UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Regulatory Impact Analysis for the New Source Performance Standards Review for Stationary Combustion Turbines

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1 INTRODUCTION

1.1 Background

The Environmental Protection Agency (EPA) is proposing Standards of Performance for new, modified, and reconstructed stationary combustion turbines and stationary gas turbines based on the preliminary results of a review of available control technologies for limiting emissions of criteria air pollutants. This review of the new source performance standards (NSPS) is required by the Clean Air Act (CAA).

As a result of this review, the EPA is proposing to establish size-based subcategories for new and reconstructed stationary combustion turbines that also recognize distinctions between those that operate at varying loads or capacity factors and those firing natural gas or non-natural gas fuels. In general, the EPA is proposing that combustion controls with the addition of post-combustion selective catalytic reduction (SCR) is the best system of emission reduction (BSER) for limiting nitrogen oxide (NO_X) emissions from this category, with certain, limited exceptions.

Based on this and other updates in technical information, the EPA is proposing to lower the NO_X standards of performance for most of the combustion turbines subcategories included in this source category. In addition, for new and reconstructed stationary combustion turbines that fire or co-fire using hydrogen, the EPA is proposing to ensure that those sources are subject to the same level of control for NO_X emissions as sources firing natural gas or non-natural gas fuels, depending on the percentage of hydrogen fuel being utilized. The EPA is proposing to maintain the current standards for sulfur dioxide (SO_2) emissions, because after reviewing the current SO_2 standards, we have concluded that no change is warranted. Finally, the Agency is proposing amendments to address specific technical and editorial issues to clarify the existing regulations.

1.2 Legal Basis for this Rulemaking

The EPA's authority for this proposed rule is CAA section 111, which governs the establishment of standards of performance for stationary sources. Section 111(b)(1)(A) of the CAA requires the EPA Administrator to list categories of stationary sources that in the Administrator's judgment cause or contribute significantly to air pollution that may reasonably be anticipated to endanger public health or welfare. The EPA must then issue performance standards for new (and modified or reconstructed) sources in each source category pursuant to CAA section 111(b)(1)(B). These standards are referred to as new source performance standards, or NSPS. The EPA has the authority to define the scope of the source categories, determine the pollutants for which standards should be developed, set the emission level of the standards, and distinguish among classes, types, and sizes within categories in establishing the standards.

CAA section 111(b)(1)(B) requires the EPA to "at least every 8 years review and, if appropriate, revise" new source performance standards. However, the Administrator need not review any such standard if the "Administrator determines that such review is not appropriate in light of readily available information on the efficacy" of the standard.

In setting or revising a performance standard, CAA section 111(a)(1) provides that performance standards are to reflect "the degree of emission limitation achievable through the application of the BSER which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated." The term "standard of performance" in CAA section 111(a)(1) makes clear that the EPA is to determine both the BSER for the regulated sources in the source category and the degree of emission limitation achievable through application of the BSER. The EPA must then, under CAA section 111(b)(1)(B), promulgate standards of performance for new sources that reflect that level of stringency. CAA section 111(b)(5) generally precludes the EPA from prescribing a particular technological system that must be used to comply with a standard of performance. Rather, sources can select any measure or combination of measures that will achieve the standard.

Pursuant to the definition of new source in CAA section 111(a)(2), standards of performance apply to facilities that begin construction, reconstruction, or modification after the date of publication of the proposed standards in the Federal Register. Under CAA section 111(a)(4), "modification" means any physical change in, or change in the method of operation of, a stationary source which increases the amount of any air pollutant emitted by such source or which results in the emission of any air pollutant not previously emitted.

Changes to an existing facility that do not result in an increase in emissions are not considered modifications. Under the provisions in 40 CFR 60.15 (subject to any variation in the category-specific NSPS regulations), reconstruction means the replacement of components of an existing facility such that: (1) the fixed capital cost of the new components exceeds 50 percent of the fixed capital cost that would be required to construct a comparable entirely new facility; and (2) it is technologically and economically feasible to meet the applicable standards. Pursuant to CAA section 111(b)(1)(B), the standards of performance or revisions thereof shall become effective upon promulgation.

1.3 Economic Basis for this Rulemaking

Regulation can be used to address market failures, which otherwise lead to a suboptimal allocation of resources within the free market. Many environmental problems are classic examples of “negative externalities”, which arise when private entities do not internalize the full opportunity cost of their production, and some of this opportunity cost is borne by members of society who are neither consumers nor producers of the goods produced (i.e., they are “external”). For example, the smoke from a factory may adversely affect the health of nearby residents, soil quality, and visibility. Public goods such as air quality are valued by individuals but suffer from a lack of property rights, so the value of good air quality tends to be unpriced in the markets that generate air pollution. In such cases, markets fail to allocate resources efficiently and regulatory intervention is needed to address the problem.

While recognizing that the socially optimal level of pollution is often not zero, the emissions from combustion turbines impose costs on society (e.g., negative health impacts) that may not be reflected in the equilibrium market prices for the goods produced through the use of combustion turbines. If emissions from combustion turbines increase risks to human health, some social costs will be borne not by the firm and its customers but rather imposed on communities near the combustion turbines and other individuals exposed to their emissions. Consequently, absent a regulation limiting emissions from combustion turbines and causing firms to internalize the external costs of their operations, emissions will exceed the socially optimal level.

1.4 Regulatory History

A stationary combustion turbine is defined as all equipment, including but not limited to the combustion turbine; the fuel, air, lubrication, and exhaust gas systems; control systems (except emission control equipment); heat recovery system (including heat recovery steam generators (HRSG) and duct burners); and any ancillary components and sub-components comprising any simple cycle, regenerative/recuperative cycle, and combined cycle stationary combustion turbine, and any combined heat and power (CHP) stationary combustion turbine-based system. Stationary means that the combustion turbine is not self-propelled or intended to be propelled while performing its function. It may, however, be mounted on a vehicle for portability.

Standards of performance for the source category of stationary gas turbines were originally promulgated in 1979 in subpart GG of 40 CFR part 60 (44 FR 52798). As promulgated in 1979, the sources subject to the NSPS are stationary combustion turbines with a heat input at peak load equal to or greater than 10.7 gigajoules (GJ) (10 million British thermal units per hour (MMBtu/h)), based on the lower heating value of the fuel, that commenced construction, modification, or reconstruction after October 3, 1977.

The EPA last revised the NSPS on July 6, 2006, and subpart KKKK is applicable to stationary combustion turbines with a heat input at peak load equal to or greater than 10.7 GJ (10 MMBtu/h), based on the higher heating value (HHV) of the fuel, for which construction, modification, or reconstruction was commenced after February 18, 2005 (71 FR 38482).

The NO_X standards in subpart KKKK are based on the application of combustion controls (as the BSER) and allow the turbine owner or operator the choice of meeting a concentration-based emission standard or an output-based emission standard. The concentration-based emission limits are in units of parts per million by volume dry (ppmvd) at 15 percent oxygen (O_2). The output-based emission limits are in units of mass per unit of useful recovered energy, nanograms per Joule (ng/J) or pounds per megawatt-hour (lb/MWh). All of the NO_X limits in subpart KKKK are based on the application of combustion controls but individual standards may differ for individual subcategories of combustion turbines based on the following factors: the fuel input rating at peak load, the fuel used, the application, the load, and the location of the turbine. The fuel input rating of the turbine does not include any supplemental fuel input to the heat recovery system and refers to the rating of the combustion turbine itself.

Specifically, in subpart KKKK, the EPA identifies 14 subcategories of stationary combustion turbines and establishes NO_X emission limits for each. The size-based subcategories include less than or equal to 50 MMBtu/h of heat input, greater than 50 MMBtu/h of heat input and less than or equal to 850 MMBtu/h of heat input, and greater than 850 MMBtu/h of heat input. There are separate subcategories for combustion turbines operating at part load, for modified and reconstructed combustion turbines, heat recovery units operating independent of the combustion turbine, and turbines operating at low ambient temperatures. A specific NO_X performance standard ranging from 15 to 150 ppmvd is identified for each of the 14 subcategories and these standards are shown in Table 1.

Table 1 Current NO_X Emission Standards for Stationary Combustion Turbines

Combustion Turbine Type	Combustion Turbine Heat Input at Peak Load (HHV)	NO_X Emission Standard
New turbine firing natural gas, electric generating	≤ 50 MMBtu/h	42 ppm at 15 percent oxygen (O_2) or 290 ng/J of useful output (2.3 lb/MWh)
New turbine firing natural gas, mechanical drive	≤ 50 MMBtu/h	100 ppm at 15 percent O_2 or 690 ng/J of useful output (5.5 lb/MWh)
New turbine firing natural gas	> 50 MMBtu/h and ≤850 MMBtu/h	25 ppm at 15 percent O_2 or 150 ng/J of useful output (1.2 lb/MWh)
New, modified, or reconstructed turbine firing natural gas	> 850 MMBtu/h	15 ppm at 15 percent O_2 or 54 ng/J of useful output (0.43 lb/MWh)
New turbine firing fuels other than natural gas, electric generating	≤ 50 MMBtu/h	96 ppm at 15 percent O_2 or 700 ng/J of useful output (5.5 lb/MWh)
New turbine firing fuels other than natural gas, mechanical drive	≤ 50 MMBtu/h	150 ppm at 15 percent O_2 or 1,100 ng/J of useful output (8.7 lb/MWh)
New turbine firing fuels other than natural gas	> 50 MMBtu/h and ≤ 850 MMBtu/h	74 ppm at 15 percent O_2 or 460 ng/J of useful output (3.6 lb/MWh)
New, modified, or reconstructed turbine firing fuels other than natural gas	> 850 MMBtu/h	42 ppm at 15 percent O_2 or 160 ng/J of useful output (1.3 lb/MWh)

Combustion Turbine Type	Combustion Turbine Heat Input at Peak Load (HHV)	NO_X Emission Standard
Modified or reconstructed turbine	≤ 50 MMBtu/h	150 ppm at 15 percent O_2 or 1,100 ng/J of useful output (8.7 lb/MWh)
Modified or reconstructed turbine firing natural gas	> 50 MMBtu/h and ≤ 850 MMBtu/h	42 ppm at 15 percent O_2 or 250 ng/J of useful output (2.0 lb/MWh)
Modified or reconstructed turbine firing fuels other than natural gas	> 50 MMBtu/h and ≤ 850 MMBtu/h	96 ppm at 15 percent O_2 or 590 ng/J of useful output (4.7 lb/MWh)
Turbines located north of the Arctic Circle (latitude 66.5 degrees north), turbines operating at less than 75 percent of peak load, modified and reconstructed offshore turbines, and turbines operating at temperatures less than 0 °F	≤ 30 MW output	150 ppm at 15 percent O_2 or 1,100 ng/J of useful output (8.7 lb/MWh)
Turbines located north of the Arctic Circle (latitude 66.5 degrees north), turbines operating at less than 75 percent of peak load, modified and reconstructed offshore turbines, and turbines operating at temperatures less than 0 °F	> 30 MW output	96 ppm at 15 percent O_2 or 590 ng/J of useful output (4.7 lb/MWh)
Heat recovery units operating independent of the combustion turbine	All sizes	54 ppm at 15 percent O_2 or 110 ng/J of useful output (0.86 lb/MWh)

Regarding SO_2, the standards of performance in subpart KKKK reflect the use of low-sulfur fuels. The fuel sulfur content limit is 26 ng/J (0.060 lb SO_2/MMBtu) heat input for combustion turbines located in continental areas and 180 ng/J (0.42 lb SO_2/MMBtu) heat input in noncontinental areas. This is approximately equivalent to 0.05 percent sulfur by weight (500 parts per million by weight (ppmw)) for fuel oil in continental areas and 0.4 percent sulfur by weight (4,000 ppmw) for fuel oil in noncontinental areas, respectively. Subpart KKKK also includes an optional output based SO_2 standard.

In subpart GG in 1979, the EPA determined that it was appropriate to exempt emergency combustion turbines from the NO_X limits. These included emergency-standby combustion turbines, military combustion turbines, and firefighting combustion turbines. Emergency combustion turbines are further defined in subpart KKKK as units that operate in emergency situations, such as turbines used to supply electric power when the local utility service is interrupted. Subpart KKKK also includes exemptions for stationary combustion turbine test cells/stands and integrated gasification combined cycle (IGCC) combustion turbine facilities covered by subpart Da of 40 CFR part 60 (the Utility Boiler NSPS). Furthermore, under subpart KKKK, the HRSG and duct burners continue to be exempt from subparts Da, Db, and Dc (the Utility Boiler and Industrial, Commercial, and Institutional Boiler NSPS) while combustion turbines used by manufacturers in research and development of equipment for both combustion turbine emissions control techniques and combustion turbine efficiency improvements are exempt from the NO_X limits on a case-by-case basis only.

On September 5, 2006, a petition for reconsideration of the revised NSPS was filed by the Utility Air Regulatory Group (UARG). The EPA granted reconsideration of subpart KKKK and on August 29, 2012, proposed to amend subparts KKKK and GG to address specific issues identified by the petitioners (77 FR 52554) as well as other technical and editorial issues.

The 2012 proposed amendments to subparts KKKK and GG of 40 CFR part 60 were in response to issues raised in the UARG petition for reconsideration discussed above. Specifically, the EPA proposed to clarify the intent in applying and implementing specific rule requirements, to correct unintentional technical omissions and editorial errors, and address various other issues that were identified since promulgation of subpart KKKK. The EPA has not taken further action on that proposed rule and, in this action, proposes to withdraw the 2012 NSPS Proposal. However, several of the amendments in the 2012 NSPS Proposal are being reproposed in this action where appropriate, and these changes are also reflected in the new proposed NSPS.

1.5 Proposed Requirements

Sources subject to the proposed NSPS are stationary combustion turbines with a heat input at peak load equal to or greater than 10.7 gigajoules per hour (GJ/h) (10 million British thermal units per hour (MMBtu/h)), based on the higher heating value (HHV) of the fuel, that commence construction, modification, or reconstruction after the publication of this proposed rule in the Federal Register. The applicability of sources that would be subject to the proposed subpart KKKKa is similar to that for sources subject to the existing 40 CFR part 60, subpart KKKK. Stationary combustion turbines subject to the proposed standards in the new subpart KKKKa would not be subject to the requirements of subparts GG or KKKK; the HRSG and duct burners subject to these proposed standards would continue to be exempt from the requirements of 40 CFR part 60, subpart Da (the Utility Boiler NSPS) as well as subparts Db and Dc (the Industrial/Commercial/Institutional Boiler NSPS) as previously established in subpart KKKK. The proposed subpart KKKKa maintains the NO_X exemptions promulgated previously in subparts GG and KKKK.

The EPA is proposing three size-based subcategories in subpart KKKKa, to align the subcategories with those in subpart TTTTa (Standards of Performance for Greenhouse Gas Emissions for Modified Coal-Fired Steam Electric Generating Units and New Construction and Reconstruction Stationary Combustion Turbine Electric Generating Units). The proposed subcategories include combustion turbines with base load ratings of less than or equal to 250 MMBtu/h of heat input, those with base load ratings of greater than 250 MMBtu/h of heat input and less than or equal to 850 MMBtu/h, and those with base load rating greater than 850 MMBtu/h. Like subpart KKKK, these subcategories are based on the rating of the turbine engine and do not include any supplemental fuel input to the heat recovery system and are consistent with combustion control technologies (and manufacturer guarantees) currently available for different sized combustion turbines.

The EPA is proposing to subcategorize small, medium, and large combustion turbines as low load, intermediate load, or base load units based on annual capacity factors. Low load combustion turbines would have annual capacity factors less than or equal to 20 percent, intermediate load combustion turbines would have annual capacity factors greater than 20 percent and less than or equal to 40 percent, and base load combustion turbines would have annual capacity factors greater than 40 percent. For each of these proposed subcategories, the EPA is proposing to subcategorize them further depending on whether they are natural gas-fired or non-natural gas-fired stationary combustion turbines. In addition, the EPA is proposing to create subcategories for combustion turbines operating at part loads, combustion turbines located north of the Arctic Circle, or combustion turbines operating at ambient temperatures of less than 0 °F. Finally, the EPA is proposing to subcategorize HRSG units operating independent of the combustion turbine.

