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CAN COAL MAKE A COMEBACK?

Trevor Houser, Jason Bordoff,
and Peter Marsters

APRIL 2017

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By Trevor Houser, Jason Bordoff, and Peter Marsters*

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***Trevor Houser** is a partner with the Rhodium Group (RHG), leading the firm's energy and natural resources practice, and co-directs the Climate Impact Lab.

Jason Bordoff is a former Senior Director on the staff of the National Security Council and Special Assistant to President Obama. He is now a professor of professional practice in international and public affairs and the founding director of the Center on Global Energy Policy at Columbia University's School of International and Public Affairs.

Peter Marsters is a Research Analyst with the Rhodium Group (RHG) focusing on Chinese energy and environmental issues.

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

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EXECUTIVE SUMMARY

Six years ago, the US coal industry was thriving, with demand recovering from the Great Recession, and global coal prices at record highs along with the stock prices of US coal companies. By the end of 2015, however, the industry had collapsed, with three of the four largest US miners filing for bankruptcy along with many other smaller companies. While coal mining employment has been on the decline for decades – from a peak of more than 800,000 in the 1920s to 130,000 in 2011 – the pace of job loss over the past six years has been particularly dramatic. After campaigning on a promise to end what he called his predecessor's "War on Coal," President Donald Trump signed an Executive Order in March 2017 ordering agencies to review or rescind a raft of Obama-era environmental regulations, telling coal miners they would be "going back to work."

This paper offers an empirical diagnosis of what caused the coal collapse, and then examines the prospects for a recovery of US coal production and employment by modeling the impact of President Trump's executive order and assessing the global coal market outlook. In short, the paper finds:

- US electricity demand contracted in the wake of the Great Recession, and has yet to recover due to energy efficiency improvements in buildings, lighting and appliances. A surge in US natural gas production due to the shale revolution has driven down prices and made coal increasingly uncompetitive in US electricity markets. Coal has also faced growing competition from renewable energy, with solar costs falling 85 percent between 2008 and 2016 and wind costs falling 36 percent.

- Increased competition from cheap natural gas is responsible for 49 percent of the decline in domestic US coal consumption. Lower-than-expected demand is responsible for 26 percent, and the growth in renewable energy is responsible for 18 percent. Environmental regulations have played a role in the switch from coal to natural gas and renewables in US electricity supply by accelerating coal plant retirements, but were a significantly smaller factor than recent natural gas and renewable energy cost reductions.

- Changes in the global coal market have played a far greater role in the collapse of the US coal industry than is generally understood. A slow-down in Chinese coal demand, especially for metallurgical coal, depressed coal prices around the world and reduced the market for US exports. More than half of the decline in US coal company revenue between 2011 and 2015 was due to international factors.

- Implementing all the actions in President Trump's executive order to roll back Obama-era environmental regulations could stem the recent decline in US coal consumption, but only if natural gas prices increase going forward. If natural gas prices remain at or near current levels or renewable costs fall more quickly than expected, US coal consumption will continue its decline despite Trump's aggressive rollback of Obama-era regulations.

- While global coal markets have recovered slightly over the past few months due to supply restrictions in China and flooding in Australia, we expect this rally to be short-lived. Slower economic growth and structural adjustment in China will continue to put downward pressure on global coal prices and limit the market opportunities for US exports. Indian coal demand will likely grow in the years ahead, but not enough to make up for the slow-down in China. The same is true for other emerging economies, many of whom are negatively impacted by decelerating Chinese commodities demand themselves.

- Under the best case scenario for US coal producers, our modeling projects a modest recovery to 2013 levels of just under 1 billion tons a year. Under the worst case scenario, output falls to 600 million tons a year. A plausible range of US coal mining employment in these scenarios ranges from 70,000 to 90,000 in 2020, and 64,000 to 94,000 in 2025 and 2030 -- lower than anything the US experienced before 2015.

These findings indicate that President Trump's efforts to roll back environmental regulations will not materially improve economic conditions in America's coal communities. As such, the paper concludes with recommendations for steps that the federal government can take to safeguard the pension and health security of current and retired miners and dependents and support economic diversification. Attracting new sources of economic activity and job creation will not be easy, and even at its most successful will not return coal country to peak levels of past prosperity. But responsible policymakers should be honest about what's going on in the US coal sector—including the causes of coal's decline and unlikeliness of its resurgence—rather than offer false hope that the glory days can be revived. And then support those in America's coal communities working hard to build a new economic future.

INTRODUCTION

"I actually think the next decade for coal is going to be one of the best decades we've ever had."

—Steve Leer, of Arch Coal, as quoted in the Wall Street Journal, February 2011.

Six years ago, the US coal industry was thriving. Coal demand was recovering from the Great Recession, both in the United States and around the world, and it was expanding by more than 5 percent per year. Global coal prices were at record highs, as were the stock prices of the largest coal companies. The market value of the four largest US mining companies—Peabody, Arch, Alpha, and Cloud Peak—reached a combined $33 billion. Emboldened by strong balance sheets and a belief that rapid growth in Chinese coal consumption would continue for decades, these companies doubled down with big investments in new mining assets, both in the United States and around the world, and in new export capacity to ship more US coal abroad.

By the end of 2015, however, Peabody, Arch, and Alpha, along with a number of smaller companies, had all filed for bankruptcy in one of the most spectacular market collapses in history. US coal consumption was down more than 20 percent from 2011 levels. Chinese coal consumption fell in both 2014 and 2015 after decades of rapid growth. Global coal consumption was down as well in 2015. That was only the second time that had happened since the early 1990s, and it was by the largest amount in postwar history. This also occurred just as some of the large investments in new production made when the market was at its peak started coming online. As a result, coal prices around the world ended 2015 between 30 percent and 60 percent lower than they were in 2011.

This downturn hasn't just impacted coal companies and their shareholders. It has taken a significant toll on the lives of the men and women who work in the coal industry and the communities in which they live. US coal production fell by one-third between 2011 and 2016, but employment has fallen even further. There are now just over 70,000 Americans working in the coal mining industry, down from more than 130,000 at the end of 2011. It was 860,000 at the peak in 1923. Recent bankruptcies threaten the pension and healthcare security of more than 100,000 retired miners and dependents. This drop in coal production has reduced tax revenue in coal communities from West Virginia to Wyoming, resulting in service cuts and teacher layoffs.

The decline in US coal mining played a prominent role in the 2016 US presidential campaign. Donald Trump repeatedly promised to revive the US coal industry and bring back mining employment by removing environmental regulations adopted by President Obama[1].

President Trump has reiterated these promises since being elected the 45th president of the United States. After signing an executive order on March 28 directing agencies to review or rescind a wide range of Obama administration environmental regulations, President Trump told a group of coal miners gathered at the EPA to witness the signing, "You're going back to work."[2]

This paper assesses President Trump's ability to deliver on those promises to coal communities. After offering a brief history of coal's role in the US economy, we then describe the recent collapse of US coal consumption and production and explain the primary factors driving the decline. We found that 49 percent of the decline in domestic US coal consumption was due to the drop in natural gas prices, 26 percent was due to lower than expected electricity demand, and 18 percent was due to growth in renewable energy. Environmental regulations contributed to the decline by accelerating coal power plant retirement, but these were a less significant factor. We also found that changes in the global coal market have played a far greater role in the decline of US production and employment than

is generally understood. The recent collapse of Chinese coal demand, especially for metallurgical coal, depressed coal prices around the world and reduced the market for US exports. The decline in global coal prices was a particularly important factor in the recent wave of coal company bankruptcies and resulting threats to the healthcare and pension security of retired US coal miners and their dependents.

Second, the paper examines the prospects for a recovery of US coal production and employment by modeling the impact of President Trump's executive order and assessing the global coal market outlook. We found that successfully removing President Obama's environmental regulations has the potential to mitigate the recent decline in US coal consumption, but that will only occur if natural gas prices start to rise. If they remain at current levels, domestic consumption will continue to decline, particularly if renewable energy costs fall faster than expected. We similarly see little prospect of a sustainable recovery in global coal demand growth and seaborne coal prices. Combining our domestic and international market outlook, we believe it is highly unlikely US coal mining employment will return to pre-2015 levels, let alone the industry's historical highs.

Give this outlook, the paper concludes with recommendations for how the federal government can support economic diversification in coal communities through infrastructure investment, abandoned mine land reclamation, tax credits, small business incubation, workforce training, and support for locally driven economic development initiatives.

UNDERSTANDING THE COAL COLLAPSE

An accurate prognosis of future US coal production and employment requires a careful diagnosis of the causes of the recent collapse. On the campaign trail, Donald Trump attributed the decline to a "war on coal" waged by the Obama administration via environmental regulation. That mirrors arguments made by most coal state Republicans, including Senate Majority Leader Mitch McConnell (Republican, Kentucky). If that diagnosis is correct, the cure is clear: weaken those environmental protections. With Republican control of both the House and the Senate, President Trump has the ability to do just that. Before discussing recent changes in the US coal market, we start by putting those changes in a broader historical context.

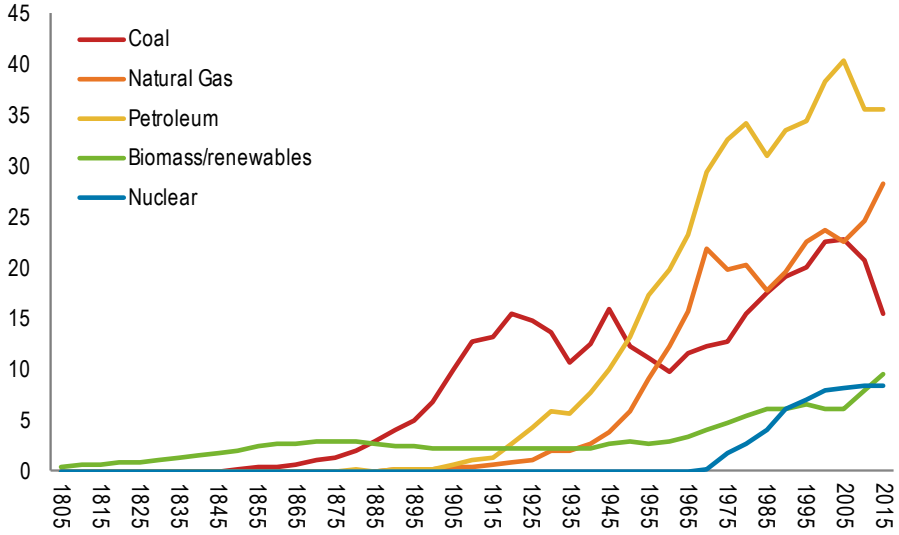
Coal's Volatile History

From colonial times until the middle of the 19th century, the vast majority of US energy supply came from timber. Trees felled to make way for farmland or urban centers or, most often, to be used specifically for energy use were burned in household stoves and fireplaces and in industrial furnaces. European settlers were shocked by the quality and quantity of fuel wood available (the result of North America's temperate climate, precipitation levels, and soil quality) and took full advantage of it as they developed East Coast colonies and then expanded west.[3]

Over the course of the 19th century, American forest coverage declined by 24 percent nationwide and 49 percent in the Northeast and Midwest. The vast majority of this wood was used for fuel—18 times the amount used for building lumber at the turn of the 19th century. Most fuel wood was burned in household fireplaces, but the commercial, industrial, and transportation sectors were important sources of demand as well. Until the mid-1800s, charcoal from Eastern forests fueled the majority of American steel production, and steam engines were powered largely by wood fires.[4]

Commercial coal mining in the United States began in 1748 in Richmond, Virginia. However, it didn't really take off until the mid-1800s, when new coal resources were discovered, mines became more mechanized, and steam engines and steel mills began switching over from wood. In 1850, coal accounted for 9 percent of US energy supply (figure 1). By 1880 coal's market share had grown to 41 percent. And the construction of the first coal-fired power plant (by Thomas Edison in 1882) laid the groundwork for coal to grow to more than 70 percent of total energy supply by the turn of the century.

Figure 1: Primary US Energy Consumption by Fuel
QBTU



Source: EIA

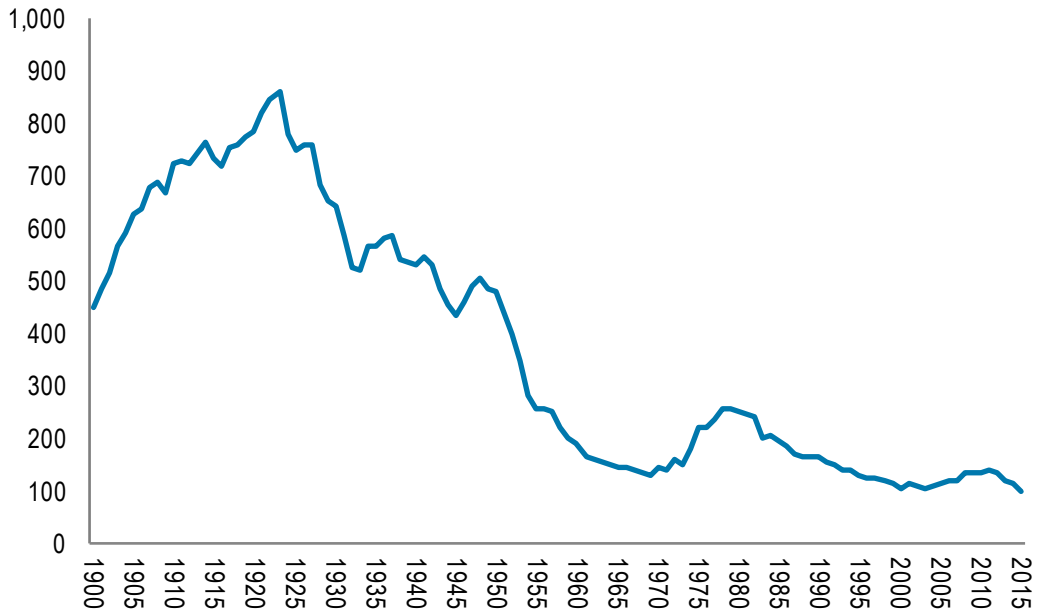
Competition from Oil and Gas

Coal provided more than half of America's energy supply for more than half a century, but by the 1920s, oil and natural gas were significantly eroding coal's market share. US oil production began in 1859, when George Bissell and Edwin Drake drilled the first commercial well in Titusville.[5] Oil's price advantage over whale oil or coal gas as an illumination fuel attracted scores of speculators to Pennsylvania and other eastern states. The industry's first 50 years were rocky, however, and by 1910 oil and natural gas together only supplied 9 percent of US energy demand.

In the 1910s and 1920s, US oil gas supply grew rapidly as production practices improved and demand grew. Oil is roughly twice as energy dense as most types of coal, and it is generally easier to move. It quickly became the fuel of choice, not just for the country's nascent vehicle market but increasingly for power generation and for use in industrial furnaces as well. Natural gas was considerably cleaner than coal and gained market share both in the industrial and power sectors, and it gained in the rapidly growing residential and commercial energy markets, thanks to an expansion of municipal gas distribution networks.

Between 1920 and 1970, US energy consumption more than tripled, and nearly all that growth was supplied with oil and natural gas. Coal consumption fell by 21 percent. In 1920, coal accounted for 73 percent of total US energy supply, and roughly 800,000 Americans were employed in coal mining (figure 2). By 1970, coal's market share had declined to 18 percent of total US energy supply. Thanks to both declining sales and mechanization, only 145,000 people were left working in the mines.

Figure 2: US Coal Mining Employment
Thousand miners



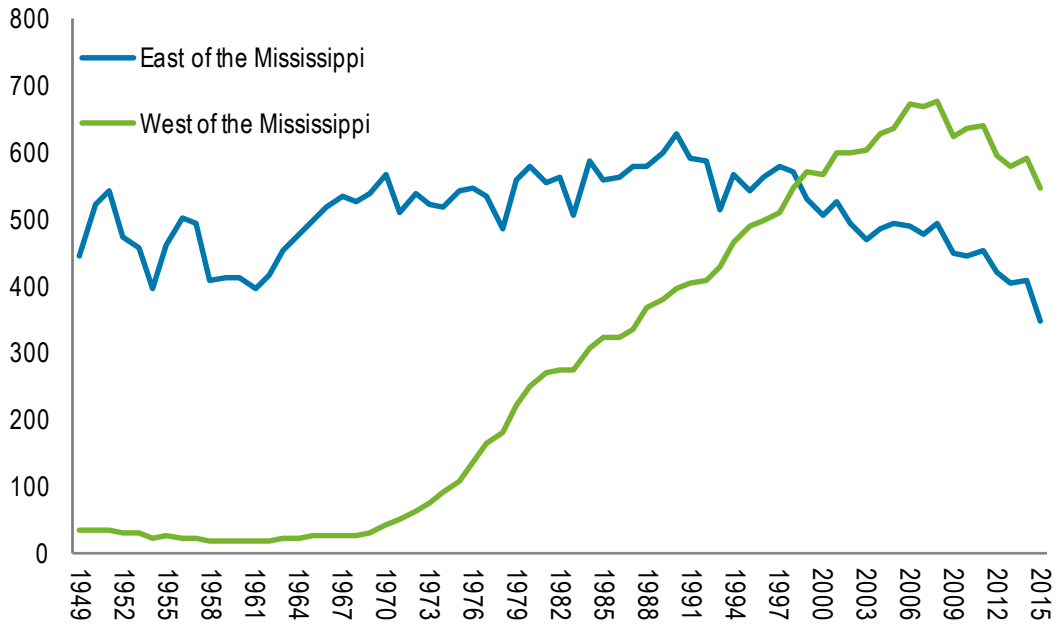
Source: Mine Safety and Health Administration, includes office workers starting in 1973.

