Environmental Assessment for Direct Final Rule, 10 CFR 433, "Energy Efficiency Standards for New Federal Commercial and High-Rise Multi-Family Residential Buildings" and 10 CFR 435, "Energy Efficiency Standards for New Federal Residential Low-Rise Residential Buildings" Baseline Standards Update (DOE/EA-1872)

DRAFT – February 22, 2011

Environmental Assessment for Direct Final Rule, 10 CFR 433, "Energy Efficiency Standards for New Federal Commercial and High-Rise Multi-Family Residential Buildings" and 10 CFR 435, "Energy Efficiency Standards for New Federal Residential Low-Rise Residential Buildings" Baseline Standards Update (DOE/EA-1872)

SUMMARY

The U.S. Department of Energy (DOE) has prepared this Environmental Assessment (EA) for DOE's Direct Final Rule, 10 CFR 433, "Energy Efficiency Standards for New Federal Commercial and High-Rise Multi-Family Residential Buildings" and 10 CFR 435, "Energy Efficiency Standards for New Federal Residential Low-Rise Residential Buildings" Baseline Standards Update. The direct final rule updates the baseline standards in 10 CFR 433 and 10 CFR 435 to the latest private sector standards based on the cost-effectiveness of the latest private sector standards and DOE's determination that energy efficiency has been improved in these codes as required by 42 U.S.C 6831 et seq. DOE is issuing its final determinations on American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)/Illuminating Engineering Society of North America (IESNA) Standard 90.1-2007 (ASHRAE 2007) and the International Code Council's 2009 International Energy Conservation Code (IECC) in the same edition of the Federal Register as this direct final rule.

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 high-rise multi-family residential buildings and low-rise residential buildings. EPCA requires DOE to establish by rule revised Federal building energy efficiency performance standards. (42 U.S.C. 6834(a)(3)(A)) The revised standards must require, in part, that new Federal buildings be designed to achieve energy consumption levels that are at least 30 percent below the minimum standards referenced in section 305(a)(2), if life-cycle cost-effective. These reference standards are the 2004 IECC for low-rise residential buildings and the ANSI/ASHRAE/IESNA Standard 90.1-2004 for commercial and multi-family high-rise buildings. (42 U.S.C. 6834(a)(3)(A)(i)) In general, life-cycle cost-effective means the savings associated with the improved efficiency are greater than the associated costs. See 10 CFR Part 436.

ECPA also requires that not later than 1 year after the date of approval of each subsequent revision of the ASHRAE Standard or the IECC, 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)) This direct final rule is the result of DOE's determination that the revised standards should be updated to reflect the amendments made in ASHRAE Standard 90.1-2007 and the 2009 IECC.

DOE has previously issued standards for all new Federal commercial and high-rise multi-family residential (over three stories in height above ground) buildings and all

new low-rise residential buildings pursuant to the requirements of ECPA, as revised by the Energy Policy Act (EPAct) of 2005. This rulemaking updates the current rule for commercial and high-rise multi-family residential buildings, 10 CFR 433 "Energy Efficiency Standards for New Federal Commercial and High-Rise Multi-Family Residential Buildings," to replace ASHRAE Standard 90.1-2004 with the more stringent ASHRAE Standard 90.1-2007, incorporated by reference. With regard to low-rise residential buildings, this rulemaking updates 10 CFR 435 Subpart A, "Energy Efficiency Standards for New Federal Residential Low-Rise Residential Buildings," to replace the IECC 2004 by the more stringent IECC 2009, incorporated by reference. Today's direct final rule makes no other changes to the Federal Building Energy Efficiency and Sustainable Design Standards.

DOE reviewed ASHRAE Standard 90.1-2007 and the 2009 IECC for its state building codes program and determined that the 2007 version of ASHRE Standard 90.1 and the 2009 version of IECC, would achieve greater energy efficiency than their respective prior versions. These determinations were subject to notice and comment. See 75 FR 54117 (September 3, 2010) and 75 FR 54131 (September 3, 2010). The final determinations for both Standard 90.1-2007 and the 2009 IECC are published in this edition of the Federal Register.

The EA examines the potential incremental environmental impacts of the Direct Final Rule on building habitability and the outdoor environment. To identify the potential environmental impacts that may result from implementing the Final Rule for new Federal commercial and residential buildings, DOE compared the Direct Final Rule with the "no-action alternative" of using the minimum requirements of the previous versions of the Federal standards – 10 CFR Part 433 and 10 CFR Part 435 Subpart A (referred to as the "no-action alternative").

