Environmental and Energy Study Institute

Fact Sheet

Energy Efficiency Standards for Appliances, Lighting and Equipment

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More than 40 percent of the total energy consumed in the United States is used for operating buildings, and most of that energy goes toward appliances and building-related equipment. In accordance with the ***Energy Policy and Conservation Act* of 1975 (EPCA), as amended**, the U.S. Department of Energy (DOE) implements minimum efficiency standards for a wide range of appliances and equipment used in residential and commercial buildings. Within the parameters of technical feasibility and cost effectiveness, federal efficiency standards compel product designers and manufacturers to reduce the amount of energy and water necessary for the proper operation of appliances and other building equipment. Operational efficiency means less waste of natural and financial resources. The legal limit on energy/water consumption for designated products—applied equally to all manufacturers of those products—makes energy efficiency a priority instead of an afterthought or a competitive disadvantage. Regular updates of the standards ensure continuous improvement.

Like government safety standards, the benefits of efficiency standards are significant and widespread, including product innovation, billions of dollars in energy savings for consumers, and significant reductions in carbon emissions. Reduced emissions of mercury and nitrogen oxide from power plants also contribute to improving public health. Currently, DOE efficiency standards cover more than 60 categories of products, from dishwashers to vending machines to lighting technologies.[1] Implementing these standards reduced our national energy bill by about $80 billion in 2015, the equivalent of the electricity needs of nearly one in three American households.[2]

DEVELOPING EFFICIENCY STANDARDS

Appliance and equipment standards are developed and proposed as federal regulations, with input from manufacturers, energy experts, consumer advocates and other stakeholders. When new appliance standards go into effect, they prohibit the production, import or sale of products that do not meet the minimum efficiency requirements. The standards do not apply to installed equipment, and manufacturers have a grace period to sell inventory that does not meet the new standards.

The *Energy Policy and Conservation Act* authorizes DOE to enforce appliance and equipment standards. The Department's Office of Enforcement verifies that products sold in the United States meet the energy and water conservation standards. Certification, compliance, and enforcement regulations for these products and equipment are published in the Code of Federal Regulations (CFR) at **Title 10 part 429**.

DOE's Appliance and Equipment Standards Program is part of a suite of programs under the **Building Technologies Office (BTO)** that work in concert to help reduce building energy consumption. Other BTO programs and industry partnerships include building envelope and product research and development, performance testing and demonstration; industry technical assistance; and consumer information.

States may choose to enforce standards that are more demanding than federal standards by requesting a waiver from DOE. Along with the District of Columbia, 15 states currently enforce efficiency standards for appliances and equipment not yet covered by federal mandates.

ENERGY STAR

Other important strategies and policies that make buildings and building products more energy efficient include building codes; tax credits; utility rebates; industry product promotions; and award or certification programs. **ENERGY STAR**, for example, is a voluntary program administered jointly by the Environmental Protection Agency (EPA) and DOE to promote products and buildings that are even more energy efficient than those that meet the minimum federal standards.

In 2014 alone, consumers using ENERGY STAR products prevented more than 300 million metric tons of greenhouse gas emissions and saved homes and business $34 billion in utility costs. Over 50,000 product models on the market have earned the ENERGY STAR label (see www.energystar.gov/products for a full list of products that are covered by ENERGY STAR ratings).[3] Homes, commercial buildings, and industrial plants can also earn ENERGY STAR certifications based on an energy performance rating by EPA. As DOE releases updated federal minimum efficiency standards, ENERGY STAR requirements must adjust to maintain higher standards.

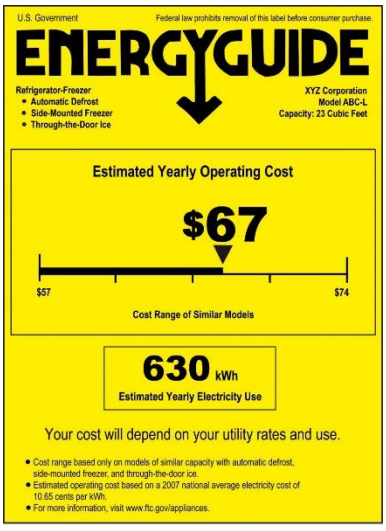
LED LIGHT BULBS

As another example, DOE's partnerships with lighting manufacturers to research, develop and test solid-state lighting technologies have resulted in market-ready **LED light bulbs** that are vastly more energy efficient than old incandescent technology. An LED (light-emitting diodes) bulb can last up to 25 times longer than an ordinary incandescent bulb, use 75 percent less energy to produce the same amount of light, and save consumers $119 in operational costs for each bulb over the course of its lifetime.[4]

LEDs are not new, but successful government-industry partnerships demonstrated their technical feasibility and cost effectiveness for a wide array of lighting applications. Worldwide, mandatory standards for lighting have increased dramatically, from covering less than 5 percent of energy consumption for lighting in 2000, to more than 60 percent by 2015.[5] In 2007, Congress directed DOE to develop new light bulb efficiency standards, which are in effect today.

