



Planning for coal mine closure in the Powder River Basin

New analytical model reveals which remaining mines and communities are most at risk from unplanned shutdown

May 2021 | By Dan Cohn

It's said that the Stone Age didn't end because of a lack of stone. Just so, the massive coal seams underlying the rangelands of Wyoming and Montana will outlast profitable coal mining.

Five decades after the onset of major strip mining in what became the country's most productive coal region, the Powder River Basin, coal communities find themselves in the midst of a well-known shift dubbed the "Seneca Effect:" although growth is slow and incremental, collapse is comparatively sudden.¹ Since hitting peak coal output in 2010, Powder River Basin coal production has fallen by half in a decade.

Against this backdrop of rapid decline, Sightline has developed an analytical model to assess which coal mines in the region are most at risk of closure. The findings reveal a stark reality: each mine in the region saw its domestic customers burn less coal in 2020 than they had averaged for the three years prior. Some of the reductions proved to be catastrophic. Of the two mines that saw the steepest declines in customers' coal burn in 2020, one has already been permanently closed and another has announced plans to close permanently.

The basin's remaining coal mines face an array of challenging circumstances. Largely for financial reasons, utility companies and electricity markets alike now largely prioritize natural gas, wind, and solar over coal, leading to the retirement of many coal plants, an end to new coal plant construction, and a dramatic decline in coal burn. These trends are clearly visible looking back on 2020: although nationwide electricity

production fell only three percent from 2019, coal-fired electricity saw nearly a 20 percent drop while electricity from gas, wind, and solar increased. Virtually all market analysts believe these trends will continue.

To understand the local impacts of these broader energy market changes, Sightline's new model uses publicly available data for individual power plants' performance and coal purchases to analyze the impacts on every mine in the Powder River Basin. Taken together, the model answers the question, "when the bottom falls out, which mines fall farthest?"

The question matters, especially to the western communities that rely on coal production. Despite the tectonic changes underway, few coal companies in the Powder River Basin have been clear with the public about the remaining lifespan of their mines.

Every coal worker and coal community deserves credible information about the outlook for the industry and major employers. They also deserve serious plans and resources to support them in building a life after coal. Sightline intends this report to help describe the scale and speed of the transition away from coal in the Powder River Basin by filling in the gaps about which coal mines are most at risk of closure. Sightline hopes this information will help coal communities plan for the future and reinforce the urgent need for policy solutions to support workers and communities through the process.

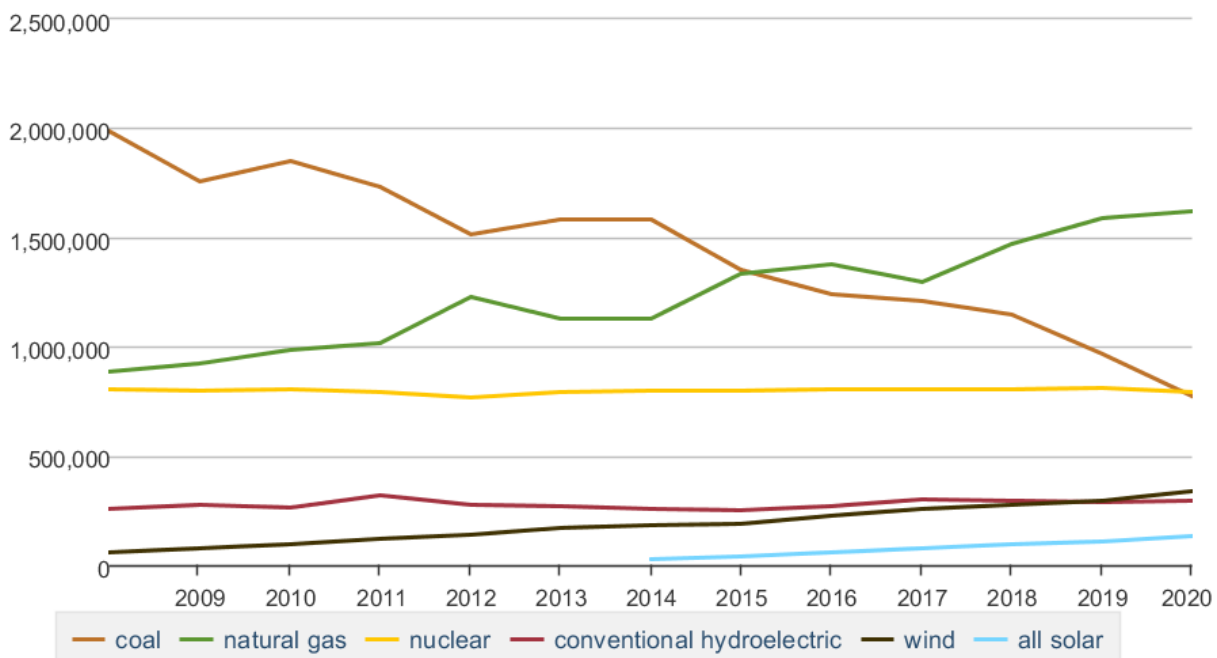
The Powder River Basin is at a turning point

The US coal industry marked some startling bleak milestones in 2020.

