CHAPTER 8. ENVIRONMENTAL ASSESSMENT

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CHAPTER 8. ENVIRONMENTAL ASSESSMENT

8.1 INTRODUCTION

This chapter describes potential environmental effects that may result from amended energy conservation standards for certain equipment covered by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)/Illuminating Engineering Society of North America (IESNA) Standard 90.1. Such equipment includes commercial packaged boilers and water-cooled and evaporatively-cooled commercial package air conditioners and heat pumps with a cooling capacity at or above 240,000 Btu/h and less than 760,000 Btu/h. DOE proposed standards for these two equipment types in a March 20, 2009 (74 FR 12000). This chapter only describes the potential environmental effects that may result from amended energy conservation standards for commercial packaged boilers. DOE did not analyze the environmental effects that may results from amended national energy conservation standards for water-cooled and evaporatively-cooled commercial package air conditioners and heat pumps with a cooling capacity at or above 240,000 Btu/h and less than 760,000 Btu/h because there is no equipment currently being manufactured in this equipment class.

The U.S. Department of Energy (DOE)'s proposed energy conservation standards are not site-specific, and would apply to all 50 States and U.S. territories. Therefore, none of the proposed standards would affect land uses, cause any direct disturbance to the land, or directly affect biological resources, or have any other impact on the human environment in any one area.

All of the potential standard levels analyzed are expected to reduce energy consumption in comparison to a baseline. For the purposes of this Environmental Assessment (EA), the baseline is defined as how much energy would be consumed if DOE adopts the efficiency levels in ASHRAE Standard 90.1-2007 for commercial boilers. The changes in the demand for fossil fuel, including fuel oil and natural gas, and the costs of achieving these savings are the primary drivers in analyzing environmental effects.

The primary, anticipated environmental impact of revised standard levels is on air quality and results from changes in fuel consumption for the equipment examined. Therefore, much of this chapter describes the air quality analysis. The latter part of the chapter describes potential impacts to other environmental resources.

8.2 AIR QUALITY ANALYSIS

The primary focus of the environmental analysis is the impact on air quality of amended energy conservation standards for commercial boilers. The outcomes of the environmental analysis are driven by changes in the quantities of fuel consumed under each of the alternatives.

8.3 AIR POLLUTANT DESCRIPTIONS

An air pollutant is any substance in the air that can cause harm to humans or the environment. Pollutants may be natural or man-made (*i.e.*, anthropogenic) and may take the form of solid particles (*i.e.*, particulates or particulate matter), liquid droplets, or gases.[a] For each of the efficiency standards examined in this analysis, DOE calculated total emissions using emission coefficients or ratios relating the amount of a particular pollutant emitted per unit of source energy consumed. This analysis considers three pollutants: nitrogen oxides (NO_x), sulfur dioxide (SO_2), and carbon dioxide (CO_2). A fourth pollutant, mercury (Hg), is emitted in such small amounts that analysis of Hg in this EA would be uninformative; as such, DOE does not discuss Hg emissions in this EA.

Sulfur Dioxide

Sulfur dioxide is a chemical compound that is produced by various natural and industrial processes and is key contributor to acid rain. Moreover, sulfur dioxide has been shown to impair human health. In addressing SO_2 emissions, the Clean Air Act Amendments of 1990 set an SO_2 emissions cap on all power generation, but permitted flexibility among generators through the use of emissions allowances and tradable permits. This SO_2 trading process (sometimes called "cap and trade") does not, however, cover commercial packaged boilers. Consequently, there is a direct SO_2 environmental benefit from a reduction in fuel consumption resulting from the proposed higher efficiency standards for commercial packaged boilers.

Nitrogen Oxides

Nitrogen oxides, or NO_x, are the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colorless and odorless. However, one common pollutant, nitrogen dioxide (NO_2), along with particles in the air, can often be seen as a reddish-brown layer over many urban areas. NO_2 is the specific form of NO_x reported in this document. NO_x is one of the main ingredients involved in the formation of ground-level ozone, which can trigger serious respiratory problems. It can contribute to the formation of acid rain, and can impair visibility in areas such as national parks. NO_x also contributes to the formation of fine particles that can impair human health.

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

Carbon Dioxide

Carbon dioxide (CO_2) is not a regulated or criteria pollutant (see below), but it is of interest because of its classification as a greenhouse gas (GHG) and its impact on global climate change. GHGs trap the sun's radiation inside the Earth's atmosphere and either occur naturally in the atmosphere or result from human activities. Naturally-occurring GHGs include water vapor, CO_2, methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Human activities, however, add to the levels of most of these naturally-occurring gases. For example, CO_2 is emitted to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), wood, and wood products are burned.

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[a] More information on air pollution characteristics and regulations is available on the U.S. Environmental Protection Agency (EPA)'s website at www.epa.gov.

During the past 20 years, about three-quarters of anthropogenic (*i.e.*, human-made) CO_2 emissions resulted from burning fossil fuels.

Concentrations of CO_2 in the atmosphere are naturally regulated by numerous processes, collectively known as the "carbon cycle." The movement of carbon between the atmosphere and the land and oceans is dominated by natural processes, such as plant photosynthesis. While these natural processes can absorb some of the anthropogenic CO_2 emissions produced each year, billions of metric tons are added to the atmosphere annually. The Earth's imbalance between emissions and absorption results in the continuing growth of GHGs in the atmosphere, causing surface air temperatures and sub-surface ocean temperatures to rise. In the United States, CO_2 emissions account for 85.4 percent of total U.S. GHG emissions.[1]

8.4 AIR QUALITY REGULATIONS

DOE prepared this EA pursuant to the National Environmental Policy Act of 1969—also known as NEPA (42 U.S.C. 4321 *et seq*.) —the regulations of the Council on Environmental Quality (40 CFR parts 1500-1508), and DOE's regulations for compliance with NEPA (10 CFR part 1021). This EA assesses environmental impacts from alternate standard levels analyzed for commercial packaged boilers based on the results of the national energy savings analysis (see chapter 7). Standards for water-cooled and evaporatively-cooled commercial package air conditioners and heat pumps with a cooling capacity at or above 240,000 Btu/h and less than 760,000 Btu/h were also considered in this rule; however, since no products could be identified on the market in this class, no subsequent energy or environmental impacts were considered in this EA.

