

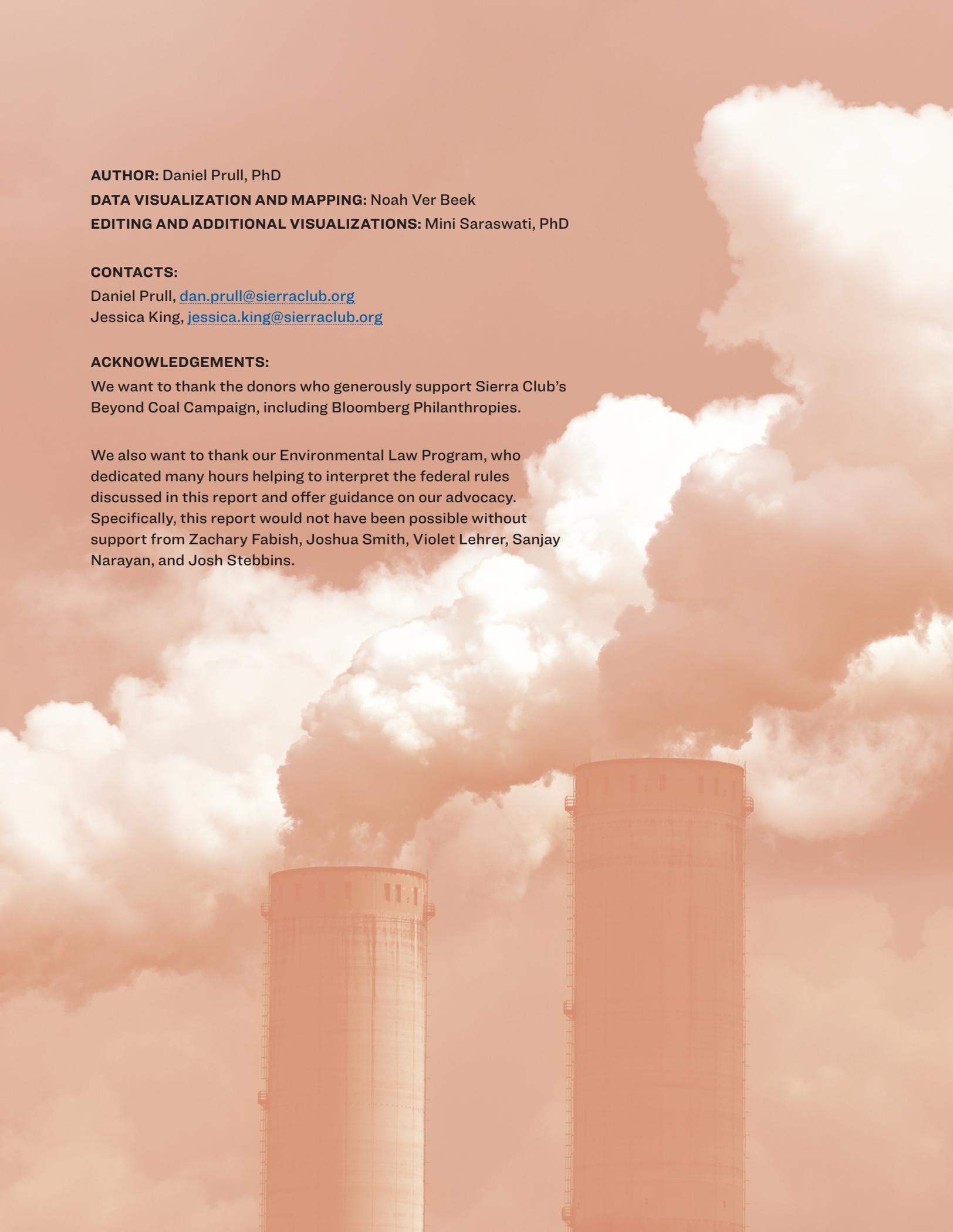
UNDER CONTROLLED

How Federal Rules Could Curb Coal Plant Pollution



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EXECUTIVE SUMMARY

Combustion of coal results in the emission of various pollutants — including sulfur dioxide (SO₂), nitrogen oxides (NO_x), and directly emitted particulate matter (PM_{2.5}). These emissions are all harmful to public health on their own, and also contribute to ambient PM_{2.5} pollution.

Our previous report, [“Out of Control: The Deadly Impact of Coal Pollution”](#) found that exposure to PM_{2.5} from remaining¹ coal-fired power plants in the United States causes an estimated 3,800 premature deaths per year. Modern pollution controls, when optimized and operated consistently, significantly reduce the level of emissions from coal combustion; namely, flue-gas desulfurization (FGD) to control SO₂, selective catalytic reduction (SCR) to control NO_x, and a baghouse (BH) to control direct PM_{2.5} emissions. However, of the 160 coal plants remaining today, only 19% have all three controls installed. We estimate that on average, units which lack SCR controls for NO_x and/or BH controls for PM are twice as deadly per energy generated as those that are fully controlled. Moreover, units which lack FGD controls for SO₂ are over three times as deadly.

There are a number of existing federal air pollution rules which present near-term opportunities for the Environmental Protection Agency to reduce harmful pollution from coal-fired power plants under the Clean Air Act — namely, amendments to the Mercury and Air Toxics Standards; attainment status updates for the 2008 and 2015 Ozone National Ambient Air Quality Standards (NAAQS); enforcement of the final Federal Good Neighbor Plan for the 2015 Ozone NAAQS; enforcement of the 2010 SO₂ NAAQS; and requirements for strong and comprehensive Round 2 Regional Haze state plans. In this report, we analyze the extent to which each of these rules could require upgrades to existing pollution controls, emission reductions commensurate with retrofit of new pollution controls, or enforceable retirement announcements.

Our analysis shows that 53% of remaining coal-fired power plants will face a decision point on retrofitting with pollution controls or retiring one or more generating units to comply with these rules. An additional 11% of remaining coal-fired power plants will need to improve existing pollution controls. Many of these plants will require multiple pollution control improvements which could impose untenable costs leading to additional decision points on retrofitting or retiring to comply. In total, generating units impacted by these rules account for 68% of SO₂ emissions, 65% of NO_x emissions, and 66% of PM_{2.5}-related premature deaths from coal. Furthermore, as designed, these rules would have the greatest impact on the worst polluters. By generating capacity, over 50% of remaining coal units that lack one or more pollution controls,² and 80% of units that are totally uncontrolled³ would face a decision point on retrofitting with pollution controls or retiring to comply. Together, if properly enforced, these rules can work in concert to force utilities to account for the true cost of their undercontrolled coal plants.

INTRODUCTION

Our previous report, [“Out of Control: The Deadly Impact of Coal Pollution”](#) detailed the widespread impact of PM_{2.5} pollution from remaining⁴ coal-fired power plants in the United States. We found that exposure to this pollution causes an estimated 3,800 premature deaths per year. The impact that a given plant has on public health is a function of how often the plant is operated, what type of fuel it burns, population density downwind, as well as the overall level of emissions.

Modern pollution controls, when optimized and operated consistently, significantly reduce the level of emissions from coal combustion; namely, flue-gas desulfurization (FGD) to control SO₂, selective catalytic reduction (SCR) to control NO_x, and a baghouse (BH) to control direct PM_{2.5} emissions. Often, individual generating units at a coal-fired power plant will have their own set of pollution controls. Depending on the age, technology, and ownership of the individual generating units, many plants will have some units that are well controlled for a given pollutant and others that are not. **Table 1** lists the most deadly power plants which remain today — representing over half of premature deaths from coal PM_{2.5} pollution exposure — as well as the percentage of those deaths

that are attributable to generating units that lack modern pollution controls. It’s clear from these percentages that nearly all of the deadliest plants lack at least some form of pollution control.

In addition, some units with pollution controls only operate those controls for part of the year (e.g. during ozone season⁶), or have controls that are out of date and ineffective. For example, despite Martin Lake and Coyote having FGD controls installed, these plants had much higher SO₂ emission rates in 2019 than any other plants in **Table 1**. This is due to the FGD controls at these plants operating at [50-60% SO₂ removal efficiency](#); whereas well-optimized FGD controls can operate at 98% efficiency or higher.⁷ Similarly, New Madrid has one of the

Table 1: The most deadly remaining coal-fired power plants,⁵ their pollution controls and emissions, and populations living within 20 miles. Source: Sierra Club analysis of data provided by Clean Air Task Force, S&P Global, and EPA.

Plant Name	Annual PM _{2.5} Related Deaths				2019 SO ₂		2019 NO _x		2019 Direct PM _{2.5}		Population within 20 miles
	Total	% from Units Lacking FGD	% from Units Lacking SCR	% from Units Lacking BH	Thou-sand tons	lb/ MMBTU	Thou-sand tons	lb/ MMBTU	Thou-sand tons	lb/ MMBTU	
General James M Gavin	244	0%	0%	100%	26	0.38	7	0.11	2.1	0.03	83,337
Labadie	195	100%	100%	100%	34	0.47	7	0.09	1.4	0.02	621,587
Keystone	160	0%	0%	100%	20	0.35	7	0.13	7.4	0.13	173,044
Shawnee	154	84%	84%	0%	16	0.45	8	0.22	7.9	0.22	101,160
Martin Lake	154	0%	100%	100%	47	0.73	9	0.15	0.9	0.01	117,630
Cardinal	132	0%	0%	100%	7	0.19	4	0.08	4.1	0.08	232,251
Harrison Power Station	122	0%	0%	100%	11	0.18	6	0.09	1.3	0.02	152,026
W. A. Parish	109	95%	0%	0%	29	0.42	4	0.05	1.2	0.02	1,741,195
Ghent	95	0%	44%	0%	9	0.16	6	0.12	1.7	0.03	79,350
New Madrid	90	100%	0%	100%	13	0.41	14	0.43	0.4	0.01	24,973
Prairie State Generating Station	76	0%	0%	100%	11	0.16	4	0.06	1.3	0.02	69,713
Antelope Valley	70	0%	100%	0%	11	0.32	4	0.11	1.2	0.03	8,547
Coyote	68	0%	100%	0%	10	0.87	5	0.46	0.3	0.02	8,299
Homer City Station	67	0%	0%	47%	8	0.21	4	0.12	5.0	0.13	181,039
Mill Creek	66	0%	0%	0%	2	0.07	7	0.16	0.9	0.02	815,502
Jim Bridger	60	0%	51%	100%	9	0.15	7	0.12	0.4	0.01	183
Bowen	59	0%	0%	52%	9	0.16	6	0.10	0.3	0.01	505,187

highest NO_x emissions rates despite having SCR controls installed — however, these SCR controls are only used 3-4 months per year.

