Draft Environmental Assessment for Final Rule, 10 CFR Part 433, "Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings' Baseline Standards Update"
(RIN 1904-AD39)
(DOE/EA-2001)

August 10, 2015

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SUMMARY

The U.S. Department of Energy (DOE) has prepared this environmental assessment (EA) for DOE's proposed action, 10 CFR Part 433, "Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings". The proposed action would update the baseline standard in 10 CFR 433 to the latest current model industry standard, based on cost-effectiveness and DOE's determination that energy efficiency has been improved in these codes as required by 42 U.S.C 6831 et seq. The model industry code for commercial buildings is American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)/Illuminating Engineering Society of North America (IESNA) Standard 90.1, hereafter "ASHRAE Standard 90.1". DOE's final determination comparing ASHRAE Standard 90.1-2013 to the prior version, ASHRAE 90.1-2010, found that the 2013 edition is more energy efficient. (79 FR 57800; September 26, 2014).

Section 305(a) of the Energy Conservation and Production Act (ECPA) requires that DOE establish, by rule, Federal building energy efficiency standards for all Federal commercial and multi-family high-rise residential buildings. ECPA requires DOE to revise those standards and determine, based on cost effectiveness, whether to update the Federal standard based on industry amendments to the model code (42 U.S.C. 6834(a)(3)(A and B).

Specifically, ECPA requires that federal new construction meet DOE-approved model code baseline energy efficiency standards and, where life-cycle cost effective, exceed them by 30 percent (42 U.S.C. 6834(a)(3)(A)(i)(I)). Current federal regulations establish ASHRAE Standard 90.1-2010 as the baseline standard for commercial and multi-family high-rise residential buildings, requiring that agencies design these buildings to achieve energy consumption levels that meet, at a minimum, the ASHRAE Standard 90.1-2010, and where life cycle cost effective, exceed it by 30 percent (10 CFR Part 433). An energy conservation measure is "life-cycle cost-effective" if the savings associated with the improved efficiency are greater than the associated costs (see 10 CFR Part 436).

Under ECPA, DOE must determine whether to amend the 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)). The proposed action is the result of DOE's determination that the standards should be updated to reflect the amendments made in ASHRAE Standard 90.1-2013.

The proposed action updates the current requirement in 10 CFR 433, "Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings." It would replace ASHRAE Standard 90.1-2010 with the more energy efficient ASHRAE Standard

90.1-2013. The proposed action would make no other changes to the Federal Building Energy Efficiency Standards.

DOE's adoption of ASHRAE Standard 90.1-2013 would require that agencies design new federal commercial and multi-family high-rise residential buildings to achieve energy efficiency performance that minimally meets ASHRAE Standard 90.1-2013, and exceeds it by up to 30%, where life cycle cost effective. The maximum life cycle cost effective building design may fall short of 30% better than ASHRAE Standard 90.1-2013 for a given building; however, agencies must design to the maximum energy efficiency that is life cycle cost effective, up to 30% better than ASHRAE 90.1-2013.

This EA examines the potential environmental impacts of the proposed action on building habitability and the outdoor environment. DOE identified the potential environmental impacts of the proposed action by comparing the proposed action with the "no-action alternative". The no-action alternative is defined as a DOE decision not to update the requirement to ASHRAE Standard 90.1-2013; the no-action alternative would retain ASHRAE Standard 90.1-2010.

Building Habitability (Indoor Air) Impacts

The proposed action would not change mechanical ventilation rates or affect sources of indoor air pollutants from the no-action alternative. For commercial and multi-family high-rise residential buildings, ASHRAE Standard 90.1-2013 does not require specific mechanical ventilation rates, and the rule does not require any changes in mechanical ventilation rates. The proposed action contains essentially the same requirements for sealing of the building envelope that have been in all previous versions of ASHRAE Standard 90.1. Accordingly, indoor air pollutant levels are not expected to increase under the proposed action.

Outdoor-Air Environmental Impacts

DOE cannot determine with precision the degree of emissions impacts that would result from DOE's replacing ASHRAE 90.1-2010 with ASHRAE Standard 90.1-2013 because the aggregate emissions volume will depend on the specific level of energy efficiency that is cost effective for discrete building designs, which themselves include numerous interdependent measures and building systems that vary within individual building designs. However, it is possible to establish a range of changes in emissions based on analysis of potential design scenarios. Under all scenarios, implementation of the proposed action would result in emission reductions.