ENERGY EFFICIENCY LABELING

While the DOE is responsible for implementing and enforcing standards, the Federal Trade Commission (FTC) is responsible for labeling, also in accordance with the *Energy Policy and Conservation Act*. The yellow FTC label on new appliances displays estimated energy-use and cost data to help consumers make informed purchases. It shows the appliance's key features (with similar models determining the cost comparison range[6]) as well as an ENERGY STAR logo (if the appliance is ENERGY STAR certified).



With its blue label, ENERGY STAR is now a familiar brand that recognizes above-average energy performance. Manufacturers offering several product lines at different price points might have appliances that meet minimum standards at a lower price than premium product lines with higher efficiency levels.

APPLIANCES AS PART OF OVERALL BUILDING EFFICIENCY

Appliances and building-related equipment such as electric motors, lighting, refrigerators, and water heaters account for almost all the energy used in buildings. DOE estimates that these products represent about 90 percent of residential energy use, 60 percent of commercial building energy use, and 30 percent of industrial energy use. And buildings are massive energy users: there are roughly 115 million households[7] and 5.6 million commercial buildings in the United States,[8] representing more than 40 percent of total energy consumption and 70 percent of electricity usage—more than for transportation and industry.[9]

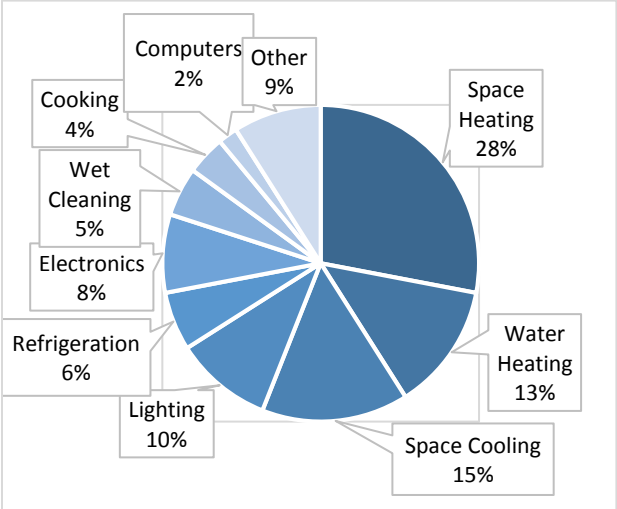


*Figure 1: **Residential Buildings Energy Consumption by End Uses** (2010). "Other" includes small electric devices and heating elements. Source: "2011 Buildings Energy Data Book," U.S. Department of Energy, Table 2.1.5.*

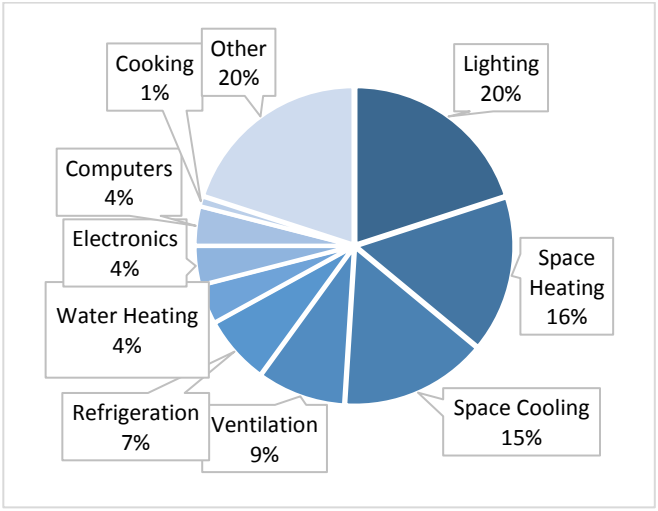


*Figure 2: **Commercial Buildings Energy Consumption by End Uses** (2010). "Other" refers to miscellaneous uses like medical equipment, ATM machines, and telecommunications equipment. Source: "2011 Buildings Energy Data Book," U.S. Department of Energy, Table 3.1.4.*