Competition from the West

The oil and gas price spikes of the 1970s, which were due to the Arab oil embargo and Iranian Revolution, gave a beleaguered US coal market a bit of a respite. Coal recovered some of its lost market share in the power sector, growing from a low of 44 percent in 1972 to 57 percent in 1987, and it made inroads in industry as well. President Jimmy Carter, who prioritized environmental issues and made energy a centerpiece of his administration ("the moral equivalent of war," he called it), was determined to substitute oil with domestic coal for security reasons. Environmental concerns with coal use were well known, but coal was routinely referred to as a "transition" or "bridge" fuel to a time when solar and conservation might displace it.[6] Coal employment doubled between 1969 and 1979, but that recovery proved short lived. Due to continued improvements in mining productivity, employment again started to decline.

In 1979, the average miner in the United States (including support staff) produced 3,000 short tons of coal a year. By 2000, that number had grown to 10,000 short tons. A major factor in the declining labor intensity of US coal production has been a shift in market share from underground mining in the East to surface mining in the West (figure 3). Changes in the federal coal leasing program in the late 1970s opened up the Powder River Basin (PRB) in Wyoming and Montana. PRB coal was also low sulfur, which gave it a competitive advantage over Appalachian coal once the Clean Air Act amendments were passed in 1990. Eastern US coal production peaked in 1990 and has been declining ever since. As coal production is 13 times less labor intensive in Wyoming than in West Virginia, this geographic shift reduced national coal employment overall.

Figure 3: US Coal Production by Region
Million Short Tons



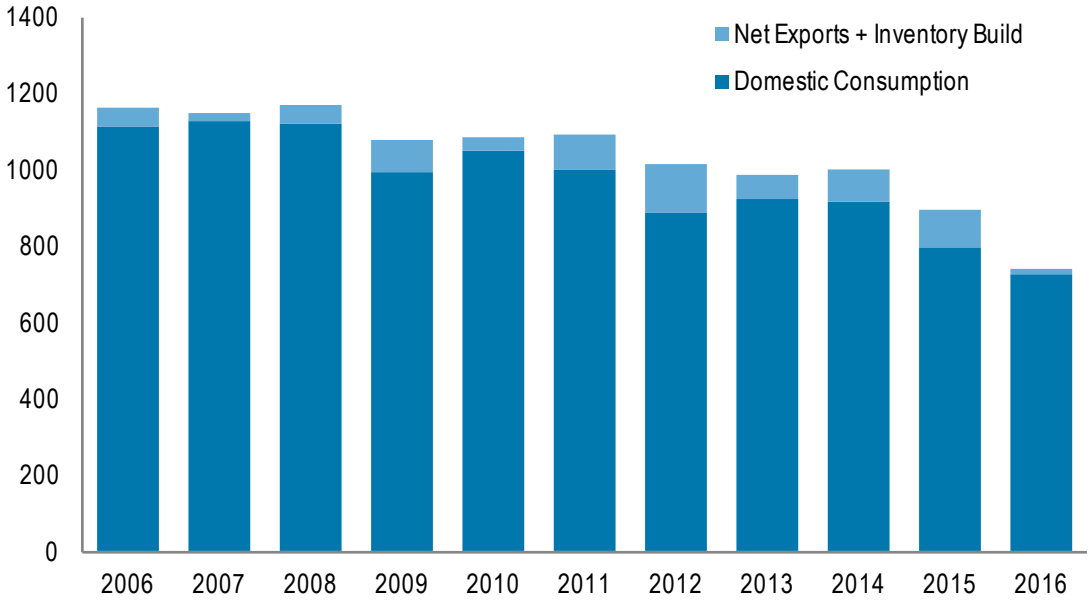
Source: EIA

The Recent Collapse

While the 1980s and 1990s weren't great for coal employment nationally, the rate of decline was manageable. By 2000, employment had leveled out at just under 100,000 and began to recover. US electricity demand grew by 8 percent between 2000 and 2008, which was enough to boost domestic coal consumption by 3 percent, despite a modest decline in coal's share of US power generation.[7] Even more important, from an employment perspective, was the China-led growth in global coal demand during this period. This raised coal prices around the world and made US coal exports from labor-intensive Appalachia more competitive. Appalachian steam coal prices increased from $27 per ton in the second quarter of 2002 to $133 per ton in the second quarter of 2008.[8] Export prices for metallurgical coal (used for steel making) rose from $44 per ton[9] to $130 per ton over the same period.[10] US coal exports grew from 40 million tons in 2002 to 82 million tons in 2008.[11] While more US coal was shipped to Europe than to Asia (because of proximity to East Coast export terminals), Asian demand made those exports commercially viable.

By 2011, US exports had surpassed 100 million tons per year, and coal mining employment had recovered to 133,000. US coal companies were trading at record valuations on the New York Stock Exchange. New mines and new export terminals were being planned. Then the bottom fell out. Between 2011 and 2016, US coal production declined by 27 percent, from 1,096 million tons to 730 million (figure 4). Domestic demand fell by 30 percent, and exports dropped as well. This was the biggest 5-year decline in postwar US history, and it had a dramatic impact on US coal companies and coal-producing communities.

Figure 4: US Coal Production, Net Exports, and Consumption
Million short tons



Source: EIA

Employment

58,407 coal miners and contractors lost their jobs between the 4th quarter of 2011 and the 4th quarter of 2016 (table 1), a 44 percent decline. Central Appalachia has been hit particularly hard, with half of all job loss nationally occurring in Kentucky and West Virginia alone. (This assumes contractor job losses are proportionally distributed.) Western coal states have also suffered, though. Mining employment has fallen by 52 percent in Colorado, 34 percent in New Mexico, 12 percent in Montana, and 22 percent in Wyoming.

Table 1: Coal Employment by State

State	Q4 2011	Q4 2016	Jobs Lost	Percent Change	Coal Jobs Lost as Percentage of Total Workforce
Alabama	4,958	2,286	2,672	−54%	0.14%
Colorado	2,605	1,254	1,351	−52%	0.05%
Illinois	4,434	2,771	1,663	−38%	0.03%
Indiana	3,674	2,771	903	−25%	0.03%
Kentucky	18,029	6,459	11,570	−64%	0.60%
Montana	1,247	1,099	148	−12%	0.03%
New Mexico	1,415	932	483	−34%	0.06%
North Dakota	1,133	1,260	−127	11%	−0.03%
Ohio	3,151	1,289	1,862	−59%	0.03%
Pennsylvania	8,629	5,238	3,391	−39%	0.06%
Texas	2,890	2,563	327	−11%	0.00%
Utah	1,801	1,226	575	−32%	0.04%
Virginia	5,439	2,529	2,910	−54%	0.07%
West Virginia	24,772	12,239	12,533	−51%	1.64%
Wyoming	7,198	5,632	1,566	−22%	0.56%
Other States	2,372	2,373	−1	0%	
Contractors (All states)	**38,409**	**21,828**	**16,581**	**−43%**	
Total	**132,156**	**73,749**	**58,407**	**−44%**	

Source: MSHA. States with over 1,000 coal mining employees in 2011 are shown individually.

Nationally, the loss of 58,407 jobs is pretty small in an economy that creates 100,000 to 300,000 new jobs each month. Indeed, in most coal producing states, the decline in mining employment since 2011 accounts for less than 0.1 percent of the statewide workforce. In West Virginia, Wyoming, and Kentucky, though, the decline has had a meaningful impact on statewide employment. Within these states (as well as other coal producing states), jobs losses can be highly concentrated.

For example, in Mingo County, West Virginia—in the heart of the state's southern coalfields—there were 1,411 people employed in coal mining in the 4th quarter of 2011 (excluding contractors). That was 17 percent of total countywide employment of 8,513. Mining played an even larger role in the county's economy than this figure suggests as relatively high-paid miners supported other local employment through the goods and services they purchased. By the second quarter of 2016, Mingo County coal mining employment had fallen to 438, and overall county employment had fallen to 4,878.

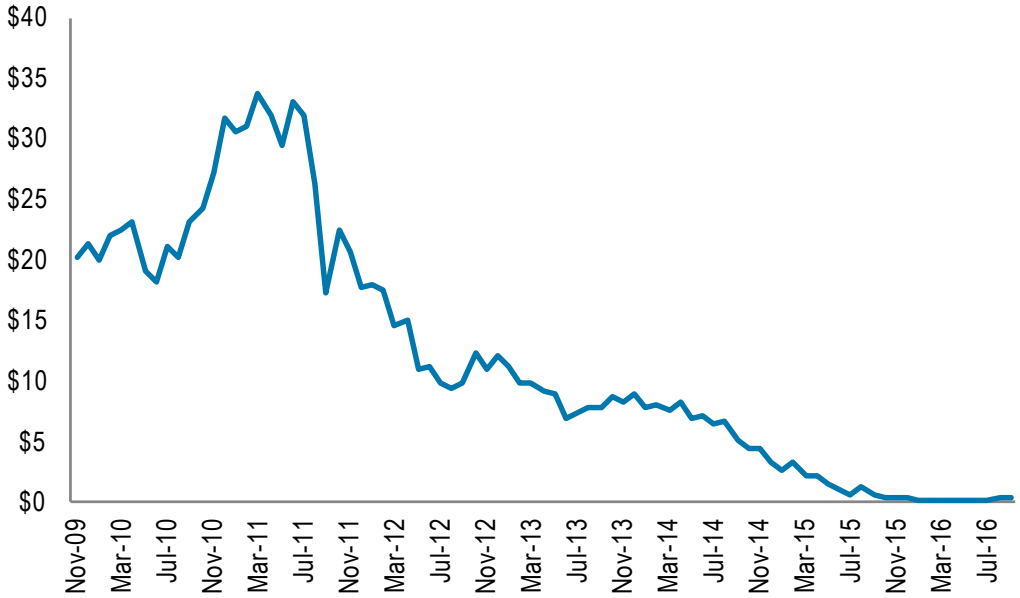
In Campbell County, Wyoming, where most large PRB mines are located, coal mining employed 5,671 people (excluding contractors) during the 4th quarter of 2011. That was 20 percent of a total county labor force of 28,033. By the second quarter of 2016, coal mining employment had fallen to 3,985, and overall county employment had dropped by more than 10 percent.

Pension and Health Security

It's not just current miners hurt by the recent drop in production. Retirees have been impacted as well. In many instances, their pensions and healthcare security depend on their former employers' financial solvency. For many US coal companies, this cratered abruptly in one of the most remarkable equity collapses in US market history. The nation's four largest coal companies by output—Peabody Energy, Arch Coal, Cloud Peak, and Alpha Natural Resources—accounted for 52 percent of US production in 2011. In March of that year, they had a combined market value of $33 billion (figure 5). By May 2016, their combined market share had fallen to $150 million, and Peabody, Arch, and Alpha had all filed for bankruptcy, along with dozens of other smaller companies.

As part of their bankruptcy proceedings, Peabody, Alpha, Patriot Coal (a Peabody spin-off), and Walter Energy all attempted to escape legacy pension and healthcare obligations to retired miners. They were successful in most cases, but with Patriot,[12] Peabody,[13] and Walter,[14] retiree benefits were voluntarily extended through negotiations with the United Mine Workers of America (UMWA). This followed public pressure from Hillary Clinton.[15, 16] Ultimately, however, more than 120,000 retired miners and dependents, including those Patriot, Peabody, and Walter retirees who got short-term extensions, risk losing their benefits if a federal backstop is not established. Joe Manchin, a West Virginian senator, has proposed such a backstop with his "Miners Protection Act," which now has 14 Democratic, 5 Republican, and 1 independent cosponsor.[17] Majority Leader Mitch McConnell has thus far refused to give the bill a vote by the full Senate.[18] In December 2016, though, Congress passed a short-term health benefit extension.

Figure 5: Market Capitalization of Four Largest US Coal Companies
Billion USD



Source: Bloomberg

Tax Revenue

Many coal communities rely on the coal industry for large shares of their tax revenue, either through production excise taxes, property taxes assessed on the value of coal reserves, or the state's share of federal royalties (if that coal is produced on public lands). As a result, the downturn in production and prices has significantly impacted the fiscal health of many coal communities and local labor markets.

In West Virginia, for example, severance taxes raised $483 million in 2011, the majority of which came from coal mining.[19] That accounted for 12 percent of total general revenue that year, and it doesn't capture the fiscal contributions of the coal sector via business taxes paid by coal companies and income and sales taxes paid by employees. In 2016, statewide severance tax revenue had fallen to $262 million, only 6 percent of general revenue.[20]

This has disproportionately impacted counties in the state's southern coalfields, which rely on severance tax revenue for local school funding. The drop in coal-related tax revenue is compounded by enrollment declines as mining families leave the region to look for work elsewhere. The public school system in Kanawha County, for example, is facing a $5.1 million budget shortfall,[21] and recently it let go 70 teachers.[22] In spring of last year, there were widespread teacher layoffs as well.[23] Boon County cut 77 positions, Cabell County cut 61 positions, Mingo County cut 65 positions, McDowell County cut 30 positions, and Fayette County cut 18 positions.

Western states have also suffered meaningful declines in coal-related tax revenue. In 2012, coal mining contributed $1.3 billion in tax revenue to the Wyoming state government through a contribution of severance taxes, federal royalties, coal lease bonus payments, and ad valorem taxes on production.[24] Wyoming coal severance tax revenue in 2016 was 26 percent below 2012 levels,[25] and it was 31 percent below what the state government had projected it would be at the beginning of 2012.[26] Federal coal royalties have declined by 34 percent,[27] and other coal-related tax revenue has fallen as well. Wyoming officials are now planning for an additional 13 percent decline in coal severance tax revenue between 2016 and 2022. That, along with the decline in oil and gas-related revenue due to the recent drop in prices, has reduced funding available for education in the state by 25 percent.[28]

A Changing Domestic Energy Market

What, or who, is to blame for the American coal industry's currently dismal state? Contrary to the way the issue is often characterized in political discourse, there is no single villain. The coal industry has a mix of enemies, both foreign and domestic, that are responsible for the production declines, bankruptcies, and layoffs of the past few years. In this section, we analyze the myriad factors at play.

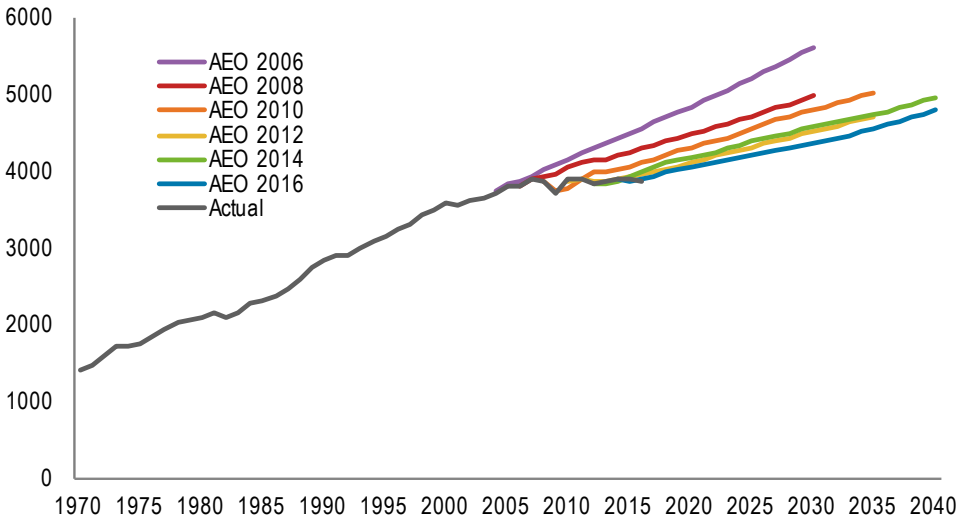
Electricity Demand

Nearly all coal consumed in the United States (93 percent) is for power generation.[29] After decades of growth, US electricity demand has essentially flatlined. The Great Recession certainly took a toll on electricity usage. US power demand fell by 4 percent year-on-year in 2009. While the economy has largely recovered since then, electricity demand hasn't. In 2016, the United States consumed less electricity than it did in 2007, even though the economy was 12 percent larger (adjusted for inflation). In 2016, the US economy expanded by 1.6 percent, but electricity consumption fell by 1.2 percent.[30]

This is a stark change from what most government forecasters, utility commissions, power generators, and coal miners predicted. The Energy Information Administration's (EIA) Annual Energy Outlook (AEO) is the US energy market forecast most widely used in both private and public sector planning. In its 2006 annual outlook, the EIA projected 1.7 percent average annual electricity demand growth between 2007 and 2016. This was broadly in line with historical averages.[31] Actual electricity consumption in 2016 was 16 percent below EIA's projection. In addition to the demand destruction unleashed by the Great Recession, significant improvements in building and appliance efficiency have constrained subsequent growth in consumption.

