ARTICLE CASE

Mercury and Air Toxics Standards: Co-Benefits and the Courts in U.S. Cost-Benefit Analysis

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ABSTRACT In April 2017, the U.S. Court of Appeals in Washington DC agreed with the U.S. Environmental Protection Agency (EPA) to delay indefinitely a lawsuit over the Agency's regulation governing mercury pollution from power plants. Lawyers for the EPA argued that they needed time to evaluate the status of the lawsuit, due to "the recent change in Administration." The case, *Murray v. EPA*, centers on the Agency's analysis of the benefits of reducing mercury pollution. Key to that litigation is the EPA's treatment of co-benefits—the incidental reductions to pollutants aside from mercury. As of this writing, the Agency has still not decided how to proceed. This case summarizes the EPA's 2011 Regulatory Impact Analysis at the heart of the legal dispute.[1]

KEY MESSAGE

This case describes the U.S. attempts to limit mercury and other airborne toxic pollutants from power plants, in detail sufficient for students to discuss the two sides in the ongoing debate. Students should be able to discuss the merits of (a) the EPA's methodology for valuing mercury reductions, (b) counting the co-benefits from reducing other pollutants, (c) alternative discount rates, (d) including only the benefits to U.S. citizens from U.S. power plant reductions, (e) extrapolations from other studies using benefit-per-ton approximations, and (f) valuing deaths using the value-of-a-statistical life (VSL) approach.

INTRODUCTION

The regulation in question—the Mercury and Air Toxics Standards (MATS)—had been finalized in 2011, but in June 2015, the U.S. Supreme court ruled 5-4 against the EPA, finding that the Agency analysis failed to demonstrate that the rule was "appropriate and necessary." That language comes from The Clean Air Act (CAA), the legislation the EPA used to justify its setting of standards for emissions of mercury and other hazardous air pollutants. The Court left the MATS rule in place temporarily, while remanding the case to the EPA for additional analysis. The EPA countered the following year with a "Supplemental Finding"[2] that the MATS was appropriate and necessary, prompting another lawsuit by opponents. In January 2017, the new Administration asked the court to delay arguments in that case, and in April the Court agreed, suspending the case indefinitely, and directing the EPA to file status reports every 90 days. The Agency's most recent update, in April 2018, states only that "EPA is continuing to review the Supplemental Finding to determine whether the rule should be maintained, modified, or otherwise reconsidered."

The Court's decision was based on a technicality of administrative law, whether the EPA's cost-benefit analysis done pursuant to an Executive Order could serve as the

2. Federal Register 81(79) 24420–24452, 15 April 2016 (www.gpo.gov/fdsys/pkg/FR-2016-04-25/pdf/2016-09429.pdf).

1. This case study was written by Arik Levinson, with research assistance from Jonah Birnberg and Craig Levites, based on the EPA's Regulatory Impact Analysis (RIA) for the Final Mercury and Air Toxics Standards, issued in December 2011 in compliance with Executive Order 12866 (www.epa.gov/sites/production/files/2015-11/documents/matsriafinal.pdf). All subsequent page numbers in square brackets [] refer to the RIA, unless otherwise stated. The Georgetown Environment Initiative provided generous funding.

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BOX 1. *Michigan v. EPA* in the U.S. Supreme Court

> "The Agency refused to consider cost when making its decision. It estimated, however, that the cost of its regulations to power plants would be $9.6 billion a year, but the quantifiable benefits from the resulting reduction in hazardous-air-pollutant emissions would be $4 to $6 million a year."
>
> Justice Scalia, for the 5-4 majority
>
> "… the regulation's yearly costs would come in at under $10 billion, while its annual measureable benefits would total many times more—between $37 and $90 billion."
>
> Justice Kagan, dissenting.

cost-benefit analysis required by the Clean Air Act. But that ruling avoids an even larger difference of opinion, highlighted in Box 1. Should cost-benefit analyses limit their consideration to only the intended objective of the rule—mercury reductions in this case—or can they consider ancillary "co-benefits" that are unintended but beneficial consequences of that rule? Justice Kagan's statement of the benefits includes co-benefits; Justice Scalia's majority opinion excluded them. This broader question has now come to the forefront of environmental policy debate. In June 2018, the Trump Administration proposed reversing the longstanding practice of including those co-benefits. Environmental groups worry that change will lead to fewer beneficial regulations.

