Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards

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Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards

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EXECUTIVE SUMMARY

This Regulatory Impact Analysis (RIA) presents the health and welfare benefits, costs, and other impacts of the final Mercury and Air Toxics Standards (MATS) in 2016.

ES.1 Key Findings

This rule will reduce emissions of Hazardous Air Pollutants (HAP), including mercury, from the electric power industry. As a co-benefit, the emissions of certain $PM_{2.5}$ precursors such as SO_2 will also decline. EPA estimates that this final rule will yield annual monetized benefits (in 2007$) of between $37 to $90 billion using a 3% discount rate and $33 to $81 billion using a 7% discount rate. The great majority of the estimates are attributable to co-benefits from 4,200 to 11,000 fewer $PM_{2.5}$-related premature mortalities. The monetized benefits from reductions in mercury emissions, calculated only for children exposed to recreationally caught freshwater fish, are expected to be $0.004 to $0.006 billion in 2016 using a 3% discount rate and $0.0005 to $0.001 billion using a 7% discount rate. The annual social costs, approximated by the compliance costs, are $9.6 billion (2007$) and the annual monetized net benefits are $27 to $80 billion using 3% discount rate or $24 to $71 billion using a 7% discount rate.[1] The benefits outweigh costs by between 3 to 1 or 9 to 1 depending on the benefit estimate and discount rate used. There are some costs and important benefits that EPA could not monetize, such as other mercury reduction benefits and those for the HAP other than mercury being reduced by this final rule. Upon considering these limitations and uncertainties, it remains clear that the benefits of the MATS are substantial and far outweigh the costs. Employment impacts associated with the final rule are estimated to be small.

The benefits and costs in 2016 of the final rule are in Table ES-1. The emission reductions from the electricity sector that are expected to result from the rule are reported in Table ES-2.

[1] As discussed in Chapter 3, costs were annualized using a 6.15% discount rate.

Table ES-1. Summary of EPA's Estimates of Annualized[a] Benefits, Costs, and Net Benefits of the Final MATS in 2016[b] (billions of 2007$)

Description	Estimate (3% Discount Rate)	Estimate (7% Discount Rate)
Costs[c]	$9.6	$9.6
Benefits[d,e,f]	$37 to $90 + B	$33 to $81 + B
Net benefits (benefits-costs)[g]	$27 to $80 + B	$24 to $71 + B

[a] All estimates presented in this report represent annualized estimates of the benefits and costs of the final MATS in 2016 rather than the net present value of a stream of benefits and costs in these particular years of analysis.

[b] Estimates rounded to two significant figures and represent annualized benefits and costs anticipated for the year 2016.

[c] Total social costs are approximated by the compliance costs. Compliance costs consist of IPM projections, monitoring/reporting/recordkeeping costs, and oil-fired fleet analysis costs. For a complete discussion of these costs refer to Chapter 3. Costs were annualized using a 6.15% discount rate.

[d] Total benefits are composed primarily of monetized PM-related health benefits. The reduction in premature fatalities each year accounts for over 90% of total monetized benefits. Benefits in this table are nationwide and are associated with directly emitted $PM_{2.5}$ and SO_2 reductions. The estimate of social benefits also includes CO_2-related benefits calculated using the social cost of carbon, discussed further in Chapter 5.

[e] Not all possible benefits or disbenefits are quantified and monetized in this analysis. B is the sum of all unquantified benefits and disbenefits. Data limitations prevented us from quantifying these endpoints, and as such, these benefits are inherently more uncertain than those benefits that we were able to quantify. Estimates here are subject to uncertainties discussed further in the body of the document. Potential benefit categories that have not been quantified and monetized are listed in Table ES-5.

[f] Mortality risk valuation assumes discounting over the SAB-recommended 20-year segmented lag structure. Results reflect the use of 3% and 7% discount rates consistent with EPA and OMB guidelines for preparing economic analyses (EPA, 2000; OMB, 2003).

[g] Net benefits are rounded to two significant figures. Columnar totals may not sum due to rounding.

Table ES-2: Projected Electricity Generating Unit (EGU) Emissions of SO_2, NO_X, Mercury, Hydrogen Chloride, PM, and CO_2 with the Base Case and with MATS, 2015[a,b]

		Million Tons			Thousand Tons		CO_2
		SO_2	NO_X	Mercury (Tons)	HCl	$PM_{2.5}$	(Million Metric Tonnes)
Base	All EGUs	3.4	1.9	28.7	48.7	277	2,230
	Covered EGUs	3.3	1.7	26.6	45.3	270	1,906
MATS	All EGUs	2.1	1.9	8.8	9.0	227	2,215
	Covered EGUs	1.9	1.7	6.6	5.5	218	1,883

[a] Source: Integrated Planning Model run by EPA, 2011

[b] The year 2016 is the compliance year for MATS, though as we explain in later chapters, we use 2015 as a proxy for compliance in 2016 for IPM emissions and costs due to availability of modeling impacts in that year.

ES.1.1 Health Co-Benefits

The final MATS Rule is expected to yield significant health co-benefits by reducing emissions not only of HAP such as mercury, but also significant co-benefits by reducing to direct fine particles ($PM_{2.5}$) and sulfur dioxide, which contributes to the formation of $PM_{2.5}$.

