Opportunities for Appliance and Equipment Efficiency Standards in Texas

Maggie Eldridge, Andrew deLaski, and Steven Nadel

September 2006

Report Number ASAP-7/ACEEE-A063

Prepared for:
Texas State Energy Conservation Office

© American Council for an Energy-Efficient Economy
1001 Connecticut Avenue, NW, Suite 801, Washington, DC 20036
(202) 429-8873 phone, (202) 429-2248 fax, http://aceee.org

and

© Appliance Standards Awareness Project
20 Belgrade Avenue, Suite 7, Boston, MA 02131
(617) 363-9470 phone, (617) 363-9973 fax, http://standardsASAP.org

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Acknowledgments

The authors would like to thank ACEEE staff members Toru Kobu, Harvey Sachs, and Jennifer Thorne Amann for assistance with the analysis and Renee Nida for report editing and production. Many people provided useful data for the analysis. Particular thanks go to the Pacific Gas & Electric Company (PG&E) and the California Energy Commission (CEC), as many of the recommendations for Texas come from standards recently adopted by CEC based on technical information provided in the Codes and Standards Enhancement Initiative (CASE) reports prepared by PG&E and its consultants. We also thank Tom "Smitty" Smith (Texas Public Citizen), Paul Wattles (ERCOT), and Art Diem (EPA) for their assistance in developing the emission factors used in the analysis. This report was prepared for and funded by the Texas State Energy Conservation Office (SECO).

Executive Summary

States first set appliance energy efficiency standards starting in the 1970s and have continued to lead the development of new standards in recent years. Eleven states have adopted efficiency standards for various appliances and equipment since 2001. In 2005, the Texas legislature enacted HB 2129, which included the following directive:

> The state energy conservation office shall determine the feasibility and cost-benefit to consumers of setting appliance standards for appliances that are not currently regulated for energy efficiency in this state, if the office determines that the new standards would reduce the emission of air contaminants.

This report has been prepared on behalf of the Texas state energy conservation office in response to this directive from the legislature. A package of new appliance and equipment energy efficiency standards would be feasible and have benefits far exceeding costs for Texas consumers. Furthermore, an identified set of recommended standards would reduce the emission of air contaminants. The recommended standards for Texas would:

- save nearly 2.5 billion kilowatt-hours (kWh) annually by 2020 (enough to power about 200,000 average Texas households), growing to three billion kWh by 2030 (enough to power about 250,000 average Texas households);
- reduce consumer electric bills by about $230 million per year by 2020, growing to about 260 million per year by 2030;
- enhance electricity grid reliability by reducing peak demand by about 600 megawatts (MW) by 2020, growing to about 725 MW by 2030; and
- improve air and water quality by reducing pollutant emissions, including eliminating 1,000 metric tons of nitrogen oxides (NOx) emissions annually by 2020.

The ten specific energy-saving product standards recommended in this report were culled from an extensive array of existing state standards and well-established voluntary programs. Key criteria used in selecting the standards recommended for Texas included: magnitude of energy savings; cost-effectiveness; availability of compliant products; and ease of implementation for the state.

ACEEE recommends that Texas adopt standards for the following ten residential and commercial products:

- bottle-type water dispensers
- commercial hot food holding cabinets
- compact audio products
- DVD players and recorders
- metal halide lamp fixtures
- single-voltage external power supplies
- state-regulated incandescent reflector lamps
- walk-in refrigerators and freezers

- residential pool pumps
- portable electric spas

The recommended standards for these products are feasible because products that meet the standard are readily available in the marketplace from multiple manufacturers. Further, they are feasible for the state to implement because at least one state has already adopted each of these recommended standards.

For consumers, the costs are outweighed by the benefits for products meeting the recommended efficiency standards. The average ratio of benefits to costs exceeds seven to one for the product meeting the recommended standards (i.e., consumers save $8 on utility bills for every $1 due to efficiency improvements). Benefit-cost ratios range from 1.4 to 1 to more than 25 to 1 depending on the technology.

By significantly reducing demand for and use of electricity, appliance efficiency standards help the state to meet its growing needs for energy by cutting energy waste. By using our energy resources more efficiently, the state can help defer or even curb the need for new generation plants in the future, improve electricity reliability, save consumers money on their energy bills, and reduce future pollutant emissions.

