ENVIRONMENTAL ASSESSMENT

FOR

Final Rule, 10 CFR Part 435, "Energy Efficiency Standards for the Design and Construction of New Federal Low-Rise Residential Buildings" (RIN 1904-AF04)

DOE/EA-2166

Prepared by the
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Abbreviations and Acronyms

ACE	Affordable Clean Energy
BECP	Building Energy Codes Program
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CEQ	Council on Environmental Quality
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CH_4	methane
CO_2	carbon dioxide
CO	carbon monoxide
CSAPR	Cross-State Air Pollution Rule
D.C.	District of Columbia
DOE	Department of Energy
EA	environmental assessment
ECPA	Energy Conservation and Production Act
EGU	electric generating unit
EIS	environmental impact statement
EPA	Environmental Protection Agency
EUI	Energy use intensity, kBtu/ft2-yr
FR	Federal Register
FRPP MS	Federal Real Property Profile Management System
ft^2	square feet
GHG	greenhouse gas
GSA	Government Services Administration
HAP	hazardous air pollutant
HFC	hydrofluorocarbon
Hg	mercury
HVAC	heating, ventilation, and air conditioning
ICC	International Code Council
IECC	International Energy Conservation Code
IPCC	Intergovernmental Panel on Climate Change
IMC	International Mechanical Code
IRC	International Residential Code
kBtu	one thousand British thermal units
MATS	Mercury and Air Toxics Standards
MMT CO_2e	metric tons of CO2 equivalent

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
O_3	ozone
PFC	perfluorocarbon
PM	particulate matter
PM_{10}	PM less than 10 microns in aerodynamic diameter
$PM_{2.5}$	PM less than 10 or 2.5 microns in aerodynamic diameter
SO_2	sulfur dioxide
SO_x	sulfur oxide gases
SPM	Summary for Policy Makers
UNEP	United Nations Environment Programme
U.S.C.	United States Code
VOC	volatile organic compound
WMO	World Meteorological Organization

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1.0 Introduction

1.1 NEPA

The National Environmental Policy Act (NEPA; 42 U.S. Code [USC] 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 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 EA evaluates the potential environmental impacts of DOE's Proposed Action to update, by rule, energy efficiency standards for new federal low rise residential buildings. The Proposed Action would update the baseline federal energy efficiency performance standards, found in 10 CFR 435, to the latest current model industry code, based on a finding that it is cost-effective and saves energy compared to the previous version of the model industry code, as required by 42 U.S.C. 6831 et seq. In this EA, DOE also evaluates the impacts that could occur if DOE were not to adopt the latest current model industry code as the energy efficiency baseline standard for new federal low-rise residential buildings (the No Action Alternative).

1.2 Background

DOE is required to establish the building energy efficiency standards for all new federal buildings pursuant to section 305 of the Energy Conservation and Production Act (ECPA), as amended. (42 U.S.C. 6834 (a)(1)). In turn, each federal agency and the Architect of the Capitol must adopt procedures to ensure that new federal buildings will meet or exceed these federal building energy efficiency standards. (42 U.S.C. 6835(a)). The head of a federal agency is barred from expending federal funds for the construction of a new federal building unless the building meets or exceeds the applicable baseline federal building energy standards established under section 305. (42 U.S.C. 6835(b)).

The standards established under section 305(a)(1) of ECPA must contain energy efficiency measures that are technologically feasible and economically justified, and that meet the energy savings and renewable energy specifications in the applicable voluntary consensus energy code specified in section 305(a)(2) (42 U.S.C. 6834(a)(1)-(3)). Under section 305 of ECPA, the referenced voluntary consensus code for federal low-rise residential buildings is the International Code Council (ICC) International Energy Conservation Code (IECC), hereafter "IECC." DOE codified the referenced code as the baseline federal building standard in its existing energy efficiency standards found at 10 CFR Part 435.

DOE must also establish, by rule, revised federal building energy efficiency performance standards for new federal buildings that require such buildings be designed to achieve energy consumption levels that are at least 30 percent below the levels established in the referenced code (baseline federal building standard), if life-cycle cost-effective. (42 U.S.C. 6834(a)(3)(A)(i)(I)).

