DOE/EA-1674

Environmental Assessment
for

10 CFR 431 Energy Conservation Program: Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines

August 2009

CHAPTER 16. ENVIRONMENTAL IMPACT ANALYSIS

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CHAPTER 16. ENVIRONMENTAL IMPACT ANALYSIS

16.1 INTRODUCTION

This chapter describes potential environmental effects that may result from energy conservation standards for refrigerated beverage vending machines. 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 impact land uses, cause any direct disturbance to the land, or directly affect biological resources in any one area.

All of the trial standard levels (TSLs) are expected to reduce energy consumption in comparison to the baseline efficiency levels. These changes in the demand for electricity and the costs of achieving these savings are the primary drivers in analyzing environmental effects. Estimates of source energy savings can be found in the utility impact analysis in chapter 14 of this technical support document (TSD). Detailed discussion on TSLs can be found in chapter 9 of this TSD.

The primary impact of the TSLs is in air quality resulting from changes in power plant operations and capacity additions. Therefore, much of this chapter describes the air quality analysis, and the latter part describes potential impacts to other environmental resources.

16.2 AIR EMISSIONS ANALYSIS

The primary focus of the environmental analysis is the impact on air quality of energy conservation standards for beverage vending machine equipment. The outcomes of the environmental analysis are driven by changes in power plant types and quantities of electricity generated under each of the alternatives. Changes in generation are described in the utility impact analysis in TSD chapter 14.

16.2.1 Air Emissions Descriptions

For each of the TSLs, DOE calculated total power-sector emissions based on output from NEMS-BT model (see TSD chapter 14). This analysis considers three criteria pollutants: nitrogen oxides (NO_x), mercury (Hg), and sulfur dioxide (SO_2). 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. More information on air pollution characteristics and regulations is available on the U.S. Environment Protection Agent (EPA)'s website, www.epa.gov. This analysis also considers carbon dioxide (CO_2) emissions from power plants.

16.2.1.1 Sulfur Dioxide

Sulfur dioxide is formed when fossil fuels (natural gas, oil, coal) are burned in electric generating stations and from other industrial combustion processes that use fossil fuels. In addressing SO_2 emissions, the Title IV of the Clean Air Act Amendments of 1990 set an SO_2 emissions cap on all affected electric generating units. The attainment of the emissions cap is flexible among generators and is enforced through the use of emissions allowances and tradable permits. Thus, DOE is not certain that there will be reduced overall SO_2 emissions from the standards. However, to the extent reduced power generation demand decreases the demand for and price of emissions allowance permits, there would be an environmentally related economic benefit from the proposed energy conservation standards reducing SO_2 emissions allowance demand. Furthermore, over time, if emissions decline, there is greater flexibility in reducing the ceiling amount. However, since DOE does not anticipate a nontrivial change in SO_2 emissions, these results are not reported in this chapter.

16.2.1.2 Nitrogen Oxides (NO_x)

Nitrogen oxides are the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of these NO_x 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 manmade sources of NO_x are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fossil fuels. Nitrogen oxides can also be formed naturally. Electric utilities account for about 22 percent of NO_x emissions in the United States.

16.2.1.3 Mercury (Hg)

Coal-fired power plants emit Hg present in coal during the burning process. While coal-fired power plants are the largest remaining source of human-generated Hg emissions in the United States, they contribute very little to the global mercury pool or to contamination of U.S. waters. U.S. coal-fired power plants emit Hg in three different forms: oxidized Hg (likely to be deposited within the continental United States); elemental Hg, which can travel thousands of miles before depositing to land and water; and Hg that is in particulate form. Atmospheric Hg is then deposited on land, lakes, rivers, and estuaries through rain, snow, and dry deposition. Once deposited, it can transform into methyl mercury and accumulate in fish tissue through bioaccumulation.

Americans are exposed to methyl mercury primarily by eating contaminated fish. Because the developing fetus is the most sensitive to the toxic effects of methyl mercury, women of childbearing age are regarded as the population of greatest concern. Children exposed to methyl mercury before birth may be at increased risk of poor performance on neurobehavioral tasks, such as those measuring attention, fine motor function, language skills, visual-spatial abilities, and verbal memory.