For the first time since records began in 1949, coal was neither the nation's largest nor second-largest source of electricity.² Natural gas has held the top spot since 2015, but in 2020 coal power declined just below nuclear energy's output. The last time coal plants produced so little electricity was 1972.³

Net generation, United States, all sectors, annual

thousand megawatthours

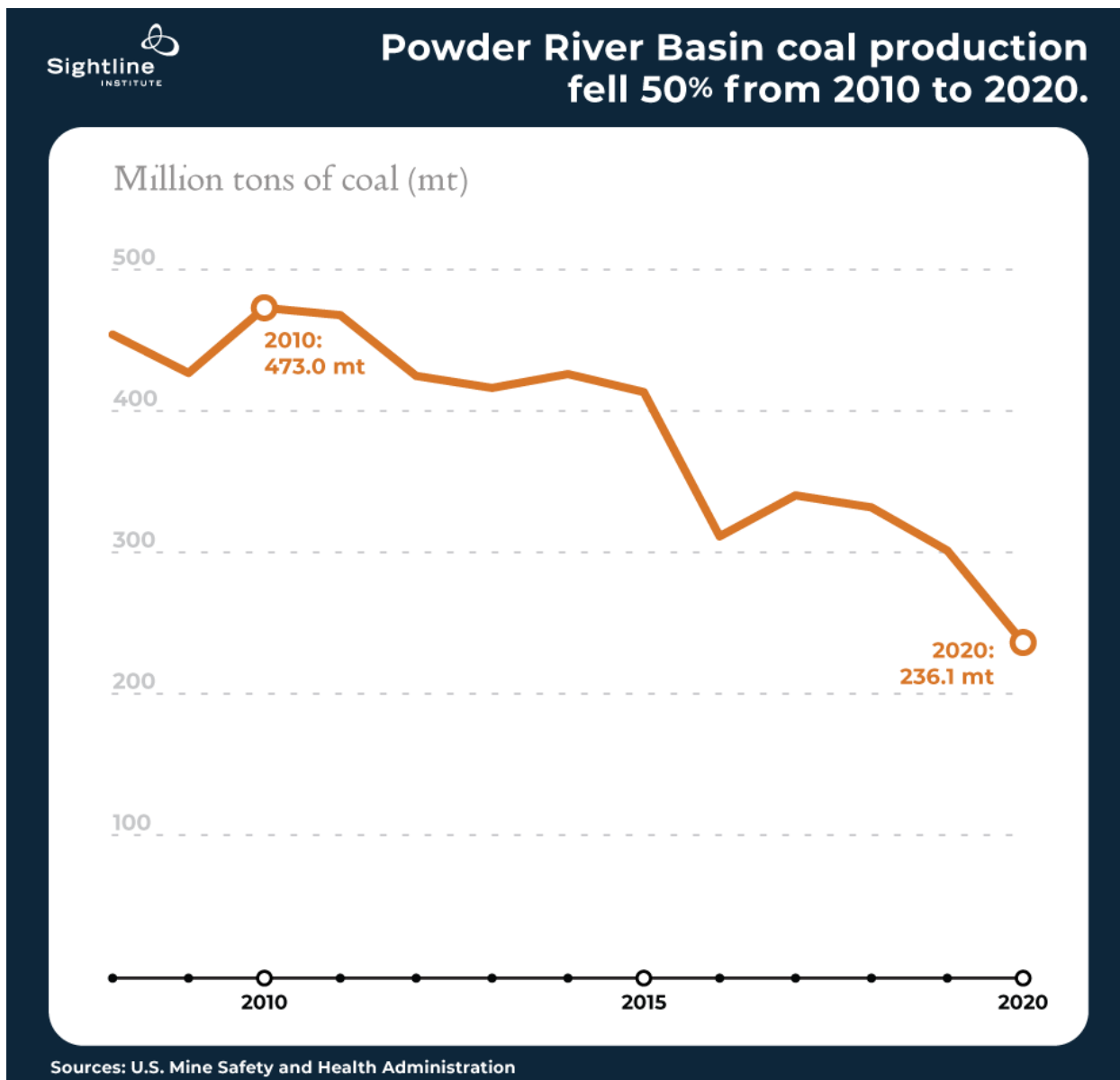


Data source: U.S. Energy Information Administration

Source: <https://www.eia.gov/electricity/data/browser/>

The second milestone explains the first: utilities ran their coal plants far less in 2020 than a decade earlier, with utilization rates dropping to just 40 percent from 63 percent in 2011.⁴ At the same time, utilities retired a significant number of their coal plants, dropping the nationwide capacity from 317 gigawatts in 2011 to 223 gigawatts in 2020. This means that even as many coal plants retired, the remaining fleet was used less, not more.

The third milestone is the result of the first two: coal production in the Powder River Basin during 2020 fell to just 50 percent of the basin’s historical peak, which it reached in 2010.