Lower than expected demand meant excess generating capacity and a smaller market in which coal plants could compete. This was the first blow.

Figure 6: US Electricity Demand, Projected versus Actual
Billion kWh



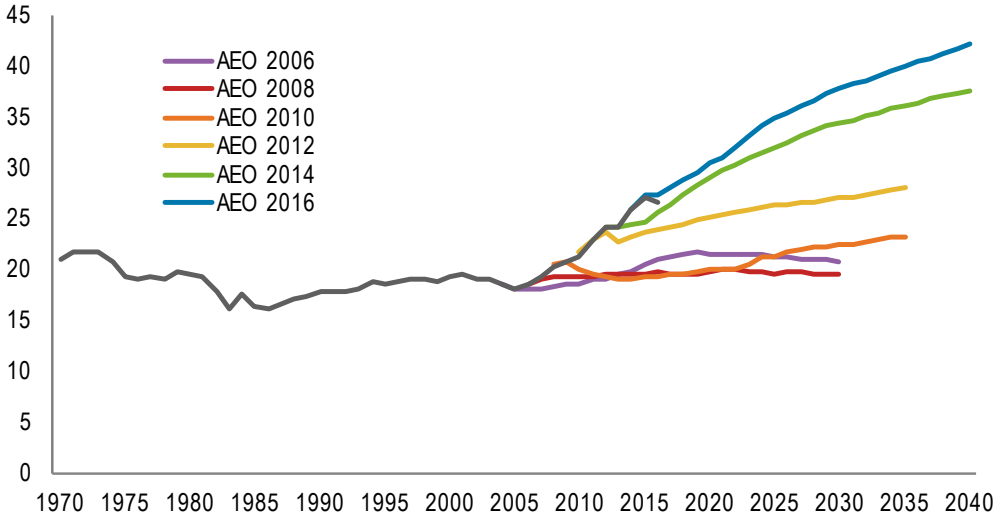
Source: EIA

Shale Gas

The second blow, however, did far more damage. Through a combination of horizontal drilling, hydraulic fracturing, and seismic imaging, US companies have unlocked oil and gas from previously inaccessible shale and other unconventional resources. This transformed the American energy landscape.[32] US natural gas production grew 37 percent between 2007 and 2016, and it is now 26 percent higher than the EIA projected in the 2006 AEO (figure 7). EIA has upward revised their projections almost every year since US drillers improved productivity and proved up additional gas reserves. The 2016 Annual Energy Outlook projects another 40 percent increase in production between now and 2030.

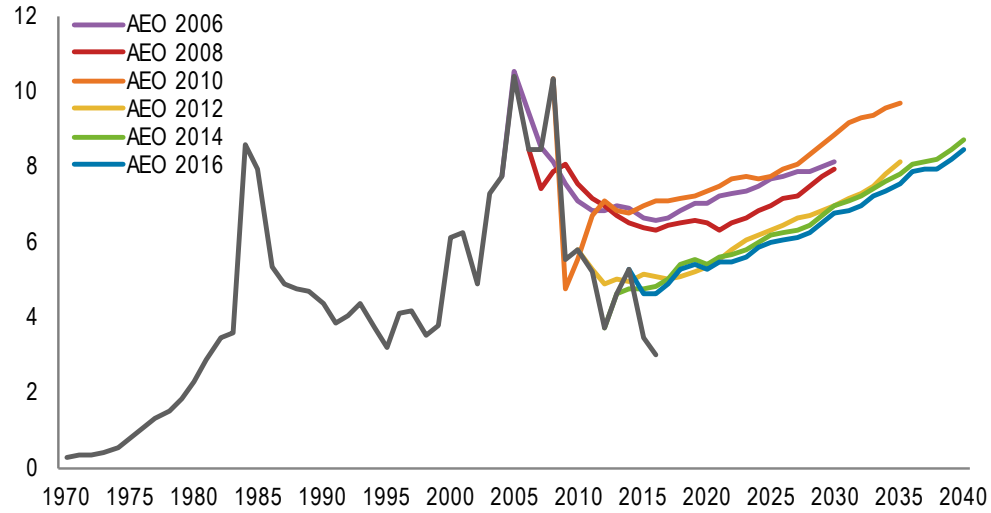
This surge in domestic gas production has significantly reduced prices. In 2008, the average US power plant paid $10 per thousand cubic feet (tcf) for delivered natural gas (in real 2016 dollars). In 2016 they paid $3, a 71 percent decline from 2008 levels. That was 53 percent less than the EIA projected in the 2008 Annual Energy Outlook (figure 8). This price decline has dramatically improved the competitiveness of natural gas versus coal, particularly in the East and Midwest. During the same period of time, the average delivered cost of coal only decreased by 8 percent in real terms.

Figure 7: US Natural Gas Production, Projected versus Actual
Trillion Cubic Feet



Source: EIA

Figure 8: Delivered Natural Gas Prices for Power Generation
Real 2016 USD per Thousand Cubic Fee

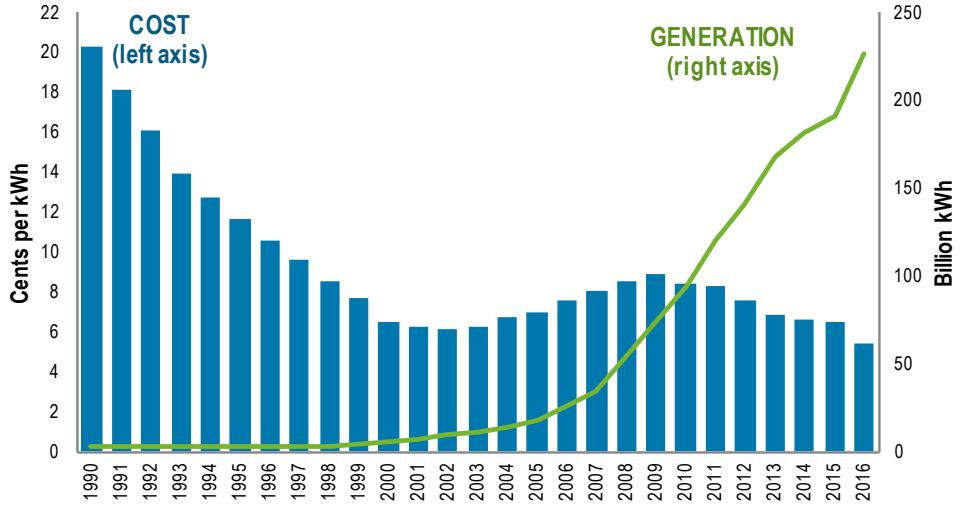


Source: EIA

Renewable Energy

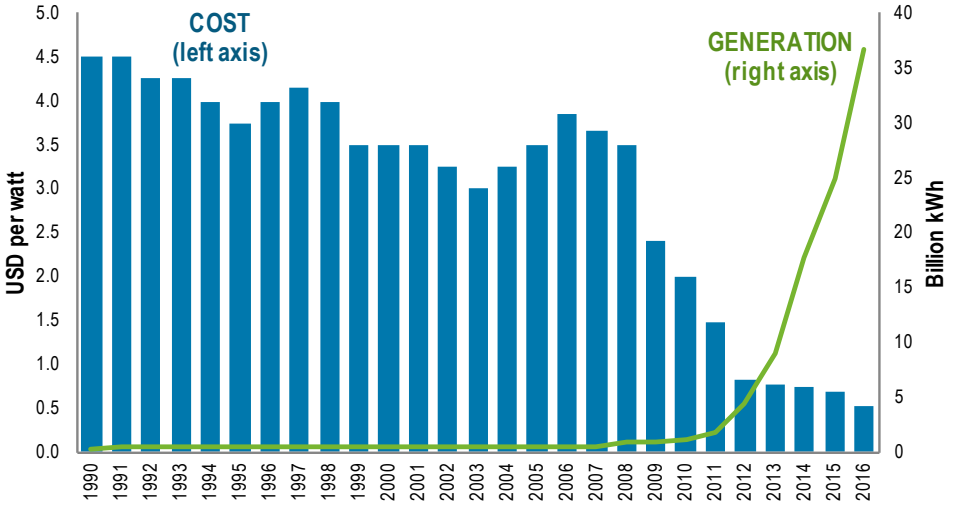
Natural gas isn't the only source of power generation that has improved its competitiveness vis-à-vis coal in recent years. Renewable energy has gotten significantly cheaper as well. That's the 3rd blow the US coal industry has suffered in domestic markets. The average cost of onshore wind generation declined 36 percent between 2008 and 2016. These cost declines, combined with federal tax incentives (the Production Tax Credit) and state renewable portfolio standards, resulted in a more than 3-fold increase in wind generation over the same period of time (figure 9). The changes in solar have been even more dramatic (figure 10). Solar PV module prices fell 85 percent between 2008 and 2016, and solar generation expanded more than 40-fold.

Figure 9: Wind Energy Costs and Generation
Cents per kWh (Left Axis) and Billion kWh (Right Axis)



Source: US Department of Energy, EIA

Figure 10: Solar PV Module Costs and Generation
Dollars per Watt (Left Axis) and Billion kWh (Right Axis)



Source: EIA, GTM Research

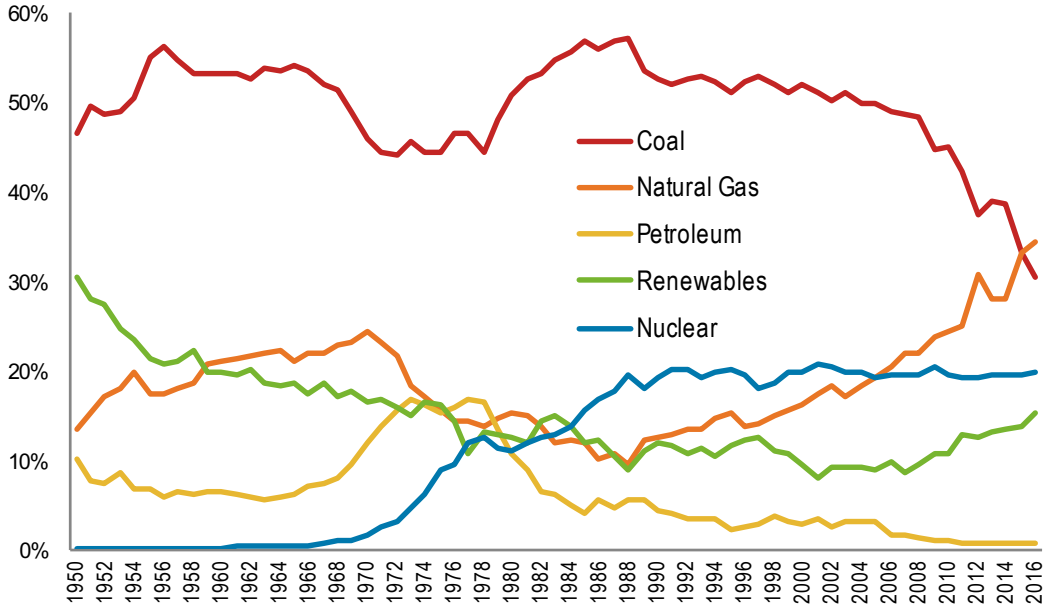
Putting It Together

How much of a role did each of these three factors—lower than expected demand, cheaper than expected natural gas, and rapid growth in renewable energy—play in the decline of US coal consumption? A precise answer to this question is difficult to obtain because it requires knowing exactly what the US energy market would have looked like absent these developments. To provide a rough estimate, we analyze the difference between the EIA's 2006 projection of US electricity generation and consumption in 2016 and actual generation and consumption that year.

The 2006 AEO projected US coal-fired power generation to grow from 1,991 billion kWh in 2006 to 2,304 billion kWh in 2016. Instead, coal plants only generated 1,240 billion kWh that year—46 percent less than expected. Holding coal's share of power generation constant, weaker electricity demand than expected in the 2006 AEO accounts for 25.6 percent of the lower-than-expected coal-fired power generation in 2016. Loss of market share to natural gas, renewables, and nuclear power accounts for the other 74.4 percent.

To attribute that 74.4 percent to specific fuels, we compared actual 2016 generation data from each of the three US electricity interconnections as reported in the EIA Form 923) with interconnect-level projections from the 2006 AEO. We explored how each fuel's share of total interconnect-level generation varied in 2016 from what the EIA had projected. Nationally, the 2006 AEO projected coal remaining at 49–50 percent of power generation through 2016, whereas it fell to 30 percent that year. Natural gas accounted for 34 percent of power generation in 2016 instead of the 20 percent projected by EIA. Renewables accounted for 15 percent instead of the previously projected 10 percent, and nuclear accounted for 20 percent instead of 18 percent. Doing this kind of analysis at the interconnect level, we estimate that natural gas is responsible for 48.9 percent of the decline in coal production nationwide, renewables (including hydro and biomass) are responsible for 17.8 percent, and nuclear is responsible for 7.7 percent.[33]

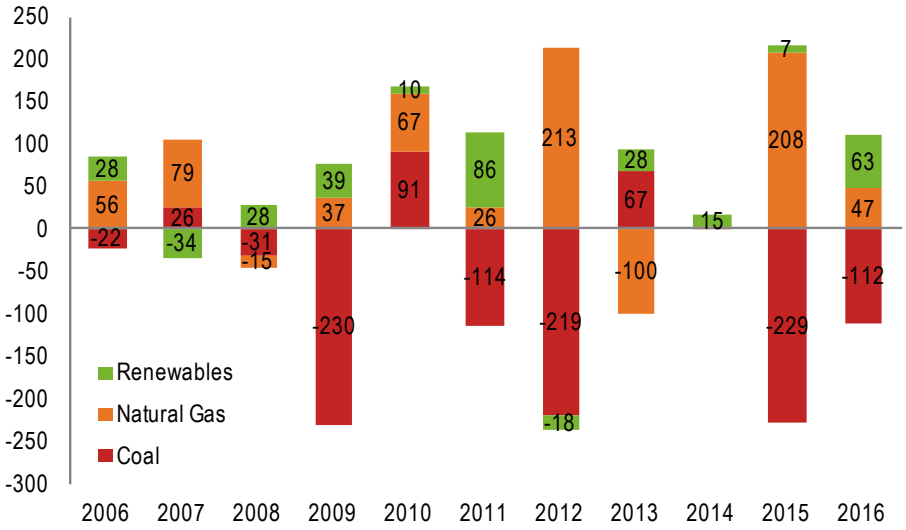
Figure 11: US Power Generation by Fuel
Percent of Total



Source: EIA

The balance between lower power demand, low-cost natural gas, and growing renewable generation in reducing coal consumption has varied year to year. In 2009, for example, coal generation fell by 230 billion kWh due primarily to the drop in total electricity consumption. Natural gas and renewables only grew by 76 billion kWh combined that year (figure 12). In 2012 and 2015, there were large price driven dispatch switches between coal and natural gas, and in 2011, 2013, and 2016, renewables added more kWh to the grid than natural gas.

Figure 12: Annual Change in US Power Generation
Year-on-Year Difference in National Generation, Billion kWh



Source: EIA

The Role of Environmental Regulations

Thus far, we've only discussed market and policy forces that have reduced electricity demand and made gas and renewables cheaper. What role have environmental regulations played in the fuel switching by making coal more expensive or prompting utilities to retire existing coal-fired power plants? The Obama administration promulgated 10 regulations that relate directly to coal mining or coal-fired power generation. We start by providing a summary of each and the EPA's estimates of its impact on US coal production below:

1. CSAPR: On June 6, 2011, the EPA finalized the Cross-State Air Pollution Rule (CSAPR) to reduce SO2 and NOx emissions.[34] In its regulatory impact analysis (RIA), the EPA estimated that the rule would reduce US coal consumption by 2 percent.[35] The EPA estimated the benefits of the rule, which included a projected 13,000 to 34,000 fewer premature deaths from air pollution each year, would significantly exceed the costs. The rule was stayed by the DC Circuit Court but ultimately upheld and took effect at the beginning of 2015. On September 7, 2016, the EPA updated CSAPR.[36] The EPA expects these updates, which take effect in 2017, to reduce US coal consumption by 0.2 percent through 2020.[37]

2. MATS: On February 16, 2012, the EPA adopted new Mercury and Air Toxics Standards (MATS) to limit mercury, acid gases, and other toxic pollution from power plants.[38] These rules have likely had some impact on US coal consumption. In the regulatory impact analysis conducted for the rule, the EPA projected that 2 percent of US coal-fired power generation capacity would become uneconomic by 2015. Because these are relatively low-

utilization plants, the RIA estimated a 1 percent decline in US coal production that year.[39] In addition to reducing neurological damage in children from mercury exposure, the EPA estimated the rule would reduce premature deaths from air pollution by 4,200 (to 11,000 per year). While the rule was challenged in court and later modified, a number of utilities had already complied.