Cumulative reductions in emissions for 30 years of construction (2015 through 2044) and 30 years of energy reduction for each building built during that period can be estimated at up to 23,533,500 metric tons of carbon dioxide, up to 23,930 metric tons of nitrogen oxides, up to 0.3270 metric tons of mercury, and up to 208,931 metric tons of methane[1]. Emission reductions

[1] The proposed action would mandate that federal agencies design new commercial and multi-family high rise residential buildings to achieve energy performance under ASHRAE Standard 90.1-2013, and to exceed it by at least 30%, **if life cycle cost effective**. Exact emissions reductions are difficult to determine because they

for sulphur dioxide (SO_2,), nitrous oxide (NO), halocarbons, carbon monoxide (CO), particulate matter (PM), and lead are negligible. Under no scenario would emissions for any of the listed compounds increase.

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depend on the cost effectiveness of energy conservation measures included in the design, which is highly variable. However, DOE can evaluate building design scenarios to derive a range of potential emissions impacts by comparing the no-action alternative to the proposed action. For example, under the no action alternative, agencies must design buildings to achieve energy performance of up to 30% more efficient than ASHRAE Standard 90.1-2010. Under the proposed action, agencies must design buildings to achieve energy performance of up to 30% more efficient than ASHRAE Standard 90.1-2013. A comparison of the no action alternative to the proposed action shows an estimated 30-year carbon dioxide reduction of up to 16,473,500 metric tons. Under all possible scenarios, the proposed action would result in emission reductions.

ABBREVIATIONS AND ACRONYMS

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
CAIR	Clean Air Interstate Rule
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
IPCC	Intergovernmental Panel on Climate Change
IES	Illuminating Engineering Society of North America
kBtu	one thousand British thermal units
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 PURPOSE AND NEED FOR AGENCY ACTION

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

Section 305 of the Energy Conservation and Production Act (ECPA), requires DOE to establish building energy efficiency standards for all new Federal buildings (42 U.S.C. 6834). Section 305(a)(1) requires standards that contain energy efficiency measures that are technologically feasible and economically justified but, at a minimum, require the subject buildings to 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) and (2)).

Section 305 of ECPA also requires that "Not later than one year after the date of approval of each subsequent revision of the ASHRAE Standard or the IECC, as appropriate, the Secretary shall determine, based on the cost-effectiveness of the requirements under the amendment, whether the revised standards established under this paragraph should be updated to reflect the amendment" (42 USC 6834(a)(3)(B)).

The proposed action is the result of DOE's determination that the revised standards should be updated to reflect the amendments made in the ASHRAE Standard 90.1-2013 based on the cost-effectiveness of the latest private sector standards and DOE's determinations as to the energy efficiency improvements of ANSI/ASHRAE/IESNA Standard 90.1-2013 as required by Title III of ECPA, which establishes requirements for the Building Energy Efficiency Standards Program (42 U.S.C. 6831 et seq.). The preliminary determination for Standard 90.1-2013 was published in the Federal Register on May 15, 2014 (see 79 FR 27778). The final determination for Standard 90.1-2013 was published September 26, 2014 (see 79 FR 57900).

2 THE PROPOSED ACTION AND ALTERNATIVES

Section 2.1 describes the proposed action and the no-action alternative for commercial and multi-family high-rise residential buildings.

2.1 Proposed Action Commercial and Multi-Family High-Rise Residential Buildings

DOE proposes to revise its building energy efficiency baseline standard for all new federal commercial and multi-family high-rise residential buildings. DOE's proposed revision would update 10 CFR 433, "Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings," by replacing ASHRAE Standard 90.1-2010 with the more energy efficient ASHRAE Standard 90.1-2013. 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 433, which require that new federal commercial and multi-family high-rise residential building designs achieve energy performance levels of ASHRAE Standard 90.1-2010.

2.1.1 No-Action Alternative– ASHRAE Standard 90.1-2010

The no-action alternative is defined as a DOE decision not to adopt ASHRAE Standard 90.1-2013 as the energy efficiency baseline standard for new federal commercial and multi-family high-rise residential buildings. Instead, DOE would retain ASHRAE Standard 90.1-2010, which is the current requirement in 10 CFR 433.

