

Written Statement of James H. Stock  
Harold Hitchings Burbank Professor of Political Economy, Department of Economics and  
Harvard Kennedy School, Harvard University  
Research Associate, National Bureau of Economic Research

*To be presented to:*

United States House Committee on Natural Resources, Subcommittee on Energy and Mineral Resources,  
hearing on “The Future of the Federal Coal Program”

July 11, 2019

Thank you for providing me with the opportunity to provide this supplementary written statement supplementing my oral testimony.

### **Summary**

In 2018, 41% of US coal was mined under Federal leases,<sup>1</sup> accounting for approximately 10% of energy-related CO<sub>2</sub> emissions in the United States. These observations lead to the questions about the connection between the US Federal coal program and the need for the US to reduce its greenhouse gas emissions. In this written statement, I make the following six points:

1. The future demand for Federal coal is part of the broader question of the future U.S. demand for coal for electricity generation. From 2008 to 2018, the use of coal for electricity declined by 35%. Through 2016, this decline was almost entirely driven by the decline in the price of natural gas, with secondary contributions from environmental regulations. Since 2016, the expansion of wind and solar has also played a role. Although many coal plants have closed, the remaining coal plants are among the newer, larger, and more efficient, and further substitution of natural gas for coal is likely to be limited unless natural gas prices drop even further, which is not expected. Accordingly, the Energy Information Administration projects that, under current policy, use for coal for electricity will fall by an additional 14% through 2022, then by only an additional 10% through 2050.
2. The Powder River Basin (PRB), which is largely mined under Federal coal leases, will continue to the lowest-cost source of US coal. In 2018, the PRB accounted for 43% of coal production, and a higher fraction of thermal (steam) coal production. Thus, Federal coal is likely to continue to be important, if not dominant, in the US coal market.

---

<sup>1</sup> The Energy Information Administration reports that 755.5 million tons of coal were produced in 2018 (<https://www.eia.gov/coal/production/quarterly/xls/t1p01p1.xls>). The Office of Natural Resource Revenue in the Department of Interior (<https://revenue.data.doi.gov/>) reports that 308.8 million tons were mined under Federal leases and an additional 13.4 million tons were mined on Native American lands.

3. A threshold question for whether to view Federal coal policy as a climate issue is whether a policy action that decreased the amount of Federal coal mined would meaningfully change the *total* amount of coal burned and total CO<sub>2</sub> emissions from the power sector. Because removing some or all Federal coal from the coal supply would decrease coal supply, coal prices would increase so coal demand would fall and generation would switch to cleaner sources; the question is, by how much. In Gerarden, Reeder, and Stock (2018), we estimated that increasing royalties on Federal coal to match the Social Cost of Carbon (the monetized net present value of the climate damages imposed by an additional ton of CO<sub>2</sub> emissions) or, alternatively, issuing no new leases, would induce only small substitution of non-Federal for Federal coal and would reduce cumulative emissions through 2035 by an amount comparable to the (now-withdrawn) Clean Power Plan. The annual emissions reduction in 2035 would be several times the amount were the rollback of the Obama post-2021 CAFE standards reversed. The estimates in Gerarden, Reeder, and Stock (2018) used data from 2015 so need to be updated, but they indicate that the policy decisions about the Federal coal program have meaningful climate impacts.
4. Even though the climate impacts of the Federal coal program are large, whether policy actions should in fact be based on climate considerations depends, among other things, on how costly those decisions would be. Estimates in Gerarden, Reeder, and Stock (2018) suggest that a royalty increase equaling the Social Cost of Carbon would increase retail electricity prices by 2%. That is likely to be an overestimate because natural gas and renewable prices and the share of coal generation have all come down substantially, relative to the assumptions used for those calculations.
5. Should Congress choose to scale back the Federal coal program, the policy options include:
  - (i) Ending coal leasing on Federal lands, perhaps with some phase-out considerations such as certain lease modifications.
  - (ii) Increasing significantly the royalty rate on Federal coal, for example by incorporating a carbon charge into the royalty.
  - (iii) Imposing a carbon budget for Federal coal mined in new leases, thereby capping cumulative emissions in the Federal coal program.

Exemptions could be made for coal burned using carbon capture and storage. Because new Federal leases last for 20 years, and lease renewals last for 10 years, and because Secretary Zinke's order lifting Secretary Jewell's moratorium on Federal coal leases has led to several new coal leases, all three of these policies would provide the electricity market with a 20-year glide path with existing leases grandfathered.