3. NAAQS for PM: On January 15, 2013, the EPA strengthened the National Ambient Air Quality Standards (NAAQS) for particulate matter (PM), a major source of respiratory illness in the United States.[40] The EPA did not quantify the impact of this rule on US coal consumption, but we expect it to be considerably smaller than the 2012 MATS rule. This is due in part to the PM reductions resulting from the implementation of MATS and in part to the fact that the areas of the country out of attainment with the new standard lacked much coal power generation.

4. Cooling Water Intake: On August 15, 2014, the EPA adopted new discharge standards on discharge from cooling water intake systems at electric power plants and other industrial facilities. This was to protect aquatic species.[41] In their RIA, the EPA estimated a resulting reduction in US coal consumption of less than 0.1 percent through 2030.[42]

5. Coal Combustion Residuals: On April 17, 2015, the EPA promulgated new regulations on disposal of coal combustion residuals from electric utilities.[43] In its RIA, the EPA estimated the rule will reduce US coal production by 0.5 percent by 2020.[44] The EPA estimated the benefits of the rule (less neurological damage in children from mercury and lead exposure, reduced incidents of cancer, and so on) do not exceed the costs of the rule, but they were unable to monetize many of the benefits.

6. Carbon Pollution Standards for New Plants: On August 3, 2015, the EPA finalized the first ever carbon pollution standards for new, modified, or reconstructed power plants.[45] This rule effectively requires all new coal-fired power plants to be equipped with carbon capture and sequestration technology (CCS). Given low natural gas prices, though, there is little market appetite for new coal-fired power plants, with or without CCS. Indeed, in their 2015 Annual Energy Outlook, published before the EPA standards were finalized, EIA only projected one new coal-fired power plant getting built between 2016 and 2040.[46]

7. Effluent Guidelines: On September 30, 2015, the EPA established the first federal limits on the levels of toxic metals in wastewater that can be discharged from power plants. While the rule has yet to impact US coal consumption, the RIA projects a 0.6 percent decline in coal generating capacity and mining employment as a result of implementation in 2020.[47] The RIA estimated the benefits of the rule slightly outweigh the costs.

8. Clean Power Plan: No Obama administration environmental regulation has attracted more attention than EPA regulations on carbon dioxide emissions from existing power plants finalized on October 23, 2015.[48] This rule, known as the Clean Power Plan (CPP), was scheduled to take effect in 2022 but was stayed by the Supreme Court on February 9, 2016. While implementation of the CPP would certainly impact future coal demand (which we analyze later in this report), it has played no direct role in the reduction of US coal consumption and production experienced over the past few years. It is possible it has contributed to utility decisions on coal plant retirements, which we analyze in more depth below.

9. NAAQS for Ozone: On October 26, 2015, the EPA finalized new NAAQS for ground-level ozone. In their RIA, the EPA estimated that 4 percent of coal-fired power plants nationwide could be impacted by the standard by 2025, but they expect most of these plants to comply by installing pollution control technology.[49] Given the implementation time line of the rule, it has had no direct impact on US coal production or consumption over the past few years. Like the CPP, though, it might have played a role in decisions by utility executives on whether or not to retire existing coal-fired power plants.

10. Stream Protection Rule: On December 20, 2016, the Office of Surface Mining Reclamation and Enforcement finalized new regulations to address water pollution from underground and surface mining.[50] However, on February 16, 2017, President Trump signed H. J. Res. 38, which disapproved the rule before it was implemented.

Of the ten regulations listed above, only four took effect before 2016. Assuming their impact on US coal production is additive, which is not necessarily the case, they are directly responsible for a roughly 3.5 percent decline in US coal production relative to a world in which these regulations hadn't been adopted. While meaningful, it's a relatively small share of the 33 percent decline in US production that occurred between 2011 and 2016.

These are only EPA estimates, of course, of regulatory costs and consequent coal market impacts. Industry estimates of the projected costs were much higher during these rule making processes. As noted above, it's possible that even those rules that only recently took or have yet to take effect still impacted recent coal production if utility executives factored them into coal plant retirement decisions. Our ability to empirically estimate the impact of these rules is challenged by the myriad market, technological, and policy dynamics that have shaped US power markets over the past few years. However, we can use recent coal plant retirement data to create an upper bound estimate.

Between 2012 and 2015, a combined 238 coal boiler units in power plants across the country were retired, taking a combined 34 GW of power generation capacity offline.[51] Using plant-level survey data from the EIA, we quantified the average coal consumption and generation from these plants by using an average from the 3-year period prior to their closures.[52] We estimate that these retirements were responsible for a 5 percent decline in US coal generation and a 3.9 percent decline in US coal production in 2016 (relative to 2011 levels). Compared to a total coal generation decline of 28 percent and coal production decline of 33 percent during that period, the impact of coal plant retirements was relatively modest. Much more important was the reduction in overall electricity demand and the reduction in generating hours by operating coal plants because of increasingly competitive natural gas and renewable options. While some of the environmental regulations mentioned above might have modestly increased the operating costs of those coal plants still running—and thus contributed to lower dispatch—low natural gas and renewable costs also played an important role in coal retirements. We believe the latter is more significant than the former, and the 3.9 percent and 5 percent, therefore, are reasonable upper bound estimates.

It's also worth noting that past EPA regulatory cost estimates have proved more accurate than industry estimates, and EPA estimates are more often than not too high. For example, the actual costs of the Clean Air Act amendments turned out to be around 20 percent of initially projected costs by the industry, and the actual costs of the acid rain SO2 reductions were around 20–30 percent of even initial EPA forecasts.[53]

A 2014 study by the EPA's National Center for Environmental Economics found that "ex ante cost estimates are more often found to overestimate than underestimate realized costs, and in cases where industry estimates are available it appears that the regulator is often more accurate in its assessments of costs ex ante."[54] Table 2 summarizes the extensive review of existing literature in support of this conclusion that was conducted by EPA economists. As the EPA notes, however, the review was not conclusive. The paucity of ex post data means many predictions of overestimation and underestimation likely have large error bounds, and the total sample size is small and unlikely to form a representative sample of the universe of environmental rules.

In addition to the studies below, the EPA separately summarized the extensive literature assessing ex post analysis of the cap-and-trade program created by the 1990 Clean Air Act amendments to reduce SO2 emissions. Ex post analyses of this program tend to be some of the most analytically rigorous. These studies, summarized in table 2, find that the program proved far less costly than originally estimated.[55]

Table 2: Summary of Accuracy of Ex Ante Costs from Existing Studies

Authors (Date of Publication)	Description	Accuracy of Ex Ante Cost estimation
Putnam, Hayes, and Bartlett (1980)	Compare US EPA and industry ex ante estimates of capital expenditures to actual expenditures for 5 EPA regulations promulgated from 1974–1977.	In 4 of 5 cases, industry overestimated costs. In 3 of 5 cases, EPA overestimated costs.
Jantzen (1989) and RIVM (2001), as reported in Oosterhuis et al. (2006)	Evaluate costs of compliance for 8 regulations associated with the first Dutch National Environmental Plan of 1988.	Costs were overestimated ex ante for 5 regulations, but only one ex ante estimate was as much as 2 times the ex post estimate; in aggregate, ex ante was only 13 percent higher than ex post.
Office of Technology Assessment (1995)	8 OSHA regulations promulgated from 1974–1989 in the chemical, service, and manufacturing industries.	OSHA overestimated costs ex ante in every case. In 2 cases, costs might have been negative.
Hodges (1997)	Compare industry ex ante estimates to ex post cost estimates for 12 US environmental and workplace safety regulations from the 1970s to 1990s.	In every case evaluated, costs were overestimated ex ante; in 11 of 12 cases, ex ante estimates were more than double ex post costs.
Harrington, Morgenstern, and Nelson (2000)	28 US regulations promulgated by EPA, OSHA, and other regional and international regulators (13 were EPA regulations).	Total costs were overestimated for 14, underestimated for 3, and reasonably accurate (within ± 25 percent) for 11 regulations; unit costs were overestimated as often as underestimated. (For EPA regulations, 7 were overestimated costs ex ante, 2 were underestimated, and 3 were reasonably accurate.)
Anderson and Sherwood (2002)	11 vehicle emission and 6 fuel-quality US EPA regulations.	In most cases, ex ante estimates of induced price increases overestimated actual changes; EPA estimates tended to be more accurate than industry.
Thompson et al. (2002)	US consumer safety regulation requiring airbags in automobiles.	Costs estimated were reasonably accurate: ex ante exceeded ex post cost estimates by less than 5 percent.
Grosse et al. (2005)	Evaluated the accuracy of 3 different ex ante studies of a US FDA regulation to fortify cereal grains with folic acid.	Ex ante estimates overestimated costs by 3.5 to 9 times actual costs.
OMB (2005)	47 US regulations initiated between 1976 and 1995 (18 EPA regulations).	Of 40 regulations for which data were available, 16 overestimated costs ex ante, 12 underestimated them, and 12 were reasonably accurate.
McLeod et al. (2006)	8 UK regulations.	5 overestimated costs ex ante, 2 underestimated, and one was reasonably accurate (within ± 25 percent).
Oosterhuis et al. (2006)	5 EU environmental regulations.	Costs were overestimated ex ante by a factor of 2 or more in 4 cases, and they were reasonably accurate in 1 case.
Dale et al. (2009)	Used a hedonic regression approach to evaluate ex ante costs of US DOE energy efficiency regulations on consumer appliances.	Ex ante estimates overestimated costs.
National Research Council (NRC) (2012)	Evaluated EPA estimates of costs for a proposed EPA water regulation to establish nutrient criteria.	This was inconclusive since ex post data were not yet available.

Source: US Environmental Protection Agency, Retrospective Study of the Costs of EPA Regulations: A Report of Four Case Studies (2014), https://yosemite.epa.gov/ee/epa/eerm.nsf/vwan/ee-0575.pdf/$file/ee-0575.pdf.

As the EPA explained, there are many reasons why ex ante analyses tend to overestimate costs. First, cost estimates used by agencies often come from industry since it generally has the best information, but it might also overstate costs and limit estimates to existing technologies. Second, ex ante forecasts might fail to anticipate the development of new technologies or other forms of innovation to comply with regulation. Third, the long time periods it takes to finalize proposed rules might mean estimates that were timely at the start prove less accurate in regulatory processes subject to significant delay, amendment, and litigation.[56]

To be fair, economists have also found that benefits of projected rules might often be overestimated as well. This is often because the rules are implemented less fully than expected.[57]

In short, while it is difficult to empirically measure the impacts on coal of federal environmental regulation, EPA estimates in regulatory analyses suggest those impacts are likely to be quite small, and historical evidence suggests that even these EPA estimates might be overstated and are likely to be more accurate than higher cost estimates from industry. A coarse upper bound empirical estimate using recent coal plant retirement data supports this view.

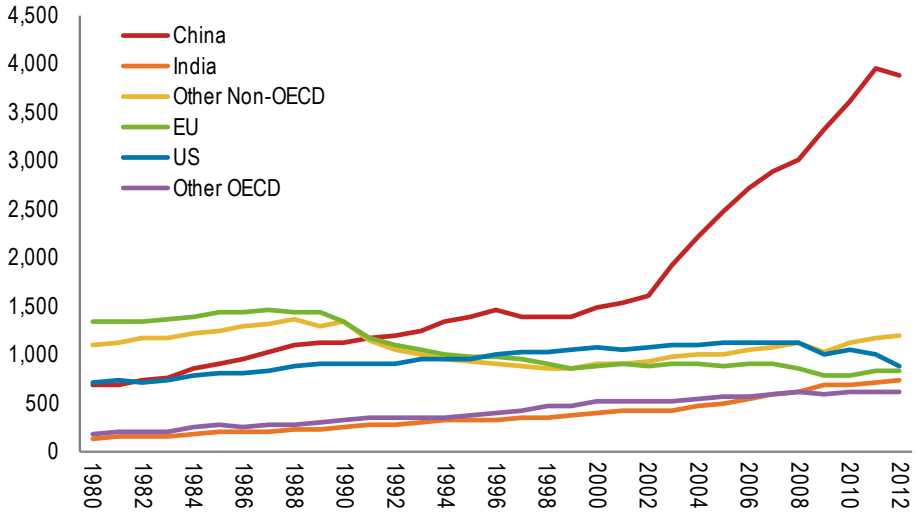
Bad Bets on China

While US coal demand is certainly on the wane, changes in coal consumption outside the United States are as much to blame for the current ills of American mining companies. Indeed, the optimism expressed by Arch Coal and others in 2011 was not out of hope for a US market renaissance but rather belief in insatiable demand in East Asia, in particular China, which would both support global coal prices and provide new export opportunities for the United States.

Chinese Demand Takes Off

Between 2001 and 2011, global coal demand grew more than twice as fast as any period since World War II. Eighty-four percent of that growth came from China (figure 13) thanks to a particularly energy-intensive period of the country's economic takeoff.[58] Incomplete reform in the financial and corporate sectors channeled a disproportionate share of Chinese investment during this period into property and infrastructure—and into factories manufacturing the building materials required for all that construction. Making building materials—steel, cement, glass, aluminum, and so forth—is incredibly energy intensive. Chinese energy demand grew by 250 percent between 2001 and 2011 due primarily to growth in heavy industry, and the vast majority of this growth was fed with coal.

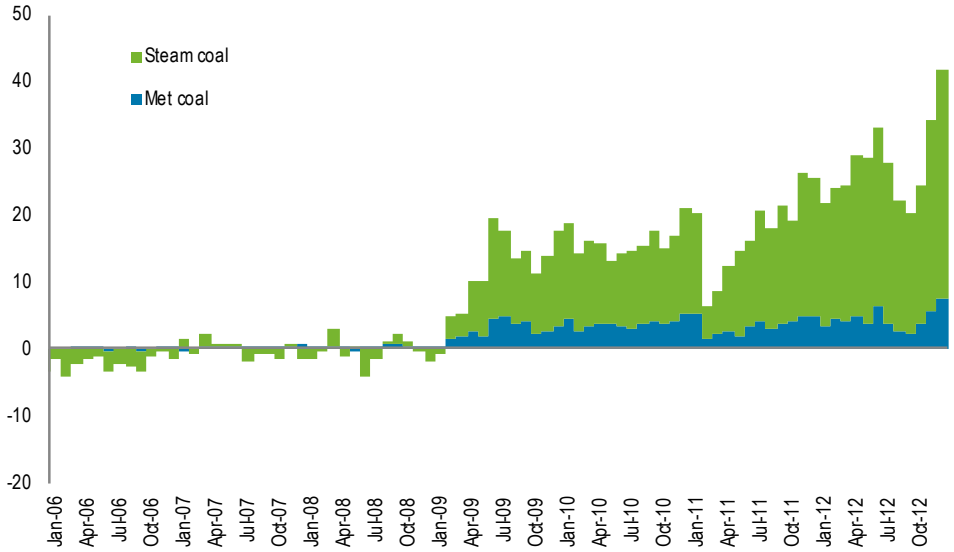
Figure 13: Global Coal Consumption by Country
Million short tons



Source: EIA

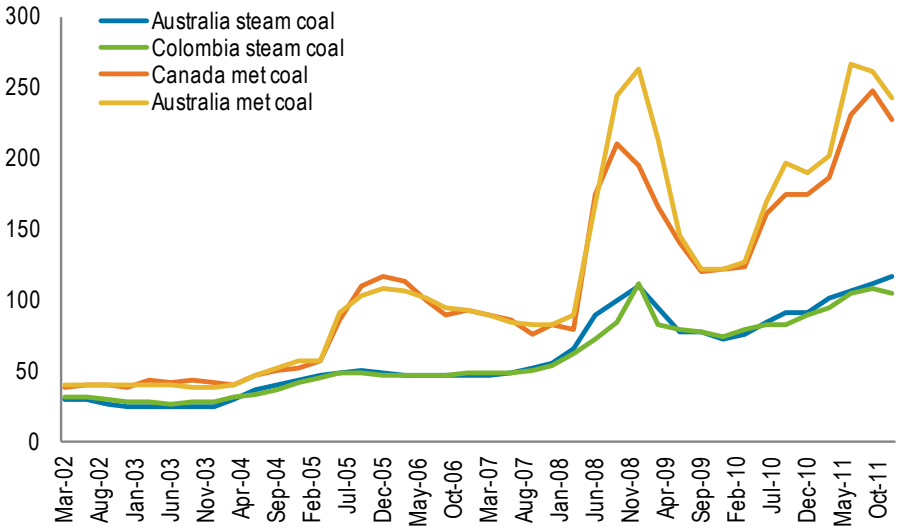
China has reasonably large domestic coal reserves and, for most of the 2001–2011 take-off period, was able to meet domestic demand with domestic supply (and even have a little left over to export). Unfortunately, most Chinese coal reserves are in interior provinces, and by 2009 Chinese rail capacity was inadequate to get that coal to demand centers along the coast. The price of domestic coal transportation grew considerably, prompting coastal power plants and industry to turn to imports (figure 14). In 2008, China ran balanced trade in coal. By 2011, it was importing 210 million tons on net—more than any other country on earth.

