FINAL ENVIRONMENTAL ASSESSMENT

FOR

Supplemental Notice of Proposed Rulemaking, 10 CFR Parts 433 and 435, "Clean Energy for New Federal Buildings and Major Renovations of Federal Buildings"
(RIN 1904-AB96)
(DOE/EA-2183)

Prepared by the
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

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Cover Page

SUMMARY

DOE Proposed Action:	**DOE would revise the federal building energy efficiency standards by adding Scope 1 fossil fuel-based energy consumption targets for all new federal buildings and federal buildings undergoing major renovation. The Proposed Action would update 10 CFR 433, "Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings," and 10 CFR 435, "Energy Efficiency Standards for New Federal Low-Rise Residential Buildings" by adding the new Scope 1 fossil fuel-generated energy consumption requirements.**
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Comment Opportunities:	**Comments on the draft EA were accepted from December 7, 2022, through December 22, 2022.** **Comments on the Supplemental Notice of Proposed Rulemaking were accepted from December 21, 2022, through March 23, 2023**
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Summary:

DOE is required by Section 433 of the Energy Independence and Security Act (EISA) of 2007 (Pub. L. 110-140) to establish fossil fuel-generated energy consumption standards for new federal buildings and federal buildings undergoing major renovation. This final EA evaluates the potential environmental impacts of DOE adding, by rule, Scope 1 fossil fuel-generated energy consumption standards for new federal buildings and federal buildings undergoing major renovations. DOE would add Scope 1 fossil fuel-generated energy consumption standards to the federal energy efficiency performance standards, found in 10 CFR Parts 433 and 435.

Abbreviations and Acronyms

ACE	Affordable Clean Energy
AEO	*Annual Energy Outlook*
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
BECP	Building Energy Codes Program
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CBECS	Commercial Buildings Energy Consumption Survey
CEQ	Council on Environmental Quality
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CO	carbon monoxide
CSAPR	Cross-State Air Pollution Rule
CTS	Compliance Tracking System
DASD	Deputy Assistant Secretary of Defense
D.C.	District of Columbia
DoD	U.S. Department of Defense
DOE	Department of Energy
EA	environmental assessment
ECPA	Energy Conservation and Production Act
eGRID	Emissions & Generation Resource Integrated Database
EGU	electric generating unit
EIA	Energy Information Administration
EIS	Environmental impact statement
EISA	Energy Independence and Security Act
EPA	Environmental Protection Agency
EUI	Energy use intensity, kBtu/ft^2-yr
FEMP	Federal Energy Management Program
FIM	Facilities Investment and Management
FONSI	Finding of No Significant Impact
FR	Federal Register
FRPP MS	Federal Real Property Profile Management System

ft^2	square feet
GHG	greenhouse gas
GSA	Government Services Administration
GWH	gigawatt hour
HAP	hazardous air pollutants
HFC	hydrofluorocarbon
HVAC	heating, ventilation, and air-conditioning
IECC	International Energy Conservation Code
IgCC	International Green Construction Code
IPCC	Intergovernmental Panel on Climate Change
IES	Illuminating Engineering Society of North America
kBtu	1 thousand British thermal units
Hg	mercury
MATS	Mercury and Air Toxics Standards
MMBtu	1 million British thermal units
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NEMS	National Energy Modeling System
NEPA	National Environmental Policy Act of 1969
NESHAP	national emissions standards for hazardous air pollutants
NF_3	nitrogen trifluoride
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
NRC	National Research Council
NREL	National Renewable Energy Laboratory
O_3	ozone
PFC	perfluorinated carbon
PM	particulate matter
RECS	Residential Energy Consumption Survey
SF_6	sulfur hexafluoride
SO_2	sulfur dioxide
SO_x	sulfur oxide gases
UNEP	United Nations Environment Programme
U.S.C.	United States Code
VOC	volatile organic compounds
WMO	World Meteorological Organization

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1.0 Introduction

1.1 NEPA

The National Environmental Policy Act (NEPA; 42 U.S. Code (U.S.C.) 4321 et seq.), the Council on Environmental Quality's (CEQ's) NEPA regulations (40 Code of Federal Regulations (CFR), 1500 to 1508), and the U.S. Department of Energy's (DOE's) NEPA-implementing procedures (10 CFR part 1021) require that DOE consider the potential environmental impacts of a major federal action. This requirement applies to DOE's decisions that concern establishing or updating energy efficiency standards.

DOE must meet its obligations under NEPA before making a final decision whether to proceed with any proposed federal action that could cause adverse impacts to human health or the environment. This final Environmental Assessment (EA) evaluates the potential individual and cumulative impacts of the Proposed Action and provides DOE the information needed to make an informed decision about the Proposed Action.

In compliance with NEPA and the regulations cited above, this final EA evaluates the potential environmental impacts of DOE's Proposed Action to add, by rule, Scope 1 fossil fuel-generated energy consumption standards for new federal buildings and federal buildings undergoing major renovations. The Proposed Action would add Scope 1 fossil fuel-generated energy consumption standards to the federal energy efficiency performance standards, found in 10 CFR parts 433 and 435. For the purposes of this final EA and proposed rulemaking, Scope 1 refers to CEQ's federal greenhouse gas (GHG) accounting reporting guidance section 2.2.1 for generation of electricity, heat, cooling, or steam from fossil fuel sources only (biomass and biofuel are not a part of the rulemaking as they do not count as fossil fuels). In this final EA, DOE also evaluates the impacts that could occur if DOE were not to adopt these Scope 1 fossil fuel-generated energy consumption standards (the No Action Alternative). This final EA provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement (EIS) or to issue a Finding of No Significant Impact (FONSI).

1.2 Background

DOE is required by Section 433 of the Energy Independence and Security Act (EISA) of 2007 (Pub. L. 110-140) to establish fossil fuel-generated energy consumption standards for new federal buildings and federal buildings undergoing major renovation. Section 433 of the EISA of 2007 modified section 305 of the Energy Conservation and Production Act (ECPA) by adding a new section 305(a)(3)(D) (42 U.S.C. 6834(a)(3)(D)), which requires DOE through regulation to update the energy efficiency requirements such that:

> "(i) For new federal buildings and federal buildings undergoing major renovations, with respect to which the Administrator of General Services is required to transmit a prospectus to Congress under section 3307 of title 40, United States Code, in the case of public buildings (as defined in section 3301 of title 40, United States Code), or of at least $2,500,000 in costs adjusted annually for inflation for other buildings: (I) The buildings shall be designed so that the fossil fuel-generated energy consumption of the buildings is reduced, as compared with such energy consumption by a similar building in fiscal year 2003 (as measured by Commercial Buildings Energy Consumption Survey (CBECS) or Residential Energy Consumption Survey (RECS) data from the Energy Information Agency), by the percentage specified in the following:

Fiscal Year	Percentage Reduction
2010	55
2015	65
2020	80
2025	90
2030	100”

The Proposed Action (referred to as the “Clean Energy for New Federal Buildings and Major Renovations of Federal Buildings” or the “Clean Energy Rule”) would apply to federal buildings, which more specifically includes new federal commercial and multi-family high-rise and low-rise residential buildings and major renovations to those buildings. It is estimated that the new federal commercial and multi-family high-rise residential building construction volume that falls above the required cost $2.5 million threshold (in 2007 dollars) for applicability of this rule (prior to 2030) will be 13.3 million square feet per year.[1] Section 205(c)(ii) of Executive Order 14057, “Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability” (December 8, 2021) requires “design new construction and modernization projects greater than 25,000 gross square feet to be net-zero emissions by 2030.” Effectively, after 2030, the proposed rule would then apply (for the purpose of analyzing the effects of this rule) to new construction and major renovation projects that are above the cost threshold and are below 25,000 gross square feet. For the year 2030 and beyond, the estimated new federal commercial and multi-family high-rise residential building construction volume per year is 2.1 million square feet per year. It is also estimated that for renovation of existing federal commercial and multi-family high-rise residential buildings the volume will be 1.4 million square feet per year for years prior to 2030 and 0.4 million square feet for years 2030 and beyond. All of these estimates are discussed in more detail in the Technical Support Document (TSD) and 10 CFR Parts 433 AND 435, “Clean Energy for New Federal Buildings and Major Renovations of Federal Buildings.”

While federal low-rise residential buildings are addressed in the Clean Energy Rule, DOE believes that no new federal low-rise residential buildings or renovated federal low-rise residential buildings are likely to meet the $2.5 million threshold (in 2007 dollars; for FY2022 a $3.375 million cost threshold) for inclusion in this analysis. DOE analyzed federal real property data of the construction rates for the last 10 years, and there were no instances of single family or other federal low-rise buildings that met this threshold. Therefore, the remainder of this final EA focuses exclusively on the impacts associated with application of this rule to federal commercial and high-rise multi-family residential buildings.

1.3 Purpose and Need

In accordance with EISA 2007 Sec 433 Federal Building Energy Efficiency Performance Standards, DOE is proposing to revise the federal building energy efficiency standards by adding fossil fuel-based energy consumption reduction targets for all new federal buildings and federal buildings undergoing major renovation. In fulfilling its statutory mandate to revise these standards, the standards will also provide positive environmental benefits, shift energy loads to an improving electric grid, and provide less reliance on fossil fuel resources.

1.4 Public Participation and Agency Consultation

On December 7, 2022, DOE released a draft EA and initiated a 15-day comment period which concluded on December 22, 2022. The draft EA was also made available on DOE’s website (https://www.energy.gov/nepa/articles/doeea-2183-draft-environmental-assessment). DOE circulated the

[1] This number is based upon the Federal Real Property Profile Management System (FRPP MS) extraction described in Section 3.3.1.3.

draft EA to subscribers of the DOE Office of NEPA Policy & Compliance email list highlighting NEPA documents and notices. DOE received no comments on the draft EA.

2.0 Alternatives Including the Proposed Action

This section describes DOE's Proposed Action (revising the federal building energy efficiency standards by adding fossil fuel-based energy consumption standards for all new federal buildings and federal buildings undergoing major renovation) and the No Action Alternative (no revisions to the existing standards).