Building Habitability (Indoor Air) Impacts

The rule does not change mechanical ventilation rates or affect sources of indoor air pollutants from the no-action alternative. For commercial and high-rise multi-family residential buildings, ASHRAE Standard 90.1-2007 does not require specific mechanical ventilation rates and the rule does not require any changes in mechanical ventilation rates. The rule 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 Final Rule. For residential buildings, the changes between the codes do not affect sources of indoor emissions. 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 new Federal buildings, the rule is expected to reduce outdoor emissions primarily by reducing consumption of fossil fuels. The reduction in the amount of energy that would otherwise be consumed by these buildings under the Final Rule depends on the cost-effective level of energy efficiency achieved by the agencies. For purposes of this EA, DOE considers new construction that meets ASHRAE Standard 90.1-2007, as well as construction that exceeds the Standard by 10 percent, 20 percent, 30 percent, 40 percent, and 50 percent. DOE then compares the energy consumption of these six levels to ASHRAE Standard 90.1-2004. Although 90.1-2004 was the minimum requirement, buildings were also required to exceed the Standard by up to 30% if life-cycle cost-effective, so the Final Rule was compared to an energy efficiency level 30% better than 90.1-2004 as well.

Assuming that new Federal buildings meet but do not exceed the new minimum requirement and that buildings would have otherwise met but not exceeded the existing requirement, carbon dioxide emissions avoided (relative to a building meeting minimum requirements of the previous standard, ASHRAE Standard 90.1-2004) are expected to be 6,200 metric tons. This emission reduction is for the first year the Final Rule is in effect, with the savings compounding in future years as more Federal construction occurs. Methane emissions avoided are expected to be 24 metric tons in the first year the Final Rule is in effect. Nitrogen oxide emissions avoided are expected to be 6 metric tons in the first year the rule is in effect, while the sulfur dioxide emissions avoided are expected to be 14 metric tons.

For low-rise residential buildings subject to the requirement of the Final Rule, the Federal government is estimated to construct about 2000 housing units annually. (See Section 5.2.2 for an explanation of this estimate.) Similar to the commercial rule, energy savings of the minimum requirement as well as 10 percent, 20 percent, 30 percent, 40 percent, and 50 percent below the energy consumption level of the new baseline code (the 2009 IECC) are examined here. These consumption levels are compared to the existing minimum requirement, the 2004 IECC, as well as a consumption level 30 percent below the 2004 IECC. Assuming that buildings meet the minimum requirements in the 2009 IECC, carbon dioxide emissions avoided (relative to a buildings meeting minimum requirements in the 2004 IECC) are expected to be 3,600 metric tons in the first year. Avoided methane emissions are expected to equal 22 metric tons in the first year. Avoided nitrogen oxide emissions are expected to be about 1 ton in the first year the rule is in effect and avoided sulfur dioxide emissions are expected to be 2 tons.

Other Impacts

The Final 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 Final Rule is not expected to have any adverse impacts on sensitive environmental resources, such as wetlands, endangered species, or historic or archaeological sites, and would not be affected by a terrorist act.

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
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CO_2	carbon dioxide
CO	carbon monoxide
DOE	Department of Energy
EPA	Environmental Protection Agency
EUI	Energy use intensity, kBtu/ft2-yr
FR	Federal Register
HVAC	Heating, ventilation, and air conditioning
HFC	hydrofluorocarbon
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
NEPA	National Environmental Policy Act of 1969
New building	a building that has never been in service
NO_2	nitrogen dioxide
PFC	perfluorocarbon
SF_6	sulfur hexafluoride
SO_2	sulfur dioxide
TSD	Technical support document
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 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 1 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))

On December 4, 2006, the Department issued an interim final rule establishing energy conservation standards for new Federal commercial and multi-family high rise residential buildings (10 CFR part 433) and new Federal low-rise residential buildings (10 CFR part 435, subpart A). 71 FR 70275. On December 21, 2007 DOE issued a final rule to adopt with changes the interim final rule. 72 FR 72570 Today's direct final rule is the result of DOE's determination that the revised standards should be updated to reflect the amendments made in the ASHRAE Standard 90.1-2007 and the 2009 IECC based on the cost-effectiveness of the latest private sector standards and DOE's determinations as to the energy efficiency improvements of the 2009 version of the IECC and ANSI/ASHRAE/IESNA Standard 90.1-2007 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 determinations for Standard 90.1-2007 and the 2009 IECC were published in the Federal Register on September 3, 2010 (75 FR 54117 and 75 FR 54131). The final determinations for both Standard 90.1-2007 and the 2009 IECC are published in the same edition of the Federal Register as the notice for this direct final rule.