Figure 14: Net Chinese Coal Imports
Million metric tons, steam and metallurgical



Source: CEIC

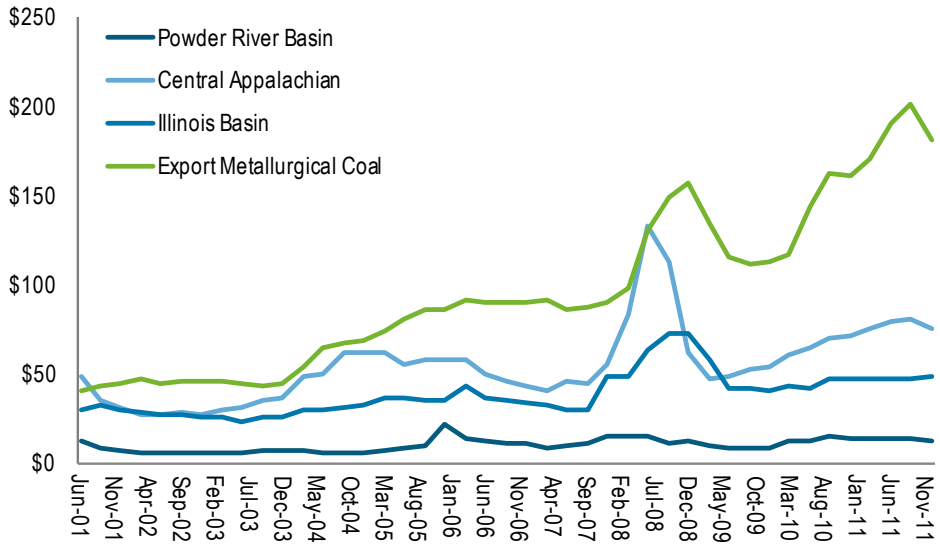
Figure 15: Seaborne Coal Prices
Dollars per metric ton



Source: Bloomberg

The United States has not traditionally been a large coal exporter. Indeed, most US reserves are relatively far from port. The exception is Appalachia, which has reasonably good access to East Coast coal terminals and occasionally ships coal into the Atlantic Basin when prices are attractive enough. That's what happened in response to the China-driven seaborne coal market boom. Metallurgical coal prices in the eastern United States rose alongside global prices, and steam coal prices increased as well (figure 16). US exports grew from 40 million tons in 2002 to 126 million tons in 2012. While only 12 percent of this growth was actually shipped to China, it was China-driven growth in global coal prices that made US exports to closer markets in Europe and Latin America commercially viable. Both higher coal prices and increased export sales helped boost the share price of US mining companies and contributed to the uptick in mining employment discussed above.

Figure 16: US Coal Prices
USD per ton



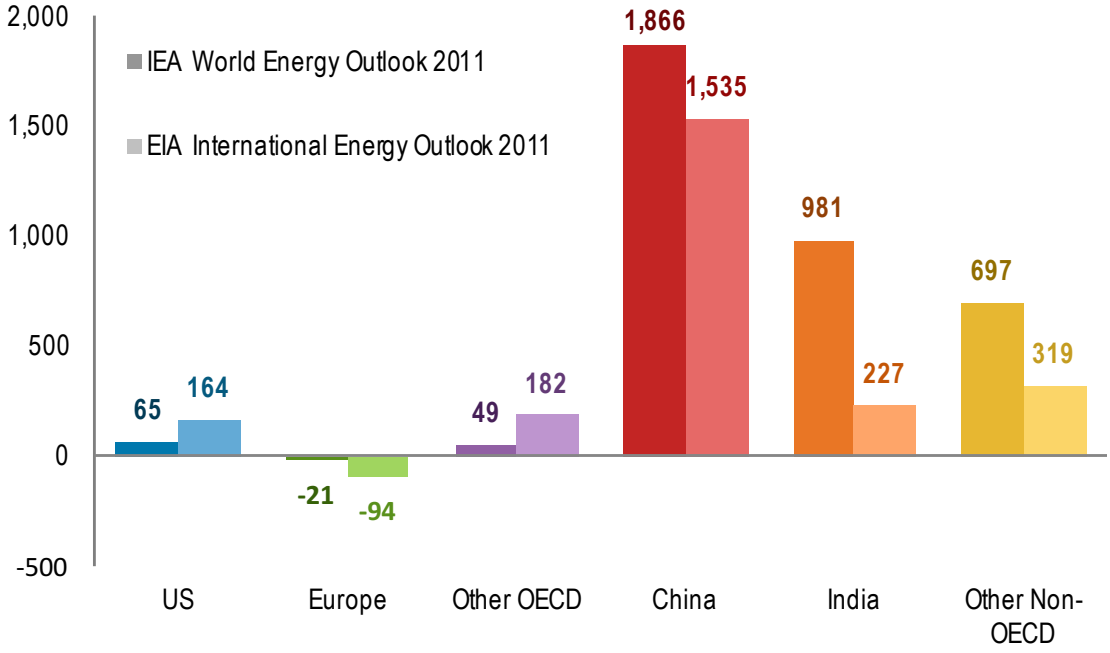
Source: EIA

Hoping the Ride Never Stops

Near the peak of the market in 2011, US coal companies expected rapid growth in Chinese demand to continue. The International Energy Agency (IEA) that year projected Chinese coal demand would grow by another 1.9 billion tons by 2030 (figure 17). The EIA projected 1.5 billion tons of additional Chinese demand. The outlook for Indian coal consumption was also rosy, along with a handful of other countries in Southeast Asia and the Middle East.

So they made two big bets. The first was that demand for metallurgical coal would continue to be strong and justify high-cost mining investments from the United States to Australia. Walter Energy, Arch Coal, Alpha Natural Resources, and Peabody all made expensive acquisitions of metallurgical coal companies in 2011 (table 3). These four acquisitions alone totaled almost US$19 billion—more than half the total market value of those four companies at the beginning of that year.

Figure 17: Projected 2010–2030 Coal Demand Growth in 2011
Million short tons



Source: EIA, IEA

Table 3: Metallurgical Coal-Oriented Acquisitions
2011 deals

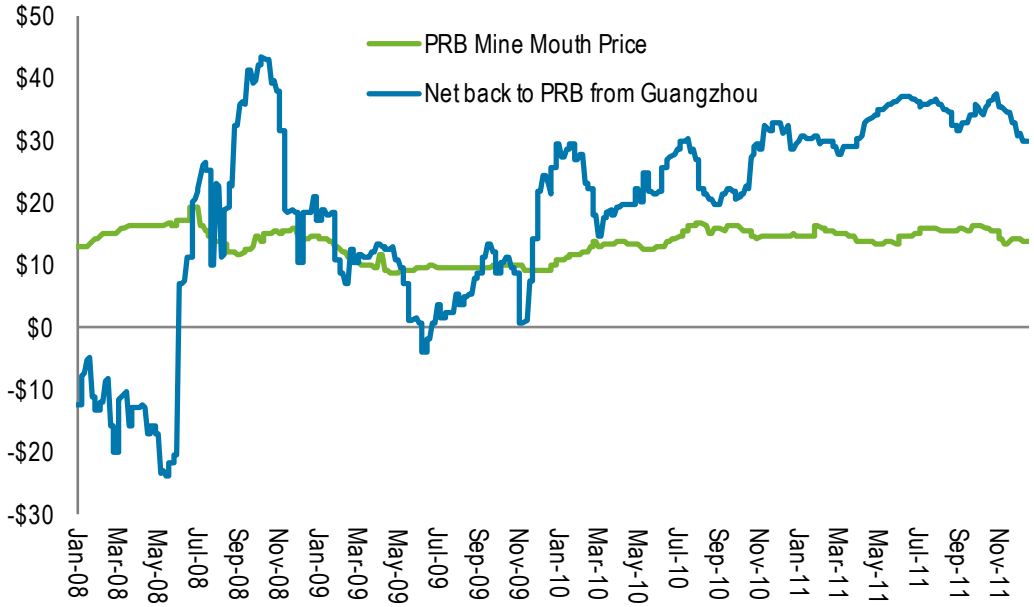
Acquiring Company	Purchased Company	Acquisition Date	Announced Price ($Billion)
Walter Energy	Western Coal	4/1/2011	$3.3
Arch Coal	International Coal	6/15/2011	$3.4
Alpha Natural Resources	Massey Energy Co.	6/1/2011	$7.1
Peabody Energy	Macarthur Coal	12/20/2011	$5.1

Source: EIA, IEA

The second was that Asian markets would have an appetite for low-sulfur Powder River Basin (PRB) coal—which needed new West Coast ports to export cost effectively. Sitting in landlocked Montana and Wyoming, The PRB accounts for over one-third of total US coal reserves and is some of the world's cheapest coal to extract. Wyoming and Montana are distant from East Coast terminals generally used for coal exports. Four seaports—New Orleans, Mobile, Norfolk, and Baltimore, accounting for 86 percent of total coal exports in 2011—were at capacity that year due to growing demand for US metallurgical coal. And none were close enough to make exporting coal from the PRB cost effective.

While there were three terminals on the West Coast, they were used largely to export Canadian metallurgical coal. To compete in the Asian seaborne market, PRB coal needed its own West Coast terminals. And given high delivered steam coal prices in Asia in 2011, new terminals seemed like a pretty good investment. Mine mouth prices in the PRB generally range from $10 to $15 per metric ton. To calculate the commercial viability of exporting PRB coal to Asia, we calculated "net back" pricing from the southern Chinese port of Guangzhou, which is China's largest demand center (figure 18). Our net back calculation subtracts shipping costs, port fees, and value-added taxes to get an estimate of what a PRB producer could charge at the mine mouth and still be competitive once delivered to Guangzhou, adjusted for coal quality. Chinese coal prices, port fees, taxes, and domestic shipping costs are taken from the National Bureau of Statistics and other Chinese government and industry association sources. The cost of shipping coal from the West Coast to China is derived from weekly dry bulk shipping cost indices reported by Bloomberg for routes of comparable distance. The cost of shipping coal from the PRB to the West Coast is more speculative. We use an estimate of $30 per ton based on conversations with industry sources.

Figure 18: The Competitiveness of PRB Coal in Asia
USD per metric ton



Source: Bloomberg, CEIC, EIA, RHG Estimates

Using these assumptions, PRB coal looked highly competitive in Asian markets in 2010 and 2011. Netback prices averaged $33 per ton, more than twice the $14 per ton PRB miners averaged selling to the domestic market during that period. In response, Arch Coal, Peabody, Ambre Energy, and Cloud Peak Energy and other companies started working with terminal developers to plan new West Coast export capacity. By the end of 2011, there were six new terminals proposed for the West Coast, with a combined 138 million short tons of export capacity (table 4).

Table 4: Proposed Export Terminals

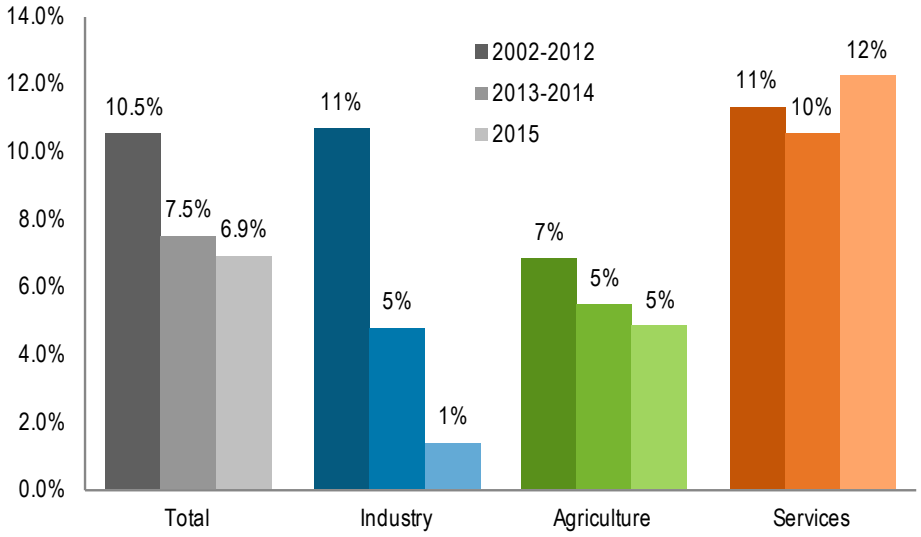
Project Name	Location	Company	Capacity (million short tons per year)
Millennium Bulk	Longview, WA	Millennium Bulk, LLC	44
Morrow Pacific	Port of Morrow, OR	Ambre Energy	8
Port Westward	Clatskanie, OR	Kinder Morgan	22
Gateway Pacific	Bellingham, WA	SSA Marine	48
Coos Bay	Port of Coos Bay, OR	Metro Ports	11
Grays Harbor	Port of Grays Harbor, OR	RailAmerica	5

Source: Bloomberg, PR Newswire

The China Boom Comes to an End

Shortly after US coal companies made their big bets on rapid Chinese coal demand continuing, the China-led global commodities rally started to unwind. Chinese GDP, which had grown at 10.5 percent per year, on average between 2002 and 2012, slowed to 7.5 percent growth in 2013 and 2014 (figure 19). More importantly, the structure of Chinese growth started changing as the country began shifting away from the heavy industry-oriented investment boom that defined the 2002–2012 period to more high-end manufacturing and service sector activity. Industrial GDP growth slowed from the 11 percent average between 2002 and 2012 to a 5 percent average in 2013 and 2014 and only 1 percent in 2015. Service sector GDP, on the other hand, grew faster in 2015 than the 2002 to 2012 average.

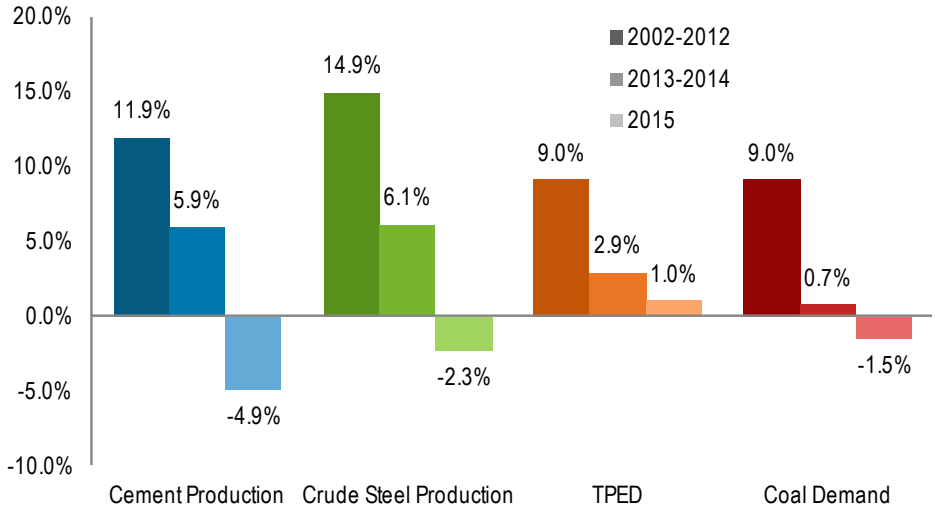
Figure 19: Chinese GDP Growth by Sector
Percent



Source: World Bank, CEIC, RHG estimates

The energy implications of this shift were dramatic. Less investment in property and infrastructure meant less demand for energy-intensive building materials. Cement production growth fell from an 11.9 percent annual average between 2002 and 2012 to 5.9 percent in 2013 and 2014 and -4.9 percent in 2015 (figure 20). Average annual steel production fell from 14.9 percent 2002–2012 to 6.1 percent 2013–2014 and -2.3 percent in 2015. Given the outsized role these and other heavy industrial sectors play in Chinese energy consumption, total primary energy demand (TPED) growth fell from a 9 percent average between 2002 and 2012 to 2.9 percent in 2013 and 2014 and 1 percent in 2015. Coal demand flatlined in 2013 and 2014 and fell by 1.5 percent in 2015—a dramatic change from the 9 percent average annual growth experienced between 2002 and 2012. Preliminary Chinese data suggests that coal consumption fell by another 1.8 percent in 2016 (heat content adjusted).