2.1 Proposed Action

Under the Proposed Action, DOE would revise the federal building energy efficiency standards by adding Scope 1 fossil fuel-based energy consumption standards for all new federal buildings and federal buildings undergoing major renovation. The Proposed Action would update 10 CFR 433, "Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings," and 10 CFR 435, "Energy Efficiency Standards for New Federal Low-Rise Residential Buildings"[2] by adding the new Scope 1 fossil fuel-generated energy consumption requirements. For the purposes of this final EA and proposed rulemaking, Scope 1 refers to CEQ's federal GHG accounting reporting guidance section 2.2.1 for generation of electricity, heat, cooling, or steam from fossil fuel sources only (biomass and biofuel are not a part of the rulemaking as they do not count as fossil fuels). Specifically, the Proposed Action would require that federal agencies meet the following fossil fuel energy reductions as compared to DOE's 2003 Commercial Building Energy Consumption Survey (CBECS)[3] levels when constructing new buildings or doing major renovations to federal buildings, as shown in the following:

Fiscal Year	Percentage Reduction
2010	55
2015	65
2020	80
2025	90
2030	100"

Note that prior years are included as per language included in statute.

DOE notes that the energy efficiency portions of 10 CFR part 433 did not include any application to whole building major renovations.[4] Additionally, the revised standards as part of the Clean Energy Rule, major renovations in buildings subject to 10 CFR part 433 that meet the project cost threshold but are less than whole building renovations (meaning projects within an existing building comprising of retrofits to just a system (*i.e.*, HVAC system) or a component (*i.e.*, boiler)), agencies would now also be required to follow the following prescriptive efficiency performance requirements.

For component level renovations (*i.e.*, just a product or piece of equipment), agencies are required to utilize electric or non-fossil fuel using Federal Energy Management Program (FEMP) designated or ENERGY STAR equipment, which follow existing federal requirements for equipment efficiency (found in 10 CFR 436, subpart C, "Agency Procurement of Energy Efficient Products"). FEMP designated and

[2] DOE believes that for federal low-rise residential buildings, the $2.5 million cost threshold associated with this rule would preclude any application of this rule to those buildings.

[3] See http://www.eia.gov/consumption/commercial/ for CBECS. The rule also requires federal low-rise residential buildings to meet the same fossil fuel percentage reduction targets over the 2005 Residential Energy Consumption Survey (RECS). See http://www.eia.gov/consumption/residential/. However, as previously noted, DOE does not believe that any federal low-rise residential buildings will meet the $2.5 million threshold.

[4] The "No Action" alternative does apply to replacement buildings where the entire building is replaced down to the foundation, but these buildings are considered new construction in the federal standards and are thus not considered renovations.

Energy Star equipment have been previously analyzed to provide better life-cycle value compared to alternatives available on the market and as per 10 CFR 436 do not require additional cost benefit analysis when selected for one for one equipment replacement.

For system level renovations, agencies are required to utilize electric or non-fossil fuel using FEMP designated or ENERGY STAR equipment, in alignment with 10 CFR 436 subpart C and also meet the system level requirements for the systems being renovated in the baseline standards (i.e., the applicable ASHRAE Standard 90.1 for federal commercial and high-rise multi-family buildings covered under 10 CFR 433 or the applicable International Energy Conservation Code (IECC) for federal low-rise buildings covered under 10 CFR 435).

The proposed rule places no requirement on federal agencies regarding the composition of methods they will employ to meet these standards. Any specific proposal by a federal agency to construct a new federal building or conduct a major renovation in a federal building may be subject to NEPA review by that federal agency, in accordance with that agency's legal authorities and NEPA implementing procedures. Further, per 42 U.S.C. 6834(a)(2)(C), federal agencies must consider (in consultation with the Environmental Protection Agency (EPA) and other federal agencies, and where appropriate contain) measures regarding radon and other indoor air pollutants. DOE's proposed rule would make no other changes to the federal building energy efficiency standards.

DOE examined the potential environmental impacts of the Proposed Action by comparing the Proposed Action with the standards that federal agencies must achieve under the No Action Alternative (the baseline).

2.2 No Action Alternative

Under the No Action Alternative, DOE would not revise the federal building energy efficiency standards by adding fossil fuel-based energy consumption standards for all new federal buildings and federal buildings undergoing major renovation. Under the No Action Alternative, which is the baseline for comparison to the Proposed Action, federal agencies must meet the requirements of the existing energy efficiency portions of 10 CFR part 433 (which requires use of ASHRAE Standard 90.1-2019 (ASHRAE 2019)) and of 10 CFR part 435 (which requires the use of the 2021 IECC). In addition, federal buildings must achieve a level of efficiency 30 percent better than ASHRAE 90.1-2019 or the 2021 IECC, if life-cycle cost-effective.

3.0 Affected Environment and Environmental Impacts

This section describes the environmental resources potentially affected by DOE's Proposed Action, as well as the potential environmental impacts that may result from implementing the Proposed Action and the No Action Alternative.

3.1 Environmental Resources Evaluated and Dismissed from Detailed Analysis

Consistent with NEPA-implementing regulations and guidance, DOE focused the analysis in this final EA on topics with the greatest potential for significant environmental impacts. Table 1 presents DOE's evaluations of the environmental resource areas on which the Proposed Action and the No Action Alternative would not be expected to have any measurable effects. These resource areas were not carried forward for detailed analysis. Many of the resources were not considered due to the nature of this rule affecting the entire federal portfolio of new buildings being constructed or renovated and that the location of those projects cannot be known within the scope of this rulemaking. federal agencies would be required to conduct NEPA analysis of individual projects at the time of their implementation.

Table 1. Resources Not Carried Forward for Detailed Analysis

Resource Area	Considerations
Sensitive Ecosystems	Proposed Action is not site specific
Geology and Soils	Proposed Action is not site specific
Wetlands, Floodplains and Coastal Zones	Proposed Action is not site specific
Prime Agricultural Lands	Proposed Action is not site specific
Historic, Cultural or Archeological Resources	Proposed Action is not site specific
Species, including Threatened and Endangered Species	Proposed Action is not site specific
Solid Waste Management	Proposed Action does not result in increased waste generation
Hazardous Materials and Hazardous Waste	No hazardous materials used or produced as result of Proposed Action
Intentionally Destructive Acts	Proposed Action is not site specific
Environmental Justice	Proposed Action does not impact any specific group of persons as it is not a site-specific rule
Cumulative Impacts	There are no known actions or regulations which would lead to a cumulative impact of this rule
Health and Safety	Proposed Action does not impact operational Health Safety
Socioeconomics	Proposed Action does not impact
Water Resources	Proposed Action does not impact water resources
Visual Impacts	Proposed Action does not have direct visual impacts
Noise	Proposed Action does not impact Noise
Transportation and Accidents	Proposed Action does not impact transportation and accidents

3.2 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, DOE would not update energy conservation baseline standards by adding Scope 1 fossil fuel-generated energy consumption targets for new federal buildings and federal

buildings undergoing major renovation. Therefore, there would be no impacts to the environment and resources discussed in this final EA from activities related to the proposed rule. The expected reductions in fossil fuel-generated energy pollutant emissions realized by the Proposed Action would not be realized under the No Action Alternative.

3.3 Environmental Consequences of the Proposed Action

This section of the final EA describes the baseline environmental conditions and analyzes the environmental impacts of the Proposed Action on the following resource areas. It is noted that the construction of new, or major renovation of existing, federal buildings would be subject to a separate NEPA analysis by the federal agency taking the action.

- Indoor Air
- Outdoor Air
- Energy Resources
- Global Climate Change.

3.3.1 Indoor Air

Indoor air quality is a resource area with possible impacts from the Proposed Action and No Action Alternative.

3.3.1.1 Affected Environment

Energy efficiency baseline standards can affect indoor air quality. Indoor air quality is influenced by sources of pollutants both within and outside of a building, as well as natural and mechanical ventilation of the building. An air pollutant is any substance in the air that can cause discomfort or harm to humans or the environment. Pollutants may be natural or man-made (*i.e.,* anthropogenic), and may take the form of solid particles (*i.e.,* particulates or particulate matter), liquid droplets, or gases.[5] The primary indoor air emissions in typical commercial and high-rise residential buildings are particulate matter (PM), carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2), radon, volatile organic compounds (VOCs) including formaldehyde, and biological contaminants.

These emissions can be continuously or intermittently released within buildings and can originate from furnishings within a building (*e.g.*, carpet, furniture), building materials (*e.g.*, insulation material, particle board), interior finishes (*e.g.*, paints), from the ground (*e.g.*, radon), the building occupants' indoor activities (*e.g.*, tobacco smoking, painting), fossil fuel appliances (*e.g.*, gas stoves, gas water heaters), or wood stoves and fireplaces. Combustion emissions include CO, CO_2, nitrogen oxide (NO_x), and sulfur dioxide (SO_2). Fossil-fuel-burning appliances and tobacco smoke are the main sources of combustion products indoors.

Pollutants that occur outside the building (particularly vehicle exhaust) may be drawn inside where they affect indoor air quality. These pollutants can enter or be expelled from the commercial and high-rise residential building through natural and/or mechanical ventilation. Natural ventilation includes air that can enter or be expelled from the building through non-mechanical means due to differences in air pressure inside the building and outside the building. This is often through the building envelope in the form of air leakage, or through intentionally designed openings. Natural ventilation rates are significantly

[5] More information on air pollution characteristics and regulations is available on EPA's website at www.epa.gov.

influenced by weather. Mechanical ventilation involves a system that actively introduces fresh air into the building and expels indoor air to the outside.

Indoor air quality is thus influenced by pollutant sources inside and outside the building, as well as ventilation rates of the building. Table 2 summarizes the principal indoor air emissions that can be of concern within buildings.