The current 10 CFR 435 baseline standard is based on the 2015 version of the IECC. ICC has updated the IECC standard twice, first to the 2018 version and then to the 2021 version. Under section 305 of ECPA, not later than one year after the date of approval of each subsequent revision of the IECC standard, DOE must determine whether to amend the baseline federal building standards with the revised voluntary standard based on the cost-effectiveness of the revised voluntary standard. (42 U.S.C. 6834(a)(3)(B)). It is this requirement that the Proposed Action seeks to address.

DOE determined that the 2021 IECC would achieve greater energy efficiency than the 2018 version of the IECC (See 86 FR 40529; July 28, 2021). DOE also determined that the 2018 version of the IECC would achieve greater energy efficiency than the prior version (the 2015 version that is currently referenced in 10 CFR Part 435) (See 84 FR 67435; December 10, 2019). DOE has also determined that the 2021 IECC would be cost effective if applied to new federal low-rise residential buildings.[1] Since the amended 2021 IECC meets the statutory criteria for DOE to incorporate it as the baseline standard for low-rise residential federal buildings, DOE is considering a rule (the Proposed Action) to update the baseline standard to the 2021 IECC.[2] The Proposed Action, if implemented, would require that federal agencies design new federal low-rise residential buildings to meet the 2021 IECC; and, if life-cycle cost-effective, achieve energy consumption levels that are at least 30 percent below the levels of the 2021 IECC.

1.3 Purpose and Need

It is estimated that future construction of federal low-rise residential buildings will be approximately 9.78 million square feet per year.[3] Newly constructed buildings can consume large amounts of energy each year in heating, cooling, ventilating, and providing domestic hot water if they lack adequate energy conservation features. Accordingly, EPCA directs DOE to establish building energy efficiency standards for all new federal low-rise residential buildings to make them more energy efficient. The purpose for the Proposed Action is to determine whether to amend the current baseline federal standards with the revised voluntary standard based on the cost-effectiveness of the revised voluntary standard.

The Proposed Action is needed to reduce energy consumption, manage energy costs for federal low-rise residential buildings, reduce outdoor pollutants from the combustion of fossil fuels, and reduce the emissions of greenhouse gases that may lead to climate change. This reduction will prevent waste of energy, can help the U.S. government reduce dependence on imported energy, and strengthen the U.S.'s strategic position.

[1] See DOE's analysis of the cost savings of the 2018 and 2021 IECC at *www.energycodes.gov/sites/default/files/2021-07/2018IECC_CE_Residential.pdf* and *www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf*, respectively.

[2] Although ICC published two versions of the IECC since 10 CFR Part 435 was last updated, the 2018 IECC and the 2021 IECC, the Proposed Action would update 10 CFR Part 435 to the 2021 IECC directly, without requiring agencies to comply with the 2018 IECC.

[3] This number is based upon the Federal Real Property Profile Management System (FRPP MS) extraction and Department of Defense estimates of privatized housing described in Section 3.3.2.3.

1.4 Public Participation and Agency Consultation

In accordance with CEQ regulations in 40 CFR 1501.5(c)(2), DOE states that no additional persons/agencies were consulted during the development of this environmental assessment.

Public involvement is an important requirement of the NEPA process. The public review period for the Draft EA was 15 days after its publication. DOE received no comments on the Draft EA.

2.0 Alternatives Including the Proposed Action

This section describes the Proposed Action and the No Action Alternative for updating energy efficiency baseline standards for new federal low-rise residential buildings. The updated federal energy efficiency baseline standard establishes the minimum level of energy savings that DOE requires federal agencies to achieve in new building designs, including design, and performance-based energy efficiency requirements for building envelope; heating, ventilation, and air-conditioning (HVAC) systems and equipment; service water heating systems and equipment; electrical distribution systems and equipment for electric power; and lighting.

2.1 Proposed Action

Under the Proposed Action DOE would revise its building energy efficiency baseline standard for all new federal low-rise residential buildings. The Proposed Action would update 10 CFR 435, "Energy Efficiency Standards for the Design and Construction of New Federal Low-Rise Residential Buildings," by replacing the 2015 IECC with the more energy efficient 2021 IECC as the baseline standard.[4] The Proposed Action, if implemented, would require that federal agencies design new federal low-rise residential buildings to meet the 2021 IECC and, if life-cycle cost-effective, achieve energy consumption levels that are at least 30 percent below the levels of the 2021 IECC. The Proposed Action would make no other changes to the federal building energy efficiency standards.

