental regulations.

### *Wave of coal plants retirement appears irreversible despite political support.*

The robust growth of shale gas production has set the U.S. power supply mix in transition since 2008, facilitating a shift away from coal-fired power generation. The sector downturn has forced over 40 U.S. coal companies to file for bankruptcy as well as the coal-mining workforce to shrink by 40 percent since 2012.<sup>6</sup> Given current trends and regardless of the intentions of the current administration, this transition looks set to continue for the foreseeable future. There have been and continues to be a swath of retirement announcements of coal power plants, in addition to the announcement by other plants to convert to natural gas. An analysis by the Union of Concerned Scientists has indicated that 38 percent of operating coal capacity is facing or may face retirement.<sup>7</sup> This includes 51 GW that has already been announced for retirement or possible conversion, and a further 57 GW that has been identified as uneconomic when compared to existing gas-fired power plants (the majority of which are located in the southeast of the country).

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<sup>6</sup> U.S. Department of Labor, "Employment, Hours, and Earnings from the Current Employment Statistics survey (National)," Bureau of Labor Statistics, <http://data.bls.gov/timeseries/CES1021210001>.

<sup>7</sup> Union of Concerned Scientists, "A Dwindling Role for Coal Appendix: Technical Document," October 2017, 9, <http://www.ucsusa.org/sites/default/files/attach/2017/09/A-Dwindling-Role-for-Coal-technical-appendix.pdf>.

**Table 1: Regulations That Affect Coal-fired Power Generation (as of January 2018)**

Regulation	Description	Status
Carbon Pollution Emission Guidelines	It aims to limit carbon pollution from new and certain modified fossil-fired plants. The final standards reflect the degree of emission limitation achievable through the application of the best system of emission reduction that EPA has determined has been adequately demonstrated for each type of unit. For coal-fired power generation this standard amounts to the equivalent to the application of partial CCS.	While the rule was finalized in 2015, it has been subject to litigation. The Trump administration has requested and received a stay of litigation to review the rule, but has not yet announced whether it intends to repeal, replace, or leave as is.
Clean Power Plan (CPP)	It aims to limit the amount of carbon pollution and other pollutants that cause soot and smog from existing fossil-fired power plants. The emission standards set by the CPP are achievable through reduction measures taken at the plants and shifting generation from high- to low- and zero-emitting resources. The rule is enforced through state plans and comes in two phases from 2022–2029 and 2030 and beyond.	The Trump administration has requested and received a stay of the litigation. Because SCOTUS ruled that carbon pollution must be regulated under the Clean Air Act, EPA will likely be unable to rescind the rule but rather have to revise it. EPA submitted a proposal to the Federal Register in October 2017 to repeal the CPP. No replacement rule has been issued and EPA is taking comments on the proposed repeal until April 2018 and on the advance notice of proposed rulemaking until February 2018. The D.C. Circuit Court ordered litigations against the CPP to be put on hold for 60 days while EPA reviews the rule.
Mercury and Air Toxics Standards (MATS)	It requires limits to be set on mercury and toxic emissions from coal-fired power plants. This rule affects all coal-fired power plants and is one of the few regulations that has directly caused retirements.	After a revisited version of the standards was put into effect in 2016, several industry groups and states issued challenges to the rule. In April 2017, the D.C. Circuit Court suspended litigations against the rule indefinitely and directed EPA to file status reports every 90 days. Oral arguments in the case against MATS have been delayed.
National Ambient Air Quality Standards for Ozone (NAAQS)	It requires EPA to set standards for states to meet NAAQS. Power plant emissions including NOx and other particulate matter, which are precursors and subject to NAAQS. States must submit plans to achieve NAAQS for EPA approval. The Clean Air Act requires EPA to review and revise existing NAAQS every 5 years, while also designating states areas as “attainment” or “nonattainment” to the standards in place.	The deadline for EPA to make all compliance designations and stricter air quality standards were to take effect on October 1, 2017. On November 16, 2017, EPA certified about 2,650 areas as in compliance but no noncompliant areas with no timeline to do so. H.R. 806 was passed to delay tighter air-quality standards until 2025. EPA, currently under litigations from a public health and environmental coalition for delaying noncompliance designation, has been ordered by the D.C. Circuit Court to file a final rule establishing air-quality designations. EPA plans to complete all attainment designations by April 2018.
Cross-State Air Pollution Rule (CSAPR)	It requires upwind states to eliminate the transport of NAAQS pollutants to downwind states. Downwind states affected by out-of-state pollution that impairs interstate air quality are able to file Section 126 petitions to request EPA to regulate pollution from another state. If EPA agrees to respond within 60 days, the upwind state must address the emissions problem with a State Implementation Plan or	This requirement has been subject to litigation in both directions, in terms of challenges to update the rule and also from states suing for more relief. The Trump administration has yet to take action on this requirement. Specifically, lawsuits have targeted Federal Implementation Plans and Phase 2 SO <sub>2</sub> emissions budgets. Connecticut, Delaware, and Maryland have

	emissions limits from a Federal Implementation Plan will be assigned.	sued EPA for failure to respond to submitted Section 126 petitions.
Regional Haze Rule	Announced by the EPA in 1999, it aims to improve air quality in national parks. The Clean Air Act also requires states to impose Best Available Retrofit Technology on major sources of NOx emissions that affect visibility in national parks. EPA under the Obama administration amended the existing Regional Haze Rule in January 2017 that led to the closure or conversion of coal-fired plants.	The Trump administration has requested and received an extension of the briefing schedule due to the change in administration following the amendment of the Rule in the final days of the Obama administration.
Clean Water Act	It requires the EPA to set national wastewater discharge standards on an industry-by-industry basis, which are to be enforced at the state level. Consequently, the Steam Electric Power Generating Effluent Guidelines of 1982 were updated in 2015.	This has been subject to litigation, and the Trump administration has requested and received a stay, after announcing its intention to commence a rulemaking process to potentially revise the guidelines and has also sent guidance to states emphasizing compliance deadline flexibility. In July 2017, EPA and the Department of the Army submitted a proposal to review and revise the original 2015 Clean Water Act. In November 2017, EPA further proposed to delay the effective date on the act by 2 years, until 2020. The SCOTUS will make a ruling on whether federal appeals or district courts are the proper venues for cases to be heard.
Resource Conservation and Recovery Act (RCRA)	It directs EPA to regulate the disposal of certain types of solid waste. Coal-fired power plants dispose of coal combustion residuals such as coal ash in landfills and impoundments. This led to the Coal Combustion Residuals Rule (2015), which establishes minimum technical standards for state permits for disposal.	The state plans are subject to EPA approval, to which EPA has issued guidance. This rule is also subject to litigation to which the Trump administration has yet to take action; however, they have been working on establishing revised guidance to states.

Source: Environmental Regulation Rollback Tracker, Environmental Law Program, Harvard University, <http://environment.law.harvard.edu/policy-initiative/regulatory-rollback-tracker/>.

*Climate and resource sustainability considerations drive U.S. focus on Carbon Capture and Sequestration (CCS), but competitiveness of the coal industry is a driver as well.*

There are two ways to reduce emissions from coal-based power generation—install or upgrade power generation facilities to higher efficiency and lower emissions technologies or find a way to capture the carbon emitted from the plant. The declining demand for coal-fired power generation is inhibiting new investment in new coal plants, essentially precluding the fleet modernization with high efficiency, low emissions (HELE) technology plants in the United States. The current coal fleet was for the most part built before 1990 and as such, the average age of a coal-fired power plant today is 39 years. Therefore, HELE retrofit is a highly uncertain financial proposition against the fast-evolving fuel mix.

