DRAFT ENVIRONMENTAL ASSESSMENT

FOR

Final Rule, 10 CFR Part 435, "Energy Efficiency Standards for New Federal Low-Rise Residential Buildings' Baseline Standards Update"
(RIN 1904-AD56)
(DOE/EA-2020)

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

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ABBREVIATIONS AND ACRONYMS

CAIR	Clean Air Interstate Rule
CAP	Climate Action Plan
CEQ	Council on Environmental Quality
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
EPA	Environmental Protection Agency
EUI	energy use intensity, kBtu/ft2-yr
FR	Federal Register
ft^2	square feet
GHG	greenhouse gas
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
Hg	mercury
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act of 1969
NESHAP	national emissions standards for hazardous air pollutants
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
NRC	National Research Council
O_3	ozone
PM	particulate matter
SO_2	sulfur dioxide
SO_x	sulfur oxide gases
UNEP	United Nations Environment Programme
U.S.C.	United States Code
VOC	volatile organic compounds

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1 INTRODUCTION

1.1 NEPA

This draft Environmental Assessment (EA) complies with the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.), the implementing regulations of the Council on Environmental Quality (CEQ) (40 CFR Parts 1500-1508), and DOE's regulations for implementing NEPA (10 CFR Part 1021).

The U.S. Department of Energy (DOE) prepared this draft EA to evaluate the potential direct, indirect, and cumulative 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 Part 435, to the latest current model industry code, based on a finding that it is cost-effective and saves energy compared to previous versions of the model industry code, as required by 42 U.S.C 6831 et seq. In this draft 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). This draft EA provides DOE with information needed to make an informed decision about the Proposed Action.

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. 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 saving 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 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 2009 version of the IECC. ICC has updated the IECC from the version currently referenced in DOE's regulations at 10 CFR Part 435. Under section 305 of ECPA, not later than one year after the date of approval of each subsequent revision of the ASHRAE Standard or the International Energy Conservation Code (IECC), 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 2015 IECC would achieve greater energy efficiency than the 2012 version of the IECC (See 80 FR 33250; June 11, 2015). DOE also determined that the 2012 version of the IECC would achieve greater energy efficiency than the prior version (the 2009 version that is currently referenced in 10 CFR Part 435) (See 77 FR 29322; May 17, 2012). Both of these determinations were subject to notice and comment. DOE also determined that the 2015 IECC would be cost effective if applied to new Federal low-rise residential buildings. Since the amended 2015 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 2015 IECC.[1] Specifically, the Proposed Action, if implemented, would require that Federal agencies design new Federal low-rise residential buildings to (i) meet the 2015 IECC; and (ii) if life-cycle cost-effective, achieve energy consumption levels that are at least 30 percent below the levels of the 2015 IECC.

1.3 Purpose and Need

As discussed in more detail in Section 1.2, ECPA directs DOE to take action to update its building energy efficiency standards for all new Federal buildings based on model code revisions. The purpose for the Proposed Action is to improve energy efficiency in new Federal low-rise residential buildings in a manner consistent with DOE statutory mandate under ECPA.

The need for the Proposed Action is two-fold. First, the Proposed Action is necessary to reduce energy consumption, manage energy costs for Federal low-rise buildings, reduce outdoor pollutants, and reduce the emissions of greenhouse gases that may lead to climate change. Large amounts of fuel are unnecessarily consumed each year in heating, cooling, ventilating, and providing domestic hot water for newly constructed residential buildings because they lack adequate energy conservation features. Second, the Proposed Action is necessary to meet DOE’s statutory mandate under ECPA regarding the energy efficiency standards for Federal buildings, as discussed in more detail in Section 1.2.

It is estimated that future construction of Federal low-rise residential buildings will vary from 1000 to 5000 Federal housing units per year. Therefore, updating the energy efficiency standards for new Federal low-rise residential buildings to achieve greater energy efficiency levels can help to reduce national energy consumption, reduce outdoor pollutants produced from the combustion of fossil fuels, and reduce the emissions of greenhouse gases that may lead to

[1] Although ICC published two versions of the IECC since 10 CFR Part 435 was last updated, the 2012 IECC and the 2015 IECC, the Proposed Action would update 10 CFR Part 435 to the 2015 IECC directly, without requiring agencies to comply with the 2012 IECC.

climate change. This reduction will prevent waste of energy, can help the U.S. government reduce dependence on imported energy, and strengthen its strategic position.