Table 2. Indoor Pollutants in Commercial and High-Rise Residential Buildings

Pollutant	Potential Health Impacts	Sources
Particulate Matter (PM)	Bronchitis and respiratory infections. Eye, nose, and throat irritations. [a]	Combustion, dust, infiltration of outdoor air.
Carbon Monoxide (CO)	CO is an odorless and colorless gas that is an asphyxiate and disrupts oxygen transport. At high concentration levels, CO causes loss of consciousness and death. [b]	Unvented kerosene and gas space heaters; leaking chimneys and furnaces; back drafting from furnaces, gas water heaters, wood stoves, and fireplaces; gas stoves; and automobile exhaust.
Carbon Dioxide (CO_2)	An excessive concentration of CO_2 triggers increased breathing to maintain the proper exchange of oxygen and CO_2. Exposure to concentrations of CO_2 in air of 5% for 30 minutes can cause symptoms of intoxication, and exposure to concentrations of 7% to 10% for few minutes can cause loss of consciousness. [C]	Human respiration, tobacco smoking, gas stoves, and gas ovens.
Nitrogen Dioxide (NO_2)	Short-term exposure to NO_2 is linked with negative respiratory effects including inflammation of airways and increased symptoms of those with asthma. [d]	Kerosene heaters, gas stoves, ovens, and tobacco smoke.
Radon	Radon in breathed air can deposit and stay in the lungs, contributing to lung cancer. Radon is the leading cause of lung cancer in non-smokers. [e]	Radon is a radioactive gas that occurs in nature and comes from the decay of uranium that is found in soil. [f] Radon can migrate through cracks and openings in the building foundation.
Formaldehyde	The EPA has classified formaldehyde as a probable human carcinogen. In low concentration levels, formaldehyde irritates the eyes and mucous membranes of the nose and throat. Formaldehyde can cause watery eyes; burning sensations in the eyes, nose, and throat; nausea; coughing; chest tightness; wheezing; skin rashes; and allergic reactions. [g]	Various pressed-wood products can emit formaldehyde, including particle board, plywood, pressed wood, paneling, some carpeting and backing, some furniture and dyed materials, urea-formaldehyde insulating foam, and pressed textiles. [h]
Volatile organic compounds (VOCs)	VOCs can cause a wide variety of health problems. Some examples of potential health effects include increased cancer risks, depression of the central nervous system, irritation to the eyes and respiratory tract, and liver and kidney damage. [i]	VOCs are emitted from a variety of products including paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions. [i]
Biological Contaminants	Many biological pollutants are small enough to be inhaled and can cause allergic reactions as well as infectious illnesses. Molds and mildews in particular release disease-causing toxins. Symptoms of health problems include sneezing, watery eyes, coughing, shortness of breath, dizziness, lethargy, fever, and digestive problems. [j]	Common biological pollutants include mold; dust mites; pet dander; droppings and body parts from cockroaches, rodents, and other pests; viruses; and bacteria. These contaminants are typically found in damp or wet areas such as humidifiers, condensate pans, or unvented bathrooms as well as in areas where dust accumulates. [j]

(a) EPA – U.S. Environmental Protection Agency. 2021g. Particulate Matter (PM) Pollution. https://www.epa.gov/pm-pollution.
(b) EPA – U.S. Environmental Protection Agency. 2021c. Carbon Monoxide (CO) Pollution in Outdoor Air. https://www.epa.gov/co-pollution.
(c) CDC – Center for Disease Control. 2014. Immediately Dangerous to Life or Health Concentrations (IDLH): Carbon dioxide. Available at: http://www.cdc.gov/niosh/idlh/124389.html
(d) EPA – U.S. Environmental Protection Agency. 2021f. Nitrogen Dioxide (NO_2) Pollution. https://www.epa.gov/no2-pollution

(e) EPA – U.S. Environmental Protection Agency. 2020a. Health Risk of Radon. https://www.epa.gov/radon/health-risk-radon
(f) EPA – U.S. Environmental Protection Agency. 2021i. Radon. https://www.epa.gov/radon.
(g) EPA – U.S. Environmental Protection Agency. 2019. Formaldehyde. https://www.epa.gov/formaldehyde
(h) CPSC – Consumer Product Safety Commission. 2016. *An Update on Formaldehyde—2016 Revision.* Washington, D.C. https://www.cpsc.gov/s3fs-public/An-Update-On-Formaldehyde-725_1.pdf?O3CFjmPrIFt_ogVb7OhX4ZDPu7fYky8Q
(i) EPA – U.S. Environmental Protection Agency. 2021j. Volatile Organic Compounds' Impact on Indoor Air Quality. https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality.
(j) EPA – U.S. Environmental Protection Agency. 2020b. Indoor Air Quality, Biological Pollutants' Impact on Indoor Air Quality. https://www.epa.gov/indoor-air-quality-iaq/biological-pollutants-impact-indoor-air-quality.

3.3.1.2 Impacts of the Proposed Action

The Proposed Action would not change ventilation rates (natural or mechanical), air leakage into or out of buildings, or the mandatory requirements for venting of exhaust for combustion as required by the Guiding Principles for Sustainable Federal Buildings criteria 4.1 for ventilation and thermal comfort (enforcing the most recent version of ASHRAE 62 or the International Green Construction Code (IgCC) Sections 801.3.1 and 801.3.2). Although the Proposed Action would potentially change the sources of indoor air pollutants from the No Action Alternative (as design teams have the choice to design appliances such as stoves or water heaters to be electric or natural gas), the quality of the indoor air delivered within the system will still be governed to the same standards described above. Therefore, the rule is not expected to have a measurable effect on indoor air quality. For commercial and multi-family high-rise residential buildings, both the Clean Energy Rule compliant building and ASHRAE Standard 90.1-2019 all rely on ASHRAE Standard 62.1 for required ventilation rates.

- ASHRAE Standard 90.1-2019 explicitly requires the use of ASHRAE Standard 62.1-2016 plus 16 specific addenda[6] to ASHRAE Standard 62.1-2016. There is no mention of changes in ventilation rates for any building type in the technical analysis associated with DOE's determination on ASHRAE Standard 90.1-2019.

DOE's Proposed Action does not change these mechanical ventilation requirements. DOE's Proposed Action would also not change building envelope sealing requirements.

- ASHRAE Standard 90.1-2019 requires the use of the same whole building air leakage test from Standard 90.1-2016 and requires that the same approved materials or assemblies be used in addition to the test. The end result is that the Proposed Action contains the same requirements for sealing of the building envelope that have been in all previous versions of ASHRAE Standard 90.1.

Even though the potential sources of indoor air quality contaminants may be affected by the proposed rule, the final delivered indoor air quality must still comply with the unchanged design standards in place. Accordingly, indoor air pollutant levels are not expected to change under the Proposed Action.

3.3.2 Outdoor Air

Outdoor air quality is a resource area with possible impacts from the Proposed Action and No Action Alternative. Specifically, impacts would include changes in pollutant emissions, including GHGs due to changes in fossil fuel-generated energy use associated with operation of the buildings.

3.3.2.1 Affected Environment

The GHGs absorb infrared radiation, thereby trapping heat and making the planet warmer. The most important GHGs directly emitted by humans include CO_2, methane (CH_4), nitrous oxide (N_2O), and

[6] Addenda b, c, d, e, f, g, h, j, k, o, q, r, u, v, w, and z to ASHRAE Standard 62.1-2016 are listed in the references for ASHRAE Standard 90.1-2019.

several other fluorine-containing halogenated substances (HFCs, PFCs, SF_6 and NF_3).[7] Although CO_2, CH_4, and N_2O occur naturally in the atmosphere, human activities have changed their atmospheric concentrations" (EPA 2021b, Section ES-1).

The combustion of fossil fuels for electrical generation was the second largest source of U.S. GHG emission in 2019, generating an estimated 24.4 percent of total U.S. emissions expressed in metric tons (MT) of carbon dioxide equivalent (CO_2e)[8] (EPA 2021b, Table ES-2). In addition, combustion of fossil fuels for residential and commercial usage (for heating, cooking, and hot water) generated another 5.2 percent and 3.6 percent of total U.S. emissions[9] (EPA 2021b, Table ES-2). Because not all electricity generated in the United States is consumed in buildings (for example, some is used for electric vehicles or aluminum smelters), EPA also attributes electricity-related emissions to the residential and commercial building sectors. EPA's analysis (EPA 2021b, Table ES-7) indicates that residential buildings account for 14.9 percent of total U.S. emissions and commercial buildings account for 15.4 percent of total U.S. emissions when emissions associated with electricity generation are attributed properly.[10] This analysis also indicates that U.S. buildings as a whole account for a higher percentage of U.S. emissions (30.4 percent) than the industry, transportation, or agricultural sectors.

According to the EPA, total U.S. GHG emissions rose from 1990 to 2005 and have since declined to levels slightly higher than those found in 1990, with the 2019 level being 2.0 percent higher than the 1990 level (EPA 2021b, Table ES-7). During the same period, total GHG emission associated with buildings followed a similar trend, with residential and commercial buildings in 2019 each being 2.7 percent higher than the 1990 levels.

The major outdoor air pollutants considered in this final EA are described in more detail in this section.

Carbon Dioxide. CO_2 is of interest because of its classification as a GHG. GHGs, which trap the sun's radiation inside the Earth's atmosphere, either occur naturally in the atmosphere or result from human activities. Naturally occurring GHGs include water vapor, CO_2, CH_4, N_2O, and ozone (O_3). Human activities, however, add to the levels of most of these naturally occurring gases. For example, CO_2 is emitted to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), wood, and wood products are burned. In 2019, 92.6 percent of anthropogenic (*i.e.,* human-made) CO_2 equivalent emissions resulted from burning fossil fuels (Table 2-1 of EPA 2021b).

Numerous processes, collectively known as the "carbon cycle," naturally regulate concentrations of CO_2 in the atmosphere. Natural processes, such as plant photosynthesis, dominate the movement of carbon between the atmosphere and the land and oceans. While these natural processes can absorb some of the anthropogenic CO_2 emissions produced each year, billions of metric tons are added to the atmosphere annually. In the United States, CO_2 emissions from electricity generation and fossil fuels burned in commercial buildings accounted for nearly 16.2 percent of total U.S. GHG emissions in 2019 (Table 2-5 of EPA 2021b).

Nitrogen Oxide. NO_x is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colorless and odorless. Quoting from EPA 2021b, "The primary climate change effects of nitrogen oxides (*i.e.,* NO and NO_2) are indirect. Warming effects can occur due to reactions leading to the formation of ozone in the troposphere, but cooling effects can occur due to the role of NO_x as a precursor to nitrate particles (*i.e*., aerosols) and due to destruction of stratospheric ozone when emitted from very high-altitude aircraft. Additionally, NO_x emissions are also likely to decrease CH_4 concentrations, thus having a negative radiative forcing effect

[7] HFCs – hydrofluorocarbons, PFCs – perfluorinated carbons, SF_6 – sulfur hexafluoride, NF_3 – nitrogen trifluoride
[8] Percentages based on total emissions.
[9] Percentages based on total emissions.
[10] Percentages based on total emissions.

(IPCC 2013). Nitrogen oxides are created from lightning, soil microbial activity, biomass burning (both natural and anthropogenic fires) fuel combustion, and, in the stratosphere, from the photo-degradation of N_2O" (EPA 2021b).

Stationary combustion sources, including electric utilities and combustion of fossil fuels in buildings, account for about 33.3 percent of NO_x emissions in the United States (Table 2-15 of EPA 2021b).

Mercury. Coal-fired power plants emit mercury (Hg) found in coal during the burning process. Coal-fired power plants are the largest remaining source of human-generated Hg emissions in the United States. Airborne Hg is deposited on land, lakes, rivers, and estuaries through rain, snow, and dry deposition. Once there, it can transform into methylmercury and accumulate in fish tissue through bioaccumulation (EPA 2021e).