6. If Federal leasing were phased out, mining employment on Federal leases would decline over the 20-year period of the phaseout. In 2015, mining employment in Wyoming (the location of most PRB production) was 6,635; by 2018, it was 5,534, and just last week, 700 more jobs were lost with the closure of the Eagle Butte and Belle Ayr mines near Gillette, Wyoming. Depending on how the phaseout is implemented, it could have substantial effects on certain state budgets, most notably Wyoming, which relies heavily on surface coal severance fees. During the phaseout, Eastern and Midwestern coal mining employment would get a boost because of the substitution effect.

## Policy Framework

Evolving policy goals have shaped Federal coal leasing for many decades. A policy goal of nineteenth century minerals policy was to promote the settlement of the American West. Coal mining in the Powder River Basin (PRB) started in the 1920s, however production volumes were small.<sup>2</sup> In the 1970s, policy goals evolved in response to increasing awareness of the environmental damages from burning high sulfur coal. In addition, the energy crisis of the 1970s led to new concerns about energy security, which resulted in a drive to replace natural gas and imported oil as sources of power generation with domestic coal.<sup>3</sup> As a result, the first large-scale open pit mines in the Powder River Basin were opened in the 1970s, starting a period of rapid growth in coal production.

Energy and environmental issues today are very different than they were in the 1970s. The power sector now relies almost entirely on fuels that are domestically produced or, like Canadian hydropower, are purchased under long-term contracts. In particular, the sector does not use significant amounts of oil, so electricity generation is no longer subject to international supply disruptions and price volatility. Because the power sector relies almost entirely on domestic fuels and sources, the energy security policy goal is no longer a relevant consideration for Federal coal policy. Similarly, this Administration's energy dominance policy goal is not relevant for coal, because the substitute for domestic coal is domestic gas, wind, or solar, and because coal exports are small and likely to continue to be constrained by coal export capacity.

Environmental needs have also changed. According to the Energy Information Administration (EIA), annual U.S. power sector emissions of sulfur oxide fell by 88% from 1997 to 2017<sup>4</sup>, a result of the Acid Rain Program under the 1990 Clean Air Act Amendments<sup>5</sup> which led to the adoption of scrubbers for high-sulfur Eastern and Midwestern coal and, since 2010, the substitution of cleaner natural gas for coal in electricity generation. Because of scrubbers for Eastern coal, the declining sulfur dioxide emissions as coal is replaced by natural gas and renewables, and the success of the EPA's tradeable permit system for SO<sub>2</sub>, the environmental benefits of promoting low-sulfur PRB coal no longer need to be a major driver of Federal coal policy. In fact, recent research (Holland et. al. (2018)) suggests that there have been large gains in health benefits since 2010 from reduced particulates from burning coal, as coal (including PRB coal) has been replaced by natural gas and renewables.

Instead, the great environmental challenge we are facing today is climate change. This challenge was largely unrecognized in the 1970s when the Federal coal program was last reformed. From an economist's perspective, the reason climate change is a problem warranting policy attention is that it stems from a market failure: the lack of a price on emissions of carbon dioxide (CO<sub>2</sub>) creates an externality so that burning fossil fuels is cheaper than it would be were the price to reflect the economic damages to others of doing so. This logic, applied to sulfur dioxide pollution, led EPA to impose a price on sulfur dioxide emissions from power plants through its successful cap-and-trade system. Absent such a price on CO<sub>2</sub>

---

<sup>2</sup> Consadine (2013).

<sup>3</sup> Wyoming State Geological Survey, "Powder River Basin Coal Field," at <https://www.wsgs.wyo.gov/energy/coal-prb>.

<sup>4</sup> US EIA, "Changes in coal sector led to less SO<sub>2</sub> and NO<sub>x</sub> emissions from electric power industry," *Today in Energy*, December 11, 2018 at <https://www.eia.gov/todayinenergy/detail.php?id=37752>.

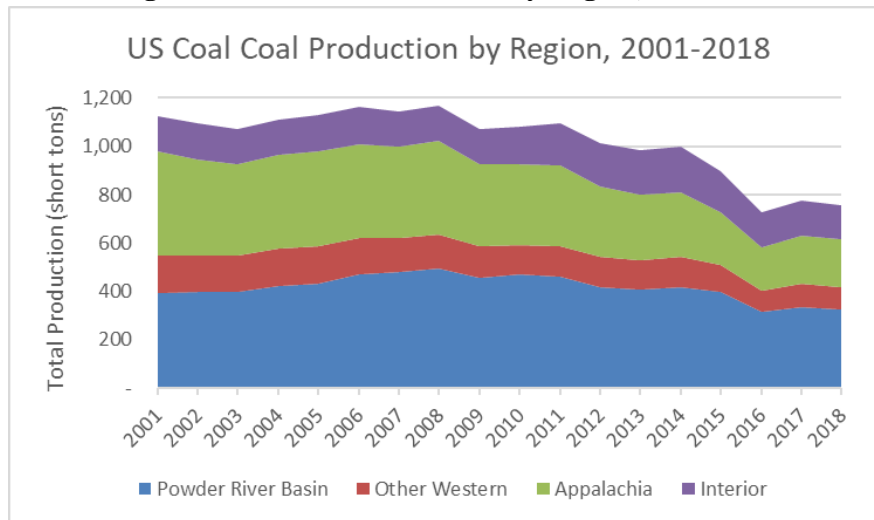
<sup>5</sup> US EPA, Acid Rain Program, at <https://www.epa.gov/airmarkets/acid-rain-program>.