Carbon capture and sequestration (also referred to as CCUS for carbon capture, utilization, and storage) was once a technology promoted by policymakers and advocates seeking a scalable solution to reducing emissions from fossil-fuel-based power generation and industrial facilities. CCS/CCUS, which mitigates the release of carbon dioxide from the combustion of fossil fuels, has long been recognized as an important part of the solution to climate change but is now also being promoted by the administration, not directly in support of reducing emissions for climate change



purposes, but to ensure the U.S. coal and power-generation industry can remain competitive in domestic and international markets. Many oil and natural gas companies also support CCS/CCUS development because it will be an important technology for a carbon-constrained future in which they hope to sell natural gas. In early February 2018, Congress passed support for a tax credit for CCS that will help CCS project developers, mostly those looking to use CCS for enhanced oil recovery, but is far short of the kind of economic and policy support likely to get CCS scaled up anytime soon.

Indeed, it remains commercially challenging to sustain CCS projects unless the captured carbon is used in enhanced oil recovery due to the higher economic value the recovered crude oil generally commands than does the captured carbon. However, the United States is already home to one of only two power plants with CCS in the world, at the Petra Nova facility in Texas. How robustly CCS can be deployed in the power sector depends on how quickly the CCS cost curve can come down, and the policy and economic support lawmakers are willing to extend.

## China: Reducing Reliance on Coal-fired Power Generation

China is the world's largest coal consumer and accounts for nearly one-half of total global coal consumption today. Also a large coal producer, China has long utilized abundant domestic coal resources to fuel its industrialization. In recent years, China has increasingly relied on imports as domestic coal production could no longer keep up with demand and the logistics of moving coal around the country became too unwieldy. The coal industry is also a major employer in China—providing jobs in both the formal state-owned coal industry but also in private coal mining, processing, and power-generating enterprises. As China moves into a new stage of development, the role of coal in Chinese society has begun to present a range of problems. China is in the midst of navigating through this complex web of worsening environmental degradation, industrial restructuring, and growing import dependence.

*Coal use may continue to decline relative to other energy sources in China due to a range of government policies, while the country's total coal consumption has also likely peaked.*

As the Chinese economy grew rapidly in the past few decades, the country's reliance on the fuel also grew to meet its rising electricity demand and to fuel industrial activities, pushing China to become the world's top consumer of coal today. In 2016, Chinese demand constituted about 54 percent of global coal demand<sup>8</sup> and the country is forecast to remain the largest coal consumer through 2035.<sup>9</sup> The share of coal, however, has been declining in China's total energy mix—from recent highs of 74 percent in the mid-2000s to 62 percent in 2016.<sup>10</sup> The share may continue to decline relative to other energy resources pursuant to a range of government policy targets in effort to reduce the economy's carbon intensity by 40–45 percent by 2020, and by 60–65 percent by 2030 against the 2005 level. Most notably, China's 13th Five-Year Plan (2016–2020) calls for increasing the nonfossil energy (e.g., wind, solar, hydro, and nuclear) share in total energy consumption to 15 percent; capping the share of coal in total energy consumption at 58 percent;

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<sup>8</sup> International Energy Agency, "Coal 2017," 24.

<sup>9</sup> BP, "BP Energy Outlook—2016 edition," 2016, 37, <http://biomasspower.gov.in/document/Reports/bp-energy-outlook-2016.pdf>.

<sup>10</sup> BP, "BP Country and regional insights—China," <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/country-and-regional-insights/china.html>.

and increasing the share of the service sector—which is much less energy intensive than the power or industrial sector—in total GDP to 56 percent. Additionally, the government has called for halting new coal mining project approvals through 2018 as well as capping the share of coal to about 55 percent of total power mix and the increase in coal capacity by 200 GW—to a total installed capacity at 1,100 GW—by 2020. More importantly, China’s coal demand appears to have peaked in 2013, and in 2016, China’s coal consumption declined for the third consecutive year.

*State-owned enterprises continue to dominate the country’s coal sector and their influence can significantly impact the role of coal in China’s economy*

China’s coal industry has become decentralized since late 2000s, but the coal sector continues to be dominated by powerful state-owned enterprises (SOEs) along the supply chain, including mining, coal plant equipment manufacturing, coal-fired power generation, and power transmission and distribution. In the coal-mining sector, most of the mines are owned by national, local, and municipal level governments. The top state-owned coal mining companies, including Shenhua Group and China National Coal Group, produce about a half of the country’s coal while local state-owned companies produce about one-fifth, and small town mines produce the rest although the recent government call for closure of inefficient operations and industry consolidation has reduced the share of small mines.<sup>11</sup> In terms of installed coal power capacity, SOEs own 61 percent and controlling shares in another 33 percent.<sup>12</sup> The state ownership can entail ownership by SOE parent companies, their subsidiaries, joint ventures between SOEs, or majority state-ownership.<sup>13</sup> These SOEs enjoy government support through preferential access to bank capital, lower rate loans, favorable tax rates, and state capital injection when needed.<sup>14</sup> By comparison, companies in the renewable energy sector, equipment manufactures, and project developers tend to be non-SOEs and are much smaller in terms of market capitalization.

The governments at the provincial and local levels generally have strong interest in coal-sector activities as it is a major source of tax revenue and employment. For example, in the most prominent coal-mining province of Shanxi, coal industry contributed over half of its economic growth annually during the first half of this decade. At the end of 2015, Shanxi’s coal industry employed 1.15 million people, according to the province’s 13th Five-Year Plan document. Chinese president Xi Jinping has identified SOE reform as an essential part of transforming the Chinese economy, yet very little progress has been made to date. The noneconomic externalities associated with coal industry, such as employment, complicates the task of reforming the sector.

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<sup>11</sup> U.S. Energy Information Agency, “China: International Data and Analysis,” May 14, 2015, [http://www.eia.gov/beta/international/analysis\\_includes/countries\\_long/China/china.pdf](http://www.eia.gov/beta/international/analysis_includes/countries_long/China/china.pdf).

<sup>12</sup> Thomas Spencer, Nicolas Berghmans, and Oliver Sartor, “Coal transitions in China’s power sector,” Institute for Sustainable Development and International Relations (IDDRI) Study, No. 12/17, November 2017, 5, [http://www.iddri.org/Publications/Collections/Analyses/ST1217\\_China%20coal.pdf](http://www.iddri.org/Publications/Collections/Analyses/ST1217_China%20coal.pdf).

<sup>13</sup> Climate Policy Initiative, “Slowing the Growth of Coal Power in China: The Role of Finance in State-Owned Enterprises,” December 2015, 8, <http://climatepolicyinitiative.org/wp-content/uploads/2015/12/Slowing-the-Growth-of-Coal-Power-in-China-%E2%80%93-the-Role-of-Finance-in-State-Owned-Enterprises.pdf>.

<sup>14</sup> Andrew Szamoszegi and Cole Kyle, “An Analysis of State-owned Enterprises and State Capitalism in China,” U.S.-China Economic and Security Review Commission, October 26, 2011, [http://Sites.utexas.edu/chinaecon/files/2015/06/US-China-Commission\\_State-Owned-Enterprises-and-State-Capitalism.pdf](http://Sites.utexas.edu/chinaecon/files/2015/06/US-China-Commission_State-Owned-Enterprises-and-State-Capitalism.pdf).

**Table 2: Main Coal-Related Economic Indicators of Industrial Enterprises in Shanxi Province in 2015 (Billion RMB)**

	Revenue from Principal Business	Taxes and Extra Charges from Principal Business	Income Taxes Payable	Value Added Taxes Payable
Total	1462.41	21.65	8.71	47.86
Mining and Washing of Coal	372.24	15.22	2.92	24.95
%	25.45	70.32	33.54	52.13

Source: Created with data from Shanxi Statistical Year Book 2016.