Methylmercury exposures in the United States primarily occur through eating fish and shellfish. Women of childbearing age are regarded as the population of greatest concern because the developing fetus is the most sensitive to the toxic effects of methylmercury. Children exposed to methylmercury before birth may be at increased risk of poor performance on neurobehavioral tasks, such as those measuring attention, fine motor function, language skills, visual-spatial abilities, and verbal memory (EPA 2021e).

Sulfur Dioxide. SO_2 belongs to the family of sulfur oxide (SO_x) gases. These gases dissolve easily in water. Sulfur is prevalent in raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SO_x gases are formed when fuel containing sulfur, such as coal and oil, is burned; when gasoline is extracted from oil; or metals are extracted from ore. SO_2 dissolves in water vapor to form acid and interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and their environment (EPA 2021h).

SO_2 is primarily emitted from coal combustion for electric power generation and the metals industry. Sulfur-containing compounds emitted into the atmosphere tend to exert a negative radiative forcing (*i.e.*, cooling) and therefore are discussed separately (EPA 2021b). Stationary combustion sources, including electric utilities and combustion of fossil fuels in buildings, account for about 66.3 percent of SO_2 emissions in the United States (Table 2-15 of EPA 2021b).

Quoting from EPA 2021b,

> *The indirect effect of sulfur-derived aerosols on radiative forcing can be considered in two parts. The first indirect effect is the aerosols' tendency to decrease water droplet size and increase water droplet concentration in the atmosphere. The second indirect effect is the tendency of the reduction in cloud droplet size to affect precipitation by increasing cloud lifetime and thickness. Although still highly uncertain, the radiative forcing estimates from both the first and the second indirect effect are believed to be negative, as is the combined radiative forcing of the two (IPCC 2013).*
>
> *Sulfur dioxide is also a major contributor to the formation of regional haze, which can cause significant increases in acute and chronic respiratory diseases. Once SO_2 is emitted, it is chemically transformed in the atmosphere and returns to the Earth as the primary source of acid rain. Because of these harmful effects, the United States has regulated SO_2 emissions in the Clean Air Act.*
>
> *Electric power is the largest anthropogenic source of SO_2 emissions in the United States, accounting for 46.9 percent in 2019. Coal combustion contributes nearly all of those emissions (approximately 92 percent). Sulfur dioxide emissions have decreased in recent years, primarily as a result of electric power generators switching from high-sulfur to low-sulfur coal and installing flue gas desulfurization equipment.*

Methane. Just over half of CH_4 emissions are primarily from human-related sources activities including fossil fuel production and use, agriculture, and waste disposal (IPCC 2007). The CH_4 emitted from energy sources occurs primarily during the production and processing of natural gas, coal, and oil; not in the actual use (combustion) of these fuels. CH_4 is the primary ingredient in natural gas, and production, processing, storage, and transmission of natural gas account for 58.4 percent of the energy related CH_4 emissions in 2019 (Table 3-2 of EPA 2021b). Natural gas distribution systems also account for 23.7 percent of all CH_4 emissions (Table 2-2 of EPA 2021b).

Nitrous Oxide. N_2O emission rates are more uncertain than those for CO_2 and CH_4, with nitrogen fertilization of agricultural soils being the primary human-related source. In 2019, N_2O emissions from stationary combustion accounted for 56.7 percent of N_2O emissions (Table 3-1 of EPA 2021b). In addition, electric power generation accounted for 48.1 percent of N_2O emissions in 2019, with residential and commercial buildings accounting for 2.1 percent and 0.7 percent, respectively (Table 3-7 of EPA 2021b).

Halocarbons and Other Gases. Halocarbons and other engineered gases not usually found in nature are another group of human made GHGs. Four of these gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). HFCs are compounds containing carbon, hydrogen, and fluorine. HFCs do not reach the stratosphere to destroy ozone; therefore, these are considered more environmentally benign than ozone-depleting substances such as chlorofluorocarbons (CFCs), even though HFCs are GHGs. HFCs are used as refrigerants and are becoming more common as ozone-depleting refrigerants are phased out. PFCs, SF_6, and NF_3 are primarily emitted as byproducts from industrial processes such as electric power transmission and distribution, aluminum smelting, semiconductor manufacturing, and magnesium casting. Quoting from EPA 2021b, "Currently, the radiative forcing impact of PFCs, SF_6, and NF_3 is also small, but they have a significant growth rate, extremely long atmospheric lifetimes, and are strong absorbers of infrared radiation, and therefore have the potential to influence climate far into the future (IPCC 2013)." In 2019, total emissions of HFCs, PFCs, SF_6, and NF_3 were negligible (Table 2-2 of EPA 2021b).

Carbon Monoxide. The main source of CO is the incomplete burning of fossil fuels such as gasoline. Per Intergovernmental Panel on Climate Change (IPCC) guidelines it is assumed that all of the carbon in fossil fuels, including CO, used to produce energy eventually becomes atmospheric CO_2. Exhaust from mobile combustion sources contributed about 46 percent of all CO emissions in 2017, (Table 2-3 of EPA 2021a). Fuel combustion in residential, commercial, and industrial buildings and electric generation accounted for 5.9 percent of CO emissions with most coming from wood burning in residential buildings (Table 2-3 of EPA 2021a). Almost 15 percent of fuel combustion CO emissions, or less than 1 percent of total CO emissions, came from fuel combustion for electrical generation by utilities in 2017 (Table 2-3 of EPA 2021a).

Particulate Matter. PM, also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets. PM pollution consists of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles (EPA 2021g).

PM impacts are a concern because human exposures can adversely affect respiratory and cardiac health. Particle pollution—especially fine particles—contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including, for example, increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease (EPA 2021g).

Power plant emissions can have either direct or indirect impacts on PM. A portion of the pollutants emitted by a power plant leave the smokestack in the form of particulates. These are direct, or primary, PM emissions. However, the great majority of PM emissions associated with power plants are in the form of secondary sulfates, which are produced at a significant distance from power plants by complex atmospheric chemical reactions that often involve the gaseous (non-particulate) emissions of power plants, mainly SO_2 and NO_x. The quantity of the secondary sulfates produced is determined by a very complex set of factors including the atmospheric quantities of SO_2 and NO_x, and other atmospheric constituents and conditions. Because these highly complex chemical reactions produce PM comprised of different constituents from different sources, EPA does not distinguish direct PM emissions from power plants from the secondary sulfate particulates in its ambient air quality requirements, PM monitoring of ambient air quality, or PM emissions inventories.

Lead. Exposure to lead can cause a variety of health problems. Lead can adversely affect the brain, kidneys, liver, nervous system, and other organs. Sources of lead emissions vary from one area to another. At the national level, major sources of lead in the air are ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other sources are waste incinerators, utilities, and lead-acid battery manufacturers. The highest air concentrations of lead are usually found near lead smelters. As a result of EPA's regulatory efforts including the removal of lead from motor vehicle gasoline, levels of lead in the air decreased by 98 percent between 1980 and 2014 (EPA 2021d).

3.3.2.2 Outdoor Air Quality Regulation

As required by the Clean Air Act (CAA) (EPA 1990), EPA has set national air quality standards, known as the National Ambient Air Quality Standards (NAAQS), for six common pollutants (also referred to as "criteria" pollutants). (42 U.S.C. 7409) The standards are set to protect public health and welfare. Pollutants for which standards have been set include CO, NO_2, particulate matter less than 10 or 2.5 microns in aerodynamic diameter (PM_{10} and $PM_{2.5}$), O_3, SO_2, and lead. VOCs can cause or contribute to ozone levels that violate the NAAQS for ozone, so EPA has taken several actions to reduce VOC emissions. 40 CFR 59

To reduce acid rain, the CAA requires emission reductions of SO_2 and NO_x, the primary precursors of acid rain, from the power sector. (42 U.S.C. 7651 et seq.) There is also an annual emissions cap on SO_2 for affected electric generating units (EGUs) in the 48 contiguous States and the District of Columbia (D.C.). Additionally, emissions of NO_x and SO_2, which contribute to harmful levels of $PM_{2.5}$ and ozone, from numerous States in the eastern half of the United States are limited under the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce SO_2, annual NO_x, and ozone season NO_x emissions from EGUs. Compliance with CSAPR is flexible among EGUs and is enforced through the use of state-level caps on emissions and an interstate tradable emissions program.

The CAA also requires EPA to control the emissions of hazardous air pollutants (HAPs). (42 U.S.C. 7412) EPA issued national emissions standards for hazardous air pollutants (NESHAPs) for Hg and certain other pollutants emitted from EGUs, which are also known as the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012).

3.3.2.3 Impacts of Proposed Action

To determine the impact of the Proposed Action on outdoor air quality, it is necessary to estimate the reduction in air pollutant emissions resulting from an expected decrease in Scope 1 fossil fuel-generated energy consumption in new federal buildings and federal buildings undergoing major renovation. To calculate the total change in Scope 1 fossil fuel-generated energy use, DOE estimated the total new federal commercial and high-rise multi-family residential buildings to be constructed, and the total

number of federal commercial and high-rise multi-family residential buildings undergoing major renovation, and multiplied that estimate by the expected decrease in Scope 1 fossil fuel-generated energy use per building associated with the required reduction in fossil fuel-based energy consumption. Finally, in order to arrive at estimated emission reductions, DOE calculated anticipated reductions based on total reductions in Scope 1 fossil fuel-based energy use and subsequent increases in electricity procured.

New commercial and multi-family high-rise construction Government Services Administration (GSA) data were used to find the distribution of existing federal building types (GSA 2021).[11] A database query was run on the Federal Real Property Profile Management System (FRPP MS) for federally owned buildings 100 square feet and greater in February 2022 to determine the characteristics of new commercial and multi-family high-rise construction added to the database from 2011 through 2020. These buildings were aggregated to the federal building types used in the FRPP MS.[12] It was assumed that new federal construction for years prior to 2030 would have a similar distribution between building types. Section 205(c)(ii) of Executive Order 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability" (December 8, 2021) requires "design new construction and modernization projects greater than 25,000 gross square feet to be net-zero emissions by 2030." Effectively, the proposed rule would then apply to new construction and major renovation projects that are above the cost threshold and are below 25,000 gross square feet. An additional query was run on the FRPP MS database to rule out those buildings above 25,000 square feet and those buildings were aggregated to the federal building types. As discussed in the next sections, the federal building types in the FRPP MS were mapped to DOE building prototypes to calculate energy savings and emissions reductions. In order to better map federal buildings into the DOE building prototypes, additional FRPP MS building characteristic data on Asset Height Range and Reporting Agency were utilized.

