PUBLIC COMMENTS

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Comments to the EPA on the Advanced Notice of Proposed Rulemaking for a Replacement to the Clean Power Plan

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US Environmental Protection Agency
EPA Docket Center (EPA/DC), Mail Code 28221T
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Attention Docket ID No. EPA-HQ-OAR-2017-0355

On behalf of Resources for the Future (RFF), I am pleased to share the accompanying comments to the United States Environmental Protection Agency (EPA) on the replacement of the Clean Power Plan (CPP). These comments are also relevant to the EPA's request for comments on the CPP repeal, and will be submitted to that separate docket accordingly.

For the past several decades, RFF experts have helped decisionmakers better understand air pollution and climate policy challenges. RFF has developed methods for assessing the costs and benefits of possible solutions, such as a clean energy standard, Clean Air Act regulation, and various state-level programs. RFF has an extensive history of expertise in this area, and RFF experts are uniquely positioned to provide unbiased information based on rigorous research and policy analysis.

As you may know, RFF is an independent, nonprofit research institution in Washington, DC. Our mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. RFF neither lobbies nor takes positions on specific regulatory proposals, although individual researchers are encouraged to offer their expertise to inform policy decisions.

As always, the goal at RFF is to identify the most cost-effective and net-beneficial ways, from an economic perspective, to meet energy policy objectives through regulation, policy, or market mechanisms. To that end, researchers at RFF have been actively analyzing the previous administration's Clean Power Plan proposal and this administration's proposed repeal and replacement.

Several RFF experts have provided comments on the issues listed below. All authors' comments are their own and submitted as independent authors.

- Emissions reductions that can be achieved by an "on-site" replacement to the Clean Power Plan, including increases in emissions at many plants and in some regions of the country, and potential disbenefits for human health: Dallas Burtraw
- Consideration of the co-benefits of non-targeted pollution reductions; electricity sector assumptions for the CPP repeal RIA and an "on-site" replacement: Joshua Linn
- Methods and estimation of health co-benefits: Alan Krupnick, Amelia Keyes
- Ecological co-benefits: Jhih-Shyang Shih, Dallas Burtraw

If you have any questions or would like additional information, please contact my colleague Dr. Dallas Burtraw at burtraw@rff.org.

Sincerely,

Richard Newell
President and CEO

cc: Dallas Burtraw

Comments to the EPA on the Advanced Notice of Proposed Rulemaking for a Replacement to the Clean Power Plan

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I am pleased to offer the attached comments to the U.S. Environmental Protection Agency (EPA) on a potential replacement to the Clean Power Plan. I am writing as the Darius Gaskins Senior Fellow at Resources for the Future. Drawing on my work and work of my colleagues and coauthors, including several peer reviewed scientific publications, I submit comments on issues raised in considering a potential replacement to the Clean Power Plan. These comments address many questions specifically identified by the EPA.

A fundamental conclusion in my comments is the necessity to consider the potential repeal and the potential replacement to the Clean Power Plan in a consistent and comprehensive framework. Although the subject of repeal is taken up in a different forum, the question of replacement is inevitably informed by the same set of issues relevant to the repeal, and some of those issues surface in my comments.

Sincerely,

Key Findings

- Indications from the Advanced Notice of a Proposed Rulemaking for a replacement to the Clean Power Plan suggest a replacement standard would be limited in stringency to improvements that can be achieved at individual facilities - a so-called "on-site" approach.
- An on-site approach that relies on heat rate improvements at existing coal-fired boilers can be expected to realize emissions rate improvements of roughly 4 percent. The resulting emissions reductions would be smaller, after accounting for the rebound effect.
- The expected on-site heat rate improvements would lead to increased utilization of coal plants (the "rebound effect") at many facilities, which would erode about 30 percent of the potential emissions reductions in the short term. The investments at these plants also would extend the lifetimes at these facilities, which could yield an absolute increase in total lifetime emissions.
- The on-site approach also would yield an overall increase in sulfur dioxide emissions and associated premature mortality nationally and in many individual states.
- In contrast to its expected replacement, the Clean Power Plan produces large and widespread improvements in air quality and health outcomes that far exceed costs. Every one of the lower 48 states and the District of Columbia can expect environmental improvement under the Plan.
- If opportunities for on-site actions to reduce emissions rates are evaluated on the criterion of adequately demonstrated measures, then natural gas and biomass co-firing should be considered in

setting the stringency of the standard. Natural gas cofiring is an adequately demonstrated approach to achieving much more substantial emissions reductions at existing coal-fired plants compared to heat rate improvements using only coal.

- If the regulation grants flexibility to states to adopt measures other than heat rate improvements on-site to demonstrate compliance with the standard of performance, such as natural gas and biomass co-firing, or emissions rate averaging, then the stringency of the standard should reflect this expanded set of options available for compliance. Moreover, the Regulatory Impact Analysis should reflect the costs and benefits of the anticipated compliance activity.
- A federal standard of performance based on a regulation that grants states full flexibility in their implementation is projected to yield emissions rate and emissions reductions that are more than four times greater, at the same level (constant) marginal cost, than the emissions outcome that would result from on-site measures alone.

Consideration of "On-Site" Measures as the *Best System of Emission Reductions*

The potential repeal and replacement of the Clean Power Plan has substantial implications for the environment and public health through the change in expected greenhouse gas emissions in the US power sector and in associated emissions of conventional air pollutants.

My comments draw on several scholarly studies in leading scientific journals that present analysis of the potential repeal and replacement of the Clean Power Plan. These studies quantify the emissions reduction potential, public health and ecological impacts of emissions reductions that would be obtained in a regulatory approach that was limited to on-site measures, and compare this outcome to reductions that would be achieved by the Clean Power Plan in its current form.

