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US coal industry challenged by over a decade of declining productivity

By Taylor Kuykendall and Rizwan Qureshi

Following a rise in productivity from technological and other mining improvements, the amount of coal produced per employee hour appears to have peaked around 2000 in most major U.S. coal-producing regions and then notably declined over the past decade.

Coal mining productivity, a measure of the clean tons of coal a mine produces per employee hour, is highly variable across different operations. The most obvious factor playing into coal miner productivity is the method of coal mining, such as underground versus surface, but there are also major regional and geological variables.

Producing region	Type of mine		Total
	Surface	Underground	
Central Appalachia	3.19	1.95	2.38
Illinois Basin	5.44	4.37	4.60
Northern Appalachia	2.94	3.47	3.38
Powder River Basin	29.86	NA	29.86

Only surface and underground mines included.
 NA = not applicable
 As of Feb. 27, 2014.
 Source: SNL Energy

An SNL Energy analysis of U.S. Mine Safety and Health Administration data on coal mines from 1994 to 2013 shows varying levels of productivity decline over the past several years.

While most basins saw a slight uptick in productivity rates in 2013, this could be due to factors such as idling of the most inefficient mines instead of improvement in mining techniques or processes, though operators have been increasingly focused on various cost-cutting measures, including worker productivity.

In the Central Appalachian Basin, productivity at underground coal mines hit a peak at 4.15 tons per employee hour in 1999. By 2013, average full-year underground productivity in the basin was at 1.92 tons per employee hour — a decline of about 54% from 1999. In 2013, productivity in the region rebounded

slightly from 1.82 tons per employee hour in 2012, but it has generally been on the decline over the 14-year period.

Surface productivity in Central Appalachia also has fallen off sharply from its recent peak of 6.11 tons per employee hour in 2000 to 3.13 tons per employee hour in 2013.

Illinois Basin data tells a different story. In addition to bucking the industrywide trend of lagging production, the basin is generating recent improvements in productivity. Coal from underground mines in the basin surged 22% from the level in 2009 to an average rate of 4.52 tons per employee hour in 2013, a rate similar to the basin's 19-year peak in 1999.

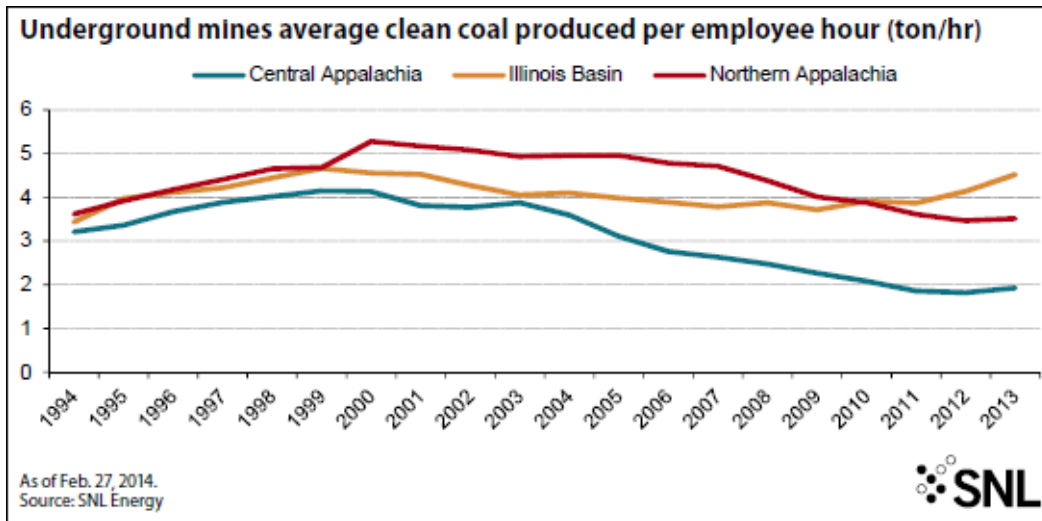
Surface production in the Illinois Basin has remained relatively flat, between 5 and 6 tons per employee hour, since 1999.

The Powder River Basin, where development is relatively new and focused on large-scale, minimal-cost surface production, has begun to see declines in surface mining productivity as well. From a peak of 42.01 tons per employee hour in 2001, production had declined more than 28% to 30.05 tons per employee hour by the end of 2013.