2 THE FINAL RULE AND ALTERNATIVES

Section 2.1 describes the Final Rule and the no-action alternatives for commercial and high-rise multi-family residential buildings. Section 2.2 describes the Final Rule and the no-action alternatives for low-rise residential buildings.

2.1 Commercial and High-Rise Multi-Family Residential Buildings

The potential environmental impacts that would result from implementing the Final Rule for new Federal commercial and high-rise multi-family residential (over three stories in height above ground) buildings were examined by comparing the Final Rule with the minimum that Federal agencies must achieve under the existing 10 CFR 433, ASHRAE Standard 90.1-2004. The Final Rule was also compared with a level of energy efficiency 30% better than Standard 90.1-2004, because the existing 10 CFR 433 requires buildings to be at least 30% better than Standard 90.1-2004 if life-cycle cost-effective. It is worth pointing out that for buildings where it is cost-effective to exceed Standard 90.1-2007 this update to the rule may have no impact on improving energy efficiency. This is because both the previous and the updated rule requires building to cost-effective levels of energy efficiency and the underlying update from 90.1-2004 to 90.1-2007 has no impact on cost-effectiveness of energy efficiency improvements.

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

The proposed action is the Direct Final Rule, which would update the baseline standard to ASHRAE Standard 90.1-2007.

2.1.2 "No-Action" Alternative One – Standard 90.1-2004

The first no-action alternative is defined as the use of Standard 90.1-2004, as required by the current 10 CFR Part 433. This standard establishes the minimum level of energy savings that Federal agencies should achieve under the new Federal commercial standard. Section 305(a)(1) of ECPA 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.

2.1.3 "No-Action" Alternative Two- 30% Better than Standard 90.1-2004

The second no-action alternative is defined as a level of energy efficiency 30% better than Standard 90.1-2004. Although the second no-action alternative is not explicitly required, 10 CFR Part 433 does require new Federal buildings achieve a level of energy consumption 30% below Standard 90.1-2004 if that level is life-cycle cost-effective.

2.2 Low-Rise Residential Buildings

The potential environmental impacts that would result from implementing the Final Rule for new Federal low-rise residential buildings (three stories or less in height above ground) were examined by comparing the Final Rule with the minimum that Federal agencies must achieve under existing 10 CFR 435, IECC 2004. The Final Rule was also compared with a level of energy efficiency 30% better than the 2004 IECC, because buildings are required to be at least 30% better than the 2004 IECC if life-cycle cost-effective. This update to the rule may have no impact on improving energy efficiency for some buildings for the reasons discussed in Section 2.1.

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

The proposed action is the Direct Final Rule, which would update the baseline standard to the 2009 IECC.

2.2.2 "No-Action" Alternative One–The 2004 IECC

The first no-action alternative is defined as the use of the 2004 IECC, as required by the current 10 CFR Part 435. This standard sets the minimum level of energy savings that Federal agencies must achieve under the new Federal low-rise residential building standard. It sets energy efficiency requirements for building envelope; heating, ventilation, and air-conditioning (HVAC) systems; and domestic water-heating systems.

2.2.3 "No-Action" Alternative Two- The 2004 IECC

The second no-action alternative is defined as a level of energy efficiency 30% better than the 2004 IECC. Although the second no-action alternative is not explicitly required, 10 CFR Part 435 does require new Federal buildings achieve a level of energy consumption 30% below the 2004-IECC.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The Final Rule contains requirements that could have some impact on building habitability (indoor environment), the outdoor environment, the nation's economy, and the Federal agencies that procure commercial and residential buildings. Section 3.1 touches on 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 reduces indoor-generated pollutant concentration levels. This rulemaking will not change ventilation or infiltration relative to the no-action alternatives for either commercial or 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. The Final Rules are not expected to change pollutant rates from indoor sources of air pollution compared to the no-action alternative. (DOE will be issuing a subsequent rulemaking that addresses the requirement for use of sustainable design principles in siting, design, and construction of new Federal buildings and this rule may reasonably be assumed to address pollutant 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 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 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, 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 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).