Our analyses suggest this rule would yield co-benefits in 2016 of $37 to $90 billion (based on a 3% discount rate) and $33 to $81 billion (based on a 7% discount rate). This estimate reflects the economic value of a range of avoided health outcomes including 510 fewer mercury-related IQ points lost as well as avoided $PM_{2.5}$-related impacts, including 4,200 to 11,000 premature deaths, 4,700 nonfatal heart attacks, 2,600 hospitalizations for respiratory and cardiovascular diseases, 540,000 lost work days, and 3.2 million days when adults restrict normal activities because of respiratory symptoms exacerbated by $PM_{2.5}$. We also estimate substantial additional health improvements for children from reductions in upper and lower respiratory illnesses, acute bronchitis, and asthma attacks. See Table ES-3 for a list of the annual reduction in health effects expected in 2016 and Table ES -4 for the estimated value of those reductions. In addition, we include in our monetized co-benefits estimates the effect from the reduction in CO_2 emissions resulting from this rule. We calculate the co-benefits associated with these emission reductions using the interagency estimates of the social cost of carbon (SCC)[1].

It is important to note that the health co-benefits from reduced $PM_{2.5}$ exposure reported here contain uncertainty, including from the following key assumptions:

1. The $PM_{2.5}$-related co-benefits of the regulatory alternatives were derived through a benefit per-ton approach, which does not fully reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an over-estimate or under-estimate of the actual co-benefits of controlling PM precursors. In addition, differences in the distribution of emissions reductions across states between the modeled scenario and the final rule scenario add uncertainty to the final benefits estimates.

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[1] Docket ID EPA-HQ-OAR-2009-0472-114577, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866,* Interagency Working Group on Social Cost of Carbon, with participation by Council of Economic Advisers, Council on Environmental Quality, Department of Agriculture, Department of Commerce, Department of Energy, Department of Transportation, Environmental Protection Agency, National Economic Council, Office of Energy and Climate Change, Office of Management and Budget, Office of Science and Technology Policy, and Department of Treasury (February 2010). Also available at http://www.epa.gov/otaq/climate/regulations.htm

2. We assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because $PM_{2.5}$ produced via transported precursors emitted from EGUs may differ significantly from direct $PM_{2.5}$ released from diesel engines and other industrial sources, but the scientific evidence is not yet sufficient to allow differential effects estimates by particle type.

3. We assume that the health impact function for fine particles is linear within the range of ambient concentrations under consideration. Thus, the estimates include health co-benefits from reducing fine particles in areas with varied concentrations of $PM_{2.5}$, including both regions that are in attainment with fine particle standard and those that do not meet the standard down to the lowest modeled concentrations.

A large fraction of the $PM_{2.5}$-related benefits associated with this rule occur below the level of the National Ambient Air Quality Standard (NAAQS) for annual $PM_{2.5}$ at 15 $\mu g/m^3$, which was set in 2006. It is important to emphasize that NAAQS are not set at a level of zero risk. Instead, the NAAQS reflect the level determined by the Administrator to be protective of public health within an adequate margin of safety, taking into consideration effects on susceptible populations. While benefits occurring below the standard may be less certain than those occurring above the standard, EPA considers them to be legitimate components of the total benefits estimate.

Based on the modeled interim baseline which is approximately equivalent to the final baseline (see Appendix 5A), 11% and 73% of the estimated avoided premature deaths occur at or above an annual mean $PM_{2.5}$ level of 10 $\mu g/m^3$ (the LML of the Laden et al. 2006 study) and 7.5 $\mu g/m^3$ (the LML of the Pope et al. 2002 study), respectively. These are the source studies for the concentration-response functions used to estimate mortality benefits. As we model avoided premature deaths among populations exposed to levels of $PM_{2.5,}$ we have lower confidence in levels below the LML for each study. However, studies using data from more recent years, during which time PM concentrations have fallen, continue to report strong associations with mortality. EPA briefly describes these uncertainties below and in more detail in the benefits chapter of this RIA.

ES.1.2 Welfare Co-Benefits

The term *welfare co-benefits* covers both environmental and societal benefits of reducing pollution, such as reductions in damage to ecosystems, improved visibility and improvements in recreational and commercial fishing, agricultural yields, and forest productivity. EPA did not quantify any of the important welfare co-benefits expected from the final MATS, but these are discussed in detail in Chapter 5.

Table ES-3. Estimated Reduction in Incidence of Adverse Health Effects of the Mercury and Air Toxics Standards (95% confidence intervals)[a,b]

Impact	Eastern U.S.[c]	Western U.S.	Total
Mercury-Related Endpoints			
IQ Points Lost			510.8
PM-Related Endpoints			
Premature death			
Pope et al. (2002) (age >30)	4,100 (1,100 – 7,000)	130 (30 – 220)	4,200 (1,200 – 7,200)
Laden et al. (2006) (age >25)	10,000 (4,800 – 16,000)	320 (140 – 510)	11,000 (5,000 – 17,000)
Infant (< 1 year)	19 (-21 – 59)	1 (-1 – 2)	20 (-22 – 61)
Chronic bronchitis	2,700 (89 – 5,400)	100 (-1 – 210)	2,800 (88 – 5,600)
Non-fatal heart attacks (age > 18)	4,600 (1,200 – 8,100)	120 (25 – 210)	4,700 (1,200 – 8,300)
Hospital admissions—respiratory (all ages)	820 (320 – 1,300)	17 (6 – 27)	830 (330 – 1,300)
Hospital admissions—cardiovascular (age > 18)	1,800 (1,200 – 2,100)	42 (27 – 50)	1,800 (1,200 – 2,200)
Emergency room visits for asthma (age < 18)	3,000 (1,500 – 4,500)	110 (52 – 160)	3,100 (1,600 – 4,700)
Acute bronchitis (age 8-12)	6,000 (-1,400 – 13,000)	250 (-69 – 560)	6,300 (-1,400 – 14,000)
Lower respiratory symptoms (age 7-14)	77,000 (30,000 – 120,000)	3,100 (1,100 – 5,200)	80,000 (31,000 – 130,000)
Upper respiratory symptoms (asthmatics age 9-18)	58,000 (11,000 – 110,000)	2,400 (360 – 4,400)	60,000 (11,000 – 110,000)
Asthma exacerbation (asthmatics age 6-18)	130,000 (4,500 – 430,000)	5,200 (-6 – 18,000)	130,000 (4,500 – 450,000)
Lost work days (ages 18-65)	520,000 (440,000 – 600,000)	21,000 (18,000 – 24,000)	540,000 (460,000 – 620,000)
Minor restricted-activity days (ages 18-65)	3,100,000 (2,500,000 – 3,700,000)	120,000 (99,000 – 150,000)	3,200,000 (2,600,000 – 3,800,000)