Asset Height Range was used to disaggregate federal dormitories and barracks, family housing, and office building types. Because not all buildings in the FRPP MS included Asset Height Range data, the fractions of square footage with that data included were applied to all buildings of that building type. The Asset Height Range of 0 to 30 feet was assumed to represent three stories or less, and therefore delineates between low-rise residential construction and multi-family high-rise construction for the dormitories and barracks and family housing building types; since the Proposed Action covers only four stories or greater, only buildings estimated to be greater than 30 feet in height were included in the floorspace estimates for this Proposed Action. Additionally, there are three DOE office building types defined by number of stories, so the Asset Height Range was used to disaggregate the federal office building type to better align with the DOE building prototypes.

Reporting Agency data were used to disaggregate federal dormitories and barracks to estimate new construction of dormitories, which are predominantly residential in nature, and training barracks, which include non-residential spaces. U.S. Department of Defense (DoD) agencies were assumed to construct training barracks, while non-DoD agencies were assumed to construct dormitories. Non-DoD dormitory buildings less than 30 feet in height (using the Asset Height Range data) were assumed to be outside the scope of this Proposed Action as they would be considered low-rise residential buildings.

[11] The current FRPP MS data for federal buildings were used. Buildings less than 100 square feet, buildings marked as "Report of Excess Submitted" or "Report of Excess Accepted," buildings outside the United States and Territories, and buildings not owned by the Federal Government were not included in the database query.
[12] See the FRPP MS Data Dictionary at https://www.gsa.gov/cdnstatic/FY_2020_FRPP_DATA_DICTIONARY_v2_final2.pdf for description of federal building types used.

Additionally, DoD data were used to provide an estimate of high-rise privatized housing. This estimate was combined with an estimate of the average turnover of DoD housing stock of 50 years to develop an annual estimate and was combined with the FRPP MS Family Housing numbers.[13]

A total of 13.32 million square feet of new federal buildings are assumed to be constructed each year prior to 2030 with the number of new constructed square feet affected by this rule reduced to 2.10 million square feet in years 2030 and beyond. This assumption is based on the GSA FRPP MS data (and DoD privatized high-rise housing data) and represents the annual average of the square footage extracted during the search described above. The distribution shown in Table 3 and Table 4 was used for new federal commercial and multi-family high-rise construction.

Table 3. Estimated Floor Area Fraction of Federal Commercial Building New Construction above the Required Cost Threshold for Applicability of this Rule

Facility Type	Percent
Office	17.77%
Small Office	*12.08%*
Medium Office	*3.73%*
Large Office	*1.95%*
Dormitories and Barracks*	14.57%
School	15.65%
Service	15.16%
Other Institutional Uses	5.76%
Hospital	7.80%
Warehouses	2.95%
Laboratories	4.24%
All Other	2.74%
Outpatient Healthcare Facility	5.00%
Industrial	1.63%
Childcare Center	0.89%
Communications Systems	1.42%
Prisons and Detention Centers	0.18%
Family Housing *	1.06%
Navigation and Traffic Aids	0.53%
Land Port of Entry	0.68%
Border/Inspection Station	0.64%
Facility Security	0.25%
Data Centers	0.34%

[13] Facilities Investment and Management (FIM) Office of the Assistant Secretary of Defense for Energy, Installations and Environment, The Pentagon, Room 5C646 Washington, DC 20301. Estimate prepared by Patricia Coury, Deputy to the Deputy Assistant Secretary of Defense (DASD) for that office June 14, 2016. Estimate confirmed total DoD privatized family housing units of 12 high-rise privatized unaccompanied housing buildings. The high-rise buildings were converted to housing units using an average of 311 units per building based on the DoD data. Additional discussions between DoD and DOE confirmed that for purposes of estimating annual construction, a turnover of 50 years was appropriate. DoD does not estimate housing construction more than a year in advance, so no better numbers are available.

Facility Type	Percent
Museum	0.74%
Comfort Station/Restrooms	0.01%
Public Facing Facility	0.02%
Aviation Security Related	0.00%
Post Office	0.00%
Grand Total	100.00%

Table 4. Estimated Floor Area Fraction of Federal Commercial Building New Construction above the Required Cost Threshold for Applicability of this Rule and Below 25,000 SF (Accounting for EO 14057)

Facility Type	Percent
Office	8.67%
Small Office	*7.86%*
Medium Office	*0.81%*
Large Office	*0.00%*
Dormitories and Barracks *	4.29%
School	11.59%
Service	19.53%
Other Institutional Uses	13.45%
Hospital	3.16%
Warehouses	7.32%
Laboratories	4.65%
All Other	5.95%
Outpatient Healthcare Facility	8.16%
Industrial	2.19%
Childcare Center	2.85%
Communications Systems	0.93%
Prisons and Detention Centers	0.27%
Family Housing *	1.58%
Navigation and Traffic Aids	2.08%
Land Port of Entry	1.05%
Border/Inspection Station	0.38%
Facility Security	1.45%
Data Centers	0.20%
Museum	0.11%
Comfort Station/Restrooms	0.04%
Public Facing Facility	0.10%
Aviation Security Related	0.00%
Post Office	0.00%
Grand Total	100.00%

Additionally, DOE identified an estimated rate of federal major renovation projects that would be influenced by this rule. To do so DOE utilized data from the Federal Compliance Tracking System (CTS) where agencies report data on building efficiency improvement projects. The data from CTS were queried to include only those projects that would meet the cost threshold and have impacts on the site fossil fuel energy consumption. As not all agencies are compliant in reporting data into CTS, results were scaled up to account for agencies out of compliance. CTS does not supply data on the types of buildings for the reported projects; therefore, the distribution of eligible federal buildings for a renovation that would meet the cost threshold was applied to the estimated project square footage. DOE identified a rate of new federal major renovation construction of 1.36 million square feet per year with a distribution of building types as shown in Table 3 and Table 4. Starting in the year 2030 section 205(c)(ii) of Executive Order 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability" (December 8, 2021) requires that agencies "design new construction and modernization projects greater than 25,000 gross square feet to be net-zero emissions by 2030." This effectively reduces the impact of this rule to apply to new construction and major renovation projects that fall above the cost threshold but are also below 25,000 gross square feet. For the year 2030 and beyond the estimated new federal commercial and multi-family high-rise residential building major renovation construction volume per year will be 0.4 million square feet per year with a distribution of building types as shown in Table 3 and Table 4. New construction and major renovation estimated yearly construction volumes are shown in Table 5.

Table 5. Annual Construction Volumes by Building Type and Year Constructed

Construction Volume	New Construction	Major Renovation	Combined Total
Total SF Building/Year (2025–2030)	13,317,707	1,357,055	14,674,762
Total SF Building/Year (2030–2054)	2,230,380	404,411	2,634,791

Energy Use

Energy Use Intensity (EUI) is the energy consumed by a building per square foot per year. The national average EUIs were calculated using a weighted average of EUIs for the types of buildings that the federal government is expected to construct shown in Table 3 and Table 4. Site energy includes energy used only at the building site, while source energy includes energy used at the building site and energy lost in producing and delivering the energy to the site. To determine the EUI of the federal buildings listed in Table 3 and Table 4, DOE mapped the federal building stock to various building prototypes used in DOE's Building Energy Codes Program (BECP) determination of energy savings for ANSI/ASHRAE/IES Standard 90.1-2019 (Lei et al. 2020). The mapping used for this final EA is shown in Table 6.

Table 6. Mapping of Federal Building Types to BECP Prototypes

Federal Building Type	Match to BECP Prototypes
Office	Small Office, Medium Office, Large Office (weighted by estimated percentages in FRPP MS data)
Dormitories and Barracks*	Small Hotel, Mid-rise Apartment, High-Rise Apartment (weighted by estimated percentages in FRPP MS data)
School	Secondary School
Service	50% Stand-alone Retail, 50% Non-refrigerated Warehouse
Other Institutional Uses	None
Hospital	Hospital
Laboratories	25% Medium Office, 75% Hospital

Federal Building Type	Match to BECP Prototypes
Warehouses	Non-refrigerated Warehouse
Outpatient Healthcare Facility	Outpatient Health Care
All Other	None
Industrial	None
Childcare Center	Primary School
Prisons and Detention Centers	None
Communications Systems	None
Land Port of Entry	Non-refrigerated Warehouse
Family Housing*	Mid-rise Apartment
Border/Inspection Station	75% Small Office, 25% Non-refrigerated Warehouse
Navigation and Traffic Aids	None
Museum	None
Facility Security	Small Office
Data Centers	None
Family Housing*	Mid-rise Apartment
Aviation Security Related	Small Office
Public Facing Facility	Stand-alone Retail
Post Office	Stand-alone Retail
Comfort Station/Restrooms	Non-refrigerated Warehouse

* Dormitories and Family Housing less than three stories are assumed to be constructed under 10 CFR 435; Training Barracks are assumed to be constructed under 10 CFR 433.

As can be seen in Table 6, a number of federal building types have no specific match to BECP prototype buildings. These federal building types, including other institutional uses, all other, and industrial (to name the three largest by percentage), are assumed to have EUIs equal to the average of all mapped federal building types. It also can be seen in Table 6 that a large number of federal building types are mapped to the BECP small office (for buildings assumed to be more administrative in function with a consistent workforce) and stand-alone retail (for buildings assumed to have "customers" entering and exiting the building throughout the day, in addition to a consistent workforce), which are assumed to be the most plausible match. As noted in the previous section, DOE used Asset Height Range information within the FRPP MS to estimate the percentage of federal family housing buildings built subject to this Proposed Action.

It should also be noted that five federal building types - offices, dormitories and barracks, service, border and inspection stations, and laboratories - are mapped to multiple BECP prototypes. For offices, DOE utilized the Asset Height Range information in the FRPP MS to estimate the BECP category (small, medium, or large office) that each building would fall into and weighted the federal offices using those percentage weights. Because the Asset Height Range of "greater than 30 and less than or equal to 100 feet" would encompass both the medium office (four to six stories) and large office (seven or more stories), the fraction of floorspace assigned to that height range was divided equally between the two categories. Similarly, DOE utilized the Reporting Agency and Asset Height Range information for dormitories and barracks to distinguish between dormitories and training barracks, and to determine the percent of floorspace built under 10 CFR 433 (the Proposed Action discussed herein) versus those more likely be built under 10 CFR 435 (new federal low-rise residential). The resulting percentages were used to weight federal dormitories and barracks into BECP prototype categories small hotel, mid-rise apartment, and high-rise apartment. As with the office building types, because the Asset Height Range of

"greater than 30 and less than or equal to 100 feet" would encompass both mid-rise apartment (four to seven stories) and high-rise apartment (eight or more stories), the fraction of floorspace assigned to that height range was divided equally between the two categories. For federal service, DOE assumed an average of the BECP stand-alone retail and non-refrigerated warehouse to represent customer-facing and storage areas. Similarly, federal border and inspection stations were represented by 75 percent BECP small office and 25 percent non-refrigerated warehouse to represent administrative functions and storage spaces. DOE assumed that federal laboratories would best be represented by 25 percent BECP medium office for office spaces, and 75 percent hospital for more intensive laboratory energy loads.