emissions, it is relevant to consider the climate consequences of Federal coal leasing policy (Gillingham and Stock (2016)).

### Trends in Coal Production and Consumption

**US coal production has declined by 35% since 2008.** As shown in Figure 1, US coal production fell from 1,170 million short tons in 2008 to 728 million short tons in 2016, increasing slightly to 755 million short tons in 2018. The decline in coal production has been greatest in Appalachia, where production fell by 49% from 2008 to 2018; in the PRB, production fell by 35% over this period.

**Figure 1. U.S. Coal Production by Region, 2001-2018**

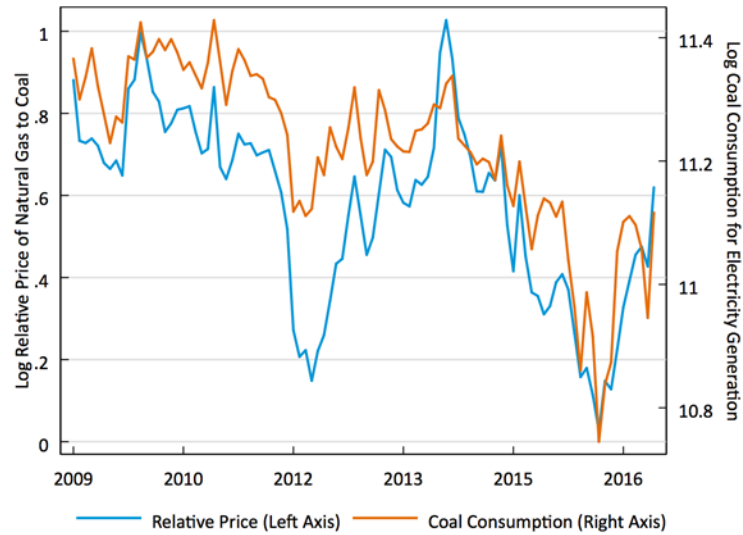


These production figures include both thermal (steam) coal for electricity generation and metallurgical coal. Thermal and metallurgical coal are two separate markets. Because Federal coal is thermal coal and the focus of climate concerns currently is thermal not metallurgical coal, it is useful to exclude metallurgical coal. Because metallurgical coal exports have fluctuated around approximately 60 million short tons from 2010-2018, these total production declines mask an even greater decline in production of thermal (steam) coal for electricity generation.

***The main driver in the decline in US coal production since 2008 has been the fall in natural gas prices.***

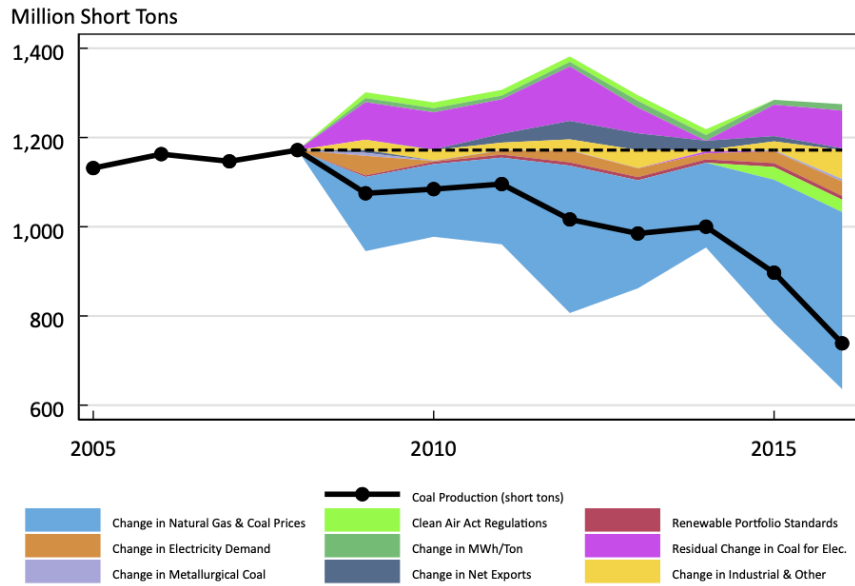
As shown in Figure 2, coal use for electricity generation moves closely with the price of natural gas, relative to coal.