By way of background, title III of the Energy Policy and Conservation Act (EPCA) sets forth a variety of provisions designed to improve energy efficiency. Part A of title III (42 U.S.C. 6291-6309) provides for the Energy Conservation Program for Consumer Products Other Than Automobiles. Part A-1 of title III (42 U.S.C. 6311-6317) provides for the Energy Conservation Program for Certain Industrial Equipment. In general, the program covers consumer products and certain commercial products (referred to hereafter as "covered products"), including commercial furnaces and boilers. EPCA contains mandatory energy conservation standards for commercial heating, air-conditioning, and water-heating equipment (42 U.S.C. 6313(a)). Specifically, the statute sets standards for small, large, and very large commercial package air-conditioning and heating equipment, packaged terminal air conditioners (PTACs) and packaged terminal heat pumps (PTHPs), warm air furnaces, packaged boilers, storage water heaters, and unfired hot water storage tanks. In doing so, EPCA established Federal energy conservation standards that generally correspond to the levels in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1, as in effect on October 24, 1992 (*i.e.*, ASHRAE Standard 90.1-1989), for each type of covered equipment listed in 42 U.S.C. 6313(a).

Congress further directed DOE through EPCA to consider amending the existing Federal energy conservation standard for each type of equipment listed, each time ASHRAE Standard 90.1 is amended with respect to such equipment (42 U.S.C. 6313(a)(6)(A)). For each type of equipment, EPCA directs that if ASHRAE Standard 90.1 is amended, DOE must adopt amended standards at the new efficiency level in ASHRAE Standard 90.1, unless clear and convincing evidence supports a determination that adoption of a more stringent level would produce significant additional energy savings and be technologically feasible and economically justified (42 U.S.C. 6313(a)(6)(A)(ii)). EPCA precludes DOE from adopting any standard that would not result in significant conservation of energy (42 U.S.C 6295(o)(3); 6313(a)(6); 6316(a)).

The Clean Air Act Amendments of 1990 list 188 toxic air pollutants that the U.S. Environmental Protection Agency (EPA) is required to control. EPA has set national ambient air quality standards for six common pollutants (also referred to as "criteria" pollutants), two of which are SO_2 and NO_x (42 U.S.C. 7408-7410).[b] Also, the Clean Air Act Amendments of 1990 gave EPA the authority to control acidification and to require operators of electric power plants to reduce emissions of SO_2 and NO_x. Title IV of the Clean Air Act established a cap-and-trade program for SO_2 that is intended to help control acid rain. This cap-and-trade program serves as a model for more recent programs with similar features. However, as a practical matter, commercial packaged boilers are in general not subject to the emission caps under the Clean Air Act amendments, for the reasons explained below.

NOx emissions from 28 eastern States and the District of Columbia (D.C.) are limited under the Clean Air Interstate Rule, published in the Federal Register on May 12, 2005. Although the rule has been remanded to EPA by the D.C. Circuit, it will remain in effect until it is replaced by a rule consistent with the Court's opinion in North Carolina v. EPA.[c] Under CAIR, States must achieve the required emission reductions using one of two compliance options: (1) meet an emission budget for each regulated State by requiring power plants to participate in an EPA-administered interstate cap-and-trade system that caps emissions in two stages, or (2) meet an individual State emissions budget through measures of the State's choosing. In general, however, CAIR basically covers two general classes of NO_x emitters: (1) stationary, fossil-fuel-fired boilers or stationary, fossil-fuel-fired combustion turbines serving generators with nameplate capacity of more than 25 MW of electricity and producing that electricity for sale, and (2) any unit that has a maximum design heat input rate of greater than 250 million Btu/h (40 CFR 96.4).[d] Commercial packaged boilers are smaller than this second limit and are not used for commercial power production. Hence, requirements of the CAIR do not apply to commercial packaged boilers.

The EPA's New Source Performance Standards (NSPS) limit, among other things, SO_2 emission from boilers built after a certain date. In particular, 40 CFR part 60 subpart Dc, Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units, requires that small industrial-commercial-institutional steam generating units must limit the allowable sulfur content in fuel oil to 0.5 weight percent for any steam-generating unit that

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[b] In 2007, the U.S. Supreme Court ruled that the EPA had authority to regulate CO_2 emissions. (Massachusetts v. Environmental Protection Agency, 549 U.S. 497 (2007). EPA does not currently regulate CO_2, but the agency has been considering introduction of CO_2 emissions regulations.

[d] On July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) issued its decision in North Carolina v. Environmental Protection Agency, in which the Court vacated the CAIR rule. 531 F.3d 896 (D.C. Cir. 2008). However, in a December 23, 2008 opinion, the same panel of the D.C. Circuit reinstated the CAIR rule pending EPA's compliance with its July 11, 2008 ruling. 550 F.3d 1176 (D.C. Cir. 2008)(*remand of vacatur*). As such, CAIR's trading programs and target deadlines remain in place at present; however, the long term prospects for and shape of those trading programs are unknown.

has a maximum design heat input capacity of 100 million British thermal units (Btu) per hour and is constructed, modified, or reconstructed after June 9, 1989. (40 CFR 60.40c-60.48c) While commercial packaged boilers that have a maximum design heat input capacity of 100 million Btu per hour would be an extremely small subset of all boilers being considered in this rule, some would likely be covered. In addition, the NSPS does help to limit the quantity of SO_2 released into the atmosphere by limiting the market for fuel oils with higher sulfur content. Note, NSPS defines a steam generating unit to be a device that combusts any fuel and produces steam or heats water or any other heat transfer medium. This term also includes any duct burner that combusts fuel and is part of a combined cycle system. This term does not include process heaters. (40 CFR 60.40c-60.48c)

8.5 GLOBAL CLIMATE CHANGE

Climate change has evolved into a matter of global concern because it is expected to have widespread adverse effects on natural resources and systems. A growing body of evidence points to anthropogenic sources of GHGs, such as carbon dioxide (CO_2), as major contributors to climate change. Because this rule, if finalized, will likely decrease CO_2 emission rates from the fossil fuel sector in the United States, the Department here examines the impacts and causes of climate change and then the potential impact of the rule on CO_2 emissions and global warming.

Impacts of Climate Change on the Environment

Climate is usually defined as the average weather, over a period ranging from months to many years. Climate change refers to a change in the state of the climate, which is identifiable through changes in the mean and/or the variability of its properties (*e.g.*, temperature or precipitation) over an extended period, typically decades or longer.