1.4 Public Participation and Agency Consultation

In accordance with Council on Environmental Quality CEQ regulations in 40 CFR 1508.9(b), DOE states that no additional persons/agencies were consulted during the development of this draft environmental assessment.

Public involvement is an important requirement of the NEPA process. The public review period for this draft EA is 15 days after its publication, after which DOE will consider all comments received. DOE invites all interested parties and individuals to supply comments.

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2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

Section 2 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 standards would revise 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; domestic water heating systems and equipment; and lighting.

2.1 Proposed Action

Under the Proposed Action, DOE would revise the Federal energy efficiency baseline standard for all new Federal low-rise residential buildings. The Proposed Action would update 10 CFR 435, "Energy Efficiency Standards for New Federal Low-Rise Residential Buildings," by replacing the 2009 IECC with the more energy efficient 2015 IECC as the baseline standard.[2] The Proposed Action, if implemented, would require that Federal agencies design new Federal low-rise residential buildings to (i) meet the 2015 IECC; and (ii) if life-cycle cost-effective, achieve energy consumption levels that are at least 30 percent below the levels of the 2015 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 the Proposed Action with the standards that Federal agencies must achieve under the existing regulations in 10 CFR 435, which adopted the energy efficiency performance levels of the 2009 IECC as the baseline standard for new Federal low-rise residential building designs.

2.2 No Action Alternative

The No Action Alternative is defined as a DOE decision not to adopt the 2015 IECC as the energy efficiency baseline standard for new Federal low-rise residential buildings. Instead, DOE would retain the 2009 IECC, which is the current baseline standard in 10 CFR 435.

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[2] Although the ICC published the 2012 version of the IECC, DOE did not update 10 CFR 435 to incorporate that standard.

3 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 on 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 No Sealing 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. There would be no direct, indirect, or cumulative impacts to the environment and resources discussed in this draft EA. 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 implementing regulations and guidance, DOE focused the analysis in this draft EA on topics with the greatest potential for environmental impacts [known as the sliding-scale approach (40 CFR 1502.2(b)]. Table 1 presents DOE's evaluations of the environmental resource areas on which the Proposed Action and No Sealing 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 draft EA presents the baseline and analyzes in detail 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, and specifically building habitability, 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, either adversely or beneficially. Indoor air quality is influenced by sources of pollutants both within and outside of a home, as well as natural and mechanical ventilation of the home. 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 residential buildings. These emissions can originate from furnishings within a building (e.g., carpet, furniture), from building materials (e.g., insulation material, particle board), from the ground (e.g., radon), from the building occupants' indoor activities (e.g., tobacco smoking, painting), or from the mechanical equipment (e.g., fossil-fuel appliances). Potential combustion emissions include CO, CO_2, nitrogen oxide (NO_x), and Sulphur dioxide (SO_2). Fossil-fuel-burning (including gas stoves/ovens) equipment and, if allowed, tobacco smoke, are the main sources of combustion products.

Pollutants that occur outside the residence (particularly vehicle exhaust), may be drawn inside, where they affect indoor air quality. These pollutants can enter or be expelled from the home through natural and/or mechanical ventilation. Natural ventilation includes air that can enter or be expelled from the home through non-mechanical means, often through the building envelope, and due to differences in air pressure inside the home and outside the home. Natural ventilation rates are significantly influenced by weather. Mechanical ventilation involves a system that actively introduces fresh air into the home and expels indoor air to the outside.