The Advanced Notice of Proposed Rulemaking for a replacement to the Clean Power Plan is skeletal in form, without a precise indication of the direction EPA will take in presenting a replacement proposal. However, one can infer clearly from the questions posed therein an indication of what might ultimately take shape. In common terms, the approach that is expected is a so-called "on-site" regulation that would redefine the *best system of emission reduction* to apply narrowly to measures that can be taken at an individual emissions source. This comes in contrast to the approach taken in the Clean Power Plan, which views the best system to encompass the full set of options from the perspective of the operator of a facility.

The replacement regulation implied by the Advanced Notice of Proposed Rulemaking and expected by most observers that would be limited to "on-site" measures presents several problems that gravely undermine the plausibility of this approach as a way for EPA to meet its obligations under the endangerment finding.

The anticipated redefinition of the *best system of emission reduction* would develop a performance standard based only on measures that could be executed at an individual facility ("on-site") to reduce emissions rate (tons/MWh). The improvement in emissions rate is achieved through an improvement in the heat rate (mmBtu/MWh), which describes the energy input necessary to generate a unit of electricity, and which leads to a roughly proportional improvement in the emissions rate. Due to the rebound effect, however, the emissions reductions that can be achieved are smaller. Several engineering studies have identified a range of possible heat rate improvements that hover around 4 percent, on average, across the fleet of coal-fired generators (e.g. Sargent & Lundy, LLC 2009). Staudt and Macedonia (2014) evaluated the performance of the best in class within groups of similar coal facilities, sorted for example by vintage, type and existing pollution controls, and found that investments to close 25 percent of the gap between the performance of a facility and the best facility in its group would amount to a 4 percent improvement across the fleet. Investments to close 40 percent of the gap would amount to a 6 percent improvement.

A statistical analysis by Linn et al. (2014) examined 25 years of operating data for existing power plants to identify how their heat rates vary in response to changes in fuel prices. They observe that within categories of types of plants, if all plants improved up to the 90 percentile level of performance, it would result in a 6 percent improvement across the fleet. Linn et al. (2014) also examined the behavior of this set of plants and found that heat rate improvements were indeed realized in response to changes in fuel prices, indicating that opportunities to improve the efficiency of existing plants exist. However, empirically one observes improvements in response to small changes in fuel prices over the study period of 0.1 – 0.4 percent; greater levels of improvement, while technically possible, are far outside of historically observed outcomes. Even the largest of these potential emissions reduction scenarios is substantially less than the emissions reductions that are anticipated under the Clean Power Plan.

A confounding and troubling issue for the design of a replacement regulation, according to scholarly analysis, is that this approach is expected to yield emissions increases at a large number of facilities and in some entire regions of the country. This outcome is the result of the likely “rebound effect,” which describes the increase in utilization of a facility in response to investments that improve the efficiency of a facility. Improved efficiency lowers the variable cost of operation and leads to greater utilization when the operation of an individual facility is considered within the electricity system.

Two separate, detailed studies suggest that a rebound effect of about 30 percent in the short run can be expected. Driscoll et al. (2015) exercise the same detailed electricity sector model that is the cornerstone of EPA’s regulatory impact analyses, arriving at a projection that in fact many individual facilities and some entire regions of the country will realize a short run increase in emissions. Linn et al. (2014) estimate rebound through greater utilization of existing facilities would erode 22 – 33 percent of the emissions reductions that would be expected if there was no rebound. The rebound effect measured in these two studies result from the increase in the utilization of a coal-fired plant where efficiency investments occur. Where there is a decrease in utilization, or the retirement of a facility, some of the electricity generation from that facility would be made up through increased utilization of natural gas facilities, which would further erode the total emissions reductions that can be achieved from a performance standard calibrated to on-site measures.

A second type of rebound emerges in the long run. Because of required investments to improve the efficiency of existing plants, these plants can be expected to have a longer useful life. A life extension of just 5 months would erase the entire emissions reductions that would be achieved after accounting for the short-run rebound effect. In other words, a regulation that was constrained to on-site measures could lead to an increase in total emissions of the regulated pollutant. Because carbon dioxide is a stock pollutant with a long residency time in the atmosphere, this outcome would in effect be worsening environmental outcomes compared to no regulation at all.

To summarize, on an average basis, the rebound effect can be expected to erode in the short run about 30 percent of the emissions reductions that would otherwise be anticipated. In the long run, the rebound effect could mean that the regulation actually yields an increase in the lifetime emissions of carbon dioxide at the regulated facilities.

Additional concern stems from the short-term environmental consequences of a replacement rule limited to on-site measures. The rebound effect with respect to utilization of the power plant will yield an increase in sulfur dioxide emissions on a national average basis. The effects vary state-by-state, but the change in exposure across the nation will lead to an increase in premature mortality (Driscoll et al. 2015).

Several scenarios were evaluated in Driscoll et al. (2015). The analysis is comprehensive, starting from changes in the operation of the electricity system, including changes in the utilization of existing facilities as well as investment and retirement of facilities. The analysis mapped changes in emissions at the facility level, through atmospheric transport and fate modeling, to human health and ecological consequences, and monetized the value of those consequences where possible. The analysis considered a regulation constrained to on-site measures and compared that outcome with a rate-based performance standard analogous to the Clean Power Plan. (The analysis also considered the ability for states to develop alternative plans, including mass-based standards, provided they achieve equivalent emissions reductions.)