The proposed NO_X performance standard that corresponds to each proposed subcategory reflects the application of the proposed BSER on sources that operate at low, intermediate, or high loads and that burn natural gas, non-natural gas (such as distillate fuels), hydrogen, or a combination of the three. As part of its review of the NSPS, the EPA evaluated dry combustion controls (e.g., lean premix/dry low NO_X (DLN) systems), wet combustion controls (e.g., water or steam injection), and post-combustion selective catalytic reduction (SCR) to determine BSER for each of the subcategories of combustion turbines that burn natural gas. For small combustion turbines (i.e., those that have a peak load heat input rating of less than or equal to 250 MMBtu/h) that operate at low and intermediate loads, the EPA proposes that the use of combustion controls remains the BSER and proposes that combustion controls with the addition of post-combustion SCR is the BSER for small combustion turbines that operate at capacity factors greater than 40 percent (i.e., base load). For medium sized combustion turbines (i.e., those that have a peak load heat input rating of greater than 250 MMBtu/h but less than or equal to 850 MMBtu/h), the EPA proposes that combustion controls remain the BSER for units that operate at capacity factors less than or equal to 20 percent (i.e., low load) and proposes that combustion controls with the addition of post-combustion SCR is the BSER for medium-sized combustion turbines that operate at capacity factors greater than 20 percent (i.e., intermediate or high load). For large combustion turbines (i.e., those that have a peak load heat input rating of greater than 850 MMBtu/h), the EPA proposes that the use of combustion controls is the BSER for units that operate at low loads (i.e., less than or equal to 20 percent capacity factor). However, for large units that operate at intermediate or high capacity factors (i.e., greater than 20 percent capacity factor), the EPA proposes that combustion controls with the addition of post-combustion SCR is the BSER for sources in those subcategories. These proposed standards are summarized in Table 2.

Table 2 Proposed Subcategories and NO_X Standards for Subpart KKKKa

Combustion turbine type	Combustion turbine fuel	BSER	NO_X emission standard (lb/MMBtu)	NO_X emission rate equivalent (ppm)
Base Load Rating ≤ 250 MMBtu/h				
New and reconstructed low and intermediate load combustion turbines	Natural gas	Dry combustion controls	0.092	25
	Non-natural gas	Wet combustion controls	0.290	74
New and reconstructed base load combustion turbines	Natural gas	Combustion controls with SCR	0.011	3
	Non-natural gas	Combustion controls with SCR	0.035	9
Modified combustion turbines, all loads	Natural gas	Dry combustion controls	0.092	25
	Non-natural gas	Wet combustion controls	0.290	74
Base Load Rating > 250 MMBtu/h and ≤ 850 MMBtu/h				
New and reconstructed low load combustion turbines	Natural gas	Dry combustion controls	0.092	25
	Non-natural gas	Wet combustion controls	0.290	74
New and reconstructed intermediate and base load combustion turbines	Natural gas	Combustion controls with SCR	0.011	3
	Non-natural gas	Combustion controls with SCR	0.035	9
Modified combustion turbines, all loads	Natural gas	Dry combustion controls	0.092	25
	Non-natural gas	Wet combustion controls	0.290	74
Base Load Rating > 850 MMBtu/h				
New, modified, and reconstructed intermediate and base load combustion turbines	Natural gas	Combustion controls with SCR	0.011	3
	Non-natural gas	Combustion controls with SCR	0.019	5
New, modified, and reconstructed low load combustion turbines	Natural gas	Dry combustion controls	0.055	15
	Non-natural gas	Wet combustion controls	0.150	42
Other combustion turbines				
Small combustion turbines (with base load rating ≤ 250 MMBtu/h) operating at part loads, operating north of the Arctic Circle, or at ambient temperatures of less than 0 °F, modified	Natural gas or non-natural gas	Diffusion Flame combustion controls	0.580	150

Combustion turbine type	Combustion turbine fuel	BSER	NO_X emission standard (lb/MMBtu)	NO_X emission rate equivalent (ppm)
offshore combustion turbines				
Medium and large combustion turbines (with base load rating > 250 MMBtu/h) operating at part loads, operating north of the Arctic Circle, or at ambient temperatures of less than 0 °F, modified offshore combustion turbines	Natural gas or non-natural gas	Diffusion flame combustion controls	0.370	96
Heat recovery units operating independent of the combustion turbine	Natural gas or non-natural gas	Dry combustion controls	0.200	54

Several statutes and executive orders (EO) apply analytical requirements to federal rulemakings. This Regulatory Impact Analysis (RIA) presents several of the analyses required by these statutes and EOs, such as EO 12866, EO 14094, and the Regulatory Flexibility Act (RFA). The guidance document associated with EO 12866 and EO 14094 is the Office of Management and Budget's (OMB) Circular A-4 (U.S. OMB, 2023), which was updated in November 2023.

This proposed action is significant under 3(f)(1) of Executive Order 12866 (as amended by EO 14094), which specifies that a rule is significant if it is likely to result in an annual effect on the economy of $200 million or more (adjusted every 3 years by the Administrator of OMB's Office of Information and Regulatory Affairs (OIRA) for changes in gross domestic product); 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, territorial, or tribal governments or communities.[1] In accordance with EO 12866 as

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[1] EO 14094 can be found at https://www.federalregister.gov/documents/2023/04/11/2023-07760/modernizing-regulatory-review.

amended by EO 14094 and the guidelines of OMB Circular A-4, this RIA analyzes the costs of complying with the requirements in this proposed rule for regulated facilities.

1.6 Organization of this RIA

The remainder of this report details the methodology and the results of the RIA. Chapter 2 presents an overview of combustion turbine types and their installation costs, as well as a brief description of the industries in which they are most prevalent. Chapter 3 describes the emissions and cost analysis prepared for this proposed rule. Chapter 4 presents the benefits analysis, which describes the health effects associated with exposure to NO_X and SO_2 and reports the estimated monetized benefits associated with this proposed rule. Chapter 5 describes the environmental justice analysis performed for this proposed rule. Chapter 6 presents a discussion of potential economic impacts, impacts on small businesses and a discussion of potential employment impacts. Chapter 7 presents a comparison of the benefits and costs. Chapter 8 contains the references for this RIA.

2 COMBUSTION TURBINE TECHNOLOGIES AND COSTS

2.1 Introduction

This section provides background information on combustion turbine technologies. Included is a discussion of simple-cycle combustion turbines (SCCTs) and combined-cycle combustion turbines (CCCTs), along with a comparison of fuel efficiency and capital costs between the two classes of turbines.

2.2 Simple-Cycle Combustion Turbine Technologies

Most stationary combustion turbines use natural gas to generate shaft power that is converted into electricity by a generator, or used to power a mechanical drive device such as a gas compressor or pump.

Combustion turbines have four basic components, as shown in Figure 1.

1. The compressor raises the air pressure up to thirty times atmospheric pressure.
2. A fuel compressor is used to pressurize the fuel.
3. The compressed air is heated in the combustion chamber at which point fuel is added and ignited.
4. The hot, high pressure gases are then expanded through a power turbine, producing shaft power, which is used to drive the air and fluid compressors of the combustion turbine as well as a generator or other mechanical drive device. Approximately one-third of the power developed by the power turbine can be required by the compressors.

Electric utilities primarily use simple-cycle combustion turbines as peaking or backup units. Their relatively low capital costs and quick start-up capabilities make them ideal for partial operation to generate power at periods of high demand or to provide ancillary services. The disadvantage of simple-cycle systems is that they are relatively inefficient, thus making them less attractive as base load generating units.

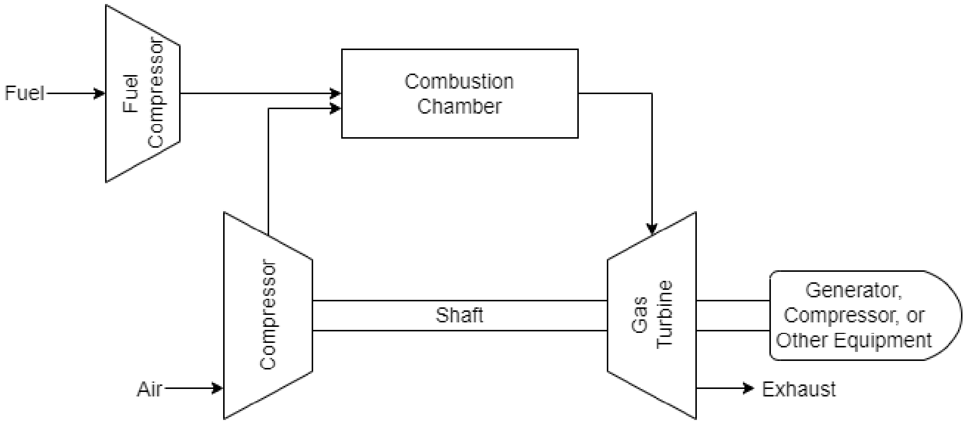

Figure 1 Simple-Cycle Gas Turbine

2.3 Combined-Cycle Combustion Turbines Technologies

The combined-cycle system incorporates two simple-cycle systems into one generation unit to maximize energy efficiency. Energy is produced in the first cycle using a gas turbine; then the heat that remains is used to create steam, which is run through a steam turbine, which is the second cycle. Thus, two single units, gas and steam, are combined to minimize lost potential energy. In a CCCT, the waste heat remaining from the gas turbine cycle is used in a boiler to produce steam. The steam is then put through a steam turbine, producing power. The remaining steam is recondensed and either returned to the boiler where it is sent through the process again or sold to a nearby industrial site to be used in a production process. Figure 2 shows a gas-fired CCCT.

There are significant efficiency gains in using a combined-cycle turbine compared to simple-cycle systems. With SCCTs, adding a second stage allows for heat that otherwise would have been emitted and completely wasted to be used to create additional power or steam for industrial purposes. While SCCTs typically range from 30-40 percent efficiency, CCCTs typically range from 50-60 percent efficiency (Gas Turbine World, 2023). In addition to energy efficiency gains, CCCTs also offer environmental efficiency gains compared to existing coal plants. In addition, efficiency gains associated with the CCCT lead to lower emissions compared to SCCTs.

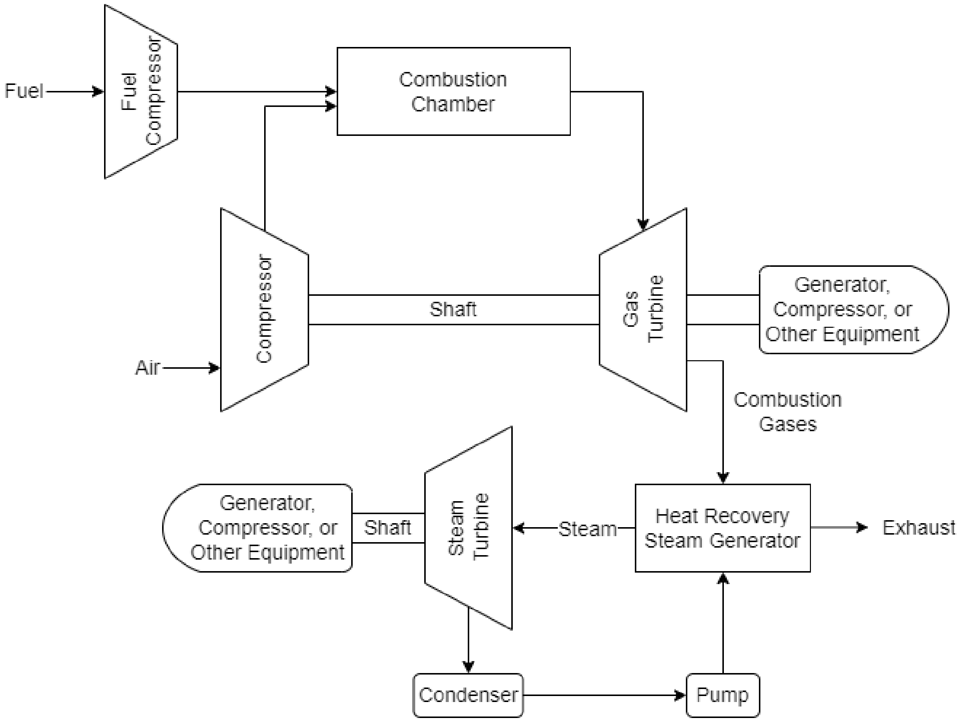

Figure 2 Combined-Cycle Gas Turbine

2.4 Capital and Installation Costs

Table 3 presents capital cost estimates for several types of utility-scale gas turbine power plants. These estimates are discussed in more detail in Gas Turbine World (2023) and are based on estimates in U.S. EIA (2020). Because these estimates are for power plants, they include the cost of generators, natural gas pipelines, and electrical grid hookups that are not applicable for all combustion turbine uses. However, these estimates provide some insight as to the overall cost of combustion turbines.

The first industrial gas turbine began operation in 1939, and the technology has undergone constant improvement since then. Table 3 shows the capital cost for three types of turbines, under the broader categories of simple cycle and combined cycle turbines discussed previously: Aeroderivative, F-Class, and H-Class. Aeroderivative turbines are lightweight and compact designs adapted from aircraft jet engines. The F-Class turbine was developed during the 1980s and began to be used in commercial operations in the early 1990s (Eldrid et al., 2001). The H-Class turbine is a more efficient design with a higher pressure ratio and higher firing temperature that was introduced in 1995 (Matta et al., 2000).

Table 3 Utility-scale Gas Turbine Power Plant Capital Cost Estimates (million 2022$ unless otherwise noted)

	Simple Cycle		**Combined Cycle**	
	100 MW Aeroderivative	**240 MW F-Class**	**430 MW H-Class**	**1100 MW H-Class**
Engineering, Procurement, and Construction Costs (EPC)				
Civil/Structural/Architectural	7.7	15.0	38.1	73.6
Mechanical - Major Equipment	52.8	65.7	159.7	360.8
Mechanical - Balance of Plant	12.0	20.9	89.7	240.5
Electrical	18.7	24.6	34.4	114.1
Project Indirect Costs	18.3	23.0	98.2	184.1
EPC Contracting Fee	10.9	14.9	42.0	97.3
Owner's Costs				
Owner's Services	8.4	11.5	32.4	74.9
Land Acquisition	0.7	0.7	2.1	2.1
Electrical Interconnection	1.5	1.5	2.2	3.0
Gas Pipeline Interconnection	5.5	5.5	7.2	7.2
Project Contingency	13.6	18.3	50.6	115.8
Total Plant Cost	150.1	201.6	556.4	1,273.3
Net Plant Rating (kW)	105,100	232,600	418,399	1,083,300
Net Plant Efficiency	41.5%	38.2%	58.9%	59.4%
Installed $/kW	1,428	867	1,330	1,175

Source: Gas Turbine World 2023 Handbook

The capital cost estimates presented in Table 3 are intended to represent a complete power plant facility on a generic site at a non-specific U.S. location. The civil/structural/architectural cost includes labor and material for site preparation, foundations, piling, structural steel, and buildings. The major mechanical equipment cost includes all costs associated with the supply and installation of the turbines and boilers (where applicable), while the balance of plant mechanical cost includes costs associated with the supply and installation of pumps and tanks, piping, valves, and other necessary equipment. The electrical cost includes all costs associated with the supply and installation of generators, transformers, control systems, and other necessary electrical equipment.

Project indirect costs include plant engineering, construction management, and start-up and commissioning, as well as contractor fees, overhead, and profit. Owner's costs include project development, land acquisition, and utility interconnections. A project contingency is included to account for cost uncertainties (Gas Turbine World, 2023; U.S. EIA, 2020).

2.5 Affected Producers

As discussed in Section 1.5, the sources subject to the proposed NSPS are stationary combustion turbines with a heat input at peak load equal to or greater than 10.7 GJ/h (10 MMBtu/h), based on the higher heating value (HHV) of the fuel, that commence construction, modification, or reconstruction after the publication of this proposed rule in the Federal Register. This rule applied to any industry using a new stationary combustion turbine as defined in Section 1.4.