Indoor air quality is thus influenced by pollutant sources inside and outside the home, as well as ventilation rates of the home. 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	Lung cancer, bronchitis and respiratory infections. Eye, nose, and throat irritations.	Fossil fuel combustion, dust, smoking.
Carbon Monoxide	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.	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 from attached garages.
Carbon Dioxide	An excessive concentration of CO_2 triggers increased breathing to maintain the proper exchange of oxygen and CO_2. Concentrations above 3 percent can cause headaches, dizziness, and nausea. Concentrations above 6 percent can cause death (NRC 1981)	Sources include human respiration, tobacco smoking, gas stoves, and gas ovens.
Nitrogen Dioxide	NO_2 acts mainly as an irritant, affecting the eyes, nose, throat, and respiratory tract. Extremely high-dose exposure to NO_2 (as in a building fire) may result in pulmonary edema and diffuse lung injury. Continued exposure to high NO_2 levels can lead to acute bronchitis (EPA 1994)	Sources include kerosene heaters, gas stoves, ovens, and tobacco smoke.
Radon	Radon decay products in breathed air can deposit and stay in the lungs, sometimes contributing to lung cancer. The National Academy of Sciences (NAS) estimates that 15,400 to 21,800 people in the United States die from lung cancer attributable to radon, although the number could be as low as 3,000 or as high as 32,000 (NAS 1998). A large majority of the deaths happen to cigarette smokers. Radon is much less of a concern in commercial buildings than in residential buildings because these buildings usually have mechanical ventilation and occupants are typically not in the buildings as many hours a week as they are in their homes.	Radon is a naturally occurring gas that seeps out of rocks and soil. Radon flows from the soil into buildings from the movement of gases in the soil beneath them. Outside air tends to contain very low levels of radon, but it builds up to higher concentrations indoors where it cannot disperse. Radon is radioactive—its airborne atoms can spontaneously decay; the resulting atoms are electrically charged and can attach themselves to tiny dust particles, and adhere to the lining of the lungs when inhaled. The deposited atoms emit radiation that can damage cells in the lungs and disrupt DNA of these lung cells, becoming one step in a chain of events that can lead to cancer.

Table 2 Continued

Pollutant	Potential Health Impacts	Sources
Formaldehyde	The National Toxicology Program has classified formaldehyde as a human carcinogen (NTP 2014). 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 (CPSC 2013).	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 (CPSC 2013). Cigarette smoke also produces formaldehyde.
Volatile organic compounds	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. Some evidence exists that VOCs can provoke some of the symptoms typical of sick-building syndrome and cause severe reactions for individuals who appear to demonstrate multiple chemical sensitivities (EPA 2015f).	VOCs contain carbon and exist as vapors at room temperatures. For indoor air quality, all organic chemical compounds whose compositions give them the potential to evaporate under normal atmospheric conditions are considered VOCs. (EPA 2015f) Building materials, finishes and furnishings are key sources of indoor VOC contaminants. A single material can emit an extremely large number of diverse compounds. Individual materials can be highly variable.in terms of emissions composition, complexity and duration. (ASHRAE 2009.)
Biological Contaminants	Biological agents in indoor air are known to cause three types of human disease: infections, where pathogens invade human tissue; hypersensitivity diseases, where specific activation of the immune system causes diseases; and toxicosis, where biologically produced chemical toxins cause direct toxic effects (EPA 1994). Evidence is available showing that some episodes of sick-building syndrome may be related to microbial contamination of buildings (EPA 1994).	Sources include outdoor air and human occupants who shed viruses and bacteria, animal occupants (insects and other arthropods, mammals) that shed allergens, and indoor surfaces and water reservoirs such as humidifiers where fungi and bacteria can grow (EPA 1994).

3.3.1.2 Impacts of the Proposed Action

The Proposed Action could influence the concentration levels of indoor air emissions by decreasing the leakage of air through the building envelope (known as infiltration). The Proposed Action potentially changes infiltration relative to the No Action Alternative. Although the 2009 IECC requires the building envelope be durably sealed to limit infiltration and goes on to provide a list of openings in the building envelope that must be sealed, it does not require any testing to verify proper sealing.[3] The 2015 IECC, and thus the Proposed Action, requires sealing of the building envelope similar to the 2009 IECC, but it also requires a pressure test of the building to verify that infiltration is at or below a stringent maximum level.[4]

DOE expects the testing added in the 2015 IECC to result in reduced infiltration in many homes because the testing will detect small leaks in the building envelope that a visual inspection could not. Lower infiltration has both a disadvantage and an advantage. It may reduce the dilution of air pollutants that may be produced inside the home. On the other hand, it may limit the entry into the home of air pollutants that occur outside the home (for example, from a garage).

Mechanical ventilation systems can be used to provide fresh air from the outdoors into a home. Effective ventilation is essential to ensure dilution of indoor contaminants, especially when homes are sealed tighter. The 2009 IECC does not require any mechanical ventilation. The 2015 IECC incorporates the 2015 International Residential Code (IRC) or International Mechanical Code (IMC), or other approved mechanical ventilation requirement, by reference which, in tandem with the 2015 IECC, requires that a mechanical ventilation system be installed in new homes.[5]

The ICC has recognized that adequate ventilation is necessary to ensure acceptable indoor air quality, so now requires mechanical ventilation to properly vent tighter constructed new homes. Accordingly, DOE's Proposed Action mandates mechanical ventilation, which ensures that impacts to indoor air quality will be minimal.