The federal energy efficiency baseline standard establishes the minimum level of energy savings that DOE requires Federal agencies to achieve in new building designs. 10 CFR 433 incorporates, by reference, 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.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The proposed action would establish requirements for new federal buildings that may impact building habitability (indoor environment), and the outdoor environment. Section 3.1 addresses air emissions that can affect indoor-air quality and related human health effects. Section 3.2 addresses air emissions in the outdoor environment.

3.1 Indoor Habitability

Energy efficiency codes can potentially affect indoor-air quality, either adversely or beneficially. The primary indoor-air emissions that can adversely affect human health in typical commercial and residential buildings are particulate matter, carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2), radon, formaldehyde, volatile organic compounds, and biological contaminants.

Building energy code requirements could influence the concentration levels of indoor-air emissions in several ways. First, they could increase or decrease the ventilation and/or infiltration of fresh air from outdoors, which generally could reduce or increase indoor-generated pollutant concentration levels, respectively. The proposed action would not change ventilation or infiltration relative to the no-action alternatives for commercial and high-rise multi-family residential buildings.

Second, requirements in energy efficiency codes have the potential to impact internally generated indoor emissions by changing the materials or equipment used within the buildings. Various emissions can be continuously or intermittently released within commercial and 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 oxides, and sulfur dioxide (SO_2). Fossil-fuel-burning (including gas stoves/ovens) equipment and, if allowed, tobacco smoke, are the main sources of combustion products. In addition, sources from outside the building (particularly vehicle exhaust) can be drawn into the building.

Table 1 summarizes the principal indoor-air emissions that can potentially be of concern within buildings.

Table 1 Indoor-Air Emissions

Pollutant	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 radioactive gas that occurs in nature. The greatest single source of radon is from the soil. It can be found in soils and rocks containing uranium, granite, shale, phosphate, and pitchblende (Moffat 1997).

Table 1. Continued

Pollutant	Health Impacts	Sources
Formaldehyde	The Environmental Protection Agency (EPA) has classified formaldehyde as a "probable human carcinogen" (EPA 1989). In low concentration levels, formaldehyde irritates the eyes and mucous membranes of the nose and throat (NRC 1981). Formaldehyde can cause watery eyes; burning sensations in the eyes, nose, and throat; nausea; coughing; chest tightness; wheezing; skin rashes; and allergic reactions (CPSC 1997).	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 1997). Cigarette smoke also produces formaldehyde.
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. 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 1991).	VOCs contain carbon and exist as vapors at room temperatures. Over 900 VOCs have been identified in indoor air (EPA 1991). Formaldehyde is one type of VOC. Many products give off VOCs as they dry, cure, set, or otherwise age (Moffat 1997).
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).

3.2 Outdoor Air

A primary focus of this environmental analysis is the impact on outdoor air emissions resulting from the proposed energy efficiency standards The proposed action would reduce energy consumption in federal buildings, and therefore would affect outdoor pollutant emissions associated with energy generation.

3.2.1 Air Emissions Descriptions and Regulation

U.S. buildings account for nearly 40% of the nation's man-made carbon dioxide emissions, 18% of the nitrogen oxide emissions, and 55% of the sulfur dioxide emissions. These emissions—primarily from 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 significant role in reducing air pollution.

This analysis first considers three air pollutants that impact air quality: sulfur dioxide (SO_2), nitrogen oxides (NO_X), and mercury (Hg). An air pollutant is any substance in the air that can cause harm to humans or the environment. Pollutants may take the form of solid particles (i.e., particulates or particulate matter), liquid droplets, or gases.[2] DOE’s analysis also considers carbon dioxide (CO_2), which is of interest because of its classification as a greenhouse gas (GHG). Seven additional pollutants – methane, nitrous oxide, halocarbons, carbon monoxide, particulate matter, and lead – are also analyzed.

Carbon Dioxide. Carbon dioxide (CO_2) is of interest because of its classification as a greenhouse gas (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, methane (CH_4), nitrous oxide (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 emissions from electricity generation accounted for nearly 40 percent of total U.S. GHG emissions. (EPA 2015d)

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

Nitrogen Oxides. Nitrogen oxides**,** or NO_x, is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colorless and odorless. However, one common pollutant, nitrogen dioxide (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 mercury (Hg) found in coal during the burning process. Coal-fired power plants are the largest remaining source of human-generated Hg emissions in the United States (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. Sulfur dioxide, or 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. Methane emissions are primarily from human-related sources, not natural sources. U.S. methane 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 methane 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. Methane 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 methane emissions) (DOE 2011).