**Figure 2. Monthly U.S. coal use at electrical generating facilities and relative price of natural gas to coal, 2009-2016.**



*Notes:* Coal consumption and relative prices are in logarithms. Data are monthly and seasonally adjusted. *Source:* Coglianesi, Gerarden, and Stock (2018, Figure 5).

**Figure 3. Decomposition of changes in annual coal production, 2008-2016**



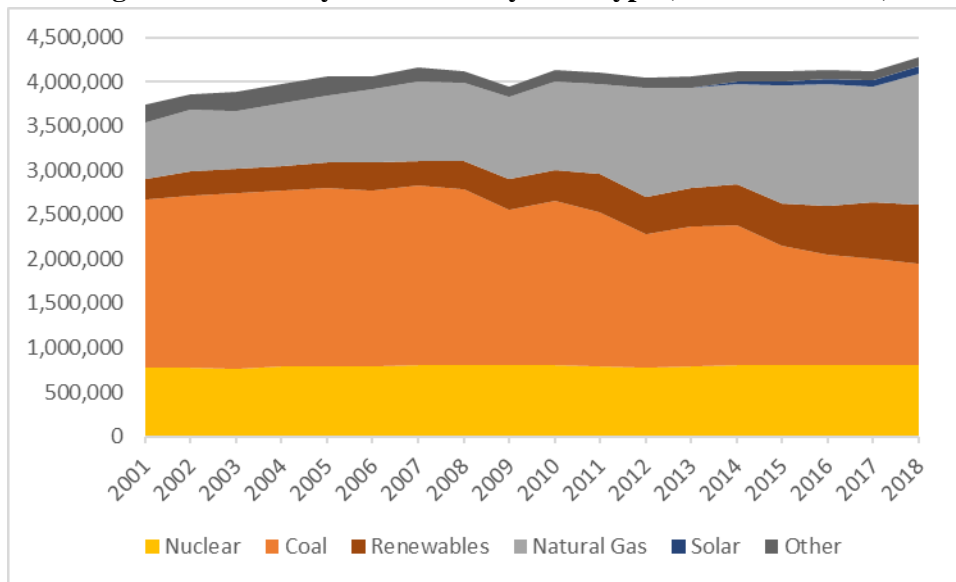
Sources: EIA Form 923, Electric Power Monthly, EIA API, FRED.

*Source:* Coglianesi, Gerarden, and Stock (2018, Figure 1)

Coglianesi, Gerarden, and Stock (2018) decompose the decline in coal production from 2008 to 2016 into the effects of declining natural gas prices, environmental regulation, renewable portfolio standards, improvements in coal plant heat rates, overall electricity demand, changes in industrial use, net exports of thermal coal, demand for metallurgical coal, and an unexplained residual. The resulting decomposition is shown in Figure 3. We estimate that falling price of natural gas relative to coal is responsible for 92% of the total decline in coal production over this period and that environmental regulations account for an additional 6%, with other factors making small and offsetting contributions. These estimates are consistent with other estimates in the literature of the importance of natural gas and renewables in the post-2008 decline in coal-generated electricity (Houser, Bordoff, and Marsten (2017), Fell and Kaffine (2018)).

*The increase in natural gas prices in 2017 slowed the penetration of natural gas temporarily and produced a temporary plateau in coal generation, but coal generation fell again in 2018 as natural gas generation increased and as large amounts of new wind and solar capacity came on line.* Henry Hub spot natural gas prices averaged \$3.15 in 2018, up 25% from an average of \$2.52 in 2016 and up 80% from their monthly trough of \$1.73 in March 2016. This increase induced a small decline in gas generation and a hiatus in the decline in coal generation, with the gap filled by increased wind generation (Figure 4). The increase in wind penetration reflects the fact that wind generation is driven by wind capacity, which increased sharply in 2016 and 2017, because electricity from wind has a very low marginal cost.

**Figure 4. Electricity Generation by Fuel Type (thousands MWh)**



Source: Energy Information Administration.