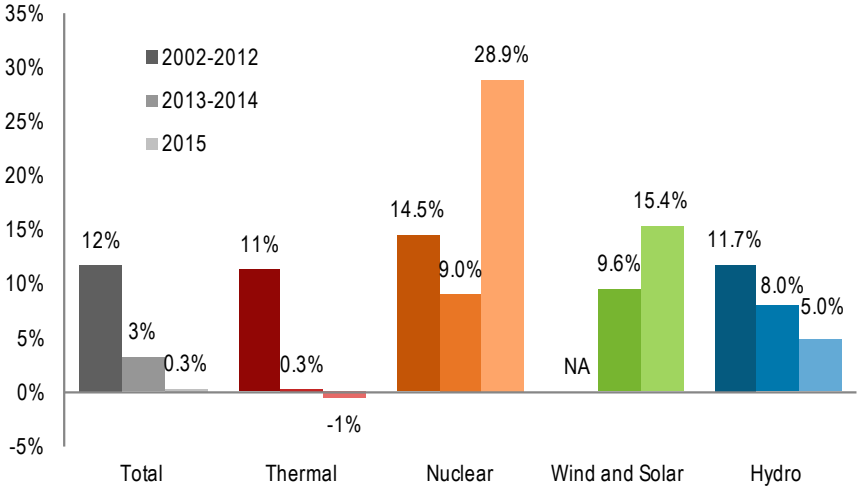
Figure 20: The Energy Implications of Chinese Rebalancing
YoY growth, percent



Source: CEIC, RHG Estimates

Exacerbating the impact of slower overall energy demand on Chinese coal consumption has been the growing competition from nuclear and renewables. Between 2011 and 2015, China added more solar capacity to the grid than any other country and almost as much wind capacity as the rest of the world combined.[59] While incomplete electricity regulatory reform has depressed utilization rates of this new capacity, wind and solar generation grew by 9.6 percent a year on average between 2013 and 2014 and 15.4 percent in 2015 (figure 21). China also accounted for 99 percent of the global increase in hydropower generation and added more nuclear power than anywhere else. This played an even greater role in displacing coal-fired power generation. After a decade of double-digit growth, Chinese thermal power generation (primarily coal) slowed to a crawl in 2013 and 2014 and declined by 1 percent in 2015.

Figure 21: Crowding Coal out of the Market
Chinese electricity generation growth, YoY



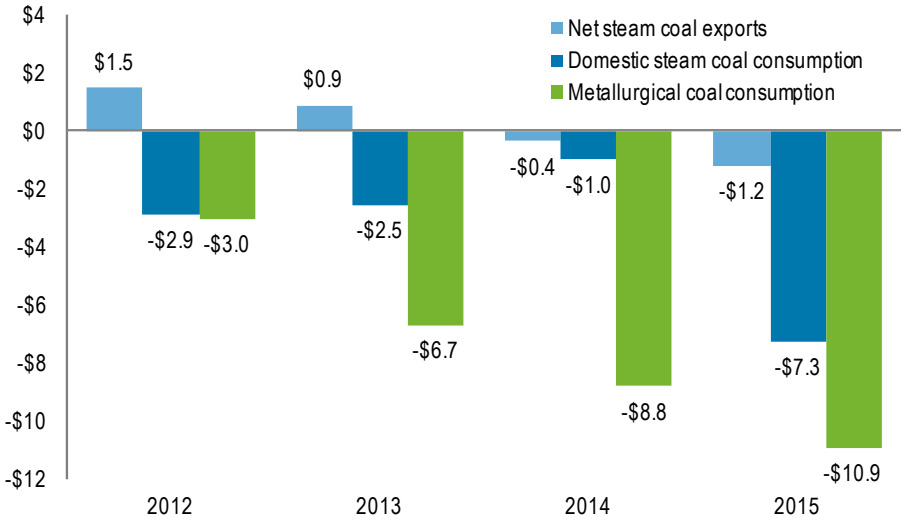
Source: CEIC

Implications for the United States

This slowdown in China sent shockwaves through global coal markets that reverberated within the United States. Seaborne metallurgical prices fell from more than $260 per ton in 2011 to less than $90 a ton by the end of 2015. Steam coal prices fell from more than $110 per ton to less than $60. The drop in metallurgical coal prices was particularly painful for US producers. Total US production revenue fell by $19.4 billion between 2011 and 2015 (figure 22). Of that decline, 56 percent was due to the decline in metallurgical coal revenue, due primarily to lower prices and fewer exports. Another 6 percent was from a drop in steam coal exports. Only 38 percent was due to the decline in domestic steam coal consumption.

To sum up, more than half of the decline in US coal company revenue between 2011 and 2015 had little to do with domestic market conditions or domestic regulations but was rather due to a dramatic slowdown in Chinese demand for metallurgical coal used to produce the steel that fueled China's industrial boom.

Figure 22: US Coal Producers Take a Hit
Change in revenue for US coal producers relative to 2011, billion USD



Source: EIA, Bloomberg, RHG estimates

Compounding woes for US coal companies were the investments they had made in metallurgical coal production assets outside the United States, which also suffered. By 2015 the amount of debt they had taken on to finance these investments far, far exceeded their market capitalization. Walter, Arch, Alpha, and Peabody all filed for bankruptcy. Two of these companies—Peabody and Arch—were equity investors in proposed West Coast coal export terminals. Their bankruptcies make these projects much harder to finance. In addition, the collapse in Asian coal prices has dramatically changed the economics of PRB exports. Our estimated netback from Guangzhou to the PRB fell from a high of $36 per ton in 2011 to -$4 per ton by the end of 2015.

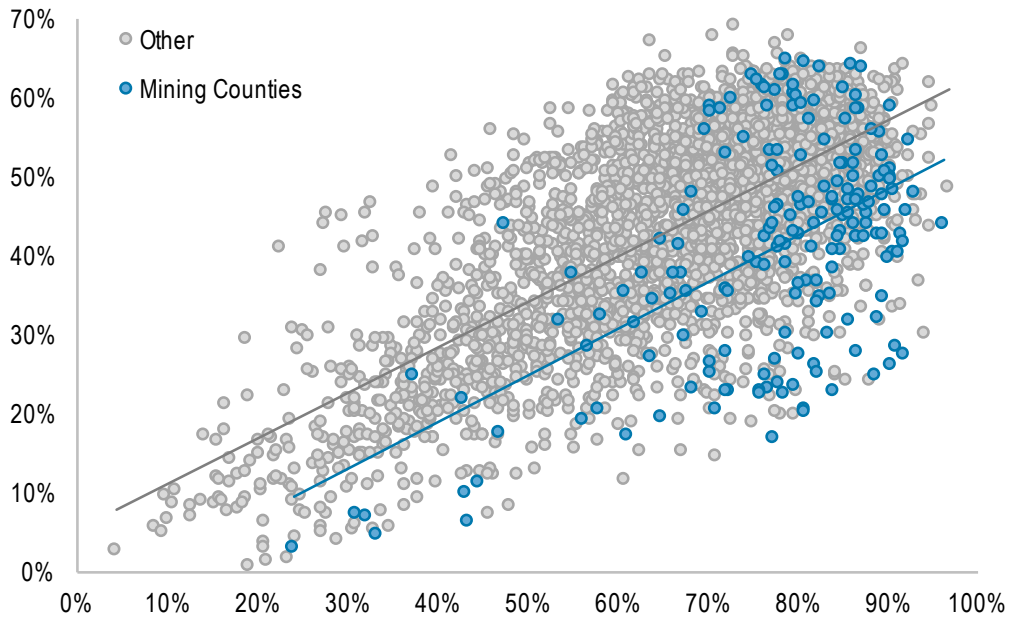
Five of the six proposed West Coast export terminals have now been cancelled. Cloud Peak Energy, the only PRB producer who has been exporting at any scale, stopped selling abroad in 2015 because they were losing money doing so. They had take-or-pay contracts with terminal operators, but it became cheaper for Cloud Peak to pay terminals the contractually obligated amounts than to use them to export coal. Seeing little respite on the horizon, Cloud Peak renegotiated their contractual obligations, electing to make one upfront payment to reduce the potential $454 million owed to the terminal.[60] The terminal operator and Cloud Peak agreed to meet on a quarterly basis to reassess the market conditions.

THE PROSPECTS OF RECOVERY

Donald Trump campaigned on a promise to roll back environmental regulations adopted by the Obama Administration and bring about a renaissance in US coal production and employment. These promises resonated in coal country. Trump's highest electoral margins were in Wyoming (+46%) and West Virginia (+42%), the states with most coal mining per capita in the country.[61] In Campbell County, Wyoming, where most PRB mines are located, Trump won twelve times more votes than Hillary Clinton. In Mingo County, West Virginia, in the heart of the southern coalfields, he won six times more votes.

By and large, coal country was in Trump's demographic sweet spot even if mining was off the table. The dominant factor in determining whether a county went for Trump in the 2016 election was the share of its population that was white, non-Hispanic, without a college degree. Figure 23 shows this relationship and breaks out counties where mining is responsible for more than 10 percent of total per capita income. Mining here includes all minerals, whether coal, oil and gas, uranium, or copper, because coal-specific county data is not available. Mining counties have a higher concentration of non-college-educated white voters than the national average. But controlled for demographics, mining countries were more like to vote for Trump than their non-mining counterparts.

Figure 23: Trends in Trump Voting
Trump share of two-party vote (X axis) vs. share of population that was white / non-Hispanic w/o a college degree



Source: Census, Election Atlas, and authors' estimates

What are the odds Trump will succeed in turning his campaign promise—which he has reiterated since inauguration—into reality? Early backer and coal mining CEO Bob Murray urged him to set more modest goals during the campaign and has warned postelection that there is little chance US production can return to prerecession levels. Senate Majority Leader Mitch McConnell has also dialed down his rhetoric, cautioning that ending the "War on Coal" might not actually bring jobs back to his home state of Kentucky.

But the president appears intent on trying. His first act after inauguration was to call for a freeze on all new regulations pending review, including those from the Environmental Protection Agency.[62] One of the first substantive pieces of legislation he signed was a Congressional joint resolution disapproving the Department of Interior's Stream Protection Rule finalized by the Obama Administration in 2016 that would have limited the amount of mining waste coal companies can dispose into streams and waterways.[63] Then on March 28, he signed an Executive Order (EO) calling on EPA to "review" the Clean Power Plan, the agency's CO2 standards for new power plants and EPA methane regulations for oil and gas production. The EO directs the Department of Interior to lift President Obama's moratorium on federal coal leasing and "suspend, revise or rescind" regulations on oil and gas production on federal lands. The EO also directs the Council on Environmental Quality to rescind its guidance to agencies to incorporate climate change considerations in NEPA reviews and directs agencies to revert to a Bush-administration estimate of the "Social Cost of Carbon."[64]

Many of these actions will take months for agencies to implement and will be challenged in the courts. But they are clearly designed to communicate Trump's commitment to deliver on his campaign promises. Indeed, he signed his March 28 EO at the EPA in front of a group of coal miners, and after signing, turned to them and said, "C'mon fellas. You know what this is? You know what this says? You are going back to work."[65]

Early Signs of Success?

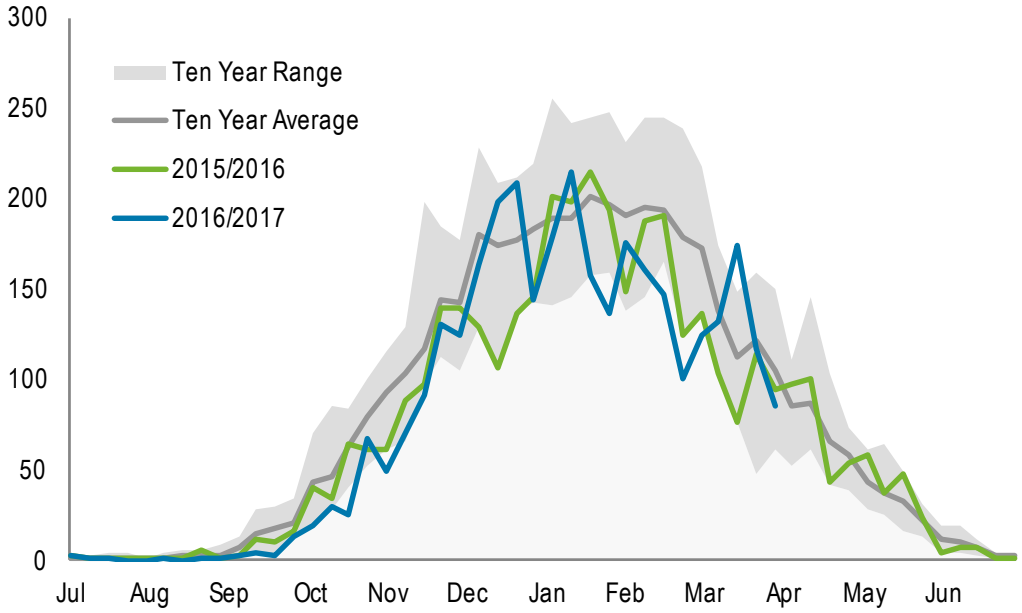
An Uptick in Domestic Demand

Short-term US coal consumption is primarily determined by the price of natural gas. As mentioned earlier, power generation accounts for more than 90 percent of US coal consumption. When natural gas prices fall, natural gas–fired power plants outcompete coal-fired power plants in wholesale markets. Only 39 percent of natural gas demand, however, comes from the power sector. A significant share (31%) is used for heating and cooking in residential and commercial buildings. When heating demand increases, natural gas demand does as well, and with it natural gas prices.

And that's exactly what happened in the weeks following Donald Trump's election. After an atypically warm summer and fall, temperatures started plummeting in early December. National Heating Degree Days (HDD), weighted by population, were higher in December than their 10-year average and considerably higher than at the same time period in 2015 (figure 24). This has boosted residential and commercial natural gas demand and pushed up natural gas prices. Higher natural gas prices made coal more competitive for power generation and power sector coal consumption started trending up towards the end of the year (figure 25).

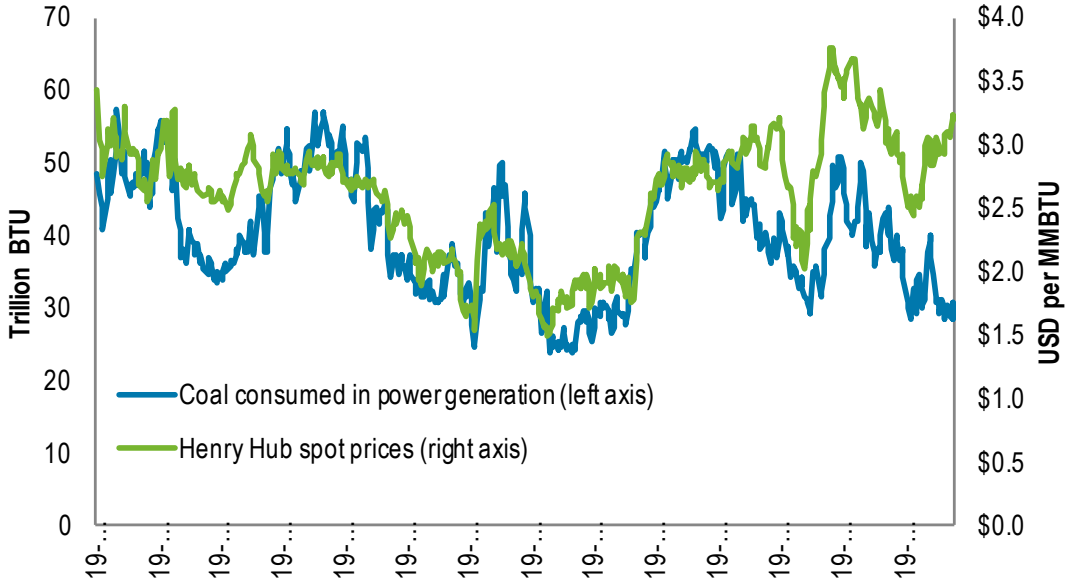
National HDDs fell below average in parts of January and February but increased again in March, pushing gas prices up above 2016 levels. On average, Q1 natural gas prices at Henry Hub were 52 percent above the same period in 2016 and among power plants tracked by GenScape, coal consumption was 7 percent higher. When nationwide first quarter coal demand numbers are released from the Mine Safety and Health Administration in May, they will likely show a modest production recovery.

Figure 24: Weather-Driven Gas Demand
Heating degree days, population weighted



Source: NOAA

Figure 25: Natural Gas Prices and Coal Consumption
Genscape coal consumption survey and Henry Hub spot natural gas prices



Source: Genscape and Bloomberg

A Supply-Driven Rally Abroad

The global market has recovered a little as well. The downturn in Chinese consumption over the past few years hit Chinese coal communities and companies, as well as those in the United States and other exporting countries. There has yet to be the same wave of bankruptcies and consolidation among Chinese firms that we've seen in the United States. Beijing is worried that allowing coal companies to go bankrupt will set off cascading defaults throughout the financial system and that the resulting layoffs will lead to social unrest. As a result, they have begun intervening in the market to try to keep that from happening.