Table 1 illustrates the emissions reductions anticipated by the EPA (2015) and the results anticipated by Driscoll et al. (2015) for an approach resembling the Clean Power Plan, in comparison with outcomes associated with a regulation limited to on-site measures. The results reported from Driscoll et al. (2015) were developed prior to the determination of the final Clean Power Plan, but they are similar. The timing of outcomes described in Driscoll et al. (2015) is 2020, based on what could be achieved in the time horizon from when the study was initiated. The EPA results are for 2030, but otherwise comparable in magnitude.

Table 1. Percent Change in National Emissions

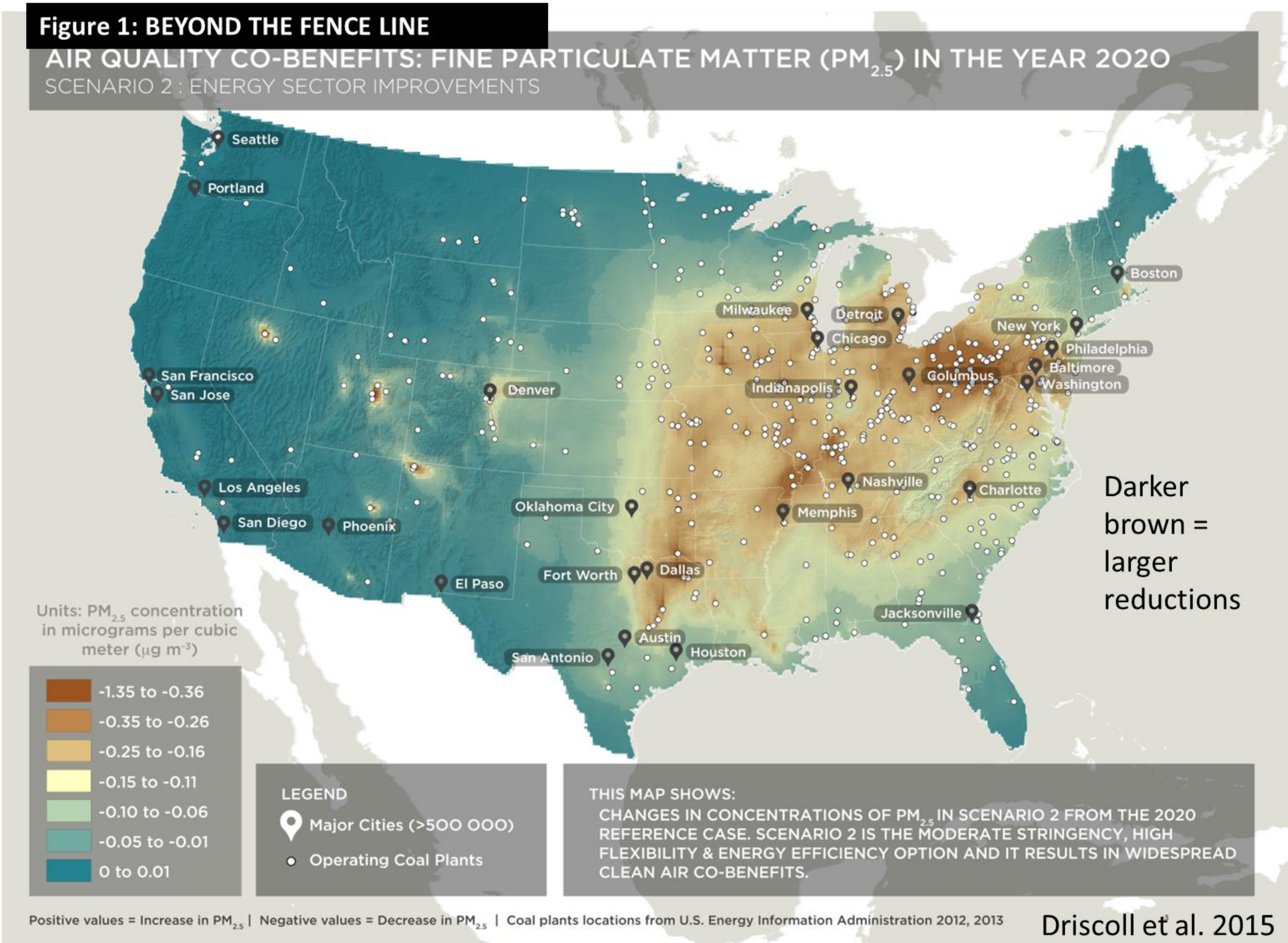
	Final Clean Power Plan 2030	**Updated Assessment of Final CPP 2030**	**Electricity System Measures (Analogous to Final CPP) 2020**	**On-Site Measures (Replacement to CPP) 2020**
	EPA (2015)	EPA (2017)	Driscoll et al. (2015)	Driscoll et al. (2015)
Carbon Dioxide *Change from 2005 Levels**	-32%	-32%	-35%	-17%
Sulfur Dioxide *Change from Reference Case*	-21%	-31%	-27%	+3%
Nitrogen Oxides *Change from Reference Case*	-21%	-23%	-22%	-3%

**Note*: Changes in carbon dioxide emissions are reported relative to 2005 levels to enable comparison of outcomes with the Clean Power Plan.

Under the scenario analogous to the Clean Power Plan in Driscoll et al. (2015), all the lower 48 states and the District of Columbia experience an improvement in air quality compared to the reference case. However, an approach that was restricted to on-site measures would result in a 3 percent *increase* in sulfur dioxide from the no Clean Power Plan reference case. On a state basis, some states would realize air quality improvements and some would realize worsened air quality under this version of the replacement rule. Driscoll et al. (2015) find that large areas of eastern and western US experience worsened air quality in 2020 compared to the reference case without the Clean Power Plan, and substantially worse compared to the Clean Power Plan. Figures 1 and 2 present changes at a detailed geographic level in atmospheric concentrations of fine particulate matter, a consequence of changes in sulfur dioxide emissions, for the scenario representing the Clean Power Plan and its envisioned replacement limited to on-site measures.

