Regulatory Impact Analysis for the Final Repeal of Amendments to National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units

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Regulatory Impact Analysis for the Final Repeal of Amendments to National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

ES.1 Introduction

In this action, the U.S. Environmental Protection Agency (EPA) is finalizing a repeal of specific amendments to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Coal- and Oil-Fired Electric Utility Steam Generating Units (EGUs), commonly referred to as the Mercury and Air Toxics Standards (MATS), promulgated May 7, 2024.[1] The amendments that the EPA is repealing include the revised filterable particulate matter (fPM) emission standard, which serves as a surrogate for non-mercury hazardous air pollutant (HAP) metals for existing coal-fired EGUs, the fPM emission standard compliance demonstration requirements, and the mercury (Hg) emission standard for lignite-fired EGUs.

In accordance with Executive Orders (E.O.) 12866 and 13563, the guidelines of OMB Circular A-4 (OMB, 2003), and the EPA's *Guidelines for Preparing Economic Analyses* (U.S. EPA, 2024), this Regulatory Impact Analysis (RIA) analyzes the regulatory compliance costs and benefits associated with this final action. This RIA builds upon the analysis in the preceding RIA for the proposed repeal of the specific amendments to MATS (90 FR 25535) (2025 Proposal) as well as feedback provided through public comments.[2]

The "baseline" in an analysis is a business-as-usual scenario that best represents the behavior of the regulated sector under market and regulatory conditions in the absence of the regulatory action under consideration. The baseline for this final repeal action includes the 2024 MATS RTR requirements, while excluding several finalized power sector rules that are in the process of reconsideration or repeal.[3] The "policy case" for this repeal action excludes the 2024 MATS RTR requirements, while still excluding the same set of power sector rules in the baseline. Further, the analysis in this RIA incorporates the exemptions granted under Presidential Proclamation 10914, titled *Regulatory Relief for Certain Stationary Sources to Promote*

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[1] This 2024 final rule titled *National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units Review of the Residual Risk and Technology Review* (89 FR 38508) is referred to as the "2024 MATS RTR" in this document and "2024 Final Action" in the preamble.

[2] The June 2025 RIA is titled *Regulatory Impact Analysis for the Proposed Repeal of Amendments to National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units* and is in the docket here: https://www.regulations.gov/document/EPA-HQ-OAR-2018-0794-6996.

[3] These actions include the following: Carbon Pollution Standards (89 FR 39798, May 9, 2024), Good Neighbor Plan (88 FR 36654, June 5, 2023), and Steam Electric Effluent Limitation Guidelines (89 FR 40198, May 9, 2024); as well as certain vehicle rules (89 FR 27842, April 18, 2024; 89 FR 29440, April 22, 2024).

American Energy, and Presidential Proclamation 10956, titled *Regulatory Relief for Certain Stationary Sources to Further Promote American Energy.*[4,5] A discussion of the potential impacts of the Presidential Proclamation can be found in Section 2.4.7.

In this RIA, we present estimates of the present value (PV) of costs calculated for the analytical timeframe of 2028 to 2037 and discounted to 2025. We also present the equivalent annualized value (EAV), which represents a flow of constant annual values that, had they occurred in each year from 2028 to 2037, would yield a sum equivalent to the PV. All estimates provided for this final repeal are presented in 2024 dollars, whereas estimates presented in the 2024 MATS RTR RIA were presented in 2019 dollars. Additionally, this RIA includes information about potential impacts of the final repeal on electricity markets, employment, and markets outside of the electricity sector. While the results are described and presented in more detail throughout the RIA, we present summary results here.

ES.2 Compliance Cost Savings

The power industry's compliance costs are represented in this analysis as the change in electric power generation costs between the baseline and policy case. In other words, these costs are an estimate of the change in power industry expenditures from repealing the 2024 MATS RTR requirements. The compliance cost estimates were primarily developed using the EPA's Power Sector Modeling Platform that uses the Integrated Planning Model (IPM).[6] The incremental costs of repealing the 2024 PM monitoring requirements were estimated outside of the modeling platform and added to the modeled cost estimates presented here and in Section 2. Table ES-1 presents compliance cost savings of the final repeal action.

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[4] Presidential Proclamation 10914 titled *Regulatory Relief for Certain Stationary Sources to Promote American Energy* (90 FR 16777, April 21, 2025) is available here: https://www.federalregister.gov/documents/2025/04/21/2025-06936/regulatory-relief-for-certain-stationary-sources-to-promote-american- energy.

[5] Presidential Proclamation 10956 titled *Regulatory Relief for Certain Stationary Sources to Further Promote American Energy* (90 FR 34583, July 23, 2025) is available here: https://www.federalregister.gov/documents/2025/07/23/2025-13883/regulatory-relief-for-certain-stationary-sources-to-further-promote-american-energy.

[6] See section 2.3 for further information.

Table ES-1 Present Value and Equivalent Annualized Value Estimates of Compliance Cost Savings from 2028-2037 (million 2024 dollars, discounted to 2025)

3% Discount Rate		7% Discount Rate	
PV	**EAV**	**PV**	**EAV**
670	78	490	69

Note: Values have been rounded to two significant figures.

The compliance costs reported in Table ES-1 are not social costs, as the estimates do not account for changes in costs and benefits due to changes in economic welfare of suppliers to the electricity market or to non-electricity consumers from those suppliers. Furthermore, costs due to interactions with preexisting market distortions outside the electricity sector are omitted.

We also report the change in the costs of real resources used by the power industry using the IPM results in Section 2. The change in expenditures on real resources includes those on capital, labor, fuel and other inputs, and excludes changes in transfers such as taxes (OMB 2003, U.S.EPA 2024). The PV and EAV of the change in real resource costs from 2028 to 2037 of the final repeal are respectively -$370 and -$43 million at a 3 percent discount rate, and -$270 and -$39 million at a 7 percent discount rate (2024 dollars).

More broadly, changes in production in a directly regulated sector may affect other markets when output from that sector is used in the production of other goods. In particular, electricity, the directly regulated sector in this action, is an input to many goods and services throughout the economy. This action may also affect production in upstream industries that supply inputs to the electricity sector and household consumption patterns as a result of electricity, natural gas, and other final good price changes. Changes in firm and household behavior could also interact with pre-existing market distortions, such as taxes. A computable general equilibrium (CGE) model can be used to evaluate the broad economy-wide impacts of a regulatory action and its social cost by accounting for these interactions and feedback.

The EPA used the peer-reviewed computable general equilibrium (CGE) model SAGE to evaluate the economy-wide social costs and economic impacts of the final repeal (U.S. EPA Science Advisory Board, 2020; Marten et al., 2024). The annualized social cost estimated using SAGE is approximately -$58 million (2024 dollars) between 2026 and 2037, and -$530 million (2024 dollars) over the period from 2026 to 2037. Note that SAGE currently does not account for the effects of changing environmental quality such as those resulting from this final repeal.

ES.3 Emissions Changes of the Regulated Pollutants

The quantified emission estimates presented in the RIA include changes in Hg and non-Hg metal HAP emissions which are regulated pollutants under MATS. We also estimate emissions changes for non-regulated pollutants which may result from changes in dispatch as the relative operating costs for affected units are projected to change under the final repeal. These changes are relative to a baseline with the 2024 MATS RTR requirements in place for each modeled year.

Table ES-2 shows the projected Hg emissions changes under the final repeal. The EPA estimated emissions changes under the final repeal for the run years 2028, 2030, and 2035 based upon projections from IPM.

Table ES-2 EGU Emissions Changes of Mercury (Hg) for 2028, 2030, and 2035[a]

		Total Emissions		
	Year	**Baseline with 2024 MATS RTR**	**Final Repeal**	**Emissions Change**
Hg (lbs.)	2028	6,990	7,066	76
	2030	6,259	7,681	1,422
	2035	6,658	8,189	1,531

[a] This analysis is limited to the geographically contiguous lower 48 states. Values are independently rounded and therefore may not appear to equal sum.

The EPA also estimates annual emissions increases of approximately 0.4 to 7.0 tons of non-Hg HAP metals due to the final repeal.[7] These reductions are likely largely composed of reductions in emissions of antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, and selenium.

ES.4 Benefits Associated with the Regulated Pollutants

Non-monetized disbenefits related to the regulated pollutants are expected from estimated increases of about 76 to 1,500 pounds of Hg annually and 0.4 to 7.0 tons of non-Hg HAP metals

[7] The estimates on non-mercury HAP metals changes were obtained by multiplying the ratio of non-mercury HAP metals to fPM by estimates of PM_{10} changes under the rule, as we do not have estimates of fPM reductions using IPM, only PM_{10}. The ratios of non-mercury HAP metals to fPM were based on analysis of 2010 MATS Information Collection Request (ICR) data. As there may have been substantially more fPM than PM_{10} reduced by the control techniques projected under the 2024 MATS RTR, these estimates of non-mercury HAP metals increases are likely underestimates. More detail on the estimated reduction in non-mercury HAP metals can be found in the docketed memorandum *Estimating Non-Hg HAP Metals Reductions for the 2024 Technology Review for the Coal-Fired EGU Source Category*.

annually. The EPA is unable to monetize the benefits of Hg and non-Hg metals emissions changes due to overall uncertainty and data limitations.

ES.5 Economic Impacts

As a result of the change in compliance costs incurred by the regulated sector, the action has economic and energy market implications. Table ES-3 presents a variety of estimates of energy market impacts for 2028, 2030, and 2035 for the final repeal. The overall projected impacts on the energy market were estimated to be negligible in all run years. A more detailed version of this table is found in Section 2.4.3, along with additional discussion of energy market impacts. For a discussion of the small entity analysis, as well as labor impacts, see Section 4.5.

Table ES-3 Summary of Certain Energy Market Impacts

	2028	2030	2035
Retail electricity prices	0.0%	0.0%	0.0%
Average price of coal delivered to the power sector	0.0%	0.2%	0.2%
Coal production for power sector use (tons)	0.0%	0.1%	0.3%
Price of natural gas delivered to power sector	0.0%	0.0%	0.0%
Price of average Henry Hub (spot)	0.0%	0.0%	0.0%
Natural gas use for electricity generation	0.0%	0.0%	0.0%

Note: the small increase in coal production, which is measured in tons, reflects small projected changes in coal ranks, which are characterized by different high heating values, or the amount of energy released per ton of coal. We do not project a change in total generation from coal (see Table 2-11).

Environmental regulation may affect groups of workers differently, as changes in abatement and other compliance activities cause labor and other resources to shift. An employment impact analysis describes the characteristics of groups of workers potentially affected by a regulation, as well as labor market conditions in affected occupations, industries, and geographic areas. Employment impacts of the action are discussed in Section 4 of this RIA.

ES.6 Net Benefits Associated with the Regulated Pollutants from the Final Action

The net benefits associated with the regulated pollutants are the cost savings of this final as action presented above in Table ES-1. As noted, there may be unquantified cost savings associated with this final repeal. Non-monetized disbenefits associated with the regulated pollutants are expected from estimated increases of about 76 to 1,500 pounds of Hg annually and increases of about 0.4 to 7.0 tons of non-Hg HAP metals annually. The rest of the RIA presents a full discussion of the projected costs and benefits of this action, as well as a discussion of uncertainty and additional impacts that the EPA could not quantify or monetize.

0.7 References

Marten, A., Schreiber, A., and Wolverton, A. (2024). *SAGE Model Documentation (2.1.1).* Washington, DC. https://www.epa.gov/system/files/documents/2024-03/sage_model_documentation_2_1_1.pdf.

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U.S. EPA Science Advisory Board. (2020). *Technical Review of EPA's Computable General Equilibrium Model, SAGE.* (EPA-SAB-20-010). Washington, DC. https://www.epa.gov/system/files/documents/2022-01/epa-sab-20-010_1.pdf.

1 INTRODUCTION AND BACKGROUND

1.1 Introduction

The U.S. Environmental Protection Agency (EPA) is finalizing the repeal of amendments to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Coal- and Oil-Fired Electric Utility Steam Generating Units (EGUs), commonly referred to as the Mercury and Air Toxics Standards (MATS), that were promulgated on May 7, 2024. The amendments included revising the fPM emission standard, which serves as a surrogate for non-mercury HAP metals for existing coal-fired EGUs, the fPM emission standard compliance demonstration requirements, and the Hg emission standard for lignite-fired EGUs.

1.2 Purpose of RIA

In accordance with Executive Orders (E.O.) 12866 and 13563, the guidelines of OMB Circular A-4 (2003), and EPA's *Guidelines for Preparing Economic Analyses* (2024), the EPA prepared this RIA for this "significant regulatory action." This action is an economically significant regulatory action under E.O. 12866 Section 3(f)(1) because it is estimated to have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities. This RIA addresses the regulatory compliance costs, emission impacts, and benefits of this action. Additionally, this RIA includes information about potential impacts of the action on electricity markets, employment, and markets outside the electricity sector.

1.3 Final Repeal of Requirements Analyzed

This final repeal focuses on three of the four requirements of the 2024 MATS RTR, which are described below and presented in Table 1-1. Separate from the technology review, the 2024 MATS RTR also added a requirement related to startup definitions that is not being repealed as a part of this action. The final repeal will return the MATS requirements to those that were in place prior to the 2024 MATS RTR. This RIA focuses on evaluating the benefits, costs, and other impacts of repealing the following:

The Revised Standard for Non-Hg HAP Metals Emissions for Existing Coal-fired EGUs: Existing coal-fired EGUs are subject to numeric emission limits for fPM, a surrogate for the total non-Hg HAP metals. Before the 2024 MATS RTR, MATS required existing coal-fired EGUs to meet a fPM emission standard of 0.030 pounds per million British thermal units (lb/MMBtu) of heat input. The 2024 MATS RTR set a fPM limit of 0.010 lb/MMBtu for existing coal-fired EGUs to be achieved beginning July 8, 2027, and the EPA is finalizing the repeal of the fPM emission standard. Additionally, the EPA is finalizing the repeal of the updated limits for non-Hg HAP metals and total non-Hg HAP metals that were reduced proportional to the reduction of the fPM emission limit.

The Revised Hg Emission Standard for Lignite-fired EGUs: Before the 2024 MATS RTR, lignite-fired EGUs were to meet a Hg emission standard of 4.0 pounds per trillion British thermal units (lb/TBtu) or 4.0E-2 pounds per gigawatt hour (lb/GWh) by July 8, 2027. The EPA is finalizing the repeal of the requirement that lignite-fired EGUs meet the same standard as existing EGUs firing other types of coal, which is 1.2 lb/TBtu or 1.3E-2 lb/GWh.

The Continuous Emissions Monitoring Systems Requirement: The EPA is finalizing the repeal of the requirement that coal- and oil-fired units demonstrate compliance with the fPM emission standard by using PM CEMS by July 8, 2027. Before the 2024 MATS RTR, EGUs had a choice of demonstrating compliance with the non-Hg HAP metals by monitoring fPM with quarterly sampling, using continuous parametric monitoring systems (CPMS), or using continuous emissions monitoring systems (PM CEMS).

Table 1-1 Summary of Regulatory Requirements Examined in this RIA

Provision	Regulatory Requirements Examined in this RIA	
	2024 MATS RTR Requirements	**Requirements after Final Repeal**
fPM Standard (Surrogate Standard for Non-Hg HAP Metals)	fPM standard of 0.010 lb/MMBtu	fPM standard of 0.030 lb/MMBtu
Hg Standard	Hg standard for lignite-fired EGUs of 1.2 lb/TBtu	Hg standard for lignite-fired EGUs of 4.0 lb/TBtu
Continuous Emissions Monitoring Systems (PM CEMS)	Require installation of PM CEMS to demonstrate compliance	Do not require installation of PM CEMS to demonstrate compliance

1.4 Overview of RIA

The “baseline” is a business-as-usual scenario that, in the context of this analysis, represents expected behavior in the power industry sector under market and regulatory conditions in the absence of this final regulatory action. From the perspective of this final repeal action, the 2024 MATS RTR requirements are in the baseline, and the baseline for this final action, as compared to the proposal action, has been updated to reflect certain regulatory and other subsequent changes since the 2024 MATS RTR was promulgated. There may be other regulatory changes before the promulgation of this final repeal that are not accounted for in the baseline for this action. These factors introduce important uncertainties in the analysis within this RIA. Please see Section 2.3 for details of the baseline modeling of this final action.

The year 2028 is the first year of detailed power sector modeling for this RIA and approximates when the requirements of the 2024 MATS RTR on the power sector would have begun. In addition, the impacts were evaluated for the specific analysis years of 2030 and 2035. We draw upon results for these analysis years to evaluate potential impacts of this action using PV estimates of costs calculated for the analysis timeframe of 2028 to 2037, discounted to 2025. We also present the EAV, which represents a flow of constant annual values that, had they occurred in each year from 2028 to 2037, would yield a sum equivalent to the PV. Additionally, this RIA includes information about potential impacts of the final repeal on electricity markets, employment, and markets outside the electricity sector.

1.5 References

OMB. (2003). *Circular A-4: Regulatory Analysis*. Washington DC. https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf.

U.S. EPA. (2024). *Guidelines for Preparing Economic Analyses (3rd edition)*. EPA-240-R-24-001. Washington, DC: U.S. Environmental Protection Agency, Office of Policy, National Center for Environmental Economics. https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses-3rd-edition.

2 COMPLIANCE COSTS, EMISSIONS, AND ENERGY IMPACTS

2.1 Introduction

This section reports the compliance costs, emissions, and energy analyses performed for the final repeal of the 2024 MATS RTR requirements. The EPA used the Integrated Planning Model (IPM) to conduct the electric generating units (EGU) analysis discussed in this section.[8] The EPA relied on an updated version of IPM, which captured key changes to the energy sector that have occurred since publication of the analysis supporting the 2024 MATS RTR. These include significantly higher electricity demand driven primarily by data center use in applications supporting artificial intelligence, and the passage of the One Big Beautiful Bill Act (OBBA).[9] In turn these updates result in higher levels of coal fired generation and economic additions of natural gas turbines absent the 2024 MATS RTR requirements as compared to the earlier analysis.

Consistent with the analysis of the proposed action, the cost estimates provided for this action are presented in 2024 dollars. As under the proposed action, the cost estimates provided here reflect the period 2026 to 2035. The reduction in costs for this action reflects the calculated change in the projected electric power system costs between the baseline (with 2024 MATS RTR) scenario and the final repeal scenario. These costs include the change in capital costs, variable costs, fixed costs, transmission costs, fuel costs, and MR&R costs that are expected to not be incurred as a result of this final repeal. This section presents the compliance costs, emissions changes, and energy impacts projected under the final repeal.

2.2 2024 MATS RTR Requirements Modeled in the Baseline Scenario

The EPA promulgated the NESHAP for Coal- and Oil-Fired EGUs, commonly referred to as the Mercury and Air Toxics Standards or MATS, on February 16, 2012 ("2012 MATS Final Rule"). The standards are codified at 40 CFR part 63, subpart UUUUU. This rule established emissions standards for coal- and oil-fired EGUs, which are combustion units of

[8] Information on IPM can be found at the following link: https://www.epa.gov/power-sector-modeling.
[9] The One Big Beautiful Bill Act (Pub. L. No. 119-21) includes revisions to tax credit provisions laid our under the earlier Inflation Reduction Act (IRA), which affect power sector operations. Details of these changes are incorporated into the IPM modeling. Details are included in the IPM documentation. Documentation available at: https://www.epa.gov/power-sector-modeling/2025-reference-case.

more than 25 megawatts (MW) that serve a generator that produces electricity for sale and are located at both major and area sources of HAP emissions.[10] The 2024 MATS RTR included the requirements discussed in section 1.3.

This RIA analyzes the impacts of repealing the 2024 MATS RTR by comparing a baseline scenario that includes the 2024 MATS RTR requirements to a scenario that does not include these requirements.

2.3 Power Sector Modeling Framework

IPM is a state-of-the-art, peer-reviewed, dynamic linear programming model that can be used to project power sector behavior under future business-as-usual conditions and to examine prospective air pollution control policies throughout the contiguous United States for the entire electric power system. The EPA used IPM to project likely future electricity market conditions with and without the final repeal.

IPM is a multi-regional, dynamic, deterministic linear programming model of the contiguous U.S. electric power sector. It provides estimates of least cost capacity expansion, electricity dispatch, and emissions control strategies while meeting energy demand and environmental, transmission, dispatch, and reliability constraints. The model accounts for all major electric regions throughout the country, including transmission capabilities and constraints between them. This ensures that key transmission constraints are represented in IPM and that each individual IPM region has less internal transmission congestion based on today's loads and resource mix.

EPA has used IPM for almost three decades to better understand power sector behavior under future business-as-usual conditions and to evaluate the economic and emissions impacts of prospective environmental policies. The model is designed to reflect electricity markets as accurately as possible. The EPA uses the best available information from utilities, industry experts, gas and coal market experts, financial institutions, and government statistics as the basis for the detailed power sector modeling in IPM. The model documentation provides additional

[10] A unit that cogenerates steam and electricity and supplies more than one-third of its potential electric output capacity and more than 25 MW electrical output to any utility power distribution system for sale is also an electric utility steam generating unit.

information on the assumptions discussed here as well as all other model assumptions and inputs.[11]

The model incorporates a detailed representation of the fossil-fuel supply system that is used to estimate equilibrium fuel prices. The model uses natural gas fuel supply curves and regional gas delivery costs (basis differentials) to simulate the fuel price associated with a given level of gas consumption within the system. These inputs are derived using ICF's Gas Market Model (GMM), a supply/demand equilibrium model of the North American gas market.[12]

IPM also endogenously models the partial equilibrium of coal supply and EGU coal demand levels throughout the contiguous U.S., taking into account assumed non-power sector demand and imports/exports. IPM reflects 36 coal supply regions, 14 coal grades, and the coal transport network, which consists of over four thousand linkages representing rail, barge, and truck and conveyer linkages. The coal supply curves in IPM were developed during a thorough bottom-up, mine-by-mine approach that depicts the coal choices and associated supply costs that power plants would face if selecting that coal over the modeling time horizon. The IPM documentation outlines the methods and data used to quantify the economically recoverable coal reserves, characterize their cost, and build the 36 coal regions' supply curves.[13]

To estimate the annualized costs of capital investments in the power sector, the EPA uses a conventional and widely accepted approach that multiplies a capital recovery factor (CRF) to upfront capital investments to account for the annual payment to investment capital over the book life of that capital, and then adds this payment to the annual incremental operating expenses to calculate compliance costs. The CRF is derived from estimates of the power sector's cost of capital (i.e., private discount rate), the amount of insurance coverage required, local property taxes, and the life of capital.[14] It is important to note that there is no single CRF factor applied in

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[11] Detailed information and documentation of EPA's 2025 Reference Case, including all the underlying assumptions, data sources, and architecture parameters can be found on EPA's website at: https://www.epa.gov/power-sector-modeling/2025-reference-case.
[12] See Chapter 8 of EPA's 2025 Reference Case documentation, available at: https://www.epa.gov/power-sector-modeling/2025-reference-case.
[13] See Chapter 7 of the IPM documentation, available at: https://www.epa.gov/power-sector-modeling/2025-reference-case.
[14] See Chapter 10 of the IPM documentation, available at: https://www.epa.gov /power-sector-modeling/2025-reference-case.

the model; rather, the CRF varies across technologies, the book life of those technologies, and regions in the model in order to better simulate power sector decision-making.

EPA has used IPM extensively over the past three decades to analyze options for reducing power sector emissions. Previously, the model has been used to estimate the costs, emission changes, and power sector impacts for the Clean Air Interstate Rule (U.S. EPA, 2005), the Cross-State Air Pollution Rule (U.S. EPA, 2011a), the Mercury and Air Toxics Standards (U.S. EPA, 2011b), the Clean Power Plan for Existing Power Plants (U.S. EPA, 2015a), the Cross-State Air Pollution Update Rule (U.S. EPA, 2016), the Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units (U.S. EPA, 2019), and the Revised Cross-State Air Pollution Update Rule (U.S. EPA, 2021), the Federal Good Neighbor Plan Addressing Regional Ozone Transport for the 2015 Ozone National Ambient Air Quality Standards (U.S. EPA, 2023), the 2024 MATS RTR (U.S. EPA 2024a) and the Carbon Pollution Standards (U.S. EPA, 2024b). The EPA has also used IPM to estimate the air pollution reductions and power sector impacts of water and waste regulations affecting EGUs, including contributing to RIAs for the Cooling Water Intakes (316(b)) Rule (U.S. EPA, 2014a), the Disposal of Coal Combustion Residuals from Electric Utilities rule (U.S. EPA, 2015b), the Steam Electric Effluent Limitation Guidelines (U.S. EPA, 2015c), the Steam Electric Reconsideration Rule (U.S. EPA, 2020), and the Effluent Limitation Guidelines (U.S. EPA, 2024c).

The model and EPA's input assumptions undergo periodic formal peer review. The rulemaking process also provides opportunity for expert review and comment by a variety of stakeholders, including owners and operators of capacity in the electricity sector that is represented by the model, public interest groups, and other developers of U.S. electricity sector models. The feedback that the Agency receives provides a highly detailed review of key input assumptions, model representation, and modeling results. IPM has received extensive review by energy and environmental modeling experts in a variety of contexts. For example, in September 2019 U.S. EPA commissioned a peer review of EPA Baseline version 6, and in October 2014 U.S. EPA commissioned a peer review of EPA Baseline version 5.13 using the Integrated

Planning Model.[15] Additionally, and in the late 1990s, the Science Advisory Board reviewed IPM as part of the CAA Amendments Section 812 prospective studies.[16] The Agency has also used the model in a number of comparative modeling exercises sponsored by Stanford University's Energy Modeling Forum over the past 20 years. IPM has also been employed by states (e.g., for the Regional Greenhouse Gas Initiative, the Western Regional Air Partnership, Ozone Transport Assessment Group), other Federal and state agencies, environmental groups, and industry.

2.3.1 EPA's Power Sector Modeling of the Baseline Run and Final Repeal Scenario

The "baseline" for a regulatory impact analysis is a business-as-usual scenario that represents expected behavior in the power industry sector under market and regulatory conditions in the absence of a regulatory action. The baseline of this final action includes the 2024 MATS RTR and reflects the exemptions granted under Presidential Proclamation 10914, titled *Regulatory Relief for Certain Stationary Sources to Promote American Energy*, and Presidential Proclamation 10956, titled *Regulatory Relief for Certain Stationary Sources to Further Promote American Energy.*[17,18] A discussion of the impacts of the Presidential Proclamations can be found in Section 2.4.7 of this document.

2.3.2 EPA's 2025 Reference Case

For our analysis of the repeal of the 2024 MATS RTR requirements, the EPA used EPA's 2025 Reference Case, as well as a companion updated database of EGU units (the National Electricity Energy Data System or NEEDS 07-02-2025) that is used in EPA's modeling applications of IPM. The 2025 Reference Case includes the CSAPR (2011a), CSAPR Update (2016), and the Revised CSAPR Update (2021), as well as the Mercury and Air Toxics Standards (2020). The 2025 Reference Case also includes the 2015 Effluent Limitation

[15] See Response and Peer Review Reports, available at: https://www.epa.gov/power-sector-modeling/ipm-peer-reviews.
[16] http://www.epa.gov/clean-air-act-overview/benefits-and-costs-clean-air-act
[17] Presidential Proclamation 10914, titled *Regulatory Relief for Certain Stationary Sources to Promote American Energy*, is available here: https://www.federalregister.gov/documents/2025/04/21/2025-06936/regulatory-relief-for-certain-stationary-sources-to-promote-american-energy.
[18] Presidential Proclamation 10956, titled *Regulatory Relief for Certain Stationary Sources to Further Promote American Energy*, is available here: https://www.federalregister.gov/documents/2025/07/23/2025-13883/regulatory-relief-for-certain-stationary-sources-to-further-promote-american-energy.

Guidelines (ELG) and the 2015 Coal Combustion Residuals (CCR), and the finalized 2020 ELG and CCR rules.[19] Additionally, the model was also updated to account for recent updates to state and federal legislation affecting the power sector, including Pub. L. No. 119-21 (July 4, 2025), commonly known as the One Big Beautiful Bill Act (OBBBA) of 2025. The Integrated Planning Model (IPM) Documentation includes a summary of all legislation reflected in this version of the model as well as a description of how that legislation is implemented in the model. The IPM documentation provides details on the provisions of the OBBBA that were incorporated into this analysis, including provisions relating to tax subsidies for non-emitting generation, energy storage, and CCS.[20] In addition, the model was also updated to account for large projected increases in electricity demand stemming from data centers and Artificial Intelligence (AI) applications.[21] The analysis of power sector cost and impacts presented in this section represents incremental impacts projected as a result of repealing the 2024 MATS RTR requirements discussed in Section 1.3.

2.3.3 Methodology for Evaluating this Rulemaking

To estimate the costs, benefits, and economic and energy market impacts of the 2024 MATS RTR repeal, the EPA conducted quantitative analysis comparing a baseline that includes the 2024 MATS RTR requirements to a final repeal scenario that does not include the 2024 MATS RTR requirements.

IPM estimates compliance costs incurred by regulated firms, but because of the availability of subsidy payments, there are also real resource costs to the economy outside of the regulated sector. IPM provides EPA's best estimate of the costs of the final rules to the electricity sector and related energy sectors (i.e., natural gas, coal mining). To estimate the social

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[19] For a full list of modeled policy parameters, please see: https://www.epa.gov/power-sector-modeling/2025-reference-case.

[20] For a discussion of the uncertainties around the modeling of the impacts of the OBBBA including CCS and market conditions, please see the Limitations Discussion in Section 3.7. Documentation is available at: https://www.epa.gov/power-sector-modeling/2025-reference-case.

[21] The EPA incorporated two major updates within the demand projections for this model release, namely repeal of the EPA vehicle rules (which reduced the demand for electricity from the transportation sector) and higher levels of data center demand (i.e. increasing levels of large load interconnections that increase the demand for electricity). In order to estimate transportation sector electricity demand consistent with the repeal of the vehicle rules, the EPA relied on the "No Action Case" developed as part of the analysis for the impact of the vehicle rules. In order to estimate large load interconnections, the EPA started with EPRI's state level estimate of historical data center demand and grew this demand consistent with current market forecasts. The EPA applied a publicly available load shape to this demand to reflect high levels of utilization expected by these applications.

costs for the economy as a whole, the EPA has used information from IPM as an input into the Agency's computable general equilibrium model, SAGE. The economy-wide analysis is considered a complement to the more detailed evaluation of sector costs produced by IPM.

2.4 Estimated Impacts of the Final Repeal

2.4.1 Emissions Changes Assessment

This RIA presents emissions changes estimates in years 2028, 2030, and 2035. Table 2-1 presents the estimated power sector emissions changes under this final repeal. The quantified emissions estimates include changes in pollutants regulated by the 2024 MATS RTR, such as Hg and non-Hg HAP metals, and other changes in pollutants emitted from the power sector as a result of projected compliance actions. The table includes estimates of changes in direct $PM_{2.5}$, PM_{10}, NO_X, SO_2, CO_2, Hg and hydrogen chloride (HCl) for each of the years analyzed.

Relative to the baseline including the 2024 MATS RTR requirements, the final repeal is projected to result in a 23 percent increase in Hg emissions in 2030 and 2035. The final repeal is also projected to result in an approximately 1 percent increase in $PM_{2.5}$ and an approximately 2 percent increase in PM_{10} in 2030 and 2035. The repeal is also projected to result in very small changes in other pollutants related to similarly small changes in projected dispatch and fuel use.

Table 2-1 EGU Emissions Changes for 2028, 2030, and 2035[a]

	Year	Total Emissions: Baseline with 2024 MATS RTR	Total Emissions: Final Repeal	Emissions Change	Emissions Change (%)
Hg (lbs.)	2028	6,990	7,066	76	1.1%
	2030	6,259	7,681	1,422	22.7%
	2035	6,658	8,189	1,531	23.0%
$PM_{2.5}$ (thousand tons)	2028	91.1	91.1	0.0	0.0%
	2030	95.4	96.1	0.7	0.7%
	2035	96.5	97.3	0.8	0.8%
PM_{10} (thousand tons)	2028	105.5	105.6	0.1	0.1%
	2030	110.1	112.0	1.9	1.7%
	2035	112.7	114.7	2.0	1.8%
SO_2 (thousand tons)	2028	681.6	681.6	0.1	0.0%
	2030	694.9	695.0	0.2	0.0%
	2035	681.5	681.8	0.2	0.0%
Ozone-season NO_X (thousand tons)	2028	276.4	276.4	0.0	0.0%
	2030	279.8	279.4	-0.3	-0.1%
	2035	253.1	252.9	-0.3	-0.1%
Annual NO_X (thousand tons)	2028	652.2	652.2	0.0	0.0%
	2030	646.8	645.8	-1.1	-0.2%
	2035	602.6	602.0	-0.7	-0.1%
HCl (thousand tons)	2028	3.8	3.8	0.0	0.0%
	2030	3.9	3.9	0.0	-0.1%
	2035	3.8	3.8	0.0	0.0%
CO_2 (million metric tons)	2028	1487.8	1487.9	0.0	0.0%
	2030	1570.6	1570.1	-0.5	0.0%
	2035	1514.5	1514.1	-0.4	0.0%

[a] This analysis is limited to the geographically contiguous lower 48 states. The small projected changes in non-HAP emissions are consistent with small projected changes in electricity dispatch.

The EPA also estimates an increase of approximately 0.4 tons of non-Hg HAP metals in 2028, and 7 tons of non-Hg HAP metals in 2030 and 2035 due to the final repeal.[22] These increases are composed of increases in emissions of antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, and selenium. Table 2-2 summarizes the total

[22] The estimates on non-mercury HAP metals reductions were obtained by multiplying the ratio of non-mercury HAP metals to fPM by estimates of PM_{10} reductions under the rule, as we do not have estimates of fPM reductions using IPM, only PM_{10}. The ratios of non-mercury HAP metals to fPM were based on analysis of 2010 MATS Information Collection Request (ICR) data. As there may be substantially more fPM than PM_{10} reduced by the control techniques projected to be used under this rule, these estimates of non-mercury HAP metals reductions are likely underestimates. More detail on the estimated reduction in non-mercury HAP metals can be found in the docketed memorandum *Estimating Non-Hg HAP Metals Reductions for the 2024 Technology Review for the Coal-Fired EGU Source Category*.

emissions changes projected over the 2028 to 2037 analysis period. As indicated previously, this RIA presents emissions reductions estimates in years 2028, 2030, and 2035. Note, the EPA is unable to quantify any additional emissions changes resulting from the repeal of the continuous monitoring of fPM requirement of the 2024 MATS RTR.[23]

Table 2-2 Cumulative Projected Emissions Changes for the Final Repeal, 2028 to 2037[a,b]

Pollutant	Emissions Changes
Hg (pounds)	12,000
$PM_{2.5}$ (thousand tons)	6.3
CO_2 (million metric tons)	-3.2
SO_2 (thousand tons)	1.9
NO_x (thousand tons)	-6
Non-Hg HAP metals (tons)	56

[a] Values rounded to two significant figures.
[b] Estimated changes from run year 2028 are applied to 2028 and 2029, those from model year 2030 are applied to 2031 and 2032, and those from model year 2035 are applied to 2032 through 2037. These values are summed to generate total emissions changes.

2.4.2 Compliance, Real Resource, and Social Cost Assessment

In this RIA, the power industry's compliance costs are estimated as the change in power sector production expenditures due to the final repeal. The total compliance costs are estimated for this RIA as the sum of two components: the IPM-projected cost estimates and the PM CEMS requirement cost estimates. This IPM-projected component constitutes the majority of the incremental costs changes for the final repeal.

The IPM-projected cost estimates are presented below in Table 2-3 for the analysis years 2028, 2030, and 2035.[24] These costs are represented as the change in electric power generation

[23] The EPA did not quantify emissions changes related to factors such as increased transparency, compliance assurance, and accelerated identification of anomalous emission anticipated from the PM CEMS requirement in the 2024 MATS RTR.

[24] The objective function of IPM minimizes the present value of system costs, and a discount rate is used in IPM to convert all future costs to a present value. The private discount rate adopted for modeling investment behavior should reflect the rate at which investors are willing to invest in the sector. For a general discussion of the risk and temporal preferences, tax treatments, and costs of borrowing that inform discount rates, Section 6.4 of the EPA's *Guidelines for Preparing Economic Analyses* (U.S. EPA, 2024d). The real discount rate used in EPA's 2025 Reference Case. Using the Integrated Planning Model, 3.76 percent, equals the real weighted average after tax cost of capital for various ownership types and technologies. The discount rate used in EPA's modeling is invariant over time. For more information, see Chapter 10 of the *Documentation for EPA's 2025 Reference Case*. The private discounting used in IPM to simulate industry behavior differs from the social discounting used to estimate the social net benefits of the regulatory action. The social discount rates used in the net benefits analysis in this RIA reflect the

costs for these specific years of analysis between the baseline in this RIA, which includes the 2024 MATS RTR, and the policy case in this RIA. Cost estimates and emissions changes for subsequent years are available in the docket.[25]

Table 2-3 National Power Sector Compliance Costs for 2028, 2030, and 2035 (million 2024 dollars)

Analysis Year	2024 MATS RTR
2028	-5.4
2030	-91
2035	-110

Note: Values have been rounded to two significant figures. Costs associated with the PM CEMS requirement (Table 2-4) are not included in this table. Costs are combined in the stream of undiscounted costs (Table 2-5).

Table 2-4 presents the incremental cost estimates of repealing the PM CEMS requirement. The annualized costs for quarterly testing are estimated at about $73,000. For the portion of EGUs that would also employ PM CEMS, we estimated the annualized costs to be about $87,000.[26]

intertemporal preferences of society as a whole, with 3 percent representing the consumption rate of interest and 7 percent representing the social opportunity cost of capital (OMB Circular A-4 (2003), and Section 6.2 of the EPA *Guidelines* (2024d)).

[25] Documentation and *Analysis of the Final Repeal of the Mercury and Air Toxics Standards Amendments* data on additional run years for EPA's Power Sector Modeling using IPM can be found at https://www.epa.gov/power-sector-modeling/analysis-final-repeal-mercury-and-air-toxics-standards-amendments and is available in the docket for this action.