*One proposed reform measure was to liberalize the coal sector but the Chinese government remains uncomfortable to let market mechanisms determine coal prices.*

Earlier in the presidency of Xi Jinping, the government signaled through the Third Plenum of the 18th Party Congress communiqué its willingness to allow greater liberalization in order to introduce market discipline and competition as measures to put its economic growth on to a more sustainable path. However, the Chinese government has since exhibited signs that it is still uncomfortable letting market mechanisms fully function. Some Chinese policymakers are reportedly worried that relaxed financial controls could allow money to flee China even when money is badly needed at home to prop up the economy, or that letting companies fail could eliminate too many jobs to a detriment to social stability.

The coal market is no exception. The coal-pricing system has moved away from a dual system of regulated and market-based prices, to one more subject to market forces earlier this decade, although government policies continue to exercise influence on them. Following nearly three straight years of coal price decline due to domestic oversupply and flat-lining demand that sent many coal companies into bankruptcy or major cost-cutting restructuring, the Chinese government in spring 2016 implemented a workplace restriction by reducing the number of allowable work days from 330 to 276 to boost base-level prices. This reduction had the intended effect of raising price levels and supporting struggling coal companies but ultimately resulted in a greater-than-desired hike in coal prices. In response, the National Development and Reform Commission has issued several notifications, essentially ordering coal-mining enterprises and utilities to enter medium- to long-term contracts with fixed prices and volumes within a given duration in effort to reduce the range of price volatility. The uneasy relationship between the government and the coal market may continue for some time.

*China also seeks to improve the efficiency of their coal consumption—their top 100 most efficient units are less carbon emitting than the top 100 units in the U.S. fleet.*

A recent study by the Center for American Progress that compared the annual average performance of the United States’ and China’s 100 most efficient coal-power units suggests that Chinese coal-fired power plants are more efficient than their American counterparts. This comparison targeted coal-power units above 600 MW in capacity as efficiency and emissions data were unavailable for smaller units in China; smaller units tend to be old, low efficiency, and high emissions. This increased efficiency is in part due to recent investments in “ultra-supercritical”

technology plants. While fleet efficiency may be increasing, the breakneck introduction of these new units is also contributing to overcapacity, which in turn is dragging down utilization rates nationwide. For comparison, the United States has thus far built only one ultra-supercritical unit as the increased affordability of domestic natural gas has significantly reduced incentives to build new coal plants.

Additionally, Chinese emission standards for conventional air pollutants are stricter than comparable U.S. standards. The difference is so stark that, if current U.S. regulatory trends continue, every coal plant operating in the United States would be illegal to operate in China. For example, by 2020, every existing coal-fired power unit in China must meet an efficiency standard of 310 grams of coal equivalent (gce) per kWh; any units that do not meet that standard by 2020 will be retired. In contrast, none of the current 100 most efficient U.S. coal-fired units would meet the same standard today.<sup>15</sup>

*China’s policymakers strive to incorporate more alternatives to coal in the country’s power grid system, yet challenges remain.*

Under the 13th Five-Year Plan, the Chinese government has called for boosting electricity generation from renewables, nuclear, and natural gas while limiting the construction of new coal-fired plants. China has been quite successful when it comes to building wind, solar, and nuclear power-generation capacity. Natural gas, on the other hand, continues to have a very limited share in the country’s power-generation mix. Despite strides in building new capacity, the integration of noncoal-fired power-generation assets into the grid has been difficult. For example, renewables curtailment, when available electricity is disconnected from the grid and thereby wasted, is a key challenge. There is no single cause for curtailment, but multiple contributing factors. These include an inflexible power grid designed for big power stations, and utility dispatch preferences for coal-power plants, the lack of stronger incentives for grid companies to better incorporate renewable generation, and poor cross-province transmission. The result is a serious under-utilization of newly installed renewable generation. For example, one-third of large-scale wind projects in China are not connected directly to the grid. Nationwide wind curtailment rates have fluctuated somewhat, but generally much higher than typical curtailment rates between zero and 4 percent in the United States and Europe.

**Table 3: National Average Wind Power Curtailment Rates in China**

Year	2010	2011	2012	2013	2014	2015	2016	2017
%	7	14	17	10	8	15	17	12

Source: Created with data from International Institute for Sustainable Development (2016) and China National Energy Administration (2018).

There are many ways that the government wishes to address the issue of curtailment. So far, the government has pledged to reduce curtailment by 5 percent by 2020, according to the 13th Five-Year Plan. A set of policies issued in 2016 most notably calls for direct compensation to renewable energy generators for curtailment up to an allocated number of hours. Also, the government has

<sup>15</sup> Melanie Hart et al., “Everything You Think You Know about Coal in China Is Wrong,” Center for American Progress, May 15, 2017, <http://www.americanprogress.org/issues/green/reports/2017/05/15/432141/everything-think-know-coal-china-wrong/>.

been promoting investment in ultra-high voltage (UHV) long-distance transmission lines to connect remote renewable generators with population centers. State Grid Corp., the country's largest state-owned utility, is halfway through plans to spend \$88 billion on such lines between 2009 and 2020. In 2016, however, only about 3 percent of national electricity consumption was transported via UHV lines. Whether the deployment momentum can remain intact for additional multibillion-dollar lines is uncertain in light of the slowdown in power demand growth, power-generation overcapacity, and resistance from provinces that prefer constructing their own power plants for GDP and employment gains to importing electricity from other provinces.<sup>16</sup>

*Excess manufacturing capacity is a serious challenge in China, with economic and climate implications.*

China's economic slowdown from the breakneck pace of 10 percent growth per year to something less than 7 percent has resulted in significant excess manufacturing capacity in some sectors, such as cement, steel, and iron. In an effort to rein in oversupply as well as to address power plant underutilization, in January 2017, the National Energy Administration—an agency responsible for economic planning and overseeing industrial output—canceled 103 coal power projects, totaling 120 GW, that were planned or under construction. Yet, 140 GW of capacity remains reportedly under construction. The continued expansion of coal power capacity despite the slowdown in the country's power demand appears to reflect the desire of heavy industries to maintain a certain level of industrial output and employment.

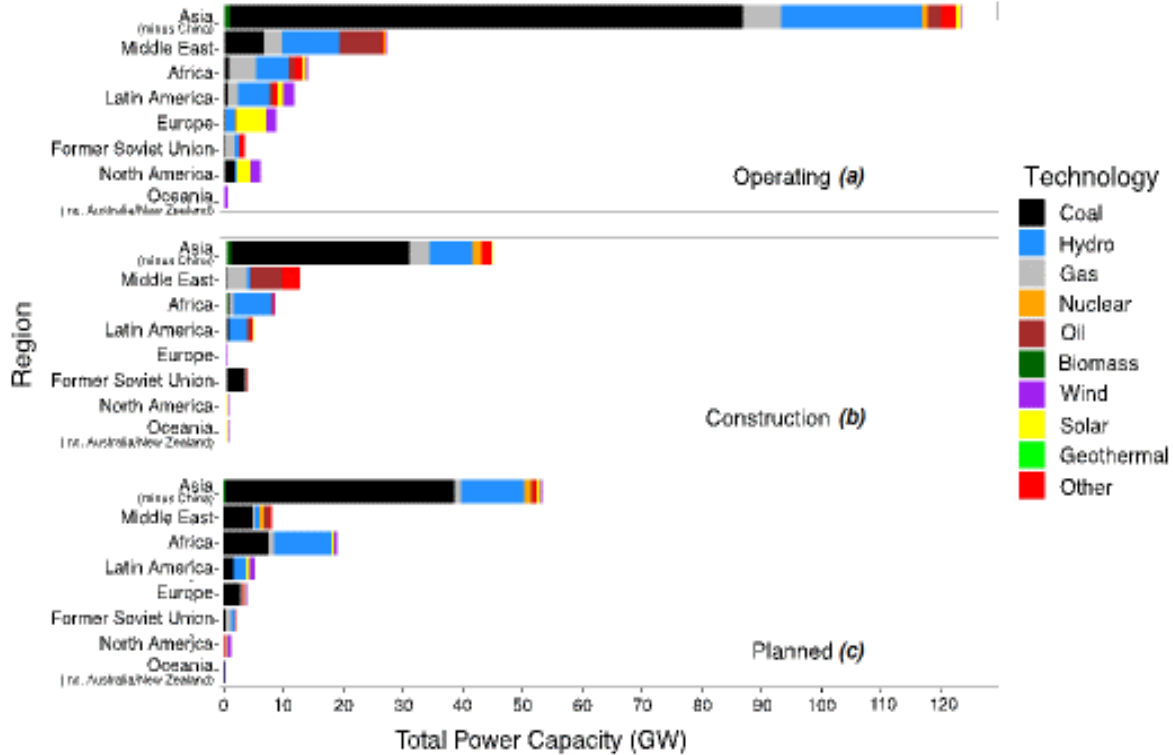
The challenge of excess manufacturing capacity is also fueling Chinese export of coal plant equipment and components. China's energy infrastructure export portfolio is significantly more coal intensive than the global average. For example, Chinese firms have been involved in 41 percent of global coal capacity addition outside of the Organization for Economic Cooperation and Development (OECD) and China since 2005, and 47 percent since 2010.<sup>17</sup> While the Chinese government strives to address environmental and climate challenges of coal-fired power generation at home, its coal capacity export drive may also be exporting the emissions issue.