CASE EXAMINATION

Mercury is a toxic metal that occurs naturally in the environment. It is most dangerous to humans in the form of methylmercury. Methylmercury is a byproduct of burning fossil fuels—coal, oil, and natural gas—which account for the bulk of U.S. electricity supply.

Power plants emit mercury into the atmosphere, where it transforms into methylmercury particles through chemical reactions. Methylmercury then settles in water and accumulates in the tissue of aquatic organisms. Methylmercury bioaccumulates, which means that organisms absorb the toxin faster than they can transform or excrete it. As a consequence, predatory fish at the top of the food chain have the highest concentrations of methylmercury.

Humans are exposed to methylmercury primarily by eating contaminated fish. Neurological effects include damage to memory and brain development. According to the National Academy of Sciences, "[t]he population at highest risk is the children of women who consumed large amounts of fish and seafood during pregnancy" [1].

Methylmercury has also been linked to increases in blood pressure, chromosomal damage, and decreased immune system activities. However, these nonneurological health effects are less well documented.

History of the Mercury Regulation and Michigan v. EPA

Table 1 presents a timeline. In 1990, President George H.W. Bush signed into law significant amendments to the Clean Air Act. These focused on improving four major environmental concerns: acid rain, urban air pollution, stratospheric ozone depletion, and toxic air emissions. Section 112 (S.112) laid out a multistep process the EPA must follow before it can regulate toxic emissions from power plants. First, the EPA must study the health hazards. And then, to implement regulation, the EPA must demonstrate that the regulation in question is "appropriate and necessary" based on the results of that study.

Running behind schedule and facing lawsuits, in 1998 the EPA submitted its "Utility Air Toxics Study." As mandated by S.112, the study included an analysis of hazardous air emissions and alternative control strategies. These included precombustion reductions like fuel switching, combustion controls like efficiency improvements, and postcombustion controls like demand side management [2].

TABLE 1. MATS timeline

1990	Clean Air Act Amendments
Early 1990s	The CAA outlines the multiyear process that the EPA must adhere to before enforcing air toxics emissions, including Mercury
December 1994	EPA agrees to complete its "Utility Air Toxics Study" to Congress to determine if it is "appropriate and necessary" to regulate power plants under CAA S.112
December 1998	EPA reports findings to Congress, including research on mercury emissions from power plants and other industrial sources
December 2000	EPA determines that coal- and oil-fired electric unit regulation is appropriate and necessary under CAA S.112
March 2005	EPA finalizes the Clean Air Mercury Rule (CAMR), with two pathways to abatement; the implementation of maximum achievable control technology (MACT), and the establishment of a market-based cap-and-trade program
February 2008	D.C. Circuit vacates CAMR and removes power plants from the CAA list of sources of hazardous pollutants
March 2011	The EPA proposes the MATS rule discussed in this case study, replacing CAM
June 2015	U.S. Supreme Court rules in *Michigan v. EPA* that EPA failed to consider costs when determining that MATS is "appropriate and necessary" under the CAA
April 2016	EPA issues Supplemental Finding that MATS costs are appropriate and necessary. Opponents immediately file suit in *Murray v. EPA*
April 2017	D.C. Circuit agrees with EPA petition to delay indefinitely arguments in *Murray* due to "the recent change in Administration."

Source: www.epa.gov/mats/history-mats-regulation.

In 2004, the EPA proposed the Clean Air Mercury Rule (CAMR) with two pathways to abatement. The first would require power plants to limit emissions using the maximum achievable control technology (MACT), as mandated by S.112 of the CAA. The goal was to reduce nationwide mercury emissions by approximately 30% by 2008. The alternative pathway, a cap and trade program, would reduce emissions by 70%. After time for public comment, the EPA finalized CAMR in March 2005.