These trends matter for the Powder River Basin, which has long been the country’s most productive coal mining region. Spanning more than 20,000 square miles of prairie in northeastern Wyoming and southeastern Montana and overlapping portions of the Crow and Northern Cheyenne Indian Reservations, the basin is home to thick, shallow seams of coal.⁵ The Powder River Basin has seen five billion tons of coal mined since 2008, with annual output topping 400 million tons many times since the turn of the millennium. Most of the basin’s mining happens in Wyoming, which in 2010 produced more coal than the next six states combined.

Some in the Pacific Northwest may remember the hype a decade ago about a “coal supercycle” that coal promoters said would sustain exports of astonishing quantities of

Powder River Basin coal to Asia.⁶ The CEO of top mining company Peabody Energy told reporters at the time, "We're opening the door to a new era of US exports from the nation's largest and most productive coal region to the world's best market for coal."⁷

Hindsight shows us that 2010 *was* the beginning of a new era, but not the one coal proponents envisioned. It was more like the beginning of the end: 2010 marked the Powder River Basin's peak productivity, setting a highwater mark followed by a decade of decline. Since 2010, all of the coal export terminals proposed for the Pacific Northwest have collapsed under sustained economic and public pressure, and the Powder River Basin has slid to a mere 50 percent of its former coal production.

Coal's decline has upended the status quo in the Powder River Basin

The explanation for coal's change in fortunes are familiar to those who follow the energy industry: low prices for natural gas following the shale boom led utilities to build new gas plants,⁸ close aging and expensive coal plants,⁹ convert other coal plants to gas, and cancel plans for new coal plants;¹⁰ electricity demand has remained flat for years¹¹ due in part to energy efficiency savings;¹² installations of solar and wind energy grew significantly; and federal protections against air pollution led utilities to close coal plants rather than install pollution controls.¹³ These changes amount to a widely-acknowledged structural decline of the coal industry.¹⁴

The cumulative effect of these changes is an unexpectedly rapid transition away from coal. Energy analysts now debate whether the US coal industry will fade quickly or slowly: will coal use end in the 2030s, or well before?¹⁵

This transition is reshaping the futures of coal workers and coal-dependent communities of Montana and Wyoming, whose livelihoods, community life, and basic community services, like K-12 education and ambulances, hang in the balance.¹⁶

Consider that in Wyoming, fossil fuel extraction generates 50 to 65 percent of the state's revenue.¹⁷ State legislators and political leaders intentionally built the state's budget on a select few revenue streams, especially from the coal, oil, and gas industries.¹⁸ This has allowed Wyoming to avoid imposing revenue measures like an income tax. The result is that the state is now struggling to fund essential services like education in an equitable way.¹⁹

A local example is Montana's Big Horn County, which is home to three Powder River Basin coal mines. The county commissioners raised property taxes to near their limit in 2020 in order to backfill decreasing and unpaid coal taxes.²⁰ Because that wasn't

enough, the commissioners also asked voters to approve mill levies, which are property taxes put to a vote, last November to support the ambulance service and provide additional funds for public safety.²¹ These were the first such levies in the county's history, and voters approved both.²²

Over-reliance on mineral revenue in general and coal mining in particular has set up Powder River Basin coal communities for failure and disappointment as coal continues to be displaced from the electric grid by gas, wind, and solar. The unavoidable truth is that more mines will close as coal demand continues to shrink. And each announcement of layoffs or mine closure will destabilize the community with unpaid wages, discarded medical and pension benefits, fear, uncertainty, and mourning.

The Powder River Basin has already seen what this looks like. When coal mining newcomer Blackjewel abruptly shut down its two Powder River Basin strip mines in July 2019, the company locked out its workers.²³ Although the mines eventually resumed operations, final paychecks bounced, and workers largely went unpaid until the US Department of Labor sued the company on their behalf.²⁴ Workers also abruptly lost their health insurance when the company plan was cancelled in bankruptcy.²⁵ On top of it all, the company collected but never deposited more than one million dollars in employee paycheck retirement contributions.²⁶

The Blackjewel fiasco was not the first time Powder River Basin coal workers were treated roughly by stumbling coal companies. In March 2016, Peabody Energy and Arch Coal coordinated layoffs of nearly 500 Wyoming miners in a single day.²⁷ The loss of breadwinners for 500 families in a county with a population of only 50,000 at the time shocked the local economy.²⁸

As the transition away from coal careens forward, workers and communities lack key information

Despite the trauma that unplanned layoffs cause workers, families, and communities, coal companies have a poor track record of transparency about their plans to shutter their mines. Mine closures and mass layoffs are destabilizing in part because of their abruptness, leaving workers, retirees, and families without lead time to absorb the impending change, grieve the loss, and make a new plan for their future.

One key reason that Powder River Basin mining companies are not more open and honest about their plans to close mines is that they are locked in a desperate stand-off with the other Powder River Basin mine operators. Each company is trying to avoid closing their mines, because a closed mine simultaneously stops bringing in revenue from coal sales and starts facing significant expenses for ecologically important but

expensive reclamation, or clean-up, of the mined land.²⁹ Meanwhile, competitors reap the benefits of reduced coal supply from the region, which can include the chance to win new sales contracts or higher prices. It pays to outlast your competitors.