To isolate the impact of pollution controls from the size and operation of each generating unit, we investigated the relationship between mortality and total net generation. A cursory analysis of the remaining coal fleet shows that, on average, units which lack SCR controls for NO_x and/or BH controls for PM are twice as deadly per energy generated as those that are fully controlled. Moreover, units which lack FGD controls for SO₂ are over three times as deadly (see **Figure A1** in the Appendix). Regardless of how large a coal plant is and how often it runs, having effective pollution controls installed makes a marked difference on how much harm that plant causes.

The vast majority of power plants that have pollution controls installed have done so in order to comply with standards set in the [Clean Air Act](#). The Clean Air Act (CAA) was established to protect human health and the environment in the United States from air pollution. Among other things, it authorizes and requires the Environmental Protection Agency (EPA) to establish minimum national standards for air quality. For example, using this authority, EPA has promulgated National

Ambient Air Quality Standards (NAAQS) for six air pollutants — including SO₂, PM and ozone (to each of which coal-power plants are a major contributor). In addition, the CAA requires EPA to periodically review and revise each standard. These revisions present a crucial opportunity to assess major sources of pollution as well as establish cost-effective technologies to reduce that pollution. While the CAA authorizes EPA to set standards, the states are responsible for establishing plans to attain and maintain them. If states submit inadequate plans to protect air quality, then EPA must step in and enforce its own plan.

There are a number of existing federal air pollution rules which present near-term opportunities for EPA to reduce harmful pollution from coal-fired power plants. The mechanisms by which these rules impact coal-fired power plants is discussed in the remainder of this report. Although these rules are intentionally limited in scope, they all have the co-benefit of reducing deadly particulate pollution. Together, if properly enforced, these rules can work in concert to force utilities to account for the true cost of their undercontrolled coal plants.

FEDERAL AIR POLLUTION RULES

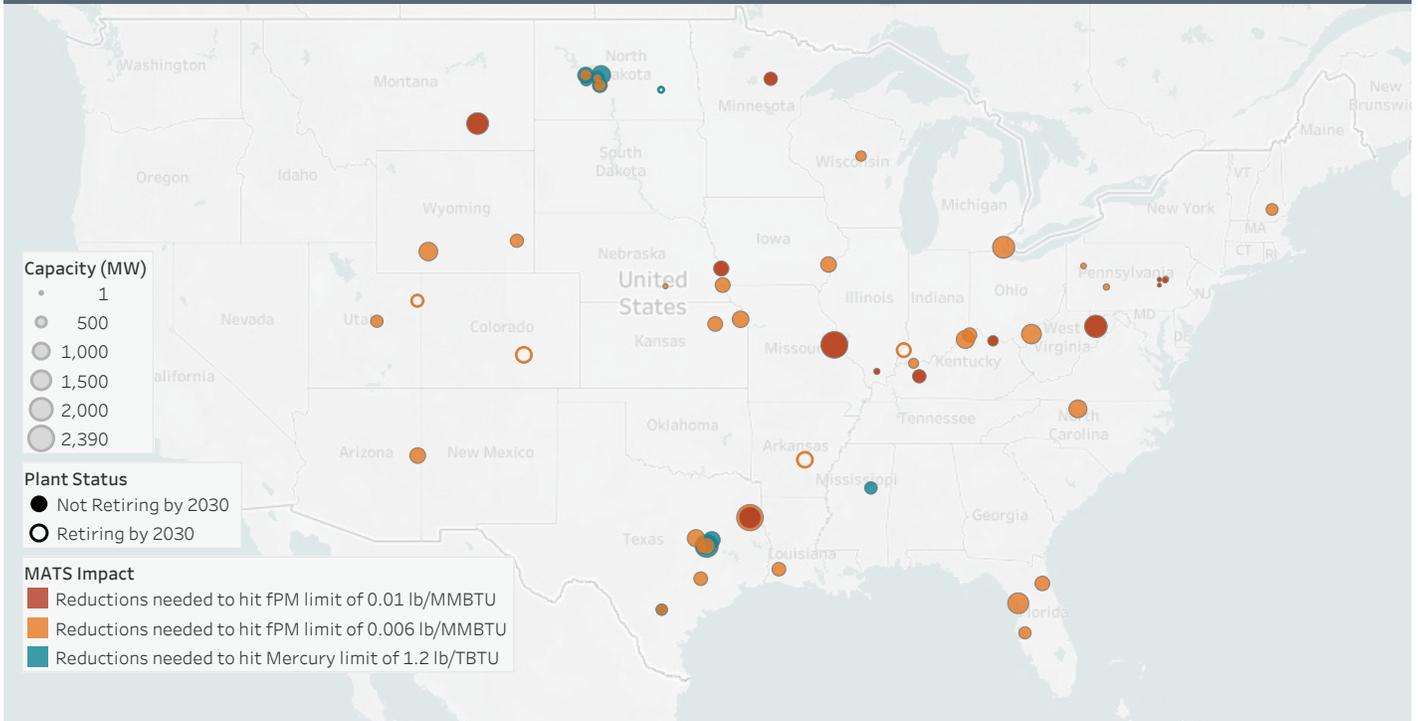
MERCURY AND AIR TOXICS STANDARDS

One of the most impactful rules crafted specifically to curb pollution from coal-fired power plants has been the Mercury and Air Toxics Standards (MATS). In the decade since the 2012 MATS rule was implemented, mercury emissions from power plants have declined by [85 percent](#). The CAA requires EPA to revisit the rule to reflect developments in pollution-control technology every eight years. Pursuant to that review, in April 2023, EPA [proposed four improvements](#) to the standards finalized in 2012: (1) reducing the particulate matter limit, which governs metallic toxics such as arsenic and chromium, to 0.01 lb/MMBTU⁸ (EPA is taking comment on whether it should lower the limit further to 0.006 lb/MMBTU); (2) requiring continuous monitoring of particulate emissions (which is likely to reveal additional underperforming plants); (3) reducing the mercury limit for lignite plants from 4.0 lb/TBTU to 1.2 lb/TBTU (the limit applicable to non-lignite plants); and (4) eliminating the four-hour exemption included in the current startup and shutdown provisions.

In its own [analysis](#) of the of the proposed rule, EPA published data on existing coal-fired generating units that would need to reduce filterable particulate matter (fPM) emissions in order to comply with both the proposed limit of 0.01 lb/MMBTU and an even stronger potential standard of 0.006 lb/MMBTU. Sierra Club assessment of this data shows that 21 generating units across 12 remaining plants would need to reduce emissions in order to achieve the proposed 0.01 lb/MMBTU fPM standard (shown as red dots in **Figure 1**).⁹ An additional 44 units across 32 plants would need to reduce emissions in order to achieve a stronger 0.006 lb/MMBTU fPM standard (shown as orange dots in **Figure 1**). EPA assumes that most impacted units would only need to upgrade their existing particulate controls to comply with the proposed fPM standard. However, under the stronger standard that was evaluated, units which don't already have a baghouse installed would likely need to do so in order to comply.

EPA also published data on mercury emissions rates for existing coal-fired generating units that burn lignite.

Figure 1: Coal-fired power plants impacted by the proposed MATS rule updates. *Source: Sierra Club analysis of data provided by S&P Global and EPA.*



Sierra Club found that 19 remaining units across 11 plants would need to reduce emissions to comply with the proposed mercury (Hg) limit of 1.2 lb/TBTU¹⁰ (shown as turquoise dots in **Figure 1**). Some of these generating units are also impacted by the proposed (or more stringent) fPM standard. In total, we find that a new MATS rule with the proposed mercury (Hg) limit of 1.2 lb/TBTU and a more stringent fPM limit of 0.006 lb/MMBTU would impact 70 generating units accounting for 26% of remaining coal capacity (37 GW). Moreover, half of these units lack a baghouse and will likely face a decision point on retrofitting with pollution controls or retiring in order to comply with a 0.006 lb/MMBTU standard. If these units alone retired to comply with MATS, total premature deaths from coal PM_{2.5} pollution could decrease by over 21%.

Finally, we determined an additional five coal-fired generating units (representing nearly 3 GW of capacity) that would be impacted by the proposed Hg standard or more stringent fPM standard have already planned to retire by 2030 (shown as hollow dots in **Figure 1**). Adopting and enforcing a strong MATS rule will help ensure that the owners of these generating units retire as scheduled or face additional pollution control requirements.

OZONE NATIONAL AMBIENT AIR QUALITY STANDARDS

The Clean Air Act (CAA) requires EPA to set NAAQS for air pollutants considered harmful to public health and the environment, including ozone. While national ozone levels have dropped [over a third](#) from 1980-2015, the [American Lung Association](#) found that as of 2022, 3 out of 8 Americans still live in counties with unhealthy levels of pollution. Sierra Club analysis of [EPA data](#) estimates that as of 2022, coal-fired power plants still account for 10% of anthropogenic NO_x emissions — which is a precursor of ozone.

Federal “Good Neighbor Plan” for the 2015 Ozone NAAQS

The Good Neighbor provision of the CAA requires that upwind states eliminate emissions that contribute to unhealthy levels of pollution in downwind states. This provision ensures that upwind states do not undermine downwind states’ ability to attain and comply with NAAQS. If an upwind state fails to meet its Good Neighbor obligations through an adequate state plan, the CAA requires that EPA promulgate a Federal Implementation Plan (FIP) to ensure compliance. In March 2023, EPA [finalized its FIP](#) to ensure that states meet their Good Neighbor obligations for the 2015 Ozone NAAQS (henceforth referred to as the Good Neighbor Plan).