16.2.1.4 Carbon Dioxide (CO_2)

The EPA does not currently require emissions controls for CO_2 under the Clean Air Act. However, CO_2 is of interest because of its classification as a greenhouse gas (GHG) that traps the sun's radiation inside the Earth's atmosphere. GHGs occur either naturally in the atmosphere or as the 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, wood, and wood products are burned. 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 (Mt) are added to the atmosphere annually. In the United States, CO_2 emissions account for 84.6 percent of total GHG emissions.[1]

16.2.2 Air Quality Regulation

The Clean Air Act Amendments of 1990 list 189 toxic air pollutants of which emissions must be reduced and that EPA is required to control (www.epa.gov/ttnatw01/orig189.html). EPA has set national air quality standards for six common air pollutants (also referred to as "criteria" pollutants), two of which are SO_2 and NO_x. Also, the Clean Air Act Amendments of 1990 gave EPA the authority to control acidification and to require operators of electric power plants to reduce emissions of SO_2 and NO_x. Title IV of the 1990 amendments established a cap-and-trade program for SO_2 from certain sources. The cap-and-trade program is intended to help control acid rain and serves as a model for more recent programs with similar features.

In 2005, EPA issued the Clean Air Interstate Rule (CAIR) under sections 110 and 111 of the Clean Air Act (40 CFR parts 51, 96, and 97; www.epa.gov/cleanairinterstaterule). CAIR would permanently cap emissions of SO_2 and NO_x in eastern States of the United States. CAIR required large reductions of SO_2 and/or NO_x emissions across 28 eastern states and the District of Columbia. 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. Phase 1 caps for NOx are to be in place in 2009. Phase 1 caps for SO_2 are to be in place in 2010. The Phase 2 caps for both pollutants are due in 2015. Also in 2005, EPA issued the final rule, "Standards of Performance for New and Existing Stationary Sources: Electric Steam Generating Units" under sections 110 and 111 of the Clean Air Act (40 CFR parts 60, 63, 72, and 75). Referred to as the Clean Air Mercury Rule (CAMR), this rule was closely related to the CAIR and established standards of performance for Hg emissions from new and existing coal-fired electric utility steam generating units beginning in 2010. The CAMR regulated mercury emissions from coal-fired power plants.

On February 8, 2008, the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) issued its decision in State of New Jersey, et al. v. EPA,[2] in which the Court, among other actions, vacated the CAMR referenced above.

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. EPA*, which vacated the CAIR issued by the EPA on March 10, 2005.[3] On December 23, 2008, the D.C. Circuit decided to allow CAIR to remain in effect until it is replaced by a rule consistent with the court's earlier opinion. *North Carolina v. EPA*, 550 F.3d 1176 (remand of vacatur).[4]

16.2.2.1 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 CO_2 as major contributors to climate change. Because this final rule will likely decrease CO_2 emission rates associated with beverage vending machines and are from the fossil fuel sector in the United States, DOE examines the impacts and causes of climate change and then the potential impact of the final rule on CO_2 emissions and global warming.

16.2.2.2 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.

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

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 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.

The IPCC Report describes incremental impacts associated with the rise in temperature. At ranges of incremental increases to the global average temperature with either "high" or "very high" confidence, there is likely to be an increasing degree of impacts such as 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 that there likely will be some beneficial impacts on crop yields in temperate regions.

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

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

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 Mt of CO_2—equivalent of anthropogenic (man-made) GHGs are emitted every year. Of this annual total, fossil fuels contribute about 29 billion Mt of CO_2. 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.

Researchers have focused on considering atmospheric CO_2 concentrations that likely will result in some level of global climate stabilization, and the emission rates associated with achieving the "stabilizing" concentrations by particular dates. They associate these stabilized CO_2 concentrations with temperature increases that plateau in a defined range. For example, at the low end, the IPCC Report scenarios target CO_2 stabilized concentrations range between 350 parts per million (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 (about 1.3 °C to 1.7 °C above today's levels). To achieve concentrations between 350 ppm to 400 ppm, the IPCC scenarios present that there would have to be a rapid downward trend in total annual global emissions of GHGs to levels that are 50 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.

The Beneficial Impact of the Rule on CO_2 Emissions. If finalized, it is anticipated that the Rule will reduce energy-related CO_2 emission rates, particularly those associated with energy consumption in buildings. In the United States, the U.S. Energy Information Administration reports in its *2009 Annual Energy Outlook* (DOE/EIA 2009) that U.S. annual energy-related emissions of CO_2 in 2007 were about 6.0 billion Mt (about 20 percent of the world energy-related CO_2 emissions and about 12 percent of total global GHG emissions), of which 2.34 billion Mt were attributed to residential and commercial buildings sector (including related energy-using equipment such as beverage vending machines). 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. In the AEO 2009 Updated Reference case,[5] EIA projected that annual energy-related CO_2 emissions would grow from 6.0 billion Mt in 2007 to 6.2 billion Mt in 2030, an increase of 4 percent (Table 16.2.1, which is based on the Updated Reference Case), while emissions attributable to electricity consumption by the commercial sector would grow from 0.87 to 1.1 billion Mt, an increase of 25.6 percent.