**Projections of demand for thermal coal and for Federal coal.** In its 2019 *Annual Energy Outlook*, the Energy Information Administration reference case projects that domestic coal demand will decrease by, on average, 5% per year from 2018 to 2021, but then decline by only an additional cumulative 11% from

2021 through 2050.<sup>6</sup> Even in 2050, the *EIA* reference case projects that coal will provide 10% of US energy. These projections assume current policy (including continuation of the Zinke order lifting the ban on new leases). The *EIA* projections are consistent the decomposition in Coglianesse, Gerarden, and Stock (2018), under the assumption that natural gas prices, relative to coal prices, will be stable or rise somewhat going forward. An important source of uncertainty in these projections is whether the declines in prices of wind and natural gas will continue. If so, then those prices will put pressure on coal and there would be additional conversion from coal to wind and solar, as was seen in 2017 and 2018.

As the price of renewables declines, the shift away from coal will occur where renewables and natural gas are cheapest and where coal (including transportation) is most expensive. Because PRB coal is the lowest-cost coal in the market (even after adjusting for thermal content), PRB coal will continue to be competitive when used in large efficient plants.

It is hard to envision an increase in demand for Federal coal. The recent bankruptcy filing of Blackjewel and the closing of the Eagle Butte and Belle Ayr mines is a further indicator of the weak demand for coal generally, even low-cost PRB coal. On the other hand, the *EIA* scenario might overstate future demand for coal, if the prices of wind, solar, and storage fall below *EIA*'s projections. Additional pressure for wind and solar could come from recent ambitious expansions of Renewable Portfolio Standards in some states.

### **Cost of CO<sub>2</sub> Emissions from Burning Federal Coal**

The emission of CO<sub>2</sub> from burning coal contributes to climate change and, because those emissions, are unpriced, creates an externality. The Social Cost of Carbon (SCC) is the monetized net present value of the climate damages imposed by an additional ton of CO<sub>2</sub> emissions. Ascertaining a value for the SCC is difficult because of the uncertainty surrounding many of its elements.<sup>7</sup> Using the final schedule produced by the Obama Administration, the estimate of the SCC for a metric ton of emissions today is approximately \$50 in today's dollars. In its Regulatory Impact Assessments, the Trump Administration uses an estimate of the SCC that uses only the domestic portion of damages, which yields a value of \$7 assuming a 3% real discount rate.<sup>8</sup> My own view is that, because climate change is a global problem that requires global coordination and leadership of all developed countries, that the global value is appropriate and the domestic is not. For the purpose of this statement, however, I use both the global and domestic value.

---

<sup>6</sup> Wood-McKenzie projects an increase in wind production coming online in 2020, the final year in which a wind farm can be finished and receive the wind Production Tax Credit.

<sup>7</sup> The National Academy of Sciences (2017) provided recommendations for improving the scientific integrity of the SCC. There is currently a major project under way to implement those recommendations and to provide an open platform for future SCC work. This project is being led by Resources for the Future (at <https://www.rff.org/energy-and-climate/social-cost-carbon/>) and involves institutional collaboration with the climate economics labs at Chicago and Berkeley and with individual scholars.

<sup>8</sup> In its RIAs using the SCC (e.g. of the ACE and SAFE rules), EPA currently reports values using both a 3% and 7% real discount rate. OMB Circular A-4 recommends using the 3% real discount rate when the tradeoff involves consumption of future vs. current generations, which is the case for the SCC. If the discount rate is chosen using the real cost of funds to the Federal government, a lower rate than 3% would be in order because of the decline in the risk-free equilibrium rate (e.g. Del Negro et. al.(2017)).

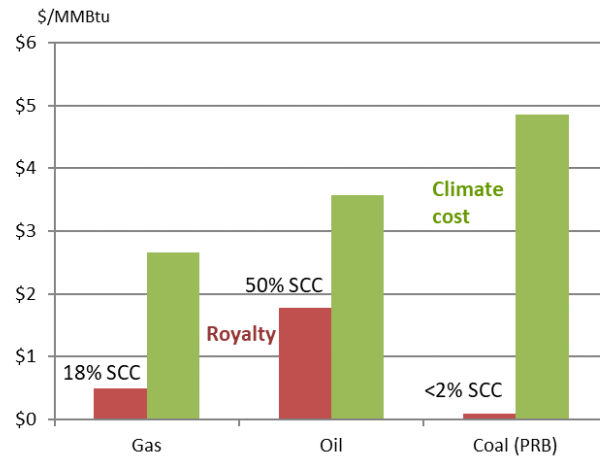
Table 1 summarizes the monetized values of climate damages for PRB coal. Because one short ton of PRB coal produces approximately 1.7 metric tons of CO<sub>2</sub>, burning one short ton of PRB coal produces climate damages of \$85, evaluated at the \$50 SCC. This is seven times the selling price of the coal. Using the \$50 SCC, the total climate damages from burning the PRB coal mined in 2018 is \$28 billion; using the \$7 SCC, the total climate damages is \$4 billion.

