Draft Environmental Assessment for Proposed Rule, 10 CFR Part 433, "Energy Conservation and Fossil Fuel-Generated Energy Consumption Reduction Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings" and 10 CFR Part 435 "Energy Conservation and Fossil Fuel-Generated Energy Consumption Reduction Standards for the Design and Construction of New Federal Low-Rise Residential Buildings"

(DOE/EA-1778)

SUMMARY

The U.S. Department of Energy (DOE) has prepared this Environmental Assessment (EA) for DOE's Proposed Rule, 10 CFR Part 433, "Energy Conservation and Fossil Fuel-Generated Energy Consumption Reduction Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings" and 10 CFR Part 435, "Energy Conservation and Fossil Fuel-Generated Energy Consumption Reduction Standards for the Design and Construction of New Federal Low-Rise Residential Buildings". Section 433 of the Energy Independence and Security Act (EISA) of 2007 (Pub. L. 110-140) modifies section 305 of ECPA by adding a new section 305(a)(3)(D) which requires DOE, through regulation, to update the energy efficiency requirements for new Federal buildings and Federal buildings undergoing major renovation by requiring that two categories of Federal buildings be designed to reduce their fossil-fuel generated energy consumption. Section 433 of EISA also requires that sustainable design principles be applied in the siting, design, and construction of Federal buildings. In addition, DOE is directed by section 523 of EISA to establish regulations that require solar hot water heaters be applied to the extent they are life-cycle cost-effective. (42 U.S.C. 6834(a)(3)(D)(vii)). However, this Environmental Assessment only addresses the fossil fuel-generated reduction requirements contained in the Proposed Rule. The sustainable design requirements from Section 433 of EISA are being addressed in a parallel but separate rulemaking.

The EA summarizes the potential incremental environmental impacts of the Proposed Rule on building habitability and the outdoor environment. To identify the potential environmental impacts that may result from implementing the Proposed Rule for new Federal buildings, DOE compared the Proposed Rule with the "no-action alternative" of using the current Federal Standards – 10 CFR Part 433 and 10 CFR Part 435 (referred to as the "no-action alternative"). The no-action alternative requires new Federal commercial and multi-family high-rise residential buildings to achieve a level of energy consumption 30 percent below that of the ANSI/ASHRAE/IESNA Standard 90.1-2004, or the IECC 2004 Supplemental Edition (2004 IECC) for new Federal low-rise residential buildings, when life-cycle cost-effective. Note that some federal buildings may not be required to meet the 30 percent requirement if it is not found to be life-cycle cost-effective. At a minimum, however, new Federal commercial or low-rise residential buildings are required to meet ASHRAE Standard 90.1-2004 or the IECC 2004 Supplemental Edition, respectively. Though individual building efficiency levels will vary, DOE has determined that it would be useful to compare the Proposed Rule to both ASHRAE 90.1-2004 and a level 30% below ASHRAE 90.1-2004 for new Federal commercial and multi-family high-rise residential buildings, and to the 2004 IECC for new Federal low-rise residential buildings.

Building Habitability (Indoor Air) Impacts

The rule does not change mechanical ventilation rates from the current standard. For commercial and high-rise multi-family residential buildings, ASHRAE Standard

90.1-2004 does not require specific mechanical ventilation rates and the rule does not require any changes in mechanical ventilation rates. DOE assumes that agencies will continue to specify the same mechanical ventilation rates they are currently using. Current minimum ventilation requirements can be found in 10 CFR 434.403.2.4. For residential buildings, the 2004 IECC does not contain any ventilation requirements and therefore the residential portion of the rule does not affect ventilation. In addition, natural ventilation through leaks and cracks in the building envelope (known as infiltration) is not expected to increase or decrease. Indoor air pollutant levels are not expected to increase under the Proposed Rule. This expectation does not imply that the potential for health-related problems in new Federal buildings does not exist. All buildings, regardless of energy efficiency codes, have some potential for indoor air quality-related health problems, such as "sick building syndrome." Sick-building syndrome can result from insufficient building air exchange. For example, if the ventilation system that brings in fresh outside air breaks down, the air will become stale and occupants in the building may get sick.