The CAMR faced initial opposition from environmental groups for exempting oil- and coal-fired power plants from meeting the MACT S.112 standards, and instead regulating them under a cap-and-trade approach. Waterkeeper Alliance Legal Director Scott Edwards called the rule "perhaps the biggest sellout to industry in the history of the EPA" [3]. In 2008, the D.C. Circuit Court vacated the CAMR, finding that the decision to remove oil-and coal-fired generators from the MACT rules contradicted the CAA.

In March 2011, the EPA proposed its replacement for the CAMR, the Mercury and Air Toxics Standard, or MATS. After a public comment period and some revisions, the MATS was finalized in December. As is required with all economically significant regulatory actions, the EPA published a "Regulatory Impact Analysis" (RIA).

The need for this regulatory benefit-cost analysis originates in part from the White House. In 1981, President Ronald Reagan signed E.O. 12291, requiring executive branch agencies to prepare and publish RIAs for all major rulemakings. President Clinton issued a similar order in 1993. President Bush's Administration issued guidance for how to conduct the analyses in 2003.[3] And President Obama followed with his own order in 2011.[4]

Regulatory analysis is also required by the CAA. The Act requires the EPA Administrator to study the hazards from toxic air emissions, report the findings to Congress, and then regulate electricity generators "if the Administrator finds such regulation is appropriate and necessary after considering the results of the study."

In June 2015, the Supreme Court ruled in *Michigan v. EPA* that the RIA conducted for the MATS rule did not satisfy the requirements of the CAA. The Court affirmed the plaintiff's claim that the EPA did not consider costs *before* it deemed its measures "appropriate and necessary." The Court did not address the co-benefits issue in making its decision. But as Box 1 makes clear, different justices had very different views as to the merits of those co-benefits.

3. Office of Management and Budget, Circular A-4.
4. E.O 13583, 18 January 2011.

TABLE 2. Summary of EPA's estimates of annualized benefits, costs, and net benefits of the final MATS in 2016 (billions of 2007$)

Total costs	$9.6	
Total benefits	**3% Discount rate**	**7% Discount rate**
	$37–$90	$33–$81
Net benefits (benefits–costs)	$27–$80	$24–$71

Not all possible benefits are quantified.
Source: RIA, Table ES-1.

TABLE 3. Total annual production cost, 2015 (billions of 2007$)

	Base case	Policy case	Net
Variable O&M	11.1	13.5	2.4
Fixed O&M	45.9	47.7	1.8
Fuel	78.8	81.5	2.7
Capital	8.5	10.9	2.4
Transport and storage	−0.1	−0.1	0
Total	144.2	153.5	9.4

Source: RIA, p. 7-22.

The majority opinion notes that only a small share of the monetized benefits come from regulating mercury. Most of the benefits are co-benefits that come from reductions in other pollutants such as particulate matter and carbon dioxide. Whether or not these co-benefits should count toward the new mercury regulation is a topic of ongoing of debate.

TABLE 4. Total costs projected for covered units under MATS, 2015 (billions of 2007$)

Integrated planning model projection	$9.4
Monitoring/reporting/record keeping	$0.16
Oil-fired fleet	$0.06
Total	$9.6

Source: RIA, Table 3-16.

COSTS OF THE MATS REGULATION

Table 2 summarizes the EPA's estimated costs and benefits of the MATS. For costs, the EPA hired a consulting firm called ICF. It used an Integrated Planning Model (IPM) to make projections of compliance costs for coal-fired power plants. The IPM is a linear programming computer model of the generation capacity, electricity demand, and constraints faced by each electricity generator. The model calculates the least costly way of meeting any given electricity demand, conditional on constraints that include environmental regulations. It considers a variety of options for complying with those regulations, including switching from coal to natural gas or installing new abatement technologies. ICF used the IPM to project electricity output, energy prices, and emissions, both for a base case without MATS and a policy case with MATS.