In developing the Good Neighbor Plan, EPA conducted air quality modeling projecting areas that will not be able to attain the 2015 standards (nonattainment areas) in 2023 and 2026. Through this modeling, EPA found that coal-fired power plants in 22 states were linked to downwind ozone nonattainment areas in 2023. For these states, in order to achieve emissions reductions as soon as possible, EPA set the initial control stringency based on full operation of existing NO_x controls. EPA's modeling also found that 19 states were linked to downwind ozone nonattainment areas in 2026. For coal-fired power plants in these states, the Good Neighbor Plan requires pollution reductions that are commensurate with installing and operating an SCR (for generating units over 100 MW) or SNCR (selective non-catalytic reduction, for generating units under 100 MW) by no later than 2030.

Sierra Club analysis shows that the final rule will require NO_x emissions reductions commensurate with retrofit of SCR or SNCR at 83 uncontrolled generating units across 46 remaining plants (see **Figure 2**).

In addition, according to our analysis, 23 remaining units which have SCR controls installed had 2022 ozone season NO_x emissions rates over 0.08 lb/MMBTU (the allowance level set in the Rule for an optimized SCR). The average ozone season emissions rate for these 23 units in 2022 was over 0.12 lb/MMBTU — thus, these units will likely need to improve operation of their NO_x controls

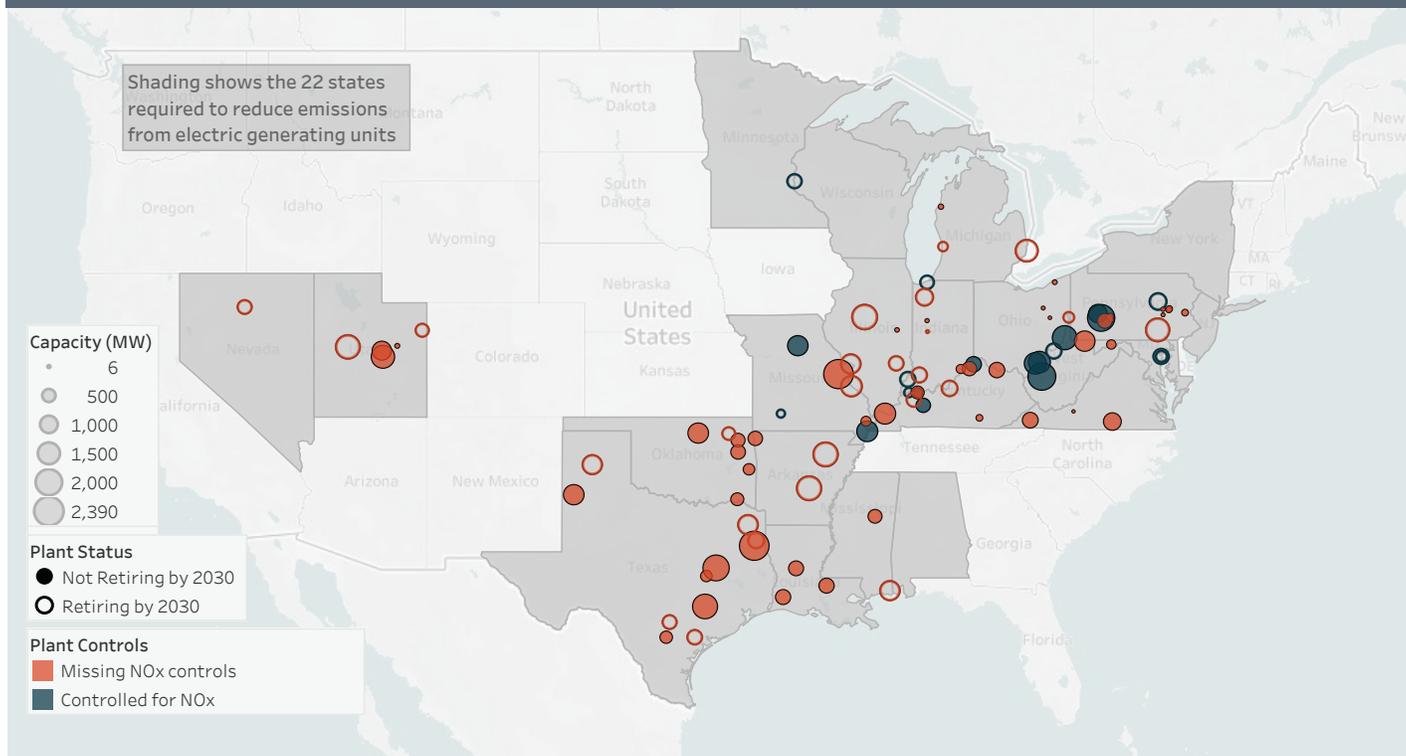
in order to comply with the rule. In total, we find that the Good Neighbor Plan could impact generating units accounting for 30% of remaining coal capacity (41 GW). If owners of generating units which will likely be required to install new pollution controls chose to comply by retiring instead, total premature deaths from coal PM_{2.5} pollution could decrease by over 25%.

Finally, there are a number of generating units which have already announced plans to retire by 2030 that would otherwise be subject to the Good Neighbor Plan. Specifically, there are 45 generating units across 28 plants that lack an SCR and another 12 units at 11 plants that have an SCR but have NO_x emissions rates above the rule's 0.08 lb/MMBTU allowance level. If enforced, the Good Neighbor Plan can help ensure that the owners of these coal plants proceed with their stated plans and timelines to retire, or face additional pollution control requirements.

Ozone Attainment Status Updates

The CAA requires EPA to periodically review the NAAQS to ensure that they are adequate or to update as necessary. The [2015 revision](#) to the 2008 Ozone NAAQS lowered the standard from 75 parts per billion (ppb) to its current level of 70 ppb. However, there are still states today with areas that are failing to attain either standard. Under the Clean Air Act, when areas failing to attain a NAAQS for ground-level ozone do

Figure 2: Coal-fired power plants impacted by the final Federal Good Neighbor Plan for the 2015 Ozone NAAQS. *Source: Sierra Club analysis of data provided by S&P Global and EPA.*



not resolve their air quality problems by the statutory attainment deadlines, they are “bumped up” into a more severe category of ozone nonattainment. Such bump-ups carry additional obligations on states, including requirements to impose “reasonably available control technology” or “RACT”-based limits on large sources of ozone precursor pollutants like NO_x.

In September 2022, in response to legal pressure from the environmental community, EPA finalized a series of bump-up determinations for problematic ozone areas in multiple states under both the [2008](#) and [2015](#) Ozone NAAQS. In turn, this triggered the requirement for states housing those bumped-up ozone areas to develop RACT for their coal plants (and the subsequent requirement for EPA to develop its own RACT plans if those states fail to meet their obligation). RACT for coal plants should consist of emission limits consistent with SCR operation.¹¹ Accordingly, coal plants in those bumped-up states could see requirements to dramatically lower their nitrogen oxide emission rates, which could entail installation of SCR on those units that currently lack controls, or to actually operate SCR on those units that already have it installed.

Figure 3 shows counties that were bumped-up to from “serious” to “severe” nonattainment for the 2008 Ozone NAAQS, and from “marginal” to “moderate” nonattainment for the 2015 Ozone NAAQS. For the 2008 Ozone NAAQS bump-ups, Sierra Club is advocating that State Implementation Plan (SIP)

revisions for reclassified “severe” areas require RACT on sources outside the nonattainment area, but within state borders, if including the controls is necessary or appropriate for areas to reach attainment by the deadline. Our analysis shows that there are 13 units (totaling 7.8 GW) across 6 plants in Texas that lack an SCR and should be subject to RACT (represented as solid turquoise dots in **Figure 3**). In addition, there are 13 units (totaling 6.0 GW) across 9 plants in Texas and Colorado that lack an SCR but have announced plans to retire by 2030 (represented as hollow turquoise dots in **Figure 3**). EPA should ensure that states either make planned retirements binding by the nonattainment deadline or require RACT on these units as well.

For the 2015 Ozone NAAQS bump-ups, Sierra Club is advocating that SIP revisions for reclassified “moderate” areas must include RACT on plants within the nonattainment area or adjacent counties. Our analysis shows that the 2.4 GW Labadie plant (which is adjacent to the Jefferson County, Missouri nonattainment area) lacks SCR and should be subject to RACT (represented as a solid teal dot in **Figure 3**). In addition, Mill Creek in Kentucky and Rawhide in Colorado (totaling 1.0 GW) are in or adjacent-to nonattainment counties. However, the uncontrolled units at these plants have announced plans to retire by 2030 (represented as hollow teal dots in **Figure 3**). Again, EPA should ensure that states either make the retirements binding by the nonattainment deadline or require RACT on these units as well.

Figure 3: Coal-fired power plants linked to areas recently bumped to a higher Ozone NAAQS nonattainment classification. Source: Sierra Club analysis of data provided by S&P Global and EPA.