At the end of 2015, current liabilities of the Chinese coal industry totaled 2.3 trillion RMB (334 billion USD). Without outside help, the industry had no feasible way of servicing this level of debt. Coal revenues had been declining for the entire industry since 2013 with a 22 percent drop in 2013 alone. To keep the lights on, miners relied on private lenders, trust companies, local governments, local banks, and the big four state-owned banks for credit. From the shadow banking industry to large SOEs, the Chinese financial system faced (and faces) significant exposure to bad debts originating from the coal sector.

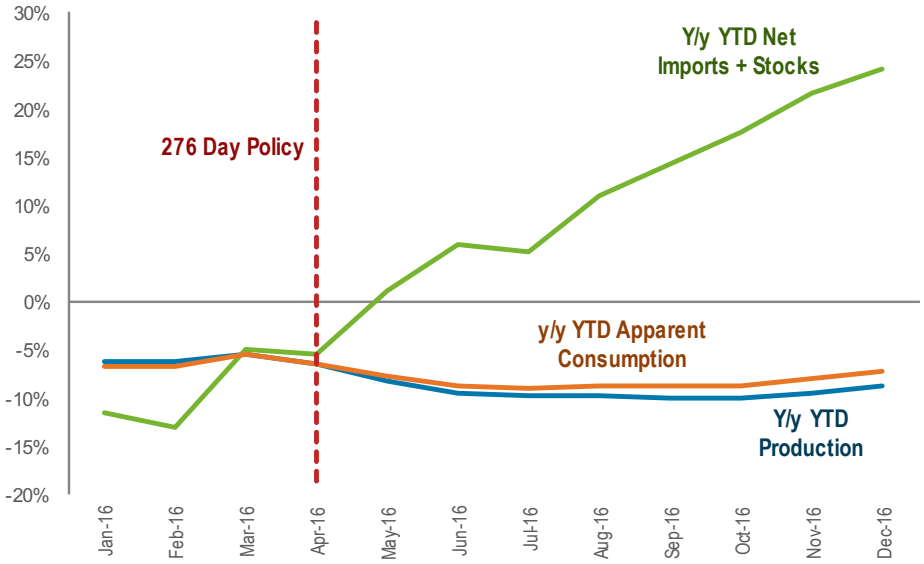
As revenues declined and debts piled up, it became clear the coal industry wouldn't be able to dig out. Given the level of exposure within China's financial system, a collapse in the coal sector threatened a broader contraction at a time when economic growth was already slowing. Coal prices continued to decline and along with them coal company revenue. Companies couldn't afford to pay their workers, and the number of coal industry protests spiked as workers demanded their employers pay up. This suggested that widespread defaults weren't far off.

Hoping to prevent this, the People's Bank of China announced in March of 2016 that debt-to-equity swaps—where nonperforming loans were exchanged for equity in coal companies—would be used to alleviate debt. Beijing rolled out other measures like forced renegotiation of debt terms, all with the goal of allowing firms to remain solvent and preventing a chain reaction of defaults.

These measures had limited effectiveness. So in April, China's State Administration of Work Safety instituted a policy stipulating that mines could only work the equivalent of 276 days a year, reduced from 330. By constraining production, Beijing successfully pushed coal prices up. So while production fell by 9 percent in 2016 (in physical terms, not heat content adjusted), miners' profits were up an astounding 170 percent year-on-year in 2016. This enabled coal companies to continue to pay their lenders, thus successfully preventing financial system risk from widespread coal defaults. With more money in the bank, coal companies were able to pay workers and avoid widespread layoffs.

Beijing's intervention also had some unintended consequences for China's coal trade position. Supply cuts left Chinese producers flatfooted when cold winter weather led to an increase in coal demand. Imports and stock withdrawals filled in the gap (much to the delight of beleaguered international coal producers). 2016 imports were up 25 percent over 2015 (figure 26).

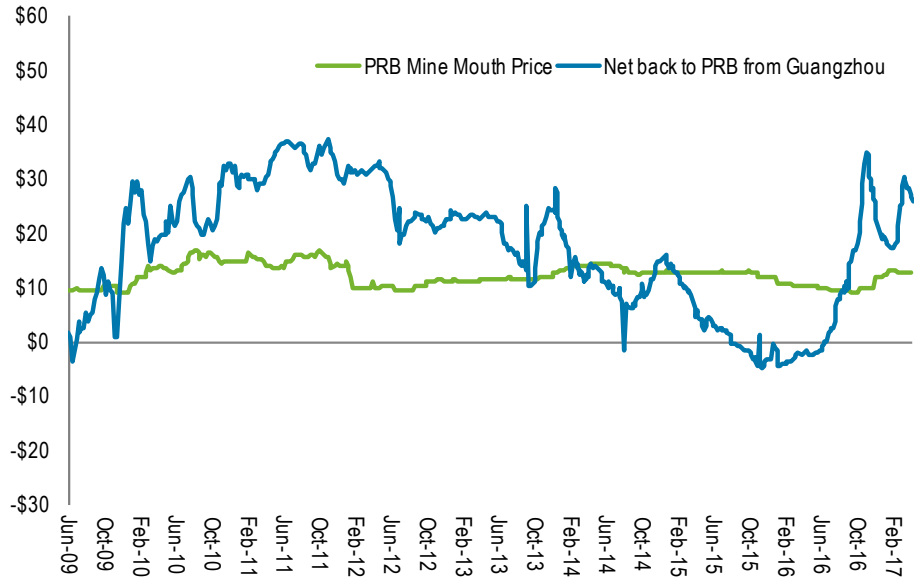
Figure 26: Apparent Consumption, Production, and Net Imports
Year-on-year change



Source: CEIC and RHG estimates

Higher global coal prices have brought some relief to metallurgical and export-oriented Appalachian mines. US production increased quarter-on-quarter during the last six months of the year, and 1,459 jobs were added after nine straight quarters of decline. Higher prices have also made PRB exports competitive again, with net-backs higher than mine mouth prices during the fourth quarter of last year (figure 27). This prompted Cloud Peak to resume exports on a limited basis, though proposed export terminals remain frozen. Australian mining outages due to flooding have also contributed to a recovery in global metallurgical coal prices.

Figure 27: The Competitiveness of PRB Coal in Asia
USD per metric ton



Source: Bloomberg, CEIC, EIA, RHG estimates

The Domestic Coal Market Implications of Trump's Policy Agenda

Looking beyond short-term energy market dynamics, how effective will President Trump's policy plans in bringing about a recovery in US coal demand? To answer this question, we modeled the impact of the regulatory rollback called for in his March 28 EO using RHG-NEMS, a version of the EIA's National Energy Modeling System[66] used to produce the Annual Energy Outlook, maintained by Rhodium Group. For this analysis, we assume that the following regulations are completely removed in 2017:

- EPA's CO2 standards for new power plants
- EPA's CO2 standards for existing power plants (the "Clean Power Plan")
- EPA's methane regulations for new oil and gas production
- BLM's methane regulations for both new and existing oil and gas production on federal lands
- DOI's coal leasing moratorium on federal lands

It is not yet clear whether the relevant agencies will completely remove these regulations or rather seek to modify them. Either will elicit legal challenge from progressive states and environmental groups. But our analysis presents an upper-bound estimate on what Trump will be able to deliver to coal miners through his recent executive order.

We started our analysis with the energy price and macroeconomic assumptions included in EIA's 2017 Annual Energy Outlook.[67] In this forecast, natural gas prices rise to $3.40 per MMBTU in 2018, $4.51 in 2020 and 2025, and $5.00 in 2030 (all in real 2016 USD). At these prices, coal consumption rises between 2016 and 2020, even under policies already adopted by the Obama Administration or in the proposal stage. But consumption then declines starting in 2020 as the Clean Power Plan (CPP) drives more natural gas and renewables into the electric power sector at coal's expense (figure 28). Assuming the CPP is implemented on time and by all states, US coal demand falls to 704 million short tons in 2025 and 608 million short tons in 2030.

With these energy price assumptions, if Trump's EO is fully implemented, US coal consumption rises to 815 million short tons in 2025 and 834 million short tons in 2030. That's still lower than US consumption was at any time between1987 and 2014 and still 26 percent below the 2007 peak. But it is a 111 million ton—or 16 percent—increase relative the Obama policy baseline in 2025, and a 226 million ton—or 37 percent increase—in 2030.

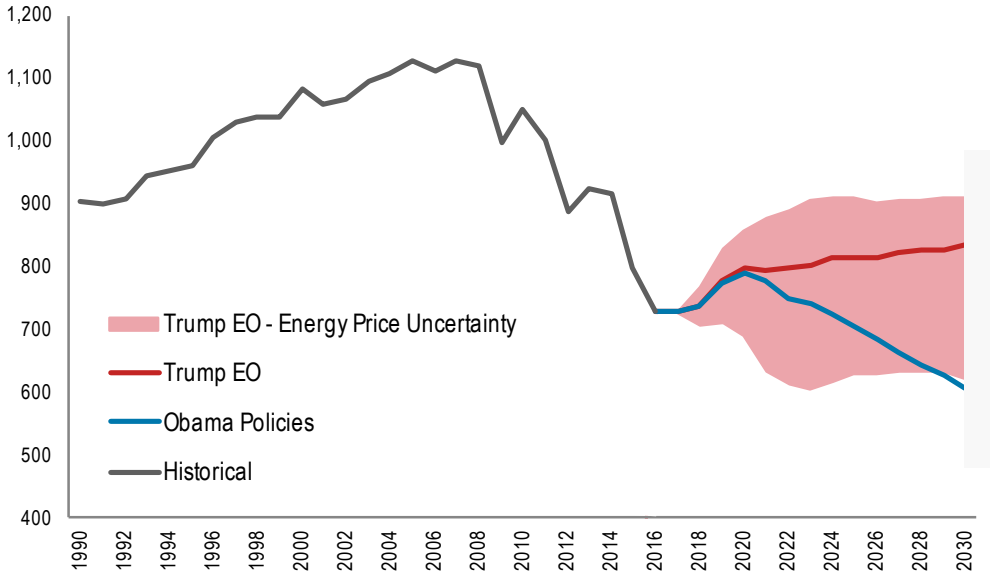
This outlook is highly sensitive to natural gas prices and renewable energy costs. To capture energy market uncertainty, we explored a range of potential scenarios. For natural gas, we modeled the impact of Trump's EO in a world where the US shale resource base proves cheaper and larger than currently expected. As a result, natural gas prices increase more modestly—to $3.12 per MMBTU on average in 2018, $3.52 in 2020, $3.41 in 2025, and $3.64 in 2030. We also modeled the impact of the EO in a future where the shale resource base proves smaller and more expensive than currently expected and natural gas prices at Henry Hub rise to $3.68 per MMBTU in 2018, $5.39 in 2020, $7.12 in 2025, and $7.95 in 2030.

For renewable energy, we modeled the impact of Trump's EO in futures where wind and solar costs evolve as currently projected in the 2017 Annual Energy Outlook. We also modeled the impact in a future where wind and solar prices are 23 percent and 60 percent lower in 2025 respectively than in the 2017 AEO. This is in line with the National Renewable Energy Laboratory's most optimistic cost projections.[68]

The impact of this energy price uncertainty is shown in figure 28. In the worst-case scenario for US coal industry that we modeled, consumption falls from 730 million short tons in 2016 to 688 million short tons in 2020 despite Trump's aggressive rollback of Obama administration climate regulations. Consumption bottoms out at 606 million tons in 2023 before recovering slightly to 623 million tons in 2030. Lower natural gas prices are responsible for the majority of this decline. Cheaper wind and solar have a more modest impact. Conversely, under our highest natural gas and renewable energy price assumptions, US coal consumption recovers from the current low of 730 million short tons to 859 million tons in 2020, 909 million tons in 2025, and 910 million tons in 2030.

The bottom line is that for the next few years, natural gas prices and, to a lesser extent, renewable energy costs will play a far greater role in determining US coal consumption than President Trump's deregulatory agenda. By 2025, the impact of regulatory rollback could be material but could still be overwhelmed by the impact of cheaper natural gas. In the best-case scenario for US coal consumption under President Trump in which natural gas prices more than double from current levels, demand would plateau at 19 percent below 2007 levels. In the worst-case scenario, coal consumption could drop below levels currently projected under Obama administration policies in 2025 and rival those levels in 2030.

Figure 28: US Coal Consumption under Obama's Policies and Trump's Proposals
Million short tons



Source: EIA and RHG estimates

The Global Outlook for US Coal

The End of the Chinese Commodities Cycle

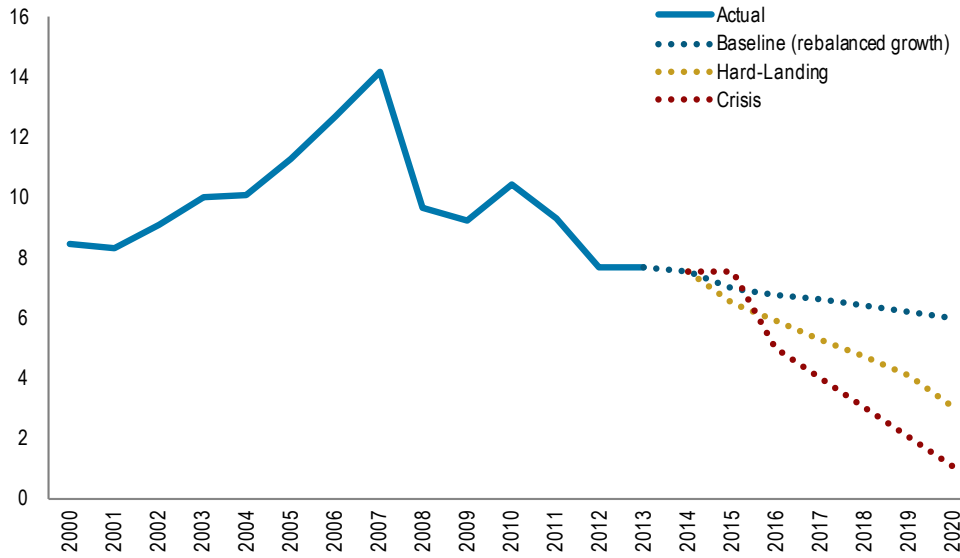
Even if potential changes in domestic policy do not bring coal back to its prior consumption levels, could a recovery in global markets lead to a renaissance in US production and employment? As described above, in recent years, strong Chinese coal demand, especially for metallurgical coal, boosted world prices and coal firm revenues, and China also provided a growing market for US coal exports.

The recent rally in global prices is unlikely to be sustained, however. Beijing increased the number of working days back to 330 in November to prevent foreign firms from benefiting from monopoly pricing intended to exclusively help domestic producers, which will result in an increase in domestic Chinese supply.

More importantly, China is past the energy-intensive part of its development trajectory. Rapid demand growth isn't going to return. In an October 2014 report for the Asia Society in New York called "Avoiding the Blind Alley," Daniel Rosen of Rhodium Group laid out three scenarios for future Chinese growth. With aggressive economic reform, Rosen predicted it would be possible for China to achieve a soft landing with headline economic growth decelerating gradually to 6 percent in 2020. But the reform required to achieve this pathway would significantly accelerate the structural shift in the Chinese economy away from energy-hungry industry and infrastructure investment to relatively energy-light service sector activity and household consumption. Thus the energy intensity of economic growth will be considerably lower than in years past.

Without reform, Rosen predicted China could experience a hard landing, with headline growth falling to 3 percent in 2020, or experience a financial crisis that dragged growth down even further. Even if the structure of the economy remained unchanged from past levels in these two scenarios, the reduction in headline economic growth would be sufficient to significantly reduce growth in Chinese energy demand.