Causes of productivity decline are difficult to pinpoint

Nicholas Paduano, a coal data expert with the U.S. Energy Information Administration, noted that improvements in technology initially allowed underground and surface mines to mine more coal with fewer employees. Now, he says, the trend is reversing, and the average number of employees at coal mines has increased almost 11% since 2007, according to EIA data, despite a decline in production.

"Production is down probably due to many reasons, a big one being drop in demand, but why would companies spend money to hire more employees if they know they are not producing as much? I would guess they need more employees just to mine the same amount, or less, than before because the coal being mined is harder to get out," Paduano said.

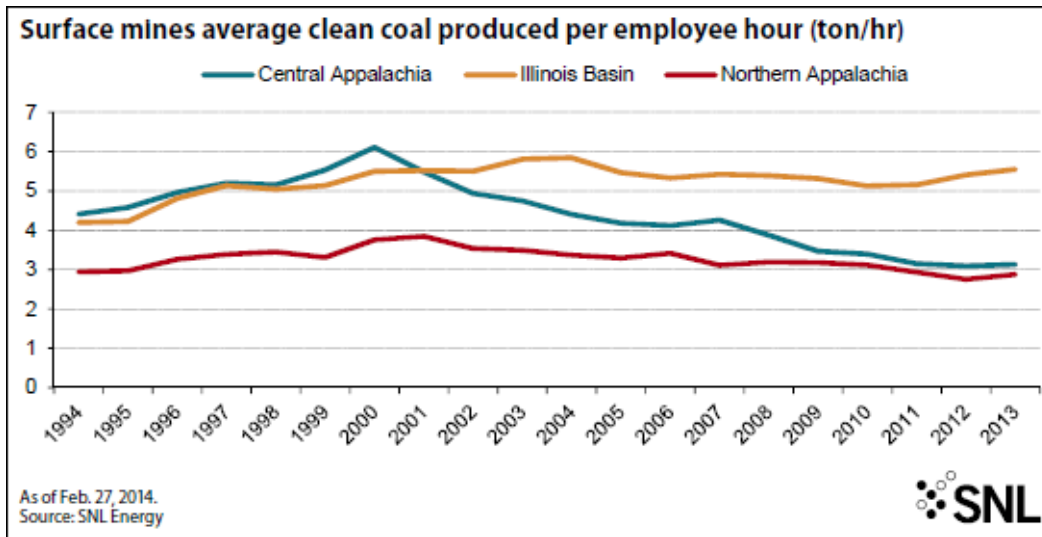


Michael Mellish, an industry economist with the EIA, said the agency has been very interested in the productivity decline of the past decade.

"While we think that basic geology is a likely candidate, we also feel that there are other factors at play as well," Mellish said. "In the past, technology improvements in coal mining seemed to outpace the impacts of reserve depletion, leading to strong improvements in coal mining productivity between 1980 and 2000."

Mellish said the agency is investigating a number of factors as it looks to determine the cause of recent declines. He said some of the key factors include increasing stripping ratios, increased regulatory scrutiny, permitting challenges, skilled labor shortages, demographic shifts, longwall saturation and decreasing coal seam thickness.

"Part of the problem we have in investigating a lot of these issues is lack of available data," Mellish said. "While EIA collects or assembles data on items such as production (including breakouts for underground mine types), seam thickness, productivity, and prices, we don't collect or have good access to data and information for other important factors such as mining costs, stripping ratios, workforce demographics, mine permitting, and regulatory oversight."



Hans Daniels, the executive vice president of Doyle Trading Consultants, said the abrupt decline in productivity that began around 2000 resulted largely from reaching the limits of economies of scale and peak efficiency improvements.

While throughout the 1990s, positive productivity gains from technology improvements and economies of scale outstripped productivity losses caused by stricter regulations and thinner and deeper coal seams, by 2000 the industry had basically maximized the gains to be had from improvements such as doubling the size of haul trucks or doubling the width of longwalls.