[a] Estimates rounded to two significant figures; column values will not sum to total value.

[b] The negative estimates for certain endpoints are the result of the weak statistical power of the study used to calculate these health impacts and do not suggest that increases in air pollution exposure result in decreased health impacts.

[c] Includes Texas and those states to the north and east.

Table ES-4. Estimated Economic Value of Health and Welfare Co-Benefits of the Mercury and Air Toxics Standards (95% confidence intervals, billions of 2007$)[a]

Impact	Pollutant	Eastern U.S.[b]	Western U.S.	Total
Avoided IQ loss associated with methylmercury exposure from self-caught fish consumption among recreational anglers				
3% discount rate	Hg			$0.004 – $0.006
7% discount rate	Hg			$0.0005 – $0.001
Adult premature death (Pope et al., 2002 PM mortality estimate)				
3% discount rate	$PM_{2.5}$	$33 ($2.6 - $99)	$1.0 (<$0.01 - $3.1)	$34 ($2.6 - $100)
7% discount rate	$PM_{2.5}$	$30 ($2.3 - $90)	$0.9 (<$0.01 - $2.8)	$30 ($2.4 - $92)
Adult premature death (Laden et al., 2006 PM mortality estimate)				
3% discount rate	$PM_{2.5}$	$84 ($7.4 - $240)	$2.6 ($0.1 - $7.6)	$87 ($7.5 - $250)
7% discount rate	$PM_{2.5}$	$76 ($6.7 - $220)	$2.3 ($0.1 - $6.9)	$78 ($6.8 - $230)
Infant premature death	$PM_{2.5}$	$0.2 ($-0.2 – $0.8)	<$0.01	$0.2 ($-0.2 - $0.8)
Chronic bronchitis	$PM_{2.5}$	$1.3 ($0.1 - $6.1)	$0.1 (<$0.01 - $0.2)	$1.4 ($0.1 - $6.4)
Non-fatal heart attacks				
3% discount rate	$PM_{2.5}$	$0.5 ($0.1 - $1.3)	<$0.01	$0.5 ($0.1 - $1.3)
7% discount rate	$PM_{2.5}$	$0.4 ($0.1 - $1.0)	<$0.01	$0.4 ($0.1 - $1.0)
Hospital admissions—respiratory	$PM_{2.5}$	$0.01 (<$0.01 - $0.02)	<$0.01	$0.01 ($0.01 - $0.02)
Hospital admissions—cardiovascular	$PM_{2.5}$	$0.03 (<$0.01 - $0.05)	<$0.01	$0.03 (<$0.01 - $0.05)
Emergency room visits for asthma	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Acute bronchitis	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Lower respiratory symptoms	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Upper respiratory symptoms	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Asthma exacerbation	$PM_{2.5}$	<$0.01	<$0.01	<$0.01
Lost work days	$PM_{2.5}$	$0.1 ($0.1 - $0.1)	<$0.01	$0.1 ($0.1 - $0.1)

(continued)

Table ES-4. Estimated Economic Value of Health and Welfare Co-Benefits of the Mercury and Air Toxics Standards (95% confidence intervals, billions of 2007$)[a] (continued)

Impact	Pollutant	Eastern U.S.[b]	Western U.S.	Total
Minor restricted-activity days	$PM_{2.5}$	$0.2 ($0.1 - $0.3)	<$0.01	$0.2 ($0.1 - $0.3)
CO_2-related benefits				
(3% discount rate)	CO_2			$0.36
Monetized total Benefits (Pope et al., 2002 $PM_{2.5}$ mortality estimate)				
3% discount rate		$35+B ($2.8 - $110)	$1.1+B ($0.03 - $3.4)	$37+B ($3.2 - $110)
7% discount rate		$32+B ($2.5 - $98)	$1.0+B ($0.03 - $3.1)	$33+B ($2.9 - $100)
Monetized total Benefits (Laden et al., 2006 $PM_{2.5}$ mortality estimate)				
3% discount rate		$87+B ($7.5 - $250)	$2.7+B ($0.1 - $7.9)	$90+B ($8.0 - $260)
7% discount rate		$78+B ($6.8 - $230)	$2.4+B ($0.1 - $7.2)	$81+B ($7.3 - $240)

[a] Economic value adjusted to 2007$ using GDP deflator. Estimates rounded to two significant figures. The negative estimates for certain endpoints are the result of the weak statistical power of the study used to calculate these health impacts and do not suggest that increases in air pollution exposure result in decreased health impacts. Confidence intervals reflect random sampling error and not the additional uncertainty associated with accounting for differences in air quality baseline forecasts described in Chapter 5. The net present value of reduced CO_2 emissions are calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SCC at 5, 3, 2.5 percent) is used to calculate net present value of SCC for internal consistency. This table shows monetized CO_2 co-benefits at discount rates at 3 and 7 percent that were calculated using the global average SCC estimate at a 3% discount rate because the interagency workgroup on this topic deemed this marginal value to be the central value. In section 5.6 we also report CO_2 co-benefits using discount rates of 5 percent (average), 2.5 percent (average), and 3 percent (95th percentile).