The World Meteorological Organization and United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) to provide an objective source of information about climate change. According to the IPCC Fourth Assessment Report (IPCC Report), published in 2007, climate change is consistent with observed changes to the world's natural systems; the IPCC expects these changes to continue.[2]

Changes that are consistent with warming include: (1) warming of the world's oceans to a depth of 3000 meters; (2) global average sea level rise at an average rate of 1.8 mm per year from 1961 to 2003; (3) loss of annual average Arctic sea ice at a rate of 2.7 percent per decade; (4) changes in wind patterns that affect extra-tropical storm tracks and temperature patterns; (5) increases in intense precipitation in some parts of the world as well as increased drought and more frequent heat waves in many locations worldwide; and (6) numerous ecological changes.[2]

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

The IPCC Report describes incremental impacts associated with the rise in temperature. At ranges of incremental increases to the global average temperature, IPCC reports, with either high or very high confidence, that there is likely to be an increasing degree of impacts (*e.g.*, coral reef bleaching, loss of wildlife habitat, loss to specific ecosystems, and negative yield impacts for major cereal crops in the tropics), but also projects likely beneficial impacts on crop yields in temperate regions.[2]

Causes of Climate Change

The IPCC Report states that the world has warmed by about 0.74 °C in the last 100 years. The IPCC Report finds that most of the temperature increase since the mid-20th century is very likely due to the increase in anthropogenic concentrations of CO_2 and other long-lived GHGs (*e.g.*, methane and nitrous oxide in the atmosphere) rather than from natural causes.[3]

Increasing the CO_2 concentration partially blocks the earth's re-radiation of captured solar energy in the infrared band, inhibits the radiant cooling of the earth, and thereby alters the energy balance of the planet, which gradually increases its average temperature. The IPCC Report estimates that CO_2 currently makes up about 77 percent of the total CO_2-equivalent[e] global warming potential in GHGs emitted from human activities, with the vast majority (74 percent) of the CO_2 attributable to fossil fuel use. For the future, the IPCC Report describes a wide range of GHG emissions scenarios. However, under each scenario, CO_2 would continue to comprise above 70 percent of the total global warming potential.[4]

Stabilization of CO_2 Concentrations

Unlike many traditional air pollutants, CO_2 mixes thoroughly in the entire atmosphere and is long-lived. The residence time of CO_2 in the atmosphere is long compared to the emission processes. Therefore, the global cumulative emissions of CO_2 over long periods determine CO_2 concentrations because it takes hundreds of years for natural processes to remove the CO_2. Globally, 49 billion metric tons of CO_2–equivalent, anthropogenic (man-made) GHGs are emitted every year. Of this annual total, fossil fuels contribute about 29 billion metric tons of CO_2.[f, 4]

Researchers have focused on considering atmospheric CO_2 concentrations that likely will result in some level of global climate stabilization, and the emission rates associated with achieving the "stabilizing" concentrations by particular dates. They associate these stabilized CO_2 concentrations with temperature increases that plateau in a defined range. For example, at the low end, the IPCC Report scenarios target CO_2-stabilized concentrations at a range between 350 ppm and 400 ppm (essentially today's value), because of climate inertia, concentrations in this low-end range would still result in temperatures projected to increase 2.0 °C to 2.4 °C above pre-industrial levels[g] (about 1.3 ºC to 1.7 ºC above today's levels). To achieve concentrations between 350 ppm to 400 ppm, the IPCC scenarios present that there would have to be a rapid

[e] GHGs differ in their warming influence (radiative forcing) on a global climate system due to their different radiative properties and lifetimes in the atmosphere. These warming influences may be expressed through a common metric based on the radiative forcing of CO_2 (*i.e.*, CO_2-equivalent). CO_2 equivalent emission is the amount of CO_2 emission that would cause the same-time integrated radiative forcing, over a given time horizon, as an emitted amount of other long-lived GHG or mixture of GHGs.
[f] Other non-fossil-fuel contributors include CO_2 emissions from deforestation and decay from agriculture biomass, agricultural and industrial emissions of methane, and emissions of nitrous oxide and fluorocarbons.
[g] IPCC Working Group 3, Table TS 2.

downward trend in total annual global emissions of GHGs to levels that are 50 percent to 85 percent below today's annual emission rates by no later than 2050. Since it is assumed that there would continue to be growth in global populations and substantial increases in economic production, the scenarios identify required reductions in GHG emissions intensity (emissions per unit of output) of more than 90 percent. However, even at these rates, the scenarios describe some warming, and some climate change is projected due to already accumulated CO_2 and GHGs in the atmosphere.[4]

As computed for the *AEO 2008* reference case[h], the cumulative U.S. energy-related CO_2 emissions between 2012 and 2042 are described at about 209 billion metric tons.

8.6 ANALYTICAL METHODS FOR AIR QUALITY

To analyze the effect of proposed efficiency standards on air resources, DOE used accepted EPA emission coefficients. In DOE rules related to electrically fueled appliances and equipment, typically a modified version of the National Energy Modeling System (NEMS), called NEMS-BT ("BT" stands for Building Technologies), is used to determine the emissions that are a result of proposed energy efficiency standards. For the EA, the output is the forecasted physical emissions. The NEMS-BT tracks CO_2 and NO_x emissions using a detailed module that provides broad coverage of all sectors and includes interactive effects. However, NEMS-BT does not consider commercial emissions of NO_x and SO_2 from the combustion of natural gas and heating fuel oil. Because an efficiency standard could result in changes in these emissions, DOE performed a limited literature search to determine appropriate emissions factors for CO_2, NO_x, and SO_2 from commercial appliances. Specifically, this work focuses on establishing emissions coefficients appropriate to commercial packaged boilers for use in calculating emissions impacts from proposed efficiency standards.

The review attempts to confirm that the emissions factors available from the EPA for CO_2, NO_x, and SO_2 from natural gas and external combustion of #2 fuel oil (*e.g.*, in boilers, furnaces) for commercial boilers are representative of the United States.[6] The EPA cautions against the use of these emissions factors as representative of actual emissions. Rather, they are to be used, and are used here, as general approximations of national average emissions factors in order to calculate emissions impacts that result from activities such as proposed commercial packaged boiler energy efficiency standards.