Nitrous Oxide. Nitrous oxide emission rates are more uncertain than those for CO_2 and methane, 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. Particulate matter (PM), also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets. Particle 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 of concern due to human exposures that can impact 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 are in the form of particulates as they leave the smoke stack. 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. Today, metals processing is the major source of lead emissions to the atmosphere. Combustion from electric utilities is less than 2 percent of all lead emissions, with most of the combustion emissions are from coal, not natural gas or oil. Lead emissions directly from buildings are a negligible share of national total emissions (EPA 2001).

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 rainThis 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),[3] (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 Transport Rule (76 FR 48208 (Aug. 8, 2011))[4]. CSAPR took effect January 1, 2015 for SO2 and annual NOX, and May 1, 2015 for ozone season NO_X.

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[3] See http://www.epa.gov/cleanairinterstaterule/.
[4] See also http://www.epa.gov/crossstaterule/.

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

3.2.2 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 carbon dioxide (CO_2), as major contributors to climate change. Because this rule will likely decrease CO_2 emission rates from the fossil fuel sector in the United States, the Department here examines the impacts and causes of climate change.

Impacts of Climate Change on the Environment. Climate is usually 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).[5]

Changes that are consistent with warming include warming of the world's oceans to a depth of 3000 meters; global average sea level rise at an average rate of 1.8 mm per year from 1961 to 2003; loss of annual average Arctic sea ice at a rate of 2.7 percent per decade; changes in wind patterns that affect extra-tropical storm tracks and temperature patterns; increases in intense precipitation in some parts of the world; increased drought; more frequent heat waves in many locations worldwide; and, numerous ecological changes (IPCC WGI 2007b).

Looking forward, the IPCC describes continued global warming of about 0.2°C per decade for the next 2 decades under a wide range of emission scenarios for carbon dioxide (CO_2), other greenhouse gases (GHGs), and aerosols. After that period, the rate of increase is less certain. The IPCC Report describes increases in average global temperatures of about 1.1°C to 6.4°C at the end of the century relative to today. These increases vary depending on the model and emissions scenarios (IPCC WGI 2007b).

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

The IPCC Report describes incremental impacts associated with the rise in temperature. At ranges of incremental increases to the global average temperature, IPCC reports, with either high or very high confidence, that there is likely to be an increasing degree of impacts such as coral reef bleaching, loss of wildlife habitat, loss of specific ecosystems, and negative yield impacts for major cereal crops in the tropics, but also projects that there likely will be some beneficial impacts on crop yields in temperate regions.

Causes of Climate Change. The IPCC Report states that the world has warmed by about 0.74°C in the last 100 years. 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 methane and nitrous oxide 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 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[6] global warming potential in GHGs emitted from human activities, with the vast majority (74 percent) of the CO_2 attributable to fossil fuel use (IPCC 2007b). 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).

Stabilization of CO_2 Concentrations. Unlike many traditional air pollutants, CO_2 mixes thoroughly in the entire atmosphere and is long-lived. The residence time of CO_2 in the atmosphere is long compared to the emission processes. Therefore, the global cumulative emissions of CO_2 over long periods determine CO_2 concentrations because it takes hundreds of years for natural processes to remove the CO_2. Globally, 49 billion metric tons of CO_2 – equivalent of anthropogenic (man-made) greenhouse gases are emitted every year.[7] Of this annual total, fossil fuels contribute about 29 billion metric tons of CO_2 (IPCC 2000).

Researchers have focused on considering atmospheric CO_2 concentrations that likely will result in some level of global climate stabilization, and the emission 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[8] (about 1.3 °C to 1.7 °C above today's levels). To achieve concentrations

[6] 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.
[7] Other non-fossil fuel contributors include CO2 emissions from deforestation and decay from agriculture biomass; agricultural and industrial emissions of methane; and emissions of nitrous oxide and fluorocarbons.
[8] IPCC Working Group 3, Table TS 2.

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 emission 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 2007c).

It is difficult to correlate specific emission 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 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.