[b] Includes Texas and those states to the north and east.

Figure ES-1 summarizes an array of $PM_{2.5}$-related monetized benefits estimates based on alternative epidemiology and expert-derived PM-mortality estimate.

Figure ES-2 summarizes the estimated net benefits for the final rule by displaying all possible combinations of health and climate co-benefits and costs. Each of the 14 bars in each graph represents a separate point estimate of net benefits under a certain combination of cost and benefit estimation methods. Because it is not a distribution, it is not possible to infer the likelihood of any single net benefit estimate.

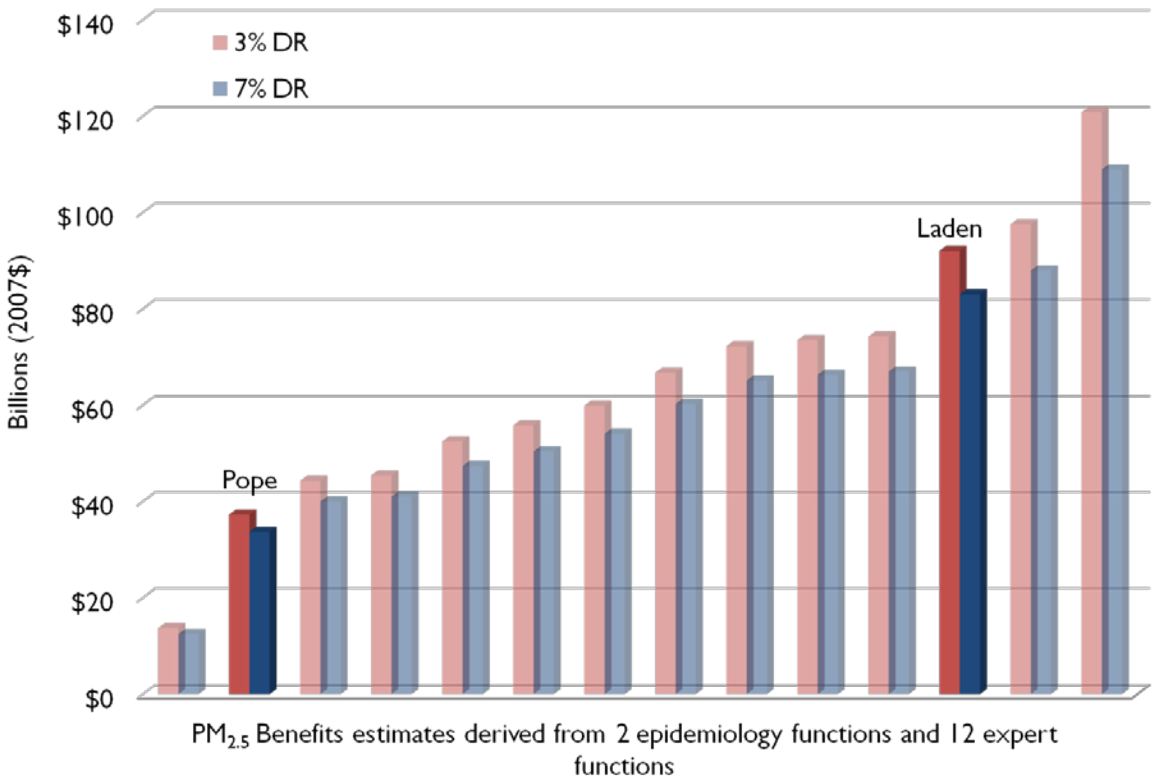

Figure ES-1. Economic Value of Estimated $PM_{2.5}$-Related Health Co-Benefits According to Epidemiology or Expert-Derived PM Mortality Risk Estimate[a,b]

[a] Based on the modeled interim baseline, which is approximately equivalent to the final baseline (see Appendix 5A)

[b] Column total equals sum of $PM_{2.5}$-related mortality and morbidity benefits.