For each efficiency level, DOE calculated the emissions based on the annual fuel consumption for the different classes of commercial boilers and furnaces. The EA considers impacts from two pollutants that are listed under the Clean Air Act (NO_x and SO_2) and are regulated under National Ambient Air Quality Standards (NAAQS). It also considers the impacts of CO_2. An air pollutant is any substance in the air that can cause harm to humans or the environment; the NAAQS regulates emissions of certain air pollutants. Pollutants may be natural or man-made and may take the form of solid particles, liquid droplets, or gases. Table 8.6.1 summarizes the emissions factor estimates for the two fuels of interest. The values presented here are based on the EPA's assessment of combustion emissions. These emissions estimates represent an approximate emissions factor for the United States as a whole. They are used,

[h] See www.eia.doe.gov/oiaf/archive/aeo08/index.html.

together with estimated energy savings, to calculate end-use site emissions impacts. The emissions factors discussed in this analysis are represented as mass (kg) of the specific emission of interest per million Btu of energy input to the commercial packaged boiler.

Table 8.6.1 Estimated National Average Emissions Factors for Commercial Fuel Combustion of Natural Gas and Fuel Oil #2

	CO_2 (kg/million Btu)	NO_x (kg/million Btu)	SO_2 (kg/million Btu)
Natural Gas	53.353	0.084	0.000
Fuel Oil #2	72.756	0.082	0.256

8.6.1 Carbon Dioxide

The CO_2 estimates in Table 8.6.1 are based on EPA's assessment of CO_2 combustion from natural gas and fuel oil #2 use. Other sources of information include DOE's Energy Information Administration (EIA) and the Canada's Environment Canada agency.[7, 8] All agree to within ± 2.0 percent of EPA's assessed estimate of CO_2 emissions. EPA's CO_2 emissions factors for natural gas and fuel oil #2 combustion are, therefore, a reasonable evaluation of averaged CO_2 emissions rates. In the case of both fuels, the estimated CO_2 emission rates assume 99 percent (or higher) conversion of fuel carbon content to CO_2.

The Beneficial Impact of the Rule on CO_2 *Emissions*

If finalized, it is anticipated that the rule will reduce energy-related emissions, particularly those associated with energy consumption in buildings., The EIA reports in its 2008 *Annual Energy Outlook* (*AEO 2008*) that U.S. annual energy-related emissions of CO_2 in 2005 were about 5.98 billion metric tons (about 20 percent of the world energy-related CO_2 emissions and about 12 percent of total global GHG emissions), of which 2.32 billion tons were attributed to residential and commercial buildings sector (including related energy–using equipment, such as commercial packaged boilers). Most of the GHG emissions attributed to residential and commercial buildings are emitted from fossil fuel-fired power plants that generate electricity used in this sector, although some emissions are the results of direct combustion equipment such as commercial boilers. In the *AEO 2008* reference case, EIA projected that annual energy-related CO_2 emissions would grow from 6.0 billion metric tons in 2005 to 6.85 billion metric tons in 2030, an increase of 14.5 percent, while emissions attributable to buildings would grow to 2.92 billion tons, an increase of 26.1 percent.

8.6.2 Nitrogen Oxides

The NO_x estimates in Table 8.6.1 are based on EPA's assessment of NO_x combustion from natural gas and fuel oil #2 use. NO_x emissions from natural gas combustion were specifically collected for large scale (>100 million Btu/hr of heat input) combustor types. In the case of fuel oil, NO_x formation in combustion processes is significantly more complex than the formation of SO_2 or CO_2. NO_x can result from oxidization of N_2. Fuel is one source of N_2, but the larger source is N_2 is through the combustion-air intake. This process is sensitive to combustion chemistry, and therefore, quite variable. It also implies that appliance design can lower NO_x emissions. NO_x is both an acid precipitation and ozone (O_3) precursor, but because commercial appliances are a relatively small and dispersed (*i.e.*, hard to monitor) source, regulation of these emissions tends to play a small role in government or private sector orchestrated NO_x control strategies. The O_3 hazards of NO_x emissions are highly variable both spatially and over time, as weather conditions favor or disfavor O_3 formation. Local NO_x emissions rules and State Implementation Plans will control NO_x to different degrees in different jurisdictions. In fact, sources of NO_x in certain States are subject to the Clean Air Interstate Rule, which gives States the option to participate in a trading scheme.

8.6.3 Sulfur Dioxide

Sulfur dioxide emissions from natural gas combustion are assumed to be zero. In the case of fuel oil, emissions of SO_2 are a direct function of the sulfur content of the fuel. Individual State and local regulations limiting the amount of sulfur in fuel oil, however, reveal substantial variability in SO_2 emissions factors. A literature survey suggested that an assumed 0.5 percent sulfur content by weight resulted in a conservative and representative estimate for the national average sulfur content for fuel oil. In addition, this 0.5 percent sulfur content by weight quantity was also referenced in the requirements of EPA's New Source Performance Standards. (40 CFR 60.40c-60.48c).[5] A straight multiplication of the fuel energy content and the percentage of sulfur content in the fuel provides the emissions factor as per the EPA's Compilation of Air Pollutant Emission Factors (AP-42) guidelines.[6] Other references provided similar figures for emission factors.[7,8]

8.7 EFFECTS ON EMISSIONS

This EA examines the environmental impact that standards would have based upon the efficiency levels shown in ASHRAE Standard 90.1-2007, and up to four higher efficiency levels. Generally, in reporting the impacts (including the environmental impacts) of setting standards, DOE compares the proposed standards against a no action alternative. Each efficiency level examined is considered an alternative action whose costs and benefits are compared with the no-action alternative. In the case of commercial packaged boilers, however, DOE is required by law to set standards at the levels indicated by a revised version of ASHRAE Standard 90.1 unless it can show by clear and convincing evidence that more stringent efficiency standards are technologically feasible and economically justified and would result in significant additional energy savings. (42 U.S.C. 6313(a)(6)(A)(ii)) For this reason, DOE is legally bound to adopt efficiency levels that meet or exceed those shown in ASHRAE Standard 90.1-2007.

However, for this EA, DOE has chosen to report impacts in two ways. In examining the environmental impact for DOE to adopt standards equivalent to the requirements in ASHRAE Standard 90.1-2007, DOE has determined that it will analyze and report these impacts against a no-new-standard scenario (*i.e.*, a "no action" scenario). Under this scenario, DOE assumed a base case in which future shipments in this no-new-standard scenario reflect that of the current market. In reporting the impacts of DOE's adoption of efficiency levels higher than ASHRAE Standard 90.1-2007 (*i.e.*, efficiency levels 1, 2, 3, and 4), DOE has determined that the environmental impacts should be provided as possible impacts over a separate base case that assumes a standard set at the minimum that DOE can legally adopt (*i.e.*, ASHRAE Standard 90.1-2007 efficiency levels).