Table 1. (continued)		
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 heath 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

The Final 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

Unless otherwise noted, all the information on greenhouse gases presented below is from the DOE report entitled, “Emissions of Greenhouse Gases in the United States” (DOE 2006). The gases in the Earth's atmosphere that trap the Sun's heat are referred to as "greenhouse gases." Most greenhouse gases occur naturally, with the most important being water vapor and carbon dioxide. Scientists have discovered that the concentration of greenhouse gases, including carbon dioxide, methane, and nitrous oxide, is increasing—more of these gases are being emitted than absorbed. Anthropogenic (human-made) emissions occur in addition to natural emissions. The U.S. government has agreed to (but not ratified) the Kyoto Protocol goal to reduce carbon emissions in the year 2010 to levels below 1990 emissions. Executive Order 13423 “Strengthening Federal Environmental, Energy, and Transportation Management” directs Federal agencies to “a) improve energy efficiency and reduce greenhouse gas emissions of the agency, through reduction of energy intensity by (i) 3 percent annually through the end of fiscal year 2015, or (ii) 30 percent by the end of fiscal year 2015, relative to the baseline of the agency's energy use in fiscal year 2003.” (72 FR 3919, Signed January 24, 2007.) The Final Rule will help reduce greenhouse gas emissions by saving energy.

The impacts presented in Section 5.0 are focused on human-made emissions and specifically those in the United States. Eighty-two percent of U.S. greenhouse gas emissions result from the combustion of fossil fuels such as coal, petroleum, and natural gas. Consequently, U.S. emissions are strongly tied to fossil energy consumption. Other greenhouse gas emissions include methane, nitrous oxide, and other gases.

Carbon Dioxide

CO_2 is by far the most common greenhouse gas emitted. More than 98 percent of U.S. CO_2 emissions can be traced to the combustion of fossil fuels. The commercial sector (as defined by DOE [2005], including all commercial buildings, not just Federal buildings) contributes an 18-percent share of U.S. CO_2 emissions. Seventy-eight percent of the commercial-sector CO_2 emissions are associated with the production of electric power used in the sector. Sixteen percent of the commercial-sector CO_2 emissions are from natural gas (used directly in buildings), with the remaining 5 percent mainly from petroleum products. The residential sector contributes a 21 percent share of U.S. CO_2 emissions. Twenty-one percent of the residential-sector CO_2 emissions are from natural gas (used directly in buildings), with 8 percent from petroleum products. Coal by far produces the largest share of the carbon emissions from electricity generation. Coal produces about 98 percent more carbon emissions than natural gas per unit of energy produced (http://www.epa.gov/solar/emissions.htm).

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) 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 56 percent of the energy source emissions (or 25 percent of all methane emissions).

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.

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 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 chlorofluoro-carbons (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 contribute a very minor amount of emissions of these greenhouse gases.

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 emissions (also referred to as "criteria pollutants"): ozone, NO_2, CO, particulate matter, SO_2, and lead. More information on these emissions is presented below. All of the following information on air emissions is from 2006 EPA data (EPA 2007) unless identified otherwise.

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.

Nitrogen Oxides

NO_2 is a precursor to acid rain as well as to ozone. The major source of human-made NO_2 emissions is high-temperature combustion of fossil fuels. About 20 percent of 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.

Carbon Monoxide

The main source of CO is the incomplete burning of fossil fuels such as gasoline. Exhaust from 'highway vehicles' contributes about 55 percent of all CO emissions. The CO produced from energy use related to buildings is 3 percent of all emissions, but most of this is from wood burning in residential buildings, which should not be impacted by these rules. 0.7% of CO emissions come from fuel combustion for electrical generation by utilities.

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. 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 7 percent for fine particles of all U.S. emissions. Most of this is from wood burning in residential buildings (EPA 2001).

Sulfur Dioxide

As with most of the other emissions, SO_2 can cause respiratory problems, including breathing problems and damage to the lungs. SO_2, along with nitrogen oxides, causes acid rain. SO_2 is formed when fuel containing sulfur is burned. Coal is the primary fuel that produces SO_2. Coal burned by electric utilities produces 70 percent of all SO_2 emissions. About 4 percent of SO_2 emissions come from direct use of coal and oil in buildings.

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).