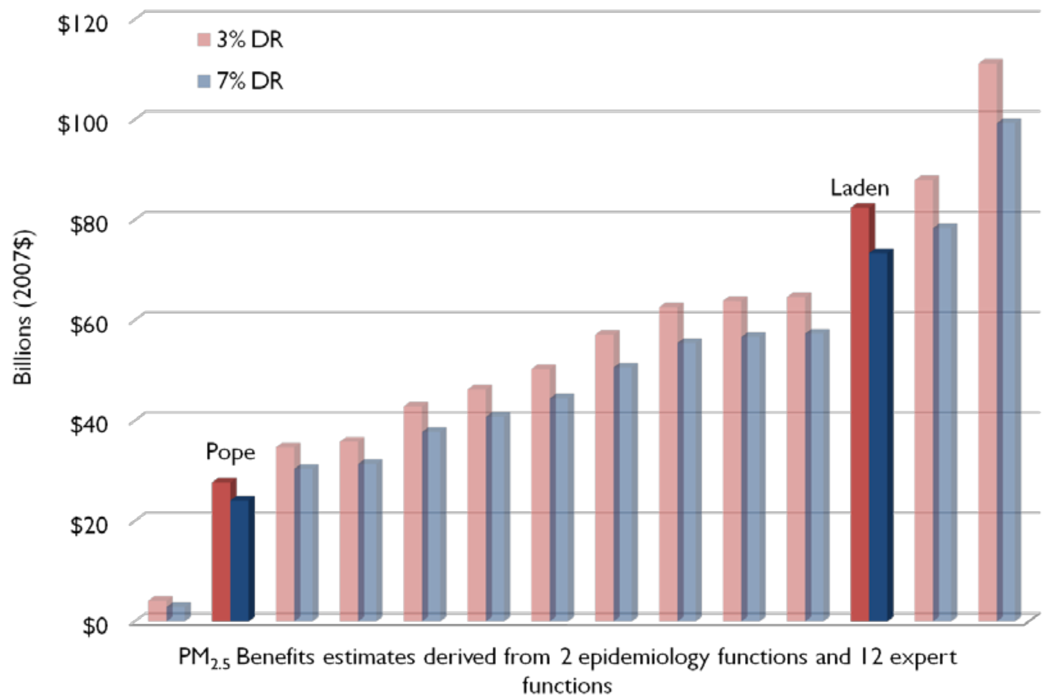

Figure ES-2. Net Benefits of the MATS Rule According to $PM_{2.5}$ Epidemiology or Expert-Derived Mortality Risk Estimate[a,b]

[a] Based on the modeled interim baseline, which is approximately equivalent to the final baseline (see Appendix 5A)

[b] Column total equals sum of $PM_{2.5}$-related mortality and morbidity benefits.

ES.2 Not All Benefits Quantified

EPA was unable to quantify or monetize all of the health and environmental benefits associated with the final MATS Rule. EPA believes these unquantified benefits could be substantial, including the overall value associated with HAP reductions, value of increased agricultural crop and commercial forest yields, visibility improvements, and reductions in nitrogen and acid deposition and the resulting changes in ecosystem functions. Tables ES-5 and ES-6 provide a list of these benefits.

Table ES-5. Human Health Effects of Pollutants Affected by the Mercury and Air Toxics Standards

Benefits Category	Specific Effect	Effect Has Been Quantified	Effect Has Been Monetized	More Information[a]
Improved Human Health				
Reduced incidence of premature mortality from exposure to $PM_{2.5}$	Adult premature mortality based on cohort study estimates and expert elicitation estimates (age >25 or age >30)	✓	✓	Section 5.4
	Infant mortality (age <1)	✓	✓	Section 5.4
Reduced incidence of morbidity from exposure to $PM_{2.5}$	Non-fatal heart attacks (age > 18)	✓	✓	Section 5.4
	Hospital admissions—respiratory (all ages)	✓	✓	Section 5.4
	Hospital admissions—cardiovascular (age >18)	✓	✓	Section 5.4
	Emergency room visits for asthma (age <18)	✓	✓	Section 5.4
	Acute bronchitis (age 8–12)	✓	✓	Section 5.4
	Lower respiratory symptoms (age 7–14)	✓	✓	Section 5.4
	Upper respiratory symptoms (asthmatics age 9-11)	✓	✓	Section 5.4
	Asthma exacerbation (asthmatics age 6–18)	✓	✓	Section 5.4
	Lost work days (age 18-65)	✓	✓	Section 5.4
	Minor restricted-activity days (age 18–65)	✓	✓	Section 5.4
	Chronic bronchitis (age >26)	✓	✓	Section 5.4
	Other cardiovascular effects (e.g., other ages)	—	—	PM ISA[c]
	Other respiratory effects (e.g., pulmonary function, non-asthma ER visits, non-bronchitis chronic diseases, other ages and populations)	—	—	PM ISA[c]
	Reproductive and developmental effects (e.g., low birth weight, pre-term births, etc)	—	—	PM ISA[c, d]
	Cancer, mutagenicity, and genotoxicity effects	—	—	PM ISA[c, d]
Reduced incidence of mortality from exposure to ozone	Premature mortality based on short-term study estimates (all ages)	—	—	Ozone CD, Draft Ozone ISA[b]
	Premature mortality based on long-term study estimates (age 30–99)	—	—	Ozone CD, Draft Ozone ISA[b]
Reduced incidence of morbidity from exposure to ozone	Hospital admissions—respiratory causes (age > 65)	—	—	Ozone CD, Draft Ozone ISA[b]
	Hospital admissions—respiratory causes (age <2)	—	—	Ozone CD, Draft Ozone ISA[b]
	Emergency room visits for asthma (all ages)	—	—	Ozone CD, Draft Ozone ISA[b]
	Minor restricted-activity days (age 18–65)	—	—	Ozone CD, Draft Ozone ISA[b]

(continued)

Table ES-5. Human Health Effects of Pollutants Affected by the Mercury and Air Toxics Standards (continued)