To understand the industries likely to be impacted by this rule, current turbines in the National Emission Inventory (NEI) were identified. While the design capacity is not always reported in the National Emission Inventory (NEI), the units identified as combustion turbines in the 2020 NEI and having a valid design capacity of greater than 10 MMBtu/h or equivalent are summarized in Table 4 by North American Industry Classification System (NAICS) code.

Table 4 Combustion Turbines over 10 MMBtu/h or equivalent by NAICS code

NAICS	Description	# of Units	# of Facilities
2111	Oil and Gas Extraction	433	132
2211	Electric Power Generation, Transmission and Distribution	2711	968
2212	Natural Gas Distribution	100	26
2213	Water, Sewage and Other Systems	25	15
3112	Grain and Oilseed Milling	7	5
3221	Pulp, Paper, and Paperboard Mills	20	15
3241	Petroleum and Coal Products Manufacturing	38	13
3251	Basic Chemical Manufacturing	93	26
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	29	11
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	9	6
3254	Pharmaceutical and Medicine Manufacturing	9	7
3259	Other Chemical Product and Preparation Manufacturing	8	4
4861	Pipeline Transportation of Crude Oil	7	4
4862	Pipeline Transportation of Natural Gas	650	329

NAICS	Description	# of Units	# of Facilities
4869	Other Pipeline Transportation	7	4
4881	Support Activities for Air Transportation	5	3
5171	Wired and Wireless Telecommunications (except Satellite)	20	18
5182	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	5	3
5241	Insurance Carriers	8	2
5311	Lessors of Real Estate	11	3
5622	Waste Treatment and Disposal	22	9
6113	Colleges, Universities, and Professional Schools	52	36
6221	General Medical and Surgical Hospitals	17	14
9241	Administration of Environmental Quality Programs	5	2
9281	National Security and International Affairs	7	7
-	Other industries with fewer than 5 turbines per industry	67	53
Total		4365	1715

Five of these NAICS codes account for over 90 percent of the turbines in the 2020 NEI. They are 2111 (Oil and Gas Extraction), 2211 (Electric Power Generation, Transmission and Distribution), 2212 (Natural Gas Distribution), 3251 (Basic Chemical Manufacturing), and 4862 (Pipeline Transportation of Natural Gas). The NAICS codes serve as a guide for readers outlining the entities that this proposed action is likely to affect. The proposed standards, once promulgated, will be directly applicable to affected facilities that begin construction, reconstruction, or modification after the date of publication of the proposed standards in the Federal Register.

NAICS 2111 comprises establishments that operate and/or develop oil and gas field properties. Operation and development activities include exploration for crude petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This subsector includes the production of crude petroleum, the mining and extraction of oil from oil shale and oil sands, the production of natural gas, sulfur recovery from natural gas, and recovery of hydrocarbon liquids. Establishments in this subsector include those that operate oil and gas wells on their own account or for others on a contract or fee basis. NAICS 2211 comprises establishments primarily engaged in generating, transmitting, and/or distributing electric power. Establishments in this industry group may perform one or more of the following activities: (1) operate generation facilities that produce electric energy; (2) operate transmission systems that convey the electricity from the generation facility to the distribution system; and (3) operate distribution systems that convey electric power received from the generation facility or the transmission system to the final consumer. NAICS 2212 comprises: (1) establishments primarily engaged in operating gas distribution systems (e.g., mains, meters); (2) establishments known as gas marketers that buy gas from the well and sell it to a distribution system; (3) establishments known as gas brokers or agents that arrange the sale of gas over gas distribution systems operated by others; and (4) establishments primarily engaged in transmitting and distributing gas to final consumers. NAICS 3251 comprises establishments primarily engaged in manufacturing chemicals using basic processes, such as thermal cracking and distillation. Chemicals manufactured in this industry group are usually separate chemical elements or separate chemically-defined compounds. NAICS 4862 comprises establishments primarily engaged in the pipeline transportation of natural gas from processing plants to local distribution systems. This industry includes the storage of natural gas because the storage is usually done by the pipeline establishment and because a pipeline is inherently a network in which all the nodes are interdependent.

The total number of firms and establishments in these five NAICS, as well as their employment and annual payroll are summarized in Table 5 below. The information in Table 5 is not meant to serve as an exhaustive presentation for each affected industry but is instead meant to serve as a high-level summary of potentially relevant information for these industries.

Table 5 Number of Firms and Establishments, Employment, and Annual Payroll for Affected Industries: 2021

NAICS	NAICS Description	Firms	Establishments	Employment	Annual Payroll ($1,000)
2111	Oil and Gas Extraction	4,337	5,444	88,532	13,164,547
2211	Electric Power Generation, Transmission and Distribution	2,227	12,481	497,375	61,888,671
2212	Natural Gas Distribution	429	2,441	89,775	9,682,205
3251	Basic Chemical Manufacturing	1,245	2,438	154,491	15,922,408
4862	Pipeline Transportation of Natural Gas	117	2,068	26,263	3,274,407

Source: U.S. Census Bureau, 2021 Statistics of U.S. Businesses.

2.6 Projected Growth of Combustion Turbines

Because the date of construction is not available in the NEI and is often not reported to the EPA Emissions Inventory System (EIS), a separate turbine dataset was created to assess the number of new turbines constructed within the past five years. This dataset was created using Form EIA-860 survey data from the Energy Information Administration, the EPA's Clean Air Markets Program Data (CAMPD), the EPA's National Electric Energy Data System (NEEDS) database, and existing major sources subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for stationary combustion turbines. A permit review was also conducted to confirm the construction date and installed emissions controls for these units. Form EIA-860 collects unit-level information about existing and planned units and associated environmental equipment at electric power plants with 1 megawatt or greater of combined nameplate capacity. Combustion turbines that are connected to a generator larger than 250 MMBtu/hMW generally report emissions and control technology information to the EPA. The EPA reviewed the reported NO_X control technology from the CAMPD for combustion turbines that commenced operation between 2019 and 2023. NEEDS is an EPA database of electric generators that serves as a resource for modeling the sector. NEEDS includes source information about existing and planned units, information about the combustion turbines themselves, and data about their air emissions. The list of sources compiled for the EPA's review of the NESHAP only includes combustion turbines that are major sources of toxic air emissions, including industrial sources that do not appear in NEEDS, CAMPD, or the Form EIA-860 survey data. This dataset was supplemented with an estimate of the number of new stationary combustion turbines at non-major sources, for which we have limited information. The development of this dataset is discussed in greater detail in the Technical Support Document titled *NO_X Control Technology Baseline*, available in the docket for this proposed rule.

Based on this combined dataset, 235 combustion turbines that would have been subject to this rule if constructed after this NSPS proposal were constructed within the past 5 years. The types of these units and their installed controls are summarized in Table 6.

Table 6 Types of Combustion Turbines Constructed 2019-2023 and Installed Controls

Turbine Type	Total Number of Simple Cycle Turbines	Number of Simple Cycle Turbines with SCR	Total Number of Combined Cycle Turbines	Number of Combined Cycle Turbines with SCR
≤ 250 MMBtu/h	31	1	6	5
> 250 MMBtu/h and ≤ 850 MMBtu/h	70	59	3	3
> 850 MMBtu/h	23	11	50	50
Direct Mechanical Drive	52	0	0	0
Total	176	71	59	58

The EPA has used this combined dataset to estimate the potential number of new combustion turbines that would be affected by this proposed rule and the additional NO_X controls they may be required to adopt. However, this combined dataset is a selected sample, which may not be representative of the entire population of combustion turbines in the future. In particular, it has greater representation of larger combustion turbines and those in the electricity sector relative to the general population of combustion turbines. Nonetheless because these data sets provide the best information regarding turbines to date, the following analysis assumes that the units in this dataset are representative of the population of combustion turbines that the EPA has limited installation and pollution control information on – in particular smaller combustion turbines and those used in industrial sectors – as sectors that employ turbines evolve in the future. These data limitations and assumptions are potentially a notable source of uncertainty in the following analysis of the benefits, costs, and other impacts of this proposed rule. The EPA is pursuing identifying better information on the NO_X controls, size, and number of smaller combustion turbines and those in use at industrial sources and we solicit comment on data and information that would aid in refining these current estimates.

3 ENGINEERING COST ANALYSIS

3.1 Introduction

This chapter provides a summary of the cost analysis conducted for this rulemaking. Section 3.2 describes the affected sources. Section 3.3 briefly describes the methodology employed in the cost analysis and presents the results of that analysis. Section 3.4 discusses the secondary impacts of the proposed rule, and Section 3.5 characterizes the uncertainty in the cost estimates.

3.2 Affected Sources

As discussed in Section 1.5, sources subject to the proposed NSPS are stationary combustion turbines with a heat input at peak load equal to or greater than 10.7 GJ/h (10 MMBtu/h), based on the higher heating value (HHV) of the fuel, that commence construction, modification, or reconstruction after the publication of this proposed rule in the Federal Register. To estimate the projected number of affected combustion turbines in each year, the dataset described in Section 2.6 was used. Based on this dataset and assuming the same distribution of units in future years, the number of new, modified, or reconstructed stationary combustion turbines in each subcategory that are expected in each year is presented in Table 7. These values were calculated by rounding the per year estimates of new units over the 2019-2023, which were reported in Table 6.

Table 7 Estimated Number of New, Modifed, or Reconstructed Turbines in Each Year

Subcategory	New Units per Year	Average New Units per Year Expected to Incur Increased Costs Relative to Baseline
≤ 250 MMBtu/h	7	7
> 250 MMBtu/h and ≤ 850 MMBtu/h	15	2
> 850 MMBtu/h	15	3
Direct Mechanical Drive	10	10
Total	47	22

For these affected combustion turbines, the NSPS BSER discussed in Section 1.5 is the use of combustion controls with the addition of post-combustion SCR. The SCR process is based on the chemical reduction of the NO_X molecule via a nitrogen-based reducing agent (reagent) and a solid catalyst. To remove NO_X, the reagent, commonly ammonia (NH_3, anhydrous and aqueous) or urea-derived ammonia, is injected into the post-combustion flue gas of the combustion turbine. The reagent reacts selectively with the flue gas NO_X within a specific temperature range and in the presence of the catalyst and oxygen to reduce the NO_X into molecular nitrogen (N_2) and water vapor (H_2O). SCR employs a ceramic honeycomb or metal-based surface with activated catalytic sites to increase the rate of the reduction reaction. Over time, however, the catalyst activity decreases, requiring replacement, washing/cleaning, rejuvenation, or regeneration to extend the life of the catalyst. Catalyst designs and formulations are generally proprietary. The primary components of the SCR include the ammonia storage and delivery system, ammonia injection grid, and the catalyst reactor.

3.3 Capital Investment, Annual Costs, and Emissions Reductions

To comply with the requirements of this proposed rule, some units will incur capital costs associated with installation of SCR or upgrades to existing controls, while some units are expected to incur increased operating costs of their existing controls to meet the proposed requirements. These capital and increased operating costs were estimated based on model plants from NETL (2023). The development of these cost estimates is discussed in detail in the Technical Support Document titled *NO_X Mitigation Measures - Selective Catalytic Reduction for Combustion Turbines*, available in the docket for this proposed rule.

For this proposed rule, we selected an 8-year analysis period to align with the NSPS review timing in CAA Section 111(B)(1)(b) and estimated compliance will begin in 2028, reflecting the time required to complete the construction of a new, modified, or reconstructed turbine. The costs and emission reductions also reflect a reduced capacity factor from 2032 on in response to the requirements of the NSPS for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units (89 FR 39798; May 9, 2024). Our economic analysis for that rule projected that new natural gas combined cycle (NGCC) turbines that do not install carbon capture and sequestration/storage (CCS) drop their capacity factor to 40 percent while the small number that do install CCS operate at an annual capacity factor of 87 percent.[2] This results in an average capacity factor for all new NGCC units of 42 percent. The results are summarized in Table 8.

Table 8 Summary of Estimated Undiscounted Costs and Emission Reductions in First 8 Years After the Rule is Final

Year	Cumulative New Units Subject to NSPS	Cumulative Units with Increased Operating Costs Relative to Baseline	Unannualized Capital Cost (million 2023$)	Total Cost (Annualized Capital Cost and Operating Cost) (million 2023$)	Annual NO_X Emission Reductions Relative to Baseline (tons)
2025	0	0	$0	$0	0
2026	0	0	$0	$0	0
2027	16	16	$48.6	$8.01	198
2028	63	40	$52.5	$17.3	714
2029	110	63	$52.5	$26.7	1,229
2030	157	86	$52.5	$36.0	1,744
2031	204	109	$52.5	$45.3	2,259
2032	251	132	$52,.5	$54.4	2,659

Note: Costs rounded to three significant figures. The annualized capital cost that is included in the total cost is annualized over the assumed 20-year lifetime of the equipment. For more information about the per unit cost of SCR, please refer to the Technical Support Document titled *NO_X Mitigation Measures - Selective Catalytic Reduction for Combustion Turbines*, available in the docket for this proposed rule.

Table 9 reports the 2024 present value and equivalent annualized value of the costs shown in Table 8 at a 2 percent discount rate. We solicit comment, data and information that would allow refinement of these estimates.

Table 9 2024 Present Value and Equivalent Annualized Value (million 2023$)

	2% Discount Rate
Present Value	$166
Equivalent Annualized Value	$22.6

Note: Values rounded to nearest thousand.

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[2] The Integrated Planning Model (IPM) used by the EPA to analyze the projected impact of environmental policies on the electric power sector does not track the number of units, instead building model plants. In the modeling used for the RIA for the NSPS for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units (89 FR 39798; May 9, 2024), the EPA projected that 870 MW of new NGCC builds installed CCS.

3.4 Secondary Impacts

SCR uses ammonia as a reactant and some ammonia is emitting either by passing through the catalyst bed without reacting with NO_X (unreacted ammonia) or passing around the catalyst bed through leaks in the seals around the catalysts bed. Both of these combined are referred to ammonia slip. Ammonia is a precursor to fine particulate matter. Ammonia slip increases as catalysts beds age and is often limited to 10 ppm or less in operating permits. Ammonia catalysts are available to reduce emissions of ammonia. The ammonia catalyst consists of an additional catalysts bed after the SCR catalyst that reacts with the ammonia that passes through and around the catalyst to reduce overall ammonia slip. In the NETL (2023) model plants used in the EPA's analysis, no additional ammonia catalyst was included and ammonia emissions were limited to 10 ppm and the end of the catalysts' life. For estimating secondary impacts, the EPA assumed average ammonia emissions of 3.5 ppm based on information from the EPA Air Pollution Control Cost Manual (U.S. EPA, 2017a).[3] The EPA estimates that for each ton of NO_X controlled 0.10 tons of ammonia are emitted.

SCR also reduces the efficiency of a combustion through the auxiliary/parasitic load requirements to run the SCR and the backpressure created from the catalyst bed. The EPA used the auxiliary load required by the SCR that was directly provided in the NETL (2023) report, and estimated the loss in output from operation of the SCR due to backpressure as 0.3% of the gross output. The overall result is a reduction in efficiency of 0.30%, resulting in 7.5 additional tons of CO_2 emissions per ton of NO_X controlled.

Table 10 summarizes the estimated increases in ammonia and CO_2 emissions.

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[3] The EPA Control Cost Manual (U.S. EPA, 2017a) notes that ammonia slip refers to the excess reagent passing through the reactor. Ammonia in the flue gas causes a number of problems, including health effects, visibility of the stack effluent, salability of the fly ash, and the formation of ammonium sulfates. Limits on acceptable ammonia slip, imposed by either regulatory limits or by design requirements, place constraints on SCR performance. Ammonia slip does not remain constant as the SCR system operates but increases as the catalyst activity decreases. Properly designed SCR systems, which operate close to the theoretical stoichiometry and supply adequate catalyst volume, maintain low ammonia slip levels, approximately 2 to 5 ppm. The 3.5 ppm value used in this analysis reflects the midpoint of this range.