4 CALCULATING ENERGY SAVINGS BY BUILDING TYPE

4.1 Commercial and High-Rise Multi-Family Residential Buildings

To compare estimated outdoor emissions, it is necessary to determine differences in building energy use by fuel type for Final Rule and the two no-action alternatives. In addition, five potential savings levels associated with the Final Rule were evaluated. The Direct Final Rule energy savings were assessed for five common buildings types in 15 cities, representing 15 climate regions within the United States. Energy savings from the Final Rule were estimated using the EnergyPlus whole building energy simulation program (DOE 2010b). Assumptions used in this analysis are described below.

4.1.1 Commercial Building Types Used to Estimate Energy Savings

GSA data was used to find the distribution of existing Federal buildings (GSA 2008, GSA 2009). 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 following distribution was used for new Federal construction:

- 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. 40 million square feet of new Federal buildings are assumed to be constructed each year.

Table 2 shows the national average energy savings in terms of energy use intensity (EUI) from the Final Rule by building and fuel type. 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. 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 EUI savings for the combined average building indicates the total energy savings averaged across the five building types using the percent distribution given above.

Table 2 Annual Energy Savings (kBtu/ft^2-yr) of Final Rule Compared to No-Action Alternative

Baseline (no-action alternative)	Final Rule- 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)
ASHRAE 90.1-2004	90.1-2007	0.6	0.7	1.3	2.8
	10% below 90.1-2007	1.5	4.3	5.8	15.1
	20% below 90.1-2007	2.4	8	10.4	27.7
	30% below 90.1-2007	3.3	11.6	14.9	40
	40% below 90.1-2007	4.2	15.2	19.4	52.2
	50% below 90.1-2007	5.1	18.9	24	64.8
30% Below ASHRAE 90.1-2004	30% below 90.1-2007	0.4	0.5	0.9	2
	40% below 90.1-2007	1.3	4.1	5.4	14.3
	50% below 90.1-2007	2.2	7.8	10	26.8

4.2 Low-Rise Residential Buildings

Energy savings for the Final Rule were estimated using the DOE-2 energy simulation software to determine the energy savings.

4.2.1 Residential Building Used to Estimate Energy Savings

The prototype building used in the energy simulations is intended to approximate a typical new house. The prototype characteristics used were:

- A rectangular two-story house, 30 ft. by 40 ft., with 2400 ft^2 of conditioned floor area.
- Window area of 15 percent of the conditioned floor.
- The heating system consisted of a gas furnace and cooling that is via central air conditioning with an air ducted system. Domestic water heating is assumed to be from natural gas.
- Foundation: Slab-on-grade in southern climates and crawlspace in northern climates.

This analysis included simulations of the 97 locations encompassing all regions and climates in the U.S. These results are combined into a weighted national average.

Table 3 shows the national average annual energy savings from the Direct Final Rule compared to the 2004 IECC baseline and a level of consumption 30 percent below the 2004 baseline. Source energy includes energy used at the building site and energy lost in producing and delivering the energy to the site for electricity (DOE 2006). The source energy impacts are used to estimate emission reductions.

Table 3 Annual Energy Savings (kBtu/ft^2-year) of Final Rule Compared to No-Action Alternative

Baseline (no-action alternative)	Final Rule- 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)
IECC-2004	IECC-2009	11.5	0.8	12.3	14
	10% below IECC-2009	20.6	1.3	21.9	24.7
	20% below IECC-2009	29.7	1.8	31.5	35.5
	30% below IECC-2009	38.8	2.3	41.2	46.2
	40% below IECC-2009	47.9	2.8	50.8	56.9
	50% below IECC-2009	57.1	3.4	60.4	67.6
30% Below IECC-2004	30% below IECC-2009	8.1	0.6	8.6	9.8
	40% below IECC-2009	17.2	1.1	18.2	20.5
	50% below IECC-2009	26.3	1.6	27.9	31.3

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 Final Rule, which is evaluated at the ASHRAE Standard 90.1-2007 level as well as increments of 10 percent increases in energy efficiency, up to 50 percent better than 90.1-2007. These values are then compared to the no-action alternatives, which are ASHRAE Standard 90.1-2004 and 30% below 90.1-2004.

5.1.1 Building Habitability (Indoor Air) Impacts

The Final 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 Final 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 Final 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 Final 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.”