Table 8.7.1 shows the cumulative emissions impacts between the no-new-standard base case (also referred to here as the market baseline) and adopting the ASHRAE Standard 90.1-2007 efficiency levels over the time range of 2012 to 2042. In general, the cumulative impact (in terms of emissions reductions) over the market base case is relatively small. Nevertheless, all equipment classes exhibit emission savings with the exception of large, gas-fired, hot water equipment and large, oil-fired, steam equipment since essentially all equipment sold today meets the ASHRAE level. In addition, no natural gas consuming equipment shows SO_2 savings since natural gas has small and essentially negligible quantities of sulfur.

Table 8.7.1 Summary of Cumulative National Emissions Impact for Commercial Boilers from 2012 to 2042 for Adopting ASHRAE Standard 90.1-2007 over the Market Baseline

	Cumulative National Emissions Impact from 2012 to 2042		
Equipment Class	CO_2 (metric kilotons)	NO_x (short tons)	SO_2 (short tons)
Small, Gas-fired, Hot Water	(674)	(1,177)	0
Small, Gas-fired, Steam, All Except Natural Draft	(31)	(54)	0
Small, Gas-fired, Steam, Natural Draft	(1,937)	(3,382)	0
Small, Oil-fired, Hot Water	(677)	(837)	(2,628)
Small, Oil-fired, Steam	(327)	(404)	(1,267)
Large, Gas-fired, Hot Water	(296)	(516)	0
Large, Gas-fired, Steam, All Except Natural Draft	(177)	(308)	0
Large, Gas-fired, Steam, Natural Draft	(1,525)	(2,662)	0
Large, Oil-fired, Hot Water	0	0	0
Large, Oil-fired, Steam	0	0	0

*Negative values, shown in parentheses, indicate emissions reductions compared with the base case

Table 8.7.2 shows the cumulative emissions impacts for selecting standards higher than the ASHRAE Standard 90.1-2007 efficiency levels over the time range of 2012 to 2042. With the exception of a few equipment classes at efficiency level 1, all equipment classes exhibit greater cumulative emission savings when going beyond the ASHRAE Standard 90.1-2007 level.

Table 8.7.3 shows the annual emission impact for selecting the ASHRAE Standard 90.1-2007 over the market baseline over the time range 2012 to 2042 for selected years. Lastly, Table 8.7.4 to Table 8.7.7 show the annual emission impact for selecting higher energy efficiency levels above the ASHRAE Standard 90.1-2007 levels over the time range 2012 to 2042.

Table 8.7.2 Summary of Cumulative National Emissions Impact for Commercial Boilers from 2012 to 2042 for Adoption of Analyzed Higher Standards over the ASHRAE Standard 90.1-2007 Levels

	Cumulative National Emissions Impact from 2012 to 2042 *,**											
	Efficiency Level 1			Efficiency Level 2			Efficiency Level 3			Efficiency Level 4		
Equipment Class	CO_2 (metric kilotons)	NO_x (short tons)	SO_2 (short tons)	CO_2 (metric kilotons)	NO_x (short tons)	SO_2 (short tons)	CO_2 (metric kilotons)	NO_x (short tons)	SO_2 (short tons)	CO_2 (metric kilotons)	NO_x (short tons)	SO_2 (short tons)
Small, Gas-fired, Hot Water	(1,226.76)	(2,141.09)	0.00	(4,038.54)	(7,048.56)	0.00	(7,858.32)	(13,715.33)	0.00	(11,879.82)	(20,734.15)	0.00
Small, Gas-fired, Steam, All Except natural Draft	3.55	6.19	0.00	(797.49)	(1,391.87)	0.00	(1,665.55)	(2,906.92)	0.00	(2,540.67)	(4,434.29)	0.00
Small, Gas-fired, Steam, Natural Draft	331.90	579.28	0.00	(879.08)	(1,534.29)	0.00	(2,354.60)	(4,109.54)	0.00	na	na	na
Small, Oil-fired, Hot Water	(1,170.76)	(1,446.79)	(4,542.92)	(2,595.67)	(3,207.67)	(10,072.08)	(4,341.53)	(5,365.15)	(16,846.59)	na	na	na
Small, Oil-fired, Steam	(703.69)	(869.60)	(2,730.54)	(2,026.48)	(2,504.27)	(7,863.40)	(5,189.36)	(6,412.88)	(20,136.43)	na	na	na
Large, Gas-fired, Hot Water	(799.40)	(1,395.21)	0.00	(2,081.94)	(3,633.66)	0.00	(3,425.35)	(5,978.35)	0.00	(9,865.63)	(17,218.73)	0.00
Large, Gas-fired, Steam, All Except Natural Draft	(1,217.11)	(2,124.26)	0.00	(3,533.34)	(6,166.83)	0.00	(5,888.71)	(10,277.71)	0.00	(8,280.64)	(14,452.42)	0.00
Large, Gas-fired, Steam, Natural Draft	1,226.11	2,139.97	0.00	(205.75)	(359.10)	0.00	(2,054.11)	(3,585.09)	0.00	(4,240.40)	(7,400.87)	0.00
Large, Oil-fired, Hot Water	(1,032.15)	(1,275.50)	(4,005.07)	(1,820.42)	(2,249.63)	(7,063.85)	(2,590.37)	(3,201.11)	(10,051.49)	na	na	na
Large, Oil-fired, Steam	(3,006.77)	(3,715.69)	(11,667.26)	(8,109.93)	(10,022.04)	(31,469.21)	(15,167.27)	(18,743.33)	(58,854.05)	(31,353.78)	(38,746.21)	(121,663.10)

*Negative values, shown in parentheses, indicate emissions savings over the base case
**na indicates that the equipment class did not have an Efficiency Level 4

Table 8.7.3 Summary of National Emissions Impact for Commercial Boilers from 2012 to 2042 for Adopting ASHRAE Standard 90.1-2007 over the Market Baseline