The forecast for health consequences at the state level is reported in Table 2, which is taken from the background analysis supporting Driscoll et al. (2015). The changes in premature mortality vary by state, but on a national basis an on-site approach to regulating carbon emissions is projected to result in an increase in 11 deaths per year. In contrast, the Clean Power Plan is projected to result in a decrease of 3,500 deaths per year.

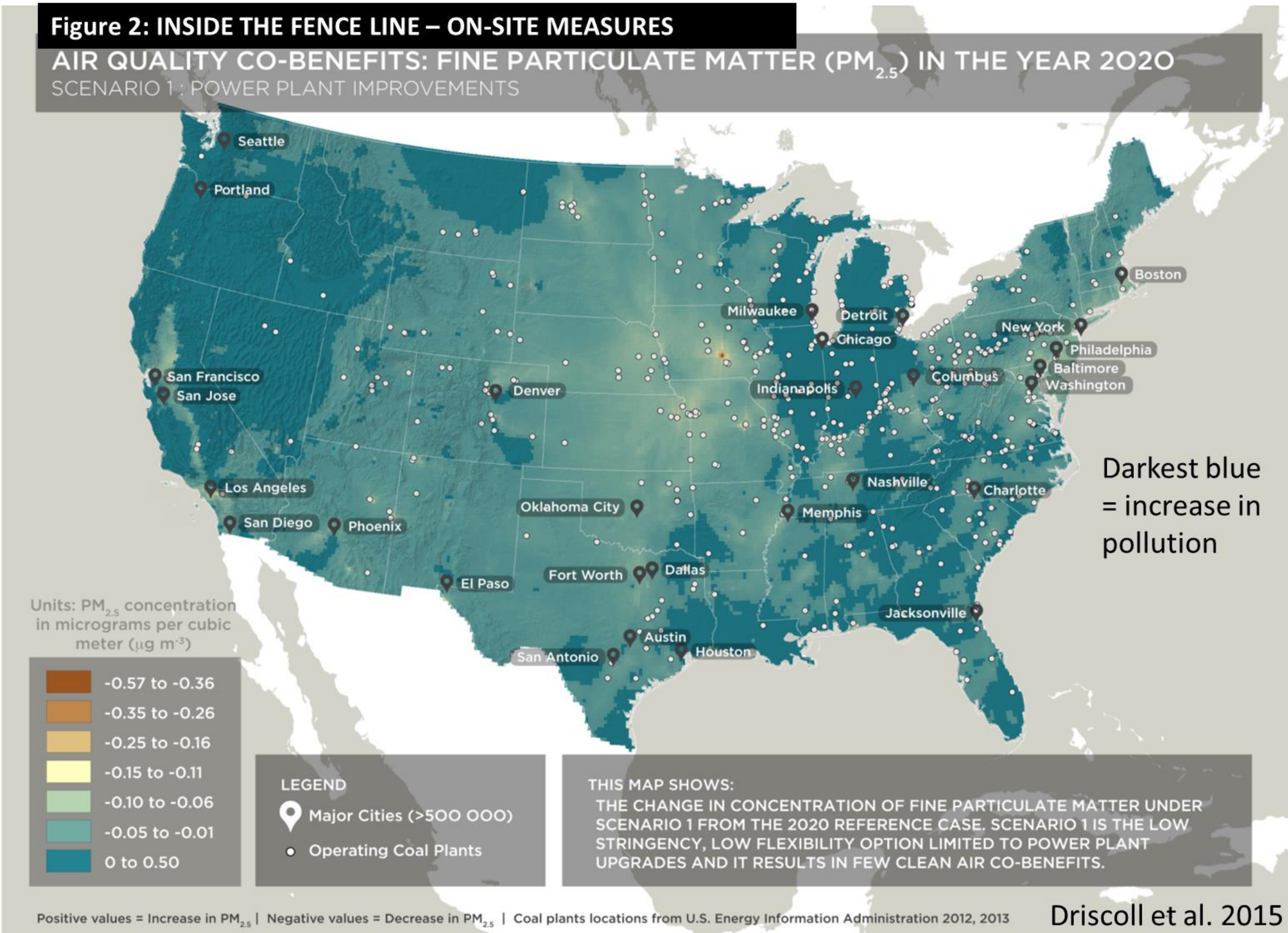
Figure 1: BEYOND THE FENCE LINE



Darker brown = larger reductions

Driscoll et al. 2015

Figure 2: INSIDE THE FENCE LINE – ON-SITE MEASURES



Darkest blue = increase in pollution

Driscoll et al. 2015

Table 2. Projected Changes in Health Outcomes.
(Based on analysis supporting Driscoll et al. 2015)

Scenario 1: INSIDE THE FENCE LINE

State	Deaths avoided	Hospitalizations avoided	Heart attacks prevented
MI	21	5	2
OH	15	6	1
LA	13	2	1
MO	12	4	1
WA	11	2	1
IA	8	3	0
TX	6	1	0
MN	5	2	0
KS	5	2	0
OR	5	1	0
NE	3	1	0
GA	3	0	0
AR	3	1	0
CO	2	1	0
ND	2	1	0
AL	2	0	0
SC	1	1	0
WV	1	1	0
SD	1	1	0
PA	1	1	0
UT	1	0	0
MS	1	0	0
NM	1	0	0
OK	0	1	0
WY	0	0	0
MT	0	0	0
ID	0	0	0
AZ	0	1	0
ME	0	0	0
VT	0	0	0
TN	0	0	0
NH	0	0	0
DC	-1	0	0
DE	-1	0	0
RI	-2	0	0
KY	-2	0	0
FL	-3	1	0
NC	-4	-2	0
NV	-4	-1	0
CT	-5	-1	0
VA	-5	-1	0
MD	-6	0	0
MA	-8	-2	-1
WI	-9	-1	-1
NJ	-12	-2	-1
IN	-12	-1	-1
IL	-13	1	-1
NY	-14	-3	-1
CA	-33	-10	-2