DOE examined the potential environmental impacts of the Proposed Action by comparing it with the standards that federal agencies must achieve under the existing regulations in 10 CFR 435, which require that new federal low-rise residential building designs achieve energy performance levels of 2015 IECC.

2.2 No Action Alternative

The no-action alternative is defined as a DOE decision not to adopt the 2021 IECC as the energy efficiency baseline standard for new federal low-rise residential buildings. Instead, DOE would retain the 2015 IECC standard, which is the current requirement in 10 CFR 435.

[4] Although the ICC published a 2018 version of the IECC, DOE did not update 10 CFR 435 to incorporate that standard.

3.0 Affected Environment and Impacts

This section describes the existing environmental setting for environmental resources with potential to be affected by the Proposed Action, as well as provides the potential environmental impacts that may result from implementing the Proposed Action and the No Action Alternative. The Proposed Action would apply to all new federal low-rise residential buildings.

This section includes consequences of the No Action Alternative; a brief description of environmental resource areas not evaluated for potential impacts; analysis of those resources that could potentially be impacted from the Proposed Action and the No Action Alternative; and analysis of cumulative impacts.

3.1 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, DOE would not update energy conservation baseline standards for federal low-rise residential buildings. Therefore, there would be no environmental impacts to the environment and resources discussed in this 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.

3.2 Environmental Resources Evaluated and Dismissed from Detailed Analysis

Consistent with NEPA, DOE focused the analysis in this 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.

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 and Floodplains	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 mandate 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

3.3 Environmental Resources Carried Forward for Analysis

This section of the EA describes the baseline and analyzes the environmental impacts of the Proposed Action on the following resource areas. It is noted that the construction of new federal low-rise residential buildings would be subject to a separate NEPA analysis.

- Indoor Air
- Outdoor Air
- Climate Change.

3.3.1 Indoor Air

Indoor air quality is a resource area with possible impacts from the Proposed Action.

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. The primary indoor air emissions that can adversely affect human health in typical 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. Sources of pollutants that affect indoor air quality occur both inside and outside a building.

Various emissions can be continuously or intermittently released within buildings. These emissions can originate from furnishings within a building (e.g., carpet, furniture), building materials (e.g., insulation material, particle board), interior finishes (e.g., paint, floor sealants), 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. Potential combustion emissions include CO, CO_2, nitrogen oxide (NO_x), and sulfur dioxide (SO_2). Fossil-fuel-burning appliances and, if allowed, tobacco smoke are the main sources of combustion products.

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 residential building through natural and/or mechanical ventilation. Natural ventilation includes air that can enter or be expelled from the residential building through non-mechanical means, often through the building envelope in the form of air leakage or intentionally designed openings, and due to differences in air pressure inside the building and outside the building. Natural ventilation rates are significantly 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 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 (NO2) 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 mechanical ventilation rates, air leakage into or out of a building, or affect sources of indoor air pollutants from the No Action Alternative. The 2015 IECC (the No-Action Alternative), 2018 IECC, and 2021 (the Proposed Action) IECC all rely on the International Residential Code (IRC) or International Mechanical Code (IMC) for required ventilation rates, with each version of the IECC referring to the IRC or IMC of the same year. The 2015 IECC, 2018 IECC, and 2021 IECC all require mechanical ventilation that complies with the IMC, IRC, or other approved means of ventilation. Thus, any change in mechanical ventilation rates would be associated with the IMC or IRC and not the IECC. The technical analysis document prepared by DOE's Building Energy Codes Program (BECP) for the 2018 IECC determination does not mention any changes in mechanical ventilation rates, leading to the assumption that the mechanical ventilation rates do not change between the 2015 IRC/IMC and 2018 IRC/IMC. The technical analysis document prepared by BECP for the 2021 IECC does not mention any changes in mechanical ventilation rates, leading to the assumption that the mechanical ventilation rates do not change between the 2018 IRC/IMC and 2021 IRC/IMC. Thus, it can be assumed that there are no mechanical ventilation rate changes for low-rise residential buildings constructed to the 2015 IECC, 2018 IECC, and 2021 IECC.

The 2015 IECC (the No Action Alternative), 2018 IECC, and 2021 IECC (the Proposed Action) also all regulate building envelope air leakage directly. This impacts the amount of outside air that may leak into a building or inside air that may leak out of a building. The requirements for air leakage are based on testing and are as follows:

- The 2015 IECC and 2018 IECC require less than 5 air changes per hour in Climate Zones 1 and 2, and less than 3 air changes per hour in Climate Zones 3 through 8.
- The 2021 IECC requires less than 5 air changes per hour in all climate zones under any compliance path. If the prescriptive compliance path is used, the requirements in the 2021 IECC are identical to those in the 2015 IECC and 2018 IECC.