Table 16.2.1 Summary of Emissions Reductions by Trial Standard Levels for Beverage Vending Machines (cumulative reductions, 2012–2042)

Emissions Reductions		**TSLs for Class A Beverage Vending Machines**						
		1	**2**	**3**	**4**	**5**	**6**	**7**
CO_2, *Mt*		0.40	1.89	4.18	6.45	7.63	8.40	10.22
NO_x, thousand tons, *kt*		0.13	0.65	1.43	2.20	2.60	2.87	3.49
Hg, tons, *t*	Low	0	0	0	0	0	0	0
	High	0.008	0.037	0.082	0.127	0.150	0.165	0.201
Emissions Reductions		**TSLs for Class B Beverage Vending Machines**						
		1	**2**	**3**	**4**	**5**	**6**	NA*
CO_2, *Mt*		0.16	0.24	1.19	1.36	3.66	4.08	--
NO_x, *kt*		0.05	0.08	0.41	0.46	1.25	1.39	--
Hg, *t*	Low	0	0	0	0	0	0	--
	High	0.003	0.005	0.023	0.027	0.072	0.080	--

* Not applicable. There is no TSL 7 for Class B equipment.

As computed for the AEO 2009 Updated Reference case and extrapolated to 2042, the cumulative U.S. energy-related CO_2 emissions from 2012–2042 are described at about 190 billion Mt. The estimated cumulative CO_2 emission reductions from a beverage vending machine efficiency standard (shown as a range of alternative TSLs) during this same 30-year period are indicated in Table 16.2.1. The estimated CO_2 emission reductions in Table 16.2.1 are calculated using NEMS-BT model.

The estimated savings, which are at most 0.01 percent of U.S. energy-related emissions of CO_2 (at TSL 7 for Class A beverage vending machines and TSL 6 for Class B beverage vending machines), comprise an even smaller fraction of U.S. and world emissions of GHGs. However, the savings would likely reduce the overall U.S. CO_2 emissions rate, compared to the U.S. CO_2 emissions rate absent an increase in the energy efficiency of beverage vending machines.

The Incremental Impact of the Rule on Climate Change. It is difficult to correlate specific emission rates with atmospheric concentrations of CO_2 and specific atmospheric concentrations with future temperatures because the IPCC Report describes a clear lag in the climate system between any given concentration of CO_2 (even if maintained for long periods) and the subsequent average worldwide and regional temperature, precipitation, and extreme weather regimes. For example, a major determinant of climate response is "equilibrium climate sensitivity," a measure of the climate system response to sustained radioactive forcing. It is defined as the global average surface warming following a doubling of CO_2 concentrations. The IPCC Report describes its estimated, numeric value as about 3 °C, but the likely range of that value is 2 to 4.5 °C, with cloud feedbacks the largest source of uncertainty. Further, as illustrated above, the IPCC Report scenarios for stabilization rates are presented in terms of a range of concentrations, which then correlates to a range of temperature changes. Thus, climate sensitivity is a key uncertainty for CO_2 mitigation scenarios that aim to meet specific temperature levels.

Because of how complex global climate systems are, it is difficult to know to what extent and when particular CO_2 emissions rates will impact global warming. However, as Table 16.2.1 indicates, the Rule will likely reduce CO_2 emissions rates from the fossil fuel sector.

16.2.3 Analytical Methods for Air Emissions

NEMS-BT incorporates capabilities to assess compliance with SO_2 restrictions specified in the Clean Air Act and its amendments. Clean Air Act provisions include New Source Performance Standards, and Revised New Source Performance Standards. The version of NEMS-BT in 2009 also includes provisions for the CAIR, which imposes stricter restrictions on SO_2 and NO_x for some states, and the CAMR, which imposed a national Hg constraint. As discussed earlier in section 16.2.2, on December 23, 2008, the D.C. Circuit decided to allow CAIR to remain in effect until it is replaced by a rule consistent with the court's earlier opinion. *North Carolina* v. *Environmental Protection Agency*, 550 F.3d 1176 (D.C. Cir. 2008) (remand of vacatur). Therefore, DOE established NO_x emissions specified by NEMS-BT as the basis to estimate the reduction in NO_x emissions in the 22 States not subject to the cap and trade regime created by CAIR. Because the 28 States and District of Columbia covered by CAIR opted to reduce NO_x emissions through participation in cap-and-trade programs for electric generating units, emissions from these sources are capped across the CAIR region. For the 28 eastern States and D.C. where CAIR is in effect, no NO_x emissions reductions will occur due to the permanent cap. Table 16.2.1 shows the NO_x emission reductions calculated by TSL.