Scenario 2: BEYOND THE FENCE LINE

State	Deaths avoided	Hospitalizations avoided	Heart attacks prevented
PA	330	71	19
OH	280	76	18
TX	230	79	14
IL	210	76	16
MI	190	45	13
NY	190	45	11
NC	130	37	8
GA	120	44	7
MO	120	31	7
VA	120	34	8
TN	120	39	8
IN	110	40	8
FL	110	38	6
NJ	110	27	7
MD	100	23	6
KY	86	39	6
AL	75	25	4
WI	74	17	4
CO	63	14	3
SC	62	19	4
OK	61	22	3
LA	58	18	3
CA	57	15	3
AR	57	21	4
MA	52	13	4
WV	49	18	4
IA	47	15	3
KS	43	15	2
MS	38	12	2
MN	34	9	2
CT	27	9	2
AZ	23	11	1
NE	18	6	1
DE	17	4	1
NM	14	7	1
RI	10	2	1
UT	9	3	0
DC	9	2	1
NH	7	2	1
ME	6	2	0
SD	5	3	0
NV	4	2	0
VT	4	1	0
WY	3	1	0
MT	2	1	0
WA	2	1	0
ND	2	1	0
ID	2	1	0
OR	1	0	0

Several considerations should be considered by EPA in evaluating our findings and in its own analysis. One is that the EPA may rely on potential on-site measures to determine a standard of performance that states must satisfy in their state plans, but the EPA might grant states the authority to adopt more flexible measures, such as emissions trading, or crediting facility retirements that would have happened anyway, in order achieve the requisite emissions rate or emissions reductions that are comparable to the federal standard. The EPA analysis in support of such a rule should anticipate in the Regulatory Impact Analysis the expected cost of the regulation. If states use emissions trading to comply, or take credit for changes in utilization of coal plants that would have happened anyway, then the costs and environmental outcomes would differ from what would be obtained under regulation that required on-site measures and did not provide flexibility. The analysis of anticipated outcomes should take into account these actions.

Flexible implementation of a performance standard would likely give facilities the latitude to comply by co-firing with natural gas. However, the technical opportunity to co-fire with natural gas is not limited to a 4 percent emissions rate reduction, as might be the performance standard if it were restricted to on-site technology measures. Natural gas co-firing could be used to achieve much greater emissions rate and emissions reductions than can be achieved by on-site heat rate improvements. Indeed, natural gas co-firing is an adequately demonstrated approach to achieving much more substantial emissions reductions at existing coal-fired plants. Further, the marginal cost of using more natural gas is relatively constant, meaning there is not an obvious stopping rule to the use of co-firing for compliance. Arguably, on-site measures could be interpreted to require substantial co-firing with, or substitution to natural gas, based on adequately demonstrated measures that could be achieved at the equivalent marginal cost. In published analysis, Burtraw et al. (2015) find that that granting full flexibility to states to implement a federal standard of performance could yield emissions rate reductions of 17.7 percent, and four times more emissions reductions, at a level (constant) marginal cost.

Another consideration is that substantial change in the population of coal-fired facilities has occurred in the last decade. Many of the least efficient coal-fired plants have already retired, and the utilization of the surviving plants has decreased. In comparing various analysis of on-site regulations with a population of plants that has evolved and differs in various studies, one can observe that the change in the population of plants may exacerbate the rebound effect. An on-site regulation applied to the population of plants in place in 2011 was likely to result in more retirements and a smaller rebound effect (Burtraw et al. 2012) than would a regulation applied to more recent representations of the population of plants (Driscoll et al. 2015). Given the current population of plants, it is likely that greater investments must occur on-site at existing facilities to achieve a requisite emissions rate reduction on average across the fleet.

A further consideration is the possibility that increased utilization at regulated facilities could be limited by new source review provisions of existing regulations. These provisions have a ten-year look back, and over the course of the last ten years many facilities have seen a decrease in their utilization as part of the secular changes in the market. This recent decrease in utilization creates headroom for many facilities to expand generation, as the studies I describe project they will. Further, many of the more modern coal-fired facilities that have maintained utilization already have a full suite of post-combustion controls in place, lessening the burden that would be required if they were subject to new source review. Typically, these are the facilities that are most efficient within their respective class of generators, and from which less would be required under an on-site regulation.

Relevant Background and Cited References

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Comments on the Proposed Repeal and Replacement of the Clean Power Plan

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1. EPA should include co-benefits of non-targeted pollution reductions or avoided costs of other regulations when analyzing costs and benefits of a regulation.

In the RIA of the proposed CPP repeal, EPA considers several estimates of health co-benefits. These estimates are based on differing assumptions on the relationship between air pollution and health. These assumptions are discussed extensively elsewhere in these comments.

EPA requests comments on the interactions between a GHG rule and existing statutory and regulatory programs. Moreover, in the proposed CPP repeal, EPA requests comment on "the extent that the EPA should rely on consideration of the benefits due to reductions in the target pollution relative to the costs…" Here I argue that the EPA should rely on the effects of a regulation on non-targeted pollution, but in certain cases it should do so differently than it has, as I discuss next.

