Lighting Efficiency Standards in the Energy Independence and Security Act of 2007: Are Incandescent Light Bulbs "Banned"?

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Summary

The Energy Independence and Security Act of 2007 (P.L. 110-140) sets new performance standards for many common light bulbs. Tier I standards require a 25%-30% increase in the energy efficiency of typical light bulbs beginning in 2012, and still greater improvements through Tier II standards starting in 2020. Supporters expect these new measures to save consumers billions of dollars in electricity costs, offset the need to build dozens of new power plants, and cut millions of tons of greenhouse gas emissions in the United States.

Efficient lighting products such as compact fluorescent lights and light emitting diodes have advanced rapidly in recent years. Light quality has improved, costs have declined, and consumer choice has expanded. Still, many consumers prefer traditional incandescent lighting products. Incandescent bulbs are not banned or outlawed by the new law, but they will need to meet the new efficiency standards to remain on the market. Some new incandescent products already available can meet Tier I requirements, and at least one manufacturer claims that it will have advanced incandescent products available in time to meet the Tier II requirements.

The Light Bulb Freedom of Choice Act (H.R. 5616) was introduced on March 13, 2008, to repeal the new standards unless special provisions are met.

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Introduction

There are an estimated 4 billion incandescent light bulbs (sometimes referred to as "lamps") in use in the United States.[1] The basic technology in these bulbs has not changed substantially since they were first introduced over 125 years ago. They convert less than 10% of the energy they use into light and over 90% into heat. Some critics refer to traditional incandescent bulbs as "resistance heaters that also give off light."

DOE estimates that about 10% of the average U.S. residential electricity bill is spent on lighting. Illuminating U.S. homes and businesses consumes nearly 300 billion kilowatt-hours of electricity each year, equivalent to the output from about 100 large power plants.[2] The environmental impacts of the electricity production used to power that lighting—including greenhouse gas emissions—are well documented.[3]

Given rising attention to energy prices, energy insecurity, and climate change, Congress passed the Energy Independence and Security Act of 2007 (hereafter referred to as the "Energy Independence Act") to address, among other things, the efficiency of current incandescent light bulbs. By one projection, the new standards will cumulatively save more than $40 billion on electricity costs and offset about 750 million metric tons of carbon emissions by the year 2030.[4]

New Energy Efficiency Requirements for Light Bulbs

The Energy Independence Act sets new performance requirements for certain common light bulbs. The Tier I requirements, set to take effect in 2012-2014, require these bulbs to be 25% to 30% more efficient than today's products (see **Table 1**). Stricter Tier II standards will be defined in an upcoming DOE rulemaking that may require that lamps produced in 2020 use at least 60% less energy than today's bulbs.

[1] *U.S. Lighting Market Characterization, Volume 1: National Lighting Inventory and Energy Consumption Estimate*, Navigant Consulting, 2002.

[2] A large power plant is defined here as 500 megawatts of capacity. For a review of electricity units and definitions, see *Electricity Basics 101*, U.S. Energy Information Administration http://www.eia.doe.gov/basics/electricity_basics.html.

[3] See, for example, CRS Report RL34018, *Air Quality: Multi-Pollutant Legislation in the 110th Congress*, by (name redacted) and (name redacted), or *Power Scorecard* at http://www.powerscorecard.org/.

[4] "Energy Bill Savings Estimates as Passed by the Senate," American Council for an Energy Efficient Economy, December 14, 2007.

Table 1. Summary of Performance Standards for Certain Light Bulbs in The New Energy Independence Act

Electricity Use in Today's Bulbs (Watts)	Light Output Range (Lumens[a])	Future Performance Standard (Watts)	Effective Date
100	1,490-2,600	72	January 1, 2012
75	1,050-1,489	53	January 1, 2013
60	750-1,049	43	January 1, 2014
40	310-749	29	January 1, 2014

a. A lumen is a measure of the amount of light that reaches an area of interest.

Some bulbs are not covered by the requirements. There are 22 categories of special-use incandescent bulbs that are exempted from the standards, including appliance bulbs, plant lights, infrared bulbs, bug lights, rough-service lamps, and reflector (i.e, recessed or flood) bulbs. The DOE is required to undertake an additional rulemaking no later than June 2009 to set new standards for reflector lights. DOE is also directed to monitor sales of key categories of excluded bulbs to ensure that the exemptions are not exploited.

Are Incandescent Bulbs Banned?

Incandescent bulbs are not banned or prohibited by the new law. Instead, a performance standard is set for non-excluded categories of bulbs, requiring them to meet minimum energy efficiency requirements. If bulbs cannot meet the standards as defined above, suppliers are not allowed to continue selling them. The law does not specify technology winners and losers. Rather, the intent of the standard is to draw more efficient light bulbs into the market.