Table 3 reports the projected total annual production cost of electricity, with and without the MATS rule. Costs without MATS were projected to be $144.2 billion in 2015, and costs with MATS $153.5 billion. The net $9.4 billion increase in annual costs does not include compliance costs for oil-fired units, monitoring, or record-keeping costs. These additional costs, listed in Table 4, add an additional $0.22 billion.

For coal-fired generators, the IPM considered a variety of options. Many generators were expected to construct new postcombustion controls that work by treating emissions with chemical reactions or filters [3-14].[5] In addition to capturing mercury, these technologies also reduce other pollutants, like sulfur dioxide (SO_2) and particulates smaller than 2.5 μm ($PM_{2.5}$), and typically reduce those pollutants by over 90% [4]. Many generators had these systems in place before MATS was enacted. Others would need to retrofit to meet the standards [5].

In addition to postcombustion controls, the IPM projected that some generators would comply by switching fuels, in particular to natural gas, which emits much less mercury than coal [2-8] [6]. Table 5 summarizes these projected changes to the mix of electricity sources.

These compliance options come with a variety of costs, summarized in Table 3. The compliance costs for coal-fired units were "disaggregated into variable operating and maintenance (O&M), fixed O&M, fuel, capital, and carbon dioxide (CO_2) transportation and storage cost" [7].

5. Page numbers in square brackets refer to the original EPA Regulatory Impact Analysis. See text footnote 1.

TABLE 5. Generation mix with the base case and the MATS, 2015 (thousands of GWh)

	2009	2015		
	Historical	Base case	Policy case	% Change from base
Coal	1,741	1,982	1,957	−1.3
Oil	36	0.11	0.11	3.6
Natural gas	841	710	731	3.1
Nuclear	799	828	831	0.4
Hydroelectric	267	286	288	0.8
Non-hydro renewables	116	252	250	−0.6
Other	10	45	45	0.0
Total	3,810	4,103	4,104	0.0

Source: RIA, Table 3-6.

TABLE 6. 2015 Power sector coal use (TBtu)

Coal rank	Base	MATS	Change (%)
Bituminous	11,314	11,248	−0.6
Subbituminous	7,736	7,554	−2
Lignite	849	895	5
Total	19,900	19,698	−1

Source: RIA, Table 3-11.

Fixed O&M costs include labor to implement and maintain the postcombustion equipment. Variable O&M costs include the chemicals needed to react with the pollutants before they enter the atmosphere, and management and storage of the byproducts [8].

The IPM projected fuel costs would increase by $2.7 billion from the base case to the policy case for the year 2015, mostly due to switching to natural gas [9]. However, natural gas prices have fallen since the RIA was written in 2011, so in hindsight the IPM likely overestimated these fuel costs.

Coal accounted for another $400 million cost increase. Although coal demand was expected to decrease, its price was expected to rise modestly. The IPM projected use of cheaper subbituminous coal to drop by 2% and lignite coal to rise by 5% [3-22]. This is shown in Table 6. Average projected coal prices rise despite reduced demand.

Of course, the MATS will also lead to price changes and demand responses. The IPM projected that coal-fired

TABLE 7. Average coal prices (2007$/MMBtu)

	2007	2015			2030		
		Base	MATS	% Change from base	Base	MATS	% Change from base
Coal	1.27	1.35	1.39	2.8	1.51	1.56	3.6
Oil	1.76	2.11	2.15	1.9	2.29	2.33	1.7

Source: RIA, Table 3-13.