4 CALCULATING ENERGY SAVINGS BY BUILDING TYPE

4.1 Commercial and Multi-Family High-Rise Residential Buildings

To compare estimated outdoor emissions, it is necessary to determine differences in building energy use by fuel type. This section provides the differences in potential building energy use that may result from implementing the proposed action. Energy use is evaluated at the ASHRAE Standard 90.1-2013 level, then compared to the no-action alternative, which is ASHRAE Standard 90.1-2010. The proposed action energy savings were assessed for five common buildings types in 15 cities, representing 15 climate regions within the United States. Energy savings from the proposed action were estimated using the EnergyPlus whole building energy simulation program (DOE 2010). Assumptions used in this analysis are described below.

4.1.1 Commercial Building Types Used to Estimate Energy Savings

GSA data were used to find the distribution of existing Federal building types (GSA 2008, GSA 2009, GSA 2010, GSA 2011, GSA 2012, GSA 2013, and GSA 2014). It was assumed that new Federal construction would have a similar distribution between building types. Several less common buildings types were put in the office category because they were not easily characterized or modeled and their use-patterns are likely similar to those of office buildings. The distribution shown in Table 2 was used for new Federal construction.

Table 2 Estimated Floor Area Fraction of New Federal Commercial Building Construction

Building Type	Estimated Fraction of Floor Space
Office	63%
Education/Training	8%
Dormitory Barracks	9%
Warehouse	15%
Hospital	4%

Office and education/training buildings were further subdivided into several common building types: small offices, medium offices, large offices, primary education, and secondary education. The distribution of building floor space within these subcategories was assumed to be the same as national building stock. A total of 39.4 million square feet of new Federal buildings are assumed to be constructed each year. This assumption is based on a combination of data from the 2015 Annual Energy Outlook (AEO) (DOE 2015a) and the 2012 Commercial Building Energy Consumption Survey (CBECS) (DOE 2015b). Data from the 2015 AEO Reference Case was used to estimate the growth in total commercial sector floor space over the time period 2015 through 2040. This data was then extrapolated to 2044 to get the total increase over the period 2015 to 2044. The 2012 CBECS was then used to estimate the fraction of total commercial floor space owned by the Federal government. In 2012, that fraction was 1.81%. This fraction was assumed constant over the period 2015 to 2044. Over the period 2015 to 2044, the average Federal commercial new construction floor space was calculated to be 39.2 million square feet.

Energy Use Intensity (EUI) is the energy consumed by a building per square foot per year. The national average EUIs were calculated using a weighted average of EUIs for the types of buildings that the Federal Government is expected to construct shown in Table 2. Site energy includes energy used only at the building site, while source energy includes energy used at the building site and energy lost in producing and delivering the energy to the site.

DOE cannot determine precisely the degree of energy use impact associated with updating the federal energy efficiency baseline standard to ASHRAE Standard 90.1-2013 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, annual site energy use reductions can be estimated to reach up to 2.7 EUI (kBtu/ ft^2-yr), and annual source energy use reductions can be estimated to reach up to 8.9 EUI (kBtu/ ft^2-yr). Under no scenario would annual site or annual source energy use increase.

5 ENVIRONMENTAL IMPACTS

5.1 Commercial and Multi-Family High-Rise Residential

This section provides the potential environmental impacts that may result from implementing the proposed action. Environmental impacts are evaluated at the ASHRAE Standard 90.1-2013 level then compared to the no-action alternative, which is the ASHRAE Standard 90.1-2010.

5.1.1 Building Habitability (Indoor-Air) Impacts

The proposed action would not change mechanical ventilation rates or affect sources of indoor-air pollutants from the no-action alternative. For commercial and multi-family high-rise residential buildings, ASHRAE Standard 90.1-2013 does not require specific mechanical ventilation rates and the proposed action does not require any changes in mechanical ventilation rates. The proposed action contains essentially the same requirements for sealing of the building envelope that have been in all previous versions of ASHRAE Standard 90.1. Accordingly, indoor-air pollutant levels are not expected to change under the proposed action.

5.1.2 Outdoor Air

Under the proposed action, carbon dioxide, nitrogen oxides, and mercury 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.