The apparent change to the air leakage requirements in the 2021 IECC does represent a weakening of the air leakage requirements for Climate Zones 3 through 8 in previous versions of the IECC. This change was made as part of a revision to the air leakage requirements that change them from mandatory requirements (not allowed in tradeoffs) to prescriptive (allowed in tradeoffs) with the intent of incentivizing builders to reduce the air leakage by providing some sort of credit for reduced air leakage. The 5 air changes per hour was left for what the IECC calls a "backstop," ensuring that no matter what tradeoff is used, the minimum air changes per hour will be maintained. The impact of this requirement would be to potentially increase outside air infiltration during times when the fans in the housing unit were not on to pressurize the inside of the house. This infiltration would increase the amount of outside air brought into the home but is not expected to have a significant positive impact on indoor air quality. Conversely, when the fans were on and the housing unit pressurized, more conditioned air could leak out. This leakage of conditioned air is likely to increase the energy usage of the home but is not expected to have a significant impact on indoor air quality. Also note that if the prescriptive compliance path is used, the air leakage requirements do not change. BECP's analyses of all versions of the IECC are based on the prescriptive path so air leakage requirements would be considered unchanged.

3.3.2 Outdoor Air

Outdoor air quality is a resource area with possible impacts from the Proposed Action. Specifically, impacts would include changes in pollutant emissions due to changes in fossil fuel generated energy use associated with operation of the building.

3.3.2.1 Affected Environment

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]

Improving the efficiency of U.S. buildings by implementing efficient building codes and standards can play a role in reducing the amount of greenhouse gases (GHG) generated by buildings. "Greenhouse gases absorb infrared radiation, thereby trapping heat and making the planet warmer. The most important greenhouse gases directly emitted by humans include CO_2, methane (CH_4), nitrous oxide (N_2O), and several other fluorine-containing halogenated substances (HFCs, PFCs, SF_6 and NF_3)[6]. 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 of CO_2 equivalent (MMT CO_2e)[7] (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[8] (EPA 2021b, Table ES-2). Because not all electricity generated in the U.S. 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.[9] 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 time period, total GHG emissions 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 EA are described in more detail in the following.

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).

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

[6] HFCs – Hydrofluorocarbons, PFCs – Prefluorinated carbons, SF_6 – Sulfur Hexafluoride, NF_3 – Nitrogen Trifluoride

[7] Percentages based on total emissions.

[8] Percentages based on total emissions.

[9] Percentages based on total emissions.

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 residential buildings accounted for nearly 18.9 percent of total U.S. GHG emissions in 2019 (Table 2-5 of EPA 2021b).

Nitrogen Oxides. Nitrogen oxides 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 (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 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 U.S. 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 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, and when gasoline is extracted from oil, or when 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 from human-related 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 greenhouse gases. 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 so are, therefore, considered more environmentally benign than ozone-depleting substances such as chlorofluorocarbons (CFCs), even though HFCs are greenhouse gases. 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 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. The 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 Part 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 energy use in new federal low-rise residential buildings. To calculate total change in energy use, DOE estimated the total new federal low-rise residential buildings to be constructed and multiplied that estimate by the expected decrease in energy use per residential building. Finally, in order to arrive at estimated emission reductions, DOE calculated anticipated reductions based on total reductions in energy use.

New Residential Low-Rise Construction

Two sources were used to estimate the new residential low-rise construction: Government Services Administration (GSA) data and Department of Defense (DoD) data. GSA data were used to find the distribution of existing federal building types for buildings owned by the Federal government (GSA 2021).[10] A database query was run on the FRPP MS in March 2021 to determine the characteristics of federally-owned new residential low-rise construction added to the database from 2010 through 2020. These buildings were aggregated to the federal building types used in the FRPP MS.[11] Only federal Dormitories and Family Housing building types were considered to be subject to the Proposed Action discussed in this document. It was assumed that new federal construction would have a similar distribution between 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 and Family Housing 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 three stories or less, only buildings estimated to be less than 30 feet in height were included in the floorspace estimates for this Proposed Action.