Benefits Category	Specific Effect	Effect Has Been Quantified	Effect Has Been Monetized	More Information
	School absence days (age 5–17)	—	—	Ozone CD, Draft Ozone ISA[b]
	Decreased outdoor worker productivity (age 18-65)	—	—	Ozone CD, Draft Ozone ISA[b]
	Other respiratory effects (e.g., premature aging of lungs)	—	—	Ozone CD, Draft Ozone ISA[c]
	Cardiovascular and nervous system effects	—	—	Ozone CD, Draft Ozone ISA[d]
	Reproductive and developmental effects	—	—	Ozone CD, Draft Ozone ISA[d]
Reduced incidence of morbidity from exposure to NO_2	Asthma hospital admissions (all ages)	—	—	NO_2 ISA[b]
	Chronic lung disease hospital admissions (age > 65)	—	—	NO_2 ISA[b]
	Respiratory emergency department visits (all ages)	—	—	NO_2 ISA[b]
	Asthma exacerbation (asthmatics age 4–18)	—	—	NO_2 ISA[b]
	Acute respiratory symptoms (age 7–14)	—	—	NO_2 ISA[b]
	Premature mortality	—	—	NO_2 ISA[c,d]
	Other respiratory effects (e.g., airway hyperresponsiveness and inflammation, lung function, other ages and populations)	—	—	NO_2 ISA[c,d]
Reduced incidence of morbidity from exposure to SO_2	Respiratory hospital admissions (age > 65)	—	—	SO_2 ISA[b]
	Asthma emergency room visits (all ages)	—	—	SO_2 ISA[b]
	Asthma exacerbation (asthmatics age 4–12)	—	—	SO_2 ISA[b]
	Acute respiratory symptoms (age 7–14)	—	—	SO_2 ISA[b]
	Premature mortality	—	—	SO_2 ISA[c,d]
	Other respiratory effects (e.g., airway hyperresponsiveness and inflammation, lung function, other ages and populations)	—	—	SO_2 ISA[c,d]
Reduced incidence of morbidity from exposure to methyl mercury (through reduced mercury deposition as well as the role of sulfate in methylation)	Neurologic effects—IQ loss	✓	✓	IRIS; NRC, 2000[b]
	Other neurologic effects (e.g., developmental delays, memory, behavior)	—	—	IRIS; NRC, 2000c
	Cardiovascular effects	—	—	IRIS; NRC, 2000[c,d]
	Genotoxic, immunologic, and other toxic effects	—	—	IRIS; NRC, 2000[c,d]

[a] For a complete list of references see Chapter 5.
[b] We assess these benefits qualitatively due to time and resource limitations for this analysis.
[c] We assess these benefits qualitatively because we do not have sufficient confidence in available data or methods.
[d] We assess these benefits qualitatively because current evidence is only suggestive of causality or there are other significant concerns over the strength of the association.

Table ES-6. Environmental Effects of Pollutants Affected by the Mercury and Air Toxics Standards

Benefits Category	Specific Effect	Effect Has Been Quantified	Effect Has Been Monetized	More Information[a]
Improved Environment				
Reduced visibility impairment	Visibility in Class I areas in SE, SW, and CA regions	—	—	PM ISA[b]
	Visibility in Class I areas in other regions	—	—	PM ISA[b]
	Visibility in residential areas	—	—	PM ISA[b]
Reduced climate effects	Global climate impacts from CO_2	—	✓	Section 5.6
	Climate impacts from ozone and PM	—	—	Section 5.6
	Other climate impacts (e.g., other GHGs, other impacts)	—	—	IPCC[c]
Reduced effects on materials	Household soiling	—	—	PM ISA[c]
	Materials damage (e.g., corrosion, increased wear)	—	—	PM ISA[c]
Reduced effects from PM deposition (metals and organics)	Effects on Individual organisms and ecosystems	—	—	PM ISA[c]
Reduced vegetation and ecosystem effects from exposure to ozone	Visible foliar injury on vegetation	—	—	Ozone CD, Draft Ozone ISA[c]
	Reduced vegetation growth and reproduction	—	—	Ozone CD, Draft Ozone ISA[b]
	Yield and quality of commercial forest products and crops	—	—	Ozone CD, Draft Ozone ISA[b,d]
	Damage to urban ornamental plants	—	—	Ozone CD, Draft Ozone ISA[c]
	Carbon sequestration in terrestrial ecosystems	—	—	Ozone CD, Draft Ozone ISA[c]
	Recreational demand associated with forest aesthetics	—	—	Ozone CD, Draft Ozone ISA[c]
	Other non-use effects			Ozone CD, Draft Ozone ISA[c]
	Ecosystem functions (e.g., water cycling, biogeochemical cycles, net primary productivity, leaf-gas exchange, community composition)	—	—	Ozone CD, Draft Ozone ISA[c]

(continued)

Table ES-6. Environmental Effects of Pollutants Affected by the Mercury and Air Toxics Standards (continued)

Benefits Category	Specific Effect	Effect Has Been Quantified	Effect Has Been Monetized	More Information
Reduced effects from acid deposition	Recreational fishing	—	—	NO_x SO_x ISA[b]
	Tree mortality and decline	—	—	NO_x SO_x ISA[c]
	Commercial fishing and forestry effects	—	—	NO_x SO_x ISA[c]
	Recreational demand in terrestrial and aquatic ecosystems	—	—	NO_x SO_x ISA[c]
	Other nonuse effects			NO_x SO_x ISA[c]
	Ecosystem functions (e.g., biogeochemical cycles)	—	—	NO_x SO_x ISA[c]
Reduced effects from nutrient enrichment	Species composition and biodiversity in terrestrial and estuarine ecosystems	—	—	NO_x SO_x ISA[c]
	Coastal eutrophication	—	—	NO_x SO_x ISA[c]
	Recreational demand in terrestrial and estuarine ecosystems	—	—	NO_x SO_x ISA[c]
	Other non-use effects			NO_x SO_x ISA[c]
	Ecosystem functions (e.g., biogeochemical cycles, fire regulation)	—	—	NO_x SO_x ISA[c]
Reduced vegetation effects from ambient exposure to SO_2 and NO_x	Injury to vegetation from SO_2 exposure	—	—	NO_x SO_x ISA[c]
	Injury to vegetation from NO_x exposure	—	—	NO_x SO_x ISA[c]
Reduced incidence of morbidity from exposure to methyl mercury (through reduced mercury deposition as well as the role of sulfate in methylation)	Effects on fish, birds, and mammals (e.g., reproductive effects)	—	—	Mercury Study RTC[c,d]
	Commercial, subsistence and recreational fishing	—	—	Mercury Study RTC[c]

[a] For a complete list of references see Chapter 5.
[b] We assess these benefits qualitatively due to time and resource limitations for this analysis.
[c] We assess these benefits qualitatively because we do not have sufficient confidence in available data or methods.
[d] We assess these benefits qualitatively because current evidence is only suggestive of causality or there are other significant concerns over the strength of the association.