[26] Estimated costs for quarterly fPM testing and PM CEMS are provided in the "Revised Estimated Non-Beta Gauge PM CEMS and Filterable PM Testing Costs" memorandum, available in the docket. The annualized costs for units employing EPA Method 5 quarterly testing were estimated at about $60,000 (2019 dollars). EPA calibrated its cost estimates for PM CEMS in response to observed installations, manufacturer input, public comment, and engineering analyses during the 2024 MATS RTR rulemaking. These calibrations include an assumed replacement lifespan of 15 years and an interest rate of 7 percent to approximate the prevailing bank prime rate. For the portion of EGUs that employ PM CEMS, we estimated the annualized costs to be about $72,000 (2019 dollars). These values have been adjusted to 2024 dollars for this analysis.

Table 2-4 Incremental Cost of Monitoring under the Final Repeal (2024 dollars)

Monitoring System	Units (no.)	Baseline Cost (per year per unit)	Total Baseline Costs (per year)	Final Repeal Cost (per year per unit)	Final Repeal Costs (per year)	Incremental Costs (per year)
Quarterly Testing	198	$87,000	$17,000,000	$73,000	$14,000,000	-$2,900,000
PM CEMS	126	$87,000	$11,000,000	$87,000	$11,000,000	$0
Total	324	---	$28,000,000	---	$25,000,000	-$2,900,000

Note: Values rounded to two significant figures. Values may not appear to equal sum due to rounding. The baseline includes the 2024 MATS RTR requirements. This table reflects the analysis years after the two-year exemption (2030 to 2037).

As detailed in Table 2-4, relative to the baseline including the 2024 MATS RTR requirements, the final repeal would no longer result in additional PM CEMS costs. The estimated incremental cost of about $14,000 per year per unit for EGUs employing quarterly testing (the difference in the baseline and final repeal per year per unit cost, $87,000 and $73,000, respectively) is avoided. As a result, total incremental costs of about $2.9 million per year are avoided for this component. This incremental avoided cost is only representative for the years 2030 to 2037 since 154 units were affected by the two-year exemption from the presidential proclamation. Estimated total incremental costs of $1.2 million per year are avoided for the years 2028 and 2029.

Table 2-5 presents the undiscounted stream of compliance costs from 2028 through 2037. Table 2-6 presents the PV and EAV of total compliance costs over the 2028 through 2037 timeframe for the final repeal. The total compliance costs are composed of the change in electric power generation costs between the baseline that includes the 2024 MATS RTR and the final repeal scenario as presented in Table 2-3 and the incremental cost of the final PM CEMS requirement as detailed in Table 2-4. There are no anticipated costs associated with the final repeal prior to 2028. The EPA projects that the total compliance cost of the final repeal will be -$6.4 million, -$93 million, and -$110 million (2024 dollars) in 2028, 2030, and 2035, respectively.

Table 2-5 Costs of the Final Repeal from 2028 through 2037 (million 2024 dollars, undiscounted) [a]

Year	Power Sector Generating Costs[b]	PM CEMS Costs	Total Sector Costs
2028	-5.4	-1.2	-6.6
2029	-5.4	-1.2	-6.6
2030	-91	-2.9	-93
2031	-91	-2.9	-93
2032	-110	-2.9	-110
2033	-110	-2.9	-110
2034	-110	-2.9	-110
2035	-110	-2.9	-110
2036	-110	-2.9	-110
2037	-110	-2.9	-110

[a] Values rounded to two significant figures. Values may not appear to equal sum due to rounding.
[b] IPM run years apply to particular calendar years as follows: IPM run year 2028 is applied to 2028 and 2029, 2030 is applied to 2030 and 2031, and 2035 is applied to 2032 to 2037.

Table 2-6 Present Value and Equivalent Annualized Values of Total Sector Costs from 2028 to 2037 (million 2024 dollars, discounted to 2025)

Power Sector Generating Costs [b]		PM CEMS Costs		Total Costs	
PV	EAV	PV	EAV	PV	EAV
3% Discount Rate					
-650	-76	-20	-2.4	-670	-78
7% Discount Rate					
-470	-67	-15	-2.1	-490	-69

[a] Values rounded to two significant figures. Values may not appear to sum due to rounding.
[b] IPM run years apply to particular calendar years as follows: IPM run year 2028 is applied to 2028 and 2029, 2030 is applied to 2030 and 2031, and 2035 is applied to 2032 to 2037.

The compliance costs associated with a regulatory action can impact households by changing the prices of goods and services; the extent of the price changes depends on if and how producers pass-through those costs (or cost savings in the case of regulatory actions that reduce compliance costs) to consumers. The ultimate distributional outcome will depend on how changes in electricity and other fuel and input prices and changes in returns to labor and capital propagate through the economy and interact with existing government transfer programs. The distribution of compliance costs may be regressive or progressive, depending on the factors such as the form of the regulation and other implementation choices.

IPM provides the EPA's best estimate of the change in costs due to the proposed action to the electricity sector and related energy sectors (i.e., natural gas, coal mining). The projected change in the national power sector costs shown in Table 2-5 is the change in costs paid by the power sector because of this action. The projected change in IPM power sector costs includes the avoided cost of additional resources that are used by the sector because of the repeal, such as the cost of pollution controls, labor, materials, fuel, transport, and storage, while the change in CEMS costs includes the avoided costs of labor, capital and other inputs. These "real resources" constitute the changes in physical and labor inputs purchased by the sector because of the EPA action.

The projected change in power sector cost also includes changes in tax and subsidy payments, financing charges for new capital, and insurance. For example, when IPM projects that a new generator will be built, the power sector cost includes the cost to purchase and install and operate the generator as well as the cost to finance the generator and expected taxes and insurance that will be paid on the investment. The power sector cost also includes any production and investment subsidies or tax credits that may offset expenditures on real resources.

Most tax payments, tax credits, and subsidy payments are transfers (OMB, 2003; U.S. EPA, 2024d).[27] Transfers are shifts in money or resources from one part of the economy (e.g., a group of individuals, firms, or institutions) to another in a way that does not affect the total resources that are available to society. In other words, the loss to one part of the economy is exactly offset by the gain to another. Transfers should be excluded from estimates of the benefits and costs of a regulatory action (OMB, 2003; U.S. EPA, 2024d).[28]

There are two important sources of tax-related transfers included in the power sector costs of the final repeal. First, the compliance costs include production and investment taxes paid on generating resources and air pollution control equipment. Second, the analysis includes tax credits awarded for certain types of generators, energy storage, and sequestration of CO_2, the levels of which are indirectly affected by the repeal of three of the four 2024 MATS RTR requirements.[29] Table 2-5 presents the compliance cost estimates from the perspective of firms in

[27] See "The Difference between Costs (or Benefits) and Transfer Payments" in OMB (2003) and sections 6.4.2 and 8.2.2.2 of U.S. EPA (2024d).
[28] Transfers themselves do affect behavior, and therefore their presence should be accounted for when estimating the social cost, social benefits, and distributional effects of a regulatory action.
[29] See Chapters 6 and 10 of the IPM documentation (U.S. EPA 2024b). Certain credits may be limited by the total tax obligation of reporting entities or the ability to transfer them to other entities. The IPM analysis in this RIA assumes that the full value of any credits is not limited by total tax obligation of reporting entities or their ability to transfer their value.

the electricity market, which is net of taxes paid and credits received. In contrast, Table 2-6 presents the full real resource costs of compliance with a presentation of both changes in taxes paid and credits received.

The real resource approach provides an alternative estimate of the cost savings from the final repeal, adjusting the power sector cost analysis to account for the fact that the taxes and subsidies represented in the analysis using IPM may be more accurately characterized as transfers. Whether the real resource costs are greater or less than the sectoral compliance costs depend on the net effect of changes in transfers both paid to and paid by affected sectors.

Table 2-7 Real Resource Costs under the Final Repeal (million 2024 dollars)

	[1]	[2]	[3]	[4]	[5]	[6]
	Total Power Sector Compliance Costs (Table 2-5)	Change in Transfers (Credits)		Change in Transfers (Government Receipts and Other)		Change in Real Resource Costs
		CO_2 Storage Tax Credit	Clean Energy Tax Credits	Corporate Income Taxes and Other Transfers	Payments For Use of Transmission	
2028	-6.6	0.00	0.3	-1.2	-0.41	-4.7
2030	-93	0.30	2.5	-20	-3.7	-67
2035	-110	35	-0.2	-18	-0.33	-56
			3% Discount Rate			
PV (2028-37)	-670	160	3.8	-120	-8.5	-380
EAV (2028-37)	-78	19	0.45	-14	-1.0	-44
			7% Discount Rate			
PV (2028-37)	-490	110	3.2	-87	-6.8	-280
EAV (2028-37)	-69	16	0.46	-12	-1.0	-40

Notes: (1) Column [6] = [1] + [2] + [3] - [4] - [5]. (2) As presented in Table 2-5, Column [1] includes changes in power sector compliance and CEMS costs as well as tax payments less tax credits (i.e., 45Q, 45Y, and 48E) (that is, Column [1] = [6] + [5] + [4] - [2] - [3]). (3) Column [4] reports the change in tax credits payments annualized using the private cost of borrowing and book life for eligible technologies. (4) Column [4] is recovered from the difference in capital charge rates and capital recovery factors applied in IPM to new capital. (5) Present values are discounted to the 2025 analysis year. (6) Values rounded to two significant figures.

Table 2-7 reports the changes in total sector costs, transfers, and incremental real resource costs for each IPM model year.[30] Negative values imply reductions relative to the baseline. To estimate the incremental resource costs of the final repeal, we must identify the portion of the

[30]The change in real resource costs treats payments to capital equivalently to the total sector costs; payments are amortized over the financing period of an investment at IPM's internal discount rate.

changes in total sector costs that are due to net changes in production and investment taxes and credits for generation and tax credits for CO_2 storage and clean energy.

To start, Column 1 of Table 2-7 shows the change in power sector costs reported in Table 2-5, which represents the expenditures that the power sector will not have to make as a result of the final repeal. Column 2 reports the projected increase in the CO_2 storage tax credit paid to the electricity sector from the final repeal. Column 3 reports the change in clean energy credits paid to the sector. The changes in the total value of the clean energy tax credits across years are primarily attributable to a change in timing of the construction of new battery storage between the baseline and policy case. The total value of the CO_2 and clean energy tax credit changes are reported separately given their scale relative to the changes in the total amount of the other transfers. Column 4 reports the net change in other taxes and other transfers paid by the sector (e.g., investment taxes, insurance). Column 5 reports changes in payments for energy transmission costs and capacity transfer costs, which are payments for the use of existing transmission and are therefore transfers.[31] The projected incremental change in real resource costs presented in Column 6 is calculated as the power system cost change plus the net change in CO_2 tax credits and clean energy tax credits minus the net change in other taxes and transfers and payments for the use of transmission capacity. That is, Column 6 equals the sum of Columns 1, 2 and 3 less Columns 4 and 5. This calculation of the real resource cost provides a transfer-adjusted estimate of the incremental costs projected to not occur as a result of the final repeal (negative values indicate costs that are not expected to occur).

Capital costs in Columns 1 and 6 are amortized using the private cost of borrowing over the book life of the capital investment. The cost of borrowing, financing period, and book life

[31] The change in the use of existing transmission capacity between the baseline and policy case is assumed to not meaningfully change the consumption of real resources that are not otherwise accounted for in the power sector costs. Therefore, the change in the payment for using transmission capacity is treated as a transfer. For example, expenditures on the maintenance of existing lines are not expected to change between the baseline and policy case because of the change in the amount of power transmitted through those lines. Furthermore, while the capacity payments for transmission reflect the cost of securing operating reserve capacity, the cost of assuring the reserve capacity is available, e.g., the fixed operating and maintenance cost of this capacity, is already accounted for in the national power sector cost and therefore in the real resource cost. The change in the cost of constructing new transmission capacity is included in the real resource cost.

varies by technology and owner-type (Chapter 10, U.S. EPA 2024b).[32] The 45Y and 48E tax credits are implemented as a reduction to overnight capital costs in IPM. For consistency with the treatment of capital in Column 1, and to retain a consistent approach to accounting for capital in Column 6, Column 3 reports the change in these tax credits annualized using the private cost of borrowing and book life for the eligible technologies.

To estimate the change in social costs of this final action, the EPA used information from IPM as an input into the Agency's economy-wide computable general equilibrium model, SAGE. As described in Section 4.3.2, the inputs to the SAGE model matched both the real resource requirements for the expected compliance pathway and the impact of net changes in tax payments on the compliance expenditures for the electricity sector. Like the real resource cost analysis summarized in Table 2-7, the economy-wide analysis is a complement to the detailed evaluation of sector costs produced by IPM. As a partial equilibrium model, IPM accounts for impacts in the directly regulated electricity sector as well as the coal and natural gas sectors but does not account for impacts in the rest of the economy. Both the real resource cost and SAGE analyses improve the characterization of regulatory costs by accounting for changes outside of the directly regulated sector.

As shown below in Section 4.2.4, in Table 4-4, the annualized reduction in social cost estimated in SAGE for the final repeal is approximately -$530 million (2024 dollars) between 2028 and 2037 using SAGE's endogenous consumption discount rate path. Note that SAGE does not currently estimate the change in social benefits and their effects on the economy from changing environmental quality. See Section 4.2 for more discussion on the economy-wide analysis with SAGE and estimates of private and social costs.

[32] Components of private financing costs may reflect omitted real resource costs. If this is the case, excluding these costs may lead to an underestimate of avoided real resource costs. For example, as discussed in Section 6.4.2 of U.S. EPA (2024a), an interest payment reflects a transfer between a borrower and a lender that would net out with social discounting. However, in some contexts, interest rates and insurance may account for risk and uncertainty, that, in expectation, reflect additional resource costs (e.g., actuarily fair insurance premia). Section 6.1.6.2 of U.S. EPA (2024a) cautions, "While it is technically possible to adjust the discount rate to account for uncertainty, doing so may hide important assumptions and information about the relative effects of discounting and uncertainty from decision-makers. Uncertainty about future values should be treated separately when discounting."

2.4.3 Generating Capacity

In this section, we discuss the projected changes in capacity by fuel type, building on and adding greater context to the information presented in the previous section. We first look at total capacity by fuel type, then retirements by fuel type, and finally new capacity builds by fuel type for the 2028, 2030, and 2035 run years.

Note that, over the past decade, there have been substantial structural changes in both the mix of generating capacity and in the share of electricity generation supplied by different types of generation. These changes are the result of multiple factors in the power sector, including replacements of older generating units with new units, changes in the electricity intensity of the U.S. economy, growth and regional changes in the U.S. population, technological improvements in electricity generation from both existing and new units, changes in the prices and availability of different fuels, and substantial growth in electricity generation from renewable energy sources. Many of these trends will likely continue to contribute to the evolution of the power sector, and are unlikely to be affected by the repeal of this rule.

Table 2-8 shows the total net projected capacity by fuel type for the baseline and the final repeal for 2028, 2030, and 2035. Here, we see the net effects of projected retirements (Table 2-9) and new capacity builds (see Table 2-10). There are no significant incremental changes in capacity projected in response to the final repeal for any given fuel type.

Table 2-8 2028, 2030, and 2035 Projected U.S. Capacity by Fuel Type for the Baseline and the Final Repeal

	Total Generation Capacity (GW)			
	Baseline	Final Repeal	Change under Final Repeal	
			GW	%
2028				
Coal	141	141	0	0.0%
Natural Gas	480	480	0	0.0%
Oil/Gas Steam	69	69	0	0.0%
Non-Hydro RE	383	383	0	0.0%
Hydro	102	102	0	0.0%
Energy Storage	88	88	0	0.0%
Nuclear	97	97	0	0.0%
Other	6	6	0	0.0%
Total	1366	1366	0	0.0%
2030				
Coal	127	127	0	0.0%
Natural Gas	524	524	0	0.0%
Oil/Gas Steam	66	66	0	0.0%
Non-Hydro RE	428	428	0	0.0%
Hydro	104	104	0	0.0%
Energy Storage	110	110	0	0.0%
Nuclear	93	93	0	0.0%
Other	6	6	0	0.0%
Total	1457	1457	0	0.0%
2035				
Coal	100	100	0	0.0%
Natural Gas	633	633	0	0.0%
Oil/Gas Steam	38	38	0	0.0%
Non-Hydro RE	616	616	0	0.0%
Hydro	108	108	0	0.0%
Energy Storage	165	165	0	0.0%
Nuclear	84	84	0	0.0%
Other	6	6	0	0.0%
Total	1750	1750	0	0.0%

Note: In this table, "Non-Hydro RE" includes biomass, geothermal, landfill gas, solar, and wind.

Table 2-9 shows the total capacity projected to retire by fuel type for the baseline and the final repeal in all run years. The final repeal is not projected to result in changes to projected retirements.

Table 2-9 2028, 2030, and 2035 Projected U.S. Retirements by Fuel Type for the Baseline and the Final Repeal

	Projected Retirements (GW)		
	Baseline	**Final Repeal**	**% Change under Final Repeal**
		2028	
Coal	4	4	0%
Natural Gas	1	1	0%
Oil/Gas Steam	2	2	0%
Non-Hydro RE	2	2	0%
Hydro	0	0	0%
Nuclear	0	0	0%
Other	0	0	0%
Total	10	10	0%
		2030	
Coal	18	18	0%
Natural Gas	1	1	0%
Oil/Gas Steam	5	5	0%
Non-Hydro RE	3	3	0%
Hydro	0	0	0%
Nuclear	4	4	0%
Other	0	0	0%
Total	31	31	0%
		2035	
Coal	36	36	0%
Natural Gas	2	2	0%
Oil/Gas Steam	34	34	0%
Non-Hydro RE	3	3	0%
Hydro	0	0	0%
Nuclear	12	12	0%
Other	1	1	0%
Total	89	89	0%

Note: In this table, "Non-Hydro RE" includes biomass, geothermal, landfill gas, solar, and wind.

Finally, Table 2-10 shows the projected U.S. new capacity builds by fuel type for the baseline and the final repeal in all run years. For the final repeal, the incremental changes in projected new capacity for any given fuel type are negligible.

Table 2-10 2028, 2030, and 2035 Projected U.S. New Capacity Builds by Fuel Type for the Baseline and the Final Repeal

	New Capacity (GW)		% Change under Final Repeal
	Baseline	Final Repeal	
2028			
Coal	0	0	0.0%
Natural Gas	35	35	0.0%
Energy Storage	36	36	0.0%
Non-Hydro RE	31	31	-0.1%
Hydro	0	0	0.0%
Nuclear	0	0	0.0%
Other	0	0	0.0%
Total	101	101	0.0%
2030			
Coal	0	0	0.0%
Natural Gas	79	79	0.0%
Energy Storage	57	57	0.1%
Non-Hydro RE	76	76	-0.1%
Hydro	2	2	0.0%
Nuclear	0	0	0.0%
Other	0	0	0.0%
Total	214	214	0.0%
2035			
Coal	0	0	0.0%
Natural Gas	189	189	0.0%
Energy Storage	113	113	0.0%
Non-Hydro RE	264	264	0.0%
Hydro	6	6	0.0%
Nuclear	0	0	0.0%
Other	0	0	0.0%
Total	572	572	0.0%

Note: In this table, "Non-Hydro RE" includes biomass, geothermal, landfill gas, solar, and wind.

2.4.4 Generation Mix

In this section, we discuss the projected changes in generation mix for 2028, 2030, and 2035 for the final repeal. Table 2-11 presents the projected generation and percentage changes in national generation mix by fuel type for run years 2028, 2030, and 2035. These generation mix estimates reflect limited changes in energy generation as a result of the final rule in any run year. Estimated changes in coal and natural gas use under the final rule are examined further in Section 2.4.5.

Table 2-11 2028, 2030, and 2035 Projected U.S. Generation by Fuel Type for the Baseline and the Final Repeal

	Generation Mix (TWh)		Incremental Change under Final Repeal	
	Baseline	**Final Repeal**	**TWh**	**%**
		2028		
Coal	724	724	0.0	0.0%
Natural Gas	1,795	1,795	0.0	0.0%
Oil/Gas Steam	43	43	0.0	0.0%
Non-Hydro RE	1,046	1,046	0.0	0.0%
Hydro	287	287	0.0	0.0%
Energy Storage	99	99	0.0	0.0%
Nuclear	774	774	0.0	0.0%
Other	29	29	0.0	0.0%
Total	**4,797**	**4,797**	**0.0**	**0.0%**
		2030		
Coal	736	735	-0.5	-0.1%
Natural Gas	2,072	2,073	0.7	0.0%
Oil/Gas Steam	28	28	0.0	0.0%
Non-Hydro RE	1,200	1,200	-0.2	0.0%
Hydro	297	297	0.0	0.0%
Energy Storage	130	130	0.0	0.0%
Nuclear	743	743	0.0	0.0%
Other	29	29	0.0	0.0%
Total	**5,235**	**5,235**	**-0.1**	**0.0%**
		2035		
Coal	666	666	0.0	0.0%
Natural Gas	2,514	2,514	0.0	0.0%
Oil/Gas Steam	6	6	0.0	0.0%
Non-Hydro RE	1,778	1,778	0.0	0.0%
Hydro	317	317	0.0	0.0%
Energy Storage	221	221	0.0	0.0%
Nuclear	675	675	0.0	0.0%
Other	29	29	0.0	0.0%
Total	**6,206**	**6,206**	**0.0**	**0.0%**

Note: In this table, “Non-Hydro RE” includes biomass, geothermal, landfill gas, solar, and wind.

2.4.5 Coal and Natural Gas Use for the Electric Power Sector

In this section we discuss the estimated changes in coal use and natural gas use in 2028, 2030, and 2035. Table 2-12 and Table 2-13 present percentage changes in national coal usage by EGUs by coal supply region and coal rank, respectively. These fuel use estimates show small changes in national coal use in the final repeal relative to the baseline in all run years. Additionally, the final repeal is not projected to result in significant coal switching between supply regions or coal rank.

Table 2-12 2028, 2030, and 2035 Projected U.S. Power Sector Coal Use by Coal Supply Region for the Baseline and the Final Repeal

Region	Year	Million Tons		% Change under Final Repeal
		Baseline	Final Repeal	
Appalachia	2028	72	72	0.0%
Interior		60	60	0.0%
Waste Coal		7	7	0.0%
West		241	241	0.0%
Total		**379**	**379**	**0.0%**
Appalachia	2030	70	70	0.0%
Interior		61	61	0.0%
Waste Coal		7	7	0.0%
West		258	259	0.2%
Total		**397**	**398**	**0.1%**
Appalachia	2035	62	62	0.0%
Interior		57	57	0.0%
Waste Coal		7	7	0.0%
West		266	267	0.5%
Total		**391**	**392**	**0.3%**

Table 2-13 2028, 2030, and 2035 Projected U.S. Power Sector Coal Use by Rank for the Baseline and the Final Repeal

Rank	Year	Million Tons: Baseline	Million Tons: Final Repeal	% Change under Final Repeal
Bituminous	2028	126	126	0.0%
Subbituminous		214	214	0.0%
Lignite		38	38	0.0%
Total		**378**	**378**	**0.0%**
Bituminous	2030	124	124	0.0%
Subbituminous		232	229	-1.1%
Lignite		38	41	8.2%
Total		**393**	**393**	**0.1%**
Bituminous	2035	109	109	0.0%
Subbituminous		238	235	-1.2%
Lignite		39	43	10.5%
Total		**387**	**388**	**0.3%**

Note: The small increase in lignite use results from small changes in regional economics, and reflects the ability of some plants to consume different coal ranks (e.g., lignite and subbituminous).

2.4.6 Impacts on Fuel Prices, Fuel Consumption, and Electricity Prices

The final repeal has minimal estimated energy market impacts. Table 2-14 presents a variety of projected national average energy market impacts that were projected. The changes to retail electricity prices and indicators for coal and natural gas were each estimated to be approximately zero percent in all run years under the final repeal under the final action.

Table 2-14 National Impacts on Fuel Prices, Fuel Consumption, and Electricity Prices (million 2024 dollars)

		2028	2030	2035
Retail electricity prices (2024 mills/kWh)	Baseline with 2024 MATS RTR	132.1	134.7	126.7
	Final Repeal	132.1	134.7	126.7
	Change	0.0%	0.0%	0.0%
Average price of coal delivered to the power sector (2024 $/MMBtu)	Baseline with 2024 MATS RTR	2.20	2.24	2.29
	Final Repeal	2.20	2.24	2.30
	Change	0.0%	0.2%	0.2%
Coal production for power sector use (million tons)	Baseline with 2024 MATS RTR	378	393	387
	Final Repeal	378	393	388
	Change	0.0%	0.1%	0.3%
Price of natural gas delivered to power sector (2024$/MMBtu)	Baseline with 2024 MATS RTR	3.73	4.18	5.23
	Final Repeal	3.73	4.18	5.23
	Change	0.0%	0.0%	0.0%
Price of average Henry Hub (spot) (2024$/MMBtu)	Baseline with 2024 MATS RTR	3.63	4.12	5.26
	Final Repeal	3.63	4.12	5.26
	Change	0.0%	0.0%	0.0%
Natural gas use for electricity generation (TCF)	Baseline with 2024 MATS RTR	13	14	16
	Final Repeal	13	14	16
	Change	0.0%	0.0%	0.0%

Note: Values rounded to two significant figures.

2.4.7 Presidential Proclamations 10914 and 10956

As discussed in this earlier in this Section, the baseline in this analysis reflects Presidential Proclamation 10914, titled *Regulatory Relief for Certain Stationary Sources to Promote American Energy*, and Presidential Proclamation 10956, titled *Regulatory Relief for Certain Stationary Sources to Further Promote American Energy*. These Proclamations temporarily exempt certain stationary sources, as identified in Annex I, from compliance with the 2024 MATS RTR requirements.[33][34] As set out in the Proclamations, the exemption lasts for a period of two years beyond the 2024 MATS RTR compliance date, which is the period beginning July 8, 2027, and concluding July 8, 2029. During this two-year period, the stationary

[33] Presidential Proclamation 10914 titled *Regulatory Relief for Certain Stationary Sources to Promote American Energy* (90 FR 16777, April 21, 2025) is available here: https://www.federalregister.gov/documents/2025/04/21/2025-06936/regulatory-relief-for-certain-stationary-sources-to-promote-american-energy.
[34] Presidential Proclamation 10956 titled *Regulatory Relief for Certain Stationary Sources to Further Promote American Energy* (90 FR 34583, July 23, 2025) is available here: https://www.federalregister.gov/documents/2025/07/23/2025-13883/regulatory-relief-for-certain-stationary-sources-to-further-promote-american-energy.

sources identified in Annex I (of both Proclamations) will continue to be subject to the pre-2024 MATS RTR compliance obligations.

Table 2-15 presents the number of EGUs the EPA estimated to be impacted by the 2024 MATS RTR and whether they appear in Annex I. The table shows that the majority of potentially-impacted units appear in Annex I. We also note that Annex I includes units that the EPA did not anticipate being incrementally impacted by the 2024 MATS RTR.

Table 2-15 Summary of the Presidential Proclamation Impacts

2024 MATS RTR Requirement	EGUs Exempt Under Annex I	EGUs Not Exempt Under Annex I
fPM Standard (Surrogate Standard for Non-Hg HAP Metals)	25	8
Hg Standard for Lignite-Fired EGUs	19	3
Continuous Emissions Monitoring Systems (PM CEMS) Requirement	122	72

2.5 Limitations of Analysis and Key Areas of Uncertainty

EPA's power sector modeling is based on expert judgment of various input assumptions for variables with uncertain outcomes. As a general matter, the Agency reviews the best available information from engineering studies of air pollution controls and new capacity construction costs to support a reasonable modeling framework for analyzing the cost, emission changes, and other impacts of regulatory actions for EGUs. The annualized cost of the final repeal, as quantified here, is EPA's best assessment of the cost of implementing the rule on the power sector.

The projected annualized cost estimates of private compliance costs provided in this analysis are meant to show the increase in production (generating) costs to the power sector in response to the finalized requirements. To estimate these annualized costs, as discussed earlier, the EPA uses a conventional and widely accepted approach that applies a capital recovery factor (CRF) multiplier to capital investments and adds that to the annual incremental operating expenses to calculate annual costs. The CRF is derived from estimates of the cost of capital (private discount rate), the amount of insurance coverage required, local property taxes, and the life of capital. The private compliance costs presented earlier are EPA's best estimate of the direct private compliance costs of the rule.

In addition, there are several key areas of uncertainty related to the electric power sector that are worth noting, including:

Electricity demand: The analysis includes an assumption for future electricity demand. This is based on AEO 2025 reference case with incremental demand representing EPA estimates of electric vehicle demand and demand associated with data center applications.[35] To the extent electricity demand is higher and lower, it may increase/decrease the projected future composition and/or dispatch of the fleet.

Natural gas supply and demand: To the extent natural gas supply and delivered prices are higher or lower, it would influence the use of natural gas for electricity generation and overall competitiveness of other EGUs (e.g., coal and nuclear units).

Longer-term planning by utilities: EPA has reflected announced builds and retirement decisions based on EIA data, however there is evidence that some of these decisions may be revised in light of rapidly evolving market conditions.

FPM emissions and control: The fPM emissions rates for each unit are based on the analysis documented in the memorandum titled "2025 Update to the 2024 Technology Review for the Coal- and Oil-Fired EGU Source Category (2025 Technical Memo)." In the modeled scenario that includes the MATS RTR requirements, for those EGUs with rates greater than the MATS RTR fPM limit, the EPA assumes that control technology summarized in Section 3.4 would be necessary to remain operational. While the emissions rate for each EGU and the cost and performance assumption for each PM control technology are the best available to EPA at this time, it is possible that some EGUs may be able to achieve the MATS RTR fPM emissions limits with less costly control technology (e.g., an electrostatic precipitator (ESP) upgrade instead of a fabric filter installation), resulting in an overestimate of cost savings resulting from this final MATS RTR repeal. It is also possible that EPA's cost assumptions reflect lower technology

[35] For details, see chapter 3 of the IPM documentation available at: https://www.epa.gov/power-sector-modeling/2025-reference-case.

costs than might be incurred by EGUs, which would result in an underestimate of cost savings resulting from this final MATS RTR repeal.

These are key uncertainties that may affect the overall composition of electric power generation fleet and/or compliance with the repeal of the MATS RTR emissions limits and could thus have an effect on the estimated costs and impacts of this action. While it is important to recognize these key areas of uncertainty, they do not change EPA's overall confidence in the projected impacts of the final repeal presented in this section. The EPA continues to monitor industry developments and makes appropriate updates to the modeling platforms in order to reflect the best and most current data available.

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3 BENEFITS

3.1 Introduction

In this section, we discuss the potential health effects of exposure to HAP emitted by coal-fired EGUs and the projected changes to HAP emissions associated with this final repeal. We also describe the methods used to quantify changes in concentrations of ozone and $PM_{2.5}$ from EGUs and describe impacts of those changes. This analysis uses methodology for determining air quality changes that has been used in the RIAs from multiple previous proposed and final rules. The approach involves developing spatial fields of air quality across the U.S. for baseline and one final action scenario for 2028, 2030, and 2035 using nationwide photochemical source apportionment modeling and related analyses. For criteria pollutants, we present qualitative health benefits information associated with the emission changes for the final repeal. The EPA did not monetize the potential health impacts of this final repeal (see Section 3.3). Consistent with E.O. 14154 "Unleashing American Energy" (90 FR 8353, January 29, 2025) and the memorandum titled "Guidance Implementing Section 6 of Executive Order 14154, Entitled 'Unleashing American Energy'," the EPA did not monetize benefits associated with CO_2 emissions changes. For a brief discussion of uncertainties and limitations associated with monetizing CO_2-related domestic climate benefits, see Section 5.4 of this RIA.

3.2 Hazardous Air Pollutants

3.2.1 Mercury

Mercury (Hg) is a persistent, bioaccumulative toxic metal that is emitted from power plants in three forms: gaseous elemental Hg (Hg0), oxidized Hg compounds (Hg+2), and particle-bound Hg (HgP). Elemental Hg does not quickly deposit or chemically react in the atmosphere, resulting in residence times that are long enough to contribute to global scale deposition. Oxidized Hg and HgP deposit quickly from the atmosphere impacting local and regional areas in proximity to sources. Methylmercury (MeHg) is formed by microbial action in the top layers of sediment and soils, after Hg has precipitated from the air and deposited into waterbodies or land. Once formed, MeHg is taken up by aquatic organisms and bioaccumulates up the aquatic food web (ATSDR, 2024). Larger predatory fish may have MeHg concentrations many times that of the concentrations in the freshwater body in which they live. MeHg can adversely impact ecosystems and wildlife.

Human exposure to MeHg is known to have several adverse neurodevelopmental impacts, such as IQ loss measured by performance on neurobehavioral tests, particularly on tests of attention, fine motor-function, language, and visual spatial ability. In addition, evidence in humans and animals suggests that MeHg can have adverse effects on both the developing and the adult cardiovascular system including fatal and non-fatal ischemic heart disease (IHD), adverse developmental effects such as malformation, and changes to the immune system. Further, nephrotoxicity and reproductive effects (impaired fertility) have been observed with MeHg exposure in animal studies (ATSDR, 2024). MeHg has some genotoxic activity and is capable of causing chromosomal damage in a number of experimental systems. The EPA has classified MeHg as a "possible" human carcinogen (U.S. EPA, 2001).

Risk from near-field deposition of Hg to subsistence fishers has previously been evaluated, using a site-specific assessment of a lake near three lignite-fired facilities (U.S. EPA, 2020a). The results suggest that MeHg exposure to subsistence fishers from lignite-fired units is below the current RfD for MeHg neurodevelopmental toxicity or IQ loss, with an estimated hazard quotient (HQ) of 0.06. In general, the EPA believes that exposures at or below the RfD are unlikely to be associated with appreciable risk of deleterious effects.

Regarding the potential magnitude of human health risk associated with this rule, we make the following observations. All of the exposure results generated as part of the 2020 Residual Risk analysis were below the presumptive acceptable cancer risk threshold and noncancer health-based thresholds. These results suggest that the residual risks from HAP exposure are low.

Regarding potential Hg benefits of the 2024 MATS rule to the general population of fish consumers, while we note that the analysis of the overall EGU sector completed for the 2023 Final A&N Review did identify significant reductions in cardiovascular and neuro-developmental effects, given the substantially smaller Hg reduction associated with the 2024 MATS rule (approximately 900 to 1000 pounds per year under the final rule compared to the approximately 29 tons of Hg evaluated in the 2023 Final A&N Review), overall uncertainty associated with modeling potential benefits for the broader population of fish consumers would be sufficiently large as to compromise the utility of those benefit estimates.

U.S. EGU Hg emissions can lead to increased deposition of Hg to nearby waterbodies. Deposition of Hg to waterbodies can also have an impact on ecosystems and wildlife. Hg contamination is present in all environmental media with aquatic systems being particularly impacted due to bioaccumulation. Bioaccumulation refers to the net uptake of a contaminant from all possible pathways and includes the accumulation that may occur by direct exposure to contaminated media as well as uptake from food. Atmospheric Hg enters freshwater ecosystems by direct deposition and through runoff from terrestrial watersheds. Once Hg deposits, it may be converted to organic MeHg mediated primarily by sulfate-reducing bacteria. Methylation is enhanced in anaerobic and acidic environments, greatly increasing Hg toxicity and potential to bioaccumulate in aquatic foodwebs (Munthe et al. 2007). The highest levels of MeHg accumulation are most often measured in fish eating (piscivorous) animals and those which prey on other fish eaters. In laboratory studies, adverse effects from exposure to MeHg in wildlife have been observed in fish, mink, otters, and several avian species at exposure levels as low as 0.25 micrograms of MeHg per gram of body weight (U.S. EPA, 1997). The risk of Hg exposure may also extend to insectivorous terrestrial species such as songbirds, bats, spiders, and amphibians that receive Hg deposition or from aquatic systems near the forest areas they inhabit (Bergeron et al., 2010a, 2010b; Cristol et al., 2008; Rimmer et al., 2005; Wada et al., 2009; Wada et al., 2010)

The projected emission increases of Hg are expected to increase deposition of Hg into ecosystems and increase U.S. EGU attributable bioaccumulation of MeHg in wildlife, particularly for areas closer to the effected units subject to near-field deposition. Because Hg emissions from U.S. EGUs can both become deposited in or bioaccumulate in organisms living in foreign and international waters, Hg emissions from U.S. EGUs could lead to some increase in exposure internationally as well. The EPA is currently unable to quantify or monetize such effects.

3.2.2 Non-Hg HAP Metal

U.S. EGUs are the largest source of selenium emissions and a major source of non-Hg HAP metals emissions including arsenic, chromium, cobalt, and nickel. Additionally, U.S. EGUs emit beryllium, cadmium, lead, and manganese. These emissions include HAP metals that are persistent and bioaccumulate (arsenic, cadmium, and lead) and others have cancer-causing potential (beryllium, cadmium, chromium, cobalt, lead, and nickel). Under the 2024 MATS RTR requirements, fPM controls were expected to reduce HAP metals emissions and therefore reduce exposure to HAP metals for the general population including those living near these facilities.

Exposure to these HAP metals, depending on exposure duration and levels of exposures, is associated with a variety of adverse health effects. These adverse health effects may include chronic health disorders (e.g., irritation of the lung, skin, and mucus membranes; decreased pulmonary function, pneumonia, or lung damage; detrimental effects on the central nervous system; damage to the kidneys; and alimentary effects such as nausea and vomiting). As of 2023, three of the key HAP metals or their compounds emitted by EGUs (arsenic, chromium as hexavalent chromium, and nickel as nickel refinery dust and nickel subsulfide) are classified as carcinogenic to humans. Specifically, hexavalent chromium is carcinogenic to humans by the inhalation route of exposure. Two other key HAP emitted by EGUs (cadmium and selenium as selenium sulfide) are classified as probable human carcinogens.