EPA should consider non-targeted pollution because failing to do so would result in regulations that are not ambitious enough from a societal perspective. For a hypothetical proposed regulation, suppose that the estimated benefits of reducing the targeted pollution are less than the estimated costs—that is, the proposed regulation would have negative net benefits if EPA includes only the benefits from the targeted pollutant. Suppose further that the estimated benefits of non-targeted pollution are sufficiently high that if the EPA were to include those benefits in its RIA, net benefits would be positive. If EPA were to break from historical practice and ignore the benefits of the non-targeted pollution, EPA may decide that the regulation is not justified on a benefit-cost basis and that the regulation should not be finalized. Such a decision would be detrimental to society, however, because the regulation would have created positive net benefits (that is, counting the benefits of the non-targeted pollution).

Thus, EPA should include the effects of the non-targeted pollution to avoid a situation in which it fails to adopt regulations that would benefit society. One might argue that EPA could improve social welfare by regulating the non-targeted pollution directly. However, this may not always be practical. To address this argument, it is worth distinguishing two general cases, because the treatment of the non-targeted pollution should differ across the two cases.

First, suppose EPA is proposing a hypothetical regulation that targets a particular pollutant, and that also reduces a non-targeted pollutant. Suppose further that EPA can reasonably assume that no other policies would affect emissions of the non-targeted pollutant. For example, suppose hypothetically that the non-targeted pollutant is particulate matter (PM) and that no areas exceed the National Ambient Air Quality Standards (NAAQS) for PM. In this hypothetical case EPA might expect that there would not be any state or federal policies that target PM. In this case, given the scientific evidence for the societal benefits of reducing PM below the NAAQS for PM, EPA should include those co-benefits of the regulation that targets a pollutant other than PM. Failing to do so could result in the EPA failing to adopt regulations that benefit society, for the reason discussed above.

Thus, in the first case, EPA should continue its long-standing practice of including co-benefits from non-targeted pollutants. However, there is a second case, and as I'll explain EPA should take a different approach in that case.

Specifically, suppose that the non-targeted pollutant is again PM, and that PM levels exceed the NAAQS. Suppose further—for simplicity—that the regulation would reduce PM levels so that the NAAQS are exactly attained. In that case, if EPA does not enact the regulation, EPA would expect states to adopt regulations that reduce PM levels so that the NAAQS are attained. With the regulation, EPA would expect the regulation to reduce PM levels so that the NAAQS are attained, and no additional state policies would be required. Note that the assumption that the regulation reduces PM so that the NAAQS are met simplifies this discussion, and the general conclusions would apply if this assumption doesn't hold.

In both cases—with or without the EPA regulation—the non-targeted pollutant is at the same level. Therefore, it would *not* be appropriate to count benefits of the non-targeted pollution reduction, because these reductions would occur with or without the regulation. However, with the regulation the state can avoid implementing the policy. Therefore, the avoided costs of the state policy should be counted when the EPA estimates net benefits of the regulation. The difference between the situation with and without the regulation is that with the regulation, the costs of the state policy are avoided. Moreover, if EPA were to include the co-benefits of PM rather than the avoided compliance costs, the EPA would overstate the net benefits of the regulation (i.e., assuming the state policy would have had positive net benefits).

To summarize, if EPA is considering a regulation that reduces non-targeted pollutants, then as long as those emissions reductions would not have occurred because of some other policy (either state or federal), EPA should include the co-benefits of the non-targeted emissions reductions. But if the emissions reductions would have occurred because of some other policy (again, either state or federal), EPA should count avoided costs of those policies, but not co-benefits of the non-targeted pollutant.

Of course, there may be regulations in which both cases apply. This is the situation with the CPP, because some areas have PM levels below the NAAQS, whereas other areas have PM levels above the NAAQS. The EPA could apply the first methodology for areas that meet the NAAQS, and the second methodology for areas that do not meet the NAAQS.

Another potential difficulty is that, for the second case where the non-targeted emissions reductions would have occurred anyway, it may be uncertain which policies would have been enacted in the absence of the regulation being considered. EPA would have to estimate the avoided costs of those policies. It would not make sense to conduct a cost-benefit analysis that ignores the avoided costs.

2. EPA should update its electricity sector assumptions for the CPP repeal and replacement RIAs

The primary estimates of benefits and costs of repeal are based on the 2015 RIA for the final CPP. The estimates are based on modeling of the electricity system, using assumptions on future electricity demand, fuel prices, renewables costs, and other inputs to the model. To estimate the benefits and costs of the CPP, for example assuming mass-based standards, the EPA compares a simulation of the model without the CPP against a scenario that is otherwise identical but includes the mass-based CPP.

In the repeal RIA, the EPA makes three major changes to the final CPP RIA, including: treating energy efficiency savings as a benefit of the CPP (i.e., a foregone benefit of repeal); using a new social cost of carbon dioxide; and considering different assumptions on the relationship between PM levels and health. All three of these changes are discussed elsewhere in these comments. Here, I focus on the fact that the repeal RIA uses the same underlying assumptions for the electricity sector modeling as the final CPP RIA. These comments are relevant to both the repeal and replacement RIAs.

Changes to the electricity sector that have occurred since the CPP was finalized affect estimated costs and benefits of repeal, as well as the costs and benefits of replacement. In fact, the repeal RIA discusses many of these changes, which have also been discussed in numerous studies including some of our own work (e.g., Burtraw et al. 2012 and Linn and McCormack 2017). For instance, between 2015 and 2017, EIA reduced its forecasts of electricity consumption in 2030 by 1.5 percent. All else equal, updating assumptions on consumption growth would imply lower emissions in the no-CPP scenario, and lower carbon emissions reductions of the CPP. Updating the consumption assumption would also result in lower estimated costs.