1. Introduction

Energy-related problems increasingly entered the spotlight during the 2006 summer season. Volatile oil and natural gas prices, growing concerns over the stability of oil resources from the Mideast, and increasing demand on electric systems are among the issues that have sparked heightened interest in energy. Volatile international politics roil energy markets on a regular basis while at home summer heat waves raise concerns about the reliability and capacity of our electric systems. Air quality problems continue to affect much of Texas, with half the state's population living in areas not meeting air quality standards. The Houston area in particular suffers from some of the worst air quality problems of any U.S. city. Throughout energy policy discussions, energy efficiency repeatedly arises as one of our cheapest, cleanest, and most ready-to-implement energy resources. Benefits of using our existing energy resources more efficiently include improved electric grid reliability, less pollution, and lower costs for consumers and businesses. In addition, efficiency is a domestic energy resource in the sense that the resource is generated right here in the homes, businesses, and industries of Texas.

Appliance efficiency standards stand out as one of the most cost-effective and proven successful energy-saving policies at both the state and national levels. Standards, which require that certain energy-consuming products meet minimum energy-savings performance levels, save consumers and businesses money while improving electric system reliability and environmental quality. While existing energy efficiency standards at the national level are already saving energy in Texas and the other states, an increasing number of states have found that new state-level standards offer an opportunity to cut energy waste.

Several states have taken action in recent years to adopt their own efficiency standards where federal standards do not exist or, in some cases, where the federal government has failed to keep standards up to date. Several of these states have begun implementing their standards. Texas, as one of the very largest states and the nation's number one electricity generator, stands to reap substantial benefits by joining other states that have developed and implemented efficiency standards. As statewide electricity consumption continues to grow and the electric power system remains strained, Texas has the opportunity to reduce growth in statewide electric usage and demand, save consumers money, and reduce pollutant emissions through new appliance efficiency standards. State adoption of efficiency standards would defer and potentially even reduce the need for some additional power plants and help reduce emissions of greenhouse gases and the critical pollutants contributing to Texas's air quality problems. In addition, standards reduce strain on the power grid, helping improve the ability of the power grid to sustain heat waves and other incidents that can lead to blackouts.

1.1 History of Standards and Recent Action in the States

States have played a crucial role in the development of appliance and equipment efficiency standards in the U.S. In 1974, California adopted the first appliance efficiency standards, which applied to refrigerators, freezers, room air conditioners, and central air conditioners. Other states, including Florida, Kansas and New York, followed with similar standards in the late 1970s and early to mid-1980s. Due to broad support from the states and increasing concern from appliance manufacturers about the impact of differing state standards on manufacturers' ability to do business on a national basis, national appliance standards were pursued in 1986. The resulting legislation was signed by President Regan as The National Appliance Energy Conservation Act (NAECA) of 1987.

Continued state action on additional appliance standards prompted further national legislation, including the Energy Policy Act (EPAct) of 1992, which covered 12 additional products, and EPAct 2005, which set new efficiency standards for 16 products and directed the U.S. Department of Energy (DOE) to set standards via rulemaking for five additional products. In the past few years, 11 states have adopted new appliance efficiency standards covering between five and more than thirty products depending on the state. In the summer of 2005, Congress copied more than a dozen of these state standards into federal law, effectively extending the savings to all fifty states.[1] Table 1.1 summarizes the most important standards adopted by states that have not subsequently been superseded by equivalent national standards. (Maryland, New Jersey, and Connecticut were the first three states to enact standards during the recent period and, because they were among the earliest to act, each of their standards was incorporated in the 2005 federal law. As a result, they do not appear in Table 1.1. Many of the standards enacted by other states were also incorporated in EPAct 2005 and thus do not appear in Table 1.1.) For all of the products recommended for Texas, there are currently no federal standards and thus Texas would not be subject to federal preemption with regard to setting efficiency standards for these products.[2]

[1] Products covered by states and subsequently EPACT 2005 include: automatic commercial ice makers, ceiling fans and ceiling fan lights, commercial clothes washers, commercial pre-rinse spray valves, commercial refrigerators and freezers, mercury vapor lamp ballasts, illuminated exit signs, large packaged air conditioners, low-voltage dry-type transformers, torchiere light fixtures, traffic signals, and gas-fired unit heaters. Under the rules of federal preemption, states that had standards for products subsequently covered by federal legislation may enforce their state standards until the federal standards for these products go into effect, but additional states may not enact standards for products with specific standards set in federal law.