Outdoor Air Environmental Impacts

For all Federal buildings, the rule is expected to reduce outdoor emissions primarily by reducing consumption of fossil fuels. The Federal Government constructs an estimated 30 million square feet of Federal commercial buildings annually. (See Section 4.1.1 for derivation of this number.) In contrast, the government rarely constructs Federal high-rise residential buildings. Also, since the Proposed Rule only pertains to buildings

that cost over $2.5 million, very few residential buildings will be affected. As such, the outdoor air environmental impacts of new Federal residential buildings were not included in this analysis.

For the purposes of this EA, DOE considers fossil fuel-generated energy savings of 55 percent, 65 percent**,** 80 percent, 90 percent, and 100 percent below the fossil fuel-generated energy consumption levels found in CBECS. DOE then compares the energy savings of these five levels to the "no-action alternative" of continued use of the existing 10 CFR Part 433 as the Federal standard, which requires a level of efficiency 30% below ASHRAE 90.1-2004, if cost-effective. Since buildings will have varying degrees of efficiency under the existing rule, DOE also compared the proposed rule to the lowest level of efficiency under the existing rule, which requires that all federal buildings meet ASHRAE 90.1-2004.

Emissions avoided are directly proportional to energy savings achieved. First-year carbon dioxide emissions avoided by the Federal sector (assuming that new buildings under the no-action alternative would have exceeded ASHRAE 90.1-2004 by 30%) would be 52,700 metric tons for the 55% percent fossil-fuel reduction. Savings will compound each year, as more the Federal building stock turns over and the percentage fossil-fuel reduction requirement increases. First-year methane emissions avoided would be 111 metric tons. Nitrogen oxide emissions avoided would be 53 metric tons in the first year the rule is in effect. Sulfur dioxide emissions avoided would be 151 metric tons in the first year.

Alternatively, assuming that new buildings under the no-action alternative would have only met the 90.1-2004 Standard, avoided carbon dioxide emissions would be 93,600 metric tons for year one. Methane emissions avoided would be 198 metric tons. Nitrogen oxide emissions avoided would be 103 metric tons. If new buildings were assumed to meet 90.1-2004, the sulfur dioxide emissions avoided would be 269 tons.

Other Impacts

The Proposed Rule is by its fundamental intent beneficial to the environment. The Proposed Rule is not expected to cause any adverse health effects, and thus would have no environmental justice impacts affecting low-income or minority populations. The Proposed Rule would not have an adverse effect on historic or archaeological sites, and would not be affected by a terrorist act. The Proposed Rule will be beneficial and have no significant impact on sensitive environmental resources, including wetlands/floodplains, prime agricultural lands, endangered species, and sensitive ecosystems.

ABBREVIATIONS AND ACRONYMS

Act or ECPA	Energy Conservation and Production Act (42 U.S.C. 6831 et seq.)
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
BTU	British thermal unit
CEQ	Council on Environmental Quality
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CO_2	carbon dioxide
CO	carbon monoxide
DOE	Department of Energy
EA	environmental assessment
EPA	Environmental Protection Agency
EUI	Energy Use Intensity, kBtu/ft^2-yr
FR	Federal Register

HFC	hydro fluorocarbon
HCFC	hydro chlorofluorocarbon
ICC	International Code Council
IECC	International Energy Conservation Code
IESNA	Illuminating Engineering Society of North America
KWh	kilowatt-hour
LCC	Life-cycle cost
MBtu	Million British Thermal Units
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act of 1969
NO_2	nitrogen dioxide
NRC	National Research Council
ODS	ozone-depleting substance(s)
SO_2	sulfur dioxide
U.S.C.	United States Code
VOC	volatile organic compounds

CONTENTS

TABLES

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 the National Environmental Policy Act of 1969 (NEPA) (10 CFR Part 1021). Section 433 of the Energy Independence and Security Act (EISA) of 2007 (Pub. L. 110-140) modifies section 305 of ECPA by adding a new section 305(a)(3)(D) which requires DOE, through regulation, to update the energy efficiency requirements such that:

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

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

This EA is in support of a Notice of Proposed Rulemaking to continue DOE’s efforts to comply with section 305(a)(3)(D) of ECPA. The EA identifies possible incremental environmental effects of the Proposed Rule on Federal buildings.