Table 10 Estimated Increased Ammonia and CO_2 Emissions Associated with NO_X Emission Reductions

Year	Ammonia (tons)	CO_2 (metric tons)
2025	0	0
2026	0	0
2027	21	1,449
2028	65	4,464
2029	108	7,479
2030	152	10,494
2031	196	13,509
2032	232	16,039

3.5 Characterization of Uncertainty

It is important to note that the cost estimates presented in this chapter are subject to multiple sources of uncertainty. The proposed rule does not dictate that controls must be installed to control pollutants, but rather that new, modified, and reconstructed turbines must meet emission standards consistent with the BSER for that unit. If the owners of affected units are able to find alternative methods to comply, then the costs presented in this RIA may be overestimates. Likewise, the costs may be underestimated if the variable cost associated with running existing controls more was underestimated in the cost analysis or if the controls the EPA assumed will be needed are not able to obtain the required reductions.

4 BENEFITS OF EMISSIONS REDUCTIONS

4.1 Introduction

Combustion turbines are a source of NO_X and SO_2 emissions. The health effects of exposure to these pollutants are briefly discussed in this section. Because the proposed NSPS is expected to result in reductions of NO_X emissions, the EPA estimated the monetized benefits related to avoided premature mortality and morbidity associated with reduced exposure to NO_X as a precursor to ozone and $PM_{2.5}$. These results are summarized below. Section 3.4 discusses the secondary impacts of this proposed rule, and the projected increases in emissions of ammonia and CO_2 are also monetized below.

The PV of the benefits of the proposed rulemaking for NOx reductions are estimated at $200 million and $670 million at a 2% discount rate. The EAV of the benefits of this proposed rulemaking for NOx reductions are estimated at $27 million and $92 million at a 2 percent discount rate. Alternative calculations of the PV of monetized benefits for this proposed rule are estimated at $150 million and $750 million at a 2 percent discount rate and alternative calculations of the EAV of the benefits are estimated at $21 million and $100 million at a 2 percent discount rate. All estimates are reported in 2023 dollars and are calculated over the 2025-2032 analytical timeframe described earlier in this RIA.

4.2 Approach to Estimating $PM_{2.5}$-related Human Health Benefits

This section summarizes the EPA's approach to estimating the incidence and economic value of the $PM_{2.5}$-related benefits estimated for this rule.

We estimate the quantity and economic value of air pollution-related effects by estimating counts of air pollution-attributable cases of adverse health outcomes, assigning dollar values to these counts, and assuming that each outcome is independent of one another. We construct these estimates by adapting primary research—specifically, air pollution epidemiology studies and economic value studies—from similar contexts. This approach is sometimes referred to as "benefits transfer." Below we describe the procedure we follow for: (1) selecting air pollution health endpoints to quantify; (2) calculating counts of air pollution effects using a health impact function; (3) specifying the health impact function with concentration-response parameters drawn from the epidemiological literature.

4.2.1 Selecting Air Pollution Health Endpoints to Quantify

As a first step in quantifying $PM_{2.5}$-related human health impacts, the EPA consults the *Integrated Science Assessment for Particulate Matter* (PM ISA) (U.S. EPA, 2019) as summarized in the TSD for the 2022 PM NAAQS Reconsideration Proposal RIA: *Estimating $PM_{2.5}$- and Ozone-Attributable Health Benefits* (U.S. EPA, 2023c) and reviewed by the EPA Science Advisory Board in *Review of BenMAP and Benefits Methods* (U.S. EPA-SAB, 2024). This document synthesizes the toxicological, clinical, and epidemiological evidence to determine whether each pollutant is 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 ISA for $PM_{2.5}$ found acute exposure to $PM_{2.5}$ to be causally related to cardiovascular effects and mortality (*i.e.*, premature death), and respiratory effects as likely-to-be-causally related. The ISA identified cardiovascular effects and total mortality as being causally related to long-term exposure to $PM_{2.5}$ and respiratory effects as likely-to-be-causal; and the evidence was suggestive of a causal relationship for reproductive and developmental effects as well as cancer, mutagenicity, and genotoxicity.

The EPA estimates the incidence of air pollution effects for those health endpoints listed above where the ISA classified the impact as either causal or likely-to-be-causal. Table 11 reports the effects we quantified and those we did not quantify in this RIA. The list of benefit categories not quantified shown in that table is not exhaustive. Among the effects we quantified, we might not have been able to completely quantify either all human health impacts or economic values. The table below omits health effects associated with changes in ambient concentrations of SO_2 and NO_2, and any welfare effects such as acidification and nutrient enrichment. These effects are described in the TSD, which details the approach EPA followed for selecting and quantifying PM-attributable effects (U.S. EPA, 2023c).

In February of 2024, EPA published the RIA for the final Particulate Matter National Ambient Air Quality Standards (U.S. EPA, 2024a). EPA quantified the PM-related benefits of this rule after publication of the final PM NAAQS RIA. The PM-related benefits reported in this RIA reflect methods consistent with the TSD (U.S. EPA, 2023c), and these PM-related benefits are estimated using methods consistent with the final PM NAAQS RIA. Specifically, we quantify PM-attributable deaths using concentration-response parameters from the Pope et al. (2019) and Wu et al. (2020) long-term exposure studies of the Medicare and National Health Interview Survey cohorts, respectively.

Table 11 Human Health Effects of PM2.5 and whether they were Quantified and/or Monetized in this RIA

Category	Effect	Effect Quantified	Effect Monetized	More Information
Premature mortality from exposure to $PM_{2.5}$	Adult premature mortality from long-term exposure (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)	✓	✓[1]	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)	✓	✓[1]	PM ISA
	Stroke (ages 65-99)	✓	✓[1]	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 (*e.g.*, other ages)	—	—	PM ISA[2]
	Other respiratory effects (*e.g.*, pulmonary function, non-asthma ER visits, non-bronchitis chronic diseases, other ages and populations)	—	—	PM ISA[2]
	Other nervous system effects (*e.g.*, autism, cognitive decline, dementia)	—	—	PM ISA[2]
	Metabolic effects (*e.g.*, diabetes)	—	—	PM ISA[2]
	Reproductive and developmental effects (*e.g.*, low birth weight, pre-term births, etc.)	—	—	PM ISA[2]
	Cancer, mutagenicity, and genotoxicity effects	—	—	PM ISA[2]

[1] We assess these benefits qualitatively due to data and resource limitations for this analysis. In other analyses we quantified these effects as a sensitivity analysis.

[2] We assess these benefits qualitatively because we do not have sufficient confidence in available data or methods.

4.2.2 Quantifying Cases of PM2.5-Attributable Premature Death

This section summarizes our approach to estimating the incidence and economic value of the $PM_{2.5}$ benefits estimated for this rule. The user manual for the environmental Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE) program separately details EPA's approach for quantifying and monetizing PM-attributable effects in the BenMAP-CE program (U.S. EPA, 2023d). In these documents the reader can find the rationale for selecting health endpoints to quantify; the demographic, health and economic data we apply within BenMAP-CE; modeling assumptions; and our techniques for quantifying uncertainty.

The PM ISA, which was reviewed by the Clean Air Scientific Advisory Committee of the EPA's Science Advisory Board (U.S. EPA-SAB, 2019), concluded that there is a causal relationship between mortality and both long-term and short-term exposure to $PM_{2.5}$ based on the body of scientific evidence. The PM ISA also concluded that the scientific literature supports the use of a no-threshold log-linear model to portray the PM-mortality concentration-response relationship while recognizing potential uncertainty about the exact shape of the concentration-response function. The PM ISA identified epidemiologic studies that examined the potential for a population-level threshold to exist in the concentration-response relationship. Based on such studies, the ISA concluded that "…the evidence from recent studies reduce uncertainties related to potential co-pollutant confounding and continues to provide strong support for a linear, no-threshold concentration-response relationship" (U.S. EPA, 2019). Consistent with this evidence, the EPA historically has estimated health impacts above and below the prevailing NAAQS.

Following this approach, we report the estimated $PM_{2.5}$-related benefits (in terms of both health impacts and monetized values) calculated using a log-linear concentration-response function that quantifies risk from the full range of simulated $PM_{2.5}$ exposures (U.S. EPA, 2023c). As noted in the preamble to the 2024 PM NAAQS final rule, the "health effects can occur over the entire distributions of ambient $PM_{2.5}$ concentrations evaluated, and epidemiological studies do not identify a population-level threshold below which it can be concluded with confidence that PM-associated health effects do not occur." In general, we are more confident in the size of the risks we estimate from simulated $PM_{2.5}$ concentrations that coincide with the bulk of the observed PM concentrations in the epidemiological studies that are used to estimate the benefits. Likewise, we are less confident in the risk we estimate from simulated $PM_{2.5}$ concentrations that fall below the bulk of the observed data in these studies (U.S. EPA, 2023c). As described further below, we lacked the air quality modeling simulations to perform such an analysis for these proposed rules and thus report the total number of avoided $PM_{2.5}$-related premature deaths using the traditional log-linear no-threshold model noted above.

4.2.3 Ozone-related Human Health Benefit

This section summarizes the EPA's approach to estimating the incidence and economic value of the ozone-related benefits estimated for this action. The RIA for the Final Revised Cross-State Air Pollution Rule (U.S. EPA, 2021a) and its corresponding Technical Support Document Estimating PM2.5 and Ozone Attributable Health Benefits (U.S. EPA, 2021b) provide a full discussion of the EPA's approach for quantifying the incidence and value of estimated ozone exposure-related health impacts. In these documents, the reader can find the rationale for selecting the health endpoints quantified; the demographic, health and economic data applied in the environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE); modeling assumptions; and the EPA's techniques for quantifying uncertainty.

4.2.4 Estimating Ozone-related Health Impacts

We estimate the quantity and economic value of air pollution-related effects by estimating counts of air pollution-attributable cases of adverse health outcomes, assigning dollar values to these counts, and assuming that each outcome is independent of one another. We construct these estimates by adapting primary research—specifically, air pollution epidemiology studies and economic value studies—from similar contexts. This approach is sometimes referred to as "benefits transfer." Below we describe the procedure we follow for: (1) selecting air pollution health endpoints to quantify; (2) calculating counts of air pollution effects using a health impact function; (3) specifying the health impact function with concentration-response parameters drawn from the epidemiological literature.

4.2.5 Selecting Air Pollution Health Endpoints to Quantify

As a first step in quantifying O_3-related human health impacts, the EPA consults the Integrated Science Assessment for Ozone (Ozone ISA) (U.S. EPA, 2020a) as summarized in the TSD for the Final Revised Cross-State Air Pollution Rule Update (U.S. EPA, 2021b). This document synthesizes the toxicological, clinical, and epidemiological evidence to determine whether each pollutant is 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.

In brief, the ISA for ozone found short-term (less than one month) exposures to ozone to be causally related to respiratory effects, a "likely to be causal" relationship with metabolic effects and a "suggestive of, but not sufficient to infer, a causal relationship" for central nervous system effects, cardiovascular effects, and total mortality. The ISA reported that long-term exposures (one month or longer) to ozone are "likely to be causal" for respiratory effects including respiratory mortality, and a "suggestive of, but not sufficient to infer, a causal relationship" for cardiovascular effects, reproductive effects, central nervous system effects, metabolic effects, and total mortality.

The EPA estimates the incidence of air pollution effects for those health endpoints listed above where the ISA classified the impact as either causal or likely-to-be-causal. Table 12 reports the effects we quantified and those we did not quantify in this RIA. The list of benefit categories not quantified shown in that table is not exhaustive. And, among the effects we quantified, we might not have been able to completely quantify either all human health impacts or economic values. The table below omits any welfare effects such as biomass loss and foliar injury. These effects are described in Chapter 7 of the Ozone NAAQS RIA (U.S. EPA, 2015).

Table 12 Human Health Effects of Ambient Ozone and whether they were Quantified and/or Monetized in this RIA

Category	Effect	Effect Quantified	Effect Monetized	More Information
Mortality from exposure to ozone	Premature respiratory mortality from short-term exposure (0-99)	✓	✓	Ozone ISA[1]
	Premature respiratory mortality from long-term exposure (age 30–99)	✓	✓	Ozone ISA
Nonfatal morbidity from exposure to ozone	Hospital admissions—respiratory (ages 65-99)	✓	✓	Ozone ISA
	Emergency department visits—respiratory (ages 0-99)	✓	✓	Ozone ISA
	Asthma onset (0-17)	✓	✓	Ozone ISA
	Asthma symptoms/exacerbation (asthmatics age 5-17)	✓	✓	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
	Decreased outdoor worker productivity (age 18–65)	—	—	Ozone ISA[2]
	Metabolic effects (*e.g.*, diabetes)	—	—	Ozone ISA[2]
	Other respiratory effects (*e.g.*, premature aging of lungs)	—	—	Ozone ISA[2]
	Cardiovascular and nervous system effects	—	—	Ozone ISA[2]
	Reproductive and developmental effects	—	—	Ozone ISA[2]

[1] We assess these benefits qualitatively due to data and resource limitations for this analysis. In other analyses we quantified these effects as a sensitivity analysis.

[2] We assess these benefits qualitatively because we do not have sufficient confidence in available data or methods.

4.2.6 Quantifying Cases of Ozone-Attributable Premature Mortality

Mortality risk reductions account for the majority of monetized ozone-related benefits. For this reason, this subsection and the following provide a brief background of the scientific assessments that underly the quantification of these mortality risks and identifies the risk studies used to quantify them in this RIA for ozone. As noted above, the Estimating $PM_{2.5}$- and Ozone-Attributable Health Benefits TSD describes fully the Agency's approach for quantifying the number and value of ozone air pollution-related impacts, including additional discussion of how the Agency selected the risk studies used to quantify them in this RIA. The TSD also includes additional discussion of the assessments that support quantification of these mortality risk than provide here.

In 2008, the National Academies of Science (NRC, 2008) issued a series of recommendations to EPA regarding the procedure for quantifying and valuing ozone-related mortality due to short-term exposures. Chief among these was that "…short-term exposure to ambient ozone is likely to contribute to premature deaths" and the committee recommended that "ozone-related mortality be included in future estimates of the health benefits of reducing ozone exposures…" The NAS also recommended that "…the greatest emphasis be placed on the multicity and [National Mortality and Morbidity Air Pollution Studies (NMMAPS)] …studies without exclusion of the meta-analyses" (NRC, 2008). Prior to the 2015 Ozone NAAQS RIA, the Agency estimated ozone-attributable premature deaths using an NMMAPS-based analysis of total mortality (Bell et al., 2004), two multi-city studies of cardiopulmonary and total mortality (Huang et al., 2005; Schwartz, 2005) and effect estimates from three meta-analyses of non-accidental mortality (Bell et al., 2005; Ito et al., 2005; Levy et al., 2005). Beginning with the 2015 Ozone NAAQS RIA, the Agency began quantifying ozone-attributable premature deaths using two newer multi-city studies of non-accidental mortality (Smith et al., 2009; Zanobetti and Schwartz, 2008) and one long-term cohort study of respiratory mortality (Jerrett et al., 2009). The 2020 Ozone ISA included changes to the causality relationship determinations between short-term exposures and total mortality, as well as including more recent epidemiologic analyses of long-term exposure effects on respiratory mortality (U.S. EPA, 2020a). In this RIA, as described in the corresponding TSD, two estimates of ozone-attributable respiratory deaths from short-term exposures are estimated using the risk estimate parameters from Zanobetti et al. (2008) and Katsouyanni et al. (2009). Ozone-attributable respiratory deaths from long-term exposures are estimated using Turner et al. (2016). Due to time and resource limitations, we were unable to reflect the warm season defined by Zanobetti et al. (2008) as June-August. Instead, we apply this risk estimate to our standard warm season of May-September.

The 2020 Ozone ISA provides a thorough discussion of the uncertainty in the effects of short- and long-term ozone exposure. One notable source of uncertainty is "the lack of examination of potential copollutant confounding." Another is the possibility of exposure measurement error. Despite these sources of uncertainty, the 2020 Ozone ISA finds that "there is coherence from animal toxicological studies that provides support for the observed epidemiologic associations".

4.3 Economic Valuation

After quantifying the change in adverse health impacts, we estimate the economic value of these avoided impacts. Reductions in ambient concentrations of air pollution generally lower the risk of future adverse health effects by a small amount for a large population. Therefore, the appropriate economic measure is willingness to pay (WTP) for changes in risk of a health effect. For some health effects, such as hospital admissions, WTP estimates are generally not available, so we use the cost of treating or mitigating the effect. These cost-of-illness (COI) estimates generally (although not necessarily in every case) understate the true value of reductions in risk of a health effect. They tend to reflect the direct expenditures related to treatment but not the value of avoided pain and suffering from the health effect. The unit values applied in this analysis are provided in the TSD for the 2022 PM NAAQS Reconsideration Final Rule RIA: Estimating PM2.5- and Ozone-Attributable Health Benefits (U.S. EPA, 2023c).