The Proposed Action also contains a number of provisions intended to reduce sources of indoor air pollutants. Specifically, the 2015 IECC contains a number of provisions focused on minimizing emissions from fireplaces and other fuel-burning appliances that are not found in the 2009 IECC.[6]

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.

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[3] See Section 402.4 of the 2009 IECC.
[4] See Section R402.4 of the 2009 IECC.
[5] See Section R403.6 of the 2015 IECC.
[6] See Sections R402.4.2 and R402.4.4 of the 2015 IECC. There is a reduced set of requirements for fireplaces in Section 402.4.3 of the 2009 IECC.

3.3.2.1 Affected Environment

An air pollutant is any substance in the air that can cause harm to humans or the environment. The generation of electricity from fossil fuels results in emission of pollutants and is the largest source of U.S. greenhouse gas (GHG) emissions. According to the Department of Energy's buildings energy data book, U.S. buildings account for 39 percent of primary energy consumption and 72 percent of all electricity consumed domestically. The two most common sources of energy for buildings are electricity and direct consumption of natural gas and petroleum for heating and cooking. Electricity accounts for approximately 78 percent of total building energy consumption and contributes to GHG emissions. According to the U.S. Environmental Protection Agency (EPA), GHG emissions from electricity have increased by about 18 percent since 1990, as the demand for electricity has grown and fossil fuel has remained the dominant source for generation. In addition, U.S. buildings account for nearly 40 percent of the nation's man-made CO_2 emissions, 18 percent of the NO_x emissions, and 55 percent of the SO_2 emissions. These emissions—primarily from the electricity generation—in turn contribute to smog, acid rain, haze, and global climate change. Improving the efficiency of the nation's buildings can play a role in reducing air pollution.[7] (Park, 2013; http://www.earthday.org/blog/2013/09/06/how-do-buildings-contribute-greenhouse-gas-emissions).

This analysis considers the impact to air quality from the following pollutants: SO_2, NO_X, Hg, CH_4, NO_x, halocarbons, CO, and lead. DOE's analysis also considers CO_2, which is of interest because of its classification as a greenhouse gas (GHG). Finally, as pollutants may take the form of solid particles (i.e., particulate matter or PM), PM is also analyzed.[8]

Carbon Dioxide. CO_2 is of interest because of its classification as a GHG. GHGs trap the sun's radiation inside the Earth's atmosphere and 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 2013, 93.7 percent of anthropogenic (i.e., human-made) CO_2 emissions resulted from burning fossil fuels (EPA 2015d).

Concentrations of CO_2 in the atmosphere are naturally regulated by numerous processes, collectively known as the "carbon cycle." The movement of carbon between the atmosphere and the land and oceans is dominated by natural processes, such as plant photosynthesis. 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, in 2013, CO_2

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[7] The amount of energy consumed in the U.S. has quadrupled since 1940, while the population roughly doubled. A sharp increase in housing units has contributed to this trend. There were 140 million housing units in 2011, an increase of more than 250 percent since 1940.

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

emissions from electricity generation accounted for nearly 40 percent of total U.S. GHG emissions (EPA 2015d).

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. However, one common pollutant, NO_2, along with particles in the air, can often be seen as a reddish-brown layer over many urban areas. NO_2 is the specific form of NO_x reported in this document. NO_x is one of the main ingredients involved in the formation of ground-level ozone, which can trigger serious respiratory problems. It can contribute to the formation of acid rain, and can impair visibility in areas such as national parks. NO_x also contributes to the formation of fine particles that can impair human health (EPA 2015b).

Nitrogen oxides form when fossil fuel is burned at high temperatures, as in a combustion process. The primary manmade sources of NO_x are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fossil fuels. NO_x can also be formed naturally. Electric utilities account for about 22 percent of NO_x emissions in the United States.

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 (EPA 2015c). U.S. coal-fired power plants emit Hg in three different forms: oxidized Hg (likely to deposit within the United States); elemental Hg, which can travel thousands of miles before depositing to land and water; and Hg that is in particulate form. Atmospheric Hg is then 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.

Americans are exposed to methylmercury primarily by eating contaminated fish. 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 (Trasande et al. 2006).

Sulfur Dioxide. SO_2 belongs to the family of sulfur oxide gases (SO_x). These gases dissolve easily in water. Sulfur is prevalent in all 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 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 2015a).