2 THE PROPOSED RULE AND ALTERNATIVES

In accordance with NEPA, this section discusses the elements of the Proposed Rule itself, as well as alternative actions that may be taken in place of the Proposed Rule. Section 2.1 describes the Proposed Rule, the no-action alternatives (meeting or exceeding ASHRAE Standard 90.1-2004) for commercial and high-rise multifamily residential buildings. Section 2.2 describes the Proposed Rule, the no-action alternatives (meeting or exceeding 2004 IECC) for low-rise residential buildings. Section 2.3 provides some details about how the Proposed Rules and no-action alternatives differ.

2.1 Commercial and High-Rise Multi-Family Residential Buildings

The potential environmental impacts that would result from implementing the Proposed Rule for new Federal commercial and high-rise multi-family residential buildings (over three stories in height above ground) were examined by comparing the Proposed Rule with the existing rule 10 CFR Part 433, which requires federal buildings to meet ASHRAE Standard 90.1-2004 at a minimum, and exceed it by up to 30% if cost-effective. Though the baseline will vary based on what efficiency levels are found to be cost-effective, the DOE believes that using both 90.1-2004 and a level 30% better than 90.1-2004, will be instructive for the purposes of this EA.

2.1.1 The Proposed Action – The Proposed Rule (Commercial and High-Rise Residential Buildings)

The Proposed Rule requires that, for new Federal commercial and multi-family high-rise residential buildings and Federal commercial and high-rise residential buildings undergoing major renovations, the buildings shall be designed so that the fossil fuel-generated energy consumption of the buildings is reduced, as compared with such energy consumption by a similar building in fiscal year 2003 (as measured by Commercial Buildings Energy Consumption Survey data from the Energy Information Agency), by the percentage specified in the following table:

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

2.1.2 The “No-Action” Alternative One – Standard 90.1-2004 (Commercial and High-Rise Residential Buildings)

The no-action alternative is defined as the current practice for new Federal buildings. Current practice for Federal buildings is prescribed by the energy efficiency requirements found in 10 CFR Part 433. 10 CFR 433.4(a)(1) requires that at a minimum, new Federal buildings must meet ASHRAE Standard 90.1-2004.

2.1.3 The “No-Action” Alternative Two – Exceed Standard 90.1-2004 by 30% (Commercial and High-Rise Residential Buildings)

The second no-action alternative is also described in 10 CFR Part 433. Under the Existing Rule, Federal buildings must achieve a level of efficiency 30% better than the 90.1-2004 Standard, if cost-effective. If a 30% reduction is not cost-effective, the highest level of efficiency that is found to be cost-effective must be used, with 90.1-2004 as a minimum. However, for the purposes of this EA, the “No-action” Alternative Two will assume a level of efficiency 30% better than 90.1-2004. DOE expects that most new Federal buildings will be able to achieve a 30% energy reduction cost-effectively.

2.2 Low-Rise Residential Buildings

The potential environmental impacts that would result from implementing the Proposed Rule for new Federal low-rise residential buildings (three stories or less in height above ground) were examined by comparing the Proposed Rule with the existing rule, 10 CFR Part 435. Under the existing rule, new buildings must be 30% more efficient than the 2004 IECC, if cost-effective. If a level of efficiency 30% below the 2004 IECC is not found to be cost-effective, the highest level of efficiency that is found to be cost-effective must be used. As a minimum, the buildings must meet the 2004 IECC. As such, the level of efficiency for each building under the proposed rule will vary significantly. However, for the purposes of this EA, the Proposed Rule is compared to both the minimum requirement under the existing rule (to meet the 2004 IECC) and a level of efficiency 30% better than the 2004 IECC.

2.2.1 The Proposed Action – The Proposed Rule (Low-Rise Residential Buildings)

The proposed action is the Proposed Rule, which requires that for new Federal low-rise residential buildings and major renovations of Federal low-rise residential buildings, the buildings shall be designed so that the fossil fuel-generated energy consumption of the buildings is reduced, as compared with such energy consumption by a similar building in fiscal year 2003 (as measured by Residential Energy Consumption

Survey data from the Energy Information Agency), by the percentage specified in the following table:

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

2.2.2 The “No-Action” Alternative One – The 2004 IECC Standard (Low-Rise Residential Buildings)

The no-action alternative is defined as the current practices for new Federal buildings. Current practices for Federal buildings are prescribed by the energy efficiency requirements found in 10 CFR Part 435. 10 CFR 435.4(a)(1) requires that at a minimum, new Federal low-rise residential buildings must meet the 2004 IECC.