[10] The current Federal Real Property Profile Management System (FRPP MS) data for Federal buildings was used. Buildings not owned by the Federal Government were not included in the database query. The FRPP MS was accessed on March 2, 2021.
[11] 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.

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. Department of Defense agencies were assumed to construct training barracks, while non-DoD agencies were assumed to construct dormitories. Only non-DoD dormitory buildings less than 30 feet in height (using the Asset Height Range data) were assumed to be included in this Proposed Action, as they would be considered low-rise residential buildings.

Additionally, DoD data were used to provide an estimate of 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.[12]

For the results shown in this EA, DOE estimated a total of 9.78 million square feet of new Federal low-rise residential buildings per year would be constructed. This assumption is based on the GSA FRPP MS data and represents the annual average of the square footage extracted during the search described above. The mapping used for this EA is shown in Table 3.

Table 3. Estimated Floor Area Fraction of New Federal Residential Building Construction

Facility Type	Percent
Dormitories and Barracks	1.4%
Family Housing	2.0%
Privatized DoD Family Housing	96.6%
Grand Total	**100.0%**

Energy Use

DOE calculated energy savings per new federal low-rise residential buildings using the EPA recommended method of calculating energy use intensity (EUI). EUI is the energy consumed by a building per square foot per year. For this EA, national average EUIs were calculated using a weighted average of EUIs for the types of buildings that the Federal Government is expected to construct, as shown in Table 3. There are two types of EUI, site and source. Site EUI includes energy used only at the building site. Source EUI includes energy used at the building site plus energy lost in producing and delivering the energy to the site. To determine the EUI of the federal buildings listed in Table 3, DOE mapped the EUIs for the various building prototypes used in DOE's BECP determination of energy savings for the 2021 version of IECC (Lei et al. 2020). The mapping used for this EA is shown in Table 4.

Table 4. Mapping of Federal Building Types to BECP Prototypes

Federal Building Type	Match to BECP Prototypes

[12] 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 DASD for that office. Estimate confirmed total DoD privatized family housing units of 198,802 privatized housing units and 140 low rise privatized unaccompanied housing buildings. The low-rise buildings were converted to housing units using an average of 2.15 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.

Dormitories and Barracks	Low-Rise Multi-family Residential
Family Housing	Single Family, Low-Rise Multi-family Residential (weighted by estimated percentages in FRPP MS data)
Privatized DoD Family Housing	Single Family

As described in the previous section, DOE utilized the Federal Agency and Asset Height Range information in the FRPP MS to distinguish between dormitories and training barracks, and then to estimate the square footage of buildings in the Federal Dormitories and Barracks and Family Housing categories that are assumed to be built under 10 CFR 435 (the Proposed Action discussed herein) versus those more likely to be built under 10 CFR 433 (New Federal Commercial and Multi-Family High-rise Residential). For Family Housing, DOE also utilized the square foot information in the FRPP MS to develop percentage weights for the Single Family prototype (less than 6,000 ft^2) and Low-rise Multi-family Residential (6,000 ft^2 and greater). The square foot demarcation was determined using the BECP assumption of approximately 1,200 ft^2 per multifamily housing unit, and an assumption that 5 or more housing units would define a multifamily building.

In the analysis for this EA, energy usage was determined for both natural gas and electricity and combined to express a total site and source EUI. The EPA recommends using source EUI as it more accurately reflects total energy usage. For this analysis, DOE compared both site and source EUI under the Proposed Action with site and source EUI under the No Action Alternative, in part to ensure that energy usage would be reduced in all scenarios.

DOE cannot precisely determine the degree of energy use impact associated with updating the Federal energy efficiency baseline standard to the 2021 version of IECC because exact energy use will depend on the specific level of energy efficiency that is cost effective for each future building design. However, it is possible to establish a range of changes in energy use. Under the Proposed Action, reductions in energy use as compared to the No Action Alternative are estimated at up to 3.5 EUI (kBtu/ ft^2-yr) for site EUI and up to 7.5 EUI (kBtu/ ft^2-yr) for source EUI. Under no scenario would annual site or annual source energy use increase.

Emission Reductions

Under the Proposed Action, CO_2, NO_x, and Hg emissions would be reduced because more energy efficient buildings consume less fossil fuel, either directly as fossil fuel consumed on site or indirectly as fossil fuel used to generate electricity that is consumed on site.

DOE cannot provide an exact determination of emissions impacts associated with the Proposed Action 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. However, it is possible to determine the range of changes in emissions reductions.