With respect to Hg, on February 8, 2008, the D.C. Circuit issued its decision in *New Jersey*, *et al.* v. *EPA*, in which the Court, among other actions, vacated the CAMR referenced above. Even though CAMR has been vacated, the *AEO2009* Reference Case assumes that emissions of Hg would decline over time as shown in Table 16.2.2. The NEMS-BT has only rough estimates of mercury emissions; therefore, the range of emissions used in the NOPR remained appropriate given these circumstances. Rather than using the NEMS-BT model, DOE established a range of Hg emission rates to estimate the Hg emissions that could be reduced through standards. DOE's low estimate assumed that future standards would displace electrical generation only from natural gas-fired power plants, thereby resulting in an effective emission rate of zero. (Under this scenario, coal-fired power plant generation would remain unaffected.) The low-end emission rate is zero because natural gas-fired power plants have virtually zero Hg emissions associated with their operation.

DOE's high estimate was based on a nationwide mercury emission rate from the AEO2009 Updated Reference Case. Because power plant emission rates are a function of local regulation, scrubbers, and the mercury content of coal, it is extremely difficult to identify a precise high-end emission rate. Therefore, the most reasonable estimate is based on the assumption that all displaced coal generation would have been emitting at the average emission rate for coal generation as specified by the AEO2009 Updated Reference Case. As noted previously, because virtually all mercury emitted from electricity generation is from coal-fired power plants, DOE based the emission rate on the tons of mercury emitted per terra-watt hour (TWh) of coal-generated electricity due to the standards considered in the utility impact analysis. Table 16.2.1 shows the estimated reduction in mercury emissions from 2012–2042. Based on the emission rate from the AEO2009 Updated Reference Case, DOE derived a high-end emission rate of 0.0255 tons per TWh. To estimate the reduction in mercury emissions, DOE multiplied the emission rate by the reduction in coal-generated electricity due to the standards considered in the utility impact analysis. Coal-fired electric generation is the single largest source of electricity in the United States. Because the mix of coals used significantly affects the emissions produced, the model includes a detailed representation of coal supply. The model considers the rank of the coal as well as the sulfur contents of the fuel used when determining optimal dispatch.

Within the NEMS-BT model, planning options for achieving emissions restrictions in the Clean Air Act Amendments include installing pollution control equipment on existing power plants and building new power plants with low emission rates. These methods for reducing emission are compared to dispatching options such as fuel switching and allowance trading. Environmental regulations also affect capacity expansion decisions. For instance, new plants are not allocated SO_2 emissions allowances according to the Clean Air Act Amendments. Consequently, the decision to build a particular capacity type must consider the cost (if any) of obtaining sufficient allowances. This could involve purchasing allowances or over complying at an existing unit.

Modeling of SO_2 trading tends to imply that the physical emissions effects will be zero, as long as emissions are at the allowed ceiling. Thus, DOE is not certain that there will be reduced overall SO_2 emissions from the standards and DOE does not report SO_2 results here.

16.2.4 Effects on Power Plant Emissions

Table 16.2.2 shows the *AEO2009* Updated Reference Case power plant emissions in selected years. The Reference case emissions are the emissions shown by the NEMS-BT model to result if none of the TSLs is promulgated.

Table 16.2.2 Emissions Forecast for AEO 2009 Reference Case

NEMS-BT Results**	2006	2010	2015	2020	2025	2030
CO_2, *Mt/yr**	2,346	2,340	2,379	2,468	2,533	2,637
NO_x, *kt/yr*	3.413	2.282	2.047	2.072	2.073	2.099
Hg, *t/yr*	49.03	43.74	29.68	29.16	29.13	28.76

* Mt, equivalent to 1.1 short tons. Emissions are from all energy-related sources.
** Emissions are from electric generation.