Under the Proposed Action, annual site energy use reductions can be estimated to be 9.803 million kbtu, this is the net impact of 33,671 million kbtu of onsite natural gas consumption saved with 23,867 million kbtus of electric consumption added. The results presented herein represent a conservative analysis with all equipment affecting the rule utilizing minimum efficiency levels from ASHRAE 90.1-2019. It should be noted that actual savings and emissions by actual projects will vary based on the level of efficiency achieved cost effectively (per 10 CFR 433/435) and the local grid electric emission factors.

Emission Impacts

Under the Proposed Action, CO_2, N_2O, Hg, SO_2 all would experience increases in emitted amounts over the course of the 30-year analysis period of the proposed rule (+30-year operating lifetime) while NO_x, and CH_4 emissions would be reduced. Therefore, the Clean Energy Rule compliant buildings consume less fossil fuel directly (onsite) but the indirect emissions from fuels used to generate electricity that is consumed onsite shift and offset some the direct savings from onsite combustion. This is because while the increased energy efficiency of the electric equipment used in the buildings under the proposed rule results in site energy savings, the loads are added back onto the electric consumption of the buildings. This analysis and ultimately the results achieved by the proposed rulemaking are highly dependent upon the anticipated fuel mixes and emissions associated with the grid, which are all future projections and contain uncertainty. This analysis has presented alternative cases of grid emission projections in the following subsections to demonstrate this sensitivity and provide a range of potential outcomes.

DOE cannot provide an exact determination of emissions impacts associated with revising the federal building energy efficiency standards by adding fossil fuel-based energy consumption standards for all new federal buildings and federal buildings undergoing major renovation because emissions will depend on the specific level of energy efficiency that is cost effective for each future building design and actual emission factors associated with the grid at each individual site's location. For the purposes of this analysis, equipment efficiencies for both pre and post rule implementation reference the minimum requirements established in ASHRAE 90.1-2019.

Electricity production ultimately used in federal commercial buildings is assumed to have the same distribution of fuel/energy sources (*e.g.*, coal, nuclear) as overall national electricity production. The emissions analysis for the Proposed Action consists of two components. The first component estimates the effect of potential energy conservation standards on power sector emissions and, if present, site combustion emissions of CO_2, NO_X, SO_2 and Hg. The second component estimates the impacts of potential standards on emissions of two additional GHGs, CH_4 and N_2O, as well as the impacts to emissions of all species due to "upstream" activities in the fuel production chain. These upstream activities comprise extraction, processing, and transporting fuels to the site of combustion. The associated emissions are referred to as upstream emissions.

The analysis of power sector emissions uses emissions intensity factors intended to represent the marginal impacts of the change in electricity consumption associated with revised efficiency standards. The methodology is based on results published for the *Annual Energy Outlook* (*AEO*) prepared by the Energy Information Administration (EIA), including a set of side cases that implement a variety of efficiency-

related policies. The methodology is described in the report "Utility Sector Impacts of Reduced Electricity Demand: Updates to Methodology and Results" (Coughlin 2019). The analysis presented herein uses projections from the *AEO2023* (DOE 2023). Because the emissions intensity factors are calculated for each end use, a simple average was calculated using the factors for the end uses estimated to be affected by commercial building energy codes: space heating, water heating, and cooking. Because the *AEO* only includes projections through 2050, the 2050 factors were used for 2051 and beyond for this analysis.

For site combustion of natural gas or petroleum fuels, the emissions of CO_2 and NO_X are estimated using emissions intensity factors from a publication of the EPA (EPA 1998). Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the EPA.[14] The emissions intensity factors are expressed in terms of physical units per megawatt hour (MWh) or 1 million British thermal units (MMBtu) of site energy savings. Total emissions reductions are estimated by multiplying the emissions intensity factor by the energy savings.

Year One Emissions Impact

DOE estimated air emission impacts for the first year of construction for which the new rule is in effect (2025) to be an increase of 3,314 metric tons of CO_2, a savings of 670 tons of CH_4, and an increase of 0.1 tons of N_2O (accounting for the total "Greenhouse Gas Impacts" as presented in the rule); along with an increase of 2.9 tons of SO_2 and a savings of 2.5 tons of NO_x (accounting for the total "Other Emission Impacts" as presented in the rule).[15] By converting these primary emissions reductions for halocarbons, CO, PM, Hg, and lead are negligible and not presented in this analysis.

To estimate the overall significance of these emissions, the EPA's Greenhouse Gas Equivalencies Calculator was utilized to combine the direct CO_2, CH_4, N_2O into a single equivalency metric: CO_2e.[16] Utilizing the CO_2e metric, this results in a year one total increase of 2,670 metric tons of CO_{2e}. Per the Federal Sustainability Plan Section I.5.D[17] published December 2021, the overall CO_2e emissions resulting from facility energy use for both standard and non-standard operations was 58.3 million metric tons of CO_2e. The resulting comparative year one impact of the fossil fuel compliant building would be an increase of 0.0046 percent to the federal portfolio's 2020 CO_2e emissions from facility energy use. Additionally, this amount of CO_2e emissions is equivalent to the consumption of 337 average homes per year (0.00024 percent of the 140 million homes in the United States), 594 gasoline powered passenger vehicle driven for 1 year (0.094 percent of the passenger fleet vehicle emission from federal use in the United States), or the amount of carbon sequestered by 17.7 acres of U.S. forests preserved from conversion to cropland in 1 year.

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[14] https://www.epa.gov/sites/production/files/2016-09/documents/emission-factors_nov_2015_v2.pdf.

[15] Actual reductions would depend on the level of energy efficiency that is life-cycle cost effective for each new building design. For example, under the No Action Alternative, agencies are required to design all new federal commercial and multi-family high-rise residential buildings at 30 percent more efficient than ASHRAE Standard 90.1-2013, if life-cycle cost effective. Under the proposed action, agencies would be required to design buildings that are 30 percent more efficient than ASHRAE Standard 90.1-2019, if life-cycle cost effective. A comparison of the No-Action Alternative to the Proposed Action yields an estimated first year emissions reduction for CO_2 of 9,612 metric tons. The values shown in the text correspond to buildings that just meet ASHRAE 90.1-2013 and ASHRAE 90.1-2019. In the final EA, values for NO_X, CH_4, and N_2O were presented in metric tons; values here are presented in short tons, in accordance with conventional unit reporting.

[16] The EPA GHG Equivalency Calculator at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results utilizes methodology for CO2 emissions equivalence at https://www.epa.gov/ghgemissions/overview-greenhouse-gases#carbon-dioxide.

[17] https://www.sustainability.gov/pdfs/federal-sustainability-plan.pdf. December 2021

Emissions Impact Progression

The year one increase in emissions is the result of the current (relatively) dirty grid. However, as time progresses the electric grid emission factors predicted as part of DOE EIA's *AEO2023*[18] improve; resulting in yearly CO_2e savings starting in the year 2028, with net cumulative savings starting in the year 2029 (see Figure 1 and chapter 1.6 of the TSD document for additional details on predicted emission rates.)

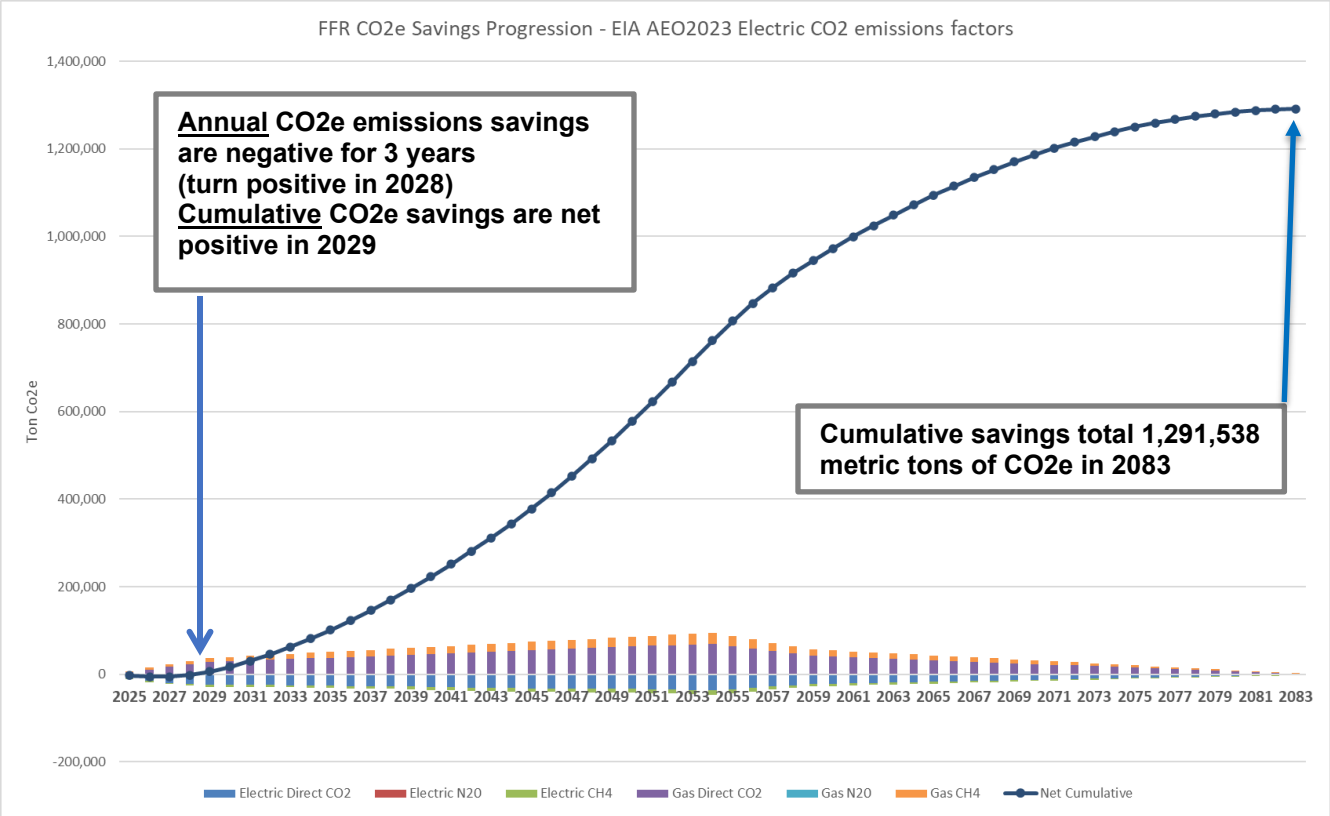

Figure 1. CO_2e Yearly Emissions Profile for Projects Affected by the Clean Energy Rule Using Standard EIA 2023 Electric Grid Emissions Factor Progression Over Time. (Note that CO_2e savings is presented as a positive number.)