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<sup>16</sup> Edmund Downie, "Sparks fly over ultra-high voltage power lines," China Dialogue, January 29, 2018, <https://www.chinadialogue.net/article/show/single/en/10376-Sparks-fly-over-ultra-high-voltage-power-lines>.

<sup>17</sup> Phillip Hannam, December 2016 update of Figure 1 from Phillip M. Hannam et al., "Developing Country Finance in a Post-2020 Global Climate Agreement," *Nature Climate Change* 5, no. 11 (2015): 983.

Figure 5: Chinese Exports Outside of China's Borders Are Coal Intensive



Source: Phillip M. Hannam et al., "Developing Country Finance in a Post-2020 Global Climate Agreement," *Nature Climate Change* 5, 11 (2015): 983; December 2916 update.

*China is a major exporter of coal power plants, and it supports the export drive with public financing.*

Policy banks, such as the China Development Bank, play a key role in financing coal export deals. China's commercial banks are also involved in coal plant exports with support of Sinosure, China's export credit insurer. There is no single authoritative data on the volume of Chinese public financing for coal plant exports, primarily because China as a non-OECD member is not obligated to disclose such information. However, China's public financing for coal plant abroad since 2000 seems to be about \$43.5 billion.<sup>18</sup> Leading up to the Paris climate agreement, the U.S. government pressed China to rein in its growing public financing for coal plants abroad. In September 2015, China committed to "strengthen green and low-carbon policies and regulations with a view to strictly controlling public investment flowing into projects with high pollution and carbon emissions both domestically and internationally," which some have presumed to include coal plant

<sup>18</sup> Kevin P. Gallagher, "China's Global Energy Finance," Global Economic Governance Initiative, Boston University, 2017, <http://www.bu.edu/cgef/#/all/EnergySource/Coal>.

exports.<sup>19</sup> Whether China will honor this commitment is uncertain, especially in the face of pro-coal policies and statement from the Trump administration.

Meanwhile, China's massive financial commitment for energy infrastructure projects in Asia has compelled Japan to pledge a large financial commitment for energy infrastructure to facilitate economic development. Budding competition between the two countries may potentially serve to facilitate a transition from low efficiency-high emissions coal units to higher efficiency-lower emissions units in developing countries. This is not currently the case as most potential markets for Chinese investment are highly price sensitive. This is because their primary concern is electricity access—with air quality/climate change a distant second.

*The challenge of excess manufacturing capacity has social implications.*

The problem of excess manufacturing capacity—and the ways in which the government has tried to address it—has serious social implications for the country's labor force. In spring 2016, the Chinese government announced plans to lay off 1.8 million coal and steel workers. To ease the transition for dislocated workers, the national government has created a \$15 billion assistance fund.<sup>20</sup> The Chinese government established this two-year fund to help solve the problem of worker placement in industries with overcapacity issues such as coal and steel. The fund acts as a block grant where municipalities can apply for relief if they are particularly struck by high unemployment. This funding mechanism has met mixed results as some municipalities have exaggerated worker overcapacity to get access to funds.

Also, there have been attempts to "reallocate" workers from coal into forestry, internet service, and agriculture jobs (among others). Those jobs are not nearly as appealing particularly because employment in coal and state-owned companies has traditionally come with many more benefits. In many cases, reallocated workers are offered lower-paying jobs with low-paying retirement plans—a clear departure from their prior conditions. In many instances—and partly due to the unique distribution of existing coal mines—reallocation has also required geographic relocation of workers. The result is widespread social unrest in communities formerly tied to coal jobs. Social unrests stemming from labor disputes, which for example led to nearly 2,700 labor protests in 2015,<sup>21</sup> pose a threat to the stability of the communist party rule in China. The issue related to employment and job security is one of the key challenges as China strives for a soft landing for its coal sector.

*Coal trade has traditionally been free of energy security or geopolitical concerns in China, but increasing dependence on maritime coal imports may change that going forward.*

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<sup>19</sup> The White House, "U.S.-China Joint Presidential Statement on Climate Change," September 25, 2015, <https://obamawhitehouse.archives.gov/the-press-office/2015/09/25/us-china-joint-presidential-statement-climate-change>.

<sup>20</sup> Sue-Lin Wong, "In China's rustbelt towns, displaced coal, steel workers lose hope and voice," Reuters, March 5, 2017, <https://www.reuters.com/article/us-china-parliament-jobs/in-chinas-rustbelt-towns-displaced-coal-steel-workers-lose-hope-and-voice-idUSKBN16C0Z3>.

<sup>21</sup> Javier C. Hernandez, "Labor Protests Multiply in China as Economy Slows, Worrying Leaders," *New York Times*, March 14, 2016, <https://www.nytimes.com/2016/03/15/world/asia/china-labor-strike-protest.html>.

Abundant and indigenous, coal has long underpinned China's sense of energy security. However, the declining domestic production as well as a perennial transportation bottleneck between coal producing regions in the northwestern part of China and the consuming regions along the coast contribute to the country's growing import dependence. Coal must be transported more than 1,000 km (or 620 miles) by railway, highway, ports, and seaborne ships.<sup>22</sup> The Chinese government has announced its commitment to expand coal delivery capacities by a third by 2020.<sup>23</sup>

China's growing coal import reliance, however, has not born political or geopolitical challenges to its government the same way its trade in oil and gas has on occasion. Both the degree of import dependence and composition of import markets may explain the absence of energy security or geopolitical dilemma for coal imports. Whereas China's import dependence was 71 percent for oil and 38 percent for natural gas in 2016, the country's coal import dependence was 13 percent in the same year.<sup>24</sup> Also, most of Chinese coal imports come from countries that do not rely on an extensive journey through global chokepoints—in contrast to the profile of oil and gas supplier countries to China. One potential exception is China's coal trade with North Korea: the Chinese decision to temporarily halt coal imports from North Korea and thereby an important source of foreign currency to the North Korean regime following the international furor over the latter's ballistic missile tests may have introduced a political element into what is normally a solely transactional relationship. As coal trade comes to depend increasingly on maritime routes, coal imports may gain more geopolitical undertones.