Electricity production ultimately used in Federal commercial buildings is assumed to have the same distribution of fuel/energy sources (e.g., coal, nuclear) as overall national electricity production. The emissions coefficients were calculated using data from multiple sources. DOE's Electric Power Annual (DOE 2015c) was used to provide the total electric generation in the U.S. in 2013. Data for CO_2 emission coefficients was taken from EPA's Greenhouse Gas Emission Inventory (EPA 2015) for the year 2013. Data for SO_2 and NO_X emissions was taken from EPA's Emissions and Generation Resource Integrated Database (eGrid) (EPA 2014) using the 2010 data from version 9. Data for mercury emissions was taken from DOE's 2015 Annual Energy Outlook (AEO) (DOE 2015a), Table A8. Data for methane emissions was taken from 4 sources. The methane sources include the Intergovernmental Panel for Climate Change (IPCC) Fifth Assessment Report (IPCC 2013) for the conversion factor for methane 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 methane from energy sources.

DOE cannot provide an exact determination of emissions impacts associated with updating the federal energy efficiency baseline standard replacing to ASHRAE Standard 90.1-2013 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 for which the proposed action is in effect can be estimated at up to 51,950 metric tons of carbon dioxide, up to 53 tons of nitrogen oxide, up to 0.00072 tons of mercury, and up to 461 metric tons of mercury[9]. Emission reductions for nitrous oxide (NO), halocarbons, carbon monoxide (CO), particulate matter (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 (2015 through 2044) and 30 years of energy reduction for each building built during that period can be estimated at up to 23,533,500 metric tons of carbon dioxide, up to 23,930 metric tons of nitrogen oxides, up to 0.3270 metric tons of mercury, and up to 208,931 metric tons of methane[10]. Emission reductions for sulphur dioxide (SO_2), nitrous oxide (NO), halocarbons, carbon monoxide (CO), particulate matter (PM), and lead are negligible. Under no scenario of future construction would emissions of any of the listed compounds increase.

Sulphur Dioxide (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 trading programs, which create uncertainty about the impact of energy efficiency standards on SO_2 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 2003] model that DOE uses to

[9] Actual reductions would depend on the level of energy efficiency that is life cycle cost effective for each new building design. For example, under the no action alternative, agencies are required to design all new federal commercial and multi-family high-rise residential buildings at 30% more efficient than ASHRAE Standard 90.1-2010, if life cycle cost effective. Under the proposed action, agencies would be required to design buildings that are 30% more efficient than ASHRAE Standard 90.1-2013, if life cycle cost effective. A comparison of the no-action alternative to the proposed action, if building at the 30% cost effective level of efficiency, yields an estimated first year emissions reduction for carbon dioxide of 36,365 metric tons.

[10] Actual reductions would depend on the level of energy efficiency that is life cycle cost effective for each new building design. For example, under the no action alternative, agencies are required to design all new federal commercial and multi-family high-rise residential buildings at 30% more efficient than ASHRAE Standard 90.1-2010, if life cycle cost effective. Under the proposed action, agencies would be required to design buildings that are 30% more efficient than ASHRAE Standard 90.1-2013, if life cycle cost effective. A comparison of the no-action alternative to the proposed action, if building at the 30% cost effective level of efficiency, yields an estimated 30-year emissions reduction for carbon dioxide of 16,473,500 metric tons.

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.

5.2 Environmental Justice and Other Resource Areas

A consideration of Environmental Justice is made pursuant to Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 FR 7629, EO signed Feb. 11, 1994). The Executive Order requires Federal agencies to address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on low-income or minority populations. DOE analyzed the potential impacts of the proposed action on low-income and minority populations and determined that the proposed action, would not result in any adverse health effects and therefore does not have the potential for disproportionately high and adverse health effects on minorities and low income population.

DOE analyzed the potential impacts of the proposed action on sensitive environmental resources and determined that it would not impact any sensitive environmental resources such as wetlands, endangered species, or historic or archaeological sites. Further, sensitive resource impacts of Federal building construction will be evaluated by individual agencies through their NEPA process.

DOE analyzed the potential impacts of a terrorist act on the proposed action and determined that there are no aspects of the proposed action that would be affected by a terrorist act.

6 AGENCIES AND PERSON 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 – Sarah Jensen, Kavita Vaidyanathan, Ami Grace-Tardy, Roak Parker, Lisa Jorgensen, Julie Anderson

Pacific Northwest National Laboratory (DOE contractor) - Mark Halverson

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