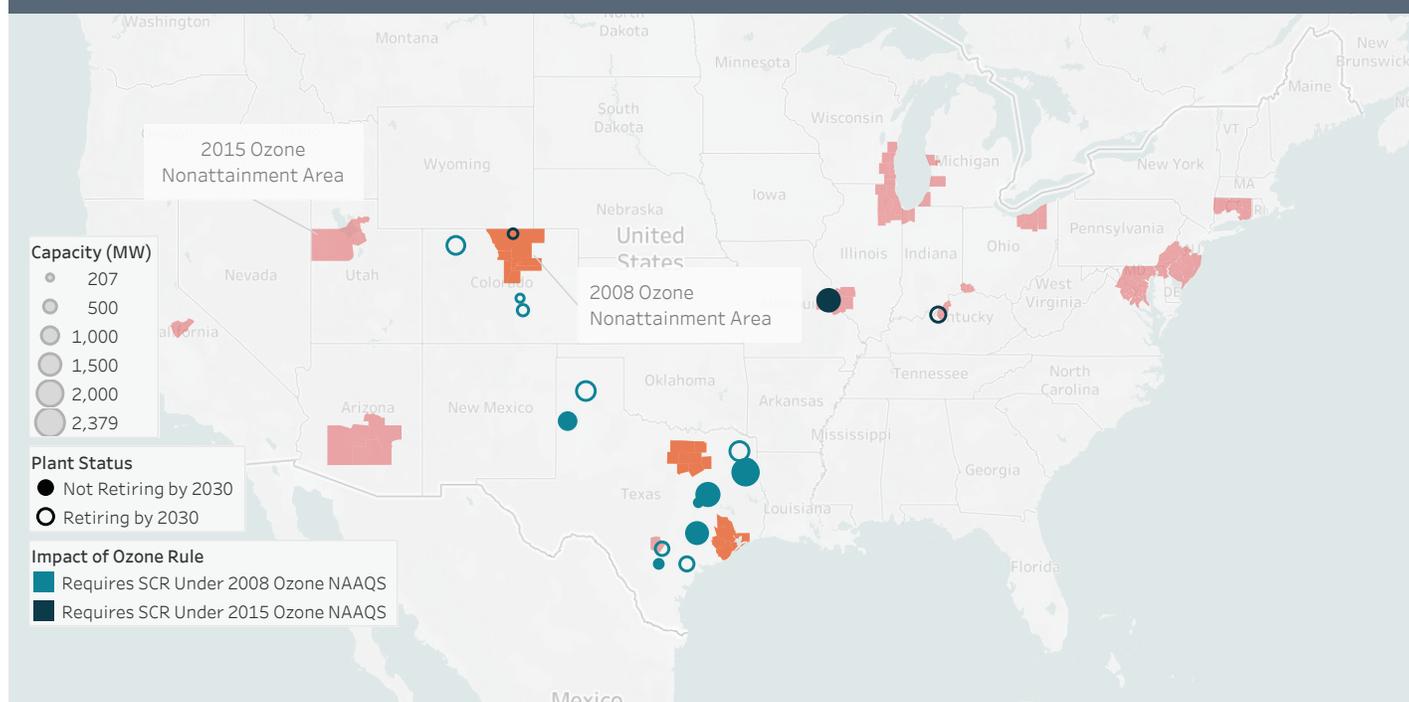
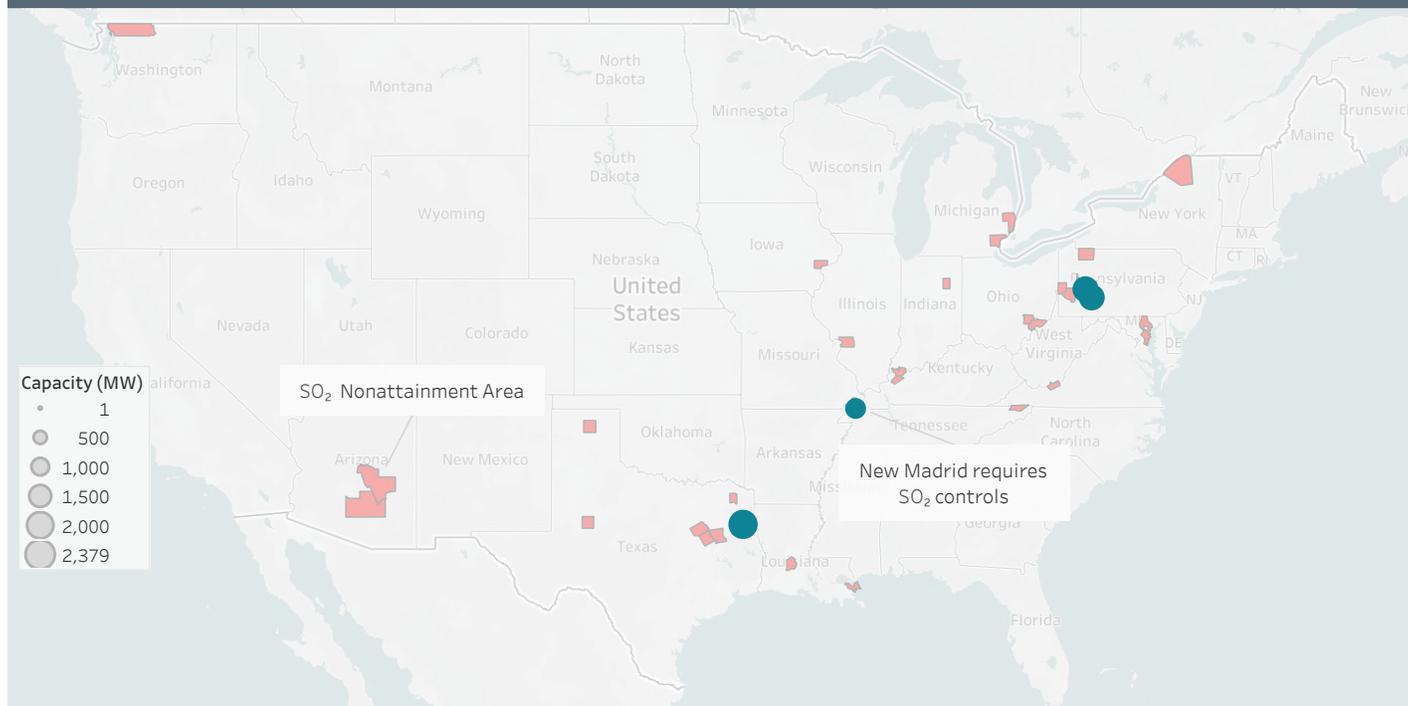


Figure 4: Coal-fired power plants linked to areas still in nonattainment for the 2010 SO₂ NAAQS. Source: Sierra Club analysis of data provided by S&P Global and EPA



In total, our analysis shows that the 2008 and 2015 Ozone NAAQS bump-ups would impact seven remaining plants, representing over 10 GW.

SULFUR DIOXIDE NATIONAL AMBIENT AIR QUALITY STANDARDS

In 2010, EPA revised the [Sulfur Dioxide NAAQS](#), setting a lower 1-hour standard of 75 ppb. Anthropogenic SO₂ pollution overwhelmingly comes from combusting coal, so lowering ambient levels of SO₂ depends in large part on controlling emissions from coal-fired power plants. Additionally, because the NAAQS has a short-term standard of just 1 hour, proper emission limits would require consistent operation of SO₂ controls. As of 2023, the 2010 NAAQS is largely implemented; however, there are some remaining areas where unfulfilled requirements of the NAAQS could result in further pollution reductions from coal plants. In particular, plants in SO₂ nonattainment areas in Texas, Missouri, and Pennsylvania could be required to either install new controls or better operate existing controls:

- In Texas, EPA designated the area around the 2.4 GW Martin Lake plant as being in nonattainment for SO₂. Both Luminant, which owns Martin Lake, and the Texas government have challenged that designation in the 5th Circuit Court of Appeals. While that decision is pending, EPA has missed a deadline to prepare a FIP to resolve the nonattainment area to which Martin

Lake contributes. Although Martin Lake has FGD controls on all 4 units, a strong FIP could require those controls to be improved or for the plant to retire.

- In Pennsylvania, EPA also designated Indiana County as being in nonattainment for SO₂; implicating the four coal plants in the area: Homer City, Keystone, Conemaugh, and Seward. Homer City already has short term, hourly emission limits to protect the NAAQS, but the other plants do not. Although these three plants (totaling 4.3 GW) all have SO₂ controls, a strong FIP from EPA or a SIP from Pennsylvania could impose emission limits forcing the plants to improve their controls or retire.
- Finally, in Missouri, the New Madrid plant is in an SO₂ nonattainment area. In late 2022, the state of Missouri proposed a SIP that failed to require reduced emissions from New Madrid (despite the plant lacking an FGD and emitting over [10 million tons of SO₂](#) a year), and instead relied on emission reductions from a nearby aluminum smelter. Sierra Club is advocating for EPA to reject the SIP and impose a FIP with tightened emission limits for New Madrid which will require a decision point on retrofitting with pollution controls or retiring to comply.

These four plants alone (shown as teal dots in **Figure 4**) represent 7.9 GW of remaining capacity.

threshold to \$10,000/ton¹³ increases the number of generating units required to retrofit with SCR or FGD controls to 32 units across 17 remaining coal-fired power plants; with an additional 14 units across 9 plants required to upgrade existing controls. These 26 plants are shown as solid teal and green dots in **Figure 5**.

In addition, our analysis identified a number of generating units which have already announced plans to retire by 2030 (according to Sierra Club) that would otherwise be subject to installing or improving pollution controls. At a cost effectiveness threshold of \$10,000/ton, 14 such generating units would be required to retrofit with SCR or FGD controls across 9 coal-fired power plants; with an additional 5 units across 3 plants required to upgrade existing controls. These 12 plants are shown as hollow teal and green dots in **Figure 5**. EPA should ensure that these generating units retire based on a timeline commensurate with emissions reductions in the SIPs or enforce them to control their emissions.

- **Units with planned retirement or limiting of operations:** Sierra Club also identified a number of coal-fired generating units for which a screening analysis was not done due to a planned retirement or limiting of operations. The Regional Haze Rule's [planning guidance](#) states that these assumptions were acceptable in a SIP if the retirement or limiting of operations was “enforceable”; moreover requiring states to explain the enforcement mechanism. In total, our analysis found 77 units across 37 plants which lacked a cost-effectiveness analysis due to a planned retirement or limiting of operations (shown as gold circles in **Figure 5**). Only 42 of the 77 units have firm plans to retire by the end of the decade, according to Sierra Club’s Beyond Coal Campaign. Regardless of how firm a utility’s plans are to retire one of these coal generating units, EPA should ensure that those retirements are enforceable in the SIP or a FIP within the implementation period.

- **Units missing cost effectiveness data:** Several states submitted a SIP but neglected or refused to conduct the required four-factor analysis for all major sources. In some cases, there may be multiple coal units or plants with missing cost effectiveness data in the SIPs which are not represented in our screening analysis. For those states that failed to conduct the required analyses, EPA must implement a FIP.
- **States which failed to submit a SIP:** As of the writing of this report, 12 states have failed to submit complete regional haze SIPs for the second planning period. These states are highlighted in gray in **Figure 5**. EPA has a [2-year deadline](#) (ending August 2024) to promulgate FIPs for these states unless they submit acceptable SIPs in that timeline. The states which failed to submit SIPs represent 25% of total remaining coal capacity. Although a SIP would not necessarily force pollution control retrofits on all of these 45 plants (shown as red circles in **Figure 5**), the states which did not submit a SIP contain some of the top polluters in the country. Only 19 of these plants have modern pollution controls installed for SO₂ and NO_x.