2.2.3 The “No-Action” Alternative Two – Exceed the 2004 IECC by 30% (Low-Rise Residential Buildings)

The second no-action alternative is also described in 10 CFR 435. Under the Existing Rule, new Federal low-rise residential buildings must achieve a level of efficiency 30% better than the 2004 IECC, if cost-effective. If a 30% reduction is not cost-effective, the highest level of efficiency that is found to be cost-effective must be used, with the 2004 IECC as a minimum. However, for the purposes of this EA, the "No-action" Alternative Two will assume a level of efficiency 30% better than the 2004 IECC.

2.3 Distinction between the Proposed Rule and the No-Action Alternatives

The Proposed Rule for Commercial and Residential buildings and the no-action alternatives differ in that they use a different, but related metric. The no-action alternatives require an overall reduction in building energy use, whereas the proposed rule requires a reduction in fossil fuel-generated energy use. However, it is reasonable to assume that a 30% reduction in building energy use will, under most circumstances, result in an approximate 30% reduction in fossil fuel-generated use. Under this assumption, the Proposed Rule requires an additional reduction in fossil fuel-generated energy as compared to the no-action alternatives.

There are provisions in the no-action alternatives that allow a lower level of overall energy use reduction if a 30% reduction is cost-effective. While there is no cost-effective requirement in the proposed rule, agencies may write a petition requesting a

lower numeric requirement if meeting the percentage reduction requirement is technically impracticable.

There is also a difference in the types of energy use that are covered by the Proposed Rule and the no-action alternatives. The no-action alternative requirements cover space heating, space cooling, ventilation, service water heating, lighting and all other energy consuming systems normally specified as part of the building design except for receptacle (plug) and process loads. In contrast, the Proposed Rule requirements cover all building energy use, including receptacle and process loads. Note that there is no specific requirement in the Proposed Rule for a reduction in receptacle or process loads. However, it is reasonable to assume that receptacle and process loads will be reduced in order to meet the Proposed Rule fossil-fuel reduction requirements.

3 ENVIRONMENTAL IMPACTS

The Proposed Rule contains specifications that impact building habitability (indoor environment), the outdoor environment, the nation's economy, and the Federal agencies that procure commercial and residential buildings. These impacts are described in more detail in this section.

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 (CO2), nitrogen dioxide (NO2), 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 reduce indoor-generated pollutant concentration levels. The Proposed Rules will not place any additional restrictions or requirements on ventilation. Under 10 CFR 434.403.2.4, Federal buildings must be designed to meet the ventilation requirements described in ASHRAE Standard

62-1989 Ventilation for Acceptable Indoor Air Quality. That requirement is unchanged in the Proposed Rule. ASHRAE Ventilation Standards are accepted in the engineering profession as the minimum ventilation rates required to provide adequate indoor air quality. Even if infiltration rates are reduced by energy conservation measures, adequate ventilation is still required to help remove buildup of indoor contaminants.

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. The Proposed Rule is not expected to change pollutant rates from indoor sources of air pollution compared to the no-action alternatives. Note that DOE is issuing an additional rulemaking that addresses the requirements for use of sustainable design principles in siting, design, and construction of new Federal buildings and that this rule may reasonably be assumed to reduce pollutant emission rates from indoor sources. 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 CO2 triggers increased breathing to maintain the proper exchange of oxygen and CO2. Concentrations above 3 percent can cause headaches, dizziness, and nausea. Concentrations above 6 percent to 8 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 of the eyes, nose, throat, respiratory tract. Extremely high-dose exposure to NO_2 may result in pulmonary edema and diffuse lung injury. Continued high exposure can lead to acute bronchitis (EPA 1994).	Sources include kerosene heaters, gas stoves, ovens, and tobacco smoke.

Pollutant	Health Impacts	Sources
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 annually, 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 as 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).

Pollutant	Health Impacts	Sources
Formaldehyde	The 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).