These emissions savings are a result of reducing and eliminating Scope 1 fossil fuel usage - primarily in the form of methane and direct CO_2 emissions whose rates of emission per unit of energy consumed remains constant over time - by shifting to an ever-improving electric grid. Real world cumulative emission reductions for 30 years of construction (2025 through 2054) and operation under the reduced onsite fossil fuel usage associated with the Proposed Action depend on both the building fuel mix and the energy generation mix used in future years, as well as a forecast of new construction.

The emissions factors and energy savings used in the base calculations for this EA represent the estimated current building fuel use (by building type) and the *AEO2023* Reference case energy generation mix and projections; therefore, these do not account for trends such as electrification within buildings or additional (unfunded or uncommitted) decarbonization of the electrical grid. Cumulative emission impacts for 30 years of construction and operation for federal buildings built during the analysis period (2025 through

[18] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *AEO2023*. *AEO2023* represents current federal and state legislation and final implementation of regulations as of the time of its preparation.

2054) were estimated to be an decrease of 851,858 metric tons of CO_2, a savings of 15,785 tons of CH_4, and an increase of 8.72 tons of N_2O (accounting for the total "Greenhouse Gas Impacts" as presented in the rule); along with a savings of 400 tons of SO2 and a savings of 3,246 tons of NOx (accounting for the total "Other Emission Impacts" as presented in the rule).[19] To estimate the overall significance of these emissions, the EPA's Greenhouse Gas Equivalencies Calculator was utilized to combine the direct CO_2, CH_4, N_2O into a single equivalency metric CO_2e.[20] Utilizing the CO_2e metric, this results in a total savings of 1,291,538 metric tons of CO_2e. This amount of CO_2e emissions is equivalent to the consumption of 162,777 average homes energy use per year, 287,406 gasoline powered passenger vehicle driven for 1 year, or the amount of GHG emissions avoided by 359 commercial wind turbines running for a year.

It should be noted that *AEO2023* is a conservative case representing "business as usual" or a lower bound for estimating the future "greenness" of the grid. Other projections such as cases from the National Renewable Energy Laboratory's (NREL's) *2022 Standard Scenarios Report: A U.S. Electricity Sector Outlook* show that accelerated adoption of no and low emitting generation sources can significantly improve the outlook of emissions factors for future purchases of electricity by orders of magnitude thus improving the timeframe to and cumulative amplitude of CO_2e savings.

Specifically, the 100 percent by 2035 case presented by NREL (where national power sector CO_2 emissions decline to 100 percent below 2005 levels by 2035) results in yearly CO_2e savings starting in first year of implementation of the rule and accumulating throughout the 30-year analysis period (including 30 year building lifetime operations). In this case, the long-run marginal CO_2, CH_4 and N_2O emission rates for the 2022 standard scenario mid-case 100 percent by 2035 sourced from the NREL Cambium database were utilized for presentation, monetization, and conversion CO_2e emissions for presentation in Figure 2. Emission rates for NOx and SO_2 were derived utilizing the corresponding Cambium case generation percentage with average emissions rates per generation type derived from eGrid[21] data. Utilizing the CO_2e metric, this results in a total savings of 2,376,318 metric tons of CO_2e for the 100 by 2035 case.

[19] Actual reductions would depend on the level of energy efficiency that is life-cycle cost effective for each new building design. For example, under the No Action Alternative, agencies are required to design all new federal commercial and multi-family high-rise residential buildings at 30 percent more efficient than ASHRAE Standard 90.1-2013, if life-cycle cost effective. Under the Proposed Action, agencies would be required to design buildings that are 30 percent more efficient than ASHRAE Standard 90.1-2019, if life-cycle cost effective. A comparison of the No-Action Alternative to the Proposed Action yields an estimated first year emissions reduction for CO_2 of 9,612 metric tons. The values shown in the text correspond to buildings that just meet ASHRAE 90.1-2013 and ASHRAE 90.1-2019. In the final EA, values for NO_X, CH_4, and N_2O were presented in metric tons; values here are presented in short tons, in accordance with conventional unit reporting.

[20] The EPA GHG Equivalency Calculator at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator results utilizes methodology for CO2 emissions equivalence at https://www.epa.gov/ghgemissions/overview-greenhouse-gases#carbon-dioxide.

[21] The Emissions & Generation Resource Integrated Database (eGRID) is published and managed by EPA. It is a comprehensive source of data from EPA's Clean Air Markets Division on the environmental characteristics of almost all electric power generated in the United States. The data include emissions, emission rates, generation, heat input, resource mix, and many other attributes. eGRID is typically used for GHG registries and inventories, carbon footprints, consumer information disclosure, emission inventories and standards, power market changes, and avoided emission estimates. eGrid is a commonly used source of emissions data for project specific (location specific) emissions calculations. It is available at https://www.epa.gov/egrid.

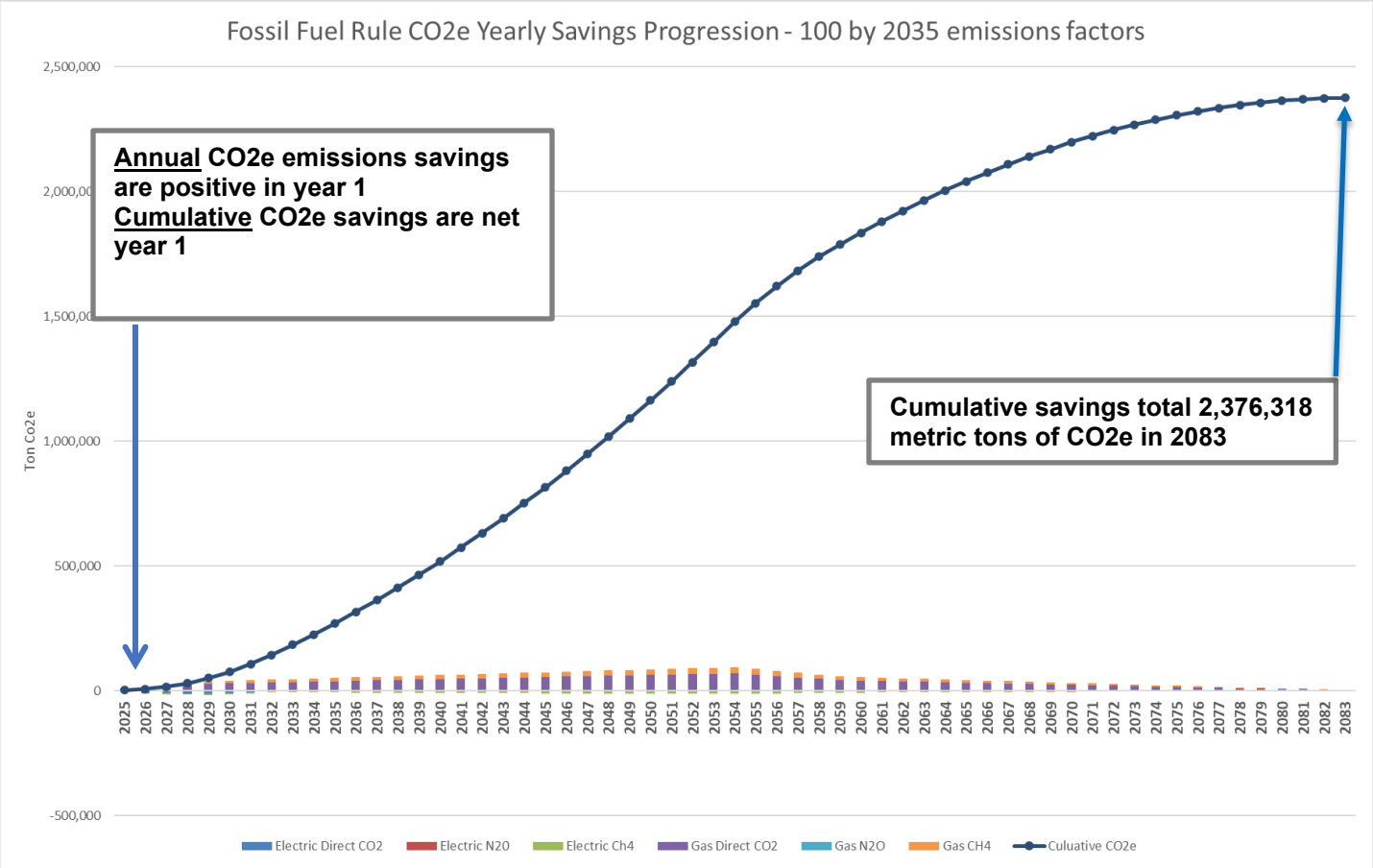

Figure 2. CO_2e Yearly Emissions Profile for Projects Affected by the Clean Energy Rule using NREL 100 Percent by 2035 Derived Electric Grid Emissions Factor Progression Over Time. (Note that CO_2e savings is presented as a positive number.)

3.3.3 Energy Resources

3.3.3.1 Affected Environment

As a result of the proposed rulemaking, federal building energy loads in qualified new construction and major renovation will be shifted from natural gas to the electric grid. This shifting will ultimately cause an increase in the required energy generation at power plants throughout the nation.

3.3.3.2 Impacts of Proposed Action

The anticipated energy generation requirement impacts in terms of gigawatt hours (GWh) of electricity production required are presented in Figure 3. DOE utilized an NIA+ model with future utility mix projections based on *AEO2023* data to predict changes in utility level energy resources. Additionally, DOE utilized the *AEO2023* projections to estimate the impact on the grid in terms of capacity (as in MW of electric production capacity) to meet the instantaneous load impacts. The results of this analysis are shown in Figure 4. Figure 3 and Figure 4 show that this type of fuel switching from onsite natural gas results in multiple increased energy generation at the utility level primarily in a mix of solar, coal and natural gas.