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 fuels that create greenhouse gases. The emissions reductions described in this section represent the annual savings from only one year of Federal commercial building construction (40 million ft^2); these savings will accumulate in the future as more and more Federal buildings are built.

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. This distribution was obtained from the Monthly Energy Review (DOE 2010a). Reductions in CO_2 emissions were calculated by multiplying the total fuel (coal, natural gas, and oil) savings from the Final Rule by emission coefficients for each fuel. The emissions coefficients were calculated using data from the Annual Energy Review (DOE 2009). Reduction in the release of methane attributable to energy

use was obtained by scaling the total national emissions by the percentage savings in total national energy use (by fuel type) resulting from the Final Rule.

Table 4 shows the estimated first-year reduction in greenhouse gas emissions. Because the energy used in Federal building sector is not a substantial source of nitrous oxide or halocarbons, the impacts of the Final Rule for these two gases are negligible. The reductions in greenhouse gas emissions will accumulate in the future as more and more Federal commercial buildings are built.

Table 4 Savings in Annual Greenhouse Gas Emissions in Metric Tons (Year One of Commercial Construction)

Baseline (no-action alternative)	Final Rule- Code or Standard	Carbon Dioxide	Methane	Nitrous Oxide or Halocarbons
ASHRAE 90.1-2004	90.1-2007	6,200	24	Negligible
	10% below 90.1-2007	33,500	116	
	20% below 90.1-2007	60,800	208	
	30% below 90.1-2007	88,100	299	
	40% below 90.1-2007	115,500	391	
	50% below 90.1-2007	142,800	483	
30% Below ASHRAE 90.1-2004	30% below 90.1-2007	4,300	17	Negligible
	40% below 90.1-2007	31,600	109	
	50% below 90.1-2007	59,000	200	

For example, if buildings meet the new minimum requirement rather than the previous requirement (ASHRAE Standard 90.1-2007 versus 90.1-2004), an estimated 6,200 metric tons of carbon dioxide will be saved in the first year of the rule for the estimated 40 million ft^2 of new construction. These savings compare to 5,835 million metric tons of total carbon dioxide emissions for the U.S. in 2004 (DOE 2009), or only one ten-thousandth of one percent of the national total.

Estimated savings in criteria emissions as a result of the Final Rule are shown in Table 5. Total criteria pollutant emissions in the United States were obtained from the

National Emissions Inventory (EPA 2009). The improved energy efficiency of the Final 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 Final 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.

Table 5 Savings in Annual Outdoor Pollutant Emissions in Metric Tons (Year One of Commercial Construction)

Baseline (no-action alternative)	Final Rule-Code or Standard	Nitrogen Oxides	Sulfur Dioxide	Carbon Monoxide, Particulate Matter, Sulfur Dioxide, or Lead
ASHRAE 90.1-2004	90.1-2007	6	14	Negligible
	10% below 90.1-2007	35	87	
	20% below 90.1-2007	64	160	
	30% below 90.1-2007	93	233	
	40% below 90.1-2007	122	305	
	50% below 90.1-2007	151	378	
30% Below ASHRAE 90.1-2004	30% below 90.1-2007	4	10	Negligible
	40% below 90.1-2007	33	83	
	50% below 90.1-2007	62	155	

5.2 Low-Rise Residential

This section provides the potential environmental impacts that may result from implementing the Direct Final Rule for low-rise residential buildings. The Direct Final Rule is evaluated at the new minimum level, the 2009 IECC, as well as increments of 10 percent increases in energy efficiency, up to 50 percent better than the 2009 IECC. These values are then compared with the no-action alternatives.

5.2.1 Building Habitability (Indoor Air) Impacts

The Direct Final Rule is not expected to have any significant impact on indoor air quality relative to the no-action alternative. The changes between the codes do not affect sources of indoor emissions or air infiltration and ventilation. This does not imply that a potential for health-related problems does not or will not exist in new Federal residential buildings. The Direct Final Rule does not address the potential for indoor air quality-related health problems. The Direct Final Rule does not impact 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 Direct Final Rule and the no-action alternative do not have any requirements specifically for radon control or control of other indoor air emissions.