Avoided premature deaths account for 95 percent of monetized ozone-related benefits and 98 percent of monetized PM-related benefits. The economics literature concerning the appropriate method for valuing reductions in premature mortality risk is still developing. The value for the projected reduction in the risk of premature mortality is the subject of continuing discussion within the economics and public policy analysis community. Following the advice of the Scientific Advisory Board's (SAB) Environmental Economics Advisory Committee (SAB-EEAC), the EPA currently uses the value of statistical life (VSL) approach in calculating estimates of mortality benefits, because we believe this calculation provides the most reasonable single estimate of an individual's WTP for reductions in mortality risk (U.S. EPA–SAB, 2000). The VSL approach is a summary measure for the value of small changes in mortality risk experienced by a large number of people.

The EPA continues work to update its guidance on valuing mortality risk reductions and consulted several times with the SAB-EEAC on the issue. Until updated guidance is available, the EPA determined that a single, peer-reviewed estimate applied consistently best reflects the SAB-EEAC advice it has received. Therefore, the EPA applies the VSL that was vetted and endorsed by the SAB in the Guidelines for Preparing Economic Analyses while the EPA continues its efforts to update its guidance on this issue (U.S. EPA, 2016b). This approach calculates a mean value across VSL estimates derived from 26 labor market and contingent valuation studies published between 1974 and 1991. The mean VSL across these studies is $12.8 million (2022$).[4]

The EPA is committed to using scientifically sound, appropriately reviewed evidence in valuing changes in the risk of premature death and continues to engage with the SAB to identify scientifically sound approaches to update its mortality risk valuation estimates. Most recently, the Agency finalized new meta-analytic approaches for updating its estimates which were subsequently reviewed by the SAB-EEAC. The EPA is taking the SAB's formal recommendations under advisement (U.S. EPA, 2017).

Because short-term ozone-related premature mortality occurs within the analysis year, the estimated ozone-related benefits are identical for all discount rates. When valuing changes in ozone-attributable deaths using the Turner et al. (2016) study, we follow advice provided by the Health Effects Subcommittee of the SAB, which found that "…there is no evidence in the literature to support a different cessation lag between ozone and particulate matter. The HES therefore recommends using the same cessation lag structure

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[4] The WTP to avoid health impacts is adjusted for income growth over time. The central estimate of elasticity of WTP with respect to income growth is 0.15 for minor health endpoints, 0.45 for severe and chronic effects, and 0.40 for mortality. Past income growth estimates are taken from the U.S. Bureau of Commerce's Bureau of Economic Analysis (BEA). GDP values were adjusted for inflation using the BEA's price index for GDP. We divided historical GDP values by populations provided by the BEA to estimate GDP per capita to maintain internal consistency in the calculation. Future changes in annual income are based on data presented in the Annual Energy Outlook (AEO) 2020, a report prepared by the U.S. Energy Information Administration (EIA) (AEO, 2020). AEO published annual GDP projections through the year 2050, which were adjusted for inflation using the GDP Chain-type Price Index reported by AEO. We divided projected GDP values by AEO's population projections to estimate per capita GDP, again maintaining internal consistency in the calculation.

and assumptions as for particulate matter when utilizing cohort mortality evidence for ozone" (U.S. EPA-SAB, 2010). [5]

These estimated health benefits do not account for the influence of future changes in the climate on ambient concentrations of pollutants (USGCRP, 2016). For example, recent research suggests that future changes to climate may create conditions more conducive to forming ozone. The estimated health benefits also do not consider the potential for climate-induced changes in temperature to modify the relationship between ozone and the risk of premature mortality (Jhun et al., 2014; Ren et al., 2008a, 2008b).

4.3.1 Benefit-per-Ton Estimates

Due to time constraints, the EPA did not conduct air quality modeling for this rule. Instead, we used a "benefit-per-ton" (BPT) approach to estimate the benefits of this rulemaking. The EPA has previously utilized BPT approaches to estimate health benefits for other rulemakings, and has consulted with its Scientific Advisory Board about the design and application of such approaches as well as alternative reduced form approaches (U.S. EPA-SAB, 2020). A fuller description of these approaches and their development is presented in Appendix A. In 2023, the EPA updated BPTs for 21 emissions sectors using an updated 2017 emissions inventory (U.S. EPA, 2023). Sectoral BPTs were calculated for 3 regions (West, North, South) for 18 of the 21 sectors and at the State-level for the other 3 sectors (industrial boilers, stationary internal combustion engines, and electricity generating units (EGUs)[6]). These BPT estimates provide the total monetized human health benefits (the sum of premature mortality and premature morbidity) of reducing one ton of the $PM_{2.5}$, NOx and SO_2 precursor for $PM_{2.5}$ and the NOx precursor for ozone from a specified source. It is important to note that Combustion Turbines were not among the

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[5] The lag structure is to assume that 30% of the deaths occur in year 0, 50% occur in years 1-5, and the remainder occur in years 6-20. This is discussed in the Benefits TSD.

[6] EGU emissions, unlike other sectors, were based on 2026 projected emissions from the 2016v3 platform as described in the Regulatory Impact Analysis for the Proposed National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units Review of the Residual Risk and Technology Review; Research Triangle Park, NC, 2023. EPA-452/R-23-002

sectors modeled by the EPA in 2023; therefore, the Agency does not have pre-calculated Benefit-per-Ton estimates for the combustion turbines sector.

For this analysis, the EPA carefully evaluated the sectors for which BPTs are currently available. We considered numerous factors, including source locations and geographic spread; source characteristics such as stack height, temperature and velocity; and emissions composition as compared to the Combustion Turbines sector. We note that because this NSPS applies to currently unbuilt (or unmodified) sources, the locations of (future) affected sources is not known. Therefore, an approach matching the spatial locations of emissions changes is not possible. However, in anticipation of such sources being dispersed across numerous geographic locations, we determined a national average BPT approach to be preferred to a state-specific BPT approach (as the latter would require the EPA to assign greater geographic specificity to the location of future sources than is supported by current knowledge). Further, we identified three source categories as potentially representative of the emissions profile of combustion turbines: Electricity Generating Units (EGUs), oil and natural gas transmission, and industrial boilers. We note that combustion turbine emissions reductions are projected to largely occur in either EGUs or gas pipeline compression stations.[7] Portions of the EGUs and oil and gas transmission sectors have similar emissions source characteristics to the sources covered by this proposed rule.

However, after further analysis, we determined that the BPTs for industrial boilers would be most consistent with potential impacts from combustion turbines due to several factors. First, boilers are a closer match to the typical stack height. EGUs typically have higher stack heights, while oil and gas transmission as a whole has lower stack heights. EGU stack heights average 225 feet high, while boiler stack heights average 51 feet high.[8]

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[7] For more detail, see the Combustion Turbine Inventory and NOx Control Technology Baseline Technical Support Document

[8] Calculations based on data available from https://gaftp.epa.gov/Air/emismod/2022/v1/ancillary_data/ and https://gaftp.epa.gov/Air/emismod/2022/v1/draft/point/flatfiles/. Direct links to data files are

Boilers are a better match for the regulated sector than EGUs for two additional reasons. First, because the BPTs calculated for EGUs in EPA's most recent modeling are dominated by coal-fired rather than gas-fired units. Second, there is no available BPT estimates for ammonia (NH_3) emissons from the EGU sector, which means that disbenefits cannot be calculated based on BPT estimates from the EGU sector. The EPA considers the boilers BPTs, which do account for NH_3 impacts, a better match for the combustion turbine sector given the fact that this proposed rule is projected to result in NH_3 increases (disbenefits), which are important to include in the analysis. Boilers are a better match for the regulated sector than oil and gas transmission due to the spatial distribution of the emissions sources. Boilers and combustion turbine locations generally follow above-ground economic drivers of economic production activity. Oil and gas transmission locations are largely located in oil and gas producing regions, areas with relatively low concentration of combustion turbines. Fann et al. (2009) note that the spatial composition of emissions sources is a primary determinant of the health impacts of emissions, making boilers preferred to oil and gas transmission. The selection of boilers is discussed further in Appendix A.

In selecting BPTs for industrial boilers as the best fit for estimating potential benefits (and disbenefits) of this proposed rule, the EPA acknowledges the significant uncertainty inherent in the benefits estimates presented in this RIA. To help illustrate the potential impact of this uncertainty, the EPA has also included estimates of the NOx benefits calculated using the alternative sectors considered (EGUs and Oil & Gas Transmission).[9] These estimates are similar to those generated using the boilers BPTs, with oil and gas transmission BPTs resulting in NOx benefits estimates that are approximately 10% lower for short-term/low benefits and 8% lower for long-term/high benefits than those derived from the boilers BPTs, and the EGU BPTs resulting in NOx

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https://gaftp.epa.gov/Air/emismod/2022/v1/draft/point/flatfiles/SmokeFlatFile_POINT_20240321_fixperm.csv.zip,
https://gaftp.epa.gov/Air/emismod/2022/v1/ancillary_data/other_ge_dat_2022hc_17jul2024.zip, and
https://sor-scc-api.epa.gov/sccwebservices/sccsearch/.

[9] As noted, NH_3 BPTs were not available for EGUs; therefore EPA has not calculated NH_3 disbenefits for any BPTs other than boilers.

benefits estimates that are approximately 23% lower for short-term/low benefits and 11% higher for long-term/high benefits than those derived from the boilers BPTs. The EPA considers all of these estimates to be illustrative of the potential magnitude of NOx benefits from this proposed rule, but acknowledges the considerable uncertainty attached to these estimates. Ideally, the EPA would conduct full-scale air quality modeling, or develop sector-specific BPTs for combustion turbines, to provide a fuller and more precise picture of the potential benefits (and disbenefits) of this rule at the time it is finalized. It is also important to note that we were unable to quantify the value of changes in exposure to HAP and dioxin/furans that may result from this NSPS.

The estimation of BPTs involves analytic uncertainties. BPT estimates reflect the geographic distribution of the modeled emissions, which may not exactly match the emission reductions that would occur due to the action, and they may not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors for any specific location. Reduced-form tools can produce overestimates or underestimates relative to full-form modeling, depending on the pollutant of interest and policy scenario (IEc, 2019). In particular, reduced-form approaches should be applied with caution to policies with large changes in NOx emissions.

The scenario-specific emission inputs developed for this project are currently available online. The study design and methodology are described in the final report summarizing the results of the project (IEc, 2019). Results of this project found that the EPA's BPT approach provided a good approximation to full form air quality modeling for total $PM_{2.5}$ benefits in most scenarios, with estimates within 30% of the full form results in four scenarios and within 60% in the fifth scenario. The report found that reduced form models performed worse for NOx than for sulfates or elemental carbon. However, the report did find that the EPA's BPT approach is one of only two approachs which yielded results within a factor of two of full form modeling for nitrate emissions in all test scenarios.

This provides some initial understanding of the uncertainty which is associated with using the BPT approach instead of full-form air quality modeling. However, the limited sample size makes it difficult to draw conclusive opinions about reduced-form tool performance for any particular type of policy scenario, and the set of policies examined is not representative of all potential policy scenarios.

EPA has estimated BPT values for 2025 and 2030. For years in between, we use the nearest available year. Table 13 describes the mapping of modeled years to which BPT year was used.

Table 13 Mapping from BPT Years to Modeled Years

Modeled Year	BPT Year
2027	2025
2028	2030
2029	2030
2030	2030
2031	2030
2032	2030

4.3.2 Total Health Benefits - $PM_{2.5}$ - and Ozone- Related Benefits Results

Table 14 lists the estimated $PM_{2.5}$- and ozone- related benefits per ton applied in this national level analysis. These estimates are used to generate the total health benefits of the proposed rule, which represent the total monetized benefits of this proposed rule.

Table 14 BPT values for national industrial boilers used in BPT estimation

Precursor	Pollutant	BPT Year	2% short/low	2% high/long
O_3	NOx	2025	$8,770	$71,200
$PM_{2.5}$	NOx	2025	$15,400	$32,900
$PM_{2.5}$	NH_3	2025	$86,900	$185,000
O_3	NOx	2030	$9,390	$78,900
$PM_{2.5}$	NOx	2030	$16,800	$34,700
$PM_{2.5}$	NH_3	2030	$94,800	$195,000

Notes: The BPTs shown here are reported in the 2019-dollar year. Benefits were estimated in the 2023-dollar year. The multiplier used to adjust the dollar year in the benefits calculation was 1.1756115 from the dataseries A191RD3A086NBEA_NBD20190101 available at the FRED website.

The total health benefits of NOx reductions are presented in Table 15. Benefits are estimated using two alternative concentration-response parameters from several epidemiologic studies when quantifying both $PM_{2.5}$ and ozone-related mortality. $PM_{2.5}$-attributable deaths are quantified using a concentration-response relationships from the Wu et al. (2020) and Pope et al. (2019) studies. Ozone-attributable deaths are quantified using a concentration-response relationships from the Zanobetti et al. (2008), Katsouyanni et al. (2009), and Turner et al. (2016) studies. The measures in this proposed rule are estimated to reduce NO_X emissions by 198 tons in 2027, 714 tons in 2028, 1,229 tons in 2029, 1,744 tons in 2030, 2,259 tons in 2031, and 2,659 tons in 2032. Table 15 presents the monetized value of impacts from these emission reductions, discounted to 2024, along with the present value (PV) of these discounted values from 2025-2032 as well as the equivalent annualized value (EAV) for the 8-year period. For the proposed rule, the lower estimate of the present value in 2024 of the monetized NO_X emission reductions is $200 million at a 2 percent discount rate, while the upper estimate is $670 million. The equivalent annualized value of the lower estimate is $27 million at a 2 percent discount rate, while the upper estimate is $92 million. All estimates are reported in 2023 dollars. For the full set of underlying calculations, see the *Turbines BPT Workbook*, available in the docket for this action.

Table 15 Monetized Value, Present Value, and Equivalent Annualized Value of NO_X Emission Reductions from Proposed NSPS 2025-2032 (millions, 2023$)

Emission Year	Ozone			$PM_{2.5}$			Ozone + $PM_{2.5}$		
2025	$0	and	$0	$0	and	$0	$0	and	$0
2026	$0	and	$0	$0	and	$0	$0	and	$0
2027	$1	and	$8.3	$3.6	and	$7.7	$4.6	and	$16
2028	$3.9	and	$33	$14	and	$29	$18	and	$62
2029	$6.8	and	$57	$24	and	$50	$31	and	$110
2030	$9.6	and	$81	$34	and	$71	$44	and	$150
2031	$12	and	$100	$45	and	$92	$57	and	$200
2032	$15	and	$120	$53	and	$110	$67	and	$230
PV	$43	and	$360	$150	and	$320	$200	and	$670
EAV	$5.8	and	$49	$21	and	$43	$27	and	$92

Note: Values rounded to two significant figures. Health benefits for each year are presented in current (undiscounted) values, while PV and EAV are based on a 2% discount rate. These estimates are based on BPTs for industrial boilers. Using BPTs for other sectors could yield different results.

The EPA also conducted benefits analyses based on the two alternative considered sectors: EGUs and oil and gas transmission. The BPT values used in this analysis are presented in Table 16. The results of this analysis are presented in Table 17, along with the total results from Table 15 for comparison. Each result is the total NOx benefits combining $PM_{2.5}$ and Ozone benefits. The EGU based PV estimate of $150 million is 23% lower than the industrial boiler based PV estimate of $200 million, while the EGU based PV estimate of $750 million is 11% higher than the industrial boiler based PV estimate of $670 million.

The oil and gas transmission based estimate of $180 million is 10% lower than the industrial boiler based estimate of $200 million, while the oil and gas transmission based estimate of $620 million is 8% lower than the industrial boiler based estimate of $670 million.