Pollutant	Health Impacts	Sources
Biological Contaminants	Biological agents in indoor air are known to cause three types of human disease: infections (pathogens invade human tissue); hypersensitivity diseases (specific activation of the immune system causes diseases); and toxicosis (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

The Proposed Rule impacts energy consumption and therefore impacts pollutant emissions and greenhouse gas emissions associated with energy consumption. The emissions addressed in this report are split into two groups, namely, greenhouse gases and gases other than greenhouse gases.

3.2.1 Greenhouse Gases

While the scientific understanding of climate change continue to evolve, the International Panel on Climate Change (IPCC) Fourth Assessment Report stated that warming of Earth's climate is unequivocal, and that warming is very likely attributable to increases in atmospheric greenhouse gases (GHGs) caused by human activities (anthropogenic). The Fourth Assessment Report indicates that changes in many physical and biological systems, such as increases in global temperatures, more frequent heat waves, rising sea levels, coastal flooding, loss of wildlife habitat, spread of infectious disease, and other potential environmental impacts are linked to changes in the climate system, and that some changes could be irreversible. GHGs, which include carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), are chemical compounds in the earth's atmosphere that trap heat. Of these gases - CO2 is recognized by the IPCC as the primary GHG affecting climate change. Present atmospheric concentrations of CO2 are believed to be higher than at any time in at least the last 650,000 years, primarily as a result of combustion of fossil fuels. It is also very likely that increases in CH4 are partially due to fossil fuel use, according to the IPCC Report. The proposed Rule will help reduce GHGs by saving fossil fuel generated energy.

The impacts presented in Section 5.0 are focused on human-made emissions and specifically those in the United States. Carbon dioxide emissions from coal, petroleum, and natural gas make up about eighty-one percent of U.S. greenhouse gas emissions. Consequently, U.S. emissions are strongly tied to fossil energy consumption. Other greenhouse gas emissions include methane, nitrous oxide, and other gases. The information on greenhouse gases presented below is from the DOE report entitled, "Emissions of Greenhouse Gases in the United States" (DOE 2009).

Carbon Dioxide

CO2 is by far the most common greenhouse gas emitted. More than 98 percent of U.S. CO2 emissions can be traced to the combustion of fossil fuels. The commercial sector, (including all commercial buildings, as defined by DOE [2008], not just Federal buildings) accounts for 19 percent of U.S. CO2 emissions. Eighty percent of commercial-sector CO2 emissions are associated with the production of electric power used in the sector. Sixteen percent of the commercial-sector CO2 emissions are from natural gas (used directly in buildings), with the remaining 4 percent mainly from petroleum products. The residential sector contributes a 21 percent share of U.S. CO2 emissions. Seventy-two percent of residential CO2 emissions are associated with the production of electricity. Twenty-two percent of the residential-sector CO2 emissions are from natural gas (used directly in buildings), with 7 percent from petroleum products. The Proposed Rule will help reduce CO2 emissions by saving energy.

Methane

Methane emissions are primarily from human-related sources, not natural sources. U.S. methane emissions are from three categories of sources, each accounting for about one-third of total emissions: (1) decomposition of solid waste in landfills, (2) energy sources, and (3) emissions from domestic livestock. 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 61 percent of the methane emissions from energy sources (or 24 percent of all methane emissions). The Proposed Rule is expected to reduce Methane emissions by saving energy.

Nitrous Oxide

Nitrous oxide emission rates are more uncertain than those for CO2 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 only about 0.4% of all U.S. nitrous oxide emissions. The Proposed Rule is expected to reduce nitrous oxide emissions by saving energy.

Halocarbons and Other Gases

The final group of human-made greenhouse gases consists of halocarbons and other engineered gases not usually found in nature. Three of these gases are discussed below:

1. Hydrofluorocarbons (HFC)
2. Perfluorocarbons (PFC)
3. Sulfur hexafluoride (SF6).

HFCs are compounds containing hydrogen, fluorine, and carbon. HFCs do not reach the stratosphere to destroy ozone, therefore, they are considered more environmentally benign than ozone-depleting substances such as chlorofluoro-carbons (CFCs). 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. SF6 is used as an insulator for electric equipment. The Proposed Rule is not expected to change the emission rates of HFCs, PFCs, or SF6.