ES.3 Costs and Employment Impacts

The projected annual incremental private costs of the final MATS Rule to the electric power industry are $9.6 billion in 2015.[1] These costs represent the total cost to the electricity-generating industry of reducing HAP emissions to meet the emissions limits set out in the rule. Estimates are in 2007 dollars. These total costs of the rule are estimated using the Integrated Planning Model (IPM), as well as additional analyses for oil-fired units and monitoring/record-keeping costs.

There are several national changes in energy prices that result from the final MATS Rule. Retail electricity prices are projected to increase in the contiguous US by an average of 3.1% in 2015 with the final MATS Rule. On a weighted average basis between 2015 and 2030, consumer natural gas price anticipated to increase from 0.3% to 0.6% depending on consumer class in response to the final MATS Rule.

There are several other types of energy impacts associated with the final MATS Rule. A small amount of coal-fired capacity, about 4.7 GW (less than 2 percent of all coal-fired capacity in 2015), is projected to become uneconomic to maintain by 2015. These units are predominantly smaller and less frequently-used generating units dispersed throughout the contiguous US. If current forecasts of either natural gas prices or electricity demand were revised in the future to be higher, that would create a greater incentive to keep these units operational. Coal production for use in the power sector is projected to decrease by 1 percent by 2015, and we expect slightly reduced coal demand in Appalachia and the West with the final MATS Rule.

In addition to addressing the costs and benefits of the final MATS Rule, EPA has estimated a portion of the employment impacts of this rulemaking. We have estimated two types of impacts. One provides an estimate of the employment impacts on the regulated industry over time. The second covers the short-term employment impacts associated with the construction of needed pollution control equipment until the compliance date of the regulation. We expect that the rule’s impact on employment will be small, but will (on net) result in an expected increase in employment.

[1] The year 2016 is the compliance year for MATS, though as we explain in later chapters, we use 2015 as a proxy for compliance in 2016 for IPM emissions, costs and economic impact analysis due to availability of modeling impacts in that year.

The approaches to estimate employment impacts use different analytical techniques, are applied to different industries during different time periods, and use different units of analysis. No overlapping estimates are summed. Estimates of employment changes per dollar of expenditure on pollution control from Morgenstern et al. (2002) are used to estimate the ongoing annual employment impacts for the regulated entities (the electric power sector) as a result of this rule. The short term estimates for employment needed to design, construct, and install the control equipment in the three year period before the compliance date are also provided using an approach that estimates employment impacts for the environmental protection sector based on forecast changes from IPM on the number and scale of pollution controls and labor intensities in relevant sectors. Finally, some of the other types of employment impacts that will be ongoing are estimated using IPM outputs and labor intensities, as reported in Chapter 6, but not included in this table because they omit some potentially important categories.

In Table ES-7, we show the employment impacts of the MATS Rule as estimated by the environmental protection sector approach and by the Morgenstern approach.

Table ES-7. Estimated Employment Impact Table

	Annual (Reoccurring)	**One Time (Construction During Compliance Period)**
Environmental protection sector approach[a]	Not applicable	46,000
Net effect on electric utility sector employment from Morgenstern et al., approach[c]	8,000[b] −15,000 to 30,000[d]	Not Applicable

[a] These one-time impacts on employment are estimated in terms of job-years.

[b] This estimate is not statistically different from zero.

[c] These annual or reoccurring employment impacts are estimated in terms of production workers as defined by the US Census Bureau's Annual Survey of Manufacturers (ASM).

[d] 95% confidence interval

ES.4 Small Entity and Unfunded Mandates Impacts

After preparing an analysis of small entity impacts, EPA cannot certify that there will be no SISNOSE (significant economic impacts on a substantial number of small entities) for this rule. Of the 82 small entities affected, 40 are projected to have costs greater than 1 percent of their revenues. The exclusion of units smaller than 25 Megawatt capacity (MW) as per the requirements of the Clean Air Act has already significantly reduced the burden on small entities, and EPA participated in a Small Business Regulatory Enforcement Fairness Act (SBREFA) Panel to examine ways to mitigate the impact of the proposed Toxics Rule on affected small entities

EPA examined the potential economic impacts on state and municipality-owned entities associated with this rulemaking based on assumptions of how the affected states will implement control measures to meet their emissions. These impacts have been calculated to provide additional understanding of the nature of potential impacts and additional information.

According to EPA's analysis, of the 96 government entities considered in this, EPA projects that 42 government entities will have compliance costs greater than 1 percent of base generation revenue in 2015, based on our assumptions of how the affected states implement control measures to meet their emissions budgets as set forth in this rulemaking.

Government entities projected to experience compliance costs in excess of 1 percent of revenues may have some potential for significant impact resulting from implementation of MATS.

ES.5 Limitations and Uncertainties

Every analysis examining the potential benefits and costs of a change in environmental protection requirements is limited to some extent by data gaps, limitations in model capabilities (such as geographic coverage), and variability or uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. Despite the uncertainties, we believe this benefit-cost analysis provides a reasonable indication of the expected economic benefits and costs of the final MATS Rule.