Table 16 BPT values for EGUs and Oil & Natural Gas Transmissions used in Benefits Estimation

Precursor	Pollutant	BPT Year	2% short/low	2% high/long
EGUs				
O_3	NOx	2025	$13,800	$98,900
$PM_{2.5}$	NOx	2025	$7,710	$16,300
$PM_{2.5}$	NH_3	2025		
O_3	NOx	2030	$16,000	$130,000
$PM_{2.5}$	NOx	2030	$8,640	$17,700
$PM_{2.5}$	NH_3	2030		
Oil & Natural Gas Transmissions				
O_3	NOx	2025	$8,190	$67,200
$PM_{2.5}$	NOx	2025	$13,800	$29,500
$PM_{2.5}$	NH_3	2025	$74,900	$158,000
O_3	NOx	2030	$8,730	$74,000
$PM_{2.5}$	NOx	2030	$15,000	$30,900
$PM_{2.5}$	NH_3	2030	$82,500	$168,000

Notes: The BPTs shown here are reported in the 2019-dollar year. Benefits were estimated in the 2023-dollar year. The multiplier used to adjust the dollar year in the benefits calculation was 1.1756115 from the dataseries A191RD3A086NBEA_NBD20190101 available at the FRED website. BPTs are unavailable for $PM_{2.5}$ NH_3 emissions in the EGUs sector.

Table 17 Monetized Value, Present Value, and Equivalent Annualized Value of NO_X Emission Reductions from Proposed NSPS 2025-2032 (millions, 2023$) of Industrial Boilers, EGUs, and Oil & Gas Transmission

Emission Year	Industrial Boilers			EGUs			Oil & Gas Transmission		
2025	$0	and	$0	$0	and	$0	$0	and	$0
2026	$0	and	$0	$0	and	$0	$0	and	$0
2027	$4.6	and	$16	$3.4	and	$15	$4.2	and	$15
2028	$18	and	$62	$14	and	$69	$16	and	$57
2029	$31	and	$110	$24	and	$120	$28	and	$98
2030	$44	and	$150	$34	and	$170	$40	and	$140
2031	$57	and	$200	$44	and	$220	$51	and	$180
2032	$67	and	$230	$52	and	$260	$61	and	$210
PV	$200	and	$670	$150	and	$750	$180	and	$620
EAV	$27	and	$92	$21	and	$100	$24	and	$84

Note: Values rounded to two significant figures. Health benefits for each year are presented in current (undiscounted) values, while PV and EAV are based on a 2% discount rate. Discrepancies between the percent difference in the PV results for each sector that can be calculated using the values listed in this table and those provided in the text are because those listed in the text are based on unrounded results.

4.4 Benefits of Sulfur Dioxide Reductions

High concentrations of sulfur dioxide (SO_2) can cause inflammation and irritation of the respiratory system, especially during physical activity. Exposure to very high levels of SO_2 can lead to burning of the nose and throat, breathing difficulties, severe airway obstruction, and can be life threatening. Long term exposure to persistent levels of SO_2 can lead to changes in lung function. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly (U.S. EPA, 2017b). PM can also be formed from SO_2 emissions. Secondary PM is formed in the atmosphere through a number of physical and chemical processes that transform gases, such as SO_2, into particles. Overall, emissions of SO_2 can lead to some of the effects discussed in this section—either those directly related to SO_2 emissions, or the effects of PM resulting from the combination of SO_2 with other pollutants. Further, SO_2 emissions can lead to acid deposition, with adverse effects on aquatic and terrestrial ecosystems (U.S. EPA, 2020b). Proposing to maintain the standards of performance for emissions of SO_2 from all stationary combustion turbines would continue to protect human health and the environment from the adverse effects mentioned above.

4.5 Disbenefits from Increased Ammonia Emissions

As previously mentioned, ammonia is a precursor to $PM_{2.5}$ formation. Using the estimated ammonia emission increases reported in Table 10, the EPA estimated the monetized disbenefits associated with increased ammonia as a precursor to $PM_{2.5}$ using the same "benefit-per-ton" approach as was used for NO_X. These results are presented in Table 18. The present value of the disbenefit is estimated to be $76 million dollars and $160 million dollars, corresponding to an EAV of $10 million dollars and $21 million dollars (2023$).

Table 18 Monetized Value, Present Value, and Equivalent Annualized Value of Ammonia Emission Increases from Proposed NSPS 2025-2032 (millions, 2023$)

Emission Year		$PM_{2.5}$	
2025	$0	and	$0
2026	$0	and	$0
2027	($2.1)	and	($4.6)
2028	($7.2)	and	($15)
2029	($12)	and	($25)
2030	($17)	and	($35)
2031	($22)	and	($45)
2032	($26)	and	($53)
PV	($76)	and	($160)
EAV	($10)	and	($21)

Note: A number in parentheses represents a negative value. Values rounded to two significant figures. Health benefits for each year are presented in current (undiscounted) values, while PV and EAV are based on a 2% discount rate. These estimates are based on BPTs for industrial boilers. Using BPTs for other sectors could yield different results. BPTs are unavailable for $PM_{2.5}$ NH_3 emissions in the EGUs sector, thus monetized disbenefits from increased NH_3 emissions could not be calculated for this sector. Using BPTs for oil and gas transmission yields results that are 13% higher for short-term/low benefits (-$66 million rounded to 2 significant figures) and 14% higher for long-term/high benefits (-$130 million rounded to 2 significant figures).

4.6 Disbenefits from Increased CO_2 Emissions

The EPA monetizes the climate impacts of CO_2 emissions changes expected from this proposed rule using estimates of the social cost of carbon (SC- CO_2). The SC-CO_2 is the monetary value of the net harm to society associated with a marginal increase in CO_2 emissions in a given year, or the benefit of avoiding that increase. In principle, SC-CO_2 includes the value of all climate change impacts (both negative and positive), including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-CO_2, therefore, reflects the societal value of changing CO_2 emissions by one metric ton and is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2emissions. In practice, data and modeling limitations restrain the ability of SC-CO_2 estimates to include all physical, ecological, and economic impacts of climate change, implicitly assigning a value of zero to the omitted climate damages. The estimates are, therefore, a partial accounting of climate change impacts and likely underestimate the marginal impacts of abatement.

The EPA estimates the climate disbenefits of CO_2 emissions increases expected from this proposed rule using an updated set of SC-CO_2 estimates that reflect recent advances in the scientific literature on climate change and its economic impacts and incorporate recommendations made by the National Academies of Science, Engineering, and Medicine (National Academies, 2017). The EPA published and used these estimates in the RIA for the December 2023 Final Oil and Gas NSPS/EG Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review" (U.S. EPA, 2023a), and the methodology is explained in detail in U.S. EPA (2023b). EPA solicited public comment on the methodology and use of these estimates in the RIA for the agency's December 2022 Oil and Gas NSPS/EG Supplemental Proposal (U.S. EPA, 2022) and has conducted an external peer review of these estimates. The RIAs of two recent EPA regulations, "New Source Performance Standards for GHG Emissions from New and Reconstructed EGUs; Emission Guidelines for GHG Emissions from Existing EGUs; and Repeal of the Affordable Clean Energy Rule" (U.S.

EPA, 2024b) and the "National Emissions Standards for Hazardous Air Pollutants: Coal- and Oil- Fired Electric Utility Steam Generating Units Review of the Residual Risk and Technology Review" (U.S. EPA, 2024c) also lay out the details of the updated SC-CO_2 used within this proposed rule.

One of the methodological updates the EPA adopted in the CO_2 estimates used in this RIA is the use of a dynamic discounting approach that more fully captures the role of uncertainty in the discount rate. The SC-CO_2 estimates rely on discount rates that reflect more recent data on the consumption interest rate and uncertainty in future rates. Specifically, rather than using a constant discount rate, the evolution of the discount rate over time is defined following the latest empirical evidence on interest rate uncertainty and using a framework originally developed by Ramsey (1928) that connects economic growth and interest rates. The Ramsey approach explicitly reflects (1) preferences for utility in one period relative to utility in a later period and (2) the value of additional consumption as income changes. The dynamic discount rates used to develop the SC-GHG estimates applied in this RIA have been calibrated following the Newell et al. (2022) approach, as applied in Rennert et al. (2022a) and Rennert et al. (2022b). This approach uses the Ramsey discounting formula in which the parameters are calibrated such that (1) the decline in the certainty-equivalent discount rate matches the latest empirical evidence on interest rate uncertainty estimated by Bauer and Rudebusch (2020; 2023) and (2) the average of the certainty equivalent discount rate over the first decade matches a near-term consumption rate of interest. Uncertainty in the starting rate is addressed by using three near-term target rates (1.5, 2.0, and 2.5 percent) based on multiple lines of evidence on observed market interest rates.

The resulting dynamic discount rate provides a notable improvement over the constant discount rate framework used for SC-GHG estimation in previous EPA analyses. Specifically, it provides internal consistency within the modeling and a more complete accounting of uncertainty consistent with economic theory (Arrow et al., 2013; Cropper et al., 2014) and the National Academies (2017) recommendation to employ a more structural, Ramsey-like approach to discounting that explicitly recognizes the relationship between economic growth and discounting uncertainty. This approach is also consistent with the National Academies (2017) recommendation to use three sets of Ramsey parameters that reflect a range of near-term certainty-equivalent discount rates and are consistent with theory and empirical evidence on consumption rate uncertainty.

Table 19 presents the monetized value of the CO_2 impacts from this proposed rule, discounted to 2024, along with the present value (PV) of these discounted values from 2025-2032 as well as the equivalent annualized value (EAV) for the 8-year period.

Table 19 Discounted Monetized Value, Present Value, and Equivalent Annualized Value of CO_2 Emissions Changes from Proposed Rule 2025-2032 (millions, 2023$)

		CO_2 Ramsey discount rate	
Emission Year	**2.50%**	**2.00%**	**1.50%**
2025	$0.00	$0.00	$0.00
2026	$0.00	$0.00	$0.00
2027	($0.21)	($0.35)	($0.60)
2028	($0.65)	($1.07)	($1.83)
2029	($1.08)	($1.78)	($3.06)
2030	($1.51)	($2.49)	($4.28)
2031	($1.94)	($3.19)	($5.49)
2032	($2.29)	($3.76)	($6.51)
PV	($7.69)	($12.6)	($21.8)
EAV	($1.07)	($1.72)	($2.91)

Note: Monetized climate impacts are based on increases in CO_2 emissions and are calculated using three different estimates of the SC-CO_2 (2.5 percent, 2 percent, and 1.5 percent near-term discount rates) from U.S. EPA (2023b). A number in parentheses represents a negative value.

4.7 Characterization of Uncertainty in Monetized Health Benefits

In any complex analysis using estimated parameters and inputs from a variety of models, there are likely to be many sources of uncertainty. This analysis is no exception. This analysis includes many data sources as inputs, including emission inventories, air quality data from models (with their associated parameters and inputs), population data, population estimates, health effect estimates from epidemiology studies, economic data for monetizing benefits, and assumptions regarding the future state of the world (i.e., regulations, technology, and human behavior). Each of these inputs are uncertain and generate uncertainty in the benefits estimate. When the uncertainties from each stage of the analysis are compounded, even small uncertainties can have large effects on the total quantified benefits. Therefore, the estimates of annual benefits should be viewed as representative of the magnitude of benefits expected, rather than the actual benefits that would occur every year.

As acknowledged in section 4.3, the EPA has utilized a BPT approach to estimate the monetized benefits of this proposed rule, which introduces substantial uncertainty into the benefits estimates. Furthermore, because the Agency did not have a sector-specific BPT for combustion turbines, we used BPTs from the industrial boilers sector to calculate the potential benefits from this proposed rule and also presented sensitivity analyses based on BPTs from the EGU sector and Oil & Gas Transmission sector as alternatives. These approaches introduce substantial uncertainty into the benefits estimates presented in this RIA.

5 ENVIRONMENTAL JUSTICE ANALYSIS

5.1 Introduction

For purposes of analyzing regulatory impacts, the EPA relies upon its June 2016 "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis," which provides recommendations that encourage analysts to conduct the highest quality analysis feasible, recognizing that data limitations, time, resource constraints, and analytical challenges will vary by media and circumstance. The Technical Guidance states that a regulatory action may involve potential EJ concerns if it could: (1) create new disproportionate impacts on communities with EJ concerns; (2) exacerbate existing disproportionate impacts on communities with EJ concerns; or (3) present opportunities to address existing disproportionate impacts on communities with EJ concerns through this action under development.

The EPA's EJ technical guidance states that "[t]he analysis of potential EJ concerns for regulatory actions should address three questions: (A) Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern in the baseline? (B) Are there potential EJ concerns associated with environmental stressors affected by the regulatory action for population groups of concern for the regulatory option(s) under consideration? (C) For the regulatory option(s) under consideration, are potential EJ concerns created or mitigated compared to the baseline?"[10] The environmental justice analysis is presented for the purpose of providing the public with as full as possible an understanding of the potential impacts of this proposed action. The EPA notes that analysis of such impacts is distinct from the determinations proposed

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[10] "Technical Guidance for Assessing Environmental Justice in Regulatory Analysis", U.S. EPA, June 2016. Quote is from Section 3 – Key Analytic Considerations, page 11. https://www.epa.gov/environmentaljustice/technical-guidance-assessing-environmental-justice-regulatory-analysis

in this action under CAA section 111, which are based solely on the statutory factors the EPA is required to consider under that section.

5.2 Demographic Analysis

The locations of newly constructed sources that will become subject to the proposed Stationary Combustion Turbines and Stationary Gas Turbines NSPS (40 CFR 60, Subpart KKKKa) are not known. Therefore, to examine the potential for any EJ issues that might be associated with the proposed NSPS, we performed a proximity demographic analysis for 130 existing facilities that are currently subject to NSPS subpart KKKK. These represent facilities that might modify or reconstruct in the future and become subject to the proposed KKKKa requirements. This proximity demographic analysis characterized the individual demographic groups of the populations living within 5 km (~3 miles) and within 50 km (~31 miles) of the existing facilities. The 5 km radius was used for the near proximity because it captures a large enough population to provide demographic data without excessive uncertainty for most facilities. We do note, however, that one facility has zero population living within 5 km and another two facilities have less than 100 people living within 5 km. The EPA then compared the data from this analysis to the national average for each of the demographic groups.

It should be noted that proximity to affected facilities does not indicate that any exposures or impacts will occur and should not be interpreted as a direct measure of exposure or impact. This limits the usefulness of proximity analyses when attempting to answer questions from EPA's EJ Technical Guidance.[11]

The results of the proximity demographic analysis are shown in Table 20. The percent of the population living within 5 km of existing facilities with stationary combustion turbines is above the national average for the following racial/ethnicity demographics: Black (14 percent versus 12 percent nationally), Hispanic/Latino (20 percent versus 19 percent nationally), and Asian (9 percent versus 6 percent nationally). In

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[11] The proximity analysis is an analysis of the populations living around the facilities and their demographic makeup. It does not include an analysis of impacts/exposures. Therefore, there is no quantitative baseline versus post-control demographics

addition, the percent of population living within 5 km of the existing facilities with stationary combustion turbines is above the national average for the following demographics: people living below the poverty level (15 percent versus 13 percent nationally), people living below two times the poverty level (30 percent versus 29 percent nationally), linguistic isolation (6 percent versus 5 percent nationally), and people with one or more disabilities (13 percent versus 12 percent nationally).

The percent of the population living within 50 km of existing facilities with stationary combustion turbines is above the national average for the following racial/ethnicity demographics are: Black (14 percent versus 12 percent nationally), Hispanic/Latino (22 percent versus 19 percent nationally), and Asian (7 percent versus 6 percent nationally). In addition, the percent of population living within 50 km of existing facilities with stationary combustion turbines and stationary gas turbines is above the national average for linguistic isolation (7 percent versus 5 percent nationally) and people with one or more disabilities (13 percent versus 12 percent nationally).