U.S. EGU source category emissions of non-Hg HAP are not expected to exceed 1 in a million for inhalation cancer risk for those facilities impacted by the 2024 MATS RTR requirements. Further, cancer risk was determined to fall within the acceptable range for multipathway exposure to the persistent and bioaccumulative non-Hg HAP metals, such as arsenic, cadmium, and lead.[36] Projected emissions reductions from the 2024 MATS RTR requirements on carcinogenic HAP exposure levels in communities near the impacted facilities would no longer occur under this final repeal.

EPA also evaluated the potential for noncancer risks from exposure to non-Hg HAP metals in 2020. To address the risk from chronic inhalation exposure to multiple pollutants, we aggregated the health risks associated with pollutants that affect the same target organ. Further, we examined the potential for adverse health effects from acute inhalation exposure to individual pollutants. Lastly, we also examined the potential for health impacts stemming from multiple pathways of exposure for arsenic, cadmium, and lead. The estimated risks were not expected to exceed current health thresholds for adverse effects (U.S. EPA, 2020a). We are unable to identify

[36] *https://www.regulations.gov/document/EPA-HQ-OAR-2018-0794-0014*.

or quantify noncancer disbenefits from the projected non-Hg HAP metals emission increases associated with this final repeal.

Under this final repeal, the 2024 MATS RTR would no longer reduce emissions of Hg and non-Hg HAP metals. Those projections estimated that the 2024 MATS RTR would result in 13.6 thousand pounds of reductions in emissions of Hg and 63 tons of non-Hg HAP metals across all analytic years.

3.2.3 Additional HAP Uncertainty

As discussed in detail in the proposed amendments to the 2020 MATS RTR on April 24, 2023 (88 FR 24854), it is challenging to quantify the full range of impacts of HAP reductions. But that does not mean that these impacts are small, insignificant, or nonexistent. In the 2011 MATS RIA, the EPA discussed the potential for non-monetizable effects on fish, birds, and mammals, in part represented through the commercial and recreational fishing economy (U.S. EPA, 2011). A report submitted to EPA in comments concluded that recreational and commercial fishing are substantial contributors to regional U.S. economies with dollar values in the tens of billions (IEc, 2019). At this scale of economic activity, even small shifts in consumer behavior prompted by further HAP exposure changes can result in substantial economic impacts.

Finally, the EPA also qualitatively considers impacts on ecosystem services, which are generally defined as the economic benefits that individuals and organizations obtain from ecosystems. The monetization of endpoints like ecosystem services, tribal culture, and the activity related to fishing remains challenging. While the EPA is not able to monetize the impacts of increased HAP exposures projected for the final repeal, we note the importance of changes in HAP emissions to the sustainability of these important economic and cultural values.

3.3 Criteria Pollutant Effects

Historically, the EPA estimated the monetized benefits of avoided $PM_{2.5}$- and ozone-related impacts, which accounted for most, if not all, of the monetized benefits of many air regulations–even when the regulation was not regulating $PM_{2.5}$ or ozone. The OMB, in its annual report of the Benefits and Costs of Federal Regulations, routinely provides estimates that the monetized benefits from reducing $PM_{2.5}$ and/or ozone exceed hundreds of millions or even billions of dollars and result in most of the monetized benefits from Federal regulations.

In previous Regulatory Impact Analyses (RIAs), the Agency's approach to estimating the impacts to human health of the changes in concentrations of ozone and $PM_{2.5}$ relied substantially on information from the Integrated Science Assessments for ozone and particulate matter (e.g., (U.S. EPA, 2020a), (U.S. EPA, 2019a). These documents synthesize the toxicological, clinical, and epidemiological evidence to determine whether PM and ozone are causally related to an array of adverse human health outcomes associated with either acute (i.e., hours or days-long) or chronic (i.e., years-long) exposure; for each outcome, the ISA reports this relationship to be causal, likely to be causal, suggestive of a causal relationship, inadequate to infer a causal relationship or not likely to be a causal relationship. The ISAs reflect the Agency most up-to-date evaluation of the strength and limitations of the available scientific evidence, and clearly identify the health and welfare endpoints for which the evidence is strongest. The Agency continues to focus on these endpoints in considering how regulatory actions may impact public health and welfare. Historically, the Agency has estimated the incidence of air pollution effects for those health endpoints that the ISA classified as either causal or likely-to-be-causal and these endpoints are shown in Table 3-1. The table below omits welfare effects such as acidification and nutrient enrichment.

Table 3-1 Health Effects of Ambient Ozone and $PM_{2.5}$

Category	Effect	Causal/Likely-to-be-causal	More Information
Premature mortality from exposure to $PM_{2.5}$	Adult premature mortality based on cohort study estimates and expert elicitation estimates (age 65-99 or age 30-99)	✓	PM ISA
	Infant mortality (age <1)	✓	PM ISA
Nonfatal morbidity from exposure to $PM_{2.5}$	Heart attacks (age > 18)	✓	PM ISA
	Hospital admissions—cardiovascular (ages 65-99)	✓	PM ISA
	Emergency department visits— cardiovascular (age 0-99)	✓	PM ISA
	Hospital admissions—respiratory (ages 0-18 and 65-99)	✓	PM ISA
	Emergency room visits—respiratory (all ages)	✓	PM ISA
	Cardiac arrest (ages 0-99; excludes initial hospital and/or emergency department visits)	✓	PM ISA
	Stroke (ages 65-99)	✓	PM ISA
	Asthma onset (ages 0-17)	✓	PM ISA
	Asthma symptoms/exacerbation (6-17)	✓	PM ISA
	Lung cancer (ages 30-99)	✓	PM ISA
	Allergic rhinitis (hay fever) symptoms (ages 3-17)	✓	PM ISA
	Lost work days (age 18-65)	✓	PM ISA
	Minor restricted-activity days (age 18-65)	✓	PM ISA
	Hospital admissions—Alzheimer's disease (ages 65-99)	✓	PM ISA
	Hospital admissions—Parkinson's disease (ages 65-99)	✓	PM ISA
	Other cardiovascular effects	✓	PM ISA
	Other respiratory effects	✓	PM ISA
	Other nervous system effects	✓	PM ISA
	Cancer	✓	PM ISA
	Reproductive and developmental effects	—	PM ISA
	Metabolic effects	—	PM ISA
Mortality from exposure to ozone	Premature respiratory mortality based on short-term study estimates (0-99)	✓	Ozone ISA
	Premature respiratory mortality based on long-term study estimates (age 30–99)	✓	Ozone ISA
Nonfatal morbidity from exposure to ozone	Hospital admissions—respiratory (ages 0-99)	✓	Ozone ISA
	Emergency department visits—respiratory (ages 0-99)	✓	Ozone ISA
	Asthma onset (0-17)	✓	Ozone ISA
	Asthma symptoms/exacerbation (asthmatics age 2-17)	✓	Ozone ISA
	Allergic rhinitis (hay fever) symptoms (ages 3-17)	✓	Ozone ISA
	Minor restricted-activity days (age 18–65)	✓	Ozone ISA
	School absence days (age 5–17)	✓	Ozone ISA
	Metabolic effects (e.g., diabetes)	✓	Ozone ISA

For regulatory analyses, the Agency estimated changes in health effects in response to modeled air quality changes for each health endpoint identified as causal or likely-to-be-causal in Table 3-1. The environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE) software program was used to quantify counts of premature deaths and illnesses attributable to photochemical modeled changes in annual mean $PM_{2.5}$ and summer season average ozone. This approach to estimating health impacts involved two major steps: (1) developing spatial fields of air quality across the U.S. for the baseline and regulatory scenarios using nationwide photochemical source apportionment modeling and related analyses; and (2) using these spatial fields in BenMAP-CE to quantify selected endpoints under each scenario and each year as compared to the baseline in that year while accounting for the changes in population size, income growth, and baseline incidence and prevalence rates.

Figure 3-1 summarizes the key data inputs and modeling steps for estimating the health impacts of a regulatory impact analysis using $PM_{2.5}$ inputs as an example.

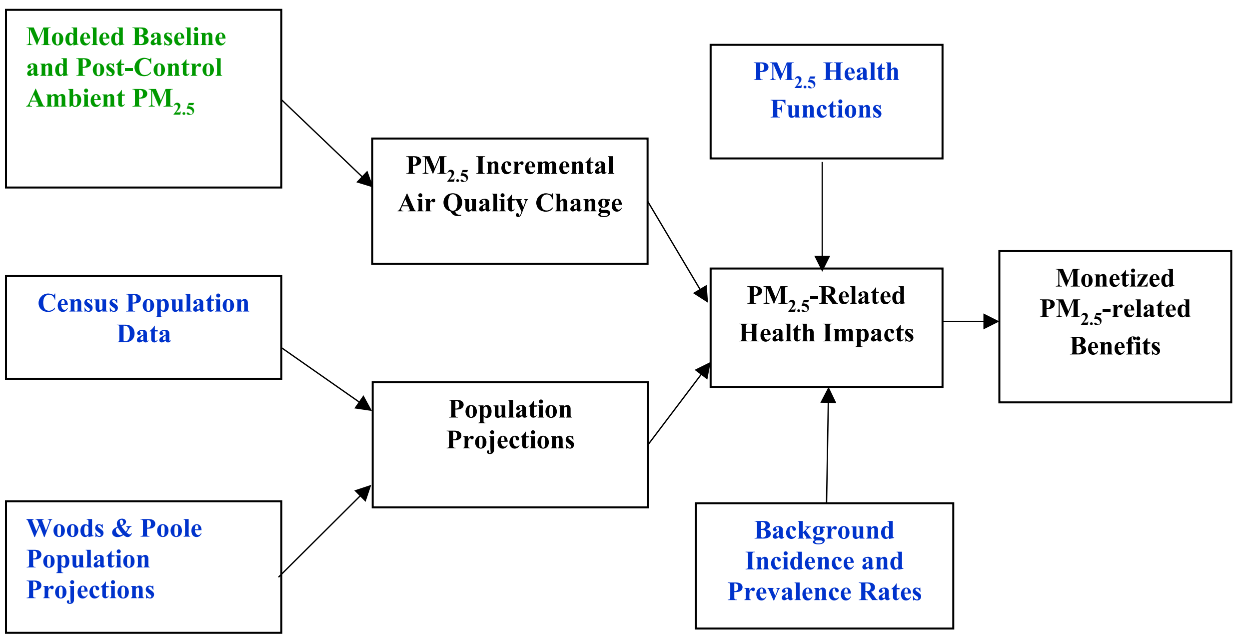

Figure 3-1 Data Inputs and Outputs for the BenMAP-CE Model Using $PM_{2.5}$ as an Example

As the diagram above illustrates, the approach for estimating $PM_{2.5}$ and O_3 benefits included health effect risk estimates from epidemiologic studies, population data, population growth estimates, economic data for monetizing risk reductions, and assumptions regarding the future state of the world (e.g., on-the-books regulations). Each of these inputs has unique uncertainties associated with it. When the uncertainties from each stage of the analysis are compounded, even small uncertainties can have large effects on the total quantified benefits. Where possible, the EPA in the past has attempted to quantitatively assess uncertainty in each input parameter. In some cases, quantitative analysis has not been possible due to lack of data, so the Agency instead characterized the sensitivity of the results to alternative plausible input parameters. And, for some inputs into the benefits analysis, such as the air quality data, we lacked the data to perform either a quantitative uncertainty analysis or sensitivity analysis.

Throughout prior regulatory impact analyses, the EPA acknowledged these significant uncertainties around input parameters and employed various techniques for characterizing the resulting uncertainty in estimates of regulatory impacts. For example, the Agency has estimated the fraction of avoided health effects occurring at various concentration ranges, conducted sensitivity analyses, and employed alternate concentration-response assumptions to show how much estimates could vary depending on which assumptions and inputs were used in primary estimates vs. sensitivity estimates.

Chapter 6 of the EPA Health Benefits TSD, Estimating PM2.5- and Ozone-Attributable Health Benefits: 2024 Update, details our approach to characterizing uncertainty associated with the estimation of $PM_{2.5}$ and O_3 benefits in both quantitative and qualitative terms (U.S.EPA, 2024). Some of the key types of uncertainty highlighted in this chapter include:

- Statistical uncertainty around the risk estimate
- Uncertainty around low concentration exposures and the potential for thresholds
- Uncertainty in exposure estimates
- Co-pollutant confounding
- Confounding by other individual risk factors
- Effect modification
- Application of risk estimates to other locations and populations
- Uncertainties regarding at-risk populations
- Baseline incidence rate uncertainties
- Economic valuation estimate uncertainties (e.g. income elasticity of willingness to pay, statistical estimates of VSL, Alzheimer's and Parkinson's onset lifetime costs)
- Unquantified uncertainties (e.g. causality determination, estimating and assigning exposures in epidemiology studies, risk attributable to long-term and short-term exposures, shape of the concentration-response relationship)

Despite substantial investments by the EPA in approaches to characterizing uncertainties, the regulatory impact analyses have still tended to focus on point estimates for PM2.5 and ozone-related benefits. Frequently, the Agency has utilized more than one epidemiologic study to estimate mortality impacts because these estimates drive overall benefits for a given regulatory action due to the large monetary value assigned to such impacts. Risk estimates using the top epidemiologic studies sometimes differ by a factor of two or more. Presenting multiple estimates drawn directly from the primary literature is one way to convey the prevailing uncertainty. While this leads to an estimated range of benefits, it is not a range that reflects the true uncertainties in the underlying parameters supporting each study, either for mortality or for other effects. Because of the significant impacts of environmental regulations on the U.S. economy, it is essential that the Agency have confidence in the estimated benefits of an action, and their underlying uncertainties, prior to utilizing these estimates in a regulatory context.

A 2024 Scientific Advisory Board reviewed EPA's methods for estimating the health effects of $PM_{2.5}$ and clearly and repeatedly recommended that EPA improve its approach to characterizing and presenting the uncertainty in estimating the health effects of $PM_{2.5}$.[37] A Tier 1 SAB recommendation was that the EPA present a single probabilistic mortality estimate based on pooled risk estimates with associated uncertainty ranges rather than present multiple estimates of mortality outcomes from the epidemiologic studies. EPA was encouraged to explore meta-analysis methods or other forms of information synthesis, and support research and development of modified methods as needed.

The OMB "2017 Report to Congress on the Benefits and Costs of Federal Regulations" listed six key assumptions underpinning $PM_{2.5}$ health effect estimation which introduce substantial uncertainties in the health effect estimates[38]:

1 That inhalation of fine particles is causally associated with premature death at concentrations near those experienced by most Americans on a daily basis;
2 That the concentration-response function for fine particles and premature mortality is approximately linear, even for concentrations below the levels established by the NAAQS;

[37] U.S. EPA. (2024). *Review of BenMAP and Benefits Methods.* (EPA/SAB/24/003). Washington DC: U.S. Environmental Protection Agency. Available at: https://sab.epa.gov/ords/sab/r/sab_apex/sab/advisoryactivitydetail?p18_id=2617&clear=18&session=15054897040198#report.

[38] See the OMB's "2017 Report to Congress on Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act" for a fuller discussion on uncertainties. Available at https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/12/2019-CATS-5885-REV_DOC-2017Cost_BenefitReport11_18_2019.docx.pdf.

3 That all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality;
4 That the forecasts for future emissions and associated air quality modeling accurately predict both the baseline (state of the world absent a rule) and the air quality impacts of the rule being analyzed;
5 That BPT approaches, when used to estimate benefits, are based on regional or national-level analysis that may not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors; and
6 That the estimated value of mortality risk reductions is an accurate reflection of what people would be willing to pay for incremental reductions in mortality risk from air pollution exposure, and that these values are constant across the life-cycle.

To the extent that any of these assumptions is incorrect, the benefit estimates will change, though the magnitude and direction of change are not known with certainty. The EPA is interested in improving understanding in each of these six areas. EPA understands that additional research is needed, and will begin to develop approaches that reduce these uncertainties. The EPA will seek peer review for new methods developed from this work consistent with the OMB's Peer Review Guidance.[39]

In particular, the EPA is interested in reevaluating the validity of the approach for estimating the benefits of air quality improvements relative to the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and ozone. These standards, which have been set at a level which the Administrator judges to be requisite to protect public health or welfare with an adequate margin of safety, are widely understood to represent the divide between clean air and air with an unacceptable level of pollution. Even in instances where an assumption is found to be justified based on scientific evidence, the EPA is interested in reevaluating its approach to characterizing and communicating underlying uncertainty to the public.

In the past, the EPA has explored a variety of approaches to shed light on how the estimated benefits of an action relate to the level of the NAAQS. For example, in estimating PM benefits, the Agency has employed techniques such as cutpoint analyses and Lowest Measured Level analyses, noting that we are most confident in the magnitude of the risks we project at $PM_{2.5}$ concentrations that coincide with the bulk of the observed $PM_{2.5}$ concentrations in the epidemiological studies that are used to estimate the benefits (Regulatory Impact Analysis for the

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[39] OMB (2005). *Memorandum M-05-03, Memorandum for the Heads of Executive Departments and Agencies: Issuance of OMB's Final Information Quality Bulletin for Peer Review*. Available at: https://www.federalregister.gov/documents/2005/01/14/05-769/final-information-quality-bulletin-for-peer-review.

Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units, Section 4.4.4, p. 4-26). However, such approaches address only a few of the sources of uncertainty that influence PM-related air quality benefits.

The limitations of reduced-form approaches, such as the BPT approach are even more pronounced than photochemical modeling/BenMAP-CE approaches due to:1) the compounding effects of emissions reductions typically occurring across many geographic areas simultaneously, with varying proximity to population centers; 2) differing atmospheric transformation pathways for nitrous oxides (NO_x), volatile organic compounds (VOCs), and secondary $PM_{2.5}$; and 3) region-specific photochemical and meteorological conditions. Using a national BPT estimate implicitly assumes uniform marginal health benefits for each ton of reduced emissions, an assumption not supported given heterogeneity in exposure patterns and atmospheric chemistry. As more areas achieve or maintain attainment with the NAAQS, the uncertainties associated with low-concentration health effects grow, and marginal benefits become more difficult to characterize with precision.

Therefore, it may be appropriate for the EPA to separate exposures and impacts above the level of the standard from those occurring at lower ambient concentrations. The EPA will investigate this prior to estimating these impacts in a regulatory analysis even for informational purposes.

3.3.1 Air Quality Modeling Methodology and Results for Ozone and $PM_{2.5}$

The Final Repeal influences the level of pollutants emitted in the atmosphere that adversely affect human health, including directly emitted $PM_{2.5}$, as well as SO_2 and NO_X, which are both precursors to ambient $PM_{2.5}$. NO_X emissions are also a precursor to ambient ground-level ozone. The EPA used air quality modeling to estimate changes in ozone and $PM_{2.5}$ concentrations that may occur as a result of the Final Repeal relative to the baseline (with MATS RTR).

As described in the Air Quality Modeling Appendix (Appendix A), gridded spatial fields of ozone and $PM_{2.5}$ concentrations representing the baseline (with MATS RTR) and Final Repeal were derived from CAMx source apportionment modeling in combination with NO_X, SO_2, and primary $PM_{2.5}$ EGU emissions obtained from the outputs of the IPM runs described in Section 2 of this RIA. While the air quality modeling includes all inventoried pollution sources in the contiguous U.S., contributions from all sources other than EGUs are held constant at 2022 levels in this analysis, and the only changes quantified between the baseline (with MATS RTR) and the Final Repeal are those associated with the projected impacts of this Final Repeal on EGU emissions. The EPA prepared gridded spatial fields of air quality for the Baseline (with MATS RTR) and the Final Repeal for two air quality metrics: annual mean $PM_{2.5}$ and April through September seasonal average eight-hour daily maximum (MDA8) ozone (AS-MO3).

The basic methodology for determining air quality changes is the same as that used in the RIAs from multiple previous rules (e.g., U.S. EPA, 2019b, 2020c, 2020d, 2021, 2022a). The Air Quality Modeling Appendix (Appendix A) provides additional details on the air quality modeling and the methodologies EPA used to develop gridded spatial fields of summertime ozone and annual $PM_{2.5}$ concentrations. The appendix also provides figures showing the geographical distribution of air quality changes. The air quality results include some locations with ASM-O3 increases and others with ASM-O3 decreases although all changes are small with the largest increases in the range of 0.01 ppb and the largest decreases in the range of 0.02 ppb across all locations and snapshot years. Additionally, there are small increases in $PM_{2.5}$ concentration as a result of the Final Repeal in 2028 and 2035 and both small increases and small decreases in $PM_{2.5}$ as a result of the Final Repeal in 2030. The largest $PM_{2.5}$ increases are in the range of 0.1 µg/m3 and the largest decreases in the range of 0.02 µg/m3 across all locations and snapshot years. Appendix A also includes figures demonstrating the change in the Baseline (with MATS RTR) and Final Repeal scenarios compared to recent 2022 conditions. All ASM-O3 and $PM_{2.5}$ differences between Baseline (with MATS RTR) and Final Repeal scenarios are dwarfed by the estimated decreases since 2022.

3.3.2 Human Health Effects

The human health effects of changes in emissions of directly emitted $PM_{2.5}$, as well as NO_X and SO_2 (which are both precursors to ambient $PM_{2.5}$), and ground-level ozone resulting from NO_x and VOC emissions, were not quantified for this rule. A qualitative description of related human health effects is provided instead.

3.3.2.1 NO_X-Related Health Effects

The Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (NO_X ISA) reviewed evidence from epidemiologic and laboratory studies on the health effects of exposure to NO_X, concluding that there is a likely causal relationship between respiratory health effects and short-term exposure to NO_2 (U.S. EPA, 2016). Epidemiologic and experimental studies encompassed several endpoints including emergency department visits and hospitalizations, respiratory symptoms, airway hyperresponsiveness, airway inflammation, and lung function. The NO_X ISA also concluded that the relationship between short-term NO_2 exposure and premature mortality was "suggestive but not sufficient to infer a causal relationship," because it is difficult to attribute the mortality risk effects to NO_2 alone. Although the NO_X ISA stated that studies consistently reported a relationship between NO_2 exposure and mortality, the effect was generally smaller than that for other pollutants such as PM. NO_X emissions are also a precursor to fine particulate matter ($PM_{2.5}$) and ozone and may affect human health through these additional pathways.

3.3.2.2 SO_2-Related Health Effects

The Integrated Science Assessment for Oxides of Sulfur – Health Criteria (SO_2 ISA) reviewed evidence from epidemiologic and laboratory studies on health effects of exposure to SO_2, concluding that there is a causal relationship between respiratory health effects and short-term exposure to SO_2. The immediate effect of SO_2 on the respiratory system in humans is bronchoconstriction. Asthmatics are more sensitive to the effects of SO_2 likely resulting from pre-existing inflammation associated with this disease. A clear concentration-response relationship has been demonstrated in laboratory studies following exposures to SO_2 at concentrations between 20 and 100 ppb, both in terms of increasing severity of effect and percentage of asthmatics adversely affected. Based on the EPA's review of this information, we identified three short-term morbidity endpoints that the SO_2 ISA identified as a "causal relationship": asthma exacerbation, respiratory-related emergency department visits, and respiratory-related hospitalizations. The differing evidence and associated strength of the evidence for these different effects is described in detail in the SO_2 ISA. The SO_2 ISA also concluded that the relationship between short-term SO_2 exposure and premature mortality was "suggestive of a causal relationship" because it is difficult to attribute the mortality risk effects to SO_2 alone. Although the SO_2 ISA stated that studies are generally consistent in reporting a relationship between SO_2 exposure and mortality, there was a lack of robustness of the observed associations to adjustment for other pollutants. SO_2 emissions are also a precursor to fine particulate matter ($PM_{2.5}$) and may affect human health through this additional pathway.

3.3.2.3 Ozone-Related Health Effects

Following a comprehensive review of toxicological, clinical, and epidemiological evidence, the Integrated Science Assessment for Ozone and Related Photochemical Oxidants (Ozone ISA) (U.S. EPA, 2020a) found both short-term (i.e., less than one month) and long-term (i.e., one month or longer) ozone exposure to be related to an array of adverse human health effects. For each effect, the Ozone ISA reports relationships to be causal, likely to be causal, suggestive of a causal relationship, inadequate to infer a causal relationship, or not likely to be a causal relationship. This assessment is based on the body of scientific evidence which can include observational human studies, experimental human exposure studies, animal model studies, and mechanistic studies.

The Ozone ISA found short-term exposure to ozone to be causally related to respiratory effects, including respiratory mortality, and likely to be causally related to metabolic effects. For short-term exposure, evidence was suggestive of a causal relationship for cardiovascular and nervous system effects as well as total mortality. The Ozone ISA reported that long-term exposure to ozone is likely-to-be-causally related to respiratory effects, including respiratory mortality. Evidence on metabolic, cardiovascular, reproductive, and nervous system effects as well as total mortality was suggestive of a causal relationship with long-term ozone exposure.

When adequate data and resources are available, the EPA has generally quantified health effects which the Ozone ISA classified as causally related or likely-to-be-causally related to short- or long-term ozone exposure. Health effects classified as suggestive-of-causality or weaker have not historically been quantified. Historically quantified health effects include premature respiratory mortality, hospital admissions and emergency department visits, asthma onset and related symptoms (chest tightness, cough, shortness of breath, and wheeze), allergic rhinitis symptoms, as well as restricted activity days and school absences. The EPA did not quantify or monetize the benefits or disbenefits associated with changes in the incidence of the listed health effects of this rule.

3.3.2.4 $PM_{2.5}$-Related Health Effects

$PM_{2.5}$ describes an array of pollutants from human and natural sources with diameters that are generally 2.5 micrometers and smaller. This includes directly emitted $PM_{2.5}$ as well as $PM_{2.5}$ formed through atmospheric chemical reactions of precursor pollutants including NO_X and SO_2.

Following a comprehensive review of toxicological, clinical, and epidemiological evidence, the Integrated Science Assessment for Particulate Matter (PM ISA) (U.S. EPA, 2020a) and the Supplement to the Integrated Science Assessment for Particulate Matter (PM ISA Supplement) (U.S. EPA, 2022b) found $PM_{2.5}$ to be related to an array of adverse human health effects. For each effect, the PM ISA and PM ISA Supplement report relationships to be causal, likely to be causal, suggestive of a causal relationship, inadequate to infer a causal relationship, or not likely to be a causal relationship. This assessment is based on the body of scientific evidence which can include observational human studies, experimental human exposure studies, animal model studies, and mechanistic studies.

The PM ISA and PM ISA Supplement found acute and chronic exposures to $PM_{2.5}$ to be causally related to cardiovascular effects and total mortality (*i.e.*, premature death), and respiratory effects as likely-to-be-causally related. Chronic exposures to $PM_{2.5}$ were also determined to be likely-to-be-causally related to nervous system effects and cancer, with the latter determination based primarily on evidence from studies of lung cancer incidence as well as decades of research on the mutagenicity and carcinogenicity of PM. Evidence was suggestive of a causal relationship for reproductive and developmental effects, pregnancy and birth outcomes, and metabolic effects.

When adequate data and resources are available, the EPA has generally quantified health effects which the PM ISA and PM ISA Supplement classified as causally related or likely-to-be-causally related to $PM_{2.5}$ exposure. Health effects classified as suggestive-of-causality or weaker have not historically been quantified. Historically quantified health effects include premature mortality, heart attacks, cardiovascular hospital admissions, cardiovascular emergency department visits, respiratory hospital admissions, respiratory emergency room visits, cardiac arrest, stroke, asthma onset, asthma symptoms/exacerbation, lung cancer, allergic rhinitis (hay fever) symptoms, lost workdays, and minor restricted-activity days. The EPA did not quantify or monetize the benefits or disbenefits associated with changes in the incidence of the listed health effects for this rule.

3.3.3 Welfare Benefits

The economic justification for regulatory actions targeting reductions in emissions of air pollutants generally follows that the regulation mandates the subject of such actions to internalize unpriced social costs, or "negative externalities." Cost analyses therefore explore the magnitude and incidence of compliance costs, such as by capital investment borne by producers or via increased market prices, while benefits analyses provide reference points for determining whether a regulation is efficient to the extent that it results in greater benefits from improved air quality than the costs that society must pay. Due to operational constraints and data limitations, most benefits analyses focus on human health effects expected to occur because of changes in primary and secondary pollutant concentrations resulting from the rulemaking; however, the benefits of reductions in emissions of air pollutants include additional effects that, unlike costs, extend beyond direct impacts to economic interests.

The Clean Air Act encourages consideration of the welfare effects of air pollutants, which it defines as including, but not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other pollutants (42 U.S.C. §7602(h)). In this section, we provide qualitative discussions of select welfare effects.

3.3.4 Ozone Welfare Effects

3.3.4.1 Vegetation and Ecosystem Effects

Exposure to ozone has been found to be associated with a wide array of vegetation and ecosystem effects in the published literature (U.S. EPA, 2020a). Sensitivity to ozone is highly variable across species, with over 66 vegetation species identified as "ozone-sensitive," many of which occur in state and national parks and forests. These effects include those that cause damage to, or impairment of, the intended use of the plant or ecosystem. Such effects are considered adverse to public welfare and can include reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changes to species composition, and changes in ecosystems and associated ecosystem services (U.S. EPA, 2020a).

3.3.4.2 Animal Welfare Effects

While effects can be context- and species-specific, a large body of scientific evidence links ozone exposure to health effects in animals. When exploring environmental pathways through which environmental effects of ozone may impact animals, the Ozone ISA found a likely-to-be-causal relationship between ambient ozone concentrations and alterations of herbivore growth and reproduction (U.S. EPA, 2020a, Girón-Calva et al. 2016, Habeck and Lindroth, 2013, Hong et al., 2016, Ueno et al., 2016). In addition, many animal toxicological studies served as evidence for determining the causality of relationships between human exposure to ozone and human health effects, including respiratory and metabolic effects. The Ozone ISA states, "A large body of experimental animal toxicological studies demonstrates (short- and long-term) ozone-induced changes in measures of lung function, inflammation, increased airway responsiveness, and impaired lung host defense" (U.S. EPA, 2020a). Additionally, animal studies report relationships between short-term ozone exposure and metabolic effects in various stocks and strains of animals across multiple laboratories (U.S. EPA, 2020a, Gordon et al., 2017, Miller et al., 2015, Ying et al., 2016,).

3.3.5 $PM_{2.5}$ Effects

3.3.5.1 Visibility Effects

Reducing secondary formation of $PM_{2.5}$ would improve levels of visibility in the U.S. because suspended particles and gases degrade visibility by scattering and absorbing light (U.S.

EPA, 2019a). Fine particles with significant light-extinction efficiencies include sulfates, nitrates, organic carbon, elemental carbon, and soil. Visibility has direct significance to people's enjoyment of daily activities and their overall sense of wellbeing. Good visibility increases the quality of life where individuals live and work, and where they engage in recreational activities. Particulate sulfate is the dominant source of regional haze in the eastern U.S. and particulate nitrate is an important contributor to light extinction in California (U.S. EPA, 2019a). Previous analyses such as U.S. EPA (2012) show that visibility benefits can be a significant welfare benefit category.

3.3.5.2 Animal Welfare Effects

While effects can be context- and species-specific, a large body of scientific evidence links $PM_{2.5}$ exposure to health effects in animals. The PM ISA (U.S. EPA, 2019a) and PM ISA Supplement (U.S. EPA, 2022b) evaluated relationships exposures to $PM_{2.5}$ and an array of health markers described in animal toxicological studies. Animal toxicological studies have found evidence that $PM_{2.5}$ induces changes in measurements including but not limited to breathing patterns (Diaz et al., 2013), airway irritation (Nikolov et al., 2008), impaired heart function (Kurhanewicz et al., 2014), changes in blood pressure (Wagner et a., 2014), oxidative stress (Ghelfi et al., 2010, Davel et al., 2012), reproductive outcomes (Pires et al., 2011, Veras et al. 2012, de Melo et al., 2015), and other outcomes (U.S. EPA, 2019a; U.S. EPA, 2022b). However, neither the PM ISA nor the PM ISA Supplement provide a causality determination of the causality of $PM_{2.5}$ affecting animal health.

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4 SOCIAL COSTS AND ECONOMIC IMPACTS

This section discusses potential energy market impacts, economy-wide social costs and economic impacts, small entity impacts, and labor impacts associated with this action. The social cost and economy-wide impacts are estimated using EPA's SAGE model. Note that SAGE does not currently estimate changes in emissions nor account for environmental impacts resulting from this action. For additional discussion of impacts on fuel use and electricity prices, see Section 2.

4.1 Energy Market Impacts

The energy sector impacts presented in Section 2 of this RIA include potential changes in the prices for electricity (the change in retail electricity prices reported here is a national average across residential, commercial, and industrial consumers), natural gas, and coal resulting from this action. Table 4-1 summarizes the impact of these potential changes on other markets. We refer to these changes as secondary market impacts.

Table 4-1 Summary of Certain Energy Market Impacts

	2028	2030	2035
Retail electricity prices	0.0%	0.0%	0.0%
Average price of coal delivered to the power sector	0.0%	0.2%	0.2%
Coal production for power sector use	0.0%	0.1%	0.3%
Price of natural gas delivered to power sector	0.0%	0.0%	0.0%
Price of average Henry Hub (spot)	0.0%	0.0%	0.0%
Natural gas use for electricity generation	0.0%	0.0%	0.0%

4.2 Economy-wide Social Costs and Economic Impacts

This section analyzes the potential economy-wide impacts of the final Repeal of Amendments to National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units using a computable general equilibrium (CGE) model. CGE models are designed to capture substitution possibilities between production, consumption, and trade; interactions between economic sectors; and interactions between a policy shock and pre-existing market distortions, such as taxes that have altered consumption, investment, and labor decisions. As such, CGE models can provide insights into the effects of regulation that occur outside of the directly regulated sector because they are able to represent the entire economy in equilibrium in the baseline and under a regulatory or policy scenario. A CGE model can also be used to estimate the positive or negative social costs of a regulatory or deregulatory action, respectively.

4.2.1 Economy-wide Modelling

In 2015, EPA formed a Science Advisory Board (SAB) panel to explore the use of general equilibrium approaches, and more specifically CGE models, to prospectively evaluate the costs, benefits, and economic impacts of environmental regulation. In its final report, the SAB recommended that the Agency enhance its regulatory analyses using CGE models "to offer a more comprehensive assessment of the benefits and costs" of regulatory actions by capturing important interactions between markets and that such efforts are most informative when there are both significant cross-price effects and pre-existing distortions in those markets (U.S. EPA Science Advisory Board, 2017).[40] Given the typical level of aggregation in CGE models and their focus on long run equilibria, the panel observed that CGE modeling results are complements to, rather than substitutes for, the other types of detailed analysis EPA conducts for its rulemakings. The report also noted that CGE frameworks offer valuable insights into the social costs of regulation even when estimates of the benefits (e.g., monetized health effects) of the regulation are not incorporated into the models, though it highlighted explicit treatment of benefits within a CGE framework as a long-term research priority. In addition, the panel observed that CGE models may also offer insights into the ways costs are distributed across regions, sectors, or households.

In response, EPA has invested in building capacity in this class of economy-wide modeling. A key outcome of this effort is EPA's CGE model of the U.S. economy, called SAGE (SAGE is an Applied General Equilibrium). The SAGE model can provide an important complement to the analyses typically performed during regulatory development by evaluating a

[40] CGE models provide "a fiscally disciplined, consistent and comprehensive accounting framework. They can ensure that projected behavior of firms and households in a regulated market is fully consistent with the behavior of those agents in other markets. Consistent representation of behavior, in turn, leads to connections between markets, allowing CGE models to pick up effects that spill over from one market to another" (U.S. EPA SAB, 2017).

broader set of economic impacts and offering an economy-wide estimate of social costs.[41] For this analysis, we use version 2.1.1 of EPA's SAGE model (Marten et al., 2024). As discussed in EPA's *Guidelines for Preparing Economic Analyses*, social costs are the total economic burden of a regulatory action (U.S. EPA, 2024). This burden is the sum of all opportunity costs incurred due to the regulatory action, where an opportunity cost is the value lost to society of any goods and services that will not be produced and consumed because of reallocating some resources towards pollution mitigation.

4.2.2 Overview of the SAGE CGE Model

SAGE is a CGE model that provides a complete, but relatively aggregated, representation of the entire U.S. economy. CGE models assume that for some discrete period of time an economy can be characterized by a set of conditions in which supply equals demand in all markets (referred to as equilibrium). When the imposition of a regulation alters conditions in one or more markets, the CGE model estimates a new set of relative prices and quantities for all markets that return the economy to a new equilibrium.[42] For example, the model estimates changes in relative prices and quantities for sector outputs and household consumption of goods, services, and leisure that allow the economy to return to equilibrium after the regulatory intervention. In addition, the model estimates a new set of relative prices and demand for factors of production (e.g., labor, capital, and land) consistent with the new equilibrium, which in turn determines estimates of household income changes as a result of the regulation (Marten et al., 2024). In CGE models, the social cost of the regulation is estimated as the change in economic welfare in the post-regulation simulated equilibrium from the pre-regulation equilibrium (i.e., the baseline).

Unlike engineering cost or partial equilibrium approaches typically used to evaluate the costs of regulations, CGE models account for how effects in directly regulated sectors interact

[41] CGE models may also be able to provide additional information on the benefits of regulatory interventions, though this is a relatively new but active area of research. Note that until the benefits that accrue to society from mitigating environmental externalities can be incorporated in a CGE model, the economic welfare measure from the CGE model is incomplete and needs to be augmented with traditional benefits analysis to develop measures of net benefits.

[42] CGE models are generally focused on analyzing medium- or long-run policy effects since they characterize the new equilibrium (i.e., when supply once again equals demand in all markets). Their ability to capture the transition path of the economy depends on the degree to which they include characteristics of the economy that restrict its ability to adjust instantaneously (e.g., rigidities in capital markets and frictions in labor markets).

with and affect the behavior of other sectors and consumers. The SAGE model includes explicit subnational regional representation within the U.S. at the Census Region level. Each region contains a representative firm for each of the 23 sectors in the model that vary by the commodity they produce and have region-specific production technologies. Each region also has five representative households that vary by income level and have region-specific preferences. Within the economy, households and firms are assumed to interact in perfectly competitive markets. In addition to households and firms, there is a single government in SAGE that represents all state, local and federal governments within the U.S. The government imposes taxes on capital earnings, labor earnings, and production and uses that revenue (in addition to deficit spending) to provide government services, make transfer payments to households, and pay interest on government debt. Table 4-2 summarizes the dimensions of the SAGE model.