16.2.5 Effects on Upstream Fuel-Cycle Emissions

Fuel-cycle emissions 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. Upstream processes include the mining of coal or extraction of natural gas, physical preparatory and cleaning processes, and transportation to the power plant. The NEMS-BT does a thorough accounting of emissions at the power plant due to downstream energy consumption, but does not account for upstream emissions (*i.e.*, emissions from energy losses during coal and natural gas production). Thus, this analysis reports only power plant emissions.

However, previous DOE environmental assessment documents have developed qualitative estimates of affects on upstream fuel-cycle emissions. These emissions factors provide the reader with a sense of the possible magnitude of upstream effects. These upstream emissions would be in addition to emissions from direct combustion. Relative to the entire fuel cycle, estimates based on the work of Dr. Mark DeLuchi and reported in earlier DOE environmental assessment documents find that an amount approximately equal to 8 percent by mass of emissions (including SO_2) from coal production are due to mining, preparation that includes cleaning the coal, and transportation from the mine to the power plant.[6] Transportation emissions include emissions from the fuel used by the mode of transportation that moves the coal from the mine to the power plant.

In addition, based on Dr. DeLuchi's work, DOE estimated that approximately an amount equal to 14 percent of emissions from natural gas production result from upstream processes. Emission factor estimates and corresponding percentages of contributions of upstream emissions from coal and natural gas production, relative to power plant emissions, are shown in Table 16.2.3 for CO_2, and NO_x. The percentages are relative to power plant emissions and provide a means to estimate upstream emission savings based on changes in emissions from power plants. The previous section indicates slight overall reductions in CO_2, and NO_x. Thus, very small reductions in upstream emissions of air pollutant could be expected. This approach does not address Hg emissions.

Table 16.2.3 Estimated Upstream Emissions of Air Pollutants as a Percentage of Direct Power Plant Combustion Emissions

Pollutant	Combustion Emissions %	
	Coal	Natural Gas
CO_2	2.7	11.9
NO_x	5.8	40

16.3 WETLAND, ENDANGERED AND THREATENED SPECIES, AND CULTURAL RESOURCES

DOE's proposed action is not site-specific, nor would it affect land disturbance or use due to beverage vending machine being installed in commercial buildings. Therefore, none of the proposed TSLs is expected to affect the quality of wetlands, or threatened or endangered species. Further, this action is not expected to impact cultural resources such as historical or archaeological sites.

16.4 SOCIOECONOMIC IMPACTS

DOE's analysis shows that the increase in the first cost of purchasing a more efficient beverage vending machine at the proposed standard level is completely or nearly offset by a reduction in the life-cycle cost (LCC) of owning a more efficient piece of equipment. In other words, the customer will pay lower operating costs over the life of the equipment even through the first cost increases. The complete analysis and its conclusions are presented in chapter 8 of the TSD.

For the subgroup of customers that are manufacturing facilities, DOE determined that the average LCC impact is similar to that for the full sample of customers. Therefore, DOE concludes that the proposed action would have no significant socioeconomic impact on a sub-group of customers. For a complete discussion on the LCC impacts on manufacturing facilities sub-group (see chapter 12 of the TSD).

Table 16.4.1 shows the mean LCC savings for both the full sample of customers and manufacturing facilities as the sub-group for beverage vending machines.

Table 16.4.1 Mean Life-Cycle Cost Savings for All Customers and Sub-Group, Beverage Vending Machines (2008$)

Customer Type	TSL *$*						
	1	**2**	**3**	**4**	**5**	**6**	**7**
All Customers–Class A Equipment	154	204	245	307	322	316	(1,194)
Manufacturing Subgroup–Class A Equipment	103	136	150	184	186	171	(1,326)
All Customers–Class B Equipment	47	56	49	39	(525)	(2,216)	NA*
Manufacturing Subgroup–Class B Equipment	28	28	10	(1)	(576)	(2,227)	NA

* Not applicable. There is no TSL 7 for Class B equipment.

16.5 ENVIRONMENTAL JUSTICE IMPACTS

According to Executive Order 12898 of February 11, 1994, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” DOE is required to examine the effect of more stringent energy-efficiency standards on (1) small businesses that either manufacture or use beverage vending machines; (2) manufacturers of niche products related to beverage vending machines; and (3) small businesses operated by disadvantaged or minority populations.

DOE identified manufacturing facilities as a sub-group that possibly could be disproportionately affected by beverage vending machine energy conservation standards. As described in chapter 12 of the TSD, DOE found that there was no disproportionately high and adverse human health or environmental effects on manufacturing facilities that would result from the proposed energy conservation standards.