For this analysis, such uncertainties include possible errors in measurement and projection for variables such as population growth and baseline incidence rates; uncertainties associated with estimates of future-year emissions inventories and air quality; variability in the estimated relationships between changes in pollutant concentrations and the resulting changes in health and welfare effects; and uncertainties in exposure estimation.

Below is a summary of the key uncertainties of the analysis:

Costs

- Compliance costs are used to approximate the social costs of this rule. Social costs may be higher or lower than compliance costs and differ because of preexisting distortions in the economy, and because certain compliance costs may represent shifts in rents.

- Analysis does not capture employment shifts as workers are retrained at the same company or re-employed elsewhere in the economy.

- We do not include the costs of certain relatively small permitting costs associated with updating Title V permits.

- Technological innovation is not incorporated into these cost estimates. Thus, these cost estimates may be potentially higher than what may occur in the future, all other things being the same.

Benefits

- The mercury concentration estimates for the analysis come from several different sources.

- The mercury concentration estimates used in the model were based on simple temporal and spatial averages of reported fish tissue samples. This approach assumes that the mercury samples are representative of “local” conditions (i.e., within the same HUC 12) in similar waterbodies (i.e., rivers or lakes).

- State-level averages for fishing behavior of recreational anglers are applied to each modeled census tract in the state; which does not reflect within-state variation in these factors.

- Application of state-level fertility rates to specific census tracts (and specifically to women in angler households.

- Applying the state-level individual level fishing participation rates to approximate the household fishing rates conditions at a block level.

- Populations are only included in the model if they are within a reasonable distance of a waterbody with fish tissue MeHg samples. This approach undercounts the exposed population (by roughly 40 to 45%) and leads to underestimates of national aggregate baseline exposures and risks and underestimates of the risk reductions and benefits resulting from mercury emission reductions.

- Assumption of 8 g/day fish consumption rate for the general population in freshwater angler households.

- The dose-response model used to estimate neurological effects on children because of maternal mercury body burden has several important uncertainties, including selection of IQ as a primary endpoint when there may be other more sensitive endpoints, selection of the blood-to-hair ratio for mercury, and the dose-response estimates from the epidemiological literature. Control for confounding from the potentially positive cognitive effects of fish consumption and, more specifically, omega-3 fatty acids.

- Valuation of IQ losses using a lost earning 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. Each unit value for IQ losses has two main sources of uncertainty (1). The statistical error in the average percentage change in earnings as a result of IQ changes and (2) estimates of average lifetime earnings and costs of schooling.

- Based on the modeled interim baseline which is approximately equivalent to the final baseline (see Appendix 5A), 11% and 73% of the estimated avoided premature deaths occur at or above an annual mean $PM_{2.5}$ level of 10 μg/m^3 (the LML of the Laden et al. 2006 study) and 7.5 μg/m^3 (the LML of the Pope et al. 2002 study), respectively. These are the source studies for the concentration-response functions used to estimate mortality benefits. As we model avoided premature deaths among populations exposed to levels of $PM_{2.5}$ that are successively lower than the LML of each study our confidence in the results diminishes. However, studies using data from more recent years, during which time PM concentrations have fallen, continue to report strong associations with mortality.

- There are uncertainties related to the health impact functions used in the analysis. These include: within study variability; across study variation; the application of concentration-response (C-R) functions nationwide; extrapolation of impact functions across population; and various uncertainties in the C-R function, including causality and thresholds. Therefore, benefits may be under- or over-estimates.

- Analysis is for 2016, and projecting key variables introduces uncertainty. Inherent in any analysis of future regulatory programs are uncertainties in projecting atmospheric conditions and source level emissions, as well as population, health baselines, incomes, technology, and other factors.

- This analysis omits certain unquantified effects due to lack of data, time and resources. These unquantified endpoints include other health and ecosystem effects. EPA will continue to evaluate new methods and models and select those most appropriate for estimating the benefits of reductions in air pollution. Enhanced collaboration between air quality modelers, epidemiologists, toxicologists, ecologists, and economists should result in a more tightly integrated analytical framework for measuring benefits of air pollution policies.

- $PM_{2.5}$ mortality co-benefits represent a substantial proportion of total monetized benefits (over 90%), and these estimates have following key assumptions and uncertainties.

- The $PM_{2.5}$ -related co-benefits of the alternative scenarios were derived through a benefit per-ton approach, which does not fully reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an over-estimate or under-estimate of the actual benefits of this rule.

- We assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because $PM_{2.5}$ produced via transported precursors emitted from EGUs may differ significantly from direct $PM_{2.5}$ released from diesel engines and other industrial sources, but no clear scientific grounds exist for supporting differential effects estimates by particle type.

- We assume that the health impact function for fine particles is linear within the range of ambient concentrations under consideration. Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of $PM_{2.5,}$ including both regions that are in attainment with fine particle standard and those that do not meet the standard down to the lowest modeled concentrations.

- To characterize the uncertainty in the relationship between $PM_{2.5}$ and premature mortality, we include a set of twelve estimates based on results of the expert elicitation study in addition to our core estimates. Even these multiple characterizations omit the uncertainty in air quality estimates, baseline incidence rates, populations exposed and transferability of the effect estimate to diverse locations. As a result, the reported confidence intervals and range of estimates give an incomplete picture about the overall uncertainty in the $PM_{2.5}$ estimates. This information should be interpreted within the context of the larger uncertainty surrounding the entire analysis.

ES.6 References

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