In total, based on the SIPs, we found that at a cost effectiveness threshold of \$10,000/ton, the Regional Haze Rule could impact units accounting for 26% of remaining coal capacity (35 GW). For those states that failed to submit plans or conduct the required analyses, EPA must implement a FIP. And most, if not all, remaining uncontrolled or undercontrolled coal units should be required to install or upgrade pollution controls. Sierra Club and our allies will continue to push EPA to ensure compliance with the visibility provision of the Clean Air Act and will urge EPA to only approve comprehensive and adequate SIPs or to issue a strong FIP — which would likely lead to more impacted units that are currently reflected in our analysis.

DISCUSSION

Each of the rules analyzed above has the potential to require both pollution controls and pollution control upgrades on part of the remaining coal fleet.

In addition, EPA has the ability to increase public health protections by making planned coal-fired generating unit retirements binding in relevant SIPs. A summary of the near term actions EPA should take to strengthen and enforce these rules is listed below:

- **MATS:** Finalize standards at the proposed levels of 1.2 lb/TBTU and more stringent fPM standard of 0.006 lb/MMBTU, or at more stringent levels (and finalize with the proposed improvements to monitoring and compliance during startup events)
- **Good Neighbor Plan:** Ensure that the updated rule is enforced requiring NO_x emissions rates commensurate with efficient operation of SCR
- **2008 Ozone NAAQS:** Ensure that SIP revisions for reclassified “severe” areas include RACT for coal-fired power plants outside the nonattainment area, but within state borders
- **2015 Ozone NAAQS:** Ensure SIP revisions for reclassified “moderate” areas must include RACT for plants within the nonattainment area or adjacent counties
- **2010 SO₂ NAAQS:** Require strong SIPs or develop FIPs for states with nonattainment areas tied to coal plant emissions
- **Regional Haze:** Unless a facility is subject to a federally enforceable retirement commitment, ensure SIPs include four-factor analyses of all coal-fired power plants (including those with planned retirements); Approve only strong SIPs that include a BART control cost-effectiveness threshold of \$10,000/ton or more; ensure that states which failed to submit a SIP for the second planning period do so, or develop and enforce a strong FIP

If these rules are strengthened and enforced as summarized above, the owners of 64% of remaining coal plants would have to more stringently address pollution from their facilities. Moreover, a third of generating units at these plants will be impacted by more than one rule (see **Figure 6**). For some generating units, these “overlapping” rules will target different pollutants and will require different control measures. For others, the overlapping rules all target the same pollutant and/or require the same control measure. However, this overlap should not diminish the perceived importance of each of

these rules on their own. Under the Clean Air Act, states have the obligation to address air quality within their own borders as well as their contribution to downwind states and the national parks and wilderness areas we all share.

As detailed in this report, each of these air pollution rules has different mechanisms with a range of impacts; from requiring plants to run existing controls more regularly or improve the efficiency of those controls (categorized below as ‘Improve Controls’), to requiring emissions reductions commensurate with the retrofit of new controls or enforcing retirement (categorized below as ‘Retire or Retrofit’). If these rules are strengthened and enforced as summarized above, our analysis shows that 53% of remaining coal-fired power plants will face a decision on retrofitting with pollution controls or retiring one or more generating units. An additional 11% of remaining coal-fired power plants will need to update or improve existing controls at one or more generating units. However, a number of these plants will require multiple pollution control improvements based on overlapping rules; which may together impose untenable costs leading to additional decisions on retrofitting with pollution controls or retiring to comply. Moreover, the majority of these plants are also in states that failed to submit complete regional haze SIPs for the second planning period. A strong SIP or FIP would likely force additional pollution control improvements, in some cases leading to even further retirement decisions.

In total, generating units impacted by these rules account for 68% of SO₂ emissions, 65% of NO_x emissions, and 66% of PM_{2.5}-related premature deaths from coal (see **Figure A3** in the Appendix) — highlighting the life-saving importance of strengthening and enforcing these public health safeguards. As designed, these rules would have the greatest impact on the worst polluters. By generating capacity, over 50% of remaining coal units that lack one or more pollution control,¹⁴ and 80% of units that are totally uncontrolled¹⁵ would face a decision on retrofitting with pollution controls or retiring to comply (see **Figure 7**).

Finally, our assessment is that 10 of the 17 most deadly power plants which remain today would face decision points on retrofitting with pollution controls or retiring one or more generating units (see **Table 2**) as a result of these rules (a detailed summary of our assumptions on

Figure 6: An Euler Diagram of the number of remaining coal-fired generating units impacted by federal rules analyzed within this report. Source: Sierra Club analysis of data provided within state implementation plans for the Regional Haze Rule, S&P Global, and EPA.

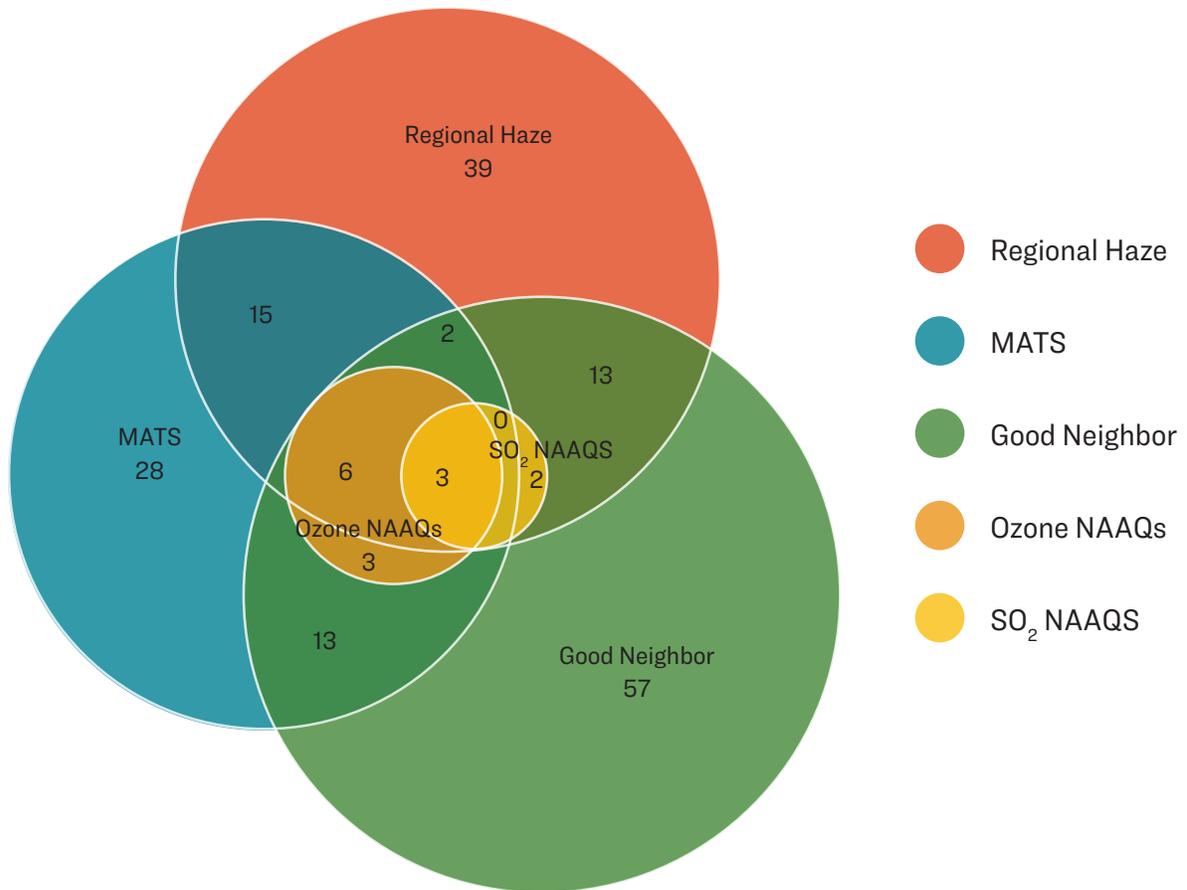


Figure 7: Sierra Club assessment of the impact federal air pollution rules could have on remaining coal-fired power plant capacity; segmented by existing controls for SO₂, NO_x and PM_{2.5}. Source: Sierra Club analysis of data provided within state implementation plans for the Regional Haze Rule, S&P Global, and EPA.