Methane. CH_4 emissions are primarily from human-related sources, not natural sources. U.S. CH_4 emissions come from three categories of sources, each accounting for about one-third of total emissions: (1) energy sources, (2) emissions from domestic livestock, and (3) decomposition of solid waste in landfills. 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 60 percent of the energy source emissions (or 25 percent of all CH_4 emissions) (DOE 2011).

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. Fuel combustion is also a source of nitrous oxide; however, in the commercial and residential sector total emissions are a negligible amount of all U.S. emissions (DOE 2011).

Halocarbons and Other Gases. One group of human-made greenhouse gases consists of halocarbons and other engineered gases not usually found in nature. Three of these gases are hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6). 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 are compounds containing carbon and fluorine. PFC emissions result as a byproduct of aluminum smelting and semiconductor manufacturing. SF_6 is used an insulator for electric equipment. Energy used in buildings contributes a negligible amount of emissions of these greenhouse gases (DOE 2011).

Carbon Monoxide. The main source of CO is the incomplete burning of fossil fuels such as gasoline. Exhaust from 'highway vehicles' contributes about 52 percent of all CO emissions. The CO produced from energy use related to buildings is 3.5 percent of all emissions, but most of this is from wood burning in residential buildings, which should not be impacted by these rules. One percent of CO emissions come from fuel combustion for electrical generation by utilities (EPA 2015e).

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

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.

Power plant emissions can have either direct or indirect impacts on PM. A portion of the pollutants emitted by a power plant leave the smoke stack 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. Further, as described below, it is uncertain whether efficiency standards will result in a net decrease in power plant emissions of $SO_{2,}$ and of NO_x in many states because those pollutants are now largely regulated by cap and trade systems. For these reasons, it is not currently possible to determine how the standards impact either direct or indirect PM emissions.

Lead. Exposure to lead can cause a variety of health problems. Lead can adversely affect the brain, kidneys, liver, nervous system, and other organs (CDC 2007). Today, mobile sources, primarily aircraft, are the major source of lead emissions to the atmosphere, followed by industrial processes. Combustion from electric utilities represents 10 percent of all lead emissions.

3.3.2.2 Air Quality Regulation

The Clean Air Act Amendments of 1990 list 188 toxic air pollutants that EPA is required to control (EPA 1990). EPA has set national air quality standards for six common pollutants (also referred to as "criteria" pollutants), two of which are SO_2 and NO_X. Also, the Clean Air Act Amendments of 1990 gave EPA the authority to control acidification and to require operators of electric power plants to reduce emissions of SO_2 and NO_X. Title IV of the 1990 amendments established a cap-and-trade program for SO_2, in all 50 states and the District of Columbia (D.C.), intended to help control acid rain. This cap-and-trade program serves as a model for more recent programs with similar features.

In 2005, EPA issued the Clean Air Interstate Rule (CAIR) under sections 110 and 111 of the Clean Air Act (40 CFR Parts 51, 96, and 97),[9] (70 FR 25162–25405 (May 12, 2005)). CAIR limited emissions from 28 eastern States and D.C. by capping emissions and creating an allowance-based trading program. Although CAIR was remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit), (see *North Carolina v. EPA*, 550 F.3d 1176 (D.C. Cir. 2008),) it remained in effect temporarily, consistent with the D.C. Circuit's earlier opinion in *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008).

On July 6, 2011, EPA promulgated a replacement for CAIR, entitled "Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals," but commonly referred to as the Cross-State Air Pollution Rule (CSAPR), or the

[9] See http://www.epa.gov/cleanairinterstaterule/.

Transport Rule (76 FR 48208 (Aug. 8, 2011))[10]. CSAPR took effect January 1, 2015 for SO2 and annual NOX, and May 1, 2015 for ozone season NO_X.

On February 16, 2012, EPA issued national emissions standards for hazardous air pollutants (NESHAPs) for Hg and certain other pollutants emitted from coal and oil-fired electric generating units (EGUs) (77 FR 9304).

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 home. Finally, in order to arrive at estimated energy reductions, DOE calculated anticipated reductions based on total reductions in energy use.

New Housing Construction
Estimates of future construction of Federal low-rise residential buildings vary from 1000 to 5000 Federal housing units per year over the next three years. For the results shown in this EA, DOE estimated that 2000 Federal housing units per year would be constructed.[11] This estimate is based on historical data obtained from the Department of Defense, which constructs the large majority of all Federal housing.