Table 4-2 SAGE Dimensional Details

Time Periods	Sectors	Census Regions	Households (income)	Capital Vintage
2016-2081 (5-year time steps)	Agriculture, forestry, fishing, and hunting Crude oil Coal mining Metal ore and nonmetallic mineral mining Electric power Natural gas Water, sewage, and other utilities Construction Food and beverage manufacturing Wood product manufacturing Petroleum refineries Chemical manufacturing Plastics and rubber products manufacturing Cement manufacturing Primary metal manufacturing Fabricated metal product manufacturing Electronics and technology manufacturing Transportation equipment manufacturing Other manufacturing Transportation Truck transportation Services Healthcare services	Northeast South Midwest West	<30k 30-50k 50-70k 70-150k >150k	Extant New

To capture domestic and international trade the model's structure accounts for the possibility that the U.S. can be both an importer and an exporter of the same good. SAGE addresses this possibility through use of the "Armington" approach, which assumes that imported and exported versions of the same good are not perfect substitutes. In SAGE, this assumption is applied to both international and cross-regional trade within the United States. In addition, SAGE recognizes that the U.S. is a relatively large part of the global economy and shifts in its imports and exports have the potential to influence world prices (i.e., the model assumes the U.S. is a large, open economy).

SAGE is a forward-looking intertemporal model, which means that the model assumes households and firms take into account what is expected to occur in future years and how current decisions will impact those outcomes when making their decisions. In an intertemporal model, care is needed to ensure that, in response to a new policy, the economy does not instantaneously jump to a new equilibrium in a way that is inconsistent with the rate at which the economy can realistically adjust. SAGE seeks to model a more realistic transition path, in part, by distinguishing between existing capital constructed in response to previous investments and new capital constructed after the start of the model's simulation. Existing capital is assumed to be relatively inflexible in that it can only be used for its original purpose unless a relatively high cost is incurred to alter its functionality. New capital is more flexible and can be adjusted to changes in the future. Independent of its vintage, once capital has been constructed in a specific region it cannot be moved to another region. While physical capital is not mobile, households can make investments in any region of the country.

The dynamics of the baseline economy in SAGE are informed through the calibration of key exogenous parameters in the model, including population and productivity growth over time. The model reflects heterogeneity in productivity growth across sectors of the economy consistent with trends that have been historically observed. In addition, the model captures improvements in energy efficiency that are expected for firms and households going forward. Additional baseline characteristics, such as changes to government spending and deficits and changes to international flows of money and investments, are calibrated to key government forecasts or informed by historical trends.

The SAGE model relies on many data sources to calibrate its parameters. The foundation is a state-level dataset produced by IMPLAN that describes the interrelated flows of market goods and factors of production over the course of a year with a high level of sectoral detail.[43] This dataset is augmented by information from other sources, such as the Bureau of Economic Analysis, Energy Information Administration, Federal Reserve, Internal Revenue Service, Congressional Budget Office, and the National Bureau of Economic Research. The result is a static dataset that describes the structure and behavior of the economy in a single year.[44] These

[43] The IMPLAN data is a constructed dataset based on several publicly available sources of information including the Bureau of Economic Analysis' Use and Supply tables, the National Income and Product Accounts, and several others. While the underlying IMPLAN data are proprietary, EPA provides the social accounting matrix based on these data in the publicly available version of SAGE. The data set for the model may also be built anew by following the instructions in the model documentation along with a licensed version of IMPLAN (www.IMPLAN.com).
[44] SAGE is solved using the General Algebraic Modeling System (GAMS) and PATH solver. The model's build stream is written in both R and GAMS.

data are combined with key behavioral parameters for firms and households that are adopted from the published literature or econometrically estimated specifically for the purposes of calibrating SAGE. To develop the forward-looking baseline for the model, additional information on key parameters, such as productivity growth, future government spending, and energy efficiency improvements are incorporated from sources including the Congressional Budget Office and Energy Information Administration.

To ensure that SAGE is consistent with economic theory and reflects the latest science, EPA initiated a separate SAB panel to conduct a technical review of SAGE (U.S. EPA Science Advisory Board, 2020). Peer review of SAGE was in accordance with requirements in OMB guidelines (OMB, 2004) for influential scientific documents. The SAB report commended the agency on its development of SAGE, calling it a well-designed open-source model. The report included recommendations for refining and improving the model, including several changes that the SAB advised EPA to incorporate before using the model in regulatory analysis (denoted as Tier 1 recommendations by the SAB). The SAB's Tier 1 recommendations, including improving the calibration of government expenditures and deficits and the foreign trade deficit; allowing for more flexibility in the consumer demand system; and representing the United States as a large open economy, are incorporated into the model version used in this analysis (v2.1.1), as are several of the SAB's other medium- and long-run recommendations. For more details on the SAGE model, complete documentation, source code and build stream are available on EPA’s website.[45]

4.2.3 Linking IPM Partial Equilibrium Model to SAGE CGE Model

The SAB noted that electricity sector regulations are a suitable candidate for economy-wide modeling because of the many linkages that may result in effects in other sectors in the economy (SAB, 2017). For example, changes in the price of electricity can affect its use in the production of other goods and services. There may also be impacts to upstream industries that supply goods and services to the electricity sector (e.g., energy commodities), labor markets in response to changes in factor prices, and household demand due to changes in the end-use price of electricity. For this analysis, EPA has relied on the IPM, a partial equilibrium large-scale

[45] https://www.epa.gov/environmental-economics/cge-modeling-regulatory-analysis

linear programming model, to assess the costs of compliance in the power sector and related energy markets (see Section 2.3 for more details on the use of IPM).

The following subsections explain the methodology for linking SAGE and IPM, particularly the details relevant to the specific context of this finalized repeal. For example, SAGE does not include an explicit representation of recent legislation, such as the Inflation Reduction Act of 2022 (IRA) and the One Big Beautiful Bill Act of 2025 (OBBBA). Therefore, the model linkage methodology accounts for tax and subsidy payments from investment and production tax credits (i.e., 45Y, 48E, and 45Q) that are not represented in the default tax and subsidy structure in the model. Schreiber et al. (2023) and Schreiber et al. (2025) include a detailed description of how the models are linked.

4.2.3.1 Compliance Costs and Social Costs

As described in Section 2.3, for the baseline and final repeal scenario, IPM solves for the least-cost approach to meet fixed electricity demand based on highly detailed information about electricity generation, air pollution control technologies, and primary energy market conditions (coal and natural gas) while satisfying regulatory requirements, resource adequacy, and other constraints in the electricity sector. Potential effects outside of the electricity, coal, and natural gas sectors are not evaluated within IPM. Electricity demand is fixed such that the quantity demanded is unchanged between the baseline and policy case. IPM estimates changes in compliance costs as the changes in expenditures by the power sector to achieve and maintain compliance with the current rules in the baseline relative to a policy case with certain rules removed or included.

Specifically, IPM minimizes system cost, which is the sum of the total amortized payments to electricity-generating, pollution control, and transmission investments, delivered fuel costs, total variable and fixed operating and maintenance (O&M) costs, and expenditures on pollution transportation and storage, subject to regulatory and other constraints:[46]

[46] For further details on IPM's objective function and model formulation, see Chapter 2, and in particular Section 2.2, of the IPM documentation. Documentation available at: https://www.epa.gov/power-sector-modeling/2025-reference-case.available at /2025-reference-case. IPM's objective function also accounts for energy and capacity payments for transmission, which accounts for the cost of constructing new transmission. Projected changes in capital expenditures on transmission from IPM are also accounted for in the SAGE analysis.

(system cost) = (amortized payments to capital) + (delivered fuel costs) + (O&M costs) + (expenditures on pollution transport and storage)

Note that system costs include transfers. For example, amortized payments to capital are inclusive of corporate, state, and local taxes, investment tax credits, and interest payments. Similarly, expenditures on pollution transport and storage account for the value of 45Q tax credits.[47] This allows IPM to account for transfers, including taxes and subsidies (e.g., IRA and OBBBA tax credits) that may target specific technologies and influence their adoption when modeling generation and investment decisions.[48]

System costs can be expressed in an alternative but equivalent way as the sum of expenditures on real resources plus taxes and interest payments less subsidies received:

(system cost) = (real resource expenditures) + (taxes) + (interest payments) – (subsidies)

Real resource expenditures are the expenditures on inputs required to produce electricity (e.g., labor, materials, fuel), less any transfer payments, as estimated by the IPM model:

(real resource expenditures) = (real capital expenditures) + (fuel expenditures) + (O&M expenditures) + (pollution transportation and storage input expenditures)

As described below, SAGE estimates the economy-wide impacts of the final repeal using the estimated change in real resource expenditures by the electricity sector, which is the compliance cost estimate from IPM excluding transfers. This allows SAGE to capture the expected change in the electricity sector's demand for these real resources due to the policy.

To determine the real resource expenditures, the estimates of system costs are separated into their constituent components, to the extent feasible. For example, the real capital expenditures are calculated as the amortized payment on capital excluding corporate, state, and local taxes, interest payments, and tax credits for battery storage. The pollution transportation

[47] Specifically, pollution transportation and storage costs include costs for transporting captured CO_2 to injection sites and storing it at these sites net of tax credits for carbon storage (i.e., 45Q) and revenues earned from selling CO_2 for enhanced oil recovery (EOR). While revenues from EOR are not explicitly represented in the expressions here, the approach to linking IPM results to SAGE accounts for the value of the change in CO_2 provided for EOR between the baseline and policy scenarios. For further details, see Chapter 6 of the IPM documentation available at: https://www.epa.gov/power-sector-modeling/2025-reference-case.available at /2025-reference-case.

[48] See Section 2 and IPM documentation for further discussion of the representation of the IRA and OBBBA in IPM, fuel and technology cost assumptions, and related uncertainties.

and storage input expenditures are calculated as the expenditures on pollution transport and storage excluding the value of 45Q credits and EOR revenues. As described below, SAGE also uses the estimated incremental subsidies from IPM to capture their effect on electricity prices (i.e., the output margin).

The estimated compliance costs from IPM differ from the social costs of this repeal for several reasons. First, the estimated compliance costs from IPM include changes beyond real resources costs, specifically transfers that should be excluded from an estimate of social costs. Second, the compliance cost estimates from IPM do not account for all relevant margins of substitution that the economy may use to respond to the final repeal (e.g., quantity of electricity demanded).[49] Third, the compliance cost estimates from IPM do not account for the possibility of significant cross-price effects and interactions with other pre-existing market distortions elsewhere in the economy. Fourth, the compliance cost estimates from IPM do not account for reallocation across sectors, potential reductions in aggregate investment, or the resulting effects on economic growth. By construction, SAGE explicitly allows for these possible responses and is therefore used to estimate social costs, while leveraging the insights that the detailed IPM provides on changes in compliance behavior and costs to the power sector from this final repeal.

4.2.3.2 Overview of the Linking Methodology

To model the economy-wide effects of the final repeal, we calibrate the SAGE model inputs that represent the impact of the final repeal. SAGE model inputs are calibrated such that sectoral costs in a corresponding partial equilibrium sub-model of SAGE (called SAGE-PE) align with the compliance costs (excluding transfers) derived from the technology-rich IPM. We then pass the calibrated inputs from SAGE-PE to the full SAGE model to obtain the full general equilibrium effects of the rule. This approach of aligning compliance costs between the two models allows us to avoid confounding the estimate of economy-wide effects with differences in the models' representations of sectors shared by both IPM and SAGE.[50] Care is given in

[49] In certain cases, such as when market prices are not expected to change meaningfully, a compliance cost estimate may provide a sufficient approximation of social costs. For this repeal, IPM estimates changes in prices in electricity, coal, and natural gas markets, and therefore, the compliance cost estimate may also differ meaningfully from a partial equilibrium estimate of social costs for these markets.

[50] The SAB (2017) noted that it will "often be necessary and appropriate for EPA to link a GE [general equilibrium] model having a modest degree of detail to one or more PE models having greater detail. Linked models will usually involve some degree of inconsistency in the definitions of overlapping variables and parameters, but that may be acceptable given the increased degree of detail that a linked analysis could provide."

translating IPM outputs for use in SAGE so that the two models adequately capture equivalent compliance costs.

Figure 4-1 provides an overview of the approach leveraging the IPM results to introduce the incremental changes in costs from the final repeal into the SAGE model. In the first step (characterized as Step 0), model differences in structure and accounting are reconciled by translating IPM incremental system costs to a format consistent with the SAGE framework. This includes aligning model years, distributing IPM costs to SAGE model inputs (by fuel, other materials, labor, and capital), attributing costs to production vintages, and removing transfer payments that may be important for IPM to capture investment behavior but inappropriate for inputs into SAGE as they would result in double counting.

The reconciled incremental costs are used to calibrate a representation of the final repeal in SAGE-PE, which is a partial equilibrium representation of the electricity sector (and related primary energy sectors, such as the coal mining and natural gas) as defined from SAGE that mimics the sectoral behavior of IPM, to the degree that is possible. While SAGE-PE does not have the technology detail of IPM, it captures aggregate endogenous responses in electricity and primary energy sector prices, input requirements, trade, and asset values of existing capital resources. SAGE-PE does not include aspects of the economy represented in the full SAGE model that are not captured in IPM. This means that market outcomes in sectors other than the electricity, coal mining and natural gas sectors, electricity demand, factor prices, and constraints on factor supply are all treated as exogenous in SAGE-PE.

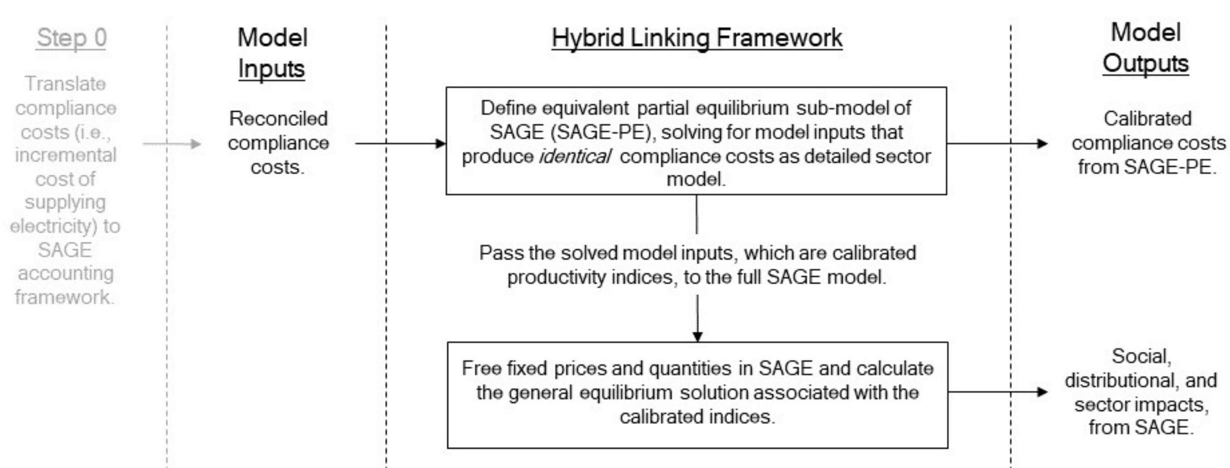

Figure 4-1 Hybrid Linkage Approach for IPM and SAGE

Because SAGE-PE is a sub-model of SAGE, most of its model equations are described in Marten et al. (2024). The subset of SAGE equations and variables that comprise SAGE-PE include conditional profit maximizing production behavior, sub-national and foreign trade, and market clearing conditions that equate supply and demand in the electricity, coal mining and natural gas sectors. As in SAGE, SAGE-PE models optimal behavior through a series of equilibrium conditions formulated as a mixed complementarity problem. Production and trade are characterized through zero profit conditions that require unit costs to be greater than or equal to unit revenues. Market clearing conditions that equate supply and demand for the electricity, coal mining and natural gas sectors determine their prices. A second set of market clearing conditions are used to determine prices in regional trade markets. SAGE-PE maintains an endogenous rental rate on extant capital to model the changes in the shadow value on existing capital stock.

A common way to represent an environmental regulation in a CGE model is through a productivity shock. This can be interpreted as requiring more inputs (e.g., control technologies) to produce the same amount of output but in compliance with the regulation. In the SAGE and SAGE-PE models, this is implemented through augmenting the reference productivity indices denominated by input (materials, fuels, labor, and capital) and is described in detail in the model documentation (Marten et al., 2024). The productivity shock is differentiated across model year, regions, sectors, and production vintages. In the baseline, all productivity indices are set to unity with the exception of those assigned to labor inputs which reflect projections of sector-differentiated labor productivity.[51]

To align SAGE with IPM, the productivity shock is calibrated so that the compliance costs are aligned between SAGE-PE and the IPM solution.[52] The incremental SAGE-PE costs are defined as the difference in production costs between the policy equilibrium and the baseline. The productivity shock is adjusted to equate SAGE-PE and IPM incremental costs. Because prices for factors and non-energy inputs are not endogenously determined in SAGE-PE the incremental input costs for factors and non-energy inputs are driven through quantity demand

[51] The SAGE model was modified to allow production with extant capital to require incremental new capital for compliance (e.g., pollution control retrofits, fuel switching). This modification is implemented by defining an additional productivity index associated with new capital demands in production with extant capital.
[52] The calibrated compliance costs, per Figure 4-1, can be calculated using code and data available in the docket.

changes for labor, new capital, and material inputs. Incremental costs for electricity, coal mining and natural gas inputs incorporate both changes in prices as well as input demand quantities.

Electricity production in SAGE-PE is exogenous except for adjustments necessary to satisfy reductions or increases in electricity input demands in the electricity sector and primary energy sectors in response to the final repeal. The calibrated productivity shock is then passed to the full SAGE model to generate social cost, distributional, and indirect impacts of the modeled policy, where model years 2026 and beyond are endogenously determined. See Schreiber et al. (2023) and Schreiber et al. (2025) for more details on the linking approach. In addition to the calibrated productivity parameters in the electricity sector, we separately represent changes in revenues from selling CO_2 for enhanced oil recovery from the final repeal as a Hicks-Neutral productivity shock in the crude oil extraction sector to account for the impact of changes in captured CO_2 being used in the production of crude oil as a result of the policy.

4.2.3.3 Translating IPM Outputs into SAGE Inputs

IPM produces detailed cost and emissions outputs by model plant, which are aggregate representations of unit-level information of existing generators or characterizations of new generators, and wholesale electricity price impacts by IPM region.[53] This detailed information is important for quantifying the sectoral compliance behavior attributed to a regulatory shock. However, to link IPM and SAGE to capture the broader economy-wide impacts, IPM costs need to be translated to SAGE factors and commodities. Table 4-3 summarizes the key dimensions of IPM used to calibrate the inputs for the SAGE model. Key variables include capital costs, fuel costs, and fixed and variable operations and maintenance costs. Capital costs are reported both as overnight capital costs and amortized capital payments. Overnight capital costs reflect the total value of the resources used to install a piece of capital "overnight," or without any financing costs associated with loan repayment. In reality, these expenditures are not paid immediately but rather spread out over a fixed time period with interest via amortized capital payments. The "cost" of capital in IPM is a combination of a rate of return, tax payments, and financing charges

[53] The reduced costs of adopting and operating fPM CEMS expected from this final rule are also accounted for when translating compliance cost outputs into SAGE inputs. The CEMS costs are treated as a reduction in fixed operating & maintenance in the translation.

(embodied in the CRF) and is used to amortize payments over the lifetime of the capital investment. Costs are further denominated by IPM region, fuel type, and generator vintage.

Table 4-3 IPM Cost Outputs

Time Periods	Cost Categories	IPM Regions	Generator Vintage
2028-2055	Overnight capital costs Amortized capital payments Fuel costs Fixed operations and maintenance costs Variable operations and maintenance costs	67 IPM Regions	Existing New

IPM incremental costs are translated into the SAGE framework by: (1) mapping IPM model years to SAGE model years;[54] (2) mapping IPM regions to SAGE regions; (3) splitting delivered fuel costs to separate transportation costs; (4) attributing a portion of total operations and maintenance costs to labor;[55] (5) mapping the remainder of total operations and maintenance costs to specific inputs in SAGE according to the reference cost structure in the model; (6) attributing incremental costs on existing and new generation to production with extant and new capital, respectively;[56] and (7) removing taxes and other transfers from capital payments using the difference between the capital charge rate and the CRF to recover the real resource costs associated with capital.

Aligning the SAGE model with IPM is complicated by the difference in how each model accounts for capital payments. First, taxes and transfers (e.g., finance payments) need to be removed from capital costs to recover the real resource requirements for inputs to SAGE.

[54] Because SAGE has a longer time horizon than IPM (to 2081), IPM incremental costs in 2055 are assumed to extend to 2061 and then fall to zero for the remainder of the model horizon. Since SAGE and IPM have different representative model years, we must also establish a mapping between IPM model years, SAGE model years, and calendar years. We have improved this methodology since proposal to ensure that the resources requirements used to calibrate the SAGE policy run preserve the present value of the real resource compliance cost estimates projected in IPM.

[55] Using information on existing capacity and generation from the Energy Information Administration, costs of operations and maintenance per unit of electricity from IPM, and employee compensation from the Quarterly Census for Employment and Wages produced by the Bureau of Labor Statistics, we find an average labor share of total operations and maintenance of 0.3 in the electricity sector.

[56] Production with extant and new capital is not equivalent to differentiating existing and new generation in the IPM modeling framework. For example, the lifespan of existing generators in IPM can be extended through investments in ways that are not directly comparable to production with extant capital in the SAGE model. In this analysis, we therefore apportion the impacts on existing generators from IPM to extant production and new production in SAGE based on the depreciation rate of capital in the SAGE model. Extant capital in SAGE is assumed to be relatively inflexible in its ability to accommodate changes in production processes when compared to new capital. Therefore, it is possible that the linked framework may over- or under-attribute incremental costs to less flexible production processes in SAGE.

Second, differences in representation of capital between the two models needs to be reconciled; SAGE accounts for capital as a cumulatively depreciated asset that represents the aggregate physical capital stock in the U.S., whereas IPM defines capital in the power sector with technology specific rates of depreciation. The models can be aligned by either targeting incremental overnight capital costs (e.g., the magnitude and timing of the resource change) or through targeting amortized capital payments. Because the accounting for capital is different between models, the former approach can lead to significant differences in capital payments between models. Therefore, the second approach is used to align incremental amortized payments to capital that exclude tax payments when calibrating the productivity shock. Because the representation of capital is different between the models, differences in induced investment in the capital stock from targeting consistent amortized payments can be thought of as a translation of payments (e.g., a means to translate a fixed term investment into a cumulatively depreciated asset).

Because SAGE does not explicitly represent investment and production tax credits that affect power sector investment, specifically the clean energy and 45Q credits, the model linkage methodology is adjusted to account for changes in the total value of these subsidies as a result of the regulation. The SAGE-PE model is calibrated to match both the real resource requirements for the expected compliance pathway and the impact of these subsidies on the compliance expenditure for the electricity sector. To accomplish this, the change in real resource requirements paid for by these subsidies are included in the incremental costs of the final repeal as described above (i.e., the incremental costs exclude subsidy payments).[57] To avoid overstating electricity price impacts and the associated social cost from changes in electricity prices, the net tax rate on electricity sector production is also adjusted within the calibration of the SAGE-PE model to reflect the expected change in these subsidy payments as a result of the policy. This approach allows the model to explicitly capture the private costs faced by the electricity sector, the upstream and downstream impacts of the resource requirements for the subsidized technologies and fuels, and changes to government budgets associated with the use of subsidies.

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[57] Clean energy tax credits are levied on capital whereas the 45Q subsidy is shared across inputs according to an assumed cost structure for carbon capture and storage based on a combination of both the natural gas extraction sector in the SAGE model and the cost structure of pipeline transportation from the Bureau of Economic Analysis. The adopted approach for modeling the costs of carbon capture and storage approximately align with information found in Ortiz et al. (2013) and McFarland and Herzog (2006).

The SAGE model is closed by assuming the government budget is balanced through lump sum transfers with households. Aggregate changes in government budgets can occur in model simulations due to changes in the use of the clean energy and 45Q tax credits and changes in revenues from other taxes (e.g., output, capital, and labor) as the economy adjusts in response to the final repeal.

4.2.4 Results

This section summarizes the estimated economy-wide impacts of the final repeal. SAGE model results include aggregate social costs, macroeconomic impacts, sectoral impacts, and distributional impacts. Note that SAGE does not currently estimate changes in emissions nor accounts for the effects of changes in environmental quality on the economy.

4.2.4.1 Economy-wide Social Costs

Table 4-4 presents the economy-wide, general equilibrium social costs of the final repeal, calculated as the change in real full consumption from the final repeal relative to the baseline. Real full consumption measures the value of the consumption of goods, services, and leisure measured in baseline prices.[58] We do not use equivalent variation because by definition it does not provide detail on how the social costs of a regulation are borne over time in an intertemporal framework limiting our ability to calculate meaningful social cost estimates for a period of time that is a subset of the SAGE model time horizon comparable with the IPM results presented in Section 3.3.[59] The present value of changes in real full consumption closely approximates the present value of equivalent variation across the full model time horizon but better communicates the temporal impacts of a regulation (e.g., when compliance investments occur).[60]

Table 4-4 also presents the real resource compliance costs estimated by IPM – which exclude all transfer payments – mapped to SAGE model years. Compliance costs are presented

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[58] Equivalent variation is a theoretically appropriate measure of social cost (U.S. EPA Science Advisory Board, 2017). Equivalent variation is an estimate of the amount of money that society would be willing to pay to avoid the compliance requirements of the final repeal, setting aside health, climate, and other benefits (quantified or described qualitatively elsewhere in the RIA).
[59] See Section 4.2 in Marten et al., (2024) for additional details for how equivalent variation is allocated over time in SAGE.
[60] Changes in real consumption has been used to approximate social costs in CGE models, for example with alternative expectations that constrain the intertemporal utility maximization problem (McKibbin and Wilcoxen, 1999).

as they are input into SAGE. For both the compliance costs and the general equilibrium social costs, Table 4-4 presents the present value and annualized costs using the consumption discount rate endogenous to the SAGE model.[61] The consumption discount rate in the model, which is the internally consistent rate to discount modeled changes in full consumption, is based on calibrated household preferences and baseline growth and averages approximately 4 percent over the model's time horizon. The model is calibrated such that social rate of return to capital in the model is approximately 7 percent, conditional on the effective marginal capital tax rate.

The annualized social cost estimated in SAGE for the final repeal is approximately -$530 million (2024 dollars) between 2026 and 2037 based on the value of changes in real full consumption and using the internal consumption discount rate in the model.[62] The temporal pattern of social costs reflects a reallocation of consumption and investment in response to the compliance requirements of the final repeal. Cost savings are highest in earlier model years due to reductions in needed investments in anticipation of reductions in capital requirements in the electricity sector.

[61] The SAGE model estimates the present value of costs for each representative household in the model and sums those estimates to calculate the present value of social costs. Implicit in those estimates are endogenous discount rates that vary by household and over time. See Section 3.4 of the SAGE model documentation at https://www.epa.gov/environmental-economics/cge-modeling-regulatory-analysis.

[62] Changes in real full consumption provides a good approximation to equivalent variation, while providing additional detail on the temporal pattern of when impacts are expected to be experienced. Across the full model time horizon, the estimated value of equivalent variation is within 1.5 percent of the value of the change in real full consumption.

Table 4-4 Real Resource Costs and Social Costs (million 2024 dollars)

SAGE Model Year	Real Resource Costs - Input to SAGE (Excluding Transfers)	General Equilibrium Social Costs
2026	-14	-62
2031	-59	-58
2036	-52	-46
2041	-34	-41
2046	-31	-40
2051	-31	-41
Present Value (2026 to 2037)	-330	-530
Equivalent Annualized Value (2026 to 2037)	-37	-59

Notes: Social costs are calculated as changes in real full consumption. Present value and annualized cost estimates are calculated by interpolating costs estimates between SAGE model years and discounted using the internal consumption discount rate in the model. IPM outputs are mapped to SAGE model years to preserve the present value of real resource compliance costs and therefore will differ from Table 2-7 in Section 2.4.2. Values rounded to two significant figures.

This social cost estimate reflects the combined effects of real resource use from the final repeal and interactions with tax credits for specific production technologies and CCS that are expected to see decreased use in response to the final repeal. We are currently not able to identify their relative roles.

4.2.4.2 Macroeconomic Impacts

The estimated percent change in real gross domestic product (GDP), or the real value of the goods and services produced by the U.S. economy, and its components are presented in Figure 4-2. GDP is defined as the sum of the value (price times quantity) of all market goods and services produced in the economy and is equal to Consumption (C) + Investment (I) + Government (G) + (Exports (X) – Imports (M)). The final repeal is estimated to increase real GDP across the model time horizon, with a peak increase of 0.0003 percent in 2036.[63]

[63] GDP is a measure of economic output and not a measure of social welfare. Thus, the expected social cost of a regulation will generally not be the same as the expected change in GDP (U.S. EPA, 2015). U.S. EPA Science Advisory Board (2017) notes: "GE models are strongly grounded in economic theory, which allows social costs to be evaluated using equivalent variation or other economically rigorous approaches. Simpler measures, such as changes in gross domestic product or in household consumption, do not measure welfare accurately and are inappropriate for evaluating social costs." Social cost estimates presented in Table 4-4 rely on measures of full consumption, which captures impacts on leisure.

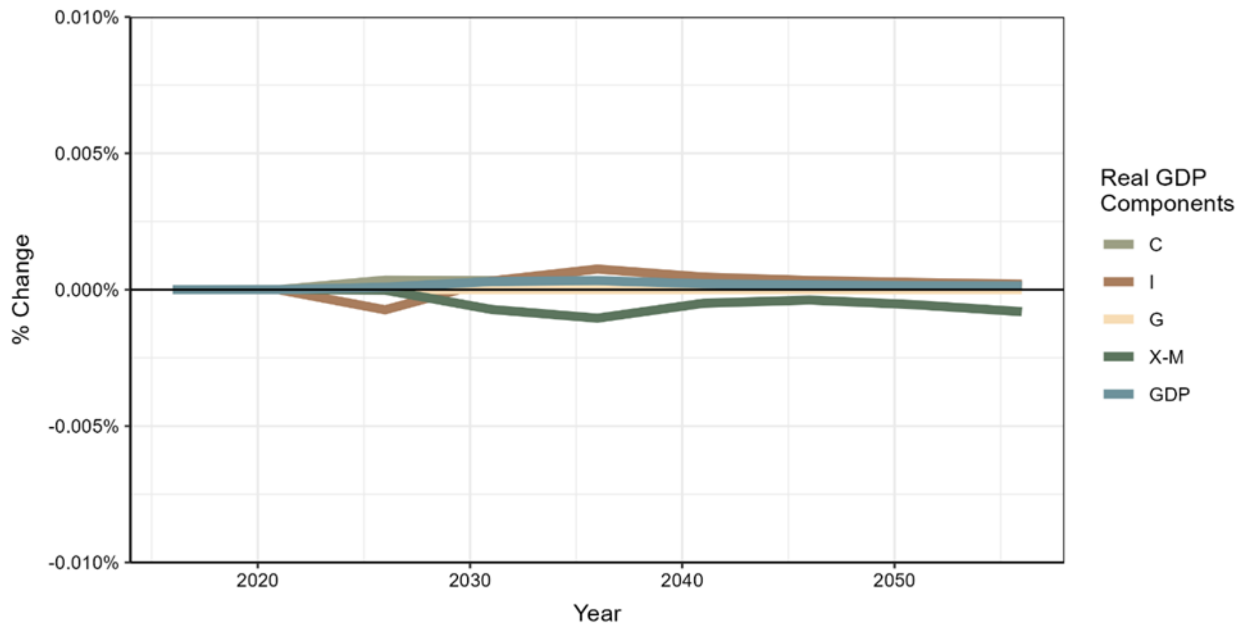

Figure 4-2 Percent Change in Real GDP and Components

Figure 4-2 also reports changes in the components of GDP from the expenditure side of the economy. The final repeal is expected to decrease investments in the electricity sector, leading to a reduction in aggregate investment in 2026 by 0.001 percent. A reduction in investment reallocates resources toward consumption and as a result, the final repeal increases consumption throughout the model time horizon. Aggregate investment is expected to then increase in later model years. The final repeal is also expected to impact the net trade balance, including a modest increase in net exports in 2026 through changes in domestic relative prices due to avoided compliance and then fall in later years from increases in imports to accommodate increases in aggregate consumption and investment.

4.2.4.3 Sectoral and Labor Impacts

Figure 4-3 presents the estimated percent change in output and real output prices for each sector in model years 2026, 2031, 2036, and 2041.[64] Changes in output reflect the estimated shifts in inputs used by generation sources in addition to an economy-wide demand response to changes in electricity prices or changes to enhanced oil recovery revenues Similarly, the

[64] CGE models report prices in relative terms. We denominate output prices in terms of a consumer price index (CPI) internal to the SAGE model, which reflects the overall change in end-use prices for the bundle of goods demanded by households. Characterizing prices relative to this CPI allows a comparison of changes in the magnitude of output prices to overall trends in the economy (i.e., a percentage change that is positive reflects a price that increases more than the average price changes across the economy).

estimated changes in sector output prices reflect compliance cost reductions associated with the final repeal, demand side changes in electricity use from both firms and households, as well as the use of clean energy and 45Q tax credits. Electricity sector prices are expected to decrease across analytic years. As the price of electricity falls, the economy is expected to increase demand for electricity through a variety of pathways. Measured in terms of percent change from the baseline, output and price changes in the electricity, coal mining, natural gas, and crude oil sectors are expected to be relatively larger than in other sectors of the economy. Output and output price changes in non-energy sectors are expected to be relatively small.

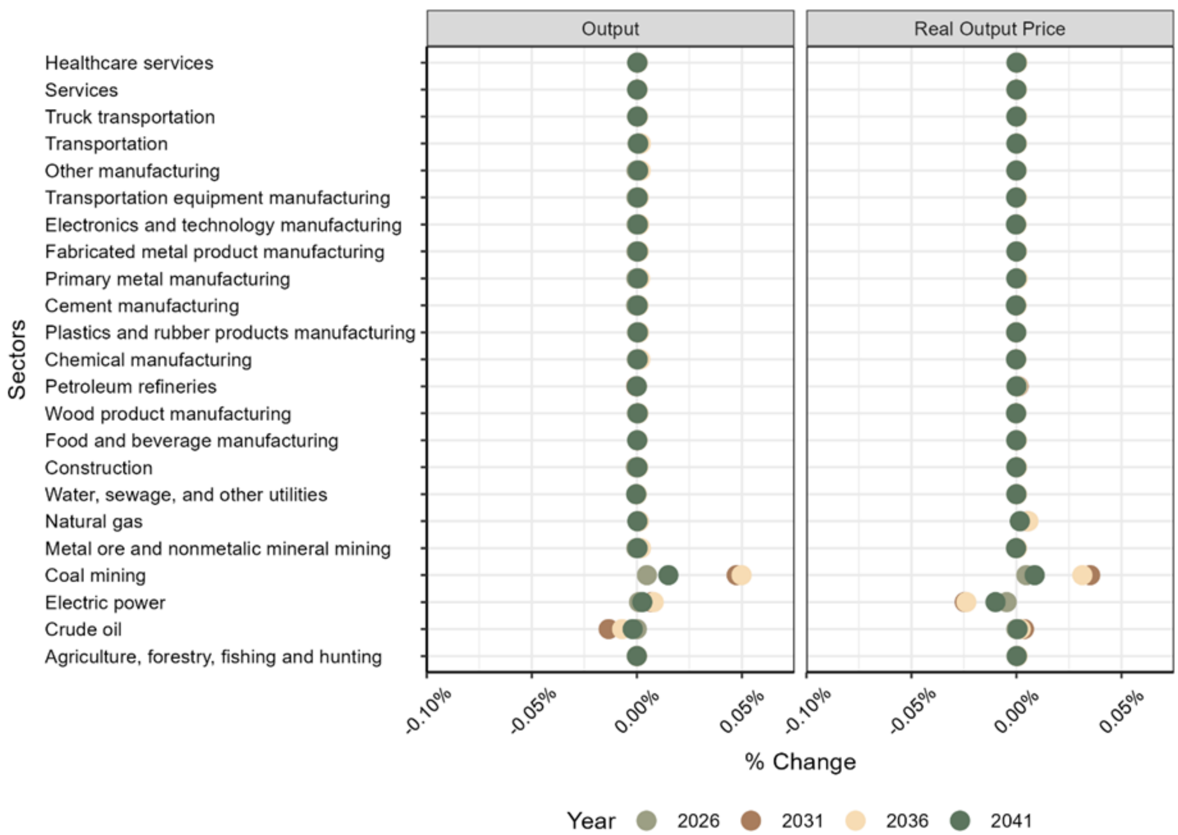

Figure 4-3 Percent Change in Sectoral Output and Real Output Prices

Estimated impacts to sectoral labor demand follows similar trends across sectors to changes in sectoral output. Labor demand impacts are relatively larger in the electricity, coal mining, natural gas sectors, and crude oil extraction whereas labor demand responses in other sectors of the economy tend to be driven by increases in demand for labor in sectors that are more energy-intensive and reductions in sectors associated with capital formation. Labor demand responses in the crude oil sector are consistent with expectations given anticipated changes in EOR as a result of the rule.[65] Figure 4-4 and Figure 4-5 presents the percent change in labor demand in all sectors of the economy for 2026, 2031, 2036, and 2041. Across model years, the total economy-wide labor demand is expected to increase by up to 0.0001 percent. The average economy-wide real wage (relative to the consumer price index) is expected to increase in these years, with a range of 0.0002 percent to 0.0007 percent. As with many other CGE models, SAGE assumes an economy with full employment, meaning that the labor market in the model adjusts to the new equilibrium such that there is no involuntary unemployment (i.e., all workers that want to work at the new prevailing wage can find a job). Any modeled net changes in employment levels are associated with voluntary changes in labor.[66] In contrast, Section 4.4 of this RIA characterizes employment impacts of the final repeal in the power and fuels sectors, providing detailed estimates by capacity and fuel type, without accounting for changes in prices, wages, and interactions with other sectors in the economy.