As another example, costs of renewables have continued to decline after 2015. Using updated cost assumptions would imply more renewables and lower emissions in the no-CPP scenario, and it would also imply lower costs of constructing renewables to comply with the CPP. Lower renewables costs would affect both benefits and costs of the CPP.

Thus, updating the assumptions would affect both benefits and costs of the repeal. There is no reason, a priori, to expect the changes in benefits and costs between 2015 and an updated analysis to cancel one another exactly. That is, updating these assumptions is likely to affect the estimated net benefits of repeal.

The question is, how large might this change be? In the repeal RIA, EPA notes that in 2016, it estimated credit prices under the CPP to be $4 per ton of carbon dioxide in 2030, which is about one-third of the credit prices it had estimated just one year prior. Because the credit prices reflect marginal costs of reducing emissions and not average costs, it would be incorrect to infer that updating the analysis would reduce compliance costs by one-third. However, this comparison suggests that the effect would be large relative to the estimated costs of the final CPP.

In the proposed repeal RIA, EPA compares emissions and other outcomes estimated in the Energy Information Administration’s (EIA) Annual Energy Outlooks in 2016 and 2017. This comparison is of little use, however, because the EIA model differs in many ways from the model EPA uses to analyze the CPP. In other words, *I cannot think of a reasonable substitute for simply updating the assumptions used to model the net benefits of repealing the CPP*.

There is also a more general point to be made here, concerning whether to update assumptions when repealing a regulation. Given the rapid changes in fuel prices, technology costs, and other factors in the electricity sector, estimated costs and benefits may change substantially between the final regulation, repeal, and replacement, even if the finalization and replacement occur close together in time. In other contexts, such as regulating industrial pollution, the factors affecting costs and benefits may change more slowly over time. Nevertheless, in cases when those inputs have changed enough to make it reasonable to expect large changes in costs or benefits, EPA should update its analysis. If the EPA proceeds with repealing the CPP, its benefit-cost analysis should use updated assumptions.

3. Setting standards within the "fence line" could affect generator operation and undermine emissions reductions

EPA requests comment on developing GHG guidelines. In the final CPP, EPA tried to minimize the extent to which the CPP would cause generation to increase for carbon-emitting sources not covered by the CPP—most particularly, newly constructed generation units. Because the CPP set standards for existing but not new sources, there was a possibility that the CPP could cause generation to shift from existing to new sources, undermining the emissions gains of the regulation. EPA attempted to reduce this risk in several ways, such as by offering states the option to include new sources in their emissions caps.

Although EPA has provided few details on a proposed replacement of the CPP, the agency appears to favor setting emissions standards based on reductions that can occur at an individual source. If the EPA pursues this approach, there are two ways the standards could affect generator operation and undermine emissions reductions caused by the standards.

First, if EPA allows states to comply by meeting an emissions cap, this cap would have to cover emissions from all existing fossil fuel-fired generators. Otherwise, the emissions cap would likely increase generation from uncovered generators, including existing and new fossil fuel-fired generators that are not covered by the cap. For example, suppose the cap applies to all steam units but not existing natural gas combined cycle units. Then, a state could comply with the cap if enough generation shifts from existing coal to existing gas-fired units. The increase in gas-fired generation caused by the cap would eliminate roughly half of the emissions reductions caused by the cap (i.e., assuming the rate of emissions per unit of generation for a coal-fired unit is twice that of a gas-fired unit).

Second, with a rate-based standard, the standard can affect unit-level operation. For example, suppose a coal-fired unit improves its fuel efficiency sufficiently to meet its emissions rate standard. The higher efficiency reduces its marginal operating costs, which could cause it to generate more electricity than if it had not made the efficiency improvement. Linn et al. (2014) estimate that this effect could erode 22 to 33 percent of the emissions reductions caused by an efficiency standard for coal-fired units. EPA should design the replacement CPP to minimize these adverse effects.

Comments on the Estimation of Health Co-benefits in EPA's Clean Power Plan

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Ancillary public health benefits, also described as co-benefits, compose a portion of the total benefits of the Clean Power Plan (CPP) and therefore compose a portion of the total foregone benefits of the CPP repeal. EPA is actively exploring ways to address uncertainty in the estimation of these ancillary benefits, and the Regulatory Impact Analysis (RIA) for CPP repeal does so by conducting a sensitivity analysis using a set of $PM_{2.5}$ cutpoints. The RIA also provides an alternative approach for estimating foregone benefits, in which only the foregone benefits from the targeted pollutant (CO_2) are considered and foregone co-benefits are excluded. This comment addresses these two elements of the RIA.

Addressing uncertainty in co-benefit estimation using cutpoints

The RIA states, "we seek comment from the public on how best to use empirical data to quantitatively characterize the increasing uncertainty in $PM_{2.5}$ co-benefits that accrue to populations who live in areas with lower ambient concentrations." It is legitimate for the administration to raise the issue of uncertainties, as there are still uncertainties about the link between levels of $PM_{2.5}$ and mortality risk despite the breadth of research on the topic.

The issue is how to best address in a benefit–cost analysis the uncertainties inherent in any empirical study or a body of research. One approach typically used in regulatory impact analysis is to represent model uncertainty. For the Clean Power Plan, in both the analysis of the original rule and the new analysis to support repeal, this involves presenting a range of benefit estimates to reflect the relationship between $PM_{2.5}$ concentrations and premature mortality found from different studies. However, the RIA for CPP repeal follows a less defensible method of accounting for uncertainty in regulatory impact analyses such as this—it presents two sensitivity analyses that assume the existence of a threshold, or cutpoint.