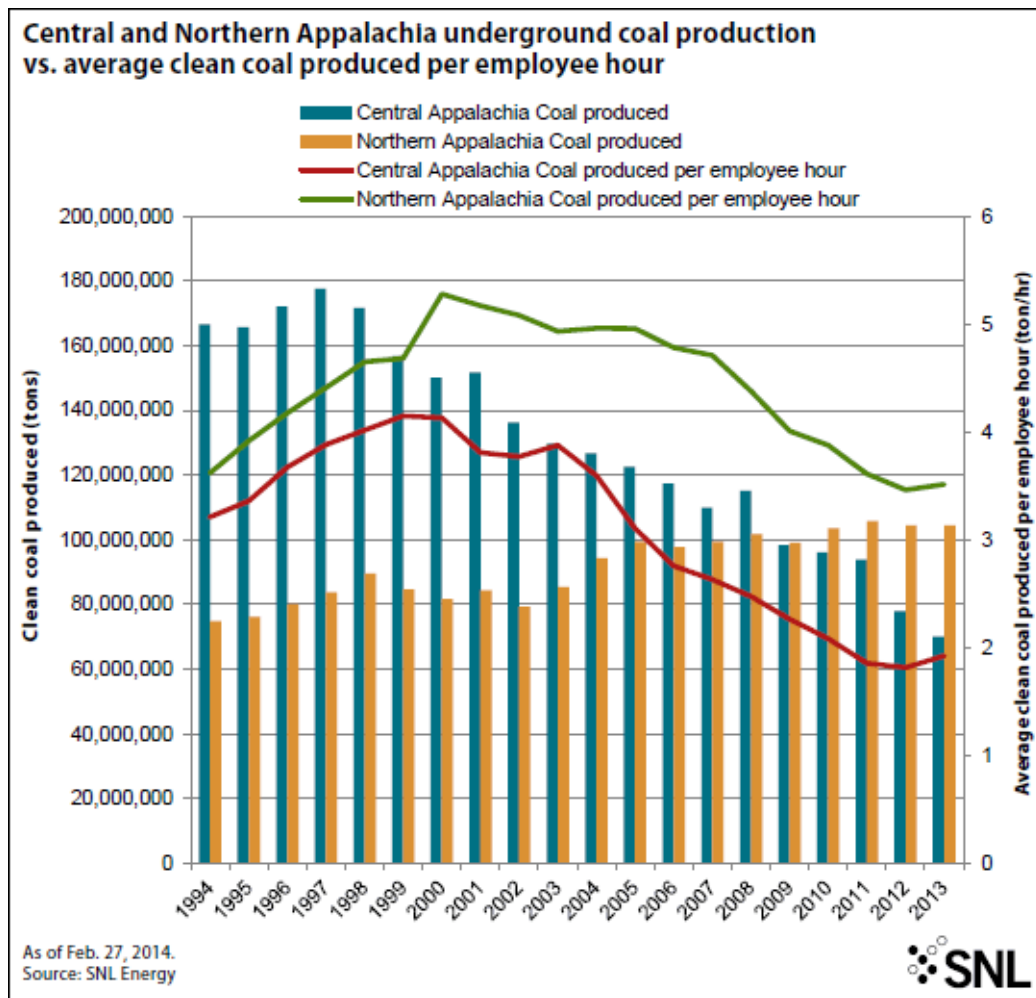
"There are some technologies that will improve productivity, such as autonomous haul trucks, but I'm not aware of any game changers on the horizon," Daniels said. "LNG-fueled trucks will bring down costs, but not improve productivity."

The Appalachia problem

Coal has been mined intensely in the Central Appalachian Basin for decades, compared to relatively new mining activity in the PRB. As more coal is mined in the region, it becomes increasingly difficult to find the thick and shallow coal seams that kicked off what remains one of the largest industries in the

region.

"Now the underground mines are coming into deeper, harder to mine geology, which will impact productivity and has impacted productivity, especially east of the Mississippi River," Paduano said.



As noted by the West Virginia Center on Budget and Policy, the decline of coal miner productivity in Central Appalachia could lead to a boost in coal mining jobs if production continues at the same rate, though that also drives cost-per-ton upward in a region that is already one of the most expensive in which to produce coal. Productivity losses and other factors contributing to increased costs in the region not only have made it more difficult to achieve favorable margins, but also have driven **down** overall demand for Central Appalachia coal.

In the face of increasing costs, many larger companies are **decreasing** their exposure to Central Appalachian thermal coal.