	Emission Impact for Adopting ASHRAE Standard 90.1-2007 Over the Market Baseline*						
	2015	**2020**	**2025**	**2030**	**2035**	**2040**	**2042**
Small, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(4.71)	(10.95)	(17.60)	(24.87)	(33.23)	(43.08)	(47.48)
NO_x (short tons/year)	(8.22)	(19.11)	(30.71)	(43.40)	(57.99)	(75.19)	(82.86)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, All Except natural Draft							
CO_2 (metric kilotons/year)	(0.50)	(0.80)	(0.80)	(1.13)	(1.51)	(1.96)	(2.16)
NO_x (short tons/year)	(0.87)	(1.40)	(1.40)	(1.98)	(2.64)	(3.43)	(3.78)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(6.28)	(11.60)	(37.24)	(70.26)	(108.28)	(153.07)	(173.06)
NO_x (short tons/year)	(10.96)	(20.25)	(64.99)	(122.63)	(188.98)	(267.16)	(302.05)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	(4.73)	(11.00)	(17.67)	(24.97)	(33.36)	(43.26)	(47.67)
NO_x (short tons/year)	(5.85)	(13.59)	(21.84)	(30.86)	(41.23)	(53.45)	(58.91)
SO_2 (short tons/year)	(18.36)	(42.67)	(68.57)	(96.89)	(129.46)	(167.85)	(184.99)
Small, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(2.28)	(5.30)	(8.52)	(12.04)	(16.09)	(20.86)	(22.99)
NO_x (short tons/year)	(2.82)	(6.55)	(10.53)	(14.88)	(19.88)	(25.78)	(28.41)
SO_2 (short tons/year)	(8.85)	(20.58)	(33.07)	(46.73)	(62.43)	(80.95)	(89.21)
Large, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(2.07)	(4.80)	(7.72)	(10.91)	(14.57)	(18.89)	(20.82)
NO_x (short tons/year)	(3.61)	(8.38)	(13.47)	(19.03)	(25.43)	(32.97)	(36.34)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, All Except Natural Draft							
CO_2 (metric kilotons/year)	(1.23)	(2.87)	(4.61)	(6.51)	(8.71)	(11.29)	(12.44)
NO_x (short tons/year)	(2.15)	(5.01)	(8.05)	(11.37)	(15.19)	(19.70)	(21.71)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(0.58)	0.02	(23.29)	(55.04)	(91.14)	(133.03)	(151.55)
NO_x (short tons/year)	(1.02)	0.03	(40.64)	(96.07)	(159.07)	(232.17)	(264.50)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NO_x (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Oil-fired, Steam							
CO_2 (metric kilotons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NO_x (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 8.7.4 Summary of National Emissions Impact for Commercial Boilers from 2012 to 2042 for Adopting Level 1 over ASHRAE Standard 90.1-2007

	Emission Impact for Adopting Level 1 Over ASHRAE Standard 90.1-2007*						
	2015	2020	2025	2030	2035	2040	2042
Small, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(2.60)	(16.08)	(30.45)	(46.17)	(64.26)	(85.57)	(95.09)
NO_x (short tons/year)	(4.54)	(28.07)	(53.14)	(80.58)	(112.15)	(149.35)	(165.96)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, All Except Natural Draft							
CO_2 (metric kilotons/year)	0.12	0.12	0.12	0.12	0.12	0.12	0.12
NO_x (short tons/year)	0.20	0.20	0.20	0.20	0.20	0.20	0.20
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(3.81)	(12.89)	(4.52)	10.09	26.94	46.78	55.63
NO_x (short tons/year)	(6.65)	(22.50)	(7.89)	17.62	47.02	81.65	97.10
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	(2.37)	(15.28)	(29.03)	(44.08)	(61.39)	(81.80)	(90.91)
NO_x (short tons/year)	(2.93)	(18.88)	(35.87)	(54.47)	(75.87)	(101.08)	(112.34)
SO_2 (short tons/year)	(9.21)	(59.27)	(112.63)	(171.04)	(238.23)	(317.41)	(352.75)
Small, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(1.69)	(9.35)	(17.52)	(26.45)	(36.73)	(48.84)	(54.25)
NO_x (short tons/year)	(2.09)	(11.56)	(21.65)	(32.69)	(45.39)	(60.36)	(67.04)
SO_2 (short tons/year)	(6.57)	(36.29)	(67.97)	(102.64)	(142.52)	(189.52)	(210.51)
Large, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(2.17)	(10.79)	(19.96)	(30.01)	(41.57)	(55.18)	(61.26)
NO_x (short tons/year)	(3.80)	(18.83)	(34.84)	(52.38)	(72.55)	(96.31)	(106.92)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, All Except Natural Draft							
CO_2 (metric kilotons/year)	(4.22)	(17.01)	(30.64)	(45.55)	(62.70)	(82.92)	(91.94)
NO_x (short tons/year)	(7.37)	(29.69)	(53.47)	(79.50)	(109.44)	(144.72)	(160.47)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(1.19)	(6.64)	13.79	43.19	77.04	116.92	134.71
NO_x (short tons/year)	(2.07)	(11.59)	24.07	75.37	134.45	204.06	235.12
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	(4.08)	(14.75)	(26.11)	(38.55)	(52.85)	(69.71)	(77.24)
NO_x (short tons/year)	(5.04)	(18.22)	(32.27)	(47.64)	(65.32)	(86.15)	(95.45)
SO_2 (short tons/year)	(15.83)	(57.21)	(101.32)	(149.58)	(205.09)	(270.51)	(299.71)
Large, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(11.88)	(42.95)	(76.06)	(112.30)	(153.97)	(203.08)	(225.01)
NO_x (short tons/year)	(14.68)	(53.08)	(94.00)	(138.77)	(190.27)	(250.96)	(278.06)
SO_2 (short tons/year)	(46.11)	(166.67)	(295.15)	(435.75)	(597.45)	(788.02)	(873.11)

Table 8.7.5 Summary of National Emissions Impact for Commercial Boilers from 2012 to 2042 for Adopting Level 2 over ASHRAE Standard 90.1-2007