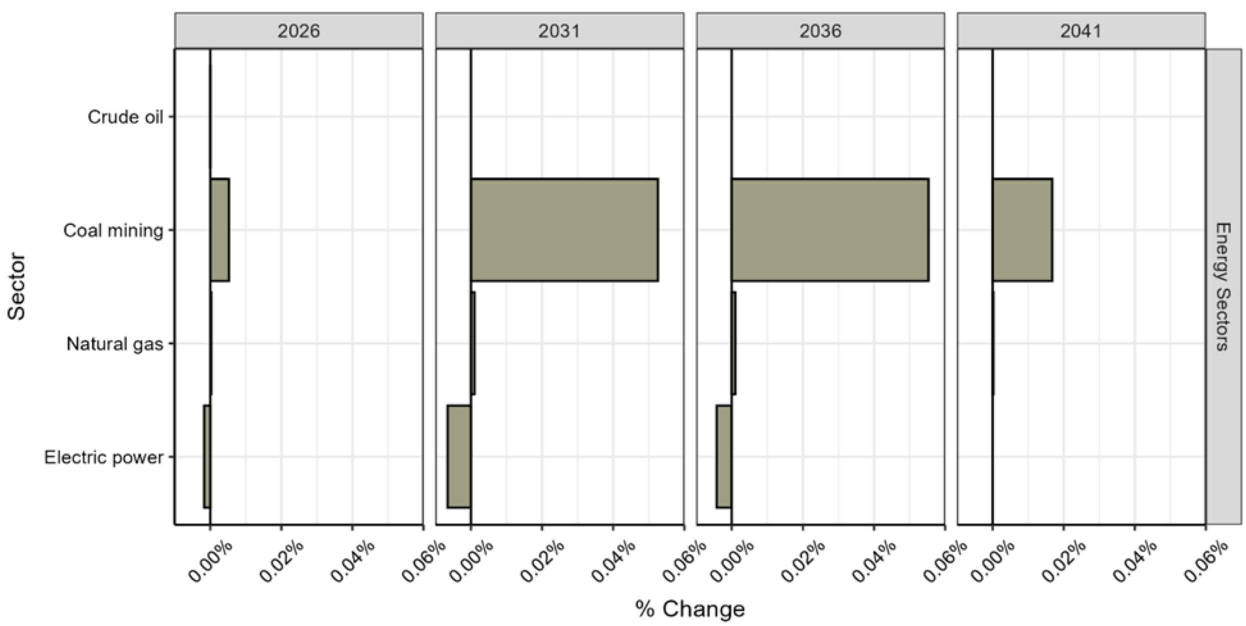

Figure 4-4 Percent Change in Labor Demand in Energy Sectors

[65] We model EOR as increasing the productivity of the crude oil extraction sector. The final repeal leads to changes in captured CO2 used in the production of crude oil therefore, requiring a change in other inputs to production (i.e., labor) to meet demand.

[66] While SAGE does not capture any near-term transition dynamics in the labor market, recent economics research suggests that they likely are a small component of overall welfare costs of environmental regulation (Rogerson, 2015; Hafstead and Williams, 2018).

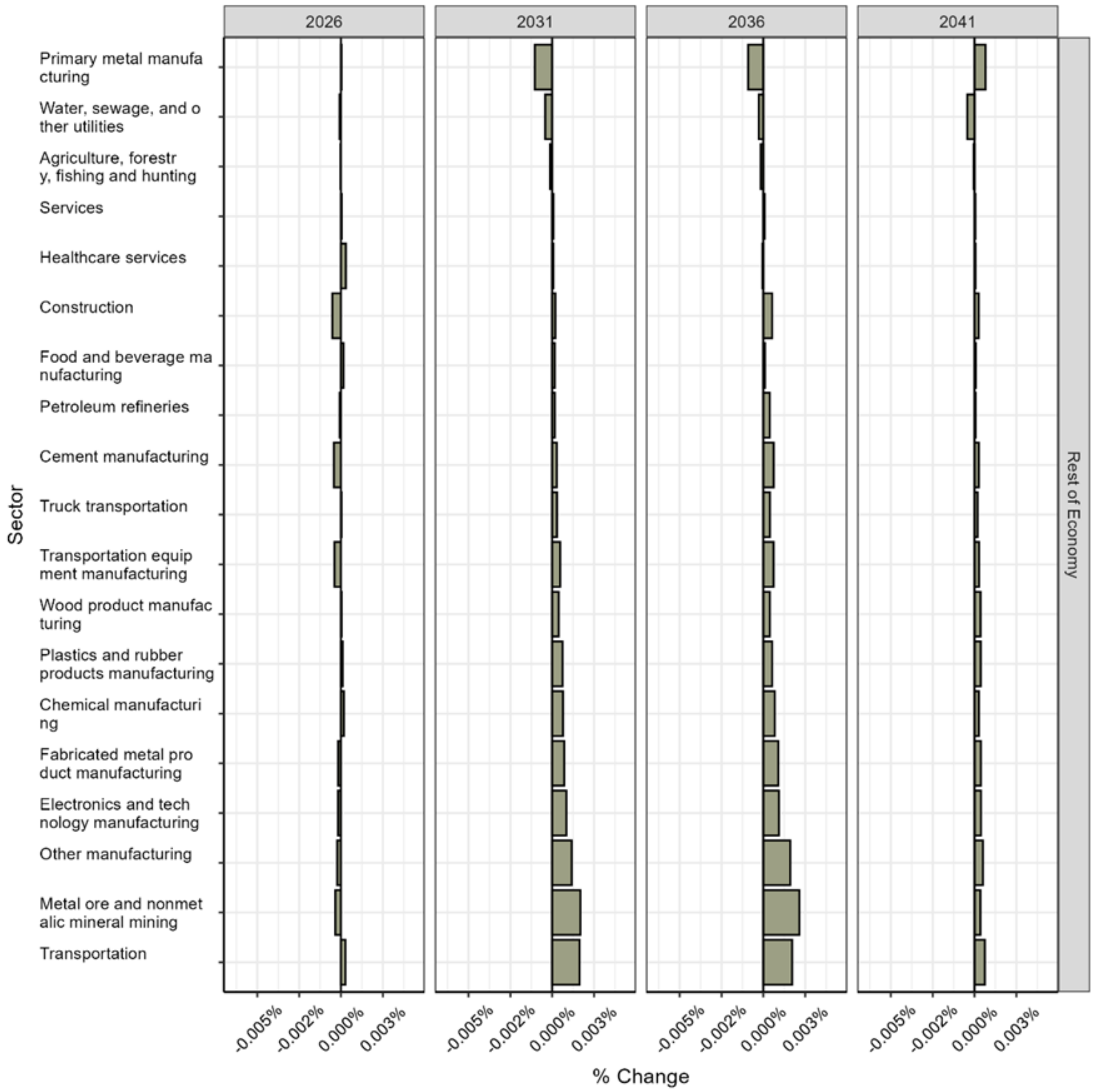

Figure 4-5 Percent Change in Labor Demand in Other Sectors

4.2.4.4 Distributional Impacts

The social costs of regulation are ultimately borne by households through changes in final goods prices or changes in labor, capital, and resource income. Consumer prices, averaged across all end-use household demands and measured relative to the wage rate are expected to decrease by up to 0.0007 percent in 2036. Small increases in overall consumer prices are estimated in some later model years by up to 0.0005 percent. The SAGE model characterizes representative households by income quintiles in each of the four Census regions. This allows the change in the present value of real full consumption over the SAGE forecast horizon to be separately estimated across the income distribution and for different regions of the country, as presented in Figure 4-6.[67] Changes in real full consumption are generally expected to increase with income with the exception the top quintile in the Midwestern Census Region, which is associated with relatively larger reductions in EOR revenues in this region as a result of this rule. Estimates in Figure 4-6 reflect a combined effect of the final repeal on resource requirements and interactions with clean energy and 45Q tax credits that are expected to see decreased use in response to the final repeal.[68]

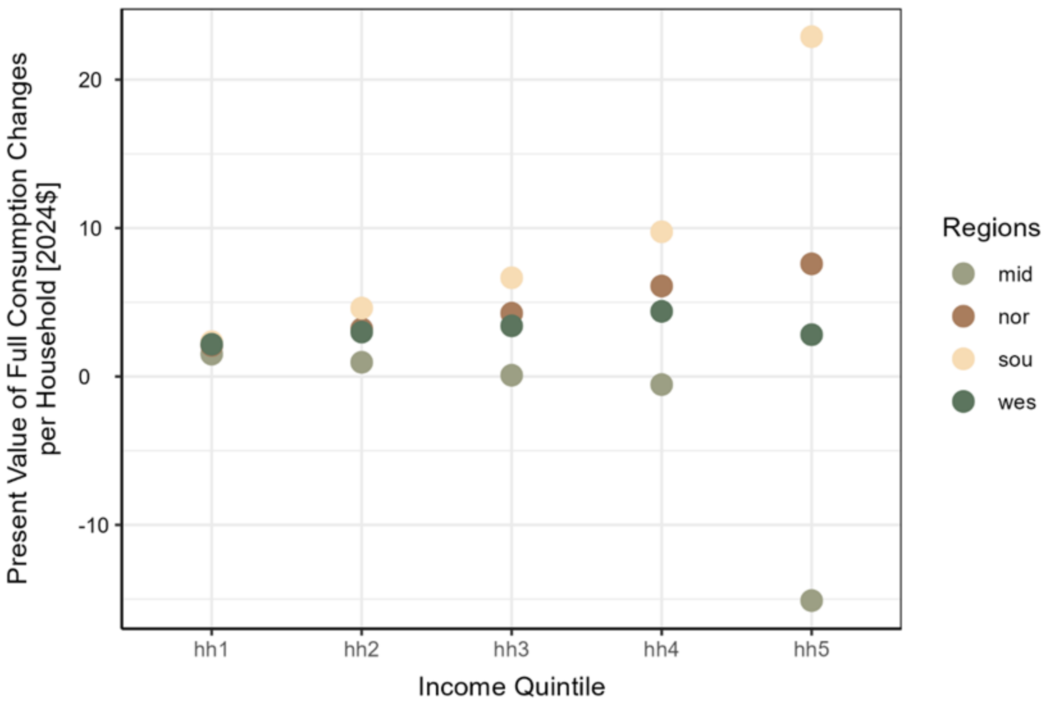

Figure 4-6 Distribution of the Present Value of the Change in Real Full Consumption (2026 to 2037), 2024 dollars

[67] The distribution of changes in real full consumption is calculated for the period 2026 to 2047 and divided by the total number of households of a given income quintile and region in the model's benchmark year using estimates from the Census' Current Population Survey.

[68] A regulation may affect the value of government expenditures through relative prices of goods and services purchased by the government. In addition, it may affect tax revenues through impacts on the value of the base for ad valorem taxes (e.g., labor and capital taxes). In these cases, a CGE model must implement a closure rule to ensure that the government has the funds necessary to support its expenditures. A common assumption in CGE models is to balance the government's budget through lump sum transfers between households and the government as a non-distortionary approach to closing the model. This is the approach used in the SAGE model. Specifically, we distribute the net change in government expenditures as a result of the repeal based on each average U.S. household's share of commodity consumption.

SAGE's representation in the incidence of regulatory changes on domestic households is affected by its ability to distinguish between the sources and uses of income for domestic and foreign consumers and asset owners. For example, SAGE distinguishes between domestic and foreign asset owners of government debt (e.g., bonds) and thus the change in the value of debt due to a regulation. It further represents the effects of trade on income earned in the U.S. and the costs of goods and services to domestic households. However, SAGE does not distinguish between the ownership of physical capital in the U.S. between domestic and foreign investment by sector – all capital is assumed to be owned by domestic households. SAGE also does not account for how the value domestic owned assets outside the U.S. may be affected by a regulatory change.

4.2.5 Limitations

The SAGE model and methodology for aligning IPM outputs for use as inputs in SAGE reflect the best available science for conducting economy-wide modeling of the final repeal. However, both the use of SAGE in a regulatory analysis and the framework for linking IPM with the SAGE model are subject to uncertainty and limitations:

- The costs of complying with many existing regulations are largely reflected in the social accounting matrix and in projections used to calibrate the SAGE model but are not distinguished from non-regulatory related costs (i.e., there is no explicit characterization of already existing regulations in the constructed baseline). Data underlying the SAGE baseline ranges from 2016 to 2020, depending on the specific source. As a result, recent changes in the economy, including new regulations, may not be captured in the source data used to calibrate the model's baseline. For these reasons, SAGE may not explicitly capture interactions that the current rules subject to this final repeal may have with compliance activities already underway to meet other existing regulatory requirements.
- Since IPM provides inputs for this SAGE analysis, the SAGE estimates are subject to many of the same uncertainties and limitations of the IPM methodology, which are detailed in Section 2. In particular, this economy-wide analysis focuses on a single illustrative compliance scenario for the current rules subject to this final repeal.
- This analysis models changes in enhanced oil recovery revenues directly within the crude oil extraction sector in SAGE. This approach captures the productivity impacts associated

with changes in captured CO_2 but does not directly allocate associated changes in oil production revenues back to the electricity sector. Therefore, electricity price impacts estimated in this chapter may be overstated.

- The methodology used to align IPM and SAGE accounts for partial equilibrium feedbacks in IPM and represents an improvement over assuming the solution of one model directly in the other, but it is limited by not being a full linkage that captures feedbacks between the models. While a full model linkage, where the models iteratively pass information back and forth until jointly converging to an equilibrium, may provide a more complete representation of the economy-wide impacts of this final repeal, it is challenging to implement and not feasible at this time.
- To align IPM outputs for use as SAGE inputs, we target the estimated change in amortized payments to capital when calibrating SAGE-PE. However, because the representation of capital differs between IPM and SAGE, the projected stream of capital investments in response to the final repeal also likely differs between the two models. See Section 4.3.2.3 for a discussion of this choice.
- Given the level of sectoral aggregation in SAGE, subsidies on specific electricity-sector technologies are reflected in the SAGE model through a sector-wide adjustment in output taxes. This sector-wide adjustment is designed to approximate the effect of subsidies levied on specific technologies but, because it assumes that the average effect of the subsidy on electricity prices equals the marginal effect, it may add a degree of uncertainty to the social cost estimate regarding the degree to which the subsidies interact with pre-existing distortions in the economy.
- SAGE assumes perfect competition within each sector, a standard assumption in CGE modeling used to ensure tractability. However, market power is itself a distortion because it moves private behavior away from the economically efficient outcome. Environmental regulations can also potentially affect the number of producers and the market structure of the regulated sector by raising production costs, modifying economies of scale, or affecting barriers to entry. A more concentrated market can result in higher prices and lower output, increasing the social cost of a regulation relative to what is estimated under an assumption of perfect competition.

- The economy-wide analysis is limited to an evaluation of social costs. SAGE does not currently estimate changes in emissions nor account for the economic impact of changes in environmental quality, which may interact with the effect of a policy's costs. The SAB (U.S. EPA 2017) noted that CGE models "have not achieved their potential for analysis of the benefits of air regulations" because they do not account for potential interactions between costs and benefits. While this means that estimates from SAGE – and CGE models generally – are a partial representation of the total effects of regulation on the economy, the SAB stated that this "does not invalidate the use of CGE models to estimate costs."

4.3 Small Entity Analysis

The Regulatory Flexibility Act (RFA; 5 U.S.C. §601 et seq.), as amended by the Small Business Regulatory Enforcement Fairness Act (Public Law No. 104121), provides that whenever an agency publishes a final repeal, it must prepare and make available an initial regulatory flexibility analysis (IRFA), unless it certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities (5 U.S.C. §605[b]). Small entities include small businesses, small organizations, and small governmental jurisdictions. An IRFA describes the economic impact of the rule on small entities and any significant alternatives to the rule that would accomplish the objectives of the rule while minimizing significant economic impacts on small entities, and the Agency is certifying that this rule will not have a significant economic impact on a substantial number of small entities because of the overall cost savings for and low impact on small entities.

As described in Section 2 of this RIA, the cost estimates presented in the 2024 MATS RTR RIA are an estimate of the increased power industry expenditures required to implement the final requirements of the 2024 MATS RTR. By repealing these provisions, this final action would lead to reductions in EAV of costs over the 2028 to 2037 timeframe of about $77 and $68 million per year at discount rates of three and seven percent, respectively.

For the final repeal, the EPA performed a small entity screening analysis for impacts on all affected EGUs and non-EGU facilities by comparing compliance costs to historic revenues at the ultimate parent company level. This is known as the cost-to-revenue or cost-to-sales test, or the “sales test.” The sales test is an impact methodology EPA employs in analyzing entity impacts as opposed to a “profits test,” in which annualized compliance costs are calculated as a share of profits. The sales test is frequently used because revenues or sales data are commonly available for entities impacted by EPA regulations, and profits data normally made available are often not the true profit earned by firms because of accounting and tax considerations. Also, the use of a sales test for estimating small business impacts for a rulemaking is consistent with guidance offered by EPA on compliance with the Regulatory Flexibility Act (RFA)[69] and is consistent with guidance published by the U.S. Small Business Administration’s (SBA) Office of Advocacy that suggests that cost as a percentage of total revenues is a metric for evaluating cost increases on small entities in relation to increases on large entities.[70]

4.3.1 Methodology

This section presents the methodology and results for estimating the impact of the rule on small EGU entities in the year of full compliance, 2030 (when the two-year exemptions would have elapsed), based on the following endpoints: annual economic impacts of the final rule on small entities, and ratio of small entity impacts to revenues from electricity generation.

For this analysis, the EPA first considered EGUs that would be subject to 2024 MATS RTR requirements and for which EPA assumed additional controls would be necessary to meet the requirements of the finalized rule. We then refined this list of MATS-affected EGUs, complementing the list with units for which the projected impacts exceeds either of the two criteria below relative to the baseline:

Fuel use (BTUs) changes by +/- 1 percent or more
Generation (GWh) changes by +/- 1 percent or more

Please see Section 2 for more discussion of the power sector modeling.

The EPA identified a total of 351 potentially affected EGUs based on the plant type. Based on the additional fuel use and generation screening criteria, the EPA identified a total of

[69] See U.S. EPA. (2006). *Final Guidance for EPA Rulewriters: Regulatory Flexibility Act as Amended by the Small Business and Regulatory Enforcement Fairness Act.* Available at: *https://www.epa.gov/sites/production/files/2015-06/documents/guidance-regflexact.pdf.*
[70] See U.S. SBA Office of Advocacy. (2017). *A Guide for Government Agencies: How to Comply with the Regulatory Flexibility Act.* Available at*: https://advocacy.sba.gov/2017/08/31/a-guide-for-government-agencies-how-to-comply-with-the-regulatory-flexibility-act*.

13 potentially affected EGUs warranting examination in 2030 in this RFA analysis. Next, we determined power plant ownership information, including the name of associated owning entities, ownership shares, and each entity's type of ownership. We primarily used data from Hitachi — Power Grids, The Velocity Suite I 2020 ("VS"), supplemented by limited research using publicly available data.

Next, the EPA used both the D&B Hoovers online database and the VS database to identify the ultimate owners of power plant owners identified in the VS database. This was necessary, as many majority owners of power plants (listed in VS) are themselves owned by other ultimate parent entities (listed in D&B Hoovers). In these cases, the ultimate parent entity was identified via D&B Hoovers, whether domestically or internationally owned.

EPA followed SBA size standards to determine which non-government ultimate parent entities should be considered small entities in this analysis. These SBA size standards are specific to each industry, each having a threshold level of either employees, revenue, or assets below which an entity is considered small. SBA guidelines list all industries, along with their associated North American Industry Classification System (NAICS) code and SBA size standard. Therefore, it was necessary to identify the specific NAICS code associated with each ultimate parent entity in order to understand the appropriate size standard to apply. Data from D&B Hoovers were used to identify the NAICS codes for most of the ultimate parent entities.

Ultimate parent entities for which the relevant measure is less than the SBA size standard were identified as small entities and carried forward in this analysis.

In the projected results for 2030, the EPA identified 13 potentially affected EGUs, owned by 7 entities. Of these, identified entities, only one was characterized as "small".

The chosen compliance strategy will be primarily a function of the unit's marginal control costs and its position relative to the marginal control costs of other units. To attempt to account for each potential control strategy, the EPA estimates compliance costs as follows:

$$C_{Compliance} = \Delta\ C_{Operating+Retrofit} + \Delta\ C_{Fuel} + \Delta\ R$$

where *C* represents a component of cost as labeled and *Δ* R represents the change in revenues, calculated as the difference in value of electricity generation between the baseline case and the rule in in 2028.

Realistically, compliance choices and market conditions can combine such that an entity may actually experience a reduction in any of the individual components of cost. Under the rule, some units will forgo some level of electricity generation (and thus revenues) to comply, and this impact will be lessened on these entities by the projected increase in electricity prices under the rule. On the other hand, those units increasing generation levels will see an increase in electricity revenues and as a result, lower net compliance costs. If entities are able to increase revenue more than an increase in fuel cost and other operating costs, ultimately, they will have negative net compliance costs (or increased profit). Overall, small entities are not projected to install relatively costly emissions control retrofits but may choose to do so in some instances. Because this analysis evaluates the total costs along each of the compliance strategies laid out above for each entity, it inevitably captures gains such as those described. As a result, what we describe as cost is actually a measure of the net economic impact of the rule on small entities.

For this analysis, the EPA used IPM-parsed output to estimate costs based on the parameters above, at the unit level. These impacts were then summed for each small entity, adjusting for ownership share. Net impact estimates were based on the following: operating and retrofit costs, sale or purchase of allowances, and the change in fuel costs or electricity generation revenues under the finalized MATS requirements relative to the base case. These individual components of compliance costs were estimated as follows:

1. **Operating and retrofit costs** ($\Delta\ C_{Operating+Retrofit}$)**:** EPA projected which compliance option would be selected by each EGU in 2030 and applied the appropriate cost to this choice (for details, please see Section 2 of this RIA). For 2028, IPM projected retrofit costs were also included in the calculation.

2. **Fuel costs** ($\Delta\ C_{Fuel}$)**:** The change in fuel expenditures under the final requirements was estimated by taking the difference in projected fuel expenditures between the IPM estimates under the final requirements and the baseline.

3. **Value of electricity generated** ($\Delta\ C_{Fuel}$)**:** To estimate the value of electricity generated, the projected level of electricity generation is multiplied by the regional-adjusted retail

electricity price ($/MWh) estimate, for all entities except those categorized as private in Ventyx. For private entities, the EPA used the wholesale electricity price instead of the retail electricity price because most of the private entities are independent power producers (IPP). IPPs sell their electricity to wholesale purchasers and do not own transmission facilities. Thus, their revenue was estimated with wholesale electricity prices.

4.3.2 Results

As indicated above, the use of a sales test for estimating small business impacts for a rulemaking is consistent with guidance offered by EPA on compliance with the RFA and is consistent with guidance published by the SBA's Office of Advocacy that suggests that cost as a percentage of total revenues is a metric for evaluating cost increases on small entities in relation to increases on large entities. The EPA assessed the economic and financial impacts of the rule using the ratio of compliance costs to the value of revenues from electricity generation, focusing on entities for which this measure is greater than one percent.

Making a determination that there is not a significant economic impact on a substantial number of small entities (often referred to as a "SISNOSE") requires an assessment of whether an estimated economic impact is significant and whether that impact affects a substantial number of small entities. The EPA identified 13 potentially affected EGU entities in the projection year of 2030. Of these, the EPA identified only one small entity affected by the rule. We projected the annual net compliance cost to this small entity to be approximately $1.6 million in 2030. This compliance cost is estimated to be greater than one percent of its revenues from capacity and energy revenue (i.e., revenues calculated based on estimates of electricity generation and pricing). However, considering the actual historical revenue of this small entity (i.e., recent financial annual reporting published by that business), the cost-to-sales ratio is estimated to be less than one percent. Based on this analysis, we conclude that the estimated costs for the final rule will not have a significant economic impact on a substantial number of small entities.

Consequently, the EPA expects that this deregulatory action would result in compliance cost savings for facilities otherwise affected by the three provisions in the 2024 MATS RTR. Based on this analysis, the EPA concludes that the estimated compliance cost savings under the final repeal will not have a significant economic impact on a substantial number of small entities.

4.4 Labor Impacts

This section discusses potential employment impacts of this regulation. As economic activity shifts in response to a regulation, typically there will be a mix of declines and gains in employment in different parts of the economy over time and across regions. To present a complete picture, an employment impact analysis will describe the potential positive and negative changes in employment levels. There are significant challenges when trying to evaluate the employment effects of an environmental regulation due to a wide variety of other economic changes that can affect employment, including the impact of the coronavirus pandemic on labor markets and the state of the macroeconomy generally. Considering these challenges, we look to the economics literature to provide a constructive framework and empirical evidence. To simplify, we focus on impacts on labor demand related to compliance behavior. Environmental regulation may also affect labor supply through changes in worker health and productivity (Zivin and Neidell, 2018).

Economic theory of labor demand indicates that employers affected by environmental regulation may increase their demand for some types of labor, decrease demand for other types, or for still other types, not change their demand at all (Berman and Bui, 2001; Deschenes, 2018; Morgenstern et al., 2002). To study labor demand impacts empirically, a growing literature has compared employment levels at facilities subject to an environmental regulation to employment levels at similar facilities not subject to that environmental regulation; some studies find no employment effects, and others find significant differences. For example, see Berman and Bui (2001), Greenstone (2002), Ferris et al. (2014), and Curtis (2018, 2020). A variety of conditions can affect employment impacts of environmental regulation, including baseline labor market conditions and employer and worker characteristics such as occupation and industry. Changes in employment may also occur in different sectors related to the regulated industry, both upstream and downstream, or in sectors producing substitute or complimentary products. Employment impacts in related sectors are often difficult to measure. Consequently, we focus our labor impacts analysis primarily on the directly regulated facilities and other EGUs and related fuel markets.

This section discusses and projects potential employment impacts for the utility power, coal and natural gas production sectors that may result from the final repeal. The EPA has a long history of analyzing the potential impacts of air pollution regulations on changes in the amount of labor needed in the power generation sector and directly related sectors. The analysis conducted for this RIA builds upon the approaches used in the past and takes advantage of newly available data to improve the assumptions and methodology.[71]

The results presented in this section are based on a methodology that estimates the impact on employment based on the differences in projections between two modeling scenarios: the baseline scenario, and a scenario that represents the final repeal. The estimated employment difference between these scenarios can be interpreted as the incremental effect of the repeal on employment in this sector. As discussed in Section 2, there is uncertainty related to the future baseline projections. Because the incremental employment estimates presented in this section are based on projections discussed in Section 2, it is important to highlight the relevance of the Section 2 uncertainty discussion to the analysis presented in this section. Note that there is also uncertainty related to the employment factors applied in this analysis, particularly factors informing job-years related to relatively new technologies, such as energy storage, on which there is limited data to base assumptions.

Like previous analyses, this analysis represents an evaluation of "first-order employment impacts" using a partial equilibrium modeling approach. It includes some of the potential ripple effects of these impacts on the broader economy. These ripple effects include the secondary job impacts in both upstream and downstream sectors. The analysis includes impacts on upstream sectors including coal, natural gas, and uranium. However, the approach does not analyze impacts on other fuel sectors, nor does it analyze potential impacts related to transmission or distribution. This approach excludes the economy-wide employment effects of changes to energy markets (such as higher or lower forecasted electricity prices). This approach also excludes labor impacts such as changes in productivity related to workforce health and changes in absenteeism related to changes in sick days of employees and dependent family members (e.g., children).

4.4.1 Overview of Methodology

The methodology includes the following two general approaches, based on the available data. The first approach uses detailed employment data that are available for several types of

[71] For a detailed overview of this methodology, including all underlying assumptions, see the U.S. EPA Methodology for Power Sector-Specific Employment Analysis, available in the docket.

generation technologies in the 2020 U.S. Energy and Employment Report (USEER).[72] For employment related to other electric power sector generating and pollution control technologies, the second approach uses information available in the U.S. Economic Census.

Detailed employment inventory data are available regarding recent employment related to coal, hydro, natural gas, geothermal, wind, and solar generation technologies as well as battery storage. The data enables the creation of technology-specific factors that can be applied to model projections of capacity (reported in MW) and generation (reported in megawatt-hours, or MWh) to estimate impacts on employment. Since employment data are only available in aggregate by fuel type, it is necessary to disaggregate by labor type to differentiate between types of jobs or tasks for categories of workers. For example, some types of employment remain constant throughout the year and are largely a function of the size of a generator, e.g., fixed operation and maintenance activities, while others are variable and are related to the amount of electricity produced by the generator, e.g., variable operation and maintenance activities.

The approach can be summarized in three basic steps:

- Quantify the total number of employees by fuel type in a given year;
- Estimate total fixed operating & maintenance (FOM), variable operating & maintenance (VOM), and capital expenditures by fuel type in that year; and
- Disaggregate total employees into three expenditure-based groups and develop factors for each group (FTE/MWh, FTE/MW-year, FTE/MW new capacity).

Where detailed employment data are unavailable, it is possible to estimate labor impacts using labor intensity ratios. These factors provide a relationship between employment and economic output and are used to estimate employment impacts related to construction and operation of pollution control retrofits, as well as some types of electric generation technologies.

For a detailed overview of this methodology, including all underlying assumptions and the types of employment represented by this analysis, see the U.S. EPA Methodology for Power Sector-Specific Employment Analysis, available in the docket.

[72] *https://www.energy.gov/policy/us-energy-employment-jobs-report-useer.*

4.4.2 Overview of Power Sector Employment

In this section we focus on employment related to electric power generation, as well as coal and natural gas extraction because these are the segments of the power sector that are most relevant to the projected impacts of the rule. Other segments not discussed here include other fuels, energy efficiency, and transmission, distribution, and storage. The following statistics are based on the 2025 USEER, which reports data from 2024.[73]

In 2024, the electric power generation sector employed nearly 934,000 people. The largest component of total 2024 employment in this sector is construction (33 percent). Other components of the electric power generation workforce include professional and business service employees (22 percent), utility workers (20 percent), manufacturing (12 percent), wholesale trade (9 percent), and other (5 percent). In 2024, jobs related to solar and wind generation represent 40 percent and 14 percent of total jobs, respectively, and jobs related to coal generation represent less than 7 percent of total employment.

In addition to generation-related employment, we also look at employment related to coal and natural gas use in the electric power sector. In 2024, the coal industry employed about 64,000 workers. Mining and extraction jobs represent the vast majority of total coal-related employment in 2024 (70 percent). The natural gas fuel sector employed about 253,000 employees in 2024. About 55 percent of those jobs were related to mining and extraction.

4.4.3 Projected Sectoral Employment Changes due to the Final Repeal

Based on EPA's power sector modeling projections, we estimate a decrease in construction-related job-years related to the decrease in new pollution control installations under the repeal. In 2030, we estimate a decrease of approximately 1,900 construction-related job-years related to the construction of new pollution controls or control upgrades. We also estimate an increase of approximately 500 job-years related to the construction of new capacity in 2030, followed by a decrease of approximately 500 job-years in 2035. Construction-related job-year changes are one-time impacts, occurring during each year of the multi-year periods during which construction of new capacity is completed. Construction-related figures in Table 4-5 represent a

[73] The annual report is available at: *https://www.energy.gov/media/348941/.*

point estimate of incremental changes in construction jobs for each year (for a three-year construction projection, this table presents one-third of the total jobs for that project).

Table 4-5 Projected Changes in Labor Utilization: Construction-Related (Number of Job-Years of Employment in a Single Year) Real Resource

	2028	2030	2035
New Pollution Controls	<100	-1,900	100
New Capacity	<100	500	-500

Notes: "<100" denotes an increase or decrease of fewer than 100 job-years. A large share of the new capacity-related job years is attributable to construction of energy storage, a relatively new technology on which there is limited data to base labor assumptions.

We also estimate changes in the number of job-years related to recurring non-construction employment. Recurring employment changes are job-years associated with annual recurring jobs including operating and maintenance activities and fuel extraction jobs. Newly built generating capacity creates a recurring stream of positive job-years, while retiring generating capacity, as well as avoided capacity builds, create a stream of negative job-years. Consistent with the small projected changes in generation over 2028 through 2035, this rule is expected to result in small impacts in recurring non-construction jobs. Table 4-6 provides detailed estimates of recurring non-construction employment changes.

Table 4-6 Projected Changes in Labor Utilization: Recurring Non-Construction (Number of Job-Years of Employment in a Single Year)

	2028	2030	2035
Pollution Controls	<100	<100	<100
Existing Capacity	<100	<100	<100
New Capacity	<100	<100	<100
Fuels (Coal, Natural Gas, Uranium)	<100	<100	<100
Coal	*<100*	*<100*	*<100*
Natural Gas	*<100*	*<100*	*<100*
Uranium	*<100*	*<100*	*<100*

Note: "<100" denotes an increase or decrease of fewer than 100 job-years; Numbers may not sum due to rounding.

4.4.4 Conclusions

Generally, there are significant challenges when trying to evaluate the employment effects due to an environmental regulation from employment effects due to a wide variety of other economic changes, including the impact of the coronavirus pandemic on labor markets and the state of the macroeconomy generally. For EGUs, this rule may result in a sizable near-term decrease in construction-related jobs related to the installation of new pollution controls that are no longer projected to be installed because of this deregulatory action, and any changes in recurring non-construction employment are expected to be small.

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5 COMPARISON OF BENEFITS AND COSTS

5.1 Introduction

This section provides a comparison of the costs and benefits of this action, as well as discusses unquantified impacts. The reduced expenditures on compliance costs reported in this section are not social costs; instead, we use compliance costs as a proxy for social costs. The projected real resource costs and economy-wide social costs are separately estimated and discussed in Section 2.4.2 (real resource costs) and Section 4.2 (economy-wide social costs), respectively, but those estimates are not applied in this section. Therefore, in this section, we do not account for changes in costs and benefits due to changes in economic welfare in the broader economy arising from shifts in production and consumption that may be induced by this action. Furthermore, costs and benefits due to interactions with pre-existing market distortions outside the electricity sector are omitted, as are changes in social costs that may be associated with the net change in transfers attributable to this action. Additional limitations of the analysis and sources of uncertainty are described throughout the RIA and summarized later in this section.

5.2 Methods

The EPA calculated the PV and EAV of costs for the years 2028 through 2037, using the discount rates of 3 and 7 percent beginning-of-period discount rates from the perspective of 2025 for the final repeal. All estimates are in 2024 dollars.

The calculations of PV and EAV use an annual stream of values from 2028 to 2037. The EPA used IPM to estimate costs and emissions changes for the projection years 2028, 2030, and 2035. The year 2028 approximates the compliance year for the 2024 MATS RTR requirements. In the IPM modeling, the 2028 projection year is representative of 2028 and 2029, the 2030 projection year is representative of 2030 and 2031, and the 2035 projection year is representative of 2032 to 2037. Estimates of costs and emissions changes in other years are determined from the mapping of projection years to the calendar years that they represent. Consequently, the costs and emissions estimates from IPM in each projection year are applied to the years that it represents.[74] As noted elsewhere in the RIA, the EPA did not monetize human health or environmental benefits associated with emissions changes.

This RIA follows the EPA's historical practice of using a technology-rich partial equilibrium model of the electricity and related fuel sectors to estimate the incremental costs of producing electricity under the requirements of major EPA power sector rules. In Section 4.2 of this RIA, we also include an economy-wide analysis that considers additional facets of the economic response to this action, including the full resource requirements of the expected compliance pathways.

5.3 Results

Table 5-1 and Table 5-2 compare cost estimates and non-monetized disbenefits from this action, with Table 5-1 providing undiscounted values, and Table 5-2 providing discounted values.

Table 5-1 Costs and Benefits of this Final Repeal (million 2024 dollars, undiscounted) [a]

Year	Power Sector Generating Costs	PM CEMS Costs	Total Sector Costs
2028	-5.4	-1.2	-6.6
2029	-5.4	-1.2	-6.6
2030	-91	-2.9	-93
2031	-91	-2.9	-93
2032	-110	-2.9	-110
2033	-110	-2.9	-110
2034	-110	-2.9	-110
2035	-110	-2.9	-110
2036	-110	-2.9	-110
2037	-110	-2.9	-110
Non-Monetized Impacts[b]			
From increases in Hg and non-Hg HAP metals			
Impacts to human health and the environment from increases in SO_2, NO_X, $PM_{2.5}$, and CO_2 emissions			
From repealing the PM CEMS requirement			

[a] Values have been rounded to two significant figures. Values may not appear to add correctly due to rounding.
[b] Several categories of costs and benefits remain unmonetized and are not reflected in the table.

[74] Projected costs associated with the CEMS requirement are not based on IPM. For information on these avoided cost estimates, see Section 2.

Table 5-2 Costs and Benefits of this Final Repeal (million 2024 dollars, discounted to 2025)[a]

	Power Sector Generating Costs		PM CEMS Costs		Total Costs	
Year	**3%**	**7%**	**3%**	**7%**	**3%**	**7%**
2028	-4.9	-4.4	-1.1	-1.0	-6.0	-5.4
2029	-4.8	-4.1	-1.1	-0.9	-5.9	-5.0
2030	-78	-65	-2.5	-2.1	-81	-67
2031	-76	-60	-2.4	-1.9	-78	-62
2032	-87	-66	-2.3	-1.8	-89	-68
2033	-84	-62	-2.3	-1.7	-86	-64
2034	-82	-58	-2.2	-1.6	-84	-59
2035	-79	-54	-2.1	-1.5	-81	-56
2036	-77	-51	-2.1	-1.4	-79	-52
2037	-75	-47	-2.0	-1.3	-77	-49
	Power Sector Generating Costs		**PM CEMS Costs**		**Total Costs**	
	Discount Rate					
	3%	**7%**	**3%**	**7%**	**3%**	**7%**
PV	**-650**	**-470**	**-20**	**-15**	**-670**	**-490**
EAV	**-76**	**-67**	**-2.4**	**-2.1**	**-78**	**-69**
Non-Monetized Impacts[b]						
From increases in Hg and non-Hg HAP metals						
Impacts to human health and the environment from increases in SO_2, NO_X, $PM_{2.5}$, and CO_2 emissions						
From repealing the PM CEMS requirement						

[a] Values have been rounded to two significant figures. Values may not appear to add correctly due to rounding.
[b] Several categories of costs and benefits remain unmonetized and are not reflected in the table.