5.2.2 Outdoor Air

Under all the alternatives examined in this environmental assessment, greenhouse gas emissions (carbon dioxide, methane, nitrous oxides, and halocarbons) are reduced because more energy efficient buildings consume less fossil fuel, which results in reduced GHG emissions. Table 6 shows the estimated reductions of greenhouse gas emissions resulting from the Direct Final Rule. This is the annual energy savings from one year of Federal construction under the 10-percent, 20-percent, 30-percent, 40-percent, and 50-percent energy savings alternatives

Electricity production ultimately used in Federal residential buildings is assumed to have the same distribution of fuel/energy sources (e.g., coal, nuclear) as overall national electricity production. This distribution was obtained from the Monthly Energy Review (DOE 2010a). Reductions in CO_2 emissions were calculated by multiplying the total fuel (coal, natural gas, and oil) savings from the Final Rule by emission coefficients for each fuel. The emissions coefficients were calculated using data from the Annual Energy Review (DOE 2009). Reduction in the release of methane attributable to energy use was obtained by scaling the total national emissions by the percentage savings in total national energy use (by fuel type) resulting from the Direct Final Rule.

The amount of Federal residential low-rise construction that must comply with the requirements in the Direct Final Rule is not known. For the results shown in this report, DOE estimated that 2000 Federal housing units per year will be constructed with an estimated over 90 percent being built for the Department of Defense. This estimate is based on historical data obtained from the Department of Defense, which constructs the

large majority of all Federal housing. Federal construction rates in the future are not known. Because the energy used in Federal buildings is not a substantial source of nitrous oxide or and halocarbons, the impacts of the Final Rule for these two gases are negligible. The reductions in greenhouse gas emissions will accumulate in the future as more and more Federal residential buildings are built.

Table 6 Savings in Annual Greenhouse Gas Emissions in Metric Tons (Year One of Residential Construction)

Baseline (no-action alternative)	Final Rule- Code or Standard	Carbon Dioxide	Methane	Nitrous Oxide or Halocarbons
IECC-2004	IECC-2009	3,600	22	Negligible
	10% below IECC-2009	6,300	40	
	20% below IECC-2009	9,000	57	
	30% below IECC-2009	11,700	74	
	40% below IECC-2009	14,400	91	
	50% below IECC-2009	17,100	109	
30% Below IECC-2004	30% below IECC-2009	2,500	16	Negligible
	40% below IECC-2009	5,200	33	
	50% below IECC-2009	7,900	50	

For example, if buildings meet the new minimum requirement rather than the previous requirement (2009 IECC versus the 2004 IECC), an estimated 3,600 metric tons of carbon dioxide will be saved in the first year of the rule for the estimated 2,000 new residential units. These savings compare to 5,835 million metric tons of total carbon dioxide emissions for the U.S. in 2004 (DOE 2009), or less than one ten-thousandth of one percent of the national total. However, annual savings will increase each year as more Federal buildings are constructed. Alternatively, if buildings were already being designed to be 30% better than the 2004 IECC; those buildings could meet the new Standard without achieving any additional energy savings.

Total criteria pollutant emissions in the United States were obtained from the National Emissions Inventory (EPA 2009). The improved energy efficiency of the Direct Final 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 Direct Final 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.

Table 7 Savings in Annual Outdoor Pollutant Emissions in Metric Tons (Year One of Residential Construction)

Baseline (no-action alternative)	Final Rule- Code or Standard	Nitrogen Oxides	Sulfur Dioxide	Carbon Monoxide, Particulate Matter, Sulfur Dioxide, or Lead
IECC-2004	IECC-2009	0.8	1.9	Negligible
	10% below IECC-2009	1.3	3.2	
	20% below IECC-2009	1.7	4.4	
	30% below IECC-2009	2.2	5.6	
	40% below IECC-2009	2.7	6.8	
	50% below IECC-2009	3.2	8.1	
30% Below IECC-2004	30% below IECC-2009	0.5	1.3	Negligible
	40% below IECC-2009	1.0	2.6	
	50% below IECC-2009	1.5	3.8	

5.3 Environmental Justice and Other Impacts

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 F.R. 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. The Final Rule 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.

The Final Rule is not expected to impact any sensitive environmental resources such as wetlands, endangered species, or historic or archaeological sites. There are no aspects of the Final Rule that would be affected by a terrorist act.

6 AGENCIES AND PERSON CONSULTED DURING THIS RULEMAKING

In accordance with 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 DOE Federal Energy Management Program – Ronald Majette and Michael Erbesfeld

Pacific Northwest National Laboratory (DOE contractor) - Mark Halverson, Robert Lucas, Todd Taylor, and James Hand

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