Because these climate damages are not priced, the price of PRB coal is below the value that would be set were future generations to have a say in it and receive compensation for their damages. Were the price of PRB coal to reflect (internalize) its full market damages, its price would be increased by the SCC valuation of its combustion, so would be approximately \$12 + \$85 = \$97/ton using the \$50 SCC (or \$24/ton using the Trump Administration SCC).

**Table 1. Climate Costs of Burning Powder River Basin Coal**

	Obama Administration	Trump Administration SCC
SCC (\$ per metric ton)	\$50/metric ton	\$7/metric ton
Climate damages from burning one short ton of PRB coal	\$85/short ton	\$12/short ton
Current price of PRB coal per short ton	\$12.25/short ton	\$12.25/short ton
Federal royalties per ton of PRB coal	\$1.50/short ton	\$1.50/short ton
PRB production, 2018	324 million short tons	324 million short tons
Total climate damages, 2018	\$28 billion	\$4 billion

**Figure 5. Climate costs of burning fossil fuels, compared to their Federal royalty rate.**



Notes: Assumed market prices: gas, \$2.6/MMBtu; crude oil, \$55/barrel; Coal, \$12.25/short ton. Oil and gas royalties are computed at the offshore rate of 18.75%, coal royalty is computed at the surface mining rate of 12.5%. Assumed value of the SCC is \$50/metric ton CO<sub>2</sub>. Source for prices and energy conversion factors and CO<sub>2</sub> emissions per MMBtu: EIA.

The SCC value of burning one ton of coal provides benchmark for comparing Federal royalty rates to their climate costs. Figure 5 compares Federal royalties to the SCC damages from burning different fossil



fuels. Because oil is a high-value fuel, the royalty received on a barrel of oil is one-half its climate cost. For natural gas, it is approximately 20% its climate cost. For PRB coal, the royalty received is less than 2% of its climate cost.

### **Estimates of Effects of Ramping Down Federal Coal Production by 2040**

I now turn to the likely economic consequences of a policy of ramping down Federal leasing.

**Policy options.** I consider three policy options, all of which are proposed for analysis in the DOI 2017 Programmatic Environmental Impact Statement Scoping Report, prepared under Secretary Jewell:<sup>9</sup>

- (i) Increase the Federal royalty rate to account for the climate impacts of its combustion, specifically increasing the royalty rate by a percentage of the SCC.
- (ii) Withdrawal of Federal coal from the minerals leasing program (no new leasing or lease modifications).
- (iii) Issue leases subject to a carbon budget.

The base case alternative is a continuation of the Zinke order lifting the pause. In all cases, I assume that the final version of the Affordable Clean Energy rule is in effect.<sup>10</sup>

The three policy options would have similar effects on electricity prices, coal production, CO<sub>2</sub> emissions from the power sector, and mining employment. The main difference among these policies is whether the revenues resulting from tightening the supply of Federal coal accrue to State and Federal governments or to the coal companies.

For numerical estimates, I focus on the royalty rate policy because it was analyzed in detail in Gerarden, Reeder, and Stock (2018). That paper uses the Integrated Planning Model (IPM) (a detailed dynamic model of the power sector) to simulate the effect of various changes to Federal royalties on coal and power markets and on state budgets.<sup>11</sup> The main caveat concerning the relevance of the numerical values in GRS is that the simulations were calibrated to data from 2014-15. Since then, the price of renewables has fallen more quickly than expected and gas prices have fallen slightly, so coal use has declined by more than projected in the base case.

---

<sup>9</sup> BLM (2017) volume 1, Executive Summary p. ES-5.

<sup>10</sup> Technically the modeling assumes no CO<sub>2</sub> regulation of the power sector. The Affordable Clean Energy rule restricts emissions reduction mandates to heat rate improvements at existing coal plants and provides states with extensive latitude for waiving or reducing those requirements. The EPA estimates that the Affordable Clean Energy plan will reduce annual power sector CO<sub>2</sub> emissions by 0.5% by 2035, relative to the no-regulation alternative (US EPA (2019)). As a result, for the modeling purposes here, the ACE rule is effectively equivalent to no regulation.

<sup>11</sup> The IPM is used by EPA to estimate the effects of multiple power sector regulations such as the Clean Power Plan and the Affordable Clean Energy rule. The base case in Gerarden, Reeder, and Stock (2018) was constructed to align with the modeling assumptions in the CPP Final Regulatory Impact Analysis.