	Emission Impact for Adopting Level 2 Over ASHRAE Standard 90.1-2007						
	2015	**2020**	**2025**	**2030**	**2035**	**2040**	**2042**
Small, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(13.72)	(56.25)	(101.58)	(151.18)	(208.24)	(275.48)	(305.50)
NO_x (short tons/year)	(23.94)	(98.17)	(177.28)	(263.86)	(363.45)	(480.80)	(533.20)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, All Except natural Draft							
CO_2 (metric kilotons/year)	(11.33)	(20.15)	(20.15)	(29.80)	(40.90)	(53.99)	(59.83)
NO_x (short tons/year)	(19.77)	(35.16)	(35.16)	(52.01)	(71.39)	(94.22)	(104.42)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(11.04)	(30.19)	(35.16)	(35.14)	(35.07)	(35.01)	(34.99)
NO_x (short tons/year)	(19.26)	(52.70)	(61.36)	(61.32)	(61.21)	(61.10)	(61.07)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	(8.00)	(35.63)	(65.07)	(97.30)	(134.36)	(178.04)	(197.54)
NO_x (short tons/year)	(9.89)	(44.03)	(80.41)	(120.24)	(166.04)	(220.02)	(244.12)
SO_2 (short tons/year)	(31.06)	(138.26)	(252.50)	(377.54)	(521.36)	(690.85)	(766.52)
Small, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(6.92)	(28.25)	(50.98)	(75.86)	(104.47)	(138.19)	(153.24)
NO_x (short tons/year)	(8.55)	(34.91)	(63.00)	(93.74)	(129.10)	(170.76)	(189.37)
SO_2 (short tons/year)	(26.86)	(109.62)	(197.81)	(294.34)	(405.37)	(536.20)	(594.62)
Large, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(7.24)	(29.11)	(52.41)	(77.91)	(107.24)	(141.81)	(157.24)
NO_x (short tons/year)	(12.64)	(50.80)	(91.47)	(135.98)	(187.17)	(247.50)	(274.43)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, All Except Natural Draft							
CO_2 (metric kilotons/year)	(13.38)	(50.10)	(89.23)	(132.06)	(181.31)	(239.36)	(265.28)
NO_x (short tons/year)	(23.34)	(87.44)	(155.73)	(230.48)	(316.45)	(417.75)	(462.99)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(7.04)	(27.85)	(23.84)	(11.88)	3.56	24.03	33.73
NO_x (short tons/year)	(12.28)	(48.61)	(41.60)	(20.73)	6.22	41.94	58.86
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	(7.19)	(26.01)	(46.05)	(67.99)	(93.22)	(122.95)	(136.23)
NO_x (short tons/year)	(8.89)	(32.14)	(56.91)	(84.02)	(115.20)	(151.94)	(168.35)
SO_2 (short tons/year)	(27.92)	(100.91)	(178.69)	(263.82)	(361.72)	(477.10)	(528.61)
Large, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(32.05)	(115.86)	(205.16)	(302.89)	(415.30)	(547.76)	(606.90)
NO_x (short tons/year)	(39.61)	(143.17)	(253.53)	(374.30)	(513.21)	(676.90)	(749.99)
SO_2 (short tons/year)	(124.37)	(449.56)	(796.07)	(1,175.30)	(1,611.47)	(2,125.46)	(2,354.96)

Table 8.7.6 Summary of National Emissions Impact for Commercial Boilers from 2012 to 2042 for Adopting Level 3 over ASHRAE Standard 90.1-2007

	Emission Impact for Adopting Level 3 Over ASHRAE Standard 90.1-2007						
	2015	2020	2025	2030	2035	2040	2042
Small, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(28.81)	(110.82)	(198.20)	(293.85)	(403.85)	(533.48)	(591.36)
NO_x (short tons/year)	(50.29)	(193.41)	(345.93)	(512.85)	(704.84)	(931.08)	(1,032.10)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, All Except natural Draft							
CO_2 (metric kilotons/year)	(23.73)	(42.11)	(42.11)	(62.22)	(85.36)	(112.62)	(124.79)
NO_x (short tons/year)	(41.41)	(73.49)	(73.49)	(108.59)	(148.97)	(196.55)	(217.80)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(19.84)	(51.27)	(72.48)	(90.24)	(110.63)	(134.67)	(145.41)
NO_x (short tons/year)	(34.63)	(89.48)	(126.51)	(157.50)	(193.09)	(235.03)	(253.79)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	(14.90)	(60.57)	(109.24)	(162.50)	(223.76)	(295.96)	(328.19)
NO_x (short tons/year)	(18.42)	(74.85)	(134.99)	(200.81)	(276.52)	(365.73)	(405.57)
SO_2 (short tons/year)	(57.83)	(235.04)	(423.87)	(630.55)	(868.27)	(1,148.41)	(1,273.48)
Small, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(19.42)	(73.43)	(130.99)	(193.98)	(266.43)	(351.81)	(389.93)
NO_x (short tons/year)	(24.00)	(90.75)	(161.87)	(239.72)	(329.25)	(434.76)	(481.86)
SO_2 (short tons/year)	(75.36)	(284.95)	(508.28)	(752.71)	(1,033.84)	(1,365.13)	(1,513.05)
Large, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(12.55)	(48.30)	(86.39)	(128.08)	(176.04)	(232.54)	(257.77)
NO_x (short tons/year)	(21.91)	(84.30)	(150.78)	(223.55)	(307.24)	(405.86)	(449.89)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, All Except Natural Draft							
CO_2 (metric kilotons/year)	(22.68)	(83.75)	(148.81)	(220.02)	(301.93)	(398.44)	(441.54)
NO_x (short tons/year)	(39.59)	(146.16)	(259.73)	(384.01)	(526.96)	(695.41)	(770.62)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(14.58)	(55.24)	(72.41)	(82.96)	(91.28)	(95.89)	(96.63)
NO_x (short tons/year)	(25.45)	(96.40)	(126.38)	(144.79)	(159.32)	(167.35)	(168.66)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	(10.24)	(37.01)	(65.53)	(96.75)	(132.65)	(174.96)	(193.85)
NO_x (short tons/year)	(12.65)	(45.73)	(80.98)	(119.55)	(163.92)	(216.21)	(239.55)
SO_2 (short tons/year)	(39.72)	(143.59)	(254.27)	(375.40)	(514.71)	(678.89)	(752.19)
Large, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(59.94)	(216.68)	(383.69)	(566.47)	(776.69)	(1,024.42)	(1,135.04)
NO_x (short tons/year)	(74.07)	(267.76)	(474.15)	(700.02)	(959.80)	(1,265.94)	(1,402.63)
SO_2 (short tons/year)	(232.59)	(840.77)	(1,488.83)	(2,198.07)	(3,013.79)	(3,975.06)	(4,404.27)

Table 8.7.7 Summary of National Emissions Impact for Commercial Boilers from 2012 to 2042 for Adopting Level 4 over ASHRAE Standard 90.1-2007