3.2.2 Other Outdoor Air Emissions

Several outdoor air emissions other than the greenhouse gases having detrimental effects on human health and/or the environment are discussed below. National air quality standards have been set for six principal air pollutants (also referred to as "criteria pollutants"): ozone, NO2, CO, particulate matter, SO2, and lead. More information on these emissions is presented below. All of the following information on air emissions is from EPA data (EPA 2009).

Ozone

Ozone occurring high in the atmosphere is beneficial, providing a protective layer from ultraviolet radiation. Closer to ground level, however, ozone is the prime ingredient of smog. Ozone can cause respiratory problems, damage plants and trees,

while fine particles in smog reduce visibility. Ozone is formed in the atmosphere by the reaction of VOCs and nitrogen oxides. Various consumer products, for example, fuel, solvents, paints and glues emit VOCs. VOCs in outdoor air come primarily from industrial processes and transportation. The Proposed Rule will reduce Ozone emissions by saving energy.

Nitrogen Oxides

NO2 is a precursor to acid rain as well as to ozone. The major source of human-made NO2 emissions is high-temperature combustion of fossil fuels. About 18 percent of NO2 emissions come from fuel combustion to produce electricity and 4 percent of emissions come from fuel consumption in buildings. The remainder is mainly from the transportation and industrial sectors. The Proposed Rule is expected to reduce NO2 emissions.

Carbon Monoxide

The main source of CO is the incomplete burning of fossil fuels such as gasoline. Vehicles exhaust contributes about 50 percent of all CO emissions. The CO produced from energy use related to buildings is about 4 percent of all CO emissions. Most of this is from wood burning in residential buildings, which should not be impacted by the Proposed Rule.

Particulate Matter

Particulate matter is a general term used for a mixture of solid particles and liquid droplets found in air. Particulate matter can cause or exacerbate respiratory problems and reduce visibility. These particles come in a wide range of sizes and originate from many human-made and natural sources. Particles less than 2.5 micrometers are known as "fine" particles. Those larger than 2.5 micrometers are known as "coarse" particles. Fuel combustion generates "fine" particles. Most particulate matter comes from roads (particularly unpaved roads), agriculture, and fires. The particulate matter emitted from energy use related to buildings is only about 3 percent for course particles and 6 percent for fine particles of all U.S. emissions. Most of this is from wood burning in residential buildings, which should not be impacted by the Proposed Rule.

Sulfur Dioxide

As with most of the other emissions, SO2 can cause respiratory problems, including breathing problems and damage to the lungs. SO2, along with nitrogen oxides, causes acid rain. SO2 is formed when fuel containing sulfur is burned. Coal is the primary fuel that produces SO2. Sixty-six percent of all SO2 emissions come from fuel used in electricity production. About 5 percent of SO2 emissions come from direct use of coal and oil in buildings. The Proposed Rule is expected to reduce SO2 emissions by saving energy.

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 about 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. However, the Proposed Rule is expected to reduce Lead emissions by saving energy.

3.3 Environmental Justice

Consideration of Environmental Justice is made pursuant to Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." 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. The Proposed Rule does 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 populations.

3.4 Other Impacts

The Proposed Rule will have no significant impact on any sensitive environmental resources such as wetlands, endangered species, or historic or archaeological sites. In addition, there is no aspect of the Proposed Rule that could be affected by a terrorist act.

4 CALCULATING ENERGY SAVINGS BY BUILDING TYPE

4.1 Commercial and High-Rise Multi-Family Residential Buildings

In order to determine emissions reductions estimates for the Proposed Rule, it was necessary to compare energy use of buildings meeting the fossil fuel reduction requirement to buildings meeting the no action alternative. The Proposed Rule was compared with two baselines; buildings meeting Standard 90.1-2004 and buildings that exceed Standard 90.1-2004. The baseline consumption levels were determined with Energy Plus simulations perfumed by Pacific Northwest National Laboratory. A weighted average of fifteen climate zones was used to compute national energy use for each building type. Assumptions used in this analysis are described below.