The compliance cost values in Table 5-1 and Table 5-2 above differ from the compliance cost values in Table 0-1. In Table 0-1, we present positive compliance cost values as cost savings.

5.4 Uncertainties and Limitations

Throughout the RIA, we considered several sources of uncertainty, both quantitatively and qualitatively, regarding the emissions changes, benefits, and costs estimated for this action. We summarize these discussions as well as other important uncertainties here.

Compliance costs: The IPM-projected annualized cost estimates provided in this analysis are meant to show the decrease in production (generating) costs to the power sector in response to repealing the 2024 MATS RTR requirements. There are several key areas of uncertainty related to the electric power sector that are worth noting, including assumptions about future electricity demand, natural gas supply and demand, longer-term planning by utilities, and assumptions about the cost and performance of controls. There is also uncertainty associated with the estimated costs for the PM CEMS requirement. Also, uncertainty in future economic conditions in the electricity creates uncertainty in the emissions changes projected in this RIA.

Uncertainty in achievability of Hg emission standard for lignite-fired EGUs: As explained in Section III.A.3 of the preamble, the EPA is finalizing the repeal of the revised Hg limit for lignite-fired EGUs because the revised standard was based on insufficient available data demonstrating that lignite units can meet the lower limit over the range of boiler types and variable compositions of fuels used at lignite-fired EGUs. While the EPA found that all 22 lignite-fired EGUs at 12 facilities would need to control their Hg emissions to 95 percent or less to meet an emission standard of 1.2 lb/TBtu in the 2024 MATS RTR, the Agency did not demonstrate that this high level of Hg removal is achievable for all lignite-fired units while taking into account the wide-ranging and highly variable Hg content of the various lignite fuels.

Monetizing $PM_{2.5}$ and ozone-related impacts:

The analysis of monetized $PM_{2.5}$ and ozone-related benefits described in Section 3.3 includes many data sources as inputs that are each subject to uncertainty. Input parameters include projected emissions inventories, projected compliance methods, air quality data from models (with their associated parameters and inputs), population data, population estimates, health effect estimates from epidemiology studies, economic data, and assumptions regarding the future state of the world (i.e., regulations, technology, and human behavior). When compounded, even small uncertainties can greatly influence the size of the total quantified benefits.

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Monetizing CO_2-related domestic climate impacts: There are significant uncertainties related to the monetization of greenhouse gases (GHGs) that include, but are not limited to: the magnitude of the change in climate due to a change in GHG emissions; the relationship between changes in the climate and the economy and therefore, the resulting economic impacts; future economic and population growth which are important for estimating vulnerability, willingness to pay to avoid impacts, and the ability to adapt to future changes; future technological advancements that would reduce vulnerability and impacts; the share of impacts from GHG emissions that affect citizens and residents of the United States; and the appropriate discount rates to use when discounting in an intergenerational context. Consistent with the memorandum titled “Guidance Implementing Section 6 of Executive Order 14154, Entitled ‘Unleashing American Energy’”, the EPA did not monetize impacts from changes in GHG emissions for this final action. Monetizing these impacts could potentially result in flawed decision-making due to overreliance on highly uncertain values.

Interaction of the action with NAAQS attainment: The projected emissions changes under this action are projected to affect ambient of $PM_{2.5}$ and ozone concentrations in parts of the U.S. Affected areas may include locations both meeting and exceeding the NAAQS for $PM_{2.5}$ and ozone. States with nonattainment areas designated as moderate or higher are required to achieve concentration reductions in those areas sufficient to attain the NAAQS. This RIA does not account for how interaction with NAAQS compliance would affect the benefits and costs projected under the final repeal.

APPENDIX A: AIR QUALITY MODELING

A.1 Introduction

The EPA used photochemical modeling to create air quality surfaces[75] that captured air pollution impacts resulting from changes in NO_X, SO_2, and direct $PM_{2.5}$ emissions from EGUs in the Final Repeal scenario relative to the Baseline (with MATS RTR). This appendix describes the source apportionment modeling and associated methods used to create air quality surfaces for the Baseline (with MATS RTR) and the Final Repeal scenario in three snapshot years: 2028, 2030, and 2035. The EPA created air quality surfaces for the following pollutants and metrics: annual average $PM_{2.5}$; April-September average of 8-hr daily maximum (MDA8) ozone (AS-MO3).

In 2025, the EPA conducted new ozone and $PM_{2.5}$ source apportionment modeling to support analyses in the RIAs for multiple final EGU rulemaking efforts. The basic methodology for determining air quality changes is the same as that used in the RIAs from multiple previous rules (e.g., U.S. EPA, 2019, 2020a, 2020b, 2021a, 2022a). The EPA calculated Baseline (with MATS RTR) and Final Repeal EGU emissions estimates of NO_X and SO_2 for all three run years using IPM (Section 2 of this RIA). EPA also used IPM outputs to estimate EGU emissions of $PM_{2.5}$ based on emission factors described in U.S. EPA (2021b)[76]. This appendix provides additional details on the source apportionment modeling simulations and the associated analysis used to create ozone and $PM_{2.5}$ air quality surfaces.

A.2 Air Quality Modeling Simulations

The air quality modeling utilized a 2022-based modeling platform which included meteorology and emissions from 2022. The air quality modeling included photochemical model simulations for a 2022 base year to provide hourly concentrations of ozone and $PM_{2.5}$ component species nationwide. In addition, source apportionment modeling was performed using this 2022 platform to quantify the contributions to ozone from NO_X emissions and to $PM_{2.5}$ from NO_X, SO_2

[75] "Air quality surfaces" refers to continuous gridded spatial fields using a 12 km grid-cell resolution.
[76] For details, please see *Flat File Generation Methodology and Post Processing Emissions Factors PM CO VOC NH_3 Updated Summer 2021 Reference Case*, available at: https://www.epa.gov/power-sector-modeling/supporting-documentation-2015-ozone-naaqs-actions

and directly emitted $PM_{2.5}$ emissions from EGUs on a state-by-state basis. As described below, the modeling results for 2022, in conjunction with EGU emissions data for the Baseline (with MATS RTR) and Final Repeal scenarios in 2028, 2030, and 2035 were used to construct the air quality surfaces that reflect the influence of emissions changes between the Baseline (with MATS RTR) and Final Repeal scenarios in each year.

The air quality model simulation (i.e., model run) was performed using the Comprehensive Air Quality Model with Extensions (CAMx) version 7.20[77] (Ramboll, 2022). The nationwide modeling domain (i.e., the geographic area included in the modeling) covers all lower 48 states plus adjacent portions of Canada and Mexico using a horizontal grid resolution of 12 × 12 km is shown in Figure A-1.

CAMx requires a variety of input files that contain information pertaining to the modeling domain and simulation period. These include gridded, hourly emissions estimates and meteorological data, and initial and boundary concentrations as described below.

The Weather Research Forecast Model (WRF) was applied for the entire year of 2022 to generate meteorological data supporting emissions and photochemical modeling applications for 2022. WRF was evaluated to ensure that its output fields reasonably represent the actual meteorological conditions during the modeling period. Identifying and quantifying these output fields allows for a downstream assessment of how the air quality modeling results are impacted by the meteorological data. WRF model setup and evaluation for 2022 is described in detail in U.S. EPA (2024).

The meteorological data generated by the WRF simulations were processed using wrfcamx v5.2 meteorological data processing program to create 35-layer gridded model-ready meteorological inputs to CAMx. During the wrfcamx processing, vertical eddy diffusivities (Kv) were calculated using the Yonsei University (YSU) (Hong et al., 2006) mixing scheme. A minimum Kv of 0.1 m2/sec was used, except for urban grid cells where the minimum Kv was reset to 1.0 m2/sec within the lowest 200 m of the surface to enhance mixing associated with the nighttime "urban heat island" effect.

[77] CAMx was run with the following configuration options: CB6r5_CF2E chemistry, ZHANG03 dry deposition scheme, NH_3 Rscale = 0, bi-directional ammonia flux turned off

The 2022 emissions include point sources, nonpoint sources, onroad mobile sources, nonroad mobile sources, biogenic emissions, and fires for the U.S., Canada, and Mexico. Detailed description of the data and methods used to create 2022 emissions are available from U.S. EPA (2025). The primary emissions processing tool used to create the model-ready emissions was the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. SMOKE version 5.1. SMOKE was used to generate emissions files for a 12-km grid covering the continental U.S. A separate photochemical model, the Community Multiscale Air Quality Model (CMAQv5.4) was run to generate biogenic VOC, soil NO, lightning NOx, and fertilizer NH_3.

Two nested CMAQ simulations were conducted to create boundary conditions for the 12-km resolution CAMx simulation. First CMAQv5.4 was run on a hemispheric scale (H-CMAQ). This version of CMAQ is described in more detail by Sarwar et al. (2024). This version of the model augments the v5.4 Carbon Bond 6 chemistry[78] with aerosol nitrate photolysis as proposed by Shah et al. (2023). The H-CMAQ simulation used meteorology derived from a 108 km resolution WRFv4.4.2 simulation using a polar stereographic grid. Both WRF and CMAQ utilize 44 vertical layers extending up to a zero-flux top at 50 hectopascals (hPa). Stratospheric ozone fluxes were parameterized based on potential vorticity. The H-CMAQ simulations used emissions included the following: 1) biogenic VOC and soil NOx emissions developed from emission files for Copernicus Atmosphere Monitoring Service's (CAMS) as documented in U.S. EPA (2021c); 2) wildfire emissions were developed globally from FINN v1.5 (Wiedinmyer et al., 2011); 3) anthropogenic emissions derived from the Hemispheric Transport of Air Pollutants Task Force Phase 3 harmonized emissions (Crippa et al., 2023). The hemispheric CMAQ results were archived at hourly resolution for all 44 layers over the whole domain for initial and boundary conditions. The standard CMAQ preprocessors ICON and BCON were used to extract initial and lateral boundary conditions for the 36-km domain shown in Figure A-1 and vertically interpolate to a 35-layer vertical structure used for the 36-km simulation. CMAQv5.4 (U.S. EPA, 2022b)[79] was then run for the 36-km model domain using boundary conditions generated from the H-CMAQ simulation. Emissions inputs and meteorology for the 36-km CMAQ simulation use the same configurations as described above for the CAMx simulations. Results from the 36-

[78] The Carbon Bond 6 chemistry included full halogen chemistry as described in Sarwar et al (2015).
[79] The 36-km resolution CMAQ simulation did not include nitrate photolysis chemistry which is more important for hemispheric and global runs.

km resolution CMAQ simulation were extracted to create boundary conditions for the 12-km resolution CAMx simulation.

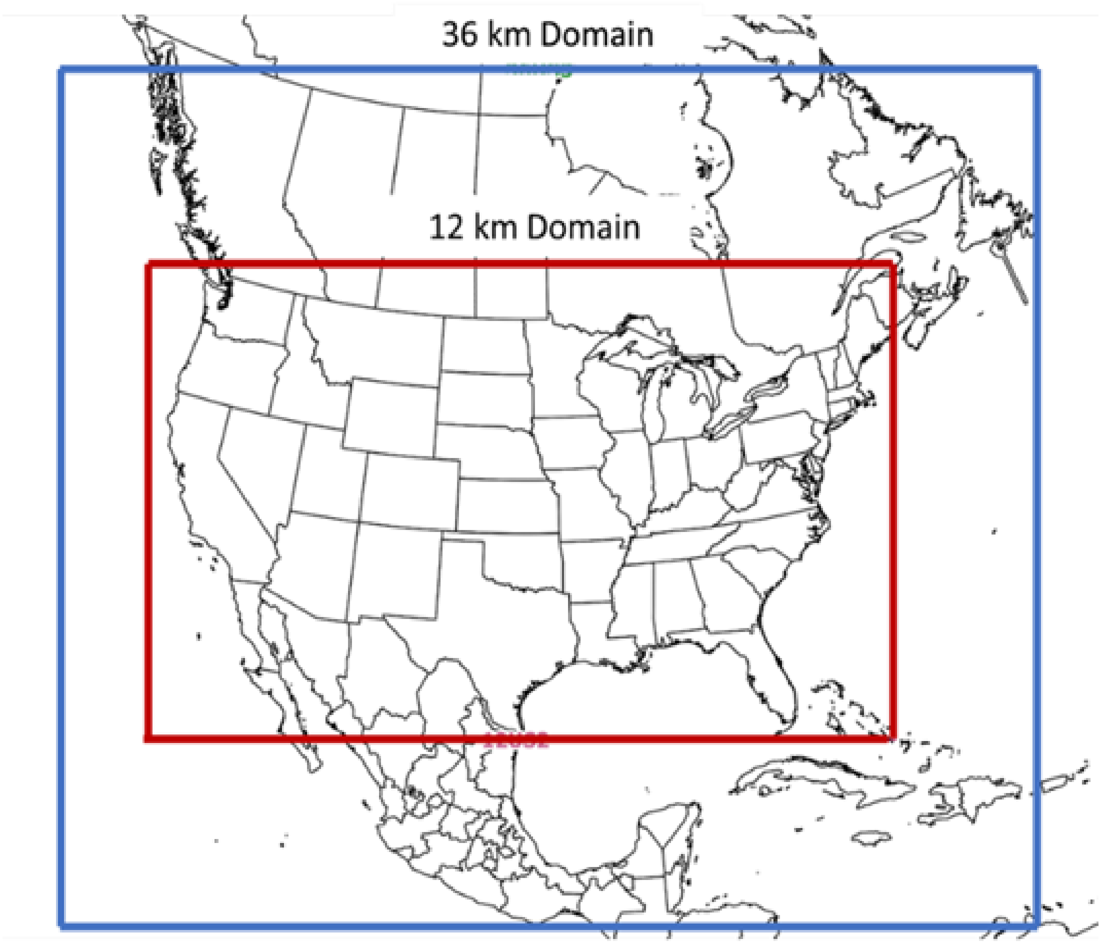

Figure A-1 Air Quality Modeling Domain

Model predictions of ozone and $PM_{2.5}$ concentrations were compared against ambient measurements. Model performance statistics were calculated as described in Simon et al (2012). Statistics were generated for each of the nine National Oceanic and Atmospheric Administration (NOAA) climate regions[80] of the 12-km U.S. modeling domain. The regions[81] include the Northeast, Ohio Valley, Upper Midwest, Southeast, South, Southwest, Northern Rockies/Plains,

[80] NOAA, National Centers for Environmental Information scientists have identified nine climatically consistent regions within the contiguous U.S., http://www.ncdc.noaa.gov/monitoring-references/maps/us-climate-regions.php.
[81] The nine climate regions are defined by States where: Northeast includes CT, DE, ME, MA, MD, NH, NJ, NY, PA, RI, and VT; Ohio Valley includes IL, IN, KY, MO, OH, TN, and WV; Upper Midwest includes IA, MI, MN, and WI; Southeast includes AL, FL, GA, NC, SC, and VA; South includes AR, KS, LA, MS, OK, and TX; Southwest includes AZ, CO, NM, and UT; Northern Rockies includes MT, NE, ND, SD, WY; Northwest includes ID, OR, and WA; and West includes CA and NV.

Northwest, and West[82] as were originally identified in Karl and Koss (1984). Performance statistics are provided in Table A-1 and Table A-2.

The model performance statistics indicate that the 8-hour daily maximum ozone concentrations predicted by the 2022 CAMx simulation closely reflect the corresponding monitored concentrations in space and time in each subregion of the 12-km modeling domain. The 8-hour daily maximum ozone at the AQS and CASTNet sites during 2022 is within ± 15 percent for all climate regions and seasons (regional/seasonal normalized mean bias ranging between -8 to 12 percent) (Table A-1). The CAMx annual Normalized Mean Bias for $PM_{2.5}$ predictions are within ± 30 percent for all regions except the Northern Rockies & Plains (NMB: -37 percent) at AQS sites (Table A-2). Correlation coefficients over the annual period between $PM_{2.5}$ model predictions and observations were greater than 0.4 in seven of nine regions for AQS sites. These performance statistics are generally within the range of model performance statistics reported in the scientific literature for state-of-the-science photochemical models (Simon et al., 2012; Kelly et al, 2019) and recent regulatory applications (e.g., U.S. EPA, 2019, 2020a, 2020b, 2021a, 2022a). This simulation is suitable for use in national scale applications. Ozone and $PM_{2.5}$ model evaluations showed model performance that was adequate for applying these model simulations for the purpose of creating air quality surfaces to estimate summertime ozone and annual $PM_{2.5}$ concentration changes for this action.

Table A-1 CAMx Performance Statistics 8-hour daily maximum ozone at AQS Sites in 2022

Region	Season	N	Mean Observation (ppb)	Mean Model (ppb)	Mean Bias (ppb)	Normalized Mean Bias (%)	Normalized Mean Error (%)	Root Mean Square Error (ppb)	r
Northeast	All	52703	39.8	41.3	1.5	3.9	11.3	5.84	0.84
	Winter	7926	33.9	33.3	-0.6	-1.9	10.3	4.55	0.77
	Spring	16165	42.5	42.9	0.4	1.0	9.2	5.11	0.76
	Summer	16222	44.8	47.6	2.9	6.4	11.4	6.63	0.83
	Fall	12390	33.5	36.1	2.6	7.9	15.0	6.33	0.78
Southeast	All	48275	39.4	41.8	2.4	6.0	12.4	6.39	0.82
	Winter	6842	36.7	38.4	1.7	4.6	10.1	4.92	0.81
	Spring	15220	43.9	44.2	0.2	0.5	9.2	5.26	0.83
	Summer	14520	37.9	42.2	4.3	11.5	16.8	8.03	0.81
	Fall	11693	37.2	40.3	3.1	8.4	13.0	6.20	0.82
Ohio Valley	All	60934	41.6	43.7	2.2	5.2	11.8	6.33	0.83

[82] Most monitoring sites in the West region are located in California, therefore statistics for the West will be mostly representative of California ozone air quality.

	Winter	5499	30.9	33.0	2.0	6.6	12.7	5.00	0.83
	Spring	20427	42.7	43.9	1.2	2.7	9.6	5.35	0.78
	Summer	20107	46.4	49.7	3.3	7.0	12.8	7.45	0.76
	Fall	14901	37.4	39.6	2.2	5.8	13.5	6.37	0.80
Upper Midwest	All	24294	40.2	40.5	0.3	0.7	10.8	5.64	0.83
	Winter	1492	33.3	32.8	-0.5	-1.5	9.8	4.20	0.77
	Spring	8201	42.0	41.6	-0.4	-1.0	8.7	4.71	0.80
	Summer	8620	43.4	43.8	0.4	0.9	11.3	6.29	0.80
	Fall	5981	34.8	36.0	1.2	3.4	13.7	6.11	0.79
South	All	45543	40.5	40.8	0.3	0.6	13.0	6.93	0.82
	Winter	9623	33.7	34.5	0.9	2.6	11.1	4.84	0.86
	Spring	12336	44.2	44.2	0.0	0.0	11.4	6.64	0.77
	Summer	12064	41.3	42.1	0.9	2.1	16.4	8.56	0.78
	Fall	11520	41.5	40.9	-0.6	-1.5	12.7	6.79	0.84
Southwest	All	46026	48.0	46.3	-1.6	-3.4	11.5	7.30	0.74
	Winter	10447	39.2	38.7	-0.5	-1.4	13.8	7.15	0.56
	Spring	11922	51.1	50.0	-1.1	-2.1	9.6	6.42	0.61
	Summer	12266	55.8	52.2	-3.6	-6.4	12.5	9.08	0.51
	Fall	11391	44.3	43.1	-1.2	-2.6	10.7	6.02	0.76
Northern Rockies & Plains	All	16891	42.1	40.3	-1.8	-4.3	11.3	6.10	0.75
	Winter	4042	38.0	35.1	-2.9	-7.6	12.6	6.02	0.65
	Spring	4278	44.6	43.0	-1.5	-3.4	9.1	5.36	0.64
	Summer	4335	47.1	45.9	-1.2	-2.6	11.8	7.03	0.64
	Fall	4236	38.3	36.7	-1.6	-4.1	12.0	5.86	0.76
Northwest	All	6337	37.7	38.3	0.7	1.8	14.0	6.96	0.77
	Winter	803	32.3	31.8	-0.5	-1.5	18.8	7.76	0.67
	Spring	1672	39.1	40.0	1.0	2.5	11.6	5.90	0.63
	Summer	2521	39.1	39.5	0.5	1.2	13.7	7.19	0.81
	Fall	1341	36.5	37.9	1.3	3.6	15.2	7.21	0.75
West	All	60629	44.5	43.8	-0.7	-1.6	13.4	7.93	0.80
	Winter	13437	34.9	38.0	3.1	8.8	17.4	8.21	0.55
	Spring	15970	47.4	46.5	-0.9	-1.9	10.4	6.52	0.73
	Summer	16392	49.8	46.9	-2.9	-5.8	14.1	9.14	0.83
	Fall	14830	44.2	42.6	-1.6	-3.5	12.9	7.63	0.79

Table A-2 CAMx Performance Statistics for 24-hr average $PM_{2.5}$ at AQS Sites in 2022

Region	Season	N	Mean Observation (µg m-3)	Mean Model (µg m-3)	Mean Bias (µg m-3)	Normalized Mean Bias (%)	Normalized Mean Error (%)	Root Mean Square Error (µg m-3)	r
Northeast	All	94803	6.86	8.41	1.55	22.6	46.4	5.29	0.59
	Winter	22620	8.12	10.50	2.38	29.3	50.6	6.50	0.63
	Spring	24144	6.03	7.78	1.75	29.0	46.2	4.49	0.62
	Summer	24631	7.12	6.81	-0.31	-4.3	34.4	4.02	0.51
	Fall	23408	6.23	8.74	2.51	40.3	55.8	5.91	0.55
Southeast	All	73423	7.67	7.75	0.08	1.1	34.4	3.75	0.59
	Winter	17747	7.91	9.04	1.13	14.3	38.4	4.37	0.65
	Spring	18413	7.81	7.72	-0.09	-1.2	32.0	3.64	0.63
	Summer	18996	7.63	6.85	-0.78	-10.2	34.7	3.67	0.42

	Fall	18267	7.33	7.46	0.14	1.9	32.6	3.26	0.62
Ohio Valley	All	87586	8.24	8.41	0.17	2.1	32.1	3.96	0.63
	Winter	21179	8.85	9.48	0.63	7.1	35.5	4.46	0.68
	Spring	22061	7.32	7.80	0.47	6.5	30.2	3.10	0.71
	Summer	22341	8.66	7.61	-1.05	-12.1	30.5	4.11	0.38
	Fall	22005	8.15	8.81	0.66	8.1	32.1	4.08	0.69
Upper Midwest	All	50413	7.33	7.03	-0.30	-4.1	34.1	3.67	0.71
	Winter	12399	8.35	8.20	-0.15	-1.8	34.2	4.08	0.72
	Spring	12210	6.35	6.57	0.22	3.5	36.1	3.51	0.68
	Summer	12422	6.78	5.41	-1.38	-20.3	36.2	3.52	0.42
	Fall	13382	7.79	7.89	0.09	1.2	30.9	3.54	0.81
South	All	50911	8.62	6.81	-1.81	-21.0	41.8	5.43	0.37
	Winter	12261	7.40	7.16	-0.24	-3.2	40.9	4.64	0.48
	Spring	12861	9.06	7.30	-1.76	-19.5	39.0	5.08	0.49
	Summer	12952	9.54	5.16	-4.38	-45.9	53.2	7.43	0.17
	Fall	12837	8.43	7.65	-0.78	-9.3	32.6	3.86	0.57
Southwest	All	40373	6.42	4.84	-1.59	-24.7	51.8	5.32	0.35
	Winter	9912	8.01	6.11	-1.91	-23.8	59.5	7.47	0.32
	Spring	10299	5.96	5.17	-0.79	-13.2	45.6	4.42	0.29
	Summer	10111	5.89	3.24	-2.65	-45.0	52.5	4.48	0.16
	Fall	10051	5.87	4.85	-1.01	-17.3	47.0	4.32	0.47
Northern Rockies & Plains	All	25372	5.67	3.57	-2.10	-37.0	51.2	4.75	0.64
	Winter	6135	5.28	3.02	-2.26	-42.8	56.6	4.98	0.40
	Spring	6286	4.10	3.45	-0.65	-15.9	43.9	2.65	0.46
	Summer	6522	5.74	2.91	-2.84	-49.4	55.3	4.28	0.29
	Fall	6429	7.52	4.90	-2.62	-34.8	48.2	6.32	0.76
Northwest	All	52038	7.58	7.26	-0.32	-4.2	64.0	13.60	0.58
	Winter	12806	8.13	6.85	-1.28	-15.8	76.5	8.96	0.17
	Spring	13327	3.81	5.01	1.20	31.4	73.7	5.85	0.18
	Summer	13174	5.19	4.84	-0.35	-6.7	50.6	7.60	0.49
	Fall	12731	13.46	12.55	-0.91	-6.7	58.9	24.20	0.62
West	All	72477	8.00	5.90	-2.10	-26.2	46.3	7.00	0.54
	Winter	18018	9.34	7.13	-2.21	-23.7	48.9	7.31	0.57
	Spring	18145	6.93	5.74	-1.20	-17.3	40.2	4.60	0.42
	Summer	17956	7.14	4.49	-2.65	-37.1	48.2	6.91	0.50
	Fall	18358	8.58	6.24	-2.35	-27.3	46.8	8.56	0.57

The contributions to ozone and $PM_{2.5}$ component species (e.g., sulfate, nitrate, ammonium, elemental carbon (EC), organic aerosol (OA), and crustal material[83]) from EGU emissions in individual states were modeled using the "source apportionment" tool approach. In general, source apportionment modeling quantifies the air quality concentrations formed from individual, user-defined groups of emissions sources or "tags". These source tags are tracked through the transport, dispersion, chemical transformation, and deposition processes within the

[83]Crustal material refers to elements that are commonly found in the earth's crust such as Aluminum, Calcium, Iron, Magnesium, Manganese, Potassium, Silicon, Titanium, and the associated oxygen atoms.

model to obtain hourly gridded contributions from the emissions in each individual tag to hourly gridded[84] modeled concentrations. For this RIA we used the source apportionment contribution data to provide a means to estimate of the effect of changes in emissions from each group of emissions sources (i.e., each tag) to changes in ozone and $PM_{2.5}$ concentrations. Specifically, we applied outputs from source apportionment modeling for ozone and $PM_{2.5}$ component species using the 2022 modeled case to obtain the contributions from EGU emissions in each state to ozone and $PM_{2.5}$ component species concentrations in each 12-km model grid cell nationwide. Ozone contributions were modeled using the Anthropogenic Precursor Culpability Assessment (APCA) tool and $PM_{2.5}$ contributions were modeled using the Particulate Matter Source Apportionment Technology (PSAT) tool (Ramboll, 2022). The ozone source apportionment modeling was performed for the period April through September to provide data for developing spatial fields for the April through September maximum daily eight-hour (MDA8) (i.e., AS-MO3) average ozone concentration. The $PM_{2.5}$ source apportionment modeling was performed for a full year to provide data for developing annual average $PM_{2.5}$ spatial fields. Table A-3 provides emissions that were tracked for each state-level EGU source apportionment tag.

Examples of the magnitude and spatial extent of ozone and $PM_{2.5}$ contributions are provided in Figure A-2 through Figure A-5 for EGUs in California, Missouri, Iowa, and Ohio. These figures show how the magnitude and the spatial patterns of contributions of EGU emissions to ozone and $PM_{2.5}$ component species depend on multiple factors including the magnitude and location of emissions as well as the atmospheric conditions that influence the formation and transport of these pollutants. For instance, NO_X emissions are a precursor to both ozone and $PM_{2.5}$ nitrate. However, ozone and nitrate form under very different types of atmospheric conditions, with ozone formation occurring in locations with ample sunlight and ambient VOC concentrations while nitrate formation requires colder and drier conditions and the presence of gas-phase ammonia. California's complex terrain that tends to trap air and allow pollutant build-up combined with warm sunny summer and cooler dry winters and sources of both ammonia and VOCs make its atmosphere conducive to formation of both ozone and nitrate. While the magnitude of EGU NO_X emissions from gas plus coal EGUs is substantially larger in Iowa, Missouri and Ohio than in California (Table A-3) the emissions from California lead to

[84] Hourly contribution information is provided for each grid cell to provide spatial patterns of the contributions from each tag

similar contributions to ozone and larger contributions to nitrate due to the conducive conditions in that state. California EGU SO_2 emissions in the 2022 apportionment modeling are over an order of magnitude smaller than SO_2 emissions in Iowa, Ohio and Missouri (Table A-3) leading to much smaller sulfate contributions from California EGUs than from Iowa, Ohio and Missouri EGUs. $PM_{2.5}$ Crustal Material EGU contributions in this modeling come from primary $PM_{2.5}$ emissions rather than secondary atmospheric formation. Consequently, the impacts of EGU emissions on this pollutant tend to occur closer to the EGU sources than impacts of secondary pollutants (ozone, nitrate, and sulfate) which have spatial patterns showing a broader regional impact. These patterns demonstrate how the model captures important atmospheric processes which impact pollutant formation and transport from emissions sources. Finally, Figure A-6 shows EGU ozone and $PM_{2.5}$ contributions from all contiguous U.S. EGUs. The spatial patterns of EGU contributions reflect the location and magnitude of emissions from EGU sources in 2022.

Table A-3 2022 Emissions Allocated to Each Modeled EGU State Source Apportionment Tag

State	Ozone Season NO_X (tons)	Annual NO_X (tons)	Annual SO_2 (tons)	Annual $PM_{2.5}$ (tons)
AL	8,706	16,510	3,722	1,849
AR	9,026	17,016	30,915	1,158
AZ	8,643	15,668	7,371	1,748
CA	3,091	5,875	1,431	1,139
CO	9,411	17,779	10,451	1,244
CT	1,498	3,076	661	346
DC	0	0	0	0
DE	484	911	505	157
FL	20,581	38,818	13,978	6,953
GA	8,259	20,637	9,246	2,090
IA	9,376	16,967	23,074	1,115
ID	789	1,559	87	202
IL	9,975	20,576	45,355	1,657
IN	17,407	41,681	35,236	4,955
KS	7,675	13,555	4,391	1,042
KY	15,405	31,990	45,010	3,056
LA	17,347	31,108	27,677	3,190
MA	2,879	5,584	1,214	303
MD	2,164	4,405	3,837	513
ME	1,725	3,594	1,365	566
MI	15,294	29,160	43,848	1,813
MN	6,938	14,492	5,656	830
MO	18,773	48,206	95,515	3,647
MS	9,477	16,334	3,465	1,605
MT	4,653	10,460	7,755	1,300
NC	13,804	26,866	10,241	2,125
ND	14,373	28,899	33,754	2,577
NE	10,737	20,179	44,275	492
NH	572	1,504	541	210
NJ	2,406	4,835	741	504
NM	5,794	10,125	2,731	1,346
NV	2,571	4,488	3,714	1,221
NY	7,418	13,762	2,996	1,498
OH	11,742	31,934	68,460	4,779
OK	11,060	18,700	12,780	1,085
OR	1,250	2,775	158	502
PA	10,562	27,252	40,227	4,678
RI	162	302	10	82
SC	7,299	14,017	7,192	2,169
SD	753	1,144	784	28
TN	4,752	8,262	10,144	1,803

TX	52,832	93,615	129,263	12,484
UT	15,267	28,092	8,808	1,774
VA	6,619	12,598	2,663	1,859
VT	75	194	2	44
WA	3,399	7,659	1,537	706
WI	5,815	10,986	4,586	838
WV	14,379	30,158	45,043	5,226
WY	13,119	26,412	27,003	1,299

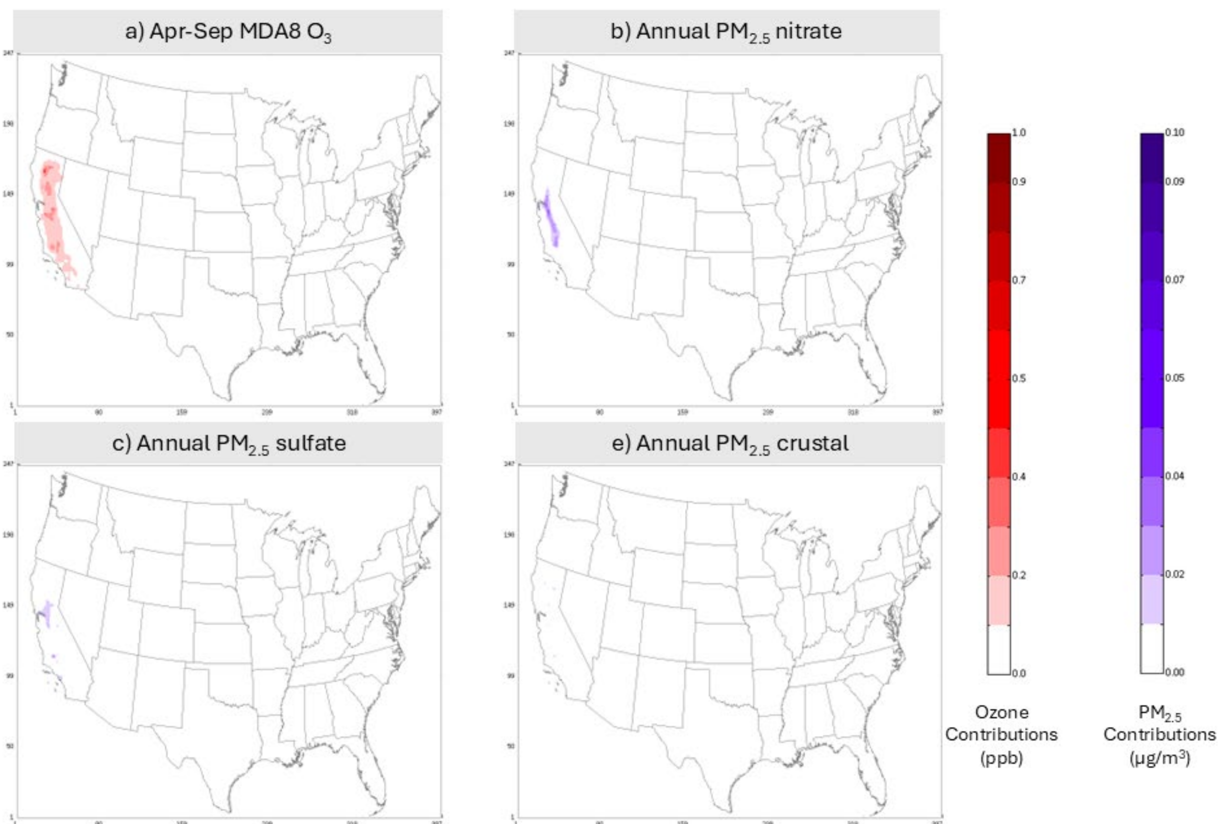

Figure A-2 Maps of California EGU tag contributions to a) April-September seasonal average 8-hour daily maximum ozone (ppb); b) annual average PM2.5 nitrate (µg/m3); c) annual average PM2.5 sulfate (µg/m3); d) annual average PM2.5 crustal material (µg/m3)

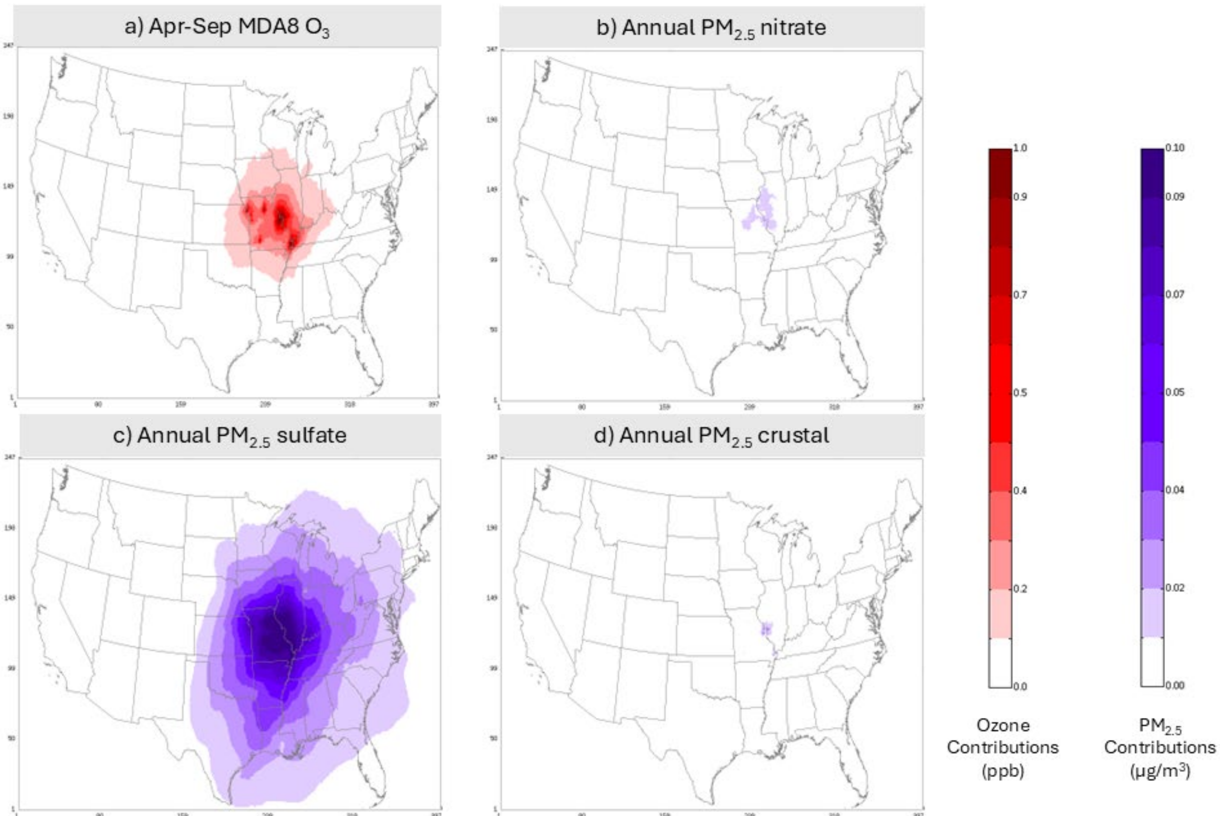

Figure A-3 Maps of Missouri EGU tag contributions to a) April-September seasonal average 8-hour daily maximum ozone (ppb); b) annual average $PM_{2.5}$ nitrate ($\mu g/m^3$); c) annual average $PM_{2.5}$ sulfate ($\mu g/m^3$); d) annual average $PM_{2.5}$ crustal material ($\mu g/m^3$)