There are multiple reasons a company in that scenario would not publicly communicate any scenarios regarding mine closure. For one thing, the company would tip its hand as to the strength of its competitive position. For another, the company may not have developed a mine closure plan if the goal is to outlast your competitors and take it from there. In either case, the company taking care of its own bottom line deprives community members of time to do effective transition planning.

The answer to which mine will close next matters. It matters to workers and their families, company retirees, elected officials, and anyone who will have to deal with the fallout of these corporate decisions. In an effort to alleviate the shock that comes with the announcements of mine closures, Sightline presents a promising new model that estimates which Powder River Basin coal mines are most at risk of closure.

Which Powder River Basin coal mines and communities are most at risk of mine closure?

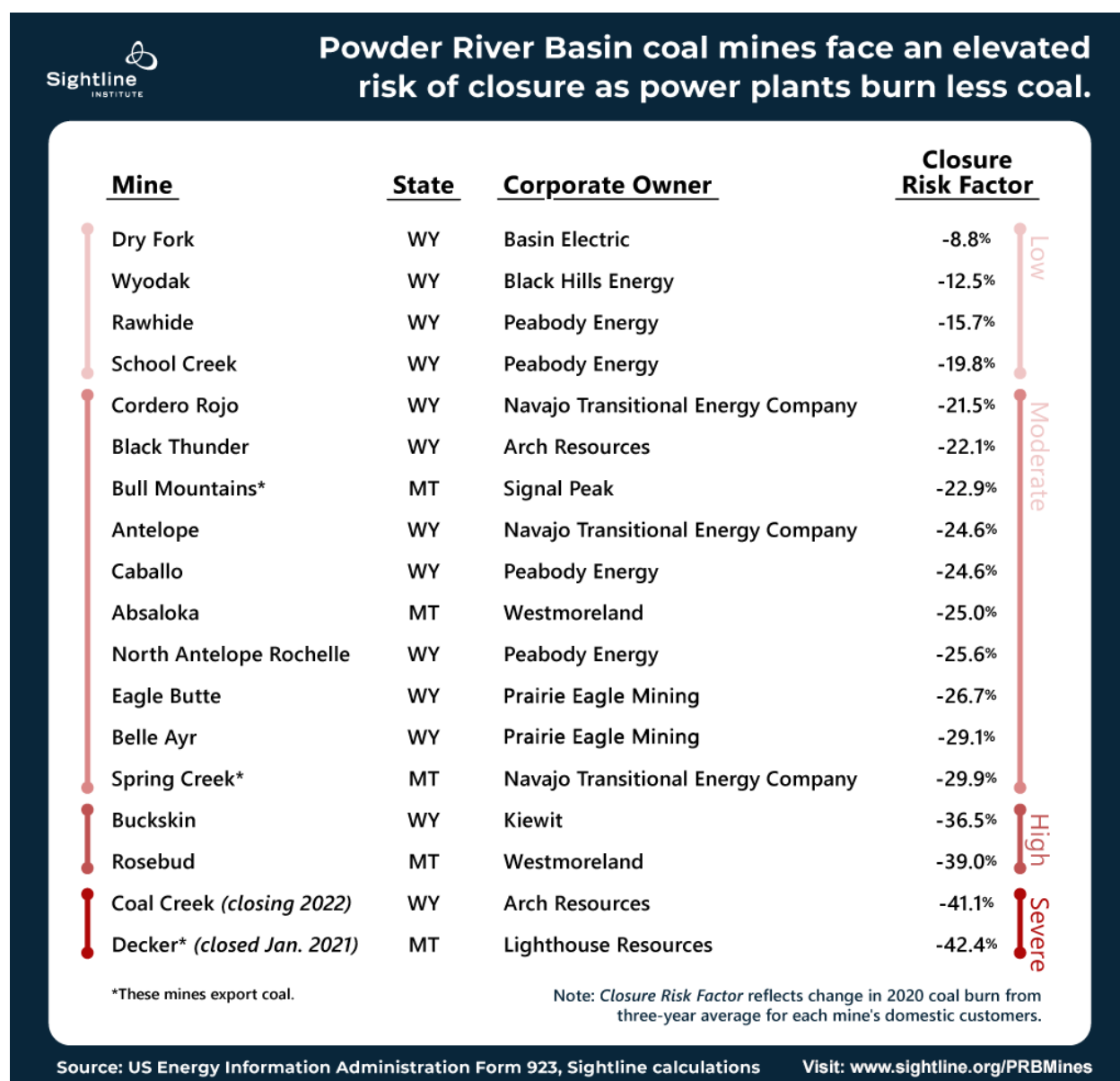
Sightline's model is designed to measure the risk of coal mine closure based on the operations of its customers. The idea is that coal mines are at higher risk of closure when their power plant customers are burning significantly less coal than they used to. As gas, wind, and solar continue to push coal out of the electric generation mix, utilities often run their least profitable coal plants less frequently or seasonally, or retire them altogether.³⁰ When the plants burn less coal, they reduce demand for a mine's output.