Manufacturers are introducing advanced incandescent bulbs, such as halogen lamps with special coatings, that meet the standards or are very close to doing so. In October 2007, Philips Lighting Company introduced the Halogená Energy Saver incandescent bulb series that reportedly meets Tier I standards.[5] The 70-watt bulb in this product line, for example, looks similar to "regular" light bulbs and can be used in table lamps, floor lamps, and ceiling fixtures. It provides high-quality light, equivalent to the output from many traditional 100-watt bulbs.

Other new incandescent products will likely be introduced by the effective dates of the law. General Electric (GE), for example, says that it will have an incandescent bulb that uses half the energy of today's bulbs by 2010 and only a quarter by 2012.[6] Non-incandescent products, including compact fluorescent lamps[7] (CFLs) and light emitting diode[8] (LED) bulbs, can already meet Tier I standards.

[5] Conversation with Chris Montemurro, Philips Lighting Company, February 18, 2008.

[6] "GE Announces Advancement in Incandescent Technology; New High-Efficiency Lamps Targeted for Market by 2010," GE Press Release, February 23, 2007.

[7] A compact fluorescent lamp (CFL) is the generic name for a family of light bulbs with folded or spiral glass tubes that use less electricity than standard incandescent lights.

[8] A light emitting diode (LED) is a semiconductor material that emits light when stimulated by electrical current. Different colors of light can be produced by altering the chemical properties of the semiconductor.

Efficient Lighting Can Reduce Energy Costs and Use

Energy efficient light bulbs can save significant quantities of electricity compared to traditional incandescent bulbs. **Table 2** summarizes the characteristics of several types of bulbs. Although a CFL bulb is more expensive to purchase than a traditional incandescent bulb, its electricity savings recover the higher purchase price in several months, depending on use. The LED example in the table is not directly comparable to the other options because it produces a different type of light than incandescent and fluorescent bulbs.

Table 2. Characteristics of Selected Lighting Options

	100-watt Incandescent	70-watt Halogen Energy Saver	27-watt Compact Fluorescent	10-watt Light Emitting Diode[a]
Brightness (Lumens)	1,700	1,600	1,750	850 x 2
Life (Hours)	1,000	3,000	10,000	50,000
Color Rendering Index[b]	85-100	95-100	82-85	85
Typical Purchase Cost ($)	0.50	2-3	2-8	40-60 x 2
Energy Saving Relative to Incandescent (%)	—	30	73	80
Annual Electricity Cost ($)[c]	18.3	12.8	4.9	3.7
Time Required to Recover Purchase Cost (Months)	—	4-7	2-7	66-99

Source: CRS calculations.

a. The LED bulb in this table is not directly comparable to the other options due to current limitations in bulb availability and differences in light output. The LED bulb modeled here produces half the lumens of a comparable incandescent or CFL bulb. Cost calculations in the LED column thus assume that two 10-watt LEDs are needed to deliver an equivalent amount of light. Unlike the other options, LED lights deliver highly directional light, so this comparison may not be completely valid.

b. Color Rendering Index is a measure of lighting color quality ranging from 0 to 100, with natural daylight equal to 100.

c. Annual electricity cost is based on 5 hours per day of usage and electricity priced at 10 cents per kilowatt-hour. In a large scale lighting retrofit project, building engineers would also need to account for changes in heating and air conditioning requirements after switching to the "cooler" efficient light bulbs. For small projects, these costs are almost insignificant. See "The Cost-Effectiveness of Compact Fluorescents in Commercial Buildings," H. Chertoff, *Energy Pulse*, January 23, 2008.

Evaluation of Lighting Options

Consumers today have a wide range of product options to meet their lighting needs. Both traditional and efficient lighting products are now available at large retail stores and on the internet, as well as at some local supermarkets. These options often require consumers to decide what types of lighting best suits their needs.

Incandescent Bulbs

Traditional incandescent bulbs are preferred by some consumers because of their familiarity, low purchase price, and relatively high quality light. These bulbs are quiet, dimmable, and turn on instantly. Despite their high energy use and relatively short lifetimes, there is a reason this technology has survived for over 125 years. Advanced incandescent technology is now entering the market and could address the shortcomings of incandescent bulbs.

Fluorescent Lamps

Fluorescent lights have been used in commercial and industrial settings since the 1930s due to their lower operating costs. They were slower to enter residential markets until compact versions became available in the 1980s and 1990s.[9] Early brands had poor light quality and higher purchase costs, which gave many consumers a negative first impression of CFLs. Two decades of market pull and technology push strategies has led to improved quality and cheaper CFLs today.[10] There are now many varieties of CFLs that meet "Energy Star" certification requirements defined by the Environmental Protection Agency (EPA) and the DOE.[11] In 2007, nearly 300 million Energy Star certified CFLs were sold in the United States, doubling previous year sales, and accounting for 20% of the light bulb market.[12] There are inexpensive, high-quality CFLs available in retail stores and through the internet, but brands can vary significantly in quality. As described more fully below, CFLs have tradeoffs, including the fact that they contain small quantities of mercury.