TABLE 8. 2015–2030 Weighted average natural gas prices (2007$/MMBtu)

	Base case	MATS	% Change from base
Henry hub	5.29	5.32	0.6
Delivered—electric power	5.56	5.60	0.6
Delivered—residential	10.94	10.97	0.3

Source: RIA, Table 3-14.

capacity would decrease from 310 to 305 GW in 2015 as a result of MATS, and that the average retail electricity price would rise 3.1% [3-22]. However, the IPM's $9.4 billion bottom line does not include that price increase. Instead, the RIA projected that price rises "would prompt end users to increase investment in energy efficiency and/or curtail (to some extent) the use of their electricity and encourage them to use substitutes" [3-33]. This will create unquantified savings that will partially offset the cost of pollution controls and fuel switching. The IPM's predicted price changes are outlined in Tables 7 and 8.

BENEFITS OF THE MATS REGULATION

MATS benefits stem from two changes: reductions in mercury itself and reductions in other pollutants indirectly caused by efforts to reduce mercury.

Mercury-Related Benefits

Of the $33–$90 billion in benefits reported by the EPA, only a small fraction comes directly from reductions in mercury emissions. Many of those benefits occur far in the future. An important consideration, therefore, is how future benefits should be valued today, or what discount rates should be applied. The Office of Management and Budget asks that regulatory analyses be done comparing two rates: 3 and 7% (see text footnote 3). At the 3% discount rate, the annualized benefits from MATS mercury reductions in 2016 were expected to be $4 million–$6 million. At the 7% discount rate, benefits drop to $0.5 million–$1 million [ES-1]. By contrast, future costs for the MATS were discounted at 6.15%. The EPA explains the 6.15% rate as "an empirically-informed price of raising capital for the power sector" whereas the 3 and 7% rates "represent social rates of time preference" [3-9].

To estimate the benefits from reducing methylmercury, the EPA focused on the IQ of children born to mothers exposed to recreationally caught freshwater fish in the United States. The EPA did not evaluate mercury exposure from self-caught saltwater or commercially purchased ocean fish because "it is nearly impossible to determine the source of the methylmercury in those fish, and thus we could not attribute mercury levels to U.S." electric generators [4-1]. To measure mercury exposure from recreational fishing, the EPA looked at survey data about "anglers," fishers who use a simple rod and line.

The EPA first used 2000 Census data to estimate the number of pregnant women in each state.[6] This is just the number of females aged 15–44 multiplied by the state-specific fertility rate. Then, the EPA multiplied this number by the fraction of households in the state with anglers to get an estimate of the number of prenatally exposed children.

These potentially exposed children were divided into 32 subpopulations, by income, rural or urban, and distance to lakes and rivers. EPA estimated the average daily mercury ingestion rate for each subpopulation separately. First the Agency multiplied 8 g of fish per day by the average mercury concentration in fish consumed by that subpopulation to get a daily mercury ingestion rate. They then used this daily mercury ingestion rate to estimate mercury concentration in the mothers' hair, using a ratio found in a published toxicology study: multiplying the local ingestion rate times 12.5 divided by the average body weight for females younger than 45 (64 kg) [10].

Next, the EPA estimated IQ decreases as 0.18 times maternal hair mercury concentration, using the ratio from epidemiological studies in the Faroe Islands, New Zealand, and the Seychelles Islands [11]. All three studies reported an inverse correlation between mercury in maternal hair and the IQ of their children. Finally, the EPA estimated two monetary changes for each lost IQ point: lifetime earnings and schooling costs. Outside studies estimated that each one-point increase in IQ corresponds to a 1.76–2.38% increase in lifetime earnings [12, 13]. The EPA calculated the present value of median lifetime earnings to be $555,427 using a 3% discount rate.

Some of those increased earnings come from the fact that people with higher IQ tend to stay in school longer, which comes with costs. The EPA estimated each one-point increase in IQ correlates with an extra 0.101–0.131 years in school, and that each year of schooling costs $13,453.

Table 9 summarizes these calculations, showing the baseline level of mercury and their estimated effects in 2005 and 2016, along with the predicted change from the MATS rule. The rule is expected to increase the total present discounted value of lifetime earnings of Americans by $0.47–$6 million, net of schooling costs, depending on the discount rate used.