As big energy users, buildings are also a major source of greenhouse gas emissions. The bulk of building-related greenhouse gas emissions is from electricity usage in appliances and equipment (when the electricity is generated from fossil fuel-fired power plants), fossil fuel combustion for heating and cooking, poor management of waste and wastewater, and refrigerant leaks from air-conditioning systems.[10]

Apart from the energy consumed by appliances, lighting and equipment, a building's energy performance also depends on properly installing and maintaining this equipment over its lifetime, and the quality of the building envelope. Low or net-zero energy-use buildings feature an energy efficient envelope or shell, which is designed to work in harmony with the mechanical, electrical and plumbing systems. The tightness and quality of the building envelope play an enormous role in building energy performance and can last for decades, which makes building energy codes and voluntary standards for high-performance design very important.

Unlike building envelopes, which are designed to last for a long time, appliances and building equipment typically need to be replaced every 15 years or so. This provides a regular opportunity to improve a building's energy efficiency. Just as regularly updated building codes ensure new homes and buildings incorporate advanced and market-proven technologies, regularly updated appliance standards do the same for the products used in homes and buildings, reducing energy consumption and greenhouse gas emissions.

BENEFITS OF APPLIANCE AND EQUIPMENT STANDARDS

As a federal policy, appliance and equipment standards have historically received bipartisan support in Congress as well as support from manufacturers, which can be attributed to the powerful and positive impact they provide to consumers, businesses, and governments alike.

COST SAVINGS	DOE is required to establish appliance and equipment standards that are cost-effective for consumers. Manufacturers must guarantee that appliance and equipment price increases will be recovered through electricity savings within the product's lifetime. For example, residential air conditioners under the 2006 standard have a payback period of three years, compared to an average lifetime of 19 years.[11] Standards phased in from 1987 to 2013 are expected to cumulatively save consumers over $950 billion on utility bills through 2020 and over $1.7 trillion through 2030.[12]
ENERGY SAVINGS	Energy efficient appliances and equipment use technologies that are less energy intensive to reduce the amount of electricity used per product. For example, compared to a refrigerator from 1973, today's new fridges use one-third of the energy while costing consumers half the price and providing 20 percent more storage capacity.[13] Cumulatively, the standards phased in through 2013 are expected to save 70 quadrillion British thermal units (quads) of energy through 2020, growing to 128 quads by 2030. For reference, total U.S. energy consumption is roughly 100 quads per year.[14]
ENERGY SECURITY	Efficient appliances and equipment provide a cheaper, faster, and more reliable means of meeting increasing consumer demand without the need to develop or import more energy sources.
EMISSIONS REDUCTIONS	Energy efficient appliances and equipment contribute to a reduction in greenhouse gas emissions, since declines in electricity consumption require less energy generation from fossil fuel-fired power plants. According to DOE's Building Technologies Office, standards implemented since 1987 have avoided 2.3 billion tons of carbon dioxide (CO2) emissions, which is roughly equivalent to the annual emissions from 500 million automobiles.[15]
TECHNOLOGICAL INNOVATIONS	Appliance and equipment standards provide a means of ensuring that manufacturers move away from outdated technologies towards the most efficient, innovative, and competitive product designs.
ELIMINATING MARKET BARRIERS	Manufacturers benefit from national standards that provide market consistency and certainty across the United States, eliminating the need to comply with different state standards. Standards create economies of scale and simplify market entry for manufacturers, which reduces the retail cost of innovative technologies for consumers.
JOB CREATION	Standards create research, manufacturing, and installation jobs. The American Council for an Energy-Efficient Economy (ACEEE) estimates that 340,000 jobs could be attributed to existing appliance standards in 2010. By 2030, that number is expected to reach 380,000 jobs in the United States.[16]

PRODUCTS REGULATED BY FEDERAL STANDARDS

The following lists provide examples of products that are regulated by existing mandatory federal energy efficiency standards. An exhaustive list is published online by DOE's Office of Energy Efficiency and Renewable Energy (see the Appliance and Equipment Standards Program's "Standards and Test Procedures").