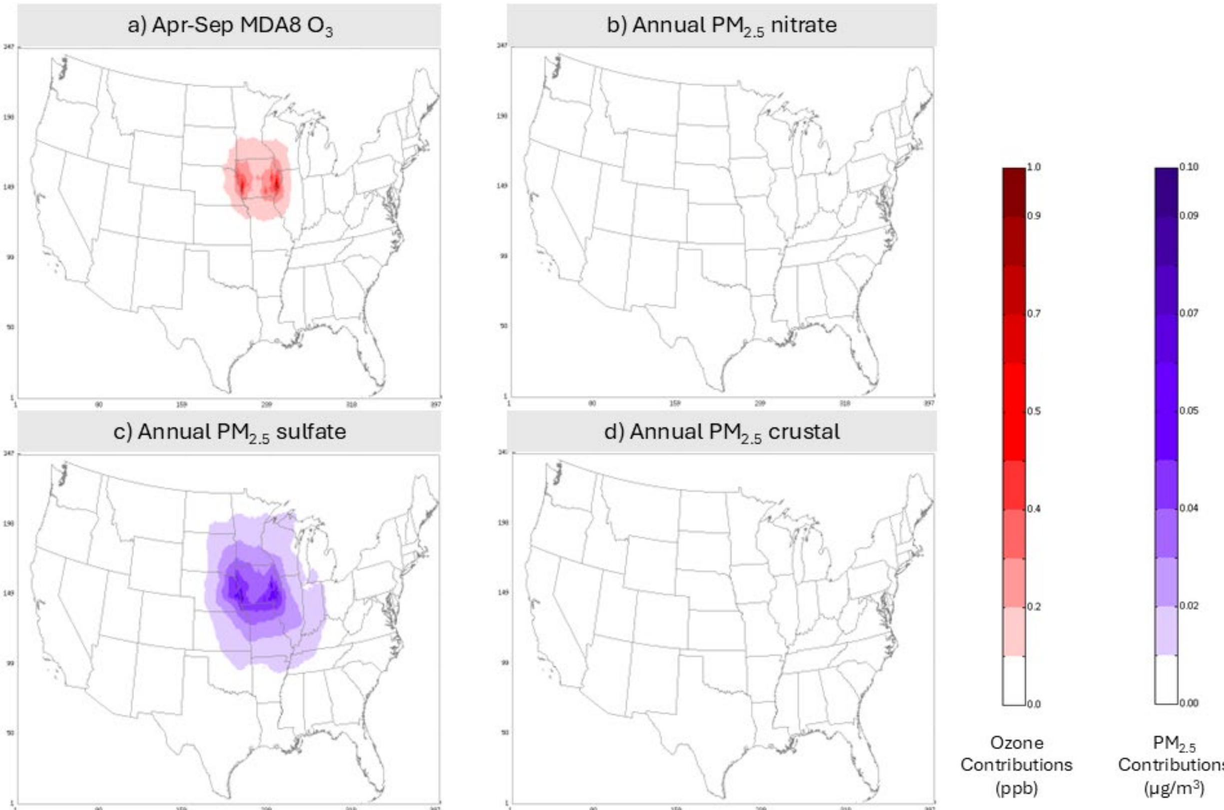

Figure A-4 Maps of Iowa EGU tag contributions to a) April-September seasonal average 8-hour daily maximum ozone (ppb); b) annual average PM2.5 nitrate (µg/m3); c) annual average PM2.5 sulfate (µg/m3); d) annual average PM2.5 crustal material (µg/m3)

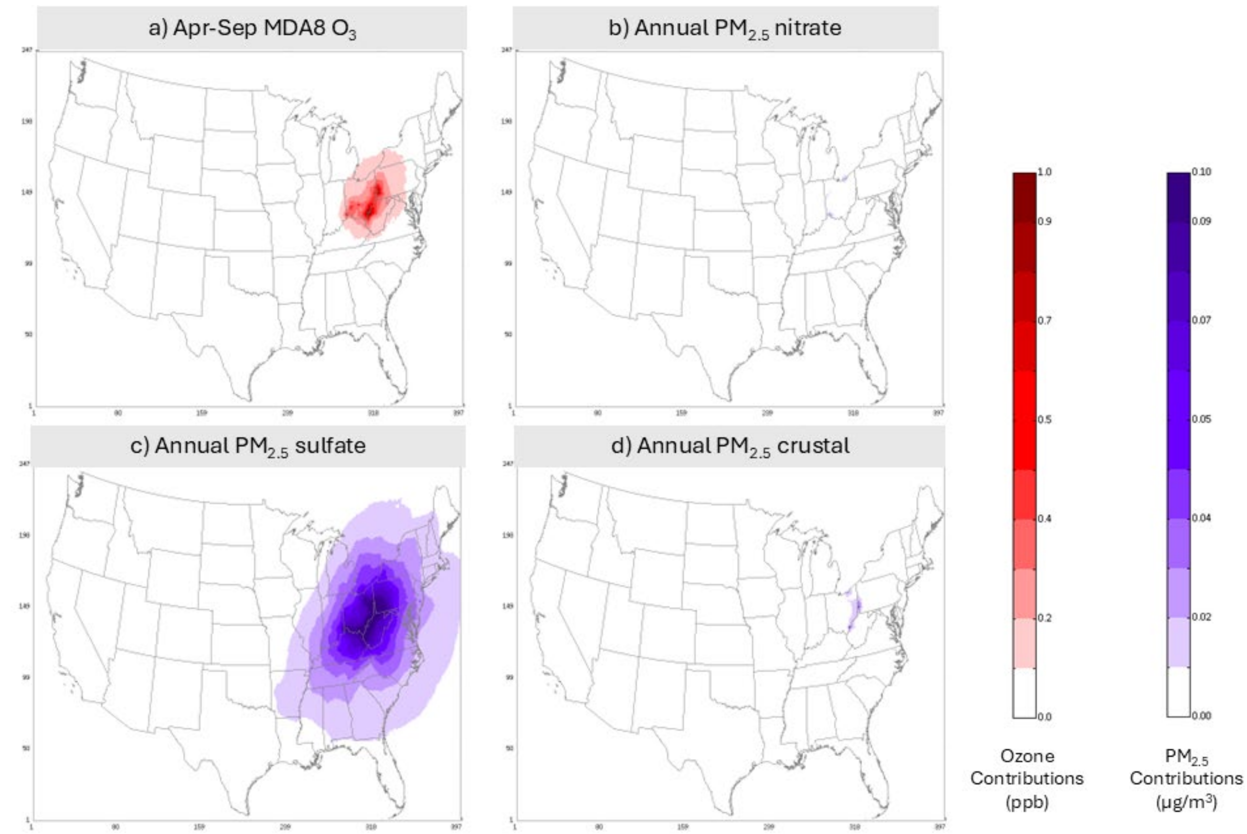

Figure A-5 Maps of Ohio EGU tag contributions to a) April-September seasonal average 8-hour daily maximum ozone (ppb); b) annual average $PM_{2.5}$ nitrate (µg/m^3); c) annual average $PM_{2.5}$ sulfate (µg/m^3); d) annual average $PM_{2.5}$ crustal material (µg/m^3)

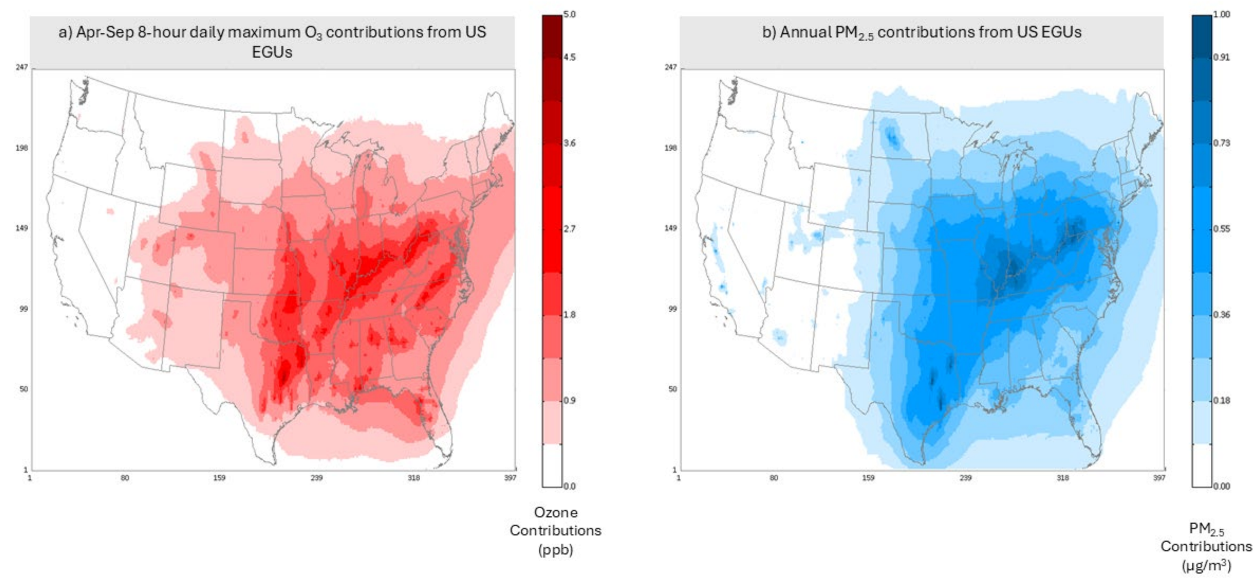

Figure A-6 Maps of National EGU Tag contributions to April-September Seasonal Average 8-hour daily maximum ozone (ppb) and Annual Average PM2.5 (µg/m3) from all tagged EUGs

A.3 Applying Modeling Outputs to Create Spatial Fields

In this section we describe the method for creating spatial fields of AS-MO3 and annual average $PM_{2.5}$ based on the 2022 base year modeling. The foundational data include (1) ozone and speciated $PM_{2.5}$ concentrations in each model grid cell from the 2022 base year modeling, (2) contributions of 2022 EGU emissions to ozone and speciated $PM_{2.5}$ concentrations in each model grid cell, (3) 2022 emissions from EGUs that were inputs to the contribution modeling (Table A-3), and (4) the EGU emissions from IPM for the Baseline (with MATS RTR) and Final Repeal scenarios in each snapshot year. The method to create spatial fields applies scaling factors to gridded 2022 source apportionment contributions based on emissions changes between 2022 and the Baseline (with MATS RTR) and Final Repeal scenarios in the snapshot years. This method is described in detail below.

Spatial fields of 2022 base year ozone and $PM_{2.5}$ were created based on "fusing" modeled data with measured concentrations at air quality monitoring locations. To create the spatial fields for each snapshot year emissions scenario, the fused 2022 base year model fields are used in combination with the EGU source apportionment modeling and the EGU emissions for each scenario and snapshot year. Contributions from each state EGU contribution "tag" were scaled based on the ratio of emissions in the year/scenario being evaluated to the 2022 emissions. Contributions from tags representing sources other than EGUs are held constant at 2022 levels for each of the scenarios and snapshot years. For each scenario and snapshot year analyzed, the scaled contributions from all sources were summed together to create a gridded surface of total modeled ozone and PM2.5. The process is described in a step-by-step manner below starting with the methodology for creating AS-MO3 spatial fields followed by a description of the steps for creating annual $PM_{2.5}$ spatial fields.

Ozone:

1. Create fused spatial fields of 2022 AS-MO3 incorporating information from the air quality modeling and from ambient measured monitoring data. The enhanced Voronoi Neighbor Average (eVNA) technique (Ding et al., 2016; Gold et al., 1997; U.S. EPA, 2007) was applied to ozone model predictions in conjunction with measured data to create modeled/measured fused surfaces that leverage measured concentrations at air quality monitor locations and model predictions at locations with no monitoring data. The AS-MO3

eVNA spatial fields are created for the 2022 base year with EPA's software package, Software for the Modeled Attainment Test – Community Edition (SMAT-CE)[85] (U.S. EPA, 2022c) using 5 years of monitoring data (2020-2024) and the 2022 modeled data.

2. Create gridded spatial fields of total EGU AS-MO3 contributions for each combination of scenario and snapshot year evaluated.

a. Use the EGU ozone season NO_X emissions for the 2028 Baseline (with MATS RTR) and the corresponding 2022 modeled EGU ozone season emissions (Table A-3) to calculate the ratio of 2028 Baseline (with MATS RTR) emissions to 2022 emissions for each EGU tag (i.e., an ozone scaling factor calculated for each state EGU tag)[86]. These scaling factors are provided in Table A-4.

b. Calculate adjusted gridded AS-MO3 EGU contributions that reflect differences in state EGU NO_X emissions between the 2022 base year and the 2028 Baseline (with MATS RTR) by multiplying the ozone season NO_X scaling factors by the corresponding gridded AS-MO3 ozone contributions[87] from each state EGU tag.

c. Add together the adjusted AS-MO3 contributions for each state EGU tag to produce spatial fields of adjusted EGU totals for the 2028 Baseline (with MATS RTR) scenario[88].

d. Repeat steps 2a through 2c for the 2028 Final Repeal scenario and for the Baseline (with MATS RTR) and Final Repeal scenarios for each additional snapshot year. All scaling factors for the Baseline (with MATS RTR) and Final Repeal scenarios are provided in Table A-4.

3. Create a gridded spatial field of AS-MO3 associated with IPM emissions for the 2028 Baseline (with MATS RTR) by combining the EGU AS-MO3 contributions from step

[85] SMAT-CE available for download at *https://www.epa.gov/scram/photochemical-modeling-tools*.
[86] Preliminary testing of this methodology showed unstable results when very small magnitudes of emissions were tagged especially when being scaled by large factors. To mitigate this issue, in cases where state EGU tags were associated with no or very small emissions, tags were combined into multi-state regions.
[87] The source apportionment modeling provided separate ozone contributions for ozone formed in VOC-limited chemical regimes (O3V) and ozone formed in NO_X-limited chemical regimes (O3N). The emissions scaling factors are multiplied by the corresponding O3N gridded contributions to MDA8 concentrations. Since there are no predicted changes in VOC emissions between the Baseline (with MATS RTR) and Final Repeal scenarios, the O3V contributions remain unchanged.
[88] The contributions from the unaltered O3V tags are added to the summed adjusted O3N EGU tags.

(2c) with the corresponding contributions to AS-MO3 from all other sources. Repeat for each of the EGU contributions created in step (2d) to create separate gridded spatial fields for the Baseline (with MATS RTR) and Final Repeal scenarios for each snapshot year.

Steps 2 and 3 in combination can be represented by equation 1:

$$\text{AS-MO3}_{g,i,y} = \text{eVNA}_{g,2022} \times \left(\frac{C_{g,BC}}{C_{g,Tot}} + \frac{C_{g,int}}{C_{g,Tot}} + \frac{C_{g,bio}}{C_{g,Tot}} + \frac{C_{g,fires}}{C_{g,Tot}} + \frac{C_{g,USanthro}}{C_{g,Tot}} + \sum_{t=1}^{T} \frac{C_{EGUVOC,g,t}}{C_{g,Tot}} + \sum_{t=1}^{T} \frac{C_{EGUNOx,g,t}\, S_{NOx,t,i,y}}{C_{g,Tot}} \right) \qquad \text{Eq-1}$$

- $AS\text{-}MO3_{g,i,y}$ is the *estimated* fused model-obs AS-MO3 for grid-cell, "g", scenario, "i"[89], and year, "y"[90];
- $eVNA_{g,2022}$ is the 2022 base year eVNA *future* year AS-MO3 concentration for grid-cell "g";
- $C_{g,Tot}$ is the total modeled AS-MO3 for grid-cell "g" from all sources in the 2022 base source apportionment modeling;
- $C_{g,BC}$ is the 2022 base year AS-MO3 modeled contribution from the modeled boundary inflow;
- $C_{g,int}$ is the 2022 base year AS-MO3 modeled contribution from international emissions within the modeling domain;
- $C_{g,bio}$ is the 2022 base year AS-MO3 modeled contribution from biogenic emissions;
- $C_{g,fires}$ is the 2022 base year AS-MO3 modeled contribution from fires;
- $C_{g,USanthro}$ is the total 2022 base year AS-MO3 modeled contribution from U.S. anthropogenic sources other than EGUs;
- $C_{EGUVOC,g,t}$ is the 2022 base year AS-MO3 modeled contribution from EGU emissions of VOCs from state, "t";
- $C_{EGUNOx,g,t}$ is the 2022 base year AS-MO3 modeled contribution from EGU emissions of NO_X from tag, "t"; and
- $S_{NOx,t,i,y}$ is the EGU NO_X scaling factor for tag, "t", scenario "i", and year, "y".

[89] Scenario "i" can represent either the Baseline (with MATS RTR) or the Final Repeal scenario
[90] Snapshot year "y" can represent 2028, 2030, or 2035

PM2.5:

4. Create fused spatial fields of 2022 base year annual $PM_{2.5}$ component species incorporating information from the air quality modeling and from ambient measured monitoring data. The eVNA technique was applied to $PM_{2.5}$ component species model predictions in conjunction with measured data to create modeled/measured fused surfaces that leverage measured concentrations at air quality monitor locations and model predictions at locations with no monitoring data. The quarterly average $PM_{2.5}$ component species eVNA spatial fields are created for the 2022 base year with EPA's SMAT-CE software package using 5 years of $PM_{2.5}$ monitoring data (2020-2024), 3 years of $PM_{2.5}$ speciation data (2021-2023) and the 2022 modeled data. 5. Create gridded spatial fields of total EGU speciated $PM_{2.5}$ contributions for each combination of scenario and snapshot year.

a. Use the EGU annual total NO_X, SO_2, and $PM_{2.5}$ emissions for the 2028 Baseline scenario (with MATS RTR) and the corresponding 2022 base year modeled EGU NO_X, SO_2, and $PM_{2.5}$ emissions from Table A-3 to calculate the ratio of 2028 Baseline (with MATS RTR) emissions to 2022 base year modeled emissions for each state EGU contribution tag (i.e., annual nitrate, sulfate and directly emitted $PM_{2.5}$ scaling factors calculated for each state tag)[91]. These scaling factors are provided in Table A-5 through Table A-7.

b. Calculate adjusted gridded annual $PM_{2.5}$ component species EGU contributions that reflect differences in state EGU NO_X, SO_2, and primary $PM_{2.5}$ emissions between the 2022 base year and the 2028 Baseline (with MATS RTR) by multiplying the annual nitrate, sulfate and directly emitted $PM_{2.5}$ scaling factors by the corresponding annual gridded $PM_{2.5}$ component species contributions from each state EGU tag[92]

[91] Preliminary testing of this methodology showed unstable results when very small magnitudes of emissions were tagged especially when being scaled by large factors. To mitigate this issue, in cases where state EGU tags were associated with no or very small emissions, tags were combined into multi-state regions.

[92] Scaling factors for components that are formed through chemical reactions in the atmosphere were created as follows: scaling factors for sulfate were based on relative changes in annual SO_2 emissions; scaling factors for nitrate were based on relative changes in annual NO_X emissions. Scaling factors for $PM_{2.5}$ components that are emitted directly from the source (OA, EC, crustal) were based on the relative changes in annual primary $PM_{2.5}$ emissions between the 2022 base year modeled emissions and the Baseline (with MATS RTR) and the Final Repeal scenarios in each snapshot year.

c. Add together the adjusted $PM_{2.5}$ contributions of for each EGU state tag to produce spatial fields of adjusted EGU totals for each $PM_{2.5}$ component species.

d. Repeat steps 5a through 5c for the Final Repeal scenario in 2028 and for the Baseline (with MATS RTR) and Final Repeal scenarios for each additional snapshot year. The scaling factors for all $PM_{2.5}$ component species for the Baseline (with MATS RTR) and Final Repeal scenarios are provided in Table A-5 through Table A-7.

6. Create gridded spatial fields of each $PM_{2.5}$ component species for the 2028 Baseline (with MATS RTR) by combining the EGU annual $PM_{2.5}$ component species contributions from step (5c) with the corresponding contributions to annual $PM_{2.5}$ component species from all other sources. Repeat for each of the EGU contributions created in step (5d) to create separate gridded spatial fields for the Baseline (with MATS RTR) and Final Repeal scenarios for all other snapshot years.

7. Create gridded spatial fields of total $PM_{2.5}$ mass by combining the component species surfaces for sulfate, nitrate, organic aerosol, elemental carbon and crustal material with ammonium, and particle-bound water. Ammonium and particle-bound water concentrations are calculated for each scenario based on nitrate and sulfate concentrations along with the ammonium degree of neutralization in the 2022 base year modeling in accordance with equations from the SMAT-CE modeling software (U.S. EPA, 2022c).

Steps 5 and 6 result in Eq-2 for $PM_{2.5}$ component species: sulfate, nitrate, organic aerosol, elemental carbon and crustal material.

$$\mathrm{PM}_{s,g,i,y} = \mathrm{eVNA}_{s,g,2022} \times \left(\frac{C_{s,g,BC}}{C_{s,g,Tot}} + \frac{C_{s,g,int}}{C_{s,g,Tot}} + \frac{C_{s,g,bio}}{C_{s,g,Tot}} + \frac{C_{s,g,fires}}{C_{s,g,Tot}} + \frac{C_{s,g,USanthro}}{C_{s,g,Tot}} + \sum_{t=1}^{T} \frac{C_{EGUs,g,t}\, S_{s,t,i,y}}{C_{s,g,Tot}} \right) \qquad \text{Eq-2}$$

- $PM_{s,g,i,y}$ is the estimated fused model-obs PM component species "s" for grid-cell, "g", scenario, "i"[93], and year, "y"[94];
- $eVNA_{s,g,2022}$ is the 2022 base year eVNA PM concentration for component species "s" in grid-cell "g".
- $C_{s,g,Tot}$ is the total modeled PM component species "s" for grid-cell "g" from all sources in the 2022 base year source apportionment modeling
- $C_{s,g,BC}$ is the 2022 base year PM component species "s" modeled contribution from the modeled boundary inflow;
- $C_{s,g,int}$ is the 2022 base year PM component species "s" modeled contribution from international emissions within the modeling domain;
- $C_{s,g,bio}$ is the 2022 base year PM component species "s" modeled contribution from biogenic emissions;
- $C_{s,g,fires}$ is the 2022 base year PM component species "s" modeled contribution from fires;
- $C_{s,g,USanthro}$ is the total 2022 base year PM component species "s" modeled contribution from U.S. anthropogenic sources other than EGUs;
- $C_{EGUs,g,t}$ is the 2022 base year PM component species "s" modeled contribution from EGU emissions of NO_X, SO_2, or primary $PM_{2.5}$ from tag, "t"; and
- $S_{s,t,i,y}$ is the EGU scaling factor for component species "s", tag, "t", scenario "i", and snapshot year, "y". Scaling factors for nitrate are based on annual NO_X emissions, scaling factors for sulfate are based on annual SO_2 emissions, scaling factors for primary $PM_{2.5}$ components are based on primary $PM_{2.5}$ emissions.

A.4 Scaling Factors Applied to Source Apportionment Tags

Table A-4 Baseline (with MATS RTR) and Final Repeal Scenario Ozone Season NO_X Scaling Factors for EGU Tags

	Baseline (with MATS RTR)			Final Repeal		
State Tag	**2028**	**2030**	**2035**	**2028**	**2030**	**2035**
AL	0.63	0.66	0.63	0.63	0.66	0.63
AR	0.86	0.84	0.80	0.86	0.84	0.80
AZ	0.15	0.46	0.55	0.15	0.46	0.55
CA	0.67	0.81	1.37	0.67	0.81	1.37
CO	0.34	0.08	0.05	0.34	0.08	0.05

93 Scenario "i" can represent either the Baseline (with MATS RTR) scenario or the Final Repeal scenario.
94 Snapshot year "y" can represent 2028, 2030, or 2035

CT	0.91	0.89	0.79	0.91	0.89	0.79
*MD_DC	0.66	0.57	0.49	0.66	0.57	0.49
DE	0.81	0.81	0.33	0.81	0.81	0.33
FL	0.56	0.55	0.45	0.56	0.55	0.45
GA	0.23	0.62	0.76	0.23	0.62	0.76
IA	1.11	1.17	1.15	1.11	1.17	1.15
ID	0.44	1.16	1.10	0.44	1.16	1.10
IL	0.38	0.28	0.26	0.38	0.28	0.26
IN	0.69	0.69	0.69	0.69	0.69	0.69
KS	0.83	0.95	0.83	0.83	0.95	0.83
KY	0.73	0.89	0.69	0.73	0.89	0.69
LA	0.50	0.59	0.39	0.50	0.59	0.39
MA	0.81	0.82	0.76	0.81	0.82	0.76
ME	0.42	0.42	0.42	0.42	0.42	0.42
MI	0.57	0.41	0.33	0.57	0.41	0.33
MN	0.52	0.56	0.52	0.52	0.56	0.52
MO	0.70	0.59	0.60	0.70	0.59	0.60
MS	0.27	0.26	0.23	0.27	0.26	0.23
MT	0.94	0.94	1.04	0.94	0.94	1.04
NC	0.99	0.22	0.17	0.99	0.22	0.17
ND	0.64	0.94	0.80	0.64	0.91	0.78
NE	0.90	0.93	0.89	0.90	0.93	0.89
*NH_VT	0.85	0.88	0.37	0.85	0.88	0.37
NJ	0.92	0.90	0.74	0.92	0.90	0.74
NM	0.35	0.33	0.28	0.35	0.33	0.28
NV	0.30	0.36	0.32	0.30	0.36	0.32
NY	0.71	0.69	0.61	0.71	0.69	0.61
OH	0.62	0.68	0.61	0.62	0.68	0.61
OK	0.53	0.80	0.54	0.53	0.81	0.54
OR	0.62	0.00	0.00	0.62	0.00	0.00
PA	1.34	1.20	0.98	1.34	1.20	0.98
RI	0.43	0.57	0.66	0.44	0.57	0.67
SC	0.92	1.28	1.01	0.92	1.28	1.01
SD	0.77	0.83	0.86	0.77	0.83	0.86
TN	0.48	0.25	0.14	0.48	0.25	0.14
TX	0.60	0.61	0.53	0.60	0.61	0.53
UT	0.58	0.63	0.65	0.58	0.63	0.65
VA	0.65	0.53	0.45	0.65	0.53	0.45
WA	0.23	0.28	0.32	0.23	0.28	0.32
WI	0.48	0.61	0.43	0.48	0.61	0.43
WV	0.97	1.02	1.08	0.97	1.02	1.08
WY	0.62	0.63	0.64	0.62	0.63	0.64

*States with low total EGU emissions were grouped with nearby states. In these cases, scaling factors were developed for multi-state regions

Table A-5 Baseline (with MATS RTR) and Final Repeal Scenario Annual NO_X Scaling Factors for EGU Tags

	Baseline (with MATS RTR)			Final Repeal		
State Tag	**2028**	**2030**	**2035**	**2028**	**2030**	**2035**
AL	0.69	0.75	0.73	0.69	0.75	0.73
AR	1.05	0.93	0.94	1.05	0.95	0.94
AZ	0.29	0.59	0.70	0.29	0.59	0.70
CA	1.01	1.37	1.86	1.01	1.38	1.86
CO	0.44	0.12	0.09	0.44	0.12	0.09
CT	0.91	0.92	0.77	0.91	0.92	0.77
*MD_DC	0.62	0.55	0.50	0.62	0.55	0.50
DE	0.74	0.63	0.34	0.74	0.63	0.34
FL	0.60	0.59	0.51	0.60	0.59	0.51
GA	0.37	0.65	1.12	0.37	0.65	1.13
IA	1.40	1.44	1.43	1.40	1.44	1.43
ID	0.65	1.56	1.31	0.65	1.56	1.31
IL	0.43	0.28	0.27	0.43	0.28	0.27
IN	0.97	0.91	0.82	0.97	0.91	0.82
KS	1.03	1.19	1.06	1.03	1.19	1.06
KY	0.80	0.90	0.76	0.80	0.90	0.76
LA	0.52	0.56	0.46	0.52	0.56	0.46
MA	0.96	0.97	0.90	0.96	0.97	0.90
ME	0.51	0.51	0.47	0.51	0.51	0.47
MI	0.63	0.44	0.37	0.63	0.44	0.37
MN	0.55	0.58	0.56	0.55	0.58	0.56
MO	0.90	0.80	0.83	0.90	0.80	0.83
MS	0.34	0.35	0.27	0.34	0.35	0.27
MT	0.95	0.95	1.04	0.95	0.95	1.04
NC	1.08	0.43	0.21	1.08	0.43	0.21
ND	0.83	1.09	0.92	0.83	1.03	0.90
NE	1.08	1.11	1.07	1.08	1.11	1.07
NH	0.64	0.74	0.32	0.64	0.74	0.32
NJ	0.98	0.91	0.84	0.98	0.91	0.84
NM	0.38	0.39	0.35	0.38	0.39	0.35
NV	0.38	0.54	0.51	0.38	0.54	0.51
NY	0.76	0.74	0.64	0.76	0.74	0.64
OH	0.71	0.72	0.55	0.71	0.72	0.55
OK	0.61	0.89	0.67	0.61	0.89	0.67
OR	0.72	0.11	0.06	0.72	0.11	0.06
PA	1.15	0.97	0.88	1.15	0.97	0.88

RI	0.59	0.67	0.56	0.59	0.67	0.56
SC	1.03	1.49	1.17	1.03	1.49	1.17
SD	1.12	1.17	1.25	1.12	1.17	1.25
TN	0.55	0.29	0.17	0.55	0.30	0.17
TX	0.71	0.71	0.63	0.71	0.71	0.63
UT	0.76	0.78	0.79	0.76	0.78	0.79
VA	0.74	0.62	0.53	0.74	0.62	0.53
VT	2.37	2.31	0.47	2.37	2.31	0.47
WA	0.35	0.40	0.41	0.35	0.40	0.41
WI	0.59	0.70	0.51	0.59	0.70	0.51
WV	1.19	1.24	1.31	1.19	1.24	1.31
WY	0.69	0.71	0.72	0.69	0.71	0.72

*States with low total EGU emissions were grouped with nearby states. In these cases, scaling factors were developed for multi-state regions

Table A-6 Baseline (with MATS RTR) and Final Repeal Scenario Annual SO_2 Scaling Factors for EGU Tags

	Baseline (with MATS RTR)			Final Repeal		
State Tag	**2028**	**2030**	**2035**	**2028**	**2030**	**2035**
AL	1.16	1.54	2.05	1.16	1.54	2.04
AR	1.49	1.10	1.12	1.49	1.11	1.12
AZ	0.13	1.51	0.61	0.13	1.51	0.61
CA	0.12	0.13	0.18	0.12	0.13	0.18
CO	0.38	0.06	0.05	0.38	0.06	0.05
CT	0.77	0.76	0.75	0.77	0.76	0.75
*MD_DC	0.07	0.07	0.07	0.07	0.07	0.07
DE	0.16	0.16	0.16	0.16	0.16	0.16
FL	0.46	0.58	0.37	0.46	0.58	0.37
GA	0.15	0.50	0.58	0.15	0.50	0.59
IA	0.52	0.53	0.55	0.52	0.53	0.55
*OR_ID	0.86	0.92	0.75	0.86	0.92	0.75
IL	0.24	0.14	0.14	0.24	0.14	0.14
IN	1.09	1.06	0.82	1.09	1.06	0.82
KS	0.80	0.93	0.94	0.80	0.93	0.94
KY	0.99	1.05	0.99	0.99	1.05	0.99
LA	0.87	1.25	1.47	0.87	1.25	1.47
*MA_RI	0.50	0.43	0.43	0.50	0.43	0.43
ME	0.49	0.49	0.49	0.49	0.49	0.49
MI	0.34	0.05	0.05	0.34	0.05	0.05
MN	0.79	0.81	0.81	0.79	0.81	0.81
MO	1.42	1.53	1.56	1.42	1.53	1.56
MS	1.21	1.21	1.19	1.21	1.21	1.19
MT	1.09	1.09	1.09	1.09	1.09	1.09

NC	1.03	0.37	0.15	1.03	0.37	0.15
ND	0.79	1.09	1.11	0.79	1.08	1.12
NE	0.98	1.00	1.15	0.98	1.00	1.15
*NH_VT	1.01	1.90	0.15	1.01	1.90	0.15
NJ	1.13	1.13	1.13	1.13	1.13	1.13
NM	1.55	1.61	1.61	1.55	1.61	1.61
NV	0.00	0.00	0.00	0.00	0.00	0.00
NY	0.47	0.47	0.47	0.47	0.47	0.47
OH	0.51	0.49	0.44	0.51	0.49	0.44
OK	0.75	1.57	1.88	0.75	1.58	1.88
PA	0.63	0.65	0.63	0.63	0.65	0.63
SC	1.35	2.30	1.71	1.35	2.30	1.71
SD	1.44	1.48	1.48	1.44	1.48	1.48
TN	0.60	0.15	0.00	0.60	0.15	0.00
TX	0.56	0.48	0.50	0.56	0.48	0.50
UT	0.62	0.62	0.62	0.62	0.62	0.62
VA	0.18	0.17	0.17	0.18	0.17	0.17
WA	0.22	0.38	0.24	0.22	0.38	0.24
WI	0.44	0.56	0.45	0.44	0.56	0.45
WV	0.94	0.94	0.84	0.94	0.94	0.84
WY	0.60	0.60	0.60	0.60	0.60	0.60

*States with low total EGU emissions were grouped with nearby states. In these cases, scaling factors were developed for multi-state regions

Table A-7 Baseline (with MATS RTR) and Final Repeal Scenario Annual Primary $PM_{2.5}$ Scaling Factors for EGU Tags

	Baseline (with MATS RTR)			Final Repeal		
State Tag	**2028**	**2030**	**2035**	**2028**	**2030**	**2035**
AL	1.41	1.46	1.41	1.41	1.46	1.41
AR	1.17	1.20	1.17	1.17	1.21	1.17
AZ	0.55	1.24	1.46	0.55	1.24	1.46
CA	2.59	2.98	3.41	2.59	2.98	3.41
CO	0.56	0.32	0.38	0.56	0.32	0.38
CT	0.74	0.76	0.55	0.74	0.76	0.55
*MD_DC	1.02	0.87	0.74	1.02	0.87	0.74
DE	1.01	0.93	0.78	1.01	0.93	0.78
FL	0.82	0.88	0.83	0.82	0.88	0.83
GA	0.83	1.07	1.27	0.83	1.07	1.27
IA	1.58	1.63	1.59	1.58	1.63	1.59
ID	1.13	3.39	3.20	1.13	3.39	3.20
IL	0.66	0.51	0.48	0.66	0.51	0.48
IN	1.21	1.18	1.27	1.21	1.18	1.27
KS	1.21	1.39	1.39	1.21	1.39	1.39

KY	0.79	0.93	0.89	0.79	0.93	0.90
LA	0.87	0.94	0.97	0.87	0.94	0.97
MA	1.00	1.19	0.97	1.00	1.19	0.98
ME	0.32	0.31	0.30	0.32	0.31	0.30
MI	1.31	0.97	1.03	1.31	0.98	1.03
MN	0.87	0.96	0.92	0.87	0.96	0.92
MO	0.93	0.82	0.89	0.92	0.88	0.96
MS	1.11	1.13	0.78	1.11	1.14	0.80
MT	1.01	0.78	1.09	1.01	1.03	1.34
NC	1.53	0.85	0.69	1.54	0.86	0.69
ND	0.86	1.12	1.13	0.86	1.07	1.13
NE	0.96	1.00	0.93	0.96	1.01	0.93
NH	0.98	1.08	0.33	0.98	1.08	0.33
NJ	1.33	1.25	1.43	1.33	1.25	1.43
NM	0.86	0.89	0.90	0.86	0.89	0.90
NV	0.95	1.19	1.13	0.95	1.19	1.13
NY	0.87	0.88	0.81	0.87	0.88	0.81
OH	0.74	0.75	0.71	0.74	0.75	0.71
OK	0.92	1.18	1.17	0.93	1.19	1.17
OR	1.09	0.18	0.12	1.09	0.18	0.12
PA	1.30	1.27	1.33	1.30	1.27	1.34
RI	1.37	1.47	1.52	1.37	1.47	1.52
SC	1.47	2.24	1.71	1.47	2.24	1.71
SD	8.02	8.56	9.03	8.02	8.56	9.03
TN	0.75	0.35	0.30	0.75	0.36	0.30
TX	0.92	1.01	1.04	0.92	1.01	1.04
UT	0.72	0.81	0.93	0.72	0.81	0.93
VA	0.88	0.77	0.64	0.88	0.77	0.64
VT	0.90	1.03	0.56	0.90	1.03	0.56
WA	0.95	0.95	1.04	0.95	0.95	1.04
WI	0.89	1.05	1.38	0.89	1.05	1.38
WV	0.92	1.00	1.17	0.92	1.03	1.20
WY	1.11	1.31	1.43	1.11	1.32	1.44

*States with low total EGU emissions were grouped with nearby states. In these cases, scaling factors were developed for multi-state regions

A.5 Air Quality Surface Results

The spatial fields of model-predicted air quality changes between the Baseline (with MATS RTR) and the Final Repeal in 2028, 2030, and 2035 for AS-MO3 are presented in Figure A-7 through Figure A-9. It is important to recognize that ozone is a secondary pollutant, meaning that it is formed through chemical reactions of precursor emissions in the atmosphere. As a result of the time necessary for precursors to mix in the atmosphere and for these reactions to occur, ozone can either be highest at the location of the precursor emissions or peak at some distance downwind of those emissions sources. The spatial gradients of ozone depend on a multitude of factors including the spatial patterns of NO_X and VOC emissions and the meteorological conditions on a particular day. Thus, on any individual day, high ozone concentrations may be found in narrow plumes downwind of specific point sources, may appear as urban outflow with large concentrations downwind of urban source locations or may have a more regional signal. However, in general, because the AS-MO3 metric is based on the average of concentrations over more than 180 days in the spring and summer, the resulting spatial fields are rather smooth without sharp gradients, compared to what might be expected when looking at the spatial patterns of MDA8 ozone concentrations on specific high ozone episode days. Air quality changes in these figures are calculated as the Final Repeal minus the Baseline (with MATS RTR). The spatial patterns shown in the figures are a result of (1) the spatial distribution of EGU sources that are predicted to have changes in emissions and (2) the physical or chemical processing that the model simulates in the atmosphere. Predicted NO_X emissions changes are heterogeneous across the country between the Baseline (with MATS RTR) and the Final Repeal scenarios resulting in increases predicted in some states and decreases predicted in others. As a result, Figure A-7 through A-9 show some areas of ASM-O3 increase and others of ASM-O3 decrease although all changes are small with the largest increases in the range of 0.01 ppb and the largest decreases in the range of 0.02 ppb across all locations and snapshot years.