Figure 29: Chinese Economic Growth Scenarios from 2014
Annual GDP growth

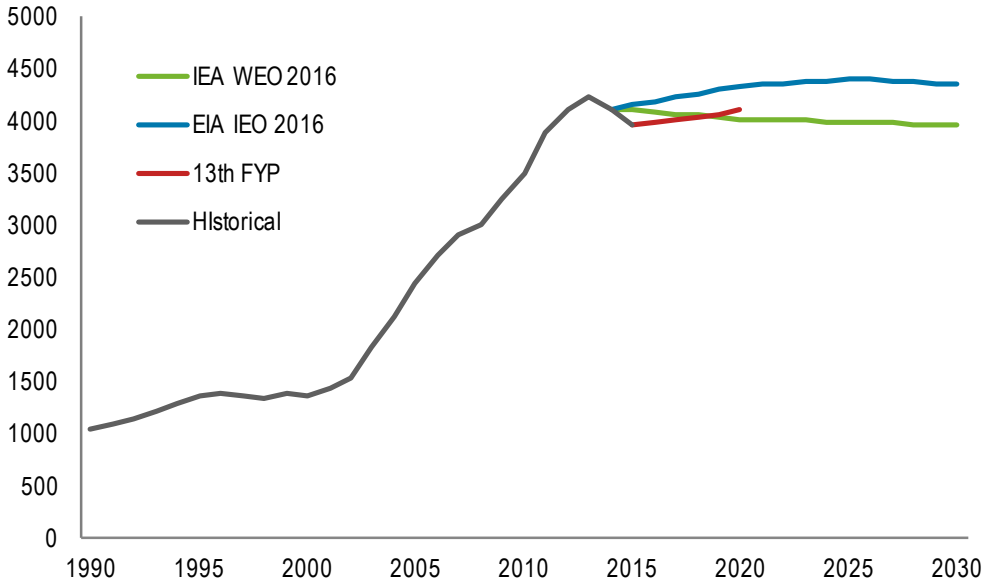


Source: Daniel H. Rosen (Rhodium Group)

With anemic energy demand growth in China and stronger government policies to address air pollution and climate change, coal will struggle to hold on to existing market share in the face of rapidly growing wind, solar, hydro, and nuclear power generation. With Chinese power demand relatively flat for the past two years, this has already started to occur. Utilization rates for Chinese coal-fired power plants have fallen by 21 percent since 2011 and are now at their lowest level since reform began in 1979. This is due both to an overbuild of coal-fired power plants and growing nuclear and renewable generation. To address the former, Beijing recently cancelled 85 planned coal-fired power plants.[69]

The 13th Five Year Plan released in December estimates Chinese coal consumption in 2020 will be 4.1 billion tons.[70] That's higher than it was in 2016 or 2015 but still lower than the 2013 peak (figure 28). In their 2016 World Energy Outlook, the IEA estimates that under current and expected policies, Chinese coal consumption will be 2.2 percent lower in 2020 than it was in 2014 and 3.7 percent lower by 2030.[71] The EIA's International Energy Outlook is the most bullish but still expects Chinese coal consumption to remain close to 2013 levels through 2030.

Figure 30: Chinese Coal Demand
Million metric tons



Source: CEIC, EIA, IEA and RHG estimates

There is considerable downside risk to these already bearish projections. The 13th Five Year Plan assumes 6.5 percent average annual growth between 2015 and 2020. The IEA's projections assume 6.2 percent growth between 2014 and 2020. In the more than two years since "Avoiding the Bling Alley" was published, Beijing has continued to use short-term fixes to prop up headline GDP, instead of undertaking politically painful economic reform. This means 6 percent GDP growth in 2020 is no longer a reasonable possibility—5 percent may now be the best-case scenario. And that will require moving relatively quickly on a number of much-needed reforms. The odds of a hard landing have also increased with delayed reform action, as has the risk of financial crisis from a growing universe of nonperforming loans. The Economist Intelligence Unit has already reduced medium term projections to as low as 4.2 percent (for 2018), a sign that mainstream forecasters are shifting their assumptions.

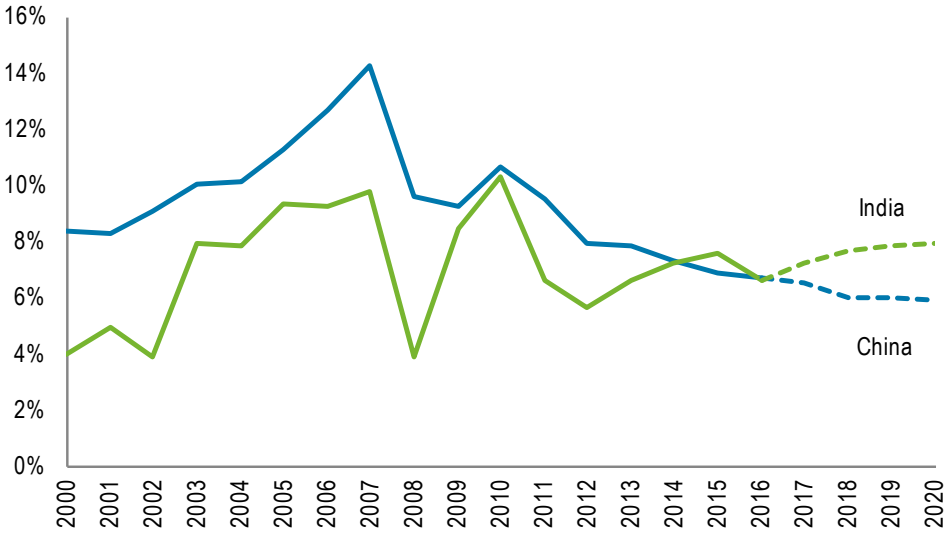
Can India Pick Up the Slack?

If China's economy is slowing and becoming less energy intensive, will India take the baton in driving global coal demand? The election of Narendra Modi as Indian Prime Minister in 2014 brought about renewed optimism in the country's economic growth prospects. The right demographic and economic fundamentals are seemingly in place for a China-like infrastructure and energy-intensive manufacturing boom in India. India's working-age adult population is predicted to increase until 2040, and 68 percent of the population still lives in rural areas. That means there is potential for the kind of investment-heavy urbanization China experienced over the past 15 years. Given Modi's economic success as governor of the state of Gujarat, many observers saw his election as prime minister as a sign that the country's true economic potential might finally be tapped.

Moreover, the Modi government is committed to expanding electricity access to the quarter of a billion people who do not have it through its "24x7 Power for All" initiative, and has made clear that coal will be a key part of that generation ramp-up, along with ambitious renewable targets.[72] Coal and lignite are not only abundant and cheap but also employ roughly 1.5 million people, making it difficult for India politically to turn away from coal. The UDAY program, a financial turnaround and revival package for electricity distribution companies of India, is also poised to boost electricity demand.

In 2015, the first year following Modi's election, the Indian economy grew faster than the Chinese economy for the first time since 1999, only the second time since 1990. Coal demand in India in 2015 was 9 percent higher than the IEA projected it would be in its 2011 World Energy Outlook.[73] The International Monetary Fund now projects that by 2020, the Indian economy will be growing a full 2 percentage points faster than China's (figure 31), and that's based on a relatively optimistic outlook for Chinese growth. And the IEA (which uses GDP growth projections from the IMF) expects a 27 percent increase in Indian coal consumption between 2014 and 2020.[74]

Figure 31: IMF GDP Growth Projections, India vs. China
Percent per year

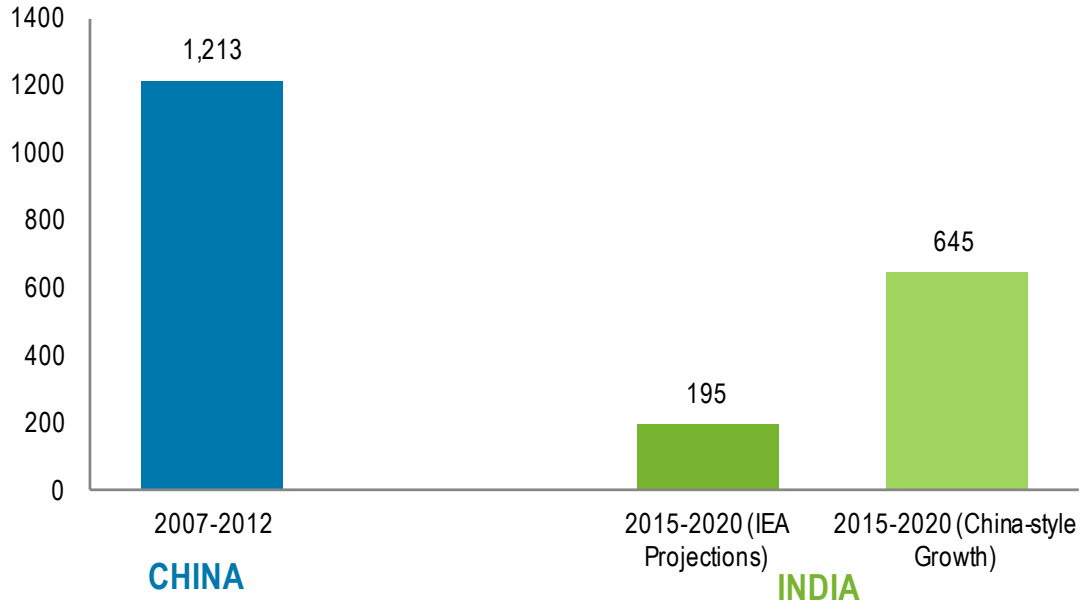


Source: IMF

Unfortunately for US coal producers, even if the Indian economy grows as quickly as the IMF expects, it won't create enough new coal demand to make up for flat or declining Chinese consumption. Even if Indian coal consumption grows at 21 percent between 2015 and 2020, as the IEA currently projects, that only translates into 195 million metric tons of additional demand (figure 32). That's considerably less than demand than China added when the coal market was at its peak (1,213 million metric tons between 2007 and 2012) and is less than the absolute decline in US coal demand over the past five years.

This is in part due to the fact that India is starting from a lower base. But it is also the result of India's more service sector–oriented economy. Fifty-three percent of Indian economic activity occurs in the relatively energy-light service sector, and only 30 percent in industry, which is far more energy intensive. Over the past 15 years in China, industry has accounted for more than 42 percent of economic activity in China and has made growth there considerably more energy intensive. Even if over the next five years the Indian economy transformed to replicate China's during its most energy-intensive days, and coal maintained its current share of energy supply, Indian coal consumption would only grow by 645 million tons between 2015 and 2020. That's still only half of what China added during its peak. And if Modi is successful in reforming the domestic coal mining sector, less of that growth will be met through imports than in years past. Indeed, in 2016, Indian coal imports declined by 6 percent, the first year-on-year drop since 2001.

Figure 32: Coal Demand Growth, India vs. China
Million metric tons



Source: CEIC, IEA and RHG estimates

Rise of the Rest?

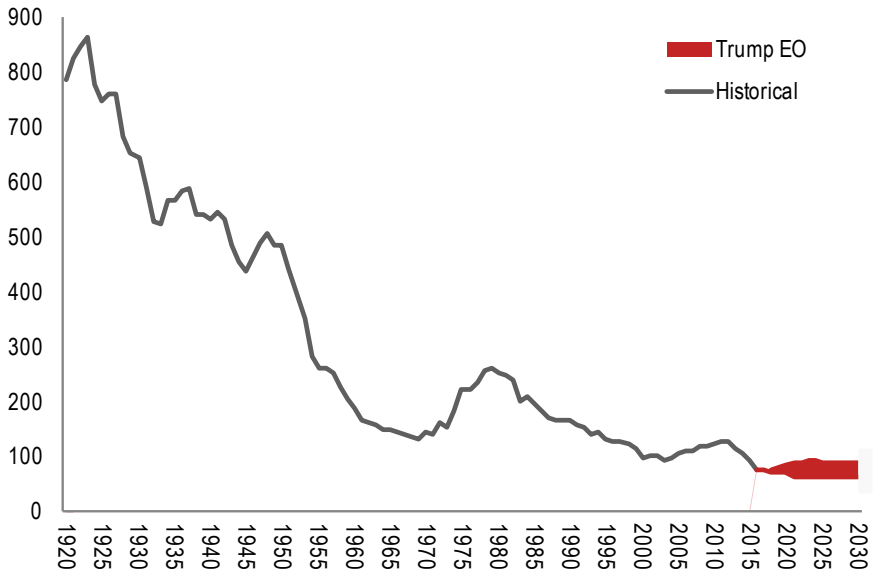
Between 2000 and 2015, China and India accounted for more than 90 percent of coal demand growth in developing countries. But they account for less than half of developing countries' population. Could economic growth in other emerging economies help shore up global coal demand? It looks unlikely, at least for the next few years. Total economic output from other developing countries was 9 percent lower in 2016 than projected by the IMF in 2011, and coal demand in these countries was 8 percent lower in 2015 than the IEA projected that same year. Part of the reason is that the slowdown in Chinese economic growth and commodities demand has had a cascading impact on developing countries that sold into the China market. Lower commodity prices and slower growth in the quantity of goods exported has reduced the amount of economic activity back home and thus reduced the amount of coal demand.

Going forward, the IEA now projects roughly 120 million metric tons of coal demand growth between 2015 and 2020 in all developing countries outside China and India. That's on par with the decline in US consumption just last year. If Chinese and Indian growth rates prove softer than current IMF forecasts (which we believe is likely), it will have further negative impact on demand in other developing countries.

BUILDING A NEW FUTURE

While US coal mining employment has been on the decline for nearly a century, the drop in the past five years has been particularly dramatic and acutely painful for coal communities in from Central Appalachia to the Powder River Basin. While President Trump has promised to reverse that decline and bring about a renaissance in US coal production and employment, our analysis suggests that's unlikely to occur. Given the outlook for coal demand, both in the United States and around the world, the best-case scenario for US coal production may be a modest recovery to 2013 levels at just under 1 billion tons a year. In the worst-case scenario, it could fall to 600 million tons due to cheaper natural gas and lower renewable energy costs. The modeling presented in this report suggests a plausible range of national coal mining employment between 70,000 and 90,000 in 2020 and 64,000 and 94,000 in 2025 and 2030. That's still lower than anything the United States experienced before 2015 (figure 33) and a far cry from what's needed to provide America's coal communities the future they have earned and deserve.

Figure 33: US Coal Mining Employment
Thousand workers, including contractors



Source: Mine Safety and Health Administration and RHG estimates

Rather than bet on a mining recovery that may never arrive, it makes more sense for coal communities, government, and other private and public sector organizations to come together or leverage the other assets—both human capital and natural resources—that exist in coal country to attract investment in new sources of job creation and economic growth. This certainly isn't easy. Despite promises from the federal government for a quarter century to provide worker retraining, education, and other support to help communities displaced by globalization and displacement, both parties have failed to fulfill those promises. Moreover, coal communities in particular are often geographically remote and lack the infrastructure necessary to attract large-scale investment. Miners and others in the local labor market often lack the skills necessary for jobs that offer the kind of compensation available in coal mining. Local entrepreneurs often lack access to credit and difficulty accessing markets. The recent national growth in opioid addiction has been particularly pronounced in coal communities in Appalachia. West Virginia and Kentucky suffer from the first and third highest rates of drug overdose deaths in the country.[75]

Despite these challenges, there are a growing number of community-driven economic diversification efforts that show promise. The "Sustainable Williamson" initiative in Mingo County, West Virginia, combines public health, sustainable local food systems, job training, and a local business incubation to help drive economic growth and diversification.[76] In McDowell County, West Virginia, the "Reconnecting McDowell" initiative brings together business, foundations, government, nonprofits, and organized labor to develop an integrated economic development strategy for the community.[77] Coal-Field Development Corporation combines job training and job creation in projects across the state ranging from the rehabilitation of dilapidated buildings to repurposing abandoned mine lands.[78]

In Kentucky, former Democratic governor Steve Beshear and Republican US representative Hal Rogers joined forces in 2013 to launch the SOAR initiative aimed at supporting economic diversification in the eastern part of the state.[79] The Mountain Association for Community Economic Development (MACED) has combined job creation with cost-saving home efficiency improvements through their How$mart program,[80] and Kentuckians for the Commonwealth (KFTC) works to accelerate clean energy deployment in coal production communities in the state.[81] Appalshop, located in Whitesburg, Kentucky, is helping to drive a local arts renaissance drawing on the region's rich cultural history.[82] BitSource, located in Pikesville, Kentucky, employs laid-off coal miners as software engineers.[83]

The coal production decline in western states is more recent and the economic diversification conversation more nascent. But there are already some promising examples. Microsoft has located one of their largest data centers in the country in Wyoming in part to take advantage of the natural cooling available thanks to the state's climate and altitude.[84] Wyoming also has the best quality wind resources in the western electricity grid,[85] which has attracted a growing amount of wind energy investment. And in 2014, the state created a new Integrated Test Center to support the development of carbon capture, utilization, and sequestration (CCS) technology.[86]

To be clear, these programs and new economic opportunities are a far cry from returning coal country to the prosperity it once knew. Revitalizing America's coal communities is not easy. The recent pace of decline in coal production has been dramatic, and new sources of employment, tax revenue, and economic growth aren't going to show up quickly. But the responsible response from policymakers is to be honest about these facts—about the causes of coal's decline and unlikeliness of its resurgence—rather than offer false hope that the glory days can be revived. And then we must redouble efforts like those above to rebuild these communities, as well as fulfill pension obligations and pay back the debt we owe to workers and families who spent generations, often at the expense of their own health and well-being, providing the energy that powered a good part of the American economy.

There is a lot the federal government can do to help accelerate locally driven economic diversification efforts. Infrastructure investment, tax credits, and repurposing of abandoned mine land that has other economic use can attract new investment and job creation. Expanded broadband access is particularly important as it can overcome the geographic barriers that limit coal communities' physical access to both suppliers and markets and enable new types of economic activity. Competitive grants can help get nascent economic diversification initiatives off the ground. And the federal government can help provide retirement and healthcare security by passing the Miners' Protection Act. But this all requires a clear-eyed assessment of the outlook for the coal industry and a commitment to put sustainable solutions ahead of politically expedient talking points.

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