The first threshold, below which any reductions in $PM_{2.5}$ concentrations are considered to have zero benefit, is the $PM_{2.5}$ level set by the National Ambient Air Quality Standard (NAAQS). The health literature does not support such an assumption, a point made clear in a 2010 summary of expert opinions.[1] Experts have been unable to identify a "knee" in the concentration-mortality response function, a point where the marginal observed health effects become smaller in number or less severe. Because the NAAQS standard concentration level of 12 micrograms per cubic meter (µg/m3) is well within the

[1] https://www3.epa.gov/ttn/ecas/regdata/Benefits/thresholdstsd.pdf

observed range of concentrations in the data used in key epidemiological studies, the assumption that health benefits below this level are zero is not legitimate and thus these results cannot be used as evidence to justify repeal.[2]

The second threshold is set at the lowest measured level (LML) of $PM_{2.5}$ concentrations in the two epidemiological studies used in the RIA to derive the concentration-mortality response relationship (Krewski et al. 2009, LML = 5.8 µg/m3; Lepeule et al. 2012, LML = 8 µg/m3). Below the LML, the health benefits from reductions in $PM_{2.5}$ concentrations are assumed to be zero. This assumption is potentially more defensible as a bounding analysis, because the data cannot identify the shape of the concentration-health response relationship at lower $PM_{2.5}$ levels. However, since the shape of the response function is unknown below the LML, a fair and transparent analysis should include a second bounding analysis in which the health benefits from reductions in $PM_{2.5}$ concentrations below the LML are assumed to be *higher* than the health benefits at observed levels of concentration (for instance by assuming that the concentration-response functions in concave).

Another way of improving the analysis would be to ask where the threshold would have to be to translate to benefits low enough for the benefits foregone from repealing the rule to be equal to the cost savings from repeal. Given that result, one could then ask if there is any literature to support such a threshold.

Furthermore, if the threshold cases are included in the RIA they should be clearly described for what they are: sensitivity analyses, not main results. The benefit-cost analyses using the threshold analyses are presented in the Executive Summary (Tables 1-7 and 1-8) and are not described as sensitivity analyses, possibly leading to the mistaken conclusion that they comprise a portion of the main results.

Including co-benefits in foregone benefits calculation

The first set of net benefit estimates presented in the RIA are the net benefits associated with the targeted pollutant, CO_2. Foregone health co-benefits are not included. This methodology addresses a concern stated in the news release for the CPP repeal Notice of Proposed Rulemaking (NPRM): “The Obama administration relied heavily on reductions in other pollutants emitted by power plants, essentially hiding the true net cost of the CPP by claiming benefits from reducing pollutants that had nothing to do with the rule’s stated purpose.”[3]

EPA’s statement is incorrect, and the estimation of net benefits that excludes foregone health co-benefits does not represent a full and fair analysis. The true net costs of repeal include the foregone co-benefits because controlling carbon dioxide emissions, given current mitigation options, inevitably will mean reducing other pollutants as well.

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[2] See Krewski et al. (2009) and Lepeule et al. (2012):
https://www.healtheffects.org/system/files/Krewski140.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3404667/

[3] https://www.epa.gov/newsreleases/epa-takes-another-step-advance-president-trumps-america-first-strategy-proposes-repeal

Ecological Co-Benefits and the Clean Power Plan

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In addition to public health impacts, combustion of fossil fuels and especially coal has an important effect on ecological systems, as a result of emissions of carbon dioxide, sulfur dioxide, nitrogen oxides, and mercury. These effects are well understood, but due to current data and modeling limitations, it is difficult to quantify and monetize the effects of ecological co-benefits of reductions in these pollutants on an incremental basis. Hence, both the analysis in support of the final rule (EPA 2015) and analysis in support of its repeal (EPA 2017) Obama's CPP and current repeal provide little information about ecological impacts. However, these co-benefits are an important consideration in evaluation of the Clean Power Plan.

Power plant carbon standards can improve crop and tree productivity, which generates co-benefits for commercial agriculture and ecosystem services (Capps et al. 2016). Acidification results when emissions of sulfur dioxide, nitrogen oxides and carbon dioxide are absorbed in water vapor in the atmosphere and then transported by wind and air current. Wet deposition (acid rain) and dry deposition cause acidification and damage to fresh water and marine ecosystems. Deposition of these pollutants contributes to ocean acidification. Some of the most convincing evidence that ocean acidification will affect marine ecosystems comes from warm water coral reefs. Deposition of nitrogen contributes to nutrient loading, considered as a major cause of hypoxia in Gulf of Mexico (Rebich et al. 2011). Atmospheric deposition of nitrogen as the most significant source of nitrogen contributions to this problem.

Maryland's valuable ecological resources are also directly affected by deposition associated with fossil fuel combustion. The EPA reports that atmospheric deposition contributes about one-third of the total nitrogen loads to the Chesapeake Bay. Direct deposition to the Bay's tidal surface waters accounts for 6 to 8 percent of the total (air and non-air) nitrogen load. Nitrogen deposited onto the land surface of the Bay's watershed and subsequently transported to the Bay contributes another 25 to 28 percent of the total nitrogen load.[1] Because the emissions sources that contribute to this deposition are primarily located outside of the state, regional or federal policy is required in order to mitigate nitrogen deposition. The Clean Power Plan provides important co-benefits in this regard.

[1] https://www.epa.gov/chesapeake-bay-tmdl/air-pollution-chesapeake-bay-watershed

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