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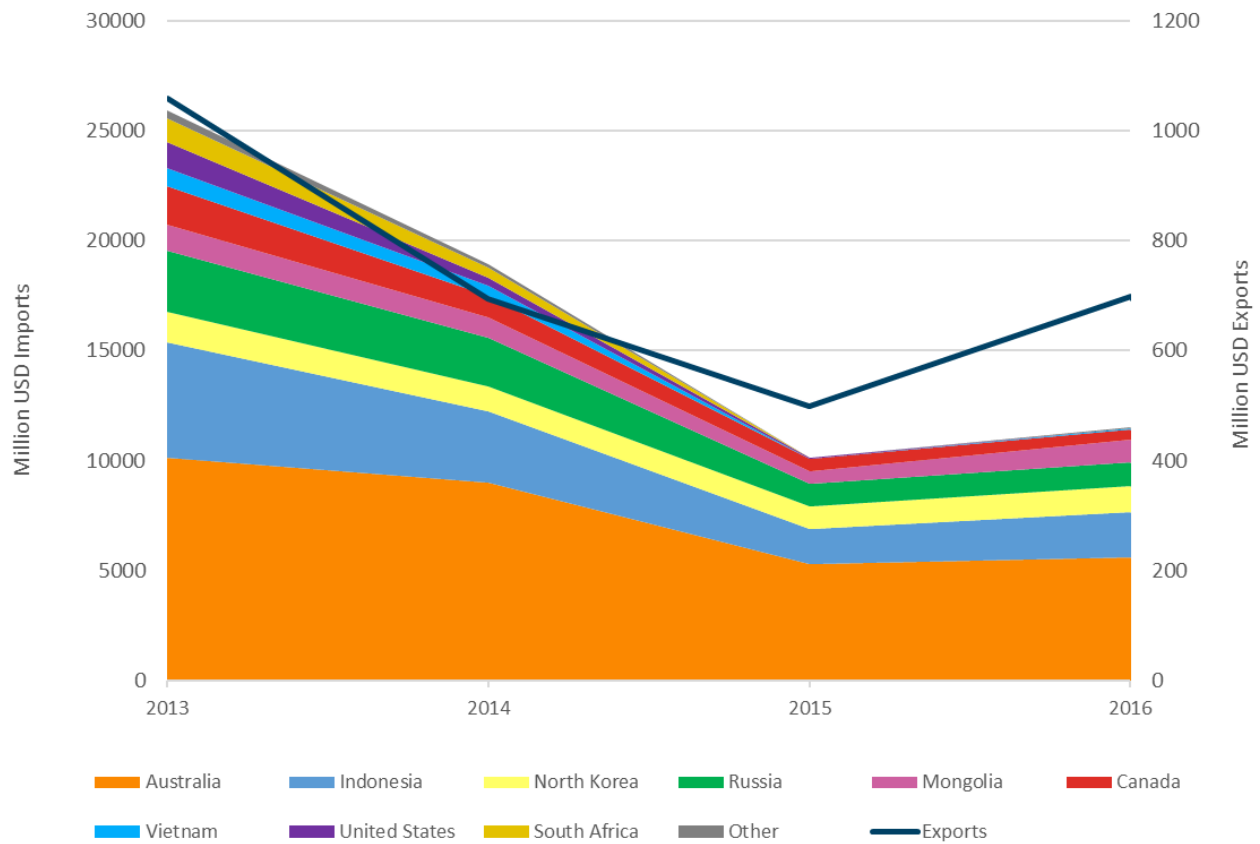
<sup>22</sup> International Energy Agency, "Midterm Coal Market Report 2016," 52.

<sup>23</sup> "China to boost annual railway coal capacity to 3 bln T by 2020," Reuters, January 14, 2014, <http://www.reuters.com/article/china-coal-rail/china-to-boost-annual-railway-coal-capacity-to-3-blnt-by-2020-idUSL3N0KO27W20140114>.

<sup>24</sup> BP, "BP Statistical Review of World Energy," June 2017, 17, 25, 31 35, and 39, <http://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf>. Import dependence is defined by the net import as a share of total consumption; "China's 2016 coal imports jump 25 percent," Reuters, January 12, 2017, <https://www.reuters.com/article/us-china-economy-trade-coal/chinas-2016-coal-imports-jump-25-percent-customs-idUSKBN14X0AZ>.



Figure 6: Chinese Coal Imports by Source, 2013–2016



Data source: UN International Trade Statistics Database, Bloomberg, *Mining Weekly*, and CNBC Africa.

## India: Managing Expectations of Growth

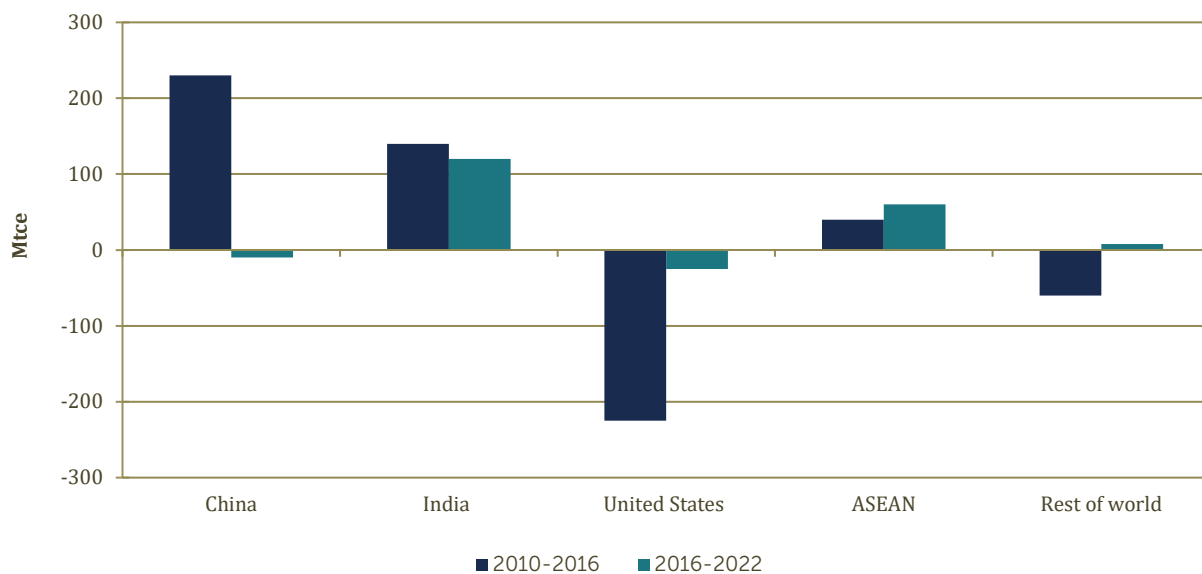
India is currently the world’s second-largest consumer and the third-largest producer of coal. India is also the fastest-growing energy market in the world and, by 2030, is expected to overtake China as the largest energy growth market. India faces many of the same challenges as China in terms of a need to manage local air pollution and a desire to contribute to the growing climate effort, yet its more fundamental needs and priorities are around providing universal energy access—nearly 300 million of India’s population are currently without access to electricity. In addition, India must continue to fuel the economic growth and development that keeps its highly youthful population productively engaged. India therefore, unlike China, has no explicit goals to limit coal use but instead recognizes the need to utilize coal resources and maximize domestic production to meet its needs. If anything, India is set to expand coal consumption as it is focused on key reforms to domestic state-owned industries involved in both the development of coal and its utilization for electric power and industrial applications. Today, roughly two-thirds of coal is consumed for power generation, and the rest is primarily for industrial activities, including steel and cement production. Far from removing coal from the sector, these reforms are designed to enable the

sector to function better with an eye toward remedying longstanding problems with debt, nonpayment issues and infrastructure shortfalls.

*Energy security concern drives India's effort to expand domestic coal production.*

India currently depends on imports to meet about a quarter of its coal consumption although the country has over 94 billion tons of proven coal reserves—third in the Asia Pacific and fifth in the world. The current level of import reliance has raised energy security concern to the India's government, and prompted the government call to increase domestic production and reduce import reliance. Although India's coal demand is beginning to stabilize, it is emerging as a dominant consumer of coal in the medium term (Figure 7).

**Figure 7: Coal Demand Growth in Selected Regions**



Data source: International Energy Agency, "Coal 2017."