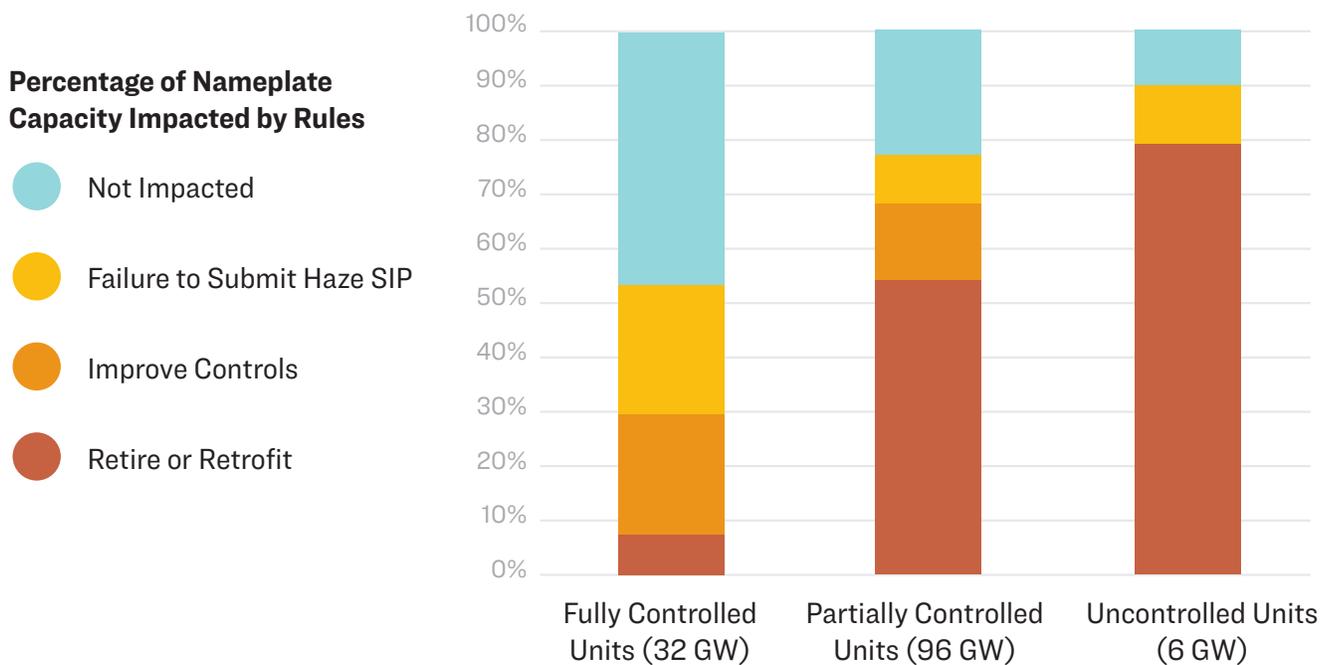


Table 2: Sierra Club assessment of the impact federal air pollution rules could have on the 17 most deadly remaining coal-fired power plants.¹⁷ 'Xs' indicate if one or more remaining generating units at that plant would be impacted by a given air pollution rule, '?' indicates plants for which impacts could not be determined as the states failed to file a SIP. The 'Impact' column is based on Sierra Club's interpretation of how these rules should be enforced (see the Appendix for further detail). Source: Sierra Club analysis of data provided by Clean Air Task Force, S&P Global, and EPA.

	Annual PM _{2.5} Related Deaths	MATS	Good Neighbor	Ozone NAAQS	SO ₂ NAAQS	Regional Haze	Impact
General James M Gavin	244	X	X				Retire or Retrofit
Labadie	195	X	X	X		X	Retire or Retrofit
Keystone	160		X		X	?	Improve Controls
Shawnee	154		X			?	Retire or Retrofit
Martin Lake	154	X	X	X	X	X	Retire or Retrofit
Cardinal	132						Not Impacted
Harrison Power Station	122						Not Impacted
W. A. Parish	109						Not Impacted
Ghent	95	X	X			?	Retire or Retrofit
New Madrid	90		X		X	X	Retire or Retrofit
Prairie State Generating Station	76					?	Not Impacted
Antelope Valley	70	X				X	Retire or Retrofit
Coyote	68	X				X	Retire or Retrofit
Homer City Station	67		X			?	Improve Controls
Mill Creek	66					?	Not Impacted
Jim Bridger	60	X				X	Retire or Retrofit
Bowen	59					X	Retire or Retrofit

how each of these plants would be impacted is provided in the **Appendix**). Five of the deadliest power plants are in states that failed to submit complete regional haze SIPs for the second planning period (including two plants which are otherwise not impacted by these rules), and should face additional pollution control requirements under a strong SIP or FIP.

We assess that 3 of the 17 most deadly power plants which remain today would still not be impacted by these rules as analyzed in this report. However, as stated above, our analysis of the Regional Haze rule (for states which submitted SIPs) is based on the state's own cost-effectiveness assumptions. Cardinal in Ohio, Harrison in West Virginia, and W.A. Parish in Texas¹⁶ were all missing cost-effectiveness data in their SIPs (see **Appendix** for more information). Sierra Club is advocating that EPA only approve strong SIPs that include cost-benefit

analysis for all remaining coal plants or impose a FIP. If and when that is done, it's likely these plants would also be impacted by the Regional Haze Rule. Of note is the Cardinal plant in Ohio, which our previous report found to be by far the largest contributor to nonattainment under the revised PM_{2.5} NAAQS proposed by EPA in January, 2023.

Although the air pollution rules detailed in this report are a necessary and important mechanism to address pollution from the remaining coal fleet, other undercontrolled plants will require additional measures and continued advocacy to ensure their owners are no longer able to enjoy pollution loopholes at the expense of people's lives and health.

APPENDIX

Sierra Club assessment of the impact of enforcing air pollution rules on the Top 17 Deadliest Plants (per **Table 2**):

General James M Gavin:

- MATS — EPA flagged that Unit 1 would need to reduce filterable PM emissions in order to comply with a stringent standard of 0.006 lb/MMBTU. Unit 1 also lacks a baghouse, and thus would likely need to retrofit or retire to comply with the stronger standard.
- Good Neighbor — Our analysis shows that although Unit 1 has an SCR control, its 2022 ozone season NO_x emission rate was over the 0.08 lb/MMBTU performance assumption in the Good Neighbor Plan. Based on this data, Unit 1 would likely need to improve operation of its NO_x controls in order to comply with the rule.
- Regional Haze — Although Ohio submitted a SIP, they did not do four-factor analysis for General James M Gavin, instead concluding that “... on-the-books and on-the-way controls are more than sufficient to achieve reasonable progress goals, and no additional measures are necessary...”. Sierra Club is advocating that EPA only approve strong SIPs that include cost-benefit analysis for all remaining coal plants.

Labadie:

- MATS — EPA flagged that all 4 units would need to reduce filterable PM emissions in order to comply with the proposed standard of 0.01 lb/MMBTU. If EPA were to select a more stringent standard of 0.006 lb/MMBTU for the final rule, these units would likely need to retrofit or retire to comply (as they all lack baghouse controls).
- Good Neighbor — All 4 units at the plant would need to reduce NO_x emissions commensurate with installing SCR in order to comply with the final rule. We estimate that all units will either need to retrofit with SCR controls or retire.
- Ozone NAAQS — Labadie lacks SCR and should be subject to RACT under the Missouri SIP for 2015 NAAQS nonattainment.
- Regional Haze — The SIP analysis showed FGD controls being cost-effective at threshold of \$5,000/ton or more.

Keystone:

- Good Neighbor — Both units at the at plants have SCR controls installed. However, Unit 1 .had a 2022 ozone season NO_x emissions rate over 0.08 lb/MMBTU and would need to improve that emissions rate to comply with the rule.
- SO₂ NAAQS — Keystone contributes to SO₂ nonattainment in Indiana County, Pennsylvania. Although both units have FGD controls installed, a strong FIP from EPA or a SIP from Pennsylvania could impose short term emission limits and overall lower emission limits, forcing the plants to improve their controls or retire.
- Regional Haze — Pennsylvania was one of 12 states that failed to submit complete regional haze SIPs for the second planning period. A strong SIP or FIP should consider controls improvements for this plant (among others in the state).

Shawnee / Homer City Station:

- Good Neighbor —
 - The Shawnee Plant in Kentucky lacks SCR controls on 7 of its 9 generating units. Under the Good Neighbor rule, it would need to achieve an ozone season NO_x emission rate commensurate with retrofitting these units with SCR. Units 1 & 3 have SCR controls installed, however they both had 2022 ozone season NO_x emissions rates over 0.08 lb/MMBTU — and would need to improve their controls to comply with the rule.
 - Similarly, all three units at the Homer City Station plant in Pennsylvania lack SCR controls and had 2022 ozone season NO_x emissions rates over 0.08 lb/MMBTU — needing to improve their controls to comply with the rule. Although Homer City Station was included in the analysis for this report, the owner [announced retirement plans in early April 2023](#), citing [compliance with EPA NO_x regulations as a factor](#).
- Regional Haze — Pennsylvania and Kentucky were among the 12 states that failed to submit complete regional haze SIPs for the second planning period. A strong SIP or FIP should consider controls improvements for these plants.

Martin Lake:

- MATS — According to EPA data, units 1 and 3 at Martin Lake would need to reduce filterable particulate matter (fPM) emissions in order to comply with the proposed limit of 0.01 lb/MMBTU. Unit 2 would need to reduce fPM to comply with a stronger potential standard of 0.006 lb/MMBTU. Under the stronger standard, as these units all lack a baghouse control, they would likely need to retrofit or retire in order to comply. In addition, all three units were flagged by EPA as needing to reduce Hg emissions to comply with the proposed limit of 1.2 lb/TBTU.
- Good Neighbor — All three units lack an SCR control for NO_x and would need to achieve ozone season NO_x emission rates commensurate with installing SCR controls to comply with the rule.
- Ozone NAAQS — Texas has multiple counties that were bumped-up to from “serious” to “severe” nonattainment for the 2008 Ozone NAAQS. Sierra Club is advocating that SIP revisions for reclassified “severe” areas must include RACT controls on sources outside the nonattainment area, but within state borders, including installing SCR at uncontrolled plants, such as Martin Lake.
- SO₂ NAAQS — In Texas, EPA designated the area around the 2.4 GW Martin Lake plant as being in nonattainment for SO₂. Although the Martin Lake plant has FGD controls on all 4 units, a strong FIP could require those controls to be improved or for the plant to retire.
- Regional Haze — At the time this report was drafted, the Texas Commission for Environmental Quality only evaluated the cost to upgrade the FGD controls for Martin Lake as part of its SIP. The SIP analysis showed upgrading those FGD controls being cost-effective at a threshold of ~\$1,000/ton or more. EPA has subsequently issued its [FIP proposal for Texas](#) — the results of which are not included in our analysis.

Ghent:

- MATS — According to EPA data, units 2 and 3 at Ghent would need to reduce filterable particulate matter (fPM) emissions in order to comply with a stronger potential standard of 0.006 lb/MMBTU.
- Good Neighbor — Unit 2 lacks an SCR control. Under the Good Neighbor rule, it would need to achieve an ozone season NO_x emission rate commensurate with retrofitting this unit with SCR. Units 3 has an SCR installed, however it had 2022 ozone season NO_x

emissions rates over 0.08 lb/MMBTU — and would need to improve its controls to comply with the rule.

- Regional Haze — Kentucky was one of 12 states that failed to submit complete regional haze SIPs for the second planning period. A strong SIP or FIP should consider controls improvements for this plant (among others in the state).
- Units 1 & 4 are otherwise not impacted by these rules based on our analysis.