Concerns with Direct Benefits Calculation

The EPA recognizes several concerns with these computations. It questions whether IQ is the best metric to quantify the effects of prenatal mercury exposure. Problem solving, social skills, and language functions could also be directly affected by mercury exposure and result in lost future earnings [4-35].

The EPA also questions the use of lost earnings. The approach "has several uncertainties, including (1) there is a linear relationship between IQ changes and net earnings losses, (2) the unit value applies to even very small changes in IQ, and (3) the unit value will remain constant (in real present value terms) for several years into the future" [ES-18]. Moreover, IQ losses may impose costs in addition to earnings reductions.

Co-Benefits

The EPA expects that the action generators take to reduce mercury emissions will also reduce emissions of SO_2, nitrogen oxides (NO_x), $PM_{2.5}$, CO_2, and ozone. These co-benefits are at the heart of the legal dispute, as illustrated in Box 1, because estimates of their value range from $33–$90 billion, making up the vast majority of the MATS benefits [5-1]. They are summarized in Table 10.

To calculate co-benefits, the EPA identified specific health and welfare effects associated with air quality, and called these

6. Sections 4.7.2 and 4.7.3 of the RIA.

TABLE 9. Mercury benefits of the MATS in 2016 (millions of 2007$)

	2005 Base case	2016 Base case	2016 MATS	Change due to MATS
Exposed children	239,174	244,286		
Average maternal daily mercury ingestion (μg/day)	3.04	2.84		
Average IQ loss per prenatally exposed child	0.1068	0.1000	0.0979	−0.00209
Total IQ point losses from one year of exposure	25,545	24,419	23,909	−511
Value of total IQ losses in 2016 (millions of 2007$)				
3% Discount rate	$210–$310	$200–$300	$200–$290	$4.2–$6.2
7%	$23–$51	$22–$49	$22–$48	$0.47–$1.0

Source: RIA, Tables 4-5, 4-6, and 4-7.

TABLE 10. Co-benefits of the MATS in 2016 (billions of 2007$)

Effect	Pollutant	Total	
		3%	7%
Adult premature death (Pope)[†]	$PM_{2.5}$	$34	$30
Adult premature death (Laden)[‡]	$PM_{2.5}$	$87	$78
Infant premature deaths	$PM_{2.5}$	$0.2	$0.2
Chronic bronchitis	$PM_{2.5}$	$1.4	$1.4
Nonfatal heart attacks	$PM_{2.5}$	$0.5	$0.4
Hospital admissions (respiratory and cardiovascular)	$PM_{2.5}$	$0.04	$0.04
Minor restricted activity days	$PM_{2.5}$	$0.2	$0.2
CO_2-related co-benefits	CO_2	$0.36	$0.36
Total using Pope		$37	$33
Total using Laden		$90	$81

†Estimates from Pope et al. [12].
‡Estimates from Laden et al. [15].
Source: Regulatory Impact Analysis, Tables ES-3 and ES-4.1.

"endpoints" [5-9]. To quantify them, the EPA followed three steps: (1) it estimated the change in $PM_{2.5}$ and ozone resulting from the MATS; (2) it determined the subsequent change in population exposed, because air quality has larger benefits in more populated areas; and (3) it used dose-response functions estimated from epidemiological studies to predict changes in those endpoints resulting from the changes in population exposures [5-10].

Finally, the EPA translated changes in endpoints into dollar values. To do so, the EPA used a concept called "value of a statistical life" (VSL). Put simply, VSL represents the price individuals would willingly pay for an incremental reduction in mortality risk [5-41]. For example, suppose a policy is able to reduce the risk of premature mortality from 2 in 10,000 to 1 in 10,000 (a reduction of 1 in 10,000). If individual willingness to pay (WTP) for this risk reduction is $100, then the WTP for an avoided statistical premature mortality amounts to $1 million ($100/0.0001) [5-11]. The next section describes this approach.