Light Emitting Diodes (LEDs)

LEDs are ubiquitous. They are found in computers, radios, televisions, traffic lights, exit signs and holiday lights. However, they have only recently become available for general illumination. Manufacturers are developing new types of LED bulbs for general lighting and expect rapid cost reductions. Although LED bulbs are beginning to match CFL and incandescent alternatives in light quality, purchase costs are still an order of magnitude higher.

LEDs produce light in a way that is fundamentally different from incandescent or fluorescent bulbs.[13] LEDs used for general illumination are expected to be more efficient than CFLs in the near future, but remain slightly less so today. LEDs can produce almost any color light and last about five times longer than CFLs. They turn on instantly, contain no mercury, and—because they have no filament or fragile bulb—are not easily damaged by vibration or external shock.

[9] Two technological advances popularized CFLs: the ability to cost-efficiently manufacture the intricately bent, gas-filled fluorescent tubes, and the introduction of small electronic ballasts.

[10] See *Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market*, Pacific Northwest National Laboratory, June 2006.

[11] Energy Star is a labeling program for efficient equipment, buildings and lights administered by U.S. DOE and U.S. EPA. A list of Energy Star certified CFL products is available at http://www.energystar.gov/.

[12] "Sales of Compact Fluorescent Lights Jump to 20% of Market," U.S. DOE, January 15, 2008.

[13] The light is produced by passing a current through a semiconductor material.

But LEDs are not widely available in general illumination markets.[14] Besides high cost, LEDs can experience problems in cold (below 15°F) or hot (above 120°F) environments. With light that is highly directional or focused, LEDs currently seem better for task lighting than for general illumination. Some consumers complain that LED light is too cold or blue. These issues may be addressed as the technology matures.

Consumer Criticism of CFLs

Some consumers complain about the quality of CFL products. They report that CFLs generate harsh, unflattering light or that they don't last as long as advertised.[15] Some of these objections may be due to experience with earlier bulbs that had poor color temperature rendition or that were used incorrectly.[16] Some objections involve personal preference; CFLs may not be appropriate for every lighting application. CFLs are now available with a broad range of size, shape, brightness, and color temperature characteristics.

Consumers have also reported objections to noise and flicker in CFL bulbs. Most of these problems have been solved with the introduction of improved electronic ballasts,[17] although some low quality brands may still exhibit these problems.

There is concern about mercury in CFL bulbs. Used and disposed of properly, CFLs can actually reduce mercury in the environment due to the lower demand for coal-fired electricity—which emits that element to the atmosphere. Still, the EPA recommends special precautions in using and disposing of CFL bulbs.[18] For a more complete discussion of CFLs and mercury, see CRS Report RS22807, *Compact Fluorescent Light Bulbs (CFLs): Issues with Use and Disposal*, by (name redacted).

Another concern involves difficulty dimming CFL bulbs. There are new varieties of CFLs designed to be used with dimming switches. These versions cost more than standard CFLs and usually have only three settings (off, low, and high) compared to a full range of light output in incandescent bulbs. Some consumers also complain about the time lag[19] between when the light is turned on and when the bulb illuminates. Again, modern electronic ballasts have at least partially addressed this issue, but most CFLs still need to warm up before reaching full illumination. Advanced CFL products may overcome this consumer concern.[20]

[14] "Bright Lights, Big Legacy?," *Forbes*, July 23, 2007.

[15] "Any Other Bright Ideas," *New York Times*, January 10, 2008.

[16] It is important to use CFLs according to their intended design. Installing certain types of CFLs upside down in recessed fixtures, turning them on and off frequently, or using them with dimmer switches when they are not labeled to be used that way can significantly shorten bulb lifetime.

[17] Ballasts control the current and voltage to the bulb.

[18] See "Information on Compact Fluorescent Light Bulbs and Mercury," U.S. EPA, May 2007.

[19] CFLs typically take from 30 seconds to 3 minutes to warm up and reach full brightness depending on the type of ballast.

[20] New "cold cathode fluorescent lights" use electrodes without a filament and are reported to have full instant-on operation like incandescent bulbs and lifetimes of 50,000 hours.

Legislation

On March 13, 2008, the Light Bulb Freedom of Choice Act (H.R. 5616) was introduced to repeal the new lighting performance standards unless the Government Accountability Office finds that (1) consumers would obtain a net financial savings by switching to the more efficient bulbs, (2) no health risks would be introduced by the switch, and (3) total U.S. CO_2 emissions would decline by 20% by 2025 as a result of the switch.

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