Table 20 Proximity Demographic Assessment Results for Stationary Combustion Turbines NSPS

Demographic Group	Nationwide	Population within 50 km of Representative Facilities	Population within 5 km of Representative Facilities
Total Population	334,369,975	145,990,767	6,177,476
		Race and Ethnicity by Percent	
White	58%	52%	52%
Black	12%	14%	14%
American Indian and Alaska Native	0.5%	0.2%	0.3%
Asian	6%	7%	9%
Hispanic or Latino (white and nonwhite)	19%	22%	20%
Other and Multiracial	4%	4%	4%
		Age by Percent	
Age 0 to 17 years	22%	21%	19%
Age 18 to 64 years	61%	62%	67%
Age ≥ 65 years	17%	16%	14%
		Income by Percent	
Below Poverty Level	13%	12%	15%
Below 2x Poverty Level	29%	27%	30%
		Education by Percent	
Over 25 and without a High School Diploma	11%	11%	10%
		Linguistically Isolated by Percent	
Linguistically Isolated	5%	7%	6%
People with One or More Disabilities	12%	13%	13%

Notes: The demographic percentages are based on the 2020 Decennial Census' block populations, which are linked to the Census' 2018-2022 American Community Survey (ACS) five-year demographic averages at the block group or tract level. To derive demographic percentages, it is assumed a block's demographics are the same as the block group or tract in which it is contained. Demographics are tallied for all blocks falling within the indicated radius.

To avoid double counting, the "Hispanic or Latino" category is treated as a distinct demographic category for these analyses. A person is identified as one of six racial/ethnic categories above: White, Black, American Indian or Alaska Native, Asian, Other and Multiracial, or Hispanic/Latino. A person who identifies as Hispanic or Latino is counted as Hispanic/Latino for this analysis, regardless of what race this person may have also identified as in the Census.

As indicated above, the locations of any new stationary combustion turbines that would be subject to NSPS subpart KKKKa are not known. In addition, it is not known which existing turbines may be modified or reconstructed and subject to NSPS subpart KKKKa. Thus, we are limited in our ability to estimate the potential EJ impacts of this proposed rule. However, we anticipate the changes to NSPS subpart KKKKa will generally minimize future emissions in surrounding communities from new, modified, or reconstructed turbines. Specifically, the EPA is proposing that the standards should be revised downward based on the identification of SCR as the BSER for limiting NO_X for certain larger and/or higher operating combustion turbines and based on updated information concerning improved combustion control performance at all combustion turbines firing natural gas. The changes will have beneficial effects on air quality and public health for populations exposed to emissions from new, modified, or reconstructed stationary combustion turbines and will provide additional health protection for most populations, including communities with EJ concerns.

The methodology and the results (including facility-specific results) of the demographic analysis are presented in the document titled *Analysis of Demographic Factors for Populations Living Near Existing Facilities Subject to the Stationary Combustion Turbines and Stationary Gas Turbines NSPS (Subpart KKKK and KKKKa)*, which is available in the docket for this action.

6 ECONOMIC AND SMALL BUSINESS IMPACTS

6.1 Introduction

This chapter presents the economic and small business impact analyses performed for this rulemaking. Section 6.2 describes the screening analysis that was performed to determine the impacts to small entities impacted by this proposed rule. Section 6.3 discusses the potential economic impacts of this proposed rule, while Section 6.4 concludes with a discussion of potential employment impacts of the proposed rule.

6.2 Screening Analysis

This section investigates characteristics of businesses and government entities that are likely to install new combustion turbines affected by this proposed rule and provides a preliminary screening-level analysis to assist in determining whether this proposed rule is likely to impose a significant impact on a substantial number of the small businesses within this industry. The analysis compares compliance costs to 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 the 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 the 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 the EPA on compliance with the Regulatory Flexibility Act and is consistent with guidance published by the U.S. Small Business Administration'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 (U.S. SBA, 2017).[12]

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[12] The RFA compliance guidance to the EPA rule writers can be found at https://www.epa.gov/sites/default/files/2015-06/documents/guidance-regflexact.pdf.

In this analysis, a small entity is defined as: (1) a small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR § 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise that is independently owned and operated and is not dominant in its field. For the purposes of the RFA, States and tribal governments are not considered small governments.

Section 6.2.1 describes the process for identification of small entities, and the small business impacts analysis is presented and discussed in Section 6.2.2.

6.2.1 Identification of Small Entities

As described in Section 3.2, the EPA projects that approximately 68 new, modified, or reconstructed combustion turbines will begin operation each year. Approximately 13 sources are expected to incur additional costs associated with running their existing controls more. No existing combustion turbines will be affected by the regulation. Because it is not possible to project specific companies or government organizations that will purchase combustion turbines in the future, the small entity screening analysis for the combustion turbine rule is based on the evaluation of owners of combustion turbines constructed within the past five years. It is assumed that the existing size and ownership distribution of combustion turbines in this dataset is representative of the future growth in new combustion turbines.

Excluding turbines with an ultimate owner of a state, local, or foreign government, the ultimate owners of combustion turbines constructed within the past five years fall into one of the NAICS codes in Table 21, which also presents the associated SBA small entity size threshold for each NAICS code.[13] These NAICS differ from the broader groups shown in Table 4 because the NAICS code of the ultimate owner is based on the primary activity of

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[13] The table of SBA's Small Business Size Standards is available at https://www.sba.gov/document/support-table-size-standards.

the company as a whole, while the NAICS code reported in the NEI is for a particular facility.

Table 21 Affected NAICS Codes and SBA Small Entity Size Standards

NAICS Code	NAICS Industry Description	Size standards in millions of dollars	Size standards in number of employees
211120	Crude Petroleum Extraction		1,250
221112	Fossil Fuel Electric Power Generation		950
221118	Other Electric Power Generation		650
221122	Electric Power Distribution		1,100
221210	Natural Gas Distribution		1,150
237990	Other Heavy and Civil Engineering Construction	$45.0	
311221	Wet Corn Milling and Starch Manufacturing		1,300
322120	Paper Mills		1,250
322291	Sanitary Paper Product Manufacturing		1,500
322299	All Other Converted Paper Product Manufacturing		500
325193	Ethyl Alcohol Manufacturing		1,000
325211	Plastics Material and Resin Manufacturing		1,250
325412	Pharmaceutical Preparation Manufacturing		1,300
325520	Adhesive Manufacturing		550
333613	Mechanical Power Transmission Equipment Manufacturing		750
423610	Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers		200
423990	Other Miscellaneous Durable Goods Merchant Wholesalers		100
424720	Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals)		200
486210	Pipeline Transportation of Natural Gas	$41.5	
523150	Investment Banking and Securities Intermediation	$47.0	
523910	Miscellaneous Intermediation	$47.0	
524126	Direct Property and Casualty Insurance Carriers		1,500
525910	Open-End Investment Funds	$40.0	
532411	Commercial Air, Rail, and Water Transportation Equipment Rental and Leasing	$45.5	
541330	Engineering Services	$25.5	
541715	Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology) 11		1,000
551112	Offices of Other Holding Companies	$45.5	
611310	Colleges, Universities and Professional Schools	$34.5	
622110	General Medical and Surgical Hospitals	$47.0	
813110	Religious Organizations	$13.0	

Source: U.S. SBA Table of Size Standards (March 17, 2023),

6.2.2 Small Business Impacts Analysis

Based on SBA criteria, 11 of the ultimate parent companies, owning 15 turbines (7.8% of the turbines constructed within the past 5 years), are small entities. One of the municipalities owning turbines constructed within the past five years is considered small. This implies that approximately 2 of the 22 new affected units each year that are expected to incur additional costs will be owned by a small entity. The 11 small entities have an average sales value of approximately $497 million and a median sales value of approximately $50.9 million. We compared the average annual total compliance cost per unit in 2027 from Table 8 ($8,011,000/16 = $488,464) with the average sales for a typical small entity and estimate that the cost to sales ratio for the potentially affected small entity is 0.1 percent. Comparing the average annual total compliance cost per unit in 2027 from Table 8 ($8,011,000/16 = $488,464) with the median sales for a typical small entity, we estimate that the cost to sales ratio for the potentially affected small entity is 0.96 percent. The average sales value and median sales value are used due to uncertainty in the individual values. Many of the small entities that have constructed turbines within the past five years are privately held, and there is considerable uncertainty surrounding the sales estimates provided for them by D&B Hoovers. There is also uncertainty regarding the implicit assumption that the same types of small entities will construct turbines in the future. Because the proposed rule would affect new sources, any additional costs should factor into the decision to proceed with a project, and could lead to a different type of project being undertaken. Based on our analysis, there are no significant economic impacts on a substantial number of small entities (SISNOSE) from this proposed rule.

It is important to note that the cost-to-sales ratio estimated in this analysis may be overstated or understated depending on the accuracy of the information in the underlying data on parent company ownership and parent company revenues in addition to the accuracy of the estimate of increased operating costs. The annual sales values for ultimate parent companies were derived from multiple sources, including D&B Hoovers, company reports, and Securities and Exchange Commission (SEC) filings. However, as previously noted, many of the small entities in this industry are privately held and do not publicly report their sales, so there is considerable uncertainty regarding the accuracy of this data.

Furthermore, the assumption that the average sales of any new affected small entity will be equal to the average sales of the existing small entities is a source of uncertainty.

6.3 Economic Impacts

Economic impact analyses focus on changes in market prices and output levels. If changes in market prices and output levels in the primary markets are significant enough, impacts on other markets may also be examined. Both the magnitude of costs needed to comply with a rule and the distribution of these costs among affected facilities can have a role in determining how the market will change in response to a rule.

This proposed rule requires new, modified, or reconstructed stationary combustion turbines to meet emission standards for the release of NO_X into the environment. While the units impacted by these requirements are expected to already have installed any required emissions control devices, some units are expected to incur increased operating costs of their existing controls to meet the proposed requirements. These changes may result in higher costs of production for affected producers and impact broader product markets if these costs are transmitted through market relationships.

However, because the increased operating costs discussed in Section 3.3 are small in comparison to the sales of the average owner of a combustion turbine, the costs of this proposed rule are not expected to result in a significant market impact, regardless of whether they are passed on through market relationships or absorbed by the firms.

6.4 Employment Impacts

This section presents an overview of the various ways that environmental regulation can affect employment. Employment impacts of environmental regulations are generally composed of a mix of potential declines and gains in different areas of the economy over time. Regulatory employment impacts can vary across occupations, regions, and industries; by labor and product demand and supply elasticities; and in response to other labor market conditions. Isolating such impacts is a challenge, as they are difficult to disentangle from employment impacts caused by a wide variety of ongoing, concurrent economic changes. The EPA continues to explore the relevant theoretical and empirical literature and to seek public comments in order to ensure that the way the EPA characterizes the employment effects of its regulations is reasonable and informative.

Environmental regulation “typically affects the distribution of employment among industries rather than the general employment level” (Arrow et al., 1996). Even if impacts are small after long-run market adjustments to full employment, many regulatory actions have transitional effects in the short run (U.S. OMB, 2015). These movements of workers in and out of jobs in response to environmental regulation are potentially important and of interest to policymakers. Transitional job losses have consequences for workers that operate in declining industries or occupations, have limited capacity to migrate, or live in communities or regions with high unemployment rates.

As indicated by the potential impacts on industries using combustion turbines discussed in Section 6.3, this proposed rule is not projected to cause large changes in those industries. As a result, the labor employed in those industries is not expected to experience significant impacts due to this proposed rule.

7 COMPARISON OF COSTS AND BENEFITS

7.1 Results

The net benefits for the proposed NSPS for combustion turbines are presented in Table 22. This table includes the present values (PV) and the equivalent annualized values (EAV) of the costs and benefits of the proposed NSPS.

Table 22 Summary of Benefits, Costs and Net Benefits for the Proposed NSPS for Combustion Turbines from 2025 to 2032 (millions, 2023$)

	2% Discount Rate	
	PV	**EAV**
Monetized Benefits[1]	$195 and $674	$26.7 and $92.0
Alternative Calculation of Monetized Benefits[2]	$151 and $749	$20.6 and $102
Total Annual Costs	$166	$22.6
Monetized Disbenefits[1]	$88.4 and $169	$12.1 and $23.0
Non-Monetized Impacts	Any other climate, health, and environmental impacts or costs associated with increased use of existing emissions controls including non-monetized impacts of NO$_X$ and NH$_3$ as well as effects of other criteria and hazardous air polllutants	
Net Benefits[1]	-$58.7 and $340	-$8.01 and $46.4

Note: Values rounded to three significant figures. Monetized benefits were calculated using BPT estimates. The BPT estimates comprise several point estimates of mortality and morbidity. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates and do not represent lower- and upper-bound estimates

[1] Monetized benefits, disbenefits and net benefits are estimated using Industrial Boiler BPTs (see Chapter 4)

[2] Alternative calculations for monetized benefits are estimated using the BPTs for EGUs and Oil & Gas Transmission (see Chapter 4). Using BPTs for EGUs yields results that are 23% lower for short-term/low benefits and 11% higher for long-term/high benefits , while using BPTs for oil and gas transmission yields results that are 10% lower for short-term/low benefits and 8% lower for long-term/high benefits.

7.2 Shadow Price of Capital

Regulations that displace or induce capital investment may have additional social benefits and/or costs relative to regulations that only affect consumption. Market distortions, such as taxes on capital income, cause the private returns on capital investments to be lower than the social returns. Therefore, the social benefits and costs of capital investment induced or displaced by a regulation will exceed the private value of those changes in capital investments. For the current rule, EPA does not have reason to expect a substantial impact on capital investment in across the economy because the U.S. operates in a global economy with high capital mobility. However, we consider the implications of such an outcome.

In general, the analytically preferred approach to address the displacement or inducement of capital investment is to convert changes in capital investment into consumption equivalents using the shadow price of capital, which can then be discounted at the consumption discount rate. The shadow price of capital reflects the amount of additional consumption that would be required to make society indifferent to losing a dollar of investment in the same period. Implementing this approach requires both a suitable estimate of the shadow price of capital and an estimate of the regulatory incidence that falls on capital investment versus consumption.

The distribution of benefits and costs across capital investment and consumption are not readily available in general, and that is true for the current rule. The effect of regulatory costs on private investment will depend upon ultimate distribution of costs across different households and firms and their marginal propensity to save, in addition to the elasticity of international investment flows (Lyon, 1990). The net effect of a regulation on the stock of productive private capital will also depend on how the benefits (e.g., labor productivity increases in the case of the current rulemaking) impact the investment decisions of firms and households (Bradford, 1975). There are also uncertainties as to the appropriate shadow price of capital, which requires information on differences between the consumption discount rate and the social opportunity cost of private capital, the depreciation rate, and reinvestment rates (Li and Pizer, 2021). The appropriate value to apply will also depend on the type of private investment affected (e.g., corporate vs. non-corporate) as the rate of return will depend on the characteristics of capital stock being impacted (Lyon, 1990).

Given these and other uncertainties, Circular A-4 (U.S. OMB, 2023) suggests examining the sensitivity of the benefit and cost estimates to potential impacts on private capital using a range of shadow prices (1.0 and 1.2) in cases where the benefits and costs fully induce or displace private investment, respectively. Under this approach, the range of net benefits in the sensitivity analysis is defined on the lower end by costs fully displacing capital investment and on the high end by benefits fulling inducing capital investment, using a shadow price of capital of 1.2 in both cases.

This analysis adopts the Circular A-4 sensitivity analysis approach. For the purpose of this analysis, the monetized disbenefits are considered costs of the proposed requirements. As shown in Table 23, under the primary estimate monetized net benefits are -$59 million and $340 million under a 2% consumption discount rate. If all costs were assumed to displace investment the monetized net benefits estimate would be -$110 million and $273 million and if all benefits were assumed to induce investment the monetized net benefits would be -$20 million and $474 million. All estimates are reported in 2023 dollars and are calculated over the 2025-2032 analytical timeframe described earlier in this RIA.