Adult Premature Deaths

The EPA expected there would be 4,200–11,000 fewer premature adult deaths as a consequence of MATS [5-95]. The EPA used two epidemiological studies to arrive at this range: Pope et al. [14] and Laden et al. [15]. Both examined the relationship between long-term exposure to $PM_{2.5}$ and mortality, from all causes, lung cancer, and cardiopulmonary disease. Both show mortality rates rising with in $PM_{2.5}$.

To convert these deaths into dollar costs, the EPA used VSL estimated following its Science Advisory Board's guidelines, which are based on 26 published VSL studies. Twenty-one of the 26 studies estimate the VSL from the difference between market wages in risky and safe jobs, controlling for other job and worker characteristics. The remaining five studies are "contingent valuations," based on survey questions that directly ask people how much they would be willing to pay to reduce the risk of dying. The average VSL across the 26 studies was $6.3 million in year-2000$ [16]. The EPA converted this to 2007$ and adjusted for income growth to 2016, because WTP to reduce mortality risk rises with incomes. These two adjustments increased the VSL to $8.9 million [5-42].

Applying these dollar values to the predicted reductions in premature mortality, the EPA estimated the MATS would produce $34 billion–$87 billion of benefits at a 3% discount rate, and $30 billion–$78 billion at 7% [5-96].

Other Co-Benefits

While reduced premature mortality provided most of the co-benefits, a variety of other human health effects also add to the MATS total benefits. Among these are reductions in chronic bronchitis, nonfatal heart attacks, lost school and work days, and hospital and emergency room admissions [5-96]. The EPA valued the health benefits using reductions in medical costs incurred. It projected that fewer cases of chronic bronchitis would provide $1.4 billion in benefits, while the other endpoints would provide less than $0.5 billion in benefits each [5-96].

The EPA also estimated monetary benefits from the reduction of CO_2 emissions. Carbon reductions by U.S. generators help reduce global greenhouse gas emissions. The EPA used an official U.S. government estimate of the global social cost of carbon, "an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year" [5-88]. These global co-benefits of the MATS rule amount to $0.36 billion.

Concerns with Co-Benefits Calculations

There are several concerns regarding the calculations using VSL. One is that the WTP for risk reduction may not be linear. WTP to reduce premature mortality by 1 in 10,000 may be much different if the underlying baseline risk is 1-in-100 than if it is 1-in-10,000.

Second, the wage studies that form most of the basis for the VSL are estimated for working-age male workers. But the people most adversely affected by air pollution are elderly, and some studies suggest older people have a lower WTP for risk reductions [16]. Nonetheless, the EPA claimed "the relationship between age and WTP for mortality risk changes is ambiguous," and therefore argued for the use of a single VSL for the entire population [16].

Similarly, many individuals benefitting from the MATS may have preexisting health conditions. As with age, some studies indicate that WTP falls with declining health, while others show no statistical relationship. The EPA followed its standard practice and did not adjust the VSL for health or any other characteristics.

Finally, the cost-of-illness approach to valuing nonfatal illnesses did not account for pain and suffering. So these co-benefits may be underestimated [5-12].

Unquantified Benefits

The EPA could not quantify or monetize some benefits. These include both human health effects as well as environmental effects [5-59]. These unquantified benefits are not included in Table 4. For example, reducing NO_x, SO_2, and $PM_{2.5}$ improves visibility, increasing road and air travel safety, as well as improving esthetics for outdoor recreation [5-62]. Although they do not include these values in their total benefits, the EPA estimated that visibility improvements from MATS could add up to $1.1 billion to the total benefits [5-93]. This calculation is based on a study in which subjects were shown photographs with varying visibility levels and asked questions designed to elicit their WTP for improved visibility [17].

In computing co-benefits from the MATS, the EPA focused only on $PM_{2.5}$ and ozone. The Agency did not try to monetize human health benefits from reductions in SO_2 or NO_x. This was due to "limits in available air quality modeling" [5-1]. But co-benefits from reduced SO_2 and NO_x could be substantial [5-88].