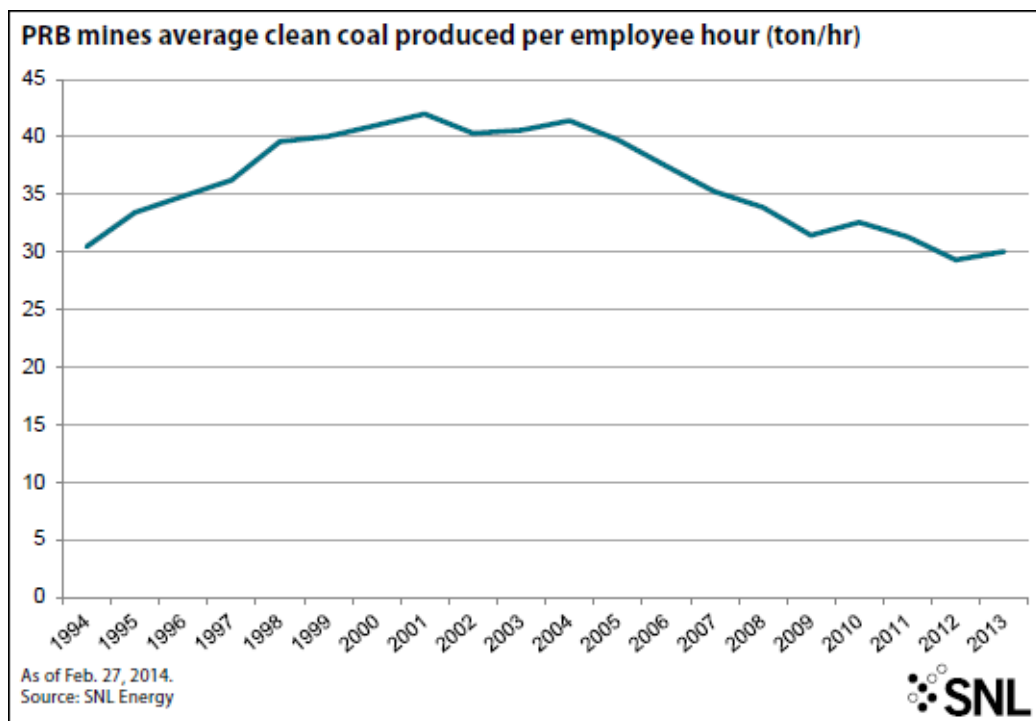
Coal that is sold at higher margins, such as metallurgical-grade coal, can continue production in the face of rising costs, and many companies in the basin are increasing their focus on metallurgical coal markets.

Kentucky Coal Association President Bill Bissett also pointed out that long-term contracts with utilities were more commonplace during the last surge in productivity. Short-term contracts now limit companies' ability to sustain consistently high production levels.

Different story in Wyoming, Illinois

Coal miners in Wyoming's PRB are facing relatively fewer challenges to productivity as the basin still offers plenty of thick, shallow coal seams accessible by large-scale surface mining.

Though producers in the PRB generally have productivity values that are multiples higher than eastern producers, the basin has seen a fairly steady decline over the past decade following a boom in activity and rise in productivity that peaked in 2000.



"These were the go-go years for the Wyoming/Montana Powder River Basin coal," said Chris Carroll, a coal geologist with the Wyoming State Geological Survey. "Due to amendments of the Clean Air Act, western U.S. coal with its very low sulfur became the fuel of choice: no washing, very thick seams, very shallow seams, all surface mineable. With the large equipment invented for such operations the economics became very favorable to the large surface mine operator in the PRB."

By 2000, U.S. power producers had scrambled for the cheaper coal from the West.