Another key driver for increased domestic production may be the 2014 commitment by Indian prime minister Narendra Modi to eliminate energy poverty by 2019. The *Power for All* campaign will serve as a major determinant for Modi's successful reelection in 2019, and likely supersedes all other energy goals, such as to raise the share of nonfossil fuels in energy mix to 40 percent by 2030.

*India's government has a detailed vision for increased domestic production.*

India seeks to reduce coal imports and has outlined specific plans through Niti Aayog, India's primary policymaking institute. In its Three-Year Action Agenda (2017–2018 to 2019–2020), Niti Aayog proposes exploring 25 percent of the untapped coal-bearing lands for new reserves (total

land area is 5,100 square kilometers) as well as roughly doubling the annual production level of Coal India Ltd. (CIL) (the state-owned coal company) to 1 billion tons per year by 2019.<sup>25</sup>

CIL's performance is seen particularly crucial for the government target of 1.5 billion tons of domestic production per year by FY 2020 given the dominance of CIL in the coal-production sector. To make CIL more efficient and competitive, the government has initiated diversification/privatization efforts. Most recently, in February 2018, the Indian government opened up coal mining to private mining companies at home and abroad through a new auction system.<sup>26</sup> CIL is an established entity—80 percent state-owned—with strong political influence that has proven largely immune to reform pressure as the government had in the past found it much more compelling to control it for its political influence and economic clout. How CIL will transform and whether CIL will be able to deliver on the output target are far from certain.

*Geography affects both the coal transport and employment conditions, with implications for coal expansion and labor displacement.*

Railways are a barrier to coal's development and need further expansion to facilitate domestic production growth. Around 87 percent of the proved coal reserves and the majority of current coal production is concentrated in the eastern and central regions in India while half of the coal-based installed power generation capacity is in the northern and western regions. This geographical disparity stresses the importance of adequate midstream infrastructure. In fact, about 25 percent of domestically produced coal is transported via road due to the lack of railway capacity. In late 2017, only 1.22 million tons per day of coal was reportedly dispatched despite 1.37 million tons of demand, resulting in power plant coal stocks shrinking to an average of six days.<sup>27</sup> Niti Aayog has highlighted three railway lines deemed critical to alleviating the coal transportation bottleneck. The work is under progress albeit very slowly.

Geographical disparity is also present in India's evolving electricity landscape. About 500,000 are employed in coal-mining areas in the eastern India, and over 20 million are supported in the coal industry today. Meanwhile, much of grid-connected wind and solar projects are in the western, coastal region. The ongoing fuel-switching from coal to renewables can result in debasing the job-creation engine in eastern India as well as reduce welfare benefits, such as provision and maintenance of infrastructure like schools and hospitals. The coastal region is already economically better off than the eastern region. Such shift may grow into a serious political problem at some point in the future.

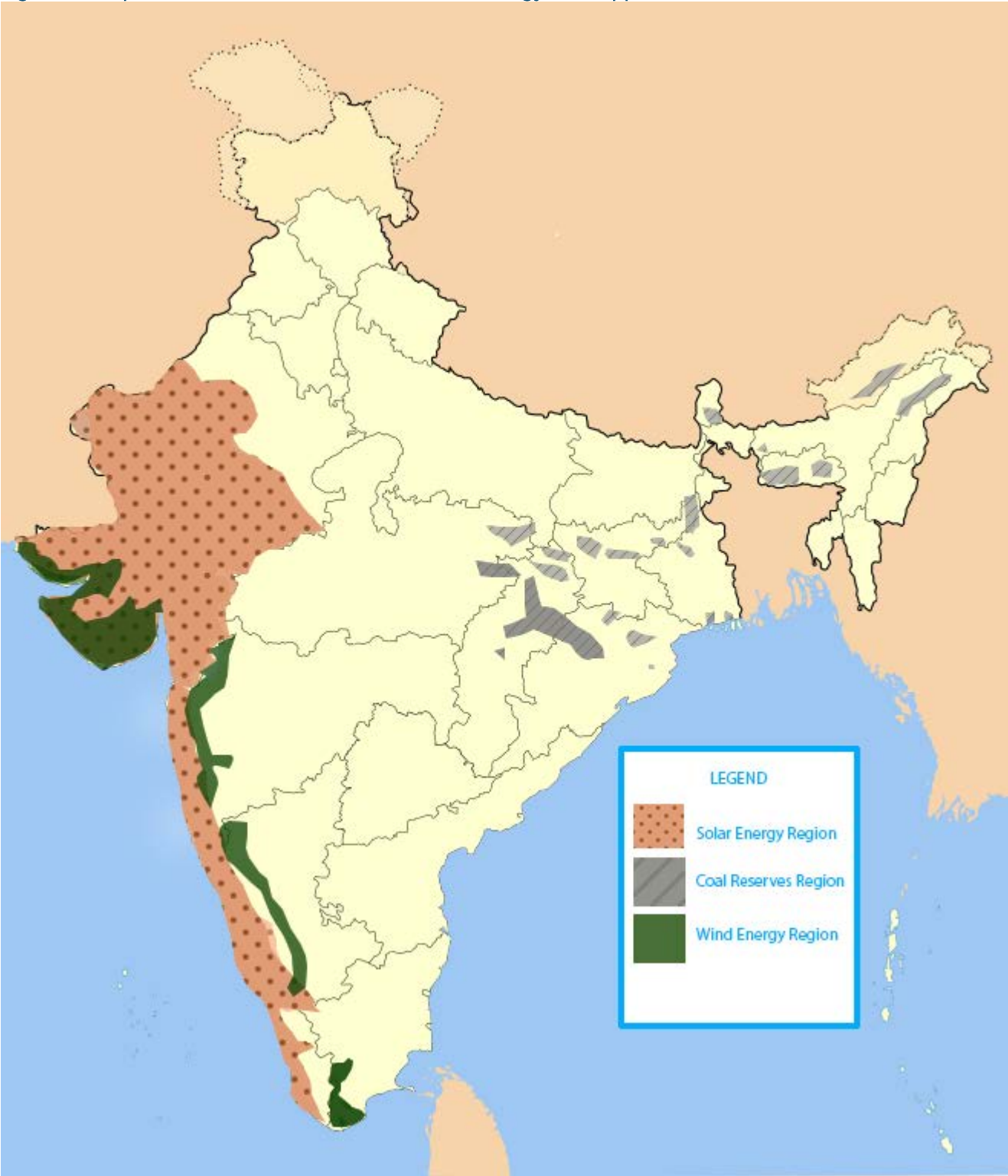
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<sup>25</sup> NITI Aayog, "India: Three Year Action Agenda," August 1, 2017, 99, <http://niti.gov.in/writereaddata/files/coop/IndiaActionPlan.pdf>.

<sup>26</sup> "Ending Coal India's monopoly, government opens coal mining to private sector firms," *Business Today*, February 20, 2018, <https://www.businesstoday.in/sectors/energy/government-opens-coal-mining-to-private-sector-firms-coal-india-monopoly/story/271070.html>.

<sup>27</sup> Shreya Jai, "Coal stocks at power plants down to six days," *Business Standard*, October 7, 2017, [http://www.business-standard.com/article/economy-policy/skewed-coal-stocks-to-hit-power-availability-and-prices-117100600513\\_1.html](http://www.business-standard.com/article/economy-policy/skewed-coal-stocks-to-hit-power-availability-and-prices-117100600513_1.html).

Figure 8: Map of India with Coal and Renewable Energy Job Opportunities



Source: Created with information from the U.S. National Renewable Energy Laboratory, National Institute of Wind Energy of India, and Banaras Hindu University Institute of Technology.