Finally, the EPA did not quantify a variety of ecosystem co-benefits from MATS [5-66]. For example, MATS would reduce ozone emissions, boosting crop yields [5-86] and improving the appearance of urban trees [5-87]. MATS would also reduce terrestrial and aquatic acidification [5-68]. Because the scale of these environmental effects remains uncertain, the EPA did not quantify their benefits.

STATUS AS OF SPRING 2018

In April 2016, the EPA issued a Supplemental Finding in response to the June 2015 Supreme Court decision. Their conclusion: "a consideration of cost does not cause us to change our determination that regulation of hazardous air pollutant emissions from coal and oil-fired generators is appropriate and necessary." Opponents of the rule sued again in *Murray v. EPA*. After President Trump took office in January 2017, the EPA needed time to figure out what to do. EPA Administrator Pruitt had joined the suits to block the MATS rule in 2012 and again in 2016, when he was Attorney General of Oklahoma. Accordingly, the EPA asked the D.C. Circuit Court to delay the case indefinitely, and in April 2017 the Court agreed, requiring that the EPA file status reports every 90 days. A year later, the Agency's April 2018 update reports that it "is continuing to review the Supplemental Finding to determine whether the rule should be maintained, modified, or otherwise reconsidered."

CONCLUSION

The issue of co-benefits has risen to the top of the U.S. environmental policy agenda. On 7 June 2018, the U.S. EPA proposed modifications to the way it conducts cost-benefit analyses, specifically mentioning its treatment of co-benefits.[7] Environmental groups worry that discounting co-benefits will result in fewer beneficial regulations. Joe Aldy points out that the U.S. Clean Air Act's Acid Rain Program in the 1990s, which was designed to reduce sulfur dioxide emissions from power plants, led to reductions in other airborne particulates and health benefits worth over $50 billion per year [18]. In 2017, the U.S. EPA proposed to repeal the Clean Power Plan. That is the Obama Administration's rule governing greenhouse gas emissions from coal-fired electric power plants. At the time it was issued, EPA analysts estimated that the majority of the rule's benefits would come from local air pollution reductions, like sulfur dioxide, rather than the targeted greenhouse gas reductions.

The Acid Rain Program, designed to reduce sulfur dioxide, also reduced particulates. The Clean Power Plan, designed to reduce greenhouse gases, would also reduce sulfur dioxide. And the MATS rule studied in this case, though designed to reduce mercury emissions, also reduces sulfur dioxide, particulates, and greenhouse gases. Should regulatory cost-benefit analyses count all those benefits, regardless of whether they are included in the stated aim of the legislation? That is the open question.

CASE STUDY QUESTIONS

1. Should any or all of the co-benefits be included? Which ones? Why or why not?
2. Why did the EPA ignore the mercury in saltwater fish? Should it have included those? Why or why not?
3. Should the accounting include only U.S. benefits or should it also include benefits to the rest of the world? Does the answer differ for direct mercury benefits and CO_2 co-benefits? Why or why not?
4. OMB recommends discount rates of 3 and 7%. Why did EPA use 6.15% to discount costs? Does it affect the results? Should the EPA have used the same discount rate for both costs and benefits? Why or why not?
5. EPA included increased schooling as a cost of the MATS rule. Do you agree with that? Why or why not?
6. The EPA did not include electricity price increases or demand reductions in its estimate of costs. Do you agree with their rationale? Why or why not?
7. Many of the co-benefits of the MATS rule are from reductions in $PM_{2.5}$. $PM_{2.5}$ is regulated under a different section of the Clean Air Act. Does the fact that this pollutant is regulated separately affect your view on whether co-benefits of further $PM_{2.5}$ reductions should be included?
8. Compare the problem of assessing the costs and benefits of regulating mercury emissions to those of greenhouse gases. What are the similarities and differences?

7. www.epa.gov/environmental-economics/increasing-consistency-and-transparency-considering-costs-and-benefits.

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COMPETING INTERESTS

The author has declared that no competing interests exist.

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