RESIDENTIAL/ CONSUMER	Furnaces, central air conditioners and heat pumps, refrigerators and freezers, dishwashers, microwave ovens, televisions, battery chargers, ceiling fans
COMMERCIAL	Commercial package air conditioners and heat pumps, water heating equipment, refrigerated beverage vending machines, walk-in freezers, electric motors
LIGHTING	Compact fluorescent lamps, incandescent lamps, light emitting diode (led) lamps, illuminated exit signs, traffic signal modules and pedestrian modules

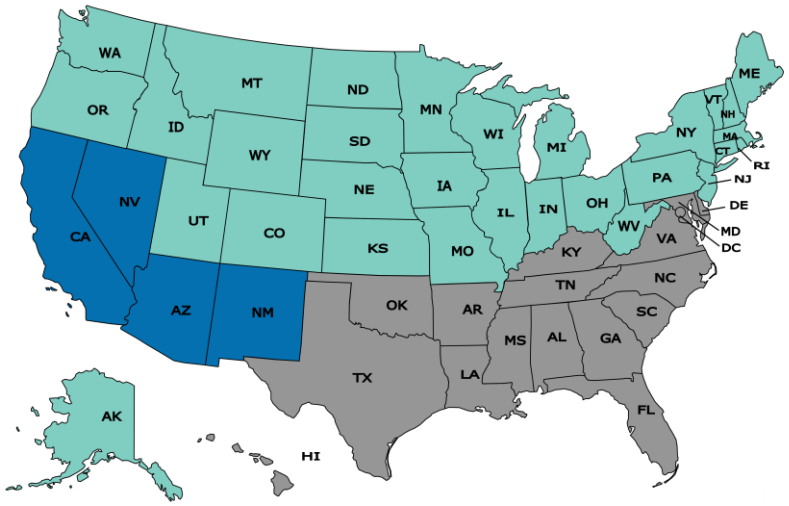
Products that are not yet federally regulated include computers, DVD players, and video game consoles. At the state level, California often takes the lead in energy efficiency regulations and currently regulates DVD players.[17] The California Energy Commission initiated a proposed rule in March 2015 to enact standards for desktop and laptop computers and monitors to target energy usage while these devices are idle.[18]

REGIONAL EFFICIENCY STANDARDS

Regional standards set minimum efficiency requirements based on the climate needs of various regions in the United States, rather than on a state or federal basis. Industry organizations such as the Air-conditioning, Heating and Refrigeration Institute (AHRI) have worked closely with DOE to develop metrics for regional standards for residential air conditioners, heat pumps, and furnaces appropriate for specific climates. The chart below describes the measurements used to assess the energy efficiency of heating and cooling products and to develop regional efficiency regulations based on minimum appliance ratings.

	SEER (SEASONAL ENERGY EFFICIENCY RATIO)	HSPF (HEATING SEASON PERFORMANCE FACTOR)	AFUE (ANNUAL FUEL UTILIZATION EFFICIENCY)
What does it measure?	Cooling efficiency	Heating efficiency	Heating efficiency
To which residential products does it apply?	Electric central air conditioners and heat pumps (in cooling mode)	Electric heat pumps (in heating mode)	Oil and gas heating furnaces
Does it also apply to commercial products?	Yes	Yes	No: Commercial boilers are rated for their "thermal efficiency"
How is it calculated?	SEER No. = total cooling output (Btu) of a unit during normal cooling season divided by total electric energy input (watt-hours) during the same season	HSPF No. = total heating output (Btu) during normal heating season divided by total electric energy input (watt-hours) during the same season	AFUE percentage = amount of heat produced by unit (usually in Btu) divided by the amount of fuel supplied to the furnace (in Btu)
Which values represent the highest efficiencies?	A higher SEER rating corresponds to a higher efficiency. Ratings range as high as SEER 24	A higher HSPF rating corresponds to a higher efficiency. Ratings range as high as HSPF 10.	A higher AFUE rating corresponds to a higher efficiency. The theoretical upper limit is 100 percent

The regions are defined according to their unique climate-related needs, which are quantified using "heating degree days" (HDD) to indicate residential energy demand for heating. States with a large value of population-weighted HDD fall in the North region, while states with lower levels form the South region. The Southwest comprises a third region, as illustrated on the map below.