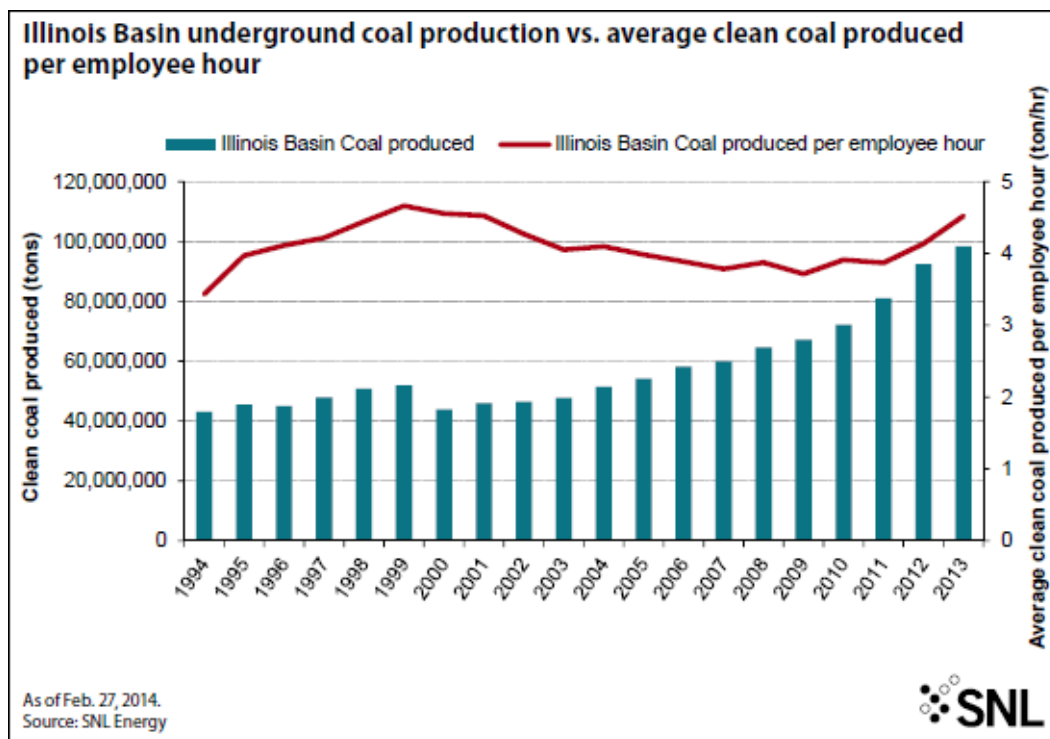
"Mostly, the surface mines in Wyoming were capturing 40% of the US market with coal selling at \$6/ton," Carroll said. "So between 2000 and 2008 Wyoming surface mines were producing the most coal that anyone had ever seen before at very high productivity rates."

Ultimately, PRB producers could run into the same problem as Central Appalachian producers as they work through the easiest-to-mine seams of coal. Right now, that problem appears far down the road.

"As the PRB mines get deeper, the cost goes up as well," Carroll said. "Productivity should remain the same in the future, unless underground mining makes a big comeback. The PRB mines are not scheduled to go underground for a long time out still."

While Wyoming coal producers have seen productivity advancements largely due to surface mining, Illinois producers have fought the trend of declining productivity mostly with advancements in underground mining technology.

"Although not a new technology, we have seen the re-emergence of longwall mines in the Illinois Basin region ... which seems to be leading to an increase in overall productivity in this basin," Mellish said.



Daniels said the low-cost nature of mining in the Illinois Basin is driving a basinwide shift in consumption patterns as Central Appalachian coal customers are driven toward the nearby higher-productivity, lower-cost Illinois Basin.

Future of coal mining productivity

Daniels said that while coal production has dropped sharply in the past five years, most producers have taken the most inefficient mines offline first. This trend, combined with the dynamic of basin-switching as customers move away from Central Appalachia coal, could lead to an overall boost in productivity in the coming years.

Productivity trends, he said, have historically been linked to coal prices.

"Looking at data stretching back to 1949, productivity and coal prices are almost perfectly inversely proportional," Daniels said. "Therefore, any loss in productivity will be reflected by a rise in coal price. From 1949 through 1969, productivity more than doubled and coal prices, in real dollars, dropped by almost half."

Coal producers have taken note of the trend in declining productivity and are adjusting their strategies in response. Alliance Resource Partners LP CEO Joseph Craft said on a recent earnings call that productivity is a "primary factor" affecting the company's costs and margins.

"I think the key for us or any operator is really productivity," Craft said. "So that drives process changes, to see how you can improve your tons produced, and then you also have to be very diligent on how many people you hire."

To find extensive details on U.S. coal mines, go to SNL Energy's [Coal Mine Briefing Book Search](#).

Omer Zahid contributed to this article.