4.2 Commercial Building Types Used to Estimate Energy Savings

Since building energy use and savings vary by building type, a weighted average of the energy savings for each building type was used. The weights used for each building type were proportional to annual new square footage for a given building type. Detailed data on square footage of new Federal buildings proved difficult to obtain. However, GSA data was used to approximate the new construction for each building type (GSA 2008, GSA 2009). Building types which increased in total square footage in FY 07 or FY 08 were assumed to be the only categories in which new construction occurred (note that if more buildings were disposed of than constructed, that building type was not

counted). This method suggests that during FY 07 and FY 08, the Federal government built an estimated 30 million new square feet per year. Since it is difficult to define typical characteristics of certain types of building (laboratories, for example), some building types were not used in this analysis. New Federal construction was assumed to have the following building type distribution:

- Office - 54%
- Education - 23%
- Dormitory/Barracks - 23%

Table 2 compares the nationally-averaged energy use intensity (EUI) for the Proposed Rule reduction requirements with Standard 90.1-2004 and a level of efficiency 30% below Standard 90.1-2004. EUI is the energy consumed by a building per square foot per year. Site energy includes energy used only at the building site.

Source energy includes energy used at the building site and energy lost in producing and delivering the energy to the site (for electricity). The total source EUIs for the combined average building indicates the total energy averaged across the building types using the percent distribution given above.

Table 2 Comparison of Simulated EUIs by Fuel Type (Commercial)

Code or Standard	**Site Energy Breakdown**		**Total**	
	Gas EUI (kBtu/ft^2-yr)	**Electric EUI (kBtu/ft^2-yr)**	**Site EUI (kBtu/ft^2-yr)**	**Source EUI (kBtu/ft^2-yr)**

Combined Average Building				
Standard 90.1-2004	13.0	40.6	53.6	139.9
30% below Standard 90.1-2004	9.1	32.5	41.6	110.8
CBECS	39.3	49.1	88.4	192.6
55% below CBECS	17.7	22.1	39.8	86.7
65% below CBECS	13.8	17.2	30.9	67.4
80% below CBECS	7.9	9.8	17.7	38.5
90% below CBECS	3.9	4.9	8.8	19.3
100% below CBECS	0.0	0.0	0.0	0.0
Note: Lower EUIs indicate lower energy usage.				

4.3 Low-Rise Residential Buildings

Under the Proposed Rule, outdoor air emissions from new Federal residential low-rise buildings are expected to decrease. However, since the Proposed Rule only pertains to buildings that cost over $2.5 million, very few residential buildings will be affected. Furthermore, finding reliable data on this building type proved difficult. As such, the outdoor air environmental impacts of new Federal residential buildings were assumed to be insignificant relative to new commercial buildings and were not included in this analysis.

5 ENVIRONMENTAL IMPACTS

5.1 Commercial and High-Rise Multi-Family Residential

This section provides the potential environmental impacts that may result from implementing the Proposed Rule, which is evaluated at each of the fossil fuel percentage reduction requirements. These values are then compared to the no-action alternatives. The improved energy efficiency of the Proposed Rule would reduce the use of fossil fuels, and therefore would reduce air emissions.

5.1.1 Building Habitability (Indoor Air) Impacts

The Proposed Rule is not expected to have any impact on indoor air quality relative to the no-action alternatives, as the changes between the codes do not alter ventilation rates or sources of indoor emissions. This does not imply that a potential for health-related problems does not or will not exist in new Federal commercial buildings. The Proposed Rule does not address the potential for indoor air quality-related health problems, such as "sick-building syndrome." Sick-building syndrome can result from insufficient building air exchange. For example, if the ventilation system that brings in fresh outside air breaks down, the air will get stale and occupants in the building may get sick. The Proposed Rule does not impact exactly how a building is operated (e.g., how a ventilation system is controlled) nor does it impact materials (e.g., type of paint used, or if occupants are exposed to fumes from painting) used in the buildings. The Proposed Rule and the no-action alternatives do not have any requirements specifically for radon control or control of other indoor air emissions. As noted in Table 1, “ radon is much less

of a concern in commercial buildings than in residential buildings, as 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." DOE has previously consulted with the U.S. Environmental Protection Agency (EPA) on the issue of radon in commercial buildings and determined that radon standards are not applicable to commercial and high-rise multi-family residential buildings.

5.1.2 Outdoor Air

In general, under all the alternatives examined in this EA, greenhouse gas emissions (carbon dioxide, methane, nitrous oxides, and halocarbons) are reduced because more energy efficient buildings consume less fossil fuel. Table 3 shows the estimated reductions of greenhouse gas emissions resulting from the Proposed Rule, as compared to the Standard 90.1-2004 and 30% below 90.1-2004 baselines. These are the estimated annual savings from one year of Federal building construction for the various fossil fuel reduction requirements.