Electricity production ultimately used in federal residential 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 carbon dioxide (CO_2), nitrogen oxides (NO_X), sulfur dioxide (SO_2) and mercury (Hg). The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, methane (CH_4) and nitrous oxide (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, 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 *Annual Energy Outlook 2021* (DOE 2021). 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 residential building energy codes: space heating, space cooling, water heating, and lighting. Because the AEO only includes projections through 2050, the 2050 factors were used for 2051 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 Environmental Protection Agency (EPA 1998). Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the EPA.[13]

The emissions intensity factors are expressed in terms of physical units per MWh or MMBtu of site energy savings. Total emissions reductions are estimated by multiplying the emissions intensity factor by the energy savings.

Air emission reductions for the first year of construction during which the Proposed Action is in effect (2022) were estimated at up to 3,845 metric tons of CO_2, up to 1.6 tons of SO_2, up to 5.9 tons of NO_x, up to 24.9 tons of CH_4, and up to 0.04 tons of N_2O,.[14] Emissions reductions for halocarbons, CO, PM, Hg, and lead are negligible. Under no scenario of future construction would emissions of any of the listed compounds increase when compared to the no-action alternative.

Cumulative emission reductions for 30 years of construction (2022 through 2051) and operation under the reduced energy usage associated with the proposed action depend on both the building fuel mix and the energy generation mix used in future years. The emissions factors and energy savings used in the calculations for this EA represent the current building fuel use (by building type) and the AEO 2021 reference case energy generation mix and therefore do not account for trends such as electrification within buildings or decarbonization of the electrical grid beyond what is assumed in the AEO 2021. The new construction forecast was held constant through the analysis period. Cumulative emission reductions for 30 years of construction and operation for federal buildings built during that period (2022 through 2051) were estimated at up to 1.3 million metric tons of CO_2, up to 0.4 thousand tons of SO_2, up to 2.3 thousand tons of NO_x, up to 0.002 tons of Hg, up to 10.8 thousand tons of CH_4, and up to 0.01 thousand tons of N_2O.[15] Emission reductions for halocarbons, CO, PM, and lead are negligible.

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

[14] 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 low-rise residential buildings at 30 percent more efficient than the 2015 IECC, if life cycle cost effective. Under the Proposed Action, agencies would be required to design buildings that are 30 percent more efficient than the 2021 IECC, 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 up to 2,690 metric tons. The values shown in the text correspond to buildings that just meet the 2015 IECC and 2021 IECC. In the draft 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.

[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 low-

3.3.3 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 greenhouse gases, 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.

3.3.3.1 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 Intergovernmental Panel on Climate Change (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,[16] "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 greenhouse gases 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_2-equivalent 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).[17] Globally, 49 billion metric tons of CO_2 equivalent of anthropogenic (man-made) greenhouse gases are emitted every year (Figure SPM 2 of IPCC 2014).[18] For the future, IPCC (2014) describes a wide range of GHG emissions

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rise residential buildings at 30 percent more efficient than the 2015 IECC, if life-cycle cost-effective. Under the Proposed Action, agencies would be required to design buildings that are 30 percent more efficient than the 2021 IECC, if life-cycle cost-effective. A comparison of the No Action Alternative to the Proposed Action yields an estimated 30-year emissions reduction for carbon dioxide of up to 0.9 million metric tons. The values shown in the text correspond to buildings that just meet the 2015 IECC and 2021 IECC. In the draft EA, values for NO_X, CH_4, N_2O, and Hg were presented in metric tons; values here are presented in short tons, in accordance with conventional unit reporting.

[16] 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 https://www.ipcc.ch/report/ar5/syr/. 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).

[17] 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.

[18] 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.

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).

3.3.3.2 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 IPCC (2014) describes 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 above, 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.

4.0 Agencies and Persons Consulted During this Rulemaking

In accordance with Council on Environmental Quality CEQ regulations in 40 CFR 1508.9(b), a list of persons/agencies consulted during the development of this rulemaking and environmental assessment is provided below.

DOE and Contractor Staff

US Department of Energy – Nicolas Baker, Matthew Ring, Roak Parker, Nicholas Rising

Pacific Northwest National Laboratory (DOE contractor) - Mark Halverson, Jennifer Williamson, Donna Hostick, Samuel Rosenburg, Erik Mets, Erica Kilgannon

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