Table 23 Sensitivity of Net Benefits to Potential Impacts on Capital Investment (Million 2023$)

	Sensitivity Assuming Costs Fully Displace Capital Investment			Primary Analysis			Sensitivity Assuming Benefits Fully Induce Capital Investment		
Benefits	$195	and	$674	$195	and	$674	$234	and	$809
Costs		$199			$166			$166	
Disbenefits	$106	and	$202	$88	and	$169	$88	and	$169
Net Benefits	-$110	and	$273	-$59	and	$340	-$20	and	$474

Note: Monetized benefits were calculated using BPT estimates. The BPT estimates comprise several point estimates of mortality and morbidity. The two benefits estimates are separated by the word “and” to signify that they are two separate estimates and do not represent lower- and upper-bound estimates

7.3 Uncertainties and Limitations

The analysis presented in this RIA is subject to many sources of uncertainty. The EPA is unable to precisely predict the number or location of combustion turbines likely to be constructed, modified, or reconstructed in the future, and therefore has to rely upon recent history to project the future. As noted in Chapter 3, the proposed rule does not dictate that controls must be installed to control pollutants, but rather that new, modified, and reconstructed turbines must meet emission standards consistent with the BSER for that unit. If the owners of affected units are able to find alternative methods to comply, then the costs presented in this RIA may be overestimates. Likewise, the costs may be underestimated if the variable cost associated with running existing controls more was underestimated in the cost analysis or if the controls the EPA assumed will be needed are not able to obtain the required reductions.

Health benefits are monetized using BPT estimates in this RIA. Because BPT values do not currently exist for the combustion turbines sector, EPA is presenting several calculations of monetized benefits reflecting estimates using the industrial boilers, EGUs, and oil and gas transmission BPT values. These sectors were chosen because these sectors have the most similar emissions characteristics to the regulated sector. This uncertainty is discussed in Section 4.7.

There is uncertainty in the small business impact assessment. The cost-to-sales ratio for the small entities expected to be impacted by this proposed rule is based on the average sales for small entities owning combustion turbines constructed in the past five years. Because we are unable to precisely predict the number of small entities likely to own new, modified, or reconstructed turbines that will be affected by this proposed rule, we have relied upon recent history as a predictor of the future. For the small entities used to estimate the average sales, we relied upon the best information the EPA had available, but because the actual sales are often not publicly available and the cost estimates are subject to the uncertainty described above, the cost-to-sales ratio may overestimate or underestimate the true impact for affected firms.

Finally, because the EPA lacks an economic model specific to combustion turbines, we are unable to predict the economic impacts that may be associated with this proposed rule. However, because the magnitude of the estimated costs is small relative to the overall sales of the industries likely to be affected by this proposed rule, we do not expect these costs to result in a significant market impact, regardless of whether they are passed on through market relationships or absorbed by the firms.

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APPENDIX A: SELECTING A BPT

The EPA provides estimates of the dollar value of health benefits for use in RIAs. The primary approach is to use modeling to project changes in emissions, then to use air quality modeling to project changes in ambient pollution levels based on these emissions changes, and then to use the Environmental Benefits Mapping Program – Community Edition (BenMAP-CE) to calculate and monetize changes in health outcomes based on changes in ambient pollution levels. This approach is computationally intensive and requires months to complete. Whenever possible, the EPA strives to estimate health benefits using this primary "full form" approach. However, in some situations (e.g., rule development timelines are compressed) the EPA may determine that the use of "reduced form" benefit estimation approaches that have been designed to approximate the more detailed analyses is appropriate.

One such reduced form approach entails the use of pre-computed average health damages for specific regulated sectors (Fann et al, 2012). These pre-computed average health damages, called Benefit-per-Ton or BPTs, describe the total monetized health impacts of each sector or sector-region's emissions divided by the aggregate emissions level in tons. To date, BPTs have been the most often applied reduced form approach by the EPA for RIA purposes. As part of the proposed rule to repeal the Clean Power Plan (CPP) in October 2017, US EPA committed to evaluate the uncertainty associated with reduced-form techniques, with a goal of better understanding the suitability of such approaches to estimating the health impacts of emissions changes. In May 2020, the EPA sent the report "Evaluating Reduced-Form Tools for Estimating Air Quality Benefits" to the Science Advisory Board (SAB) for external peer review. SAB completed their review in December 2020 and supported targeted usage of BPT-based analyses with two recommendations: a) that BPTs be periodically updated to reflect the latest emissions inventories and b) that finer-scale BPTs be developed (e.g., regional or State-level). In 2023, EPA updated BPTs using an updated 2017 emissions inventory (U.S. EPA, 2023). Sectoral BPTs were calculated for 3 regions (West, North, South) in all but three sectors and at the State-level for the other 3 sectors (industrial boilers, stationary internal combustion engines, and electricity generating units (EGUs)[14]).

EPA rulemaking timelines are subject to a variety of constraints including Clean Air Act deadlines and, in some instances, court-mandated schedules. In cases where regulatory analyses require quantification of benefits from sectors for which no BPT values exist and with a timeline too short for new air quality modeling to be undertaken, the EPA must evaluate whether other appropriate data and methods are available to estimate health benefits which include using BPT estimates for similar sectors. This Appendix describes the factors that the EPA considers when determining whether appropriate BPTs are available and sufficiently similar to quantify health impacts for specific regulatory analyses.

A.1 Overview of BPTs

The EPA has estimated BPTs for five direct and precursor pollutants that contribute to $PM_{2.5}$ and ozone concentrations for a variety of emissions sectors and geographic regions.[15] The BPTs account for directly emitted $PM_{2.5}$ and secondary $PM_{2.5}$ formation from SO_2, NO_x and NH_3 as well as atmospheric ozone formation from NO_x and VOC. For each sector-region analyzed, the EPA conducted photochemical source-apportionment air quality modeling to simulate baseline ambient levels of $PM_{2.5}$ and ozone and to track the contributions of emissions from that sector-region to gridded $PM_{2.5}$ and ozone concentrations. The EPA then used BenMAP-CE to estimate the monetized health impacts stemming from the portion of ambient pollution attributed to each sector-region and divided the aggregate monetized health benefits by the sector-region's emissions. This provides a quantification of the average benefit ($) for every ton of emissions reduced from that sector-region.

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[14] EGU emissions, unlike other sectors, were based on 2026 projected emissions from the 2016v3 platform as described in the Regulatory Impact Analysis for the Proposed National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units Review of the Residual Risk and Technology Review; Research Triangle Park, NC, 2023. EPA-452/R-23-002

[15] The BPT calculations are described in detail in the Technical Support Document (U.S. EPA, 2023). The BPT approach was reviewed by an EPA SAB (U.S. EPA, 2021). BPT estimates are available for 2025, 2030, 2035, and 2040. When analyzing other years, EPA applies the nearest available year.

Simon et al. (2023) compared the ability of various reduced form tools to replicate benefits calculated using full-form air quality modeling for a variety of emissions control scenarios impacting different emissions sectors. The reduced form tools analyzed by Simon et al. (2023) included the Air Pollution Emission Experiments and Policy analysis model version 2 (AP2), the Estimating Air pollution Social Impact Using Regression model (EASIUR), the Interventional Model for Air Pollution (InMAP), U.S. EPA BPTs and Source Apportionment-Based Air Quality Surfaces (SABAQS), a method that used state-level EGU source apportionment modeling. Considering both ozone and $PM_{2.5}$, Simon et al. (2023) found that BPTs are "generally suitable for use in applications examining impacts of emissions reductions that are similar in magnitude and geographic scope to those used to derive the [source apportionment Benefit Per Ton] relationships".[16]

As noted above, in 2020, an SAB panel reviewed the EPA's approach to reduced form tools and particularly EPA's approach to comparing reduced form tools and full-form modeling (U.S. EPA, 2021). The panel broadly endorsed the EPA's approach while offering suggestions for further explorations and model comparisons.

Table 24 lists national BPT estimates based on 2017 emissions and air quality modeling and 2025 projected population and demographic data.[17] These BPT estimates are in 2019 dollars. We note that there is variation between sectors. For NO_X, directly emitted $PM_{2.5}$, and SO_2, we see that the second highest and second lowest national BPT differ by a factor of approximately two (in the case of NO_X as an ozone precursor) to four (in the case of directly emitted directly emitted $PM_{2.5}$) by sector.

Fann et al. (2009) discuss the factors that cause variation in BPT estimates between sectors. They highlight three factors. First, differences in "chemical processes that govern the formation of $PM_{2.5}$ in the atmosphere"[18] due to "base conditions at both the emitting source and the receptor areas". Second, "characteristics of the emitting source" including

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[16] Note that "SA BPT" in this context is shorthand for source-apportionment based BPT, which is referred to just as "BPT" in this document.

[17] EPA has BPT values using population and demographic data projections for 2025, 2030, 2035, and 2040.

[18] While the Fann et al. (2009) paper focused on $PM_{2.5}$ BPT applications, these same variables are also key for any secondary pollutant including ozone.

“stack heights, stack temperatures, and velocity of emissions as they leave the stacks” which impact the transport and dispersion of pollutants between the emissions location and the ground-level locations where people are exposed. Third is “the size of the population exposed to $PM_{2.5}$ and the susceptibility of that population to adverse health outcomes”. This third factor is primarily impacted by the overlap between locations where emissions have the largest impact on ground-level pollutant concentrations and population centers.

In light of these factors, consider a sector such as taconite mining which occurs primarily in a relatively remote location (portions of northern Minnesota and northern Michigan) with minimal population exposed. As a result of the location of taconite mining sources, and all other factors being equal, taconite mining BPTs are lower than other sectors. Alternatively, consider residential woodsmoke which occurs in close proximity to people and at ground level such that pollution generally accumulates in the vicinity of the emissions source. As a result of the location of woodsmoke emissions and the characteristics of the source, woodsmoke BPTs are higher than other sectors.

Table 24 National BPTs for 2025

	PM$_{2.5}$-Related Benefits				Ozone-Related Benefits	
Sector	**Directly emitted PM$_{2.5}$**	**SO$_2$**	**NO$_X$**	**NH$_3$**	**NO$_X$**	**VOC**
Brick kilns	$230,000	$44,400	$27,400	$132,000	$86,600	$11,800
Cement kilns	$158,000	$42,700	$14,700	$65,000	$75,700	$18,500
Coke ovens	$288,000	$53,900	$26,000	--	$67,600	$36,700
Electric arc furnaces	--	$46,100	$19,300	--	$80,500	$7,060
Ferroalloy facilities	$152,000	$45,500	$15,700	--	$105,000	$7,940
Gasoline distribution	--	--	--	--	--	$7,040
Industrial Boilers	$194,000	$42,600	$15,400	$86,900	$71,200	$14,500
Integrated iron & steel	$386,000	$54,100	$23,900	$193,000	$76,800	$14,600
Internal Combustion Engines	$167,000	$38,800	$10,800	$75,700	$60,200	$9,350
Iron and steel foundries	$265,000	$54,700	$24,300		$93,100	$8,140
Oil and natural gas	$98,800	$19,500	$8,140	$24,400	$49,400	$1,840
Oil and natural gas transmission	$140,000	$29,900	$13,800	$74,900	$67,200	$8,230
Paint stripping	--	--	--	--	--	$7,060
Primary copper smelting	--	$10,100	$4,200	--	$54,500	--
Pulp and paper	$146,000	$39,400	$11,200	$51,500	$83,200	$2,340
Refineries	$369,000	$51,100	$23,200	$112,000	$63,200	$12,700
Residential woodstoves	$479,000	$34,900	$33,400	$203,000	$42,800	$13,500
Secondary lead smelters	--	$44,500	$23,700	--	$99,700	--
Synthetic organic chemical	$141,000	$42,900	$17,100	$71,400	$77,200	$6,090
Taconite mining	$62,600	$33,300	$9,430	--	$50,300	$32,600
EAF & IIS (combined)	$379,000	$52,800	$23,000	$193,000	$77,500	$12,600
Electricity generating units	$113,000	$57,000	$7,710	--	$98,900	--

While Table 24 provides national BPT values, EPA also developed regional BPT values for North, South and West US regions for all sectors except for industrial boilers, EGUs and internal combustion engines.[19] For industrial boilers, EGUs and internal combustion engines, EPA developed state-level rather than regional BPT values. Simon et al (2023) showed that state-level EGU source apportionment modeling paired with BenMAP-CE was better able to replicate full-form modeling benefits than national-level EGU BPTs for several EGU emissions control scenarios and noted that source apportionment

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[19] All BPT results can be accessed from https://gaftp.epa.gov/benmap/bpts/archives/. The BPTs in this analysis are available at https://gaftp.epa.gov/benmap/bpts/archives/2024%20BPTs/.

modeling with "more specificity . . . in terms of source characteristics or spatial scales" would allow for more accurate replication of full-form approaches.

A.2 Applying BPTs to Unmodeled Sectors

Sectors listed in Table 24 were chosen for inclusion in the BPT analysis based on the expected size of their impact on ozone and $PM_{2.5}$ concentrations and the EPA's regulatory priorities at the time these values were developed. However, the EPA's obligation to regulate sources under section 111 and 112 of the Clean Air Act is not limited to the sectors with modeled BPTs. In consideration of the factors discussed earlier from Fann (2009), in cases where the EPA must quantify rule benefits for a sector without a current BPT value on a timeline that does not permit full-form modeling, the following considerations are weighed to determine whether it is appropriate to apply an available BPT value from a different sector:

(1) Whether the locations and source characteristics (e.g. emissions composition, stack height, temperature, velocity) of affected sources known at the time of the rulemaking.

(2) Whether the source characteristics and national spatial distribution of sources for the regulated source similar to those of one of the sources with an available BPT value. Note that the absolute magnitude of emissions from the modeled and the target sector are not as important as the source locations and source characteristics given the nature of BPT which is normalized by total emissions.

(3) In cases where national spatial distributions do not match a source with an existing BPT, is finer-resolution regional or state-level BPT data provide sufficient spatial resolution to adequately represent the proximity of the regulated sources to people.

A.2.1 The Combustion Turbine Sector

This section describes how we consider the above questions as applied to new sources in the combustion turbine sector.

(1) The locations of affected sources are not known because the proposed rule would apply to currently unbuilt new sources.

(2) Timelines for the proposed rule analysis did not provide sufficient time to conduct new "full form" air quality modeling nor source apportionment modeling that would be required for creating a sector-specific BPT for combustion turbine sources.

(3) Considering the emissions characteristics of the emissions sources in the combustion turbine sector as well as the 21 sectors with modeled emissions, three sectors could be used: industrial boilers, EGUs, and oil and natural gas transmission. Boilers have similar emissions characteristics, particularly stack height. EGUs and oil and gas transmission are considered because the emissions reductions in the proposed rule are projected to occur among EGUs and gas compressors.[20] Gas compressors are a part of the oil and gas transmission sector. Boilers are preferred to EGUs because the proposed rule includes both reductions in NO_X and increases in NH_3 and there are no available BPT estimates for NH_3 reductions from the EGU sector. Boilers are preferred to oil and gas transmission because they are a closer match to the typical stack height of the regulated sector.

(4) An implicit assumption of the BPT method when applied to the modeled sector is that the spatial distribution of emissions reductions will follow the same spatial distribution as the sector's baseline emissions. Applying a BPT to an unmodeled sector relies on a distinct but related implicit assumption – that the spatial distribution of emissions reductions in the regulated sector will follow the same spatial distribution as the modeled sector's baseline emissions. In each case, there is an assumption of similar underlying economic forces causing the locations of emissions in the baseline and emissions reductions.

Given the considerations above, it was determined that using the national industrial boiler BPT values would provide the best ability to match the stack height and spatial distribution of NO_X emissions reductions and account for the NH_3 emissions increases

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[20] For more detail, see the Combustion Turbine Inventory and NOx Control Technology Baseline Technical Support Document

anticipated from this proposed rule. The national-level industrial boiler sector provides the best available match due to similar location and source characteristics.

A.3 Analytic Uncertainty

The use of BPTs based on modeling of a sector other than the unregulated sector introduces additional uncertainty in the benefits analysis beyond the fundamental uncertainties associated with full-form modeling (e.g. uncertainties in projections, statistical sampling) and in the BPT methodology (e.g. discrepancies between the modeled and actual locations of emissions reductions, nonlinearities in the relationship between emissions and benefits) as described by Fann et al (2012). For this exercise, EPA performs quantitative analyses to explore the additional uncertainty. The first approach is to recalculate the additional health benefits using an additional plausible sector (either at national- or state-levels) and compare the monetized benefits between the two calculations. Under the assumption that differences between the modeled sectors are comparable to differences between the modeled sectors and the regulated sector, the difference provides an informative estimate of the possible magnitude difference induced by comparing benefits between sectors.

A.4 References

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