Electricity used in Federal commercial buildings is ultimately assumed to have the same mix of fuel/energy sources (e.g., coal, nuclear) as overall national electricity production. This mix was obtained from the Energy Information Administration (DOE 2010). Reductions in CO2 emissions from electricity were calculated by scaling the national CO2 emissions from electric power generation by the percentage savings in national electricity use. CO2 emissions reductions from natural gas were calculated using emissions coefficients from Table B1 of DOE's report on emissions of

greenhouse gases (DOE 2001). Similarly, reductions in the release of methane were obtained by scaling the total national emissions by the percentage savings in total national energy use (by fuel type) resulting from the Proposed Rule.

In Table 3, below, reductions in CO2 and methane are in metric tons of carbon and methane, respectively. Because the energy used in Federal building sector is not a substantial source of nitrous oxide or halocarbons, the impact of the Proposed Rule for these two gases is negligible. The reductions in greenhouse gas emissions will accumulate in the future as more and more Federal commercial buildings are built, and as the fossil fuel reduction requirement increases.

Table 3 First-Year Greenhouse Gas Emissions Reductions in Metric Tons (For One Year of New Construction)

	Percentage Reduction	**Carbon Dioxide**	**Methane**	**Nitrous Oxide or Halocarbons**
Savings of Proposed Rule Reduction Targets vs. ASHRAE 90.1-2004 (no-action one)	55%	93,600	198	Negligible
	65%	118,300	250	
	80%	155,500	328	
	90%	180,200	381	
	100%	205,000	433	
Savings of Proposed Rule Reduction Targets vs. 30% below ASHRAE 90.1-2004 (no-action two)	55%	52,700	111	Negligible
	65%	77,500	164	
	80%	114,600	242	
	90%	139,400	294	
	100%	164,200	347	

Note that these savings are for one year of new construction at the current rate and are not cumulative. As the Proposed Rule takes effect, the type and quantity of buildings that the Federal government constructs will likely change significantly. As such, it is difficult to predict the cumulative savings of the Proposed Rule.

Estimated savings in criteria emissions as a result of the Proposed Rule are shown in Table 4. The savings represent the annual savings from one year of Federal commercial building construction; these savings will accumulate in the future as more and more Federal buildings are built. Total pollutant emissions in the United States were obtained from the National Emissions Inventory (EPA 2008). The improved energy efficiency of the Proposed Rule will reduce the use of coal and other fossil fuels to produce energy and therefore will reduce emissions of nitrogen oxides and sulfur dioxide. The Proposed Rule is assumed to have a negligible effect on emissions other than nitrogen oxides and sulfur dioxide because the energy use associated with buildings contributes only a small fraction of the emissions. The savings in air pollutant emissions will accumulate in the future as more Federal commercial buildings are built.

Table 4 First-Year Outdoor Pollutant Emissions Reductions in Metric Tons (For One Year of New Construction)

	Percentage Reduction	**Nitrogen Oxides**	**Sulfur Dioxide**	**Carbon Monoxide, Particulate Matter, or Lead**
Savings of Proposed Rule Reduction Targets vs. ASHRAE 90.1-2004 (no-action one)	55%	102.7	269	Negligible
	65%	134.6	340	
	80%	182.3	446	
	90%	214.2	518	
	100%	246.1	589	
Savings of Proposed	55%	53	151	Negligible

Rule Reduction Targets vs. 30% below ASHRAE 90.1-2004 (no-action two)	65%	84	223	
	80%	132	329	
	90%	164	400	
	100%	196	471	

Again, these savings are for one year of new construction at the current rate and are not cumulative. It is difficult to predict the total cumulative savings of the Proposed Rule.

6 PERSONS/AGENCIES CONSULTED DURING THIS RULEMAKING

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

DOE and Contractor Staff

- U.S. DOE Federal Energy Management Program - Cyrus Nasseri and Matt Gray
- Pacific Northwest National Laboratory (DOE contractor) - Mark Halverson, John Kaufman, James Hand, David Winiarski, Robert Lucas.

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