To illustrate the dynamic, one can look to the natural experiment of last year's stay-at-home orders, which resulted in a decline in electricity demand. As almost all electric utilities can choose from among fuels--coal, gas, renewables--to generate electricity for their customers, we can investigate which power plants they ran and which they cut first when prices were low. At a high-level, the answer is stark: in 2020, electricity generation nationwide fell only three percent from 2019, but coal-fired power fell 20 percent while gas, wind, and solar all increased.³¹ This model attempts to trace the impacts of unfavorable economics of burning coal for power at individual power plants back to the mines that source the coal.

The table below ranks Powder River Basin mines by this measure of demand: how much coal the mine's power plant customers collectively burned in 2020 compared to the annual average of the three-year period from 2017 to 2019. A positive percentage indicates greater coal burn by a mine's customers in 2020 than 2017 to 2019, while a

negative percentage indicates less coal burn. (The model results are represented in percentage points because each mine produces a different volume of coal, making it difficult to meaningfully compare increases or decreases in tons of coal burned.)

The data show that every Powder River Basin mine saw customers burn less coal in 2020 than the average for the three prior years. Although a few individual power plants did burn more coal in 2020 than in previous years, no Powder River Basin mine sold coal only to those plants. Perhaps the most important thing the data reveal is that certain mines saw much more significant decreases in demand than others.



To understand the results in the table, some explanation of the methodology is in order.

This model is not a *projection* of when specific mines will close, or even which mines will close next: it's more like an *outlook* based on current conditions. The sequence in which coal mines close will almost certainly be different than the ranking provided here due to a variety of factors that will develop over time. Just to name a few: some coal mines may ship coal to different power plants, some coal companies may shift sales from mine to another, some power plant owners may continue to run their uneconomic power plants more than expected to take advantage of captive ratepayers,³² or cease doing so, and some power markets will become much less hospitable to coal as those markets are reshaped by the massive amounts of renewable energy awaiting connection to the grid.³³

Despite the uncertainty of these and other factors, the value of Sightline's model is that it provides some indication of which mines are in most trouble over the long term. Power plant owners usually operate their plants only when it is profitable to do so, so the same coal plants that were run less by utilities in 2020 due to decreased electricity demand are likely to be least economic to run generally. Those plants will remain the most vulnerable to full retirement or further reduced operations in the future. The mines that sell their coal to the least economic power plants are likely to see demand for their coal drop faster than their competitors. This competitive disadvantage puts them at a higher risk of closure. Although decreasing demand for a mine's coal is only one of several factors that influence mine closure, it's an important one.

In the face of the declining market for Powder River Basin coal, the mines could endeavor to survive by selling coal to different power plants, but this is no panacea. Coal plants can and do buy coal from different Powder River Basin mines that produce coal of similar qualities, and they do increase or decrease the volumes of coal they buy from particular mines between years. In fact, changes in coal sourcing may even be initiated by coal mines buying market share, as one long-time Powder River Basin observer alleges happened in 2017.³⁴ But this provides no long-term relief because the main problem is that Powder River Basin mines are chasing a shrinking, oversupplied, and bounded market.

The bounded nature of the market for the basin's coal bears further explanation. Powder River Basin coal cannot easily displace coal from other basins due in large part to plant-specific engineering concerns. Most power plants are engineered to burn particular grades and qualities of coal, which makes it risky to burn coal of drastically different characteristics without modifications or upgrades to the plant's equipment. It's rare for a power plant that is optimized to burn coal from another basin to switch to Powder River Basin coal, although there are a few examples from Texas and North Dakota where plants burning lower-quality lignite coal upgraded to Powder River Basin

coal.³⁵ With coal plants shutting down across the country, the potential for power plants to convert to Powder River Basin coal is dwindling.

Another value of this model is that it may be extended beyond the Powder River Basin. It can be applied to any coal basin, any coal company or companies, or any set of specific coal mines of interest. If you would like to discuss replicating this model for coal mines in your area, you can contact Sightline.

All Powder River Basin mines saw a decrease in 2020, some large and some small

It is telling that not a single Powder River Basin mine shows an increase in coal demand in 2020. This reinforces how vulnerable the entire basin's coal mining industry is, but it's also an effect of looking at the mines during a very bad year for the industry.

Sightline's model pins Decker and Coal Creek as the most vulnerable mines to closure, given that their customers collectively burned more than 40 percent less coal in 2020 than they did on average during the prior three years. In this case, reality validates the model: these two mines are the first in the Powder River Basin to permanently close or announce permanent closure (unlike Blackjewel's, which reopened).