16.6 NOISE AND AESTHETICS

Improvements in efficiency of beverage vending machine 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 result from improved heat exchanger designs using increased levels of copper and more efficient compressors. These design changes 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.

16.7 SUMMARY OF ENVIRONMENTAL IMPACTS

Table 16.7.1 and Table 16.7.2 summarize anticipated environmental impacts for each of the TSLs across all equipment types. Air quality impacts were modeled for each of the TSLs. The summary table shows cumulative changes in emissions for CO_2, NO_x, and Hg over the period 2012 to 2042. Cumulative CO_2, NO_x, and Hg emissions show a decrease compared to the reference case.

Upstream fuel cycle emission of CO_2 and NO_x are described but not quantified in section 16.2.5. The text describes potential reductions in fuel cycle emissions as percentage of decreases in power plant emissions. This qualitative approach suggests that upstream fuel cycle emissions would decrease and provides a sense for the magnitude of effects, however, DOE does not report actual estimates of the effects. This approach does not address mercury emissions.

Socioeconomic impacts are presented as changes in life cycle costs. No impacts are anticipated in the area of environmental justice; wetlands, endangered and threatened species, and cultural resources; or noise and aesthetics.

Table 16.7.1 Environmental Impact Analysis Results Summary, Class A Beverage Vending Machine Equipment

Environmental Effects	Reference Case*	TSL						
		1	2	3	4	5	6	7
Cumulative Emission Reductions**								
CO_2, *Mt*	190,106	0.40	1.89	4.18	6.45	7.63	8.40	10.22
NO_x, *kt*	65,198	0.13	0.65	1.43	2.20	2.60	2.87	3.49
Hg, *t*	912	0.008	0.037	0.082	0.127	0.150	0.165	0.201
Fuel-Cycle (Upstream) Emissions	NA†	††	††	††	††	††	††	††
Wetlands, Endangered and Threatened Species; Cultural Resources	NA	--	--	--	--	--	--	--
Socioeconomic Impacts– Weighted Mean LCC Savings‡	NA	--	--	--	--	--	--	--
All Customers	NA	$154	$204	$245	$307	$322	$316	($1,194)
Manufacturing Facilities	NA	$103	$136	$150	$184	$186	$171	($1,326)
Environmental Justice	NA	--	--	--	--	--	--	--
Noise and Aesthetics	NA	--	--	--	--	--	--	--

* The reference case values reflect total cumulative emissions and life cycle costs in the absence of an energy conservation standard.
** Cumulative total is from 2012–2042. Negative values are in parentheses.
† NA means not applicable since this is the reference (base) case.
†† DOE does not report actual estimates of the effects of standards on upstream emissions, but section 16.2.5 provides a sense for the possible magnitude of effects.
‡ Values refer to life-cycle cost savings over the equipment lifetime.

Table 16.7.2 Environmental Impact Analysis Results Summary, Class B Beverage Vending Machine Equipment

Environmental Effects	Reference Case[*]	TSL					
		1	2	3	4	5	6
Cumulative Emission Reductions[**]							
CO_2, *Mt*	190,106	0.16	0.24	1.19	1.36	3.66	4.08
NO_x, *kt*	65,198	0.05	0.08	0.41	0.46	1.25	1.39
Hg, *t*	912	0.003	0.005	0.023	0.027	0.072	0.080
Fuel-Cycle (Upstream) Emissions	NA[†]	[††]	[††]	[††]	[††]	[††]	[††]
Wetlands, Endangered and Threatened Species; Cultural Resources	NA	--	--	--	--	--	--
Socioeconomic Impacts– Weighted Mean LCC Savings[‡]	NA	--	--	--	--	--	--
All Customers	NA	$47	$56	$49	$39	($525)	($2,216)
Manufacturing Facilities	NA	$28	$28	$10	($1)	($576)	($2,227)
Environmental Justice	NA	--	--	--	--	--	--
Noise and Aesthetics	NA	--	--	--	--	--	--

[*] The reference case values reflect total cumulative emissions and LCCs in the absence of an energy conservation standard.
[**] Cumulative total is from 2012–2042. Negative values are in parentheses.
[†] NA means not applicable since this is the reference (base) case.
[††] DOE does not report actual estimates of the effects of standards on upstream emissions, but section 16.2.5 provides a sense for the possible magnitude of effects.
[‡] Values refer to life-cycle cost savings over the equipment lifetime.

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