	Emission Impact for Adopting Level 4 Over ASHRAE Standard 90.1-2007*						
	2015	2020	2025	2030	2035	2040	2042
Small, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(44.70)	(168.27)	(299.94)	(444.04)	(609.78)	(805.10)	(892.30)
NO_x (short tons/year)	(78.02)	(293.68)	(523.48)	(774.99)	(1,064.26)	(1,405.14)	(1,557.34)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, All Except natural Draft							
CO_2 (metric kilotons/year)	(36.23)	(64.24)	(64.24)	(94.91)	(130.17)	(171.72)	(190.28)
NO_x (short tons/year)	(63.23)	(112.13)	(112.13)	(165.64)	(227.18)	(299.71)	(332.10)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Small, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	na	na	na	na	na	na	na
NO_x (short tons/year)	na	na	na	na	na	na	na
SO_2 (short tons/year)	na	na	na	na	na	na	na
Small, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	na	na	na	na	na	na	na
NO_x (short tons/year)	na	na	na	na	na	na	na
SO_2 (short tons/year)	na	na	na	na	na	na	na
Small, Oil-fired, Steam							
CO_2 (metric kilotons/year)	na	na	na	na	na	na	na
NO_x (short tons/year)	na	na	na	na	na	na	na
SO_2 (short tons/year)	na	na	na	na	na	na	na
Large, Gas-fired, Hot Water							
CO_2 (metric kilotons/year)	(38.00)	(140.30)	(249.31)	(368.62)	(505.83)	(667.53)	(739.73)
NO_x (short tons/year)	(66.33)	(244.88)	(435.13)	(643.35)	(882.83)	(1,165.05)	(1,291.06)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, All Except Natural Draft							
CO_2 (metric kilotons/year)	(32.14)	(117.92)	(209.32)	(309.36)	(424.41)	(560.00)	(620.54)
NO_x (short tons/year)	(56.09)	(205.80)	(365.33)	(539.93)	(740.73)	(977.37)	(1,083.03)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Gas-fired, Steam, Natural Draft							
CO_2 (metric kilotons/year)	(23.51)	(87.62)	(129.86)	(167.04)	(203.47)	(237.72)	(250.83)
NO_x (short tons/year)	(41.04)	(152.93)	(226.65)	(291.53)	(355.12)	(414.90)	(437.78)
SO_2 (short tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large, Oil-fired, Hot Water							
CO_2 (metric kilotons/year)	na	na	na	na	na	na	na
NO_x (short tons/year)	na	na	na	na	na	na	na
SO_2 (short tons/year)	na	na	na	na	na	na	na
Large, Oil-fired, Steam							
CO_2 (metric kilotons/year)	(123.91)	(447.91)	(793.16)	(1,171.00)	(1,605.57)	(2,117.69)	(2,346.35)
NO_x (short tons/year)	(153.13)	(553.51)	(980.16)	(1,447.08)	(1,984.11)	(2,616.96)	(2,899.53)
SO_2 (short tons/year)	(480.81)	(1,738.03)	(3,077.70)	(4,543.84)	(6,230.10)	(8,217.24)	(9,104.51)

"na" indicates that the technology did not have an energy efficiency level 4.

8.8 EFFECTS ON UPSTREAM FUEL-CYCLE EMISSIONS

Fuel-cycle emissions often refer to the emissions associated with the amount of energy used in the upstream production and downstream consumption of electricity, including energy used at the power plant. However, there are additional energy costs associated with the extraction, refining, and transport of fuel oil and the extraction, physical preparatory and cleaning processes, and transportation to the point of end use of natural gas. The analysis of emissions impacts calculated for this rule used emission coefficients based on the point of use and the site energy savings from higher-efficiency equipment. The analysis does a thorough accounting of emissions at the point of use, but does not account for upstream emissions (*i.e.*, emissions from energy losses during fuel oil and natural gas production). While the site-to-source energy conversion factor of approximately 10 percent was used in the development of source energy savings estimates, some fraction of this would occur in the form of larger equipment that would likely have more emission controls on them than are seen in commercial packaged boilers. A very rough estimate might be that an additional 10 percent impact (typically, this will be savings) might result due to impacts on upstream fuel-cycle emissions.

8.9 WETLAND, ENDANGERED AND THREATENED SPECIES, AND CULTURAL RESOURCES

DOE's proposed action is not site-specific, nor would it affect land disturbance or use resulting from the installation of commercial boilers in commercial buildings. Therefore, none of the proposed possible standard levels is expected to affect the quality of wetlands, or threatened or endangered species or their critical habitat. Further, this action is not expected to affect cultural resources such as historical or archaeological sites.

8.10 ENVIRONMENTAL JUSTICE IMPACTS

Under Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," 59 FR 7629 (Feb. 16, 1994), DOE is required to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. In examining each of the possible energy conservation standards for commercial packaged boilers, DOE did not identify any high and adverse human health or environmental effects that it believes would disproportionally or negatively impact minority or low-income populations. In general, the environmental impacts associated with adoption of higher-efficiency commercial packaged boiler standards are positive in that they are found to result in reduced overall emissions of air pollutants where such boilers are used, with correspondingly positive local environmental impacts for all populations.

In terms of standard-setting, DOE is legally mandated to adopt standards at the ASHRAE Standard 90.1-2007 efficiency levels, unless more stringent energy conservation standards are technologically feasible, economically justified, and would result in significant additional energy savings. (42 U.S.C. 6313(a)(6)(A)(ii)) Because of the ANSI/ASHRAE consensus process in developing ASHRAE Standard 90.1, the representation of industry groups like the Gas Appliance Manufacturers Association (GAMA) in that process, and the opportunity for public comment in that process, DOE believes that there would be no highly negative disproportionate impacts on small businesses used by minority or low-income commercial customers resulting from adoption of national energy conservation standards at the ASHRAE Standard 90.1-2007 efficiency levels. Accordingly, DOE's LCC analysis (see TSD Chapter 7) did not include small or disadvantaged businesses or populations as a subgroup. If DOE determines that more stringent standards are in fact justified, DOE would do an LCC Subgroup analysis to ascertain whether there would be impacts on specific populations subgroups, including certain types of commercial customers, that would need to be examined in the light of the overall justification necessary to adopt more stringent standards.

8.11 NOISE AND AESTHETICS

Improvements in efficiency of commercial boilers and furnace equipment are expected to result from changes in the choice of components and other design features. These changes are described in Chapter 5 of this TSD. Efficiency improvements are not expected to change noise levels in comparison to equipment in today's market. Equipment that is currently manufactured in the existing market that would meet the proposed standards is no louder than less-efficient equipment. Changes to the design to improve the efficiency levels are not anticipated to affect the equipment's aesthetics.

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