New Madrid:

- Good Neighbor — Both units at the plant have SCR controls installed. However, both units had 2022 ozone season NO_x emissions rates over 0.08 lb/MMBTU — and would need to improve those emissions rates to comply with the rule.
- SO₂ NAAQS — New Madrid is in an SO₂ nonattainment area. Sierra Club is advocating for EPA to reject the SIP (which did not consider controls at the plant) and impose a FIP with tightened emissions limits for New Madrid that will require the plant to retrofit with an FGD or retire.
- Regional Haze — The SIP analysis showed retrofit of both units with FGD controls being cost-effective at a threshold of ~\$5,000/ton or more.

Antelope Valley / Coyote / Jim Bridger:

- MATS — The Coyote and Antelope Valley plants were both flagged by EPA as needing to reduce Hg emissions to comply with the proposed limit of 1.2 lb/TBTU. In addition, Unit 1 at Antelope Valley and Units 3 & 4 at Jim Bridger would need to reduce filterable particulate matter (fPM) emissions in order to comply with a stronger potential standard of 0.006 lb/MMBTU. Units 3 & 4 at Jim Bridger lack baghouse controls, thus under the stronger fPM standard they would likely need to retrofit or retire in order to comply.
- Regional Haze — The North Dakota SIP showed that it would be cost effective to replace the dry FGD controls with wet FGD at both the Coyote and Antelope Valley plants at a threshold of ~\$7,500/ton or more. Wyoming did not submit a four-factor analysis of Jim Bridger in its SIP as PacifiCorp plans to [convert the plant to gas](#) (units 1 & 2 in 2024, units 3 & 4 in 2030). EPA should ensure that this fuel conversion or a retirement is enforceable through the SIP or a FIP.

Bowen:

- Regional Haze — Georgia did not submit a four-factor analysis of the Bowen plant in its SIP. Georgia Power stated plans to retire units 1 & 2 by the end of 2027 in its [2022 IRP](#), however those retirement plans should be included in the SIP and made enforceable. Georgia Power plans to keep operating units 3 & 4. EPA should ensure that these units are included in a strong SIP or FIP.

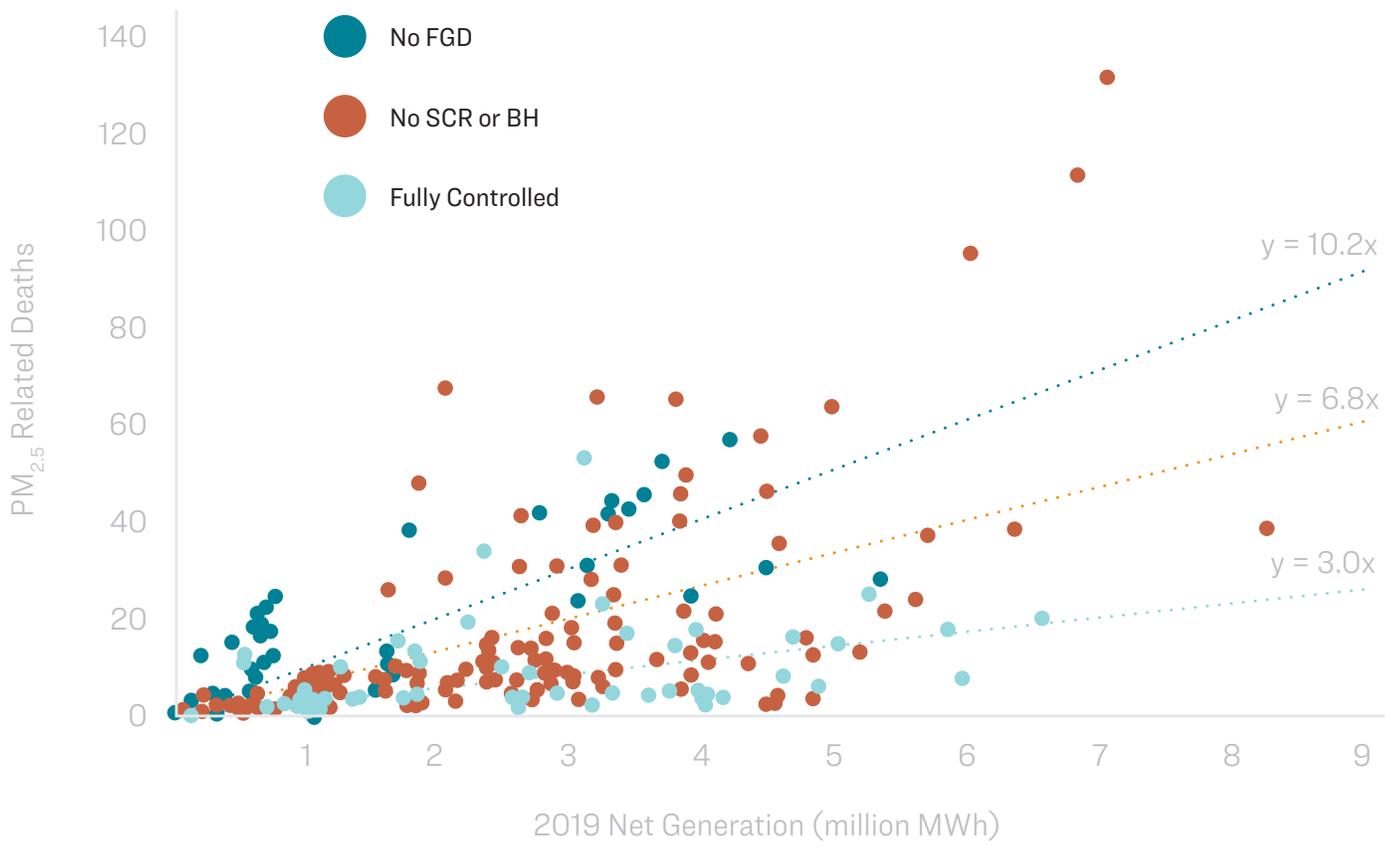
Prairie State / Mill Creek:

- Regional Haze — Illinois and Kentucky were among the 12 states that failed to submit complete regional haze SIPs for the second planning period. A strong SIP or FIP should consider controls improvements for these plants.

Cardinal / Harrison / W.A. Parish:

- Remaining coal-fired generating units at these plants were not impacted by these rules based on our analysis. However, in the case of Regional Haze, the relevant states simply did not include a four-factor analysis for these plants in their respective SIPs:
 - Cardinal: The Ohio SIP claimed that a cost-effectiveness analysis was not needed for the plant as it is “effectively controlled (FGD/SCR). Not a significant source of PM_{2.5} or NH₃”.
 - Harrison: The West Virginia Department of Environmental Protection requested a source evaluation for the plant, but it was not included in the SIP.
 - W.A. Parish: The Texas Commission on Environmental Quality did not perform a four-factor analysis for the plant.
- Sierra Club is advocating that EPA only approve strong SIPs that include cost-benefit analysis for all remaining coal plants. A strong SIP or FIP could force additional controls or control improvements for these plants.

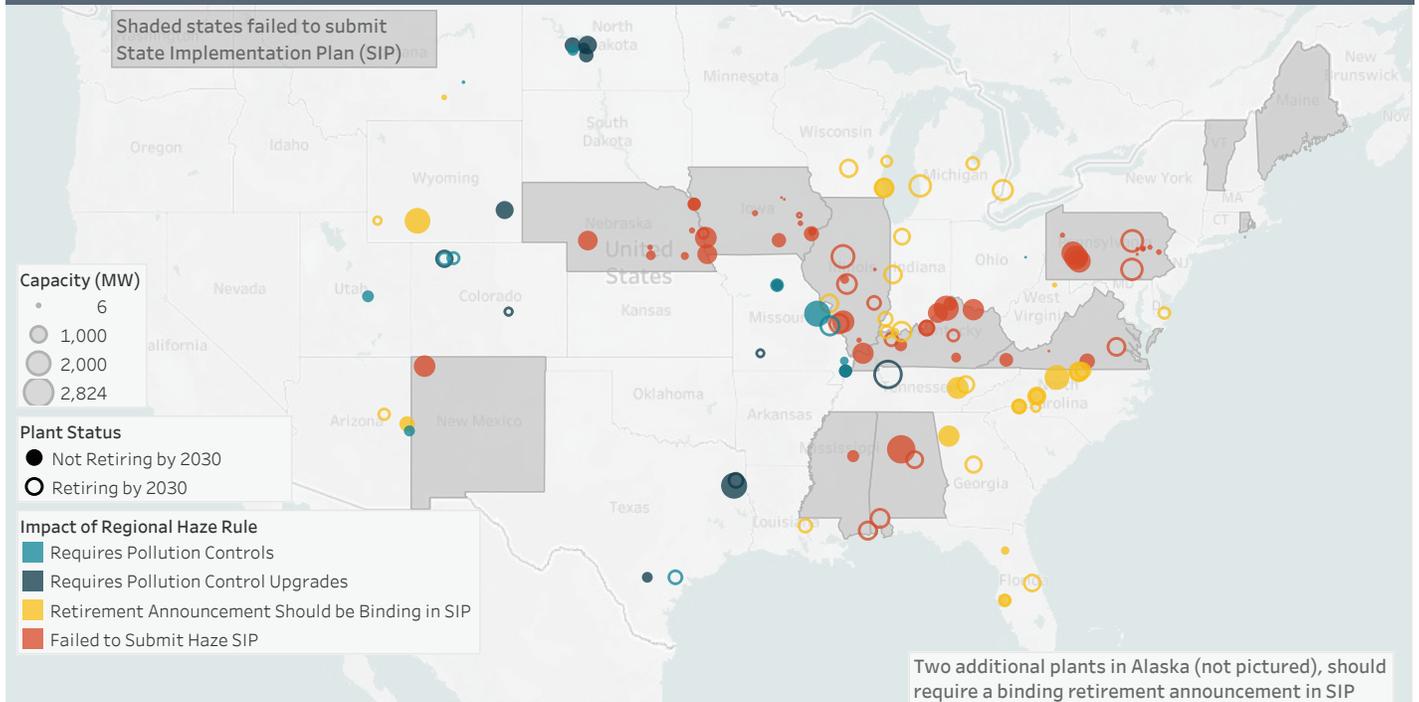
Figure A1: A scatterplot of remaining coal-fired generating units (grouped by installed pollution controls) positioned by their reported net generation and estimated mortality. The trendlines illustrate the average deaths per generation for each group of units. Based on these trendlines, we estimate that on average, units which lack SCR controls for NO_x and/or BH controls for PM are twice as deadly as those that are fully controlled per unit of energy. Similarly, on average, units which lack FGD controls for SO₂ are over three times as deadly as those that are fully controlled per unit of energy. Source: Sierra Club analysis of data provided by S&P Global and EPA.