*Share of installed coal-generation capacity is peaking and how much room remains for additional new capacity is uncertain.*

The share of installed coal-power capacity is peaking, reflecting low utilization of coal plants as well as renewables growth and efficiency gains. In recent years, the growth of installed coal-fired power-generation capacity has been overtaken by that of renewables as government support for renewables and the economic and societal difficulties associated with greater deployment of hydro power and natural gas propelled significant expansion of installed wind and solar capacity. Between 2012 and 2017, coal capacity grew by 68 percent while renewables capacity grew by 104 percent.<sup>28</sup> This development follows some years of strong coal capacity growth. Specifically, India's coal capacity has tripled since 2006 and doubled since 2010. But this growth has also led to reduced utilization of coal power plants as it outpaced the rate of coal power demand growth. For example, the capacity factors at India's coal power plants have fallen from 77.5 percent in 2010<sup>29</sup> to 56.7 percent in 2016–2017.<sup>30</sup> Against this background, the Central Electricity Authority noted in its draft National Electricity Plan for 2017–2022 that the country would require no additional coal-fired power capacity through 2027 above the 50 GW already in various stages of progress.

*India's coal fleet is relatively young yet inefficient mainly due to poor quality of domestic coal. The Modi government's coal import phaseout plan may, however, keep the degree of import growth under check.*

India's coal-fired power plant fleet is relatively young with 120 GW out of 193 GW of capacity installed since 2002.<sup>31</sup> However, much of the plants are based on subcritical technology and their average efficiency of 32 percent in India today is as low as that of China's coal-fired power plants in 2006.<sup>32</sup> Moreover, only 3 percent of coal capacity under construction uses ultra-supercritical technology.<sup>33</sup> Environmental regulations could help drive adoption of higher-standard technology, but the transition will likely be a protracted journey. In 2015, India adopted legislation that requires minimum performance standards for new coal plants and emissions control retrofits for existing coal plants from 2017. The implementation date is slipping from the end of 2017 to early 2020s in the face of pushbacks from industry stakeholders. Reportedly, almost 90 percent of India's entire thermal generation fleet is in breach of the pending emissions limits today.<sup>34</sup>

Furthermore, the performance of Indian coal plants is constrained by the low quality of domestic coal, which has a low calorific value and a high ash content. The latter renders the need for higher maintenance requirements as well as for lower plant efficiency. The Niti Aayog proposal acknowledges this issue and calls for reducing the use of low-quality coal, and recommends coal

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<sup>28</sup> Central Electricity Authority, "Power Sector March 2012 and Power Sector March 2017," <http://www.cea.nic.in/monthlyarchive.html>.

<sup>29</sup> Institute for Energy Economics and Financial Analysis, "India's Electricity Sector Transformation," November 21, 2017, 9, [http://ieefa.org/wp-content/uploads/2017/11/India-Electricity-Sector-Transformation\\_Nov-2017-3.pdf](http://ieefa.org/wp-content/uploads/2017/11/India-Electricity-Sector-Transformation_Nov-2017-3.pdf).

<sup>30</sup> *Ibid.*, 50.

<sup>31</sup> International Energy Agency, "Medium Term Coal Market Report," 2016, 29.

<sup>32</sup> *Ibid.*

<sup>33</sup> Institute for Energy Economics and Financial Analysis, "India's Electricity Sector Transformation," November 21, 2017, 34, [http://ieefa.org/wp-content/uploads/2017/11/India-Electricity-Sector-Transformation\\_Nov-2017-3.pdf](http://ieefa.org/wp-content/uploads/2017/11/India-Electricity-Sector-Transformation_Nov-2017-3.pdf).

<sup>34</sup> Deepak Patel, "Toxic sulphur dioxide norms: 90% coal power plants not compliant," *The Indian Express*, October 7, 2017, <http://indianexpress.com/article/india/toxic-sulphur-dioxide-norms-90-coal-power-plants-are-not-compliant-4878396/>.

washing to remove ash and debris. Conventional economic rationale would suggest greater reliance on imports of high-quality coal, but the Modi government's plan to expand domestic coal production and cease thermal coal imports by the end of this decade may inhibit the exponential growth in coal imports.

*Coal faces competition from renewables, but India's push for renewables does not aim at coal phase-out.*

The future of coal-fired power generation is under significant pressure from renewables, which enjoys strong government commitment as exemplified by the national target of 175 GW of installed renewable capacity by 2027 as well as the nonfossil share target of 40 percent by 2030. The price for wind and solar has been rapidly declining with competitive auctions. Moreover, falling costs and improving financial health of distributors are likely to lead to a strong growth in additional renewables capacity. Meanwhile, natural gas appears to be of little threat as India remains significantly dependent on imports for gas supply especially considering the disappointing performance of major new fields as well as output decline in more mature fields.

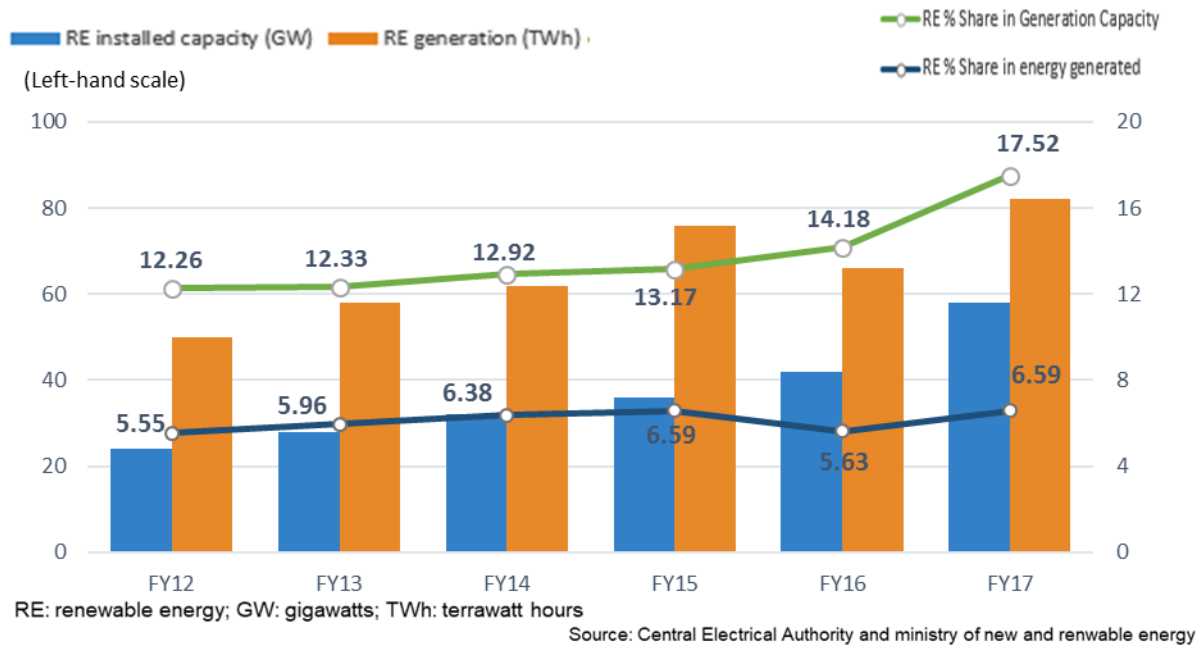
One signpost for the rate of solar growth in India is the price of Chinese solar panels and the future of solar panel-related trade tension between New Delhi and Beijing. India's solar sector growth has been fueled by imported solar modules, owing to its lack of competitive, modern solar manufacturing capacity. As a result, imported solar modules meet 88 percent of India's solar module demand and 84 percent of the imported modules come from China. The Indian government has stressed the importance of promoting domestically sourced solar module manufacturing and has, in cooperation with state-level governments, initiated capital subsidy programs in addition to operating cost subsidies and export incentives. In 2017, the Office of the Directorate General of Anti-dumping & Allied Duties (DGAD) began reviewing a case filed by Indian solar manufacturers against solar imports from China, Taiwan, and Malaysia. Renewable energy stakeholders and environmental proponents in India worry that a cost increase from antidumping duties could slow the burgeoning installation of solar panels in India. All of the utility scale solar projects already allocated to project developers and engineering procurement and construction (EPC) contractors—standing at 10,842 MW as of fall 2017—could come under the risk of provisional or antidumping duty.<sup>35</sup>

Despite the current momentum for further renewables deployment, coal-fired power generation has a significant staying power in India as the government is committed to increasing domestic coal production to meet demand. Coal continues to account for about 75 percent of actual electricity generation due to variability of renewables (day/weather) and hydro (seasonal). India's push for renewables appears driven much more by desire to reduce coal *imports* than its *usage*.