Decker, owned in recent years by Lighthouse Resources, was one of the first coal strip mines to open in Montana. The mine is located only a couple dozen miles north of the Montana-Wyoming border, with many of its 100 to 200 workers living in nearby Sheridan, Wyoming. It produced almost seven million tons in 2008 but only about three million tons in 2020. The mine closed in January 2021.³⁶

Coal Creek, owned and operated by Arch Resources, is located between the towns of Gillette and Wright in Wyoming's Campbell County. The mine's production dropped from 10 million tons per year a decade ago to just over two million tons in 2020. Its normal workforce of 150 fell to 60 in 2020. Arch Resources announced in February 2021 that it would begin final closure of the mine in 2022.³⁷

The news for the Decker and Coal Creek mines is plainly bad. For the remaining mines, the news is mixed at best.

1. The news is worst for the "8,400" mines of Wyoming.

Although Powder River Basin coal is relatively uniform in quality given its sheer volume, the energy density of the coal varies across the basin. Energy density is commonly measured in British thermal units per pound (Btu/lb). Powder River Basin

coal mined in Wyoming contains relatively little energy: it ranges from a little below 8,400 to almost 9,000 Btu/lb, but is generally classified as either 8,400 coal or 8,800 coal. Coal mines in the 8,800 Btu/lb range include Antelope, Black Thunder, North Antelope Rochelle, and School Creek. The rest fall into the 8,400 Btu/lb range.

Coal in Montana can reach 9,500 Btu/lb but often comes with higher amounts of sodium, which causes slag inside coal boilers and requires special boiler design for a power plant to burn it. It's worth noting that coal from either side of the Powder River Basin is far less energy dense than what's mined in Appalachia or British Columbia, which can reach 12,500 and 14,000 Btu/lb respectively.³⁸ (Although energy density is one of the key characteristics for thermal coal, metallurgical coals like those mined in British Columbia have a multiplicity of other quality considerations relevant to their use in steelmaking).³⁹

The 8,400 mines as a group show the highest closure risk factors. Of most concern are Kiewit's Buckskin mine and the two mines now owned and operated by Prairie Eagle Mining (formerly known as Eagle Specialty Materials), Belle Ayr and Eagle Butte.⁴⁰

It's not clear how Kiewit, a privately held diversified industrial conglomerate, thinks about the future of Buckskin. On the one hand, the company could choose to subsidize Buckskin in order to outlast competitors that don't have the non-coal businesses to rely on that Kiewit does. (It's possible that Kiewit has in fact subsidized Buckskin in the past, given that the mine recovered a much greater share of its previous coal production in 2017 following the Powder River Basin's steep drop off in coal output in 2016, which is observable in the graph above). On the other hand, the company could decide that further investment in the mine is not the most optimal use of company resources and cut the cord sooner rather than later.

The fate of Eagle Butte and Belle Ayr has been of interest ever since the mines started changing hands several years ago. Contura Energy got the mines in 2016 when that company was created in the bankruptcy of Alpha Natural Resources. It then paid coal company Blackjewel \$21 million to take over the two mines in late 2017.⁴¹ After Blackjewel went bankrupt in 2019 before having fully transferred the mining permits from Contura, Contura paid Eagle Specialty Materials nearly \$90 million to take on the mines.⁴² From the perspective of Contura management, even this steep price was a sweet deal: the two mines collectively require several hundreds of millions of dollars of cleanup, and Contura has now gotten off the hook for it. Belle Ayr and Eagle Butte were among the first Powder River Basin mines in Wyoming, so with the cheapest and best coal long mined out at those mines, it's no surprise that none of their recent owners could run the mines profitably.⁴³ It is hard to believe Prairie Eagle Mining will manage to do so for very long.

The other 8,400 mines are not in great shape, either. Caballo, Cordero Rojo, and Rawhide are feeding power plants that burned between one-sixth and one-fifth less coal in 2020 than the prior three-year average. The results are somewhat better for Dry Fork and Wyodak, which primarily sell coal to co-owned power plants and don't compete on the open market to the same degree the other 8,400 mines do. Even so, these "captive" 8,400 mines saw noticeable decreases in coal burn at their plants.

The dim prospects for 8,400 coal demand suggest that competition for remaining market share will be fierce. The city of Gillette, Wyoming, and neighboring communities are likely to see the most significant impact of this fierce competition in the near term.

2) Arch's withdrawal from the Powder River Basin may help Peabody and NTEC keep their flagship mines afloat.

At the same time Arch announced that it would accelerate the closure of Coal Creek, the company also announced that it would "reduce its operational footprint" at Black Thunder, the second-most productive coal mine in the country (and, in fact, in the entire world).⁴⁴ This is likely to reduce expenditures that Arch would prefer to make elsewhere, and it foreshadows less coal production, deferred maintenance of the mine's equipment fleet, closure of one or more of the open pits, accelerated reclamation, and layoffs.