Figure A-10 through Figure A-12 presents the model-predicted air quality changes between the Baseline (with MATS RTR) and the Final Repeal scenarios in 2028, 2030, and 2035 for PM2.5. Secondary $PM_{2.5}$ species sulfate and nitrate often demonstrate regional signals without large local gradients while primary $PM_{2.5}$ components often have heterogenous spatial patterns with larger gradients near emissions sources. Air quality changes in these figures are calculated as the Final Repeal minus the Baseline (with MATS RTR). The spatial patterns shown are a result of (1) the spatial distribution of EGU sources that are predicted to have changes in emissions and (2) the physical or chemical processing that the model simulates in the atmosphere. Both secondary and primary $PM_{2.5}$ contribute to the spatial patterns shown in Figure A-10 through Figure A-12. These figures show small increases in $PM_{2.5}$ concentration as a results of the Final Repeal in 2028 and 2035 and both small increases and small decreases in $PM_{2.5}$ as a result of the Final Repeal in 2030. All changes are small with the largest increases in the range of 0.1 µg/m3 and the largest decreases in the range of 0.02 µg/m3 across all locations and snapshot years.

Figure A-13 through Figure A-18 show how ASM-O3 and $PM_{2.5}$ change in the Baseline (with MATS RTR) and Final Repeal scenarios compared to recent 2022 conditions. The scales on these maps are much larger than the scales on Figure A-7 through Figure A-12 and all differences between Baseline (with MATS RTR) and Final Repeal scenarios are dwarfed by the estimated decreases since 2022.

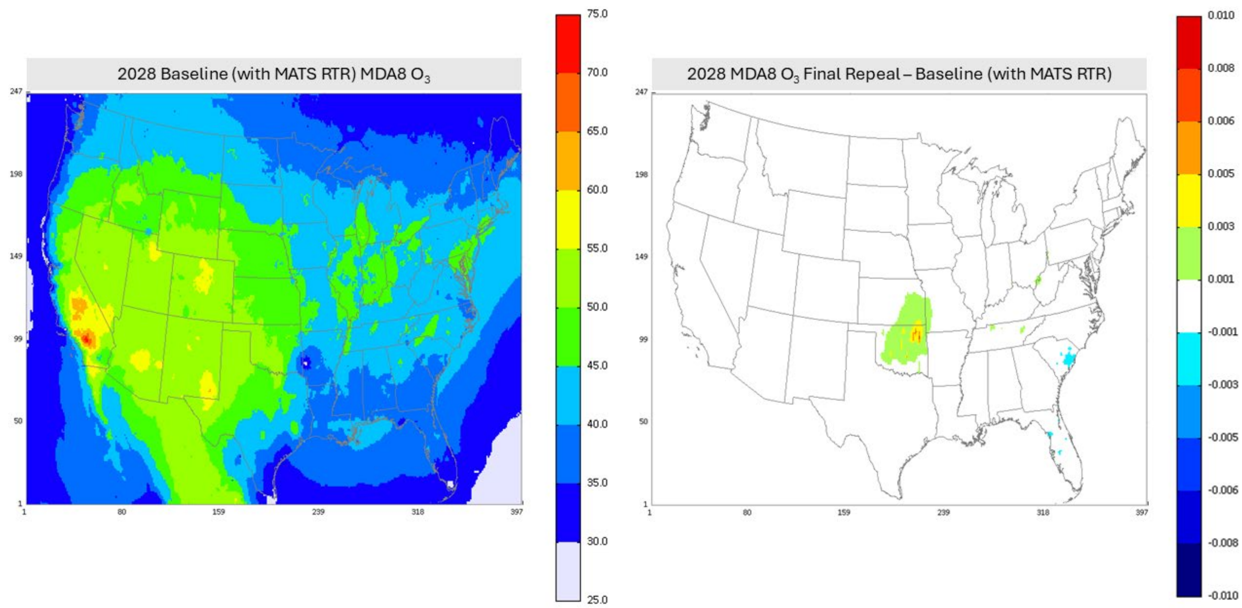

Figure A-7 Maps of ASM-O3 in 2028. Baseline (with MATS RTR) ozone concentrations (ppb) shown on the left. Change in ozone in the Final Repeal scenario compared to Baseline (with MATS RTR) values (ppb) shown on the right.

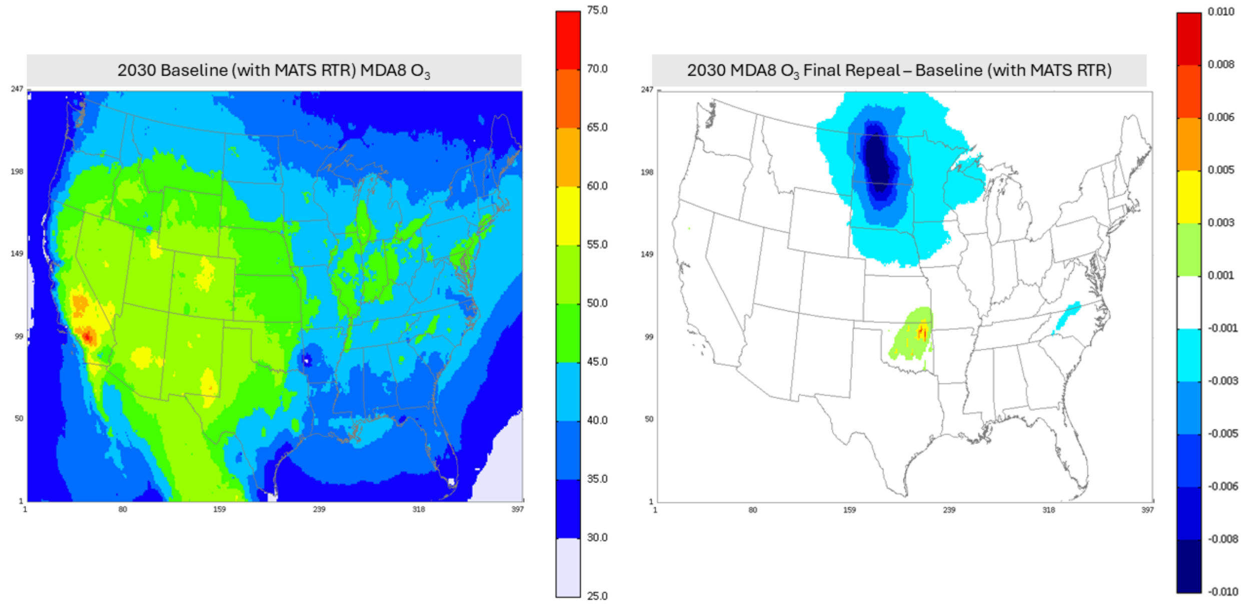

Figure A-8 Maps of ASM-O3 in 2030. Baseline (with MATS RTR) ozone concentrations (ppb) shown on the left. Change in ozone in the Final Repeal scenario compared to Baseline (with MATS RTR) values (ppb) shown on the right.

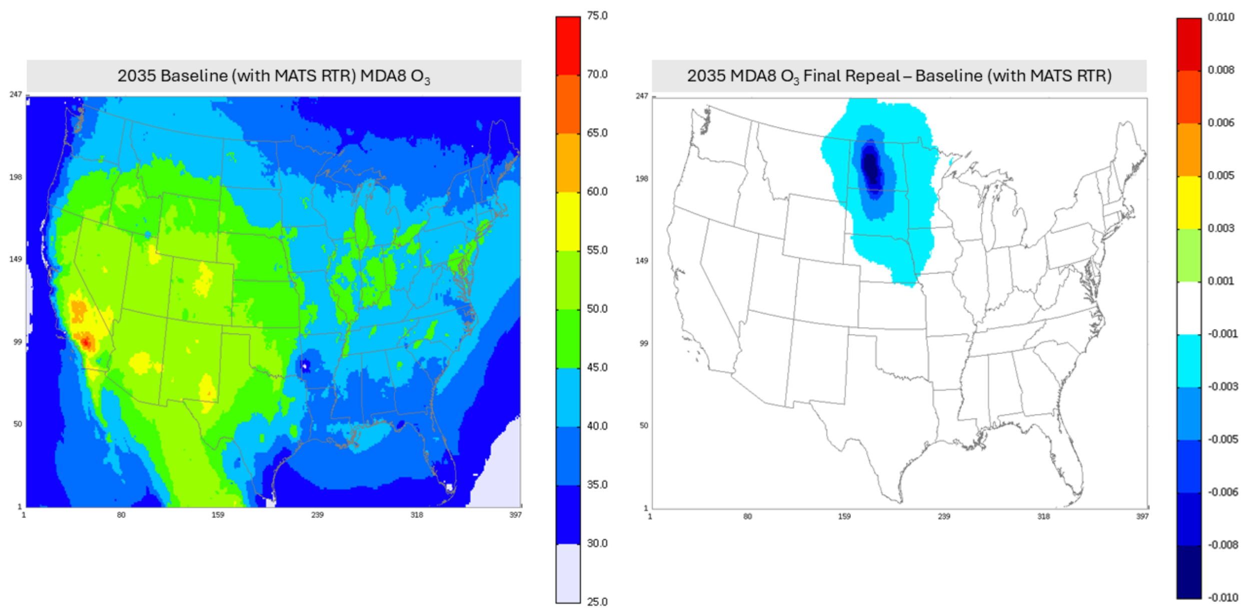

Figure A-9 Maps of ASM-O3 in 2035. Baseline (with MATS RTR) ozone concentrations (ppb) shown on the left. Change in ozone in the Final Repeal scenario compared to Baseline (with MATS RTR) values (ppb) shown on the right.

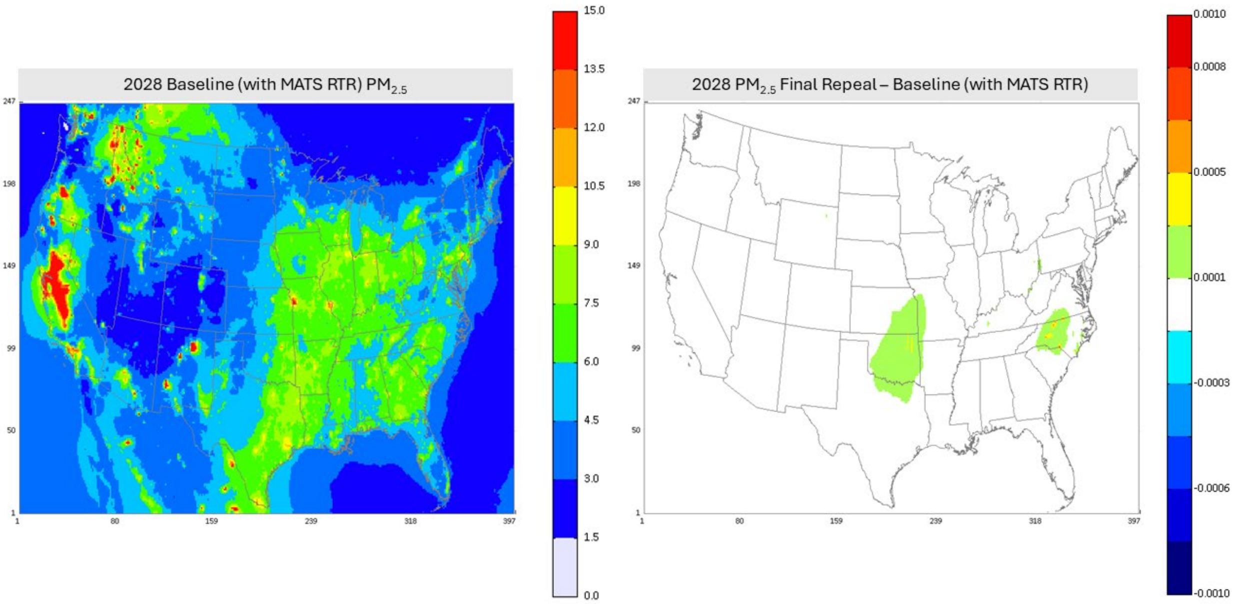

Figure A-10 Maps of $PM_{2.5}$ in 2028. Baseline (with MATS RTR) ozone concentrations (µg/m3) shown on the left. Change in $PM_{2.5}$ in the Final Repeal scenario compared to Baseline (with MATS RTR) values (µg/m3) shown on the right.

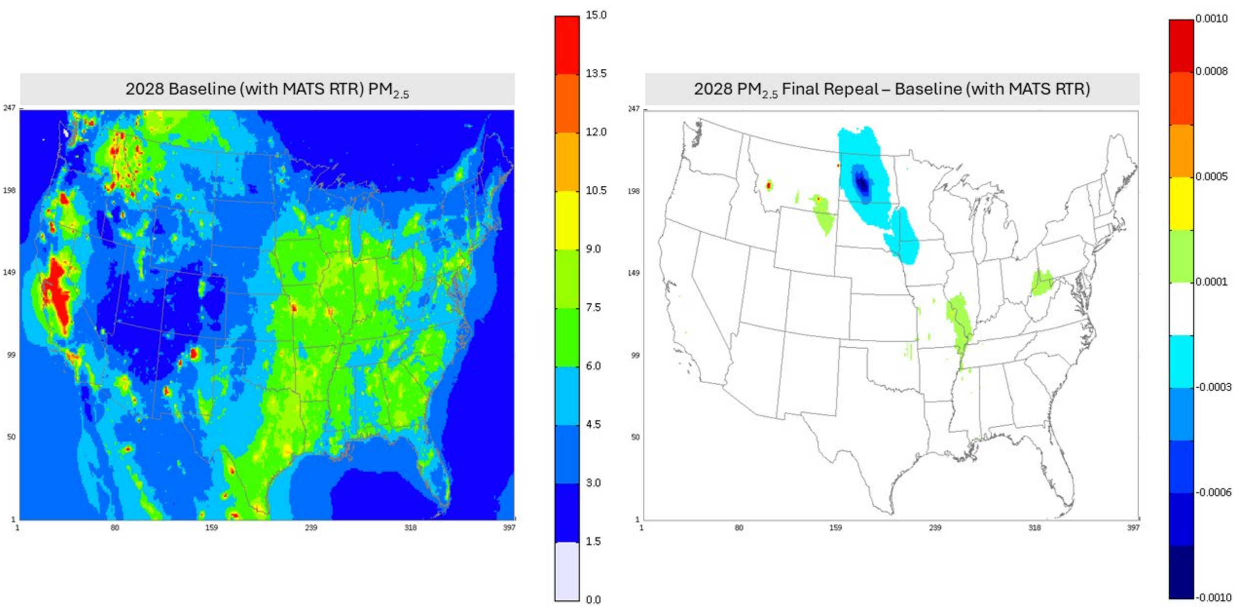

Figure A-11 Maps of $PM_{2.5}$ in 2030. Baseline (with MATS RTR) ozone concentrations (µg/m3) shown on the left. Change in $PM_{2.5}$ in the Final Repeal scenario compared to Baseline (with MATS RTR) values (µg/m3) shown on the right.

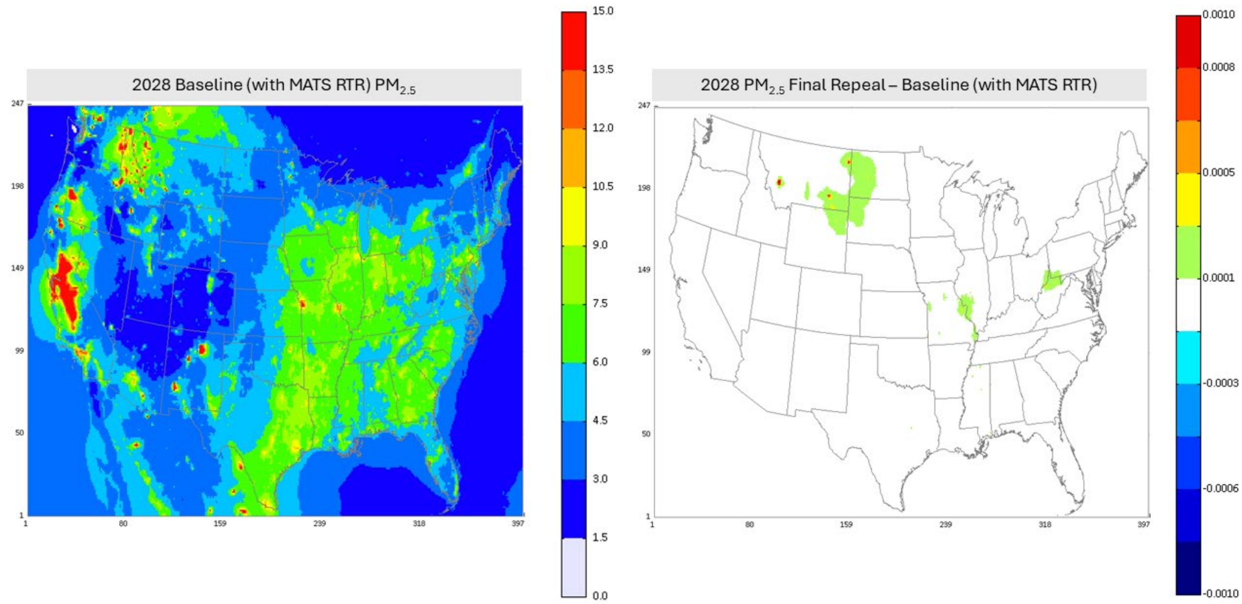

Figure A-12 Maps of $PM_{2.5}$ in 2035. Baseline (with MATS RTR) ozone concentrations (µg/m3) shown on the left. Change in $PM_{2.5}$ in the Final Repeal scenario compared to Baseline (with MATS RTR) values (µg/m3) shown on the right.

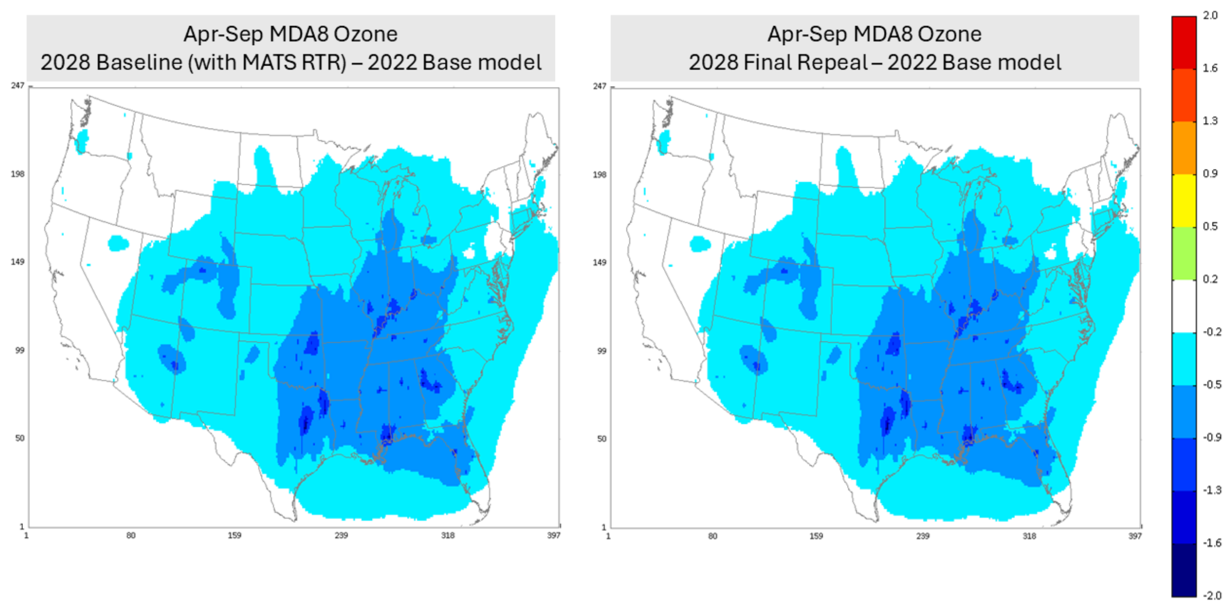

Figure A-13 Maps of changes in 2028 ASM-O3 from recent 2022 conditions. Baseline (with MATS RTR) 2028 ozone concentrations compared to 2022 ozone concentrations (ppb) shown on left. 2028 Final Repeal ozone concentrations compared to 2022 ozone concentrations (ppb) shown on right. Color bars for Figure A-13 through Figure A-15 differ in scale (±2ppb) from color bars used in Figure A-7 through Figure A-9 (±0.01ppb).

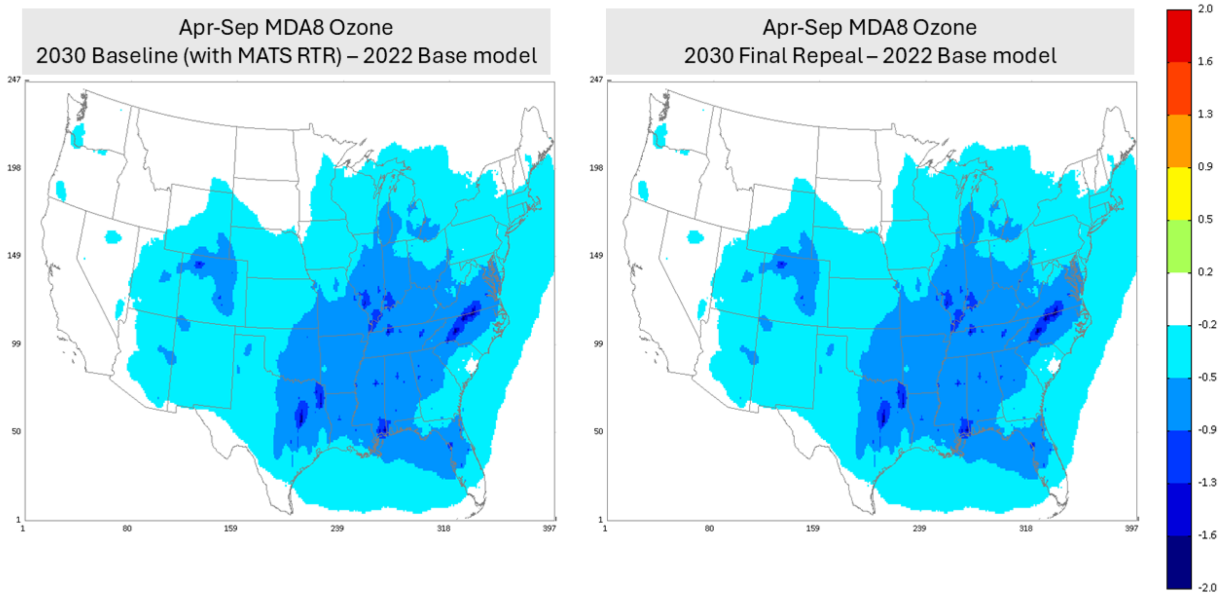

Figure A-14 Maps of changes in 2030 ASM-O3 from recent 2022 conditions. Baseline (with MATS RTR) 2030 ozone concentrations compared to 2022 ozone concentrations (ppb) shown on left. 2030 Final Repeal ozone concentrations compared to 2022 ozone concentrations (ppb) shown on right. Color bars for Figure A-13 through Figure A-15 differ in scale (±2ppb) from color bars used in Figure A-7 through Figure A-9 (±0.01ppb).

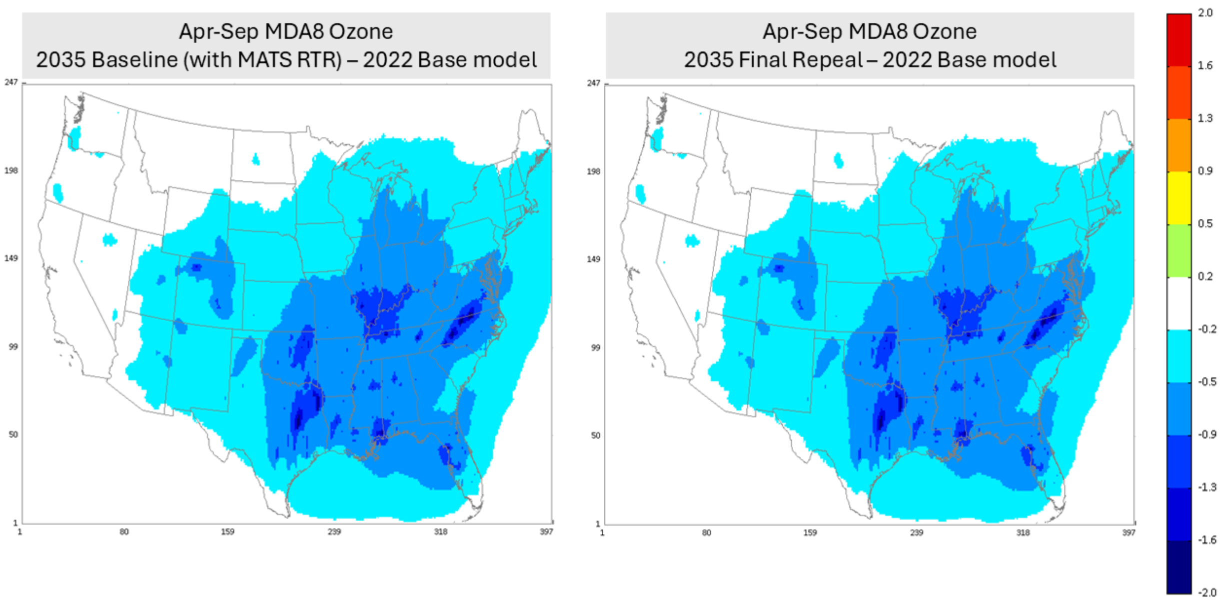

Figure A-15 Maps of changes in 2035 ASM-O3 from recent 2022 conditions. Baseline (with MATS RTR) 2035 ozone concentrations compared to 2022 ozone concentrations (ppb) shown on left. 2035 Final Repeal ozone concentrations compared to 2022 ozone concentrations (ppb) shown on right. Color bars for Figure A-13 through Figure A-15 differ in scale (±2ppb) from color bars used in Figure A-7 through Figure A-9 (±0.01ppb).

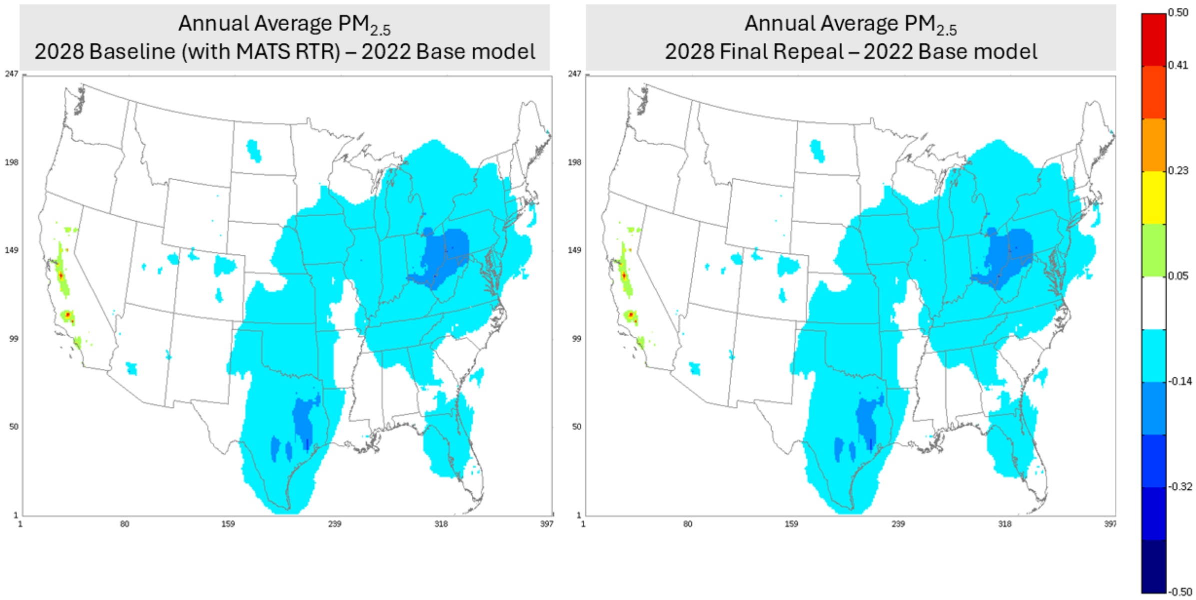

Figure A-16 Maps of changes in 2028 $PM_{2.5}$ from recent 2022 conditions. Baseline (with MATS RTR) 2028 $PM_{2.5}$ concentrations compared to 2022 $PM_{2.5}$ concentrations (µg/m3) shown on left. 2028 Final Repeal $PM_{2.5}$ concentrations compared to 2022 $PM_{2.5}$ concentrations (ppb) shown on right. Color bars for Figure A-16 through Figure A-18 differ in scale (±0.5 µg/m3) from color bars used in Figure A-7 through Figure A-9 ((±0.001 µg/m3).

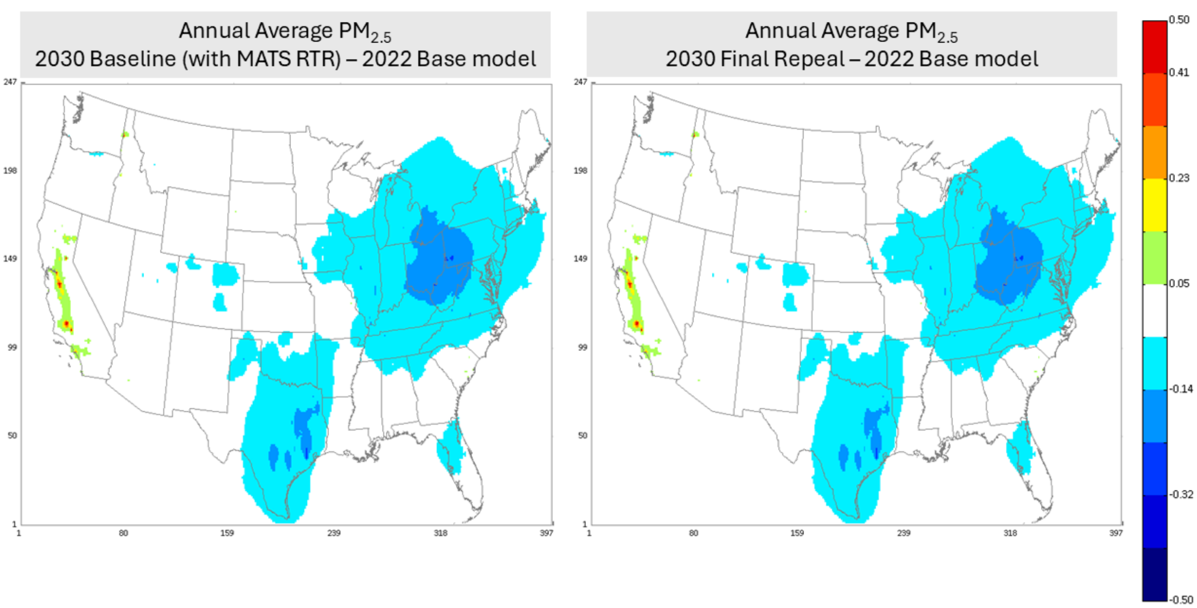

Figure A-17 Maps of changes in 2030 $PM_{2.5}$ from recent 2022 conditions. Baseline (with MATS RTR) 2030 $PM_{2.5}$ concentrations compared to 2022 $PM_{2.5}$ concentrations (µg/m3) shown on left. 2030 Final Repeal $PM_{2.5}$ concentrations compared to 2022 $PM_{2.5}$ concentrations (ppb) shown on right. Color bars for Figure A-16 through Figure A-18

differ in scale (±0.5 µg/m3) from color bars used in Figure A-7 through Figure A-9 ((±0.001 µg/m3).

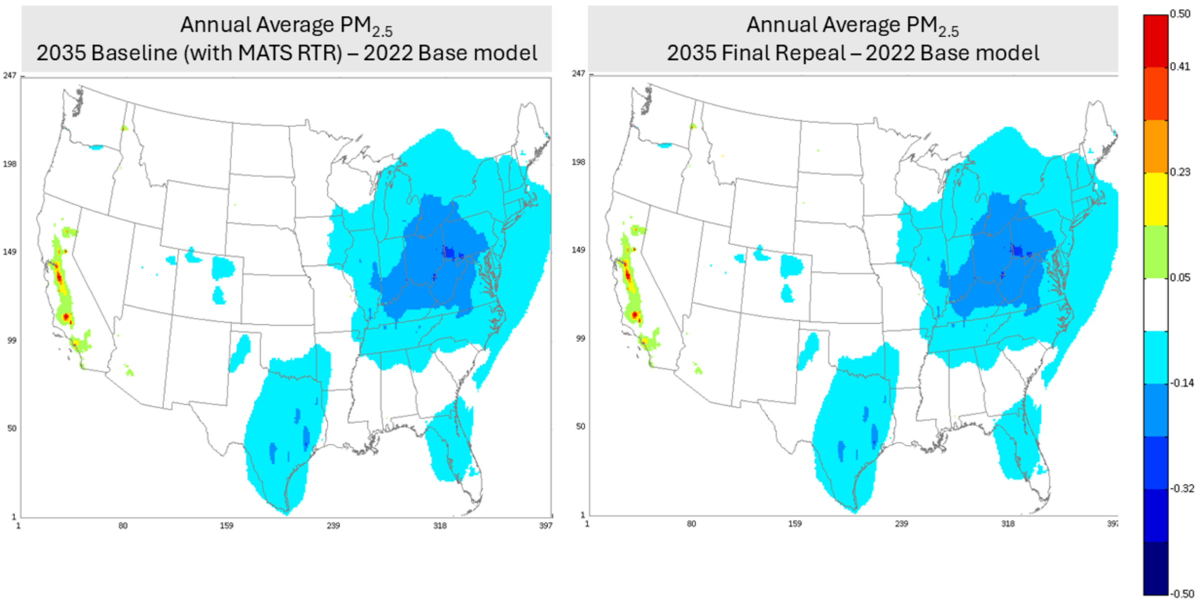

Figure A-18 Maps of changes in 2035 $PM_{2.5}$ from recent 2022 conditions. Baseline (with MATS RTR) 2035 $PM_{2.5}$ concentrations compared to 2022 $PM_{2.5}$ concentrations (µg/m3) shown on left. 2035 Final Repeal $PM_{2.5}$ concentrations compared to 2022 $PM_{2.5}$ concentrations (ppb) shown on right. Color bars for Figure A-16 through Figure A-18 differ in scale (±0.5 µg/m3) from color bars used in Figure A-7 through Figure A-9 ((±0.001 µg/m3).

A.6 Uncertainties and Limitations of the Air Quality Methodology

One limitation of the scaling methodology for creating ozone and $PM_{2.5}$ surfaces associated with the Baseline (with MATS RTR) or Final Repeal scenario described above is that the methodology treats air quality changes from the tagged sources as linear and additive. It therefore does not account for nonlinear atmospheric chemistry and does not account for interactions between emissions of different pollutants and between emissions from different tagged sources. The method applied in this analysis is consistent with how air quality estimations have been made in several prior regulatory analyses (U.S. EPA, 2012, 2019, 2020a). We note that air quality is calculated in the same manner for the Baseline (with MATS RTR) and for the Final Repeal scenarios, so any uncertainties associated with these assumptions is propagated through results for both the Baseline (with MATS RTR) and Final Repeal scenarios in the same manner. In addition, emissions changes between the Baseline (with MATS RTR) and Final Repeal scenarios are relatively small compared to modeled 2022 base year emissions that form the basis of the source apportionment approach described in this appendix. Previous studies have shown that air pollutant concentrations generally respond linearly to small emissions changes of up to 30 percent (Cohan et al., 2005; Cohan and Napelenok, 2011; Dunker et al., 2002; Koo et al., 2007; Napelenok et al., 2006; Zavala et al., 2009). A second limitation is that the source apportionment contributions are informed by the spatial and temporal distribution of the emissions from each source tag as they occur in the 2022 base year modeled case. Thus, the contribution modeling results do not allow us to consider the effects of any changes to spatial distribution of EGU emissions within a state between the 2022 base year modeled case and the Baseline (with MATS RTR) and Final Repeal scenarios analyzed in this RIA. A third limitation is that modeling scenarios do not account for ozone and $PM_{2.5}$ concentration changes that may occur as a result of other regulatory actions or interactions with NAAQS attainment. Finally, the 2022 base year CAMx-modeled concentrations themselves have some uncertainty. While all models have some level of inherent uncertainty in their formulation and inputs, the 2022 base year model outputs have been evaluated against ambient measurements and have been shown to adequately reproduce spatially and temporally varying concentrations as described in the Air Quality Modeling Simulation Section (A.1). Additionally, the 2022 base year model outputs were fused with measured 2022 values to provide a gridded surface that closely matches measured values as described in the Applying Modeling Outputs to Create Spatial Fields Section (A.2).

A.7 References

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