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<sup>35</sup> Bridge to India, "Anti-dumping duty on PV cells and modules," November 2017, 2, [www.bridgetoindia.com/wp-content/uploads/2017/11/BRIDGE-TO-INDIA\\_Anti\\_Dumping\\_Duty.pdf](http://www.bridgetoindia.com/wp-content/uploads/2017/11/BRIDGE-TO-INDIA_Anti_Dumping_Duty.pdf).

Figure 9: Growth of Renewables in India's Energy Mix



Source: Ashwini Swain, "India's pursuit of energy transformation," June 14, 2017.

*Coal-fired power generation is only one focus of India's environmental protection effort.*

India is home to some of the most polluted cities in the world. A 2016 report by the International Energy Agency notes that 11 of the world's 20 most polluted cities are in India, and over half a million premature deaths were attributed to outdoor air pollution, as well as 1 million premature deaths were attributed to household air pollution in 2015. The challenge persists. Air pollution became so severe in New Delhi in November 2017 that about 4,000 schools were shut for a week in a desperate effort to protect school children.

Coal is only one of the main sources of pollution in India. For example, road dust was by far the largest contributor of harmful small particulates like PM10 and PM2.5 in Delhi while power plants and vehicles were the main sources of NOx. Less urban areas of India may observe higher emissions shares from vehicular sources and biomass burning than from power generation. Reducing its emissions intensity by 33 to 35 percent by 2030 (against 2005)—India's commitment under the Paris Agreement—will require efforts in all key sectors, including the power sector.

*CCS faces challenges in India, but the deployment interest may be on rise.*

India showed strong interest in carbon capture and sequestration (CCS) through domestic R&D projects and international collaboration about a decade ago (2007–2012), participating in the U.S.-led Carbon Sequestration Leadership Forum, and approving 29 three-year research projects relevant to CCS R&D, but the momentum has slowed in light of some challenges relative to CCS deployment. Beyond considerable concerns about cost, the challenges include the additional stress from new CCS plants on an already fragile electricity grid, political risk of civil unrest caused

by even small increases to electricity prices resulting from CCS upkeep, legal barriers from potential land acquisitions for construction, and environmental obstacles of possible ground water contamination and CO<sub>2</sub> leakage resulting from the lack of reliable geological storage site data. Since the period of active pursuit, the Indian government seems to have placed limited emphasis on CCS and no new government-funded research projects appear to have been launched following the conclusion of existing research grants in 2015.

Yet, the government has shown signs of renewed interest in CCS, particularly in carbon-capture technology directed at enhanced oil recovery and other industrial use. In September 2017, Piyush Goyal, India's minister of state for power and renewable energy, stated that the government is ready to finance carbon capture technology.<sup>36</sup> At this point it is difficult to say whether the renewed interest in CCS is a surface-level response to the Trump administration's interest in the topic or if it is driven by something more fundamental. Either way, CCS deployment in India has a steep challenge to achieving any significant level of deployment.

### *Coherence between the federal and state coal policies affects the future of coal.*

As India is a representative democracy under the federal system, coordination between the federal government and 29 states (plus territories) holds a key to successful implementation of any policy. Laws and regulations affecting the power sector is not an exception. For example, as Prime Minister Modi pursues three main areas of intervention for the power sector—reforms for the state-owned distribution companies; providing universal electricity access; and integrating vast amounts of new renewable energy into the grid—he will need the help of state governments to achieve these goals. States are struggling to improve the fiscal health of their distribution companies without increasing tariffs.

They are also burdened with having to integrate new renewable sources of electricity into their grids at rates higher than their existing thermal power assets (depending on the time of day) and environmental mandates that require thermal power plants to utilize 100 percent of their fly ash or face closure. The situation of the power sector at the subnational level is further complicated by the fact that absent the growth of the manufacturing sector, power-generation capacity is outpacing demand. New business models and institutions will be required for states to manage the power system of the future. A first step for states is to map their power demand as requested by NTPC Ltd. (India's public power-generating entity) and integrated energy policies that help states articulate the role of various energy sources in meeting their development goals.

## Conclusion

A host of factors such as coal quality and location, midstream availability, technology choice, and the structure of coal and power sectors interact with one another and shape the contour of public debate as it relates to the role of coal-fired power generation in each of the key markets. In the case of the United States, many factors have synergetic effects, bringing about a structural change to coal-fired power generation. In China, these factors are often at odds and signal that the future

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<sup>36</sup> "India ready to fully finance carbon capture technology: Piyush Goyal," *The Economic Times*, August 31, 2017, <https://energy.economictimes.indiatimes.com/news/power/india-ready-to-fully-finance-carbon-capture-technology-piyush-goyal/60311447>.



of its coal-power fleet may take a uniquely Chinese path. Meanwhile, it is much too early to ascertain how such key factors may interact and shape the future trajectory for coal-fired power generation in India, but the Indian experience may promise many lessons for economies that are in the early stage of striving to balance economic development and environmental goals.

Moreover, power-sector policy and technology developments in the three key markets can, and do, influence each other, whether through a technology breakthrough, cost reduction, or a trade tension resulting in a punitive measure, affecting the competitiveness of coal-fired power generation directly or indirectly. Political agenda, policy initiatives, business incentives, and public awareness surrounding the role of coal in each of the key markets illuminate the dynamic nature of power-sector transition around the world today and call for continued observations and analyses.

# About the Authors

**Jane Nakano** is a senior fellow in the CSIS Energy and National Security Program. Her areas of expertise include U.S. energy policy, global market and policy developments concerning natural gas, nuclear energy and coal, and energy security issues in the Asia-Pacific region. She frequently writes and speaks on these issues at domestic and international conferences and to media around the world. She has also testified before Congress on U.S. liquefied natural gas (LNG) exports. Additionally, she is a frequent guest lecturer at area universities.

Prior to joining CSIS in 2010, Nakano worked in the Office of Policy and International Affairs in the U.S. Department of Energy, where she covered a host of energy, economic, and political issues in Asia. From 2001 to 2002, she served at the U.S. embassy in Tokyo as special assistant to the energy attaché. Nakano graduated from Georgetown University's School of Foreign Service and holds a master's degree from Columbia University's School of International and Public Affairs.

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Ladislaw formerly worked in the Office of the Americas in the Department of Energy's Office of Policy and International Affairs, where she covered a range of economic, political, and energy issues in North America, the Andean region, and Brazil. While at the department, she also worked on comparative investment frameworks and trade issues, as well as biofuels development and use both in the Western Hemisphere and around the world. She also briefly worked at Statoil as its senior director for international affairs in the Washington office. Ladislaw is frequently invited to speak at public conferences, advise companies and policymakers, and testify before Congress. She is a member of the National Renewable Energy Laboratory's Strategic Analysis Technical Review Panel, the Strategic Advisory Council for Georgia Tech's Strategic Energy Initiative, and a term member of the Council on Foreign Relations. She has taught graduate courses on energy security as an adjunct professor at the George Washington University and is a frequent guest lecturer at other universities. She also comments frequently in print, radio and television media outlets. Ladislaw received her bachelor's degree in international affairs/East Asian studies and Japanese from the George Washington University and her master's degree in international affairs/international security from the George Washington University as part of the Presidential Administrative Fellows Program.



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