Arch's reduced emphasis on the Powder River Basin is driven by two main factors. First is the company's strategic turn away from supplying thermal coal to power plants in favor of supplying metallurgical coal to steel mills.⁴⁵ Unlike most other coal companies in the Powder River Basin, Arch also owns a significant portfolio of metallurgical coal mines and has apparently decided that its future lies in that market. Last year, Arch emphasized this shift away from thermal coal by changing its name from Arch Coal to Arch Resources and flooding its website with stock photos of rolled steel and rebar.⁴⁶

The second factor is that Arch faces unique physical constraints on continued mining. The mining progress of Black Thunder is constrained to the west by the triple- and quadruple-tracked "Joint Line" operated by BNSF and Union Pacific railroads. Black Thunder has limited remaining coal on the eastern side of the tracks. Once that coal is mined, the mine would need to "jump" the railroad and open a new pit west of the Joint Line. This would be exceedingly expensive and would significantly drive up costs. Black Thunder's immediate neighbors do not face the same constraints: Peabody's North Antelope Rochelle and School Creek mines have plenty of coal east of the Joint Line, and the Antelope Mine, owned by the Navajo Transitional Energy Company (NTEC), is located west of the Joint Line.

To the extent Arch ramps down production faster than demand for 8800 coal declines, Peabody and NTEC would be well positioned to pick up the surplus demand, which could reduce the risk of closure for Peabody's North Antelope Rochelle mine and NTEC's Antelope mine. Arch's executives are also reportedly considering selling Black Thunder. Although this is unlikely given the mine's astronomical cleanup costs, a new owner could continue to run the mine and erase any potential benefit to Peabody and NTEC.

3) It's not clear how long Montana mines will last.

It's more challenging to draw general conclusions about the Montana mines. In part, this is because some export their coal to Asia in addition to selling to US power plants, and the export market is not correlated with the domestic market. It's also because there are so few mines in Montana. Let's look at them one by one.

The Absaloka Mine will not last much longer. Its production has declined significantly over the years, from a high of 6.6 million tons in 2014 to barely 2.1 million in 2020. Its customer base has dwindled to just one plant, Xcel Energy's Sherburne County plant in Minnesota.⁴⁷ "Sherco," as the plant is known, will shut down its three coal units in 2023, 2026, and 2030. That's the end of the road for Absaloka, which mines coal held in trust by the US government for the Crow Tribe. The mine has historically provided a huge proportion of the Tribe's nonfederal revenue.⁴⁸

Signal Peak Energy's Bull Mountains #1 mine has always operated behind a veil of secrecy. The company is privately owned by three colorful entities, including a commodities trading firm linked to Vladimir Putin, a Miami ex-playboy, and a utility company that bribed the Speaker of the Ohio House of Representatives to pass a billion-dollar bailout for their power plants.⁴⁹ The mine itself was defrauded by its executive management, leading a federal prosecutor to refer to it as a "den of thievery."⁵⁰ Only two power plants have received coal from the mine since 2017, and the mine made zero recorded coal shipments to US power plants in 2020. We can only guess that the six million tons mined in 2020 were exported. How long the mine can continue operations is anyone's guess.

The Spring Creek Mine, which is owned and operated by NTEC, has an uncertain future. Spring Creek sells coal to a dwindling cohort of power plants and also exports some coal to Asia. Its closure risk factor, which does not factor in exports, is more concerning than every mine in both Montana and Wyoming except Buckskin, Rosebud, Coal Creek, and Decker. NTEC inherited take-or-pay contracts with British Columbia coal export terminal Westshore and BNSF Railway to ship coal to Japanese coal plants through 2023, so it is very likely that NTEC will fulfill those contracts to avoid costly penalties.⁵¹ Pacific Rim coal prices have also returned into a profitable range for Spring

Creek from their lows last year, so it's likely the mine is exporting additional tons. Plus, Spring Creek shipped coal to some of the same customers that Decker did, so Decker's closure may give Spring Creek additional coal sales.

The Rosebud Mine is a special case, as it solely serves the Colstrip Steam Electric Station in Colstrip, Montana. Co-owned by six electric utilities including Puget Sound Energy, Portland General Electric, Avista, and PacifiCorp, the Colstrip plant has sent the bulk of its power to customers in Western Washington and Oregon since its first units came online in the 1970s. Rosebud's closure risk factor reflects the retirement of two of the four coal-fired boilers at the plant in early 2020. The remaining two units could close as soon as 2025.⁵² Unlike other Powder River Basin mines, Rosebud's fate is largely sealed due to its reliance on a single power plant. Closure is not a matter of "if" but "when."

The road ahead

Despite the rapid erosion of the Powder River Basin coal mining industry, it will still take some years for coal production to approach zero. That provides important breathing room to plan for the future. In that regard, a number of efforts are underway.

In Wyoming, renewed conversations and new initiatives have been launched regarding the ongoing economic transition and the need to diversify the state's revenue sources.⁵³ A temporary legislative committee was formed to recommend new state law to protect the state and counties' interest in unpaid coal company taxes.⁵⁴ State efforts are likely to be overtaken by work at the federal level, however.