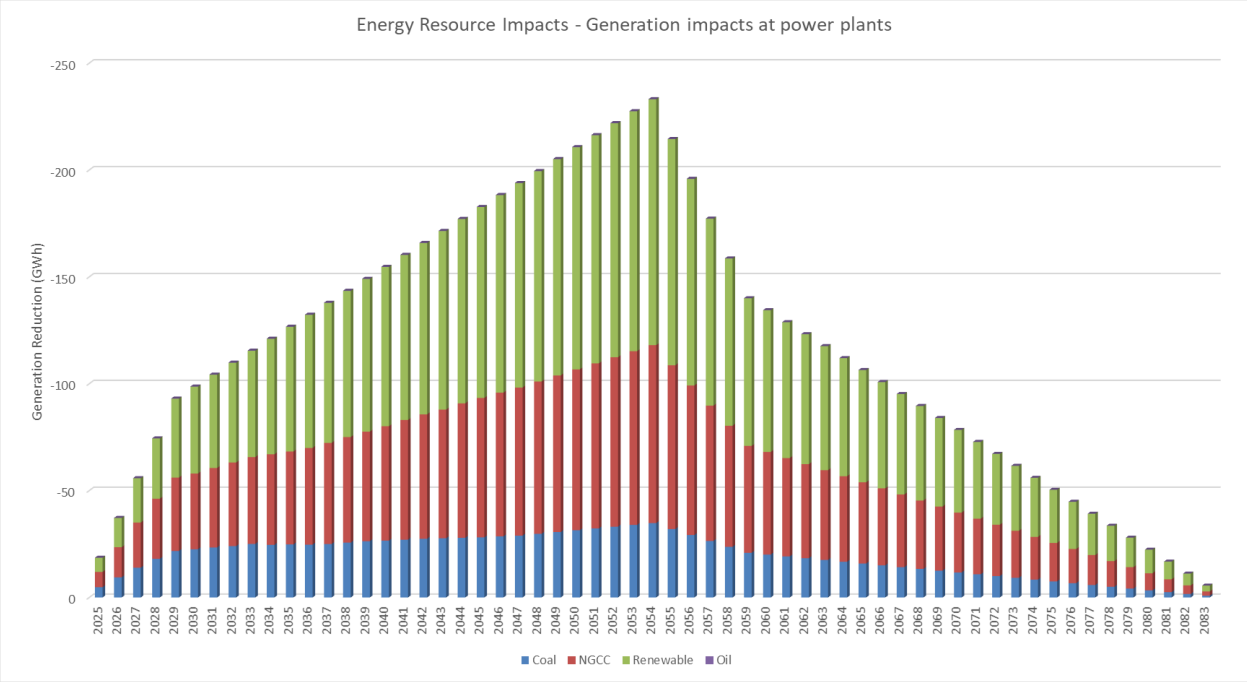

Figure 3. Impact of Proposed Rulemaking on Energy Resources using AEO2023 Utility Mix Projections

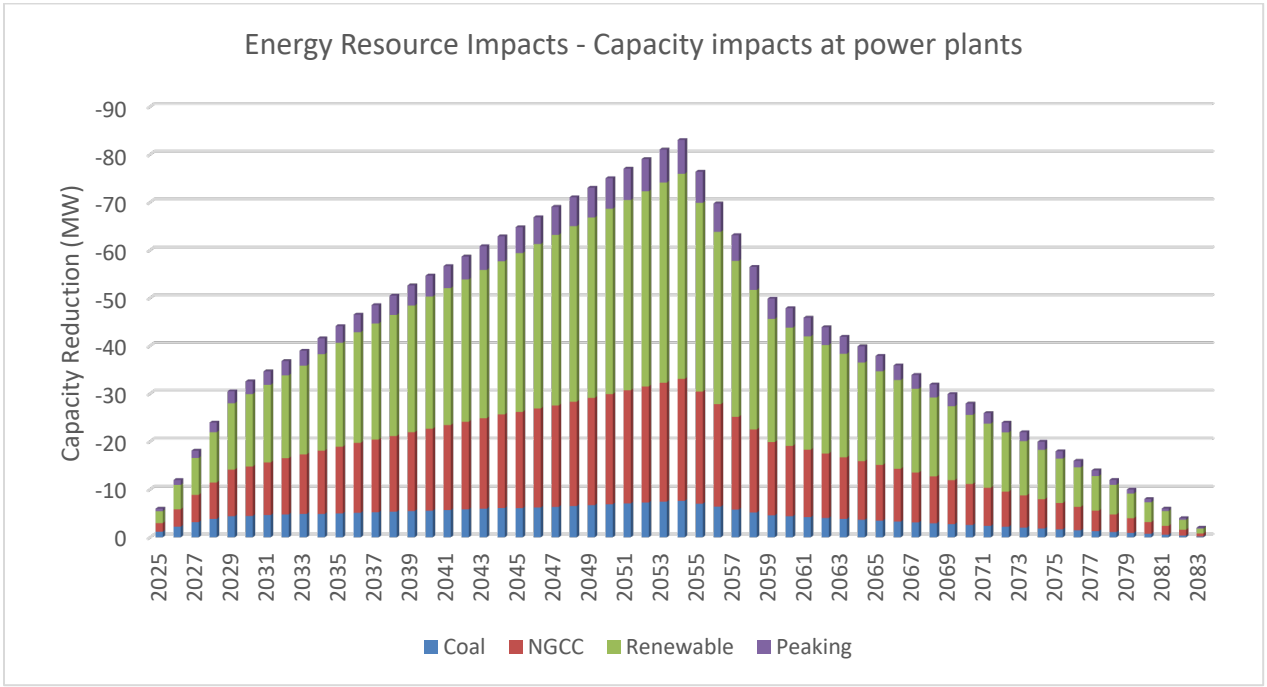

Figure 4. Impacts of Proposed Rulemaking on Energy Generation Mix using *AEO2023* Utility Mix Projections

3.3.4 Global Climate Change

Climate change has evolved into a matter of global concern because it is expected to have widespread, adverse effects on natural resources and systems. A growing body of evidence points to anthropogenic

sources of GHGs, such as CO_2, as major contributors to climate change. Climate change is a resource area with possible impacts from the Proposed Action and No Action Alternative.

3.3.4.1 Affected Environment

Climate is defined as the average weather, over a period ranging from months to many years. Climate change refers to a change in the state of the climate, which is identifiable through changes in the mean and/or the variability of its properties (*e.g.*, temperature or precipitation) over an extended period, typically decades or longer. The World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) established the IPCC to provide an objective source of information about climate change. According to the series of IPCC Fifth Assessment Reports (IPCC Reports), published in 2013 and 2014,[22] "The [Synthesis Report] SYR confirms that human influence on the climate system is clear and growing, with impacts observed across all continents and oceans. Many of the observed changes since the 1950s are unprecedented over decades to millennia. The IPCC is now 95 percent certain that humans are the main cause of current global warming" (Foreword to IPCC 2014).

IPCC (2014) states that the world has warmed by about 0.85 °C in the last 132 years (Summary for Policy Makers (SPM) 1.1 of IPCC 2014). Additionally, IPCC (2014) finds that it is extremely likely that most of the temperature increase since the mid-20th century is very likely caused by the increase in anthropogenic concentrations of CO_2 and other long-lived GHGs such as CH_4 and N_2O in the atmosphere, rather than from natural causes (SPM 1.2 of IPCC 2014). Increasing the CO_2 concentration partially blocks the Earth's re-radiation of captured solar energy in the infrared band, inhibits the radiant cooling of the Earth, and thereby alters the energy balance of the planet, which gradually increases its average temperature. IPCC (2014) estimates that currently CO_2 makes up about 72 percent of the total CO_2e global warming potential in GHGs emitted from human activities, with the vast majority (62 percent) of the CO_2 attributable to fossil fuel use (Figure SPM 2 of IPCC 2014).[23] Globally, 49 billion metric tons of CO_2e of anthropogenic (man-made) GHGs are emitted every year (Figure SPM 2 of IPCC 2014).[24] For the future, IPCC (2014) describes a wide range of GHG emissions scenarios, but "cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond" (SPM 2.1 of IPCC 2014).

Researchers have focused on considering atmospheric CO_2 concentrations that likely will result in some level of global climate stabilization, and the emissions rates associated with achieving the "stabilizing" concentrations by particular dates. They associate these stabilized CO_2 concentrations with temperature increases that plateau in a defined range. For example, at the low end, IPCC (2014) scenarios target CO_2 stabilized concentrations that would *likely* keep projected temperature rises below 2° C. To achieve this goal, the IPCC scenarios present that there would have to be a rapid downward trend in total annual global emissions of GHGs to levels that are 40 to 71 percent below today's annual emissions rates by no later than 2050 (Table 3.1, Scenario RCP2.6 of IPCC 2014).

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[22] The 5th IPCC Assessment Report was published in four volumes over the course of 2013 and 2014. The complete set of reports may be found at www.ipcc.ch/reports/. The first three volumes are the reports of Working Groups I, II, and III, while the fourth volume is the Synthesis Report for Policy Makers. This section of the EA focuses on results presented in the Synthesis Report (IPCC 2014).

[23] GHGs differ in their warming influence (radiative forcing) on a global climate system due to their different radiative properties and lifetimes in the atmosphere. These warming influences may be expressed through a common metric based on the radiative forcing of CO_2, *i.e.*, CO_2-equivalent. CO_2 equivalent emission is the amount of CO_2 emission that would cause the same- time integrated radiative forcing, over a given time horizon, as an emitted amount of other long- lived GHG or mixture of GHGs.

[24] Other non-fossil fuel contributors include CO_2 emissions from deforestation and decay from agriculture biomass; agricultural and industrial emissions of CH_4; and emissions of nitrous oxide and fluorocarbons.

3.3.4.2 Impacts of Proposed Action

It is difficult to correlate specific emissions rates with atmospheric concentrations of CO_2 and specific atmospheric concentrations with future temperatures because as IPCC (2014) describes there is a clear lag in the climate system between any given concentration of CO_2 (even if maintained for long periods) and the subsequent average worldwide and regional temperature, precipitation, and extreme weather regimes. For example, a major determinant of climate response is "equilibrium climate sensitivity," a measure of the climate system response to sustained radiative forcing. It is defined as the global average surface warming following a doubling of carbon dioxide concentrations. IPCC (2014) describes its estimated, numeric value as about 3° C, but the likely range of that value is 1.5° C to 4.5° C, with cloud feedback and vapor feedback providing the largest sources of uncertainty (Box 1.1 of IPCC 2014). Further, as illustrated previously, IPCC (2014) scenarios for stabilization rates are presented in terms of a range of concentrations, which then correlates to a range of temperature changes. Thus, climate sensitivity is a key uncertainty for CO_2 mitigation scenarios that aim to meet specific temperature levels.

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