NORTHERN REGION	
Packaged Units	**Split Systems**
A/C: 14 SEER	A/C: 13 SEER
H/P: 14 SEER, 8.0 HSPF	H/P: 14 SEER, 8.2 HSPF

SOUTHWESTERN REGION	
Packaged Units	**Split Systems**
A/C: 14 SEER, 11 EER	A/C: 14 SEER, 12.2 EER ≤ 3.5 tons, 11.7 EER ≥ 4 tons
H/P: 14 SEER, 8.0 HSPF	H/P: 14 SEER, 8.2 HSPF

SOUTHERN REGION	
Packaged Units	**Split Systems**
A/C: 14 SEER	A/C: 14 SEER
H/P: 14 SEER, 8.0 HSPF	H/P: 14 SEER, 8.2 HSPF

Figure 3: Regional standards effective January 1, 2015, for residential air conditioners (A/C) and heat pumps (H/P) in the North, South, and Southwest. Source: 2011-06-27 Energy Conservation Program: Energy Conservation Standards for Residential Furnaces and Residential Central Air Conditioners and Heat Pumps.

The new regional standards for residential air conditioners and heat pumps that have been in effect since January 2015 are expected to save $4.2 billion (156 billion kilowatt hours of electricity) for U.S. consumers over 30 years, which, for example, equates to the total electricity needs of all households in Indiana for three years.[19] Electricity savings from this enhanced air conditioner energy efficiency also leads to reduced greenhouse gas emissions: consumer electricity demand is expected to drop by 4,000 megawatts in the summer—an amount equivalent to the output of 13 large gas-fired power plants, which avoids up to 143 million metric tons of carbon dioxide emissions over 30 years.[23]

OUTLOOK FOR BUILDING-RELATED ENERGY EFFICIENCY

Energy- and water-efficient houses and buildings have lower monthly utility expenses. Energy efficiency, when designed as an integrated system, also enhances occupant comfort and health. Looking through a wider lens, energy-efficient buildings reduce pollution and greenhouse gas emissions. Several promising options exist to seize these benefits and continue making our buildings, and the appliances and equipment within them, more energy-efficient.

Standards for Electronic Devices

Most electronic products are not yet federally regulated by minimum energy efficiency standards, representing an opportunity for new standards to drastically cut energy use and consumer costs from this growing sector. Residential energy consumption has already declined over the past three decades. Federal efficiency standards, as well as state and local building energy codes for most major end-uses, including lighting, space cooling/heating, and water heating, are the main reasons for this decline.[20] However, some of these savings have been offset by the rising use of electronic devices (as well as the increase in average home size). Electricity use from electronic products is often referred to as “plug load,” and it includes the power electronics consume while on standby (a.k.a. "phantom energy" or "vampire power").[21] According to the U.S. Energy Information Administration (EIA), plug load has recently surpassed space heating and cooling as the largest energy load for residential buildings.

Additional Product Categories

The American Council for an Energy-Efficient Economy projects that new or updated federal efficiency standards for 34 product categories could be enforced by 2035. In 2035, the cumulative implementation of these new or revamped efficiency standards would decrease electricity consumption by seven percent and avoid 200 million metric tons of carbon dioxide emissions—equal to the annual emissions of 49 coal-fired power plants.[22]

Smart Appliances, Smart Buildings, Smart Grid

More manufacturers are including internet-connected (“smart”) features in thermostats and other products, enabling consumers to view real-time energy use, receive energy-related alerts, and manage appliance settings remotely.[23] Smart technologies enable two-way communication between energy utilities and end-users, providing the capability to respond to utility signals and limit energy use during more expensive peak demand times. Demand-side, grid-connected energy storage technologies, even low-tech ones like water heaters, will also play an important role in energy management. Smart technologies will enable grid operators to manage new sources of electricity generated from solar PV and other “distributed” (vs. central) renewable energy sources.

The Path to “Zero”

Ultra-energy efficient buildings that generate the power they need (or even excess power) from on-site renewable energy systems, often referred to as net-zero energy and energy-positive buildings, are being built now and are becoming ever more cost-effective. With current and emerging technologies, new markets and effective policies, the building sector has the potential to significantly reduce its energy use and the resulting expense and pollution. Technically, the building sector already has what it needs to change from energy consumer to energy producer.

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This fact sheet is available electronically (with hyperlinks and endnotes) at *www.eesi.org/papers*.

The Environmental and Energy Study Institute (EESI) is a non-profit organization founded in 1984 by a bipartisan Congressional caucus dedicated to finding innovative environmental and energy solutions. EESI works to protect the climate and ensure a healthy, secure, and sustainable future for America through policymaker education, coalition building, and policy development in the areas of energy efficiency, renewable energy, agriculture, forestry, transportation, buildings, and urban planning.

ENDNOTES

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