Under all three of these policies:

- The supply of PRB coal would be restricted and its delivered price would rise. This would induce demand for Eastern and Midwest coal, which would increase their price. However, the extent of this price increase is limited by the presence of abundant natural gas and, in some regions, inexpensive additions to capacity by solar and wind. As a result, only a fraction (one-third to one-tenth, see GRS Figure 9) of the decline in PRB coal would be offset by an increase in Eastern and Midwestern coal production. The remainder of the decline in generation by Federal coal would be picked up by natural gas and renewables.
- Total coal production and consumption would fall and, as a result, CO<sub>2</sub> emissions would decline substantially. The climate impacts of no new leases, or of a 100% SCC royalty increase, are of the same order of magnitude as the Clean Power Plan and are several times larger than the consequences of replacing the Obama post-2021 CAFE standard increases with the proposed SAFE rule.
  - Gerarden, Reeder, and Stock (2018) estimate that increasing the royalty rate on Western coal by 100% of the SCC or, alternatively, allowing no new Federal coal leases, would reduce 2030 emissions by approximately 250 million metric tons annually.
  - For a comparison, Gerarden, Reeder, and Stock (2018) estimate that the cumulative emissions reductions through 2035 for the 100% SCC or no new leases policies would be approximately equal to the cumulative emissions reductions arising under a scenario in which the CPP was put into place but Federal coal leasing policy continued (the Zinke order).
  - As another comparison, the EPA projects that replacing the Obama-era increase in CAFE standards by the proposed flatlining of fuel economy would increase CO<sub>2</sub> emissions in 2035 by approximately 90 million metric tons annually.<sup>12</sup>
  - The assumptions underlying these calculations are from 2014-2015 and the results would change using current data. Because less Federal coal is being burned, the total CO<sub>2</sub> emissions reductions would be less, however projected reductions would still be large under assumptions such as EIA's that project significant coal usage into mid-century under current policy.
- Because of port capacity constraints, there would likely be only a small effect on coal exports from any of these three policies. The most likely effect would be a small decline in exports, all else equal, because of the higher domestic price of both Federal and non-Federal coal. Imports might increase but again that increase would be limited because of port capacity and other infrastructure constraints.
- Ramping down Federal leasing would exert a small upward pressure on electricity prices, because all these policies would increase the price of coal (both Federal and non-Federal). The extent of this increase varies regionally and is the greatest in regions with the most use of PRB coal and with the least availability of inexpensive alternatives (gas, wind, or solar). Gerarden, Reeder, and

---

<sup>12</sup> EPA, Safer Affordable Fuel-Efficient Vehicle Rule for Model Year 2021-2026 Passenger Cars and Light Trucks, Draft Environmental Impact Assessment, Figure S-4 (p. S-15).

Stock (2018) estimate that a royalty increase equal to 100% of the SCC would increase wholesale electricity prices by approximately 7%, which translates into a retail price increase of less than 2%. There several reasons why this might be an overestimate. Most importantly, wind and solar prices have declined, relative to their modeling assumptions, reducing the cost of renewable alternatives. In addition, because less PRB coal is being used now than under the modeling assumptions, less would be displaced by the policy than in their modeling. Moreover, this estimate does not take into account additional technological improvements and cost reductions in wind and solar induced by the additional demand.

- Coal mining and employment in the PRB would decline to zero, or nearly zero, over the next 20 years. This would significantly affect employment, local incomes, and some tribal revenues.
  - The EIA reports 5700 coal mining employees in Wyoming in 2017, and 1146 in Montana.
  - Most coal mining in Colorado and Utah is also on Federal lands, accounting for an additional 2493 mining employees in 2017.
  - As the recent closure of the Blackjewell Eagle Butte and Belle Ayr mines indicates, there is ongoing pressure on mining jobs in the PRB already, and Western mining employment is expected to decline even under the Zinke order. A policy ramping down Federal coal production would accelerate this trend.
- This shift in demand towards Eastern coal would result in a temporary increase in Eastern and Midwestern coal employment and incomes.
- A standard approach used by economists to evaluate the cost-effectiveness of climate policies is to compare the cost per ton of a proposed policy to the SCC. The cost per ton of CO<sub>2</sub> emissions reduction from the 100% SCC royalty surcharge/no new mining would be comparable to the SCC. Gerarden, Reeder, and Stock estimate the abatement costs per ton be approximately \$60/ton in the late 2020s. This estimate does not include the health co-benefits from reducing other pollutants from burning coal.