ADDITIONAL FIGURES:

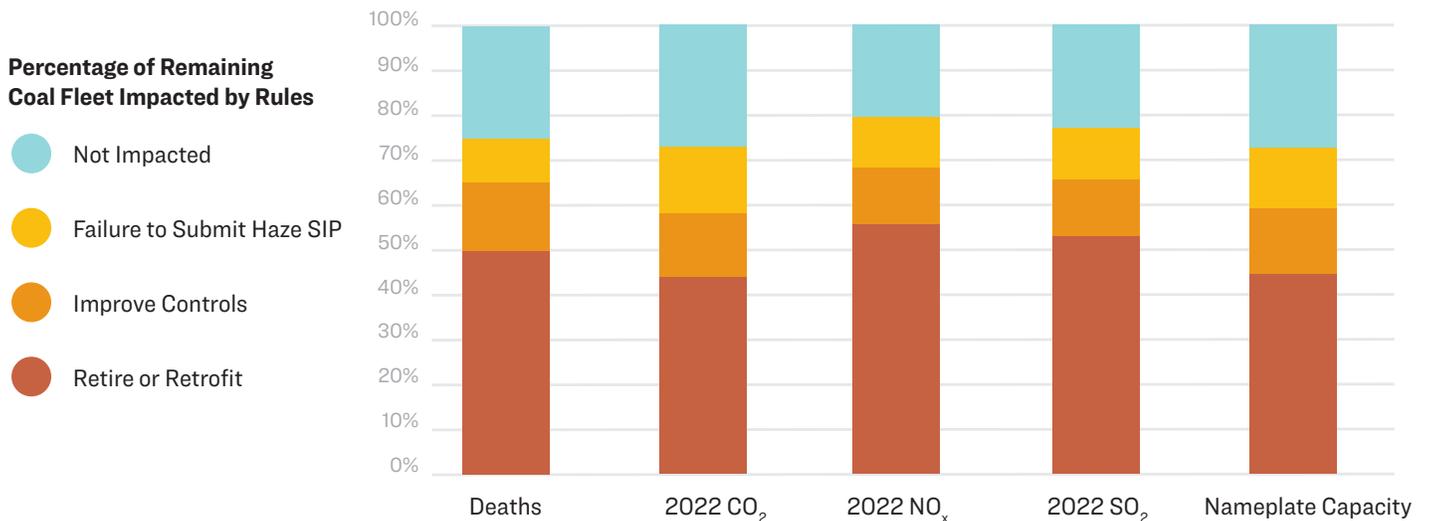
Per the Introduction section: Each dot in **Figure A1** represents an individual generating unit at one of the 160 currently remaining coal plants. The dot's position on the x-axis corresponds to the unit's 2019 net generation. The dot's position on the y-axis corresponds to the estimated PM_{2.5}-related deaths that unit causes. The dots are also grouped by color to represent units that lack an FGD, lack an SCR or BH, or are fully controlled. A least-squares trendline was fit to each group of generating units to determine an average linear relationship between PM_{2.5}-related deaths and net generation. Based on these trendlines, we estimate that on average, units which lack SCR controls for NO_x and/or BH controls for PM are twice as deadly per energy generated as those that are fully controlled. Similarly, on average, units which lack FGD controls for SO₂ are over three times as deadly as those that are fully controlled.

Figure A2: Coal-fired power plants impacted by the Regional Haze Rule assuming a more conservative \$5,000/ton cost effectiveness threshold. Source: Sierra Club analysis of data provided within state implementation plans for the Regional Haze Rule, S&P Global and EPA



Per the Federal Rules section on Regional Haze: **Figure A2** illustrates Sierra Club’s assessment of coal-fired power plants impacted by the Regional Haze rule assuming a more conservative \$5,000/ton cost effectiveness threshold.

Figure A3: The colors in each column represent Sierra Club’s assessment of the impact federal air pollution rules could have on remaining coal-fired generating units. Source: Sierra Club analysis of data provided within state implementation plans for the Regional Haze Rule, Clean Air Task Force, S&P Global, and EPA.



Per the Discussion section: **Figure A3** illustrates Sierra Club’s assessment of the impact federal air pollution rules could have on remaining coal-fired generating units. We estimate that units which will face decisions on retrofitting with pollution controls or retiring to comply with these rules represent 50% of deaths from PM_{2.5} exposure, 44% of 2022 CO₂ emissions, 56% of 2022 NO_x emissions, 53% of 2022 SO₂ emissions and 44% of remaining coal-fired generating capacity. Units which will need to Improve Controls based on these rules represent an additional 16% of deaths from PM_{2.5} exposure, 14% of 2022 CO₂ emissions, 13% of 2022 NO_x emissions, 12% of 2022 SO₂ emissions and 15% of remaining coal-fired generating capacity.

DATA AND METHODOLOGY

- Remaining coal-fired power plants: According to Sierra Club's Beyond Coal Campaign, 160 coal-fired power plants had at least one operating generating unit without firm plans to retire by 2030 (as of 4/1/2023). These retirement plans are researched and compiled by Sierra Club and may or may not comport with information stated elsewhere. These 160 plants and associated generating units are referred to as "remaining" throughout the report.
- Announced retirements: Data on which generating units (and/or plants) have announced firm plans to retire by 12/31/2030 are based on Sierra Club research. Our definition of an "announced retirement" includes generating units which cease burning coal as a primary fuel type.
- Installed pollution controls: Data on pollution controls installed at each generating unit (i.e. flue-gas desulfurization (FGD) to control SO₂, selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) to control NO_x, and baghouse (BH) to control direct PM_{2.5} emissions) based on a combination of publicly available data from EIA and EPA as well as Sierra Club research.
- Deaths from PM_{2.5} pollution exposure: Sierra Club analysis of data obtained from Clean Air Task Force on the remaining coal plants (where available). This data represents the impact of these plants based on 2019 emissions. Plant level data apportioned to individual generating units based on their portion of 2019 SO₂ emissions. More detail available in [our previous report](#).
- Emissions and emissions rates: Data on generating unit-level SO₂ and NO_x emissions and emissions rates from S&P Global. Data on unit and plant-level total direct PM_{2.5} emissions from EPA's eGRID. Data from 2019 used when also discussing deaths from PM_{2.5} pollution exposure.
- Population living within 20 miles of a coal plant: Sierra Club analysis of U.S. Census data obtained via EPA's latest version of EJSCREEN API.
- Operation of controls and control efficiency: Sierra Club analysis of data published in EIA form 923.
- Net generation: Data on generating unit-level net generation from S&P Global. Data from 2019 used when also discussing deaths from PM_{2.5} pollution exposure.
- Mercury and Air Toxic Standards: Data on plants impacted by proposed Hg standards and fPM standards published by EPA. Sierra Club analysis filtered this data based on our own assessment of which units have firm retirement plans and installed controls.
- Good Neighbor Plan: Sierra Club assessment of rule impacts based on aforementioned data on which units have firm retirement plans and installed controls. Data on 2022 Ozone Season NO_x emissions from EPA's Clean Air Markets Program Database.
- Ozone and SO₂ NAAQS nonattainment: Sierra Club assessment of remaining coal units impacting nonattainment areas based on location and ongoing advocacy on SIPs. Sierra Club analysis filtered this data based on our own assessment of which units have firm retirement plans and installed controls.
- Regional Haze: Sierra Club assessment of cost-effectiveness thresholds based on analysis of SIPs for Regional Haze. Sierra Club analysis filtered this data based on our own assessment of which units have firm retirement plans and installed controls. For coal-fired generating units in which multiple control options were analyzed, our analysis defaulted to the most effective control (e.g. installation of an FGD over more cost effective improvements to an existing SCR).

END NOTES

- 1 Throughout this report, we use the term ‘remaining’ to indicate coal-fired plants with at least one unit lacking firm plans to retire by the end of the decade, as determined by Sierra Club.
- 2 Referring to generating units which have some combination of SCR, FGD and BH controls installed, but not all three.
- 3 Referring to generating units which lack all SCR, FGD and BH controls
- 4 Throughout this report, we use the term ‘remaining’ to indicate coal-fired plants with at least one generating unit lacking firm plans to retire by the end of the decade, as determined by Sierra Club.
- 5 Although Homer City Station was included in the analysis for this report, the owner [announced retirement plans in early April 2023](#), citing [compliance with EPA NOx regulations](#) as a factor.
- 6 [Ozone season](#) denotes months when ground-level ozone, a common air pollutant, reaches its highest concentration.
- 7 Based on reported [SO₂ removal efficiency data](#) for other coal plants in Table 1
- 8 1 MMBTU = 1 million BTU (1x10⁶ BTU)
- 9 The requirement to continuously monitor fPM emissions would likely require additional units to improve their controls by revealing units that are only able to meet the standard under the brief, optimized conditions of a quarterly stack test.
- 10 1 TBTU = 1 trillion BTU (1x10¹² BTU)
- 11 EPA has indicated in both the [Good Neighbor Plan](#) and in a [RACT plan it developed for Pennsylvania](#) that SCR is both technologically and economically available, and that it can achieve long-term nitrogen oxides emission rates of 0.08 lbs/MMBTU
- 12 A map of units affected by a \$5,000/ton threshold is shown in the Appendix as **Figure A2**
- 13 Colorado and Oregon have each adopted cost-effectiveness thresholds of \$10,000/ton.
- 14 Referring to generating units which have some combination of SCR, FGD and BH controls installed, but not all three.
- 15 Referring to generating units which lack all SCR, FGD and BH controls
- 16 EPA has subsequently issued its [FIP proposal for Texas](#) - the results of which are not included in our analysis.
- 17 Although Homer City Station was included in the analysis for this report, the owner [announced retirement plans in early April 2023](#), citing [compliance with EPA NOx regulations](#) as a factor.

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