Energy Use
DOE calculated energy savings per new Federal low-rise 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. 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. 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

[10] See also http://www.epa.gov/crossstaterule/.

[11] The total inventory of Federal existing residential housing units is approximately 250,000 units. Assuming older homes are replaced with new homes at an average age of 50 years, long-term annual construction would be 5000 units. Most planned construction of new Federal housing units is for the Department of Defense (approximately 90 percent of the new Federal housing units), which estimates approximately 1000 new units per year on average over the next few years. Although DOE recognizes that its estimate of new Federal housing units is imprecise, based on the above data and factors, DOE estimates 2000 new Federal housing units per year for the future. DOE believes that actual future new Federal housing units will be closer to 1000 units per year than 5000 units per year and, therefore, has chosen the 2000 unit estimate.

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. Under the Proposed Action, reductions in energy use as compared to the No Action Alternative are estimated at up to 8.1 EUI (kBtu/ ft^2-yr) for site EUI and up to 14.1 EUI (kBtu/ ft^2-yr) for source EUI.[12] Under no scenario would annual site or annual source energy use increase.

Emission Reductions

To estimate emission reductions, DOE assumed that the energy used in Federal low-rise residential buildings would have the same distribution of fuel/energy sources (e.g., coal, nuclear) as overall national electricity production. Emission reductions were based on source EUI reductions. A range of total emission reductions for a variety of pollutants and greenhouse gases were calculated using data from multiple sources.[13]

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. However, it is possible to determine the range of changes in emissions reductions.

Air emission reductions for the first year of construction during which the Proposed Action is in effect can be estimated at up to 3,585 metric tons of CO_2, up to 2.7 tons of NO_x, up to 0.00003

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[12] DOE cannot determine precisely the change to either site or source EUI associated with the Proposed Action 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 EUI.

[13] DOE used Electric Power Annual (DOE 2015c) to provide the total electric generation in the U.S. in 2013. Data for CO2 emission coefficients was taken from EPA's Greenhouse Gas Emission Inventory (EPA 2015d) for the year 2013. Data for SO2 and NOX emissions was taken from EPA's Emissions and Generation Resource Integrated Database (eGrid) (EPA 2014) using the 2010 data from version 9. Data for Hg emissions was taken from DOE's 2015 Annual Energy Outlook (AEO) (DOE 2015a), Table A8. Data for CH4 emissions was taken from four sources. The CH4 sources include the Intergovernmental Panel for Climate Change (IPCC) Fifth Assessment Report (IPCC 2013) for the conversion factor for CH4 to CO2 equivalents, DOE's 2015 Electric Power Annual (DOE 2015c) for coal and natural gas consumption associated with electric power generation in 2013, Table 1 of DOE's 2015 Natural Gas Annual (DOE 2015d) for total natural gas consumption in 2013, and DOE's Emissions of Greenhouse Gases Report (DOE 2008) for emissions of CH4 from energy sources.

tons of Hg, and up to 30 metric tons of CH_4[14]. Emissions reductions for N_2O, halocarbons, CO, PM, and lead are negligible. Under no scenario of future construction would emissions of any of the listed compounds increase.

Cumulative emission reductions for 30 years of construction (2016 through 2045) and 30 years of energy reduction[15] for each building built during that period can be estimated at up to 1,667,200 metric tons of CO_2, up to 1,275 metric tons of NO_x, up to 0.0137 metric tons of Hg, and up to 13,934 metric tons of CH_4[16]. Emission reductions for SO_2, N_2O, halocarbons, CO, PM, and lead are negligible.

SO_2 emissions were also considered in this analysis. SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap and trade programs, which create uncertainty about the impact of energy efficiency standards on SO_2

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[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 2009 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 2015 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 6,786 metric tons.

[15] Cumulative emissions for 30 years of construction are calculated by summing up the numbers 1 to 30 to get a multiplier of 465. This multiplier is applied to the first year emissions discussed in the previous paragraph. The reasoning behind this approach is that construction is assumed to be constant across years and therefore the cumulative impact will increase year by year. For the first year, there is one year of emission reductions for one year of new construction. For the second year, there is one year of emission reductions for the new construction that takes place in the second year plus continued emission reductions from the new construction in year 1. For the third year, there is one year of emission reductions from the new construction in year 3, plus continued emission reductions from new construction in years 1 and 2. The total emission reduction in year 2 is twice the first year emission reductions. The total emission reduction in year 3 is 3 times the first year emission reductions. The total cumulative emission reduction through year 2 is 3 (1+2). The total cumulative reduction through year 3 is 6 (1+2+3). This summation is continued to year 30 where the multiplier is 465.