Ways in which the three policies have different effects:

- Under current law, half of Federal royalties are returned to the state of extraction. Thus, a SCC royalty surcharge could return large sums to Wyoming and more modest sums to other Western states. These sums could be used to buffer the labor and budgetary transition from economies based on coal extraction, and in particular to provide support for heavily impacted communities.
- Alternatively, under the no-new-leases or carbon budget policies, the price of Federal coal would increase as its supply is restricted. That price increase would boost profitability for current coal companies operating leases on Federal lands. If royalty rates were unadjusted, state severance revenues and the states' share of Federal royalties would fall as production falls, posing significant challenges for state budgets, especially Wyoming and Montana.
- The carbon budget approach would create a cap on the total amount of carbon to be emitted from the burning of Federal coal from new leases or lease modifications. A Federal coal carbon budget

could be implemented through a tradeable extraction rights system, similar to cap-and-trade system.

- A Federal coal carbon budget would translate into a given number of tons of Federal coal to be extracted, adjusted for the carbon content of the coal.
- If the extraction rights were auctioned off, the proceeds could be apportioned between the State and Federal governments. If so, the economics of this system would be very similar to those increasing the royalty, except that the value of the extraction permit would fluctuate depending on coal demand conditions.
- If instead the extraction rights were allocated to existing mining companies (e.g., allocated when a new lease or a lease modification is granted), then the value of those rights would accrue to mining companies and would enhance profitability.
- Because the price of the tradeable extraction rights would depend on the demand for Federal coal, the carbon budget/tradeable allocation system would act as a backstop climate policy. If, as some observers argue, renewables prices were to drop below expectations, then demand for Federal coal could fall below the allocation; if so, the price of the tradeable permit would be zero, and the industry would contract because of market forces, not Federal policy. Alternatively, if prices of alternatives to coal were to increase unexpectedly and/or if renewables penetration stalls, then demand for Federal coal could persist and the price of the extraction permit would increase. This increase in the price of extraction permits would increase the price of Federal coal, which would increase the price of non-Federal coal and increase the demand for gas and renewables. In this sense, a carbon budget with a tradeable extraction permit would be a backstop in the event that other policies, such as state RPSs, fail to increase renewable penetration.
- Because a one-ton mining right permit would need to be retired for each ton sold from a new mine, the price of coal from the new mine would increase by the amount of that permit, assuming complete pass-through. Whether the price of the tradeable extraction right is fully passed through depends on overall market conditions and the size of obligated mines relative to grandfathered mines. There is work on pass-through of costs to gasoline prices that bears on this issue, but I am not aware of studies of the price effects of such a system applied to mining rights and this topic needs further study.

## References

- Coglianesi, John, Todd Gerarden, and James H. Stock. 2018. The Effects of Fuel Prices, Environmental Regulations, and Other Factors on U.S. Coal Production, 2008-2016. Working Paper. [https://scholar.harvard.edu/files/stock/files/coglianesi\\_gerarden\\_stock-coal\\_production\\_decline\\_rev\\_dec2018.pdf](https://scholar.harvard.edu/files/stock/files/coglianesi_gerarden_stock-coal_production_decline_rev_dec2018.pdf).
- Consadine, Timothy J. (2013). "Powder River Basin Coal: Powering America," *Natural Resources* 4, 514-533.
- Del Negro, Marco, Domenico Giannone, Marc P. Giannoni and Andrea Tambalotti. "Safety, liquidity, and the natural rate of interest." *Brookings Papers on Economic Activity* 1 (2017): 235-316.
- Fell, Harrison, and Daniel T. Kaffine. 2018. "The Fall of Coal: Joint Impacts of Fuel Prices and Renewables on Generation and Emissions." *American Economic Journal: Economic Policy* 10 (2): 90-116.
- Gerarden, Todd, W. Spencer Reeder, and James H. Stock (2019) "Federal Coal Program Reform, the Clean Power Plan, and the Interaction of Upstream and Downstream Climate Policies," forthcoming, *American Economic Journal: Economic Policy*.
- Gillingham, Kenneth T. and James H. Stock (2016). *Aligning Federal Minerals Leasing Policy and Climate Policy*, Report, The Hamilton Project.
- Holland, Stephen P., Erin T. Mansur, Nicholas Z. Muller, and Andrew J. Yates (2018), "Decompositions and Policy Consequences of an Extraordinary Decline in Air Pollution from Electricity Generation," NBER Working Paper 25339.
- Houser, Trevor, Jason Bordoff, and Peter Marsters. 2017. "Can Coal Make a Comeback?" Columbia Center on Global Energy Policy.
- National Academy of Sciences (2017). *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* at <https://www.nap.edu/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of>.
- U.S. Environmental Protection Agency (2019). *Regulatory Impact Analysis for the Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units* at <https://www.epa.gov/stationary-sources-air-pollution/regulatory-impact-analysis-repeal-clean-power-plan-and-emission>.
- U.S. Bureau of Land Management (2017). *Federal Coal Program Programmatic Environmental Impact Statement – Scoping Report*.