In January, the Biden Administration created an "Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization" whose initial report was just released.⁵⁵ Sen. Duckworth of Illinois proposed a "Marshall Plan for Coal Country" last year that would address both mine and plant communities, and Rep. O'Halleran of Arizona introduced a bill to support coal power plant communities.⁵⁶ President Biden's American Jobs Plan allocates billions for coal mine cleanup.⁵⁷ And there are currently bills in Congress to reauthorize a trust fund that pays for cleanup of abandoned coal mines and accelerate disbursement of those funds to sites with economic development opportunities.⁵⁸

Plus, grassroots organizations in coal-dependent communities have developed a national platform to successfully transition coal-dependent communities.⁵⁹ The platform includes common-sense ideas like ensuring that coal mine workers get to work the jobs performing legally required mine reclamation, for which they are already

skilled and which will provide bridge employment for a significant portion of the mine's workforce after closure.⁶⁰ Additional policies to support an equitable energy transition like wage replacement have been recently outlined by environmental groups, labor unions, and scholars.⁶¹

The most responsible thing that coal companies can do is to be open and honest with their workers and communities about their plans and contingencies for closure. The best example of this so far is Arch Resources' announcement that it will begin closing Coal Creek in 2022 and accelerating reclamation at Black Thunder.

Having a credible timeline for mine closure will allow workers and their community to plan for the impacts and how to navigate them. It gives meaningful time for elected officials to raise revenue or gradually downsize expenses in line with decreasing tax revenue; to assess the increasing need for services across the community; to begin or continue efforts to support small businesses and diversify the local economy; and to gather resources from the federal or state government to support the community and workers in transition.

When the path to closure is clear, people come up with lots of ideas. The consultants who conducted public meetings about economic diversification in the town of Colstrip, Montana, tell a story about how community members' despair after a lawsuit settlement set two of the power plants four units on a path to closure was replaced by pragmatism through the planning process. It gave people a collective space to mourn the impending loss of the town's power plant and to come together to find a way forward.

No one knows quite how long it will take for the remaining half of the Powder River Basin's production to no longer be produced, but with significant resources and coordination at the local, state, and federal levels, coal workers and coal-dependent communities will not be left in the lurch as they live a life after coal. This model is an attempt to advance these efforts and ground them in urgency.

Methodology

The data used in this analysis comes from EIA's Form 923, including power plant generation data (Page 1, Generation and Fuel Data) and coal deliveries (Page 5, Fuel Receipts and Costs).⁶² Sightline imported this information into a PostgreSQL database using PgAdmin and then developed queries that took the following steps to deliver the results:

- From Page 5 data, extracted EIA's plant identification numbers for plants that bought Powder River Basin coal in 2019 and 2020 (filtered for plants that

bought coal from mines in Wyoming counties of Campbell and Converse and Montana counties of Big Horn, Rosebud, and Musselshell). Filtered Page 1 data by extracted plant identification numbers and extracted the sum of all coal burned annually by each plant for the years 2017 through 2020 and found the annual average for 2017 to 2019. Derived a percentage change in each plant's coal burn between 2020 and the average for 2017 to 2019.

- From Page 5 data, summed each coal mine's total deliveries in 2019 and then divided each mine's deliveries to each plant in 2019 by the mine's total deliveries to develop a proportional reliance of each mine on each plant. Separately developed figures for Belle River and St. Clair plants, which receive coal at a single shared delivery point, based on each plant's proportional coal burn.
- Combined percentage change in 2020 coal plant operations with proportional reliance of each mine on each plant to create a weighted average change in demand for each mine.

The categories of risk were assigned arbitrary thresholds of Low = 0-20%, Moderate = 20-30%, High = 30-40%, and Severe \geq 40% decrease in coal burn.

One notable shortcoming of the data used is that it is not possible to connect mines with power plants whose coal purchases pass through riverside blending terminals, such as those operated by SCH Services in the southeast.⁶³ The terminals, rather than the power plants, are recorded as recipients of the coal in EIA's data. However, the amount of coal sold this way accounts for less than 2 percent of total recorded deliveries of Powder River Basin in 2020 and the coal is primarily sourced from the Basin's largest mines, which lessens the impact of this issue on the model's results.

¹ Ugo Bardi, "The Seneca Effect," Springer International Publishing, 2017, <https://books.google.com/books?id=F14yDwAAQBAJ>.

² Owen Comstock, "Less Electricity was Generated by Coal than Nuclear in the United States in 2020," US Energy Information Administration, March 18, 2021, <https://www.eia.gov/todayinenergy/detail.php?id=47196>.

³ US Energy Information Administration, "Monthly Energy Review," April 2021, https://www.eia.gov/totalenergy/data/monthly/pdf/sec7_4.pdf.

⁴ US Energy Information Administration, "Electric Power Monthly: Capacity Factors for Utility Scale Generators Primarily Using Fossil Fuels," April 26, 2021, https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_07_a.

⁵ James A. Luppens, David C. Scott, Jon Haacke, Lee M. Osmonson, and Paul E. Pierce, "Coal geology and assessment of coal resources and reserves in the Powder River Basin, Wyoming and Montana," US Geologic Survey, 2015, <https://doi.org/10.3133/pp1809>.

⁶ Peabody Energy, "Global Coal Supercycle Alive and Well," March 26, 2012, <https://www.prnewswire.com/news-releases/global-coal-supercycle-alive-and-well--peabody-energys-chairman-and-ceo-presents-at-howard-weil-2012-energy-conference-144234835.html>.

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