[16] 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 2009 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 2015 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 3,155,700 metric tons.

emissions. The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emissions allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap and trade system, the National Energy Modeling System (NEMS) [NEMS 2009] model that DOE uses to forecast emissions reductions for many other analyses indicates that no physical reductions in power sector emissions would occur for SO_2. Therefore, no reductions in SO_2 emissions are assumed for this analysis.

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 Sealing 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 IPCC Fourth Assessment Report (IPCC Report), published in 2007, climate change is consistent with observed changes to the world's natural systems; the IPCC expects these changes to continue (IPCC WGI 2007A).[17]

The IPCC Report states that the world has warmed by about 0.74°C in the last 100 years. Additionally, the IPCC Report finds 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.

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

[17] Note that a fifth IPCC Assessment Report is now available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-ts.pdf

energy balance of the planet, which gradually increases its average temperature. The IPCC Report estimates that currently, CO_2 makes up about 77 percent of the total CO_2-equivalent global warming potential in GHGs emitted from human activities, with the vast majority (74 percent) of the CO_2 attributable to fossil fuel use.[18] Globally, 49 billion metric tons of CO_2 –equivalent of anthropogenic (man-made) greenhouse gases are emitted every year.[19] For the future, the IPCC Report describes a wide range of GHG emissions scenarios, but under each scenario, CO_2 would continue to comprise more than 70 percent of the total global warming potential (IPCC 2000).

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, the IPCC Report scenarios target CO_2 stabilized concentrations range between 350 ppm and 400 ppm (essentially today's value)—because of climate inertia, concentrations in this low-end range would still result in temperatures projected to increase 2.0°C to 2.4°C above pre-industrial levels[20] (about 1.3 °C to 1.7 °C above today's levels). To achieve concentrations between 350 ppm to 400 ppm, the IPCC scenarios present that there would have to be a rapid downward trend in total annual global emissions of greenhouse gases to levels that are 50 to 85 percent below today's annual emissions rates by no later than 2050. Because it is assumed that there would continue to be growth in global population and substantial increases in economic production, the scenarios identify required reductions in greenhouse gas emissions intensity (emissions per unit of output) of more than 90 percent. However, even at these rates, the scenarios describe some warming and some climate change is projected because of already accumulated CO_2 and GHGs in the atmosphere (IPCC WGI 2007b).

In response to global climate change concerns, the President issued a Climate Action Plan (CAP) in June 2013, where he affirmed that the Federal government must position itself as a leader in clean energy and energy efficiency. He pledged that Federal agencies must surpass previous greenhouse gas reduction achievements, through a combination of consuming 20 percent of Federal electricity from renewable sources by 2020, and by pursuing greater energy efficiency in Federal buildings. Additionally, the President directed that efficiency standards for appliances and federal buildings set in the first and second terms combined would reduce carbon pollution by at least 3 billion metric tons cumulatively by 2030 – equivalent to nearly one-half of the carbon pollution from the entire U.S. energy sector for one year.

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[18] 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.

[19] Other non-fossil fuel contributors include CO2 emissions from deforestation and decay from agriculture biomass; agricultural and industrial emissions of CH_4; and emissions of nitrous oxide and fluorocarbons.

[20] IPCC Working Group 3, Table TS 2.

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 the IPCC Report 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. The IPCC Report describes its estimated, numeric value as about 3°C, but the likely range of that value is 2°C to 4.5°C, with cloud feedbacks providing the largest source of uncertainty. Further, as illustrated above, the IPCC Report 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.

DOE estimated fifteen years of avoided cumulative emission of carbon dioxide in order to gauge the impact of the Proposed Action on GHGs, and the contribution of the Proposed Action to achievement of emission reduction targets set out in the CAP. DOE estimates avoided cumulative emissions of 376,500 metric tons of carbon dioxide through 2030.[21] Under no scenario of future construction would emissions of any GHG compounds increase under the Proposed Action.

[21] Emission reductions associated with the CAP are calculated using the same process as used for the 30-year emission calculations, with the exception that the CAP is for savings through 2030 – a 15 year period – instead of the 30 year period. The multiplier used for the CAP savings is 120 (the sum of the numbers 1 through 15).

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