[2] Under federal law, states may implement a standard tougher than the federal one for a federally regulated product only by demonstrating a compelling state interest to DOE, which must review and grant waivers from preemption. For the purposes of this report, we only considered for Texas products not subject to federal preemption.

Table 1.1 Products Covered by Various States' Standards

Product	Arizona	California	Massachusetts	New York	Oregon	Rhode Island	Vermont	Washington
Bottle-type water dispensers		X				X		
Commercial hot food holding cabinets		X				X		
Consumer audio and video equipment		X		O				
Digital television adapters		X		O				
General service incandescent lamps		X						
Liquid-immersed transformers			X					
Medium-voltage dry-type distribution transformers			X				X	
Metal halide lamp fixtures	X	X	X	X	X	X	X	X
Pool heaters not covered by federal standards		X						
Pool pumps		X						
Portable electric spas (hot tubs)		X						
Residential furnaces & boilers			X*			X*	X*	
Residential furnace fans			X			X	X	
Single-voltage external power supplies	X	X	X	O	X	X	X	X
State-regulated incandescent reflector lamps		X	X	O	X	X	X	X
Walk-in refrigerators & freezers		X				X		

Key: X = standard adopted, O = standard pending

* State must seek a waiver from federal preemption to implement this standard.

1.2 Rationale for Standards

By setting a minimum-efficiency level, standards remove the most inefficient products from the market and ensure that basic efficiency improvements are incorporated into all new products, thus providing all buyers a minimum level of efficiency performance. Without standards, in many cases, only premium products include efficiency improvements. Standards can help bring down costs for energy-efficient technologies due to economies of scale and increased competition. Standards encourage manufacturers to focus on how to achieve efficiency improvements at minimum cost as they compete for the most price-sensitive portion of the market. As a result, higher-efficiency products become more affordable and widely available and all consumers enjoy the benefits from advances in efficiency performance.

Minimum-efficiency standards make sense when high-efficiency products are readily available or can be readily produced and are cost-effective, but, due to a number of market barriers, many consumers and businesses are purchasing less efficient products. These demand- and supply-side market barriers include:

Demand-Side Barriers

- *Lack of awareness:* Many purchasers underestimate the amount of energy consumption and the associated environmental impacts of operating the equipment. Very often, they are not even aware that different models can consume significantly different amounts of energy and that buying more efficient products can lead to energy and utility bill savings.

- *Uninformed decision-makers/"panic purchases":* Even when the purchaser is aware of variations in energy efficiency, often he or she is too busy or rushed to research the cost-effectiveness of a decision, or information on high-efficiency products is not readily available. Many of these products are purchased once in a decade, so maintaining awareness to facilitate an occasional decision is not something most consumers can do. When purchases are made, often the buyer is in a rush (e.g., a broken-down walk-in refrigerator must be replaced quickly). In such "panic purchase" situations, efficiency performance gets little attention. In the commercial/industrial sector, many purchasing decisions are made by purchasing or maintenance staff that are unfamiliar with the relative efficiencies and operating costs of the equipment they purchase.

- *Third-party decision-makers ("split incentive"):* Many times the decision-maker (e.g., developer or landlord, purchasing department, etc.) is responsible for purchasing equipment but someone else (e.g., tenant, operating department, etc.) is responsible for paying the energy bills. In these instances, the purchaser tends to buy the least expensive equipment because he or she receives none of the benefits from improved equipment efficiency.

- *Financial procedures that overemphasize initial costs and de-emphasize operating costs:* In the commercial/industrial sector, accounting procedures often closely scrutinize capital costs, favoring purchase of inexpensive equipment, while operating costs are generally less scrutinized. Furthermore, when operating costs are reduced, the savings typically show up in a corporate-level account and are rarely passed on to the department that made the decision and the investment. This diversion of benefits discourages energy-saving investments (Nadel and Suozzo 1996).

- *Small per unit savings:* While per unit savings may seem significant to the individual consumer for some appliances and equipment types (e.g., heating and cooling equipment), for others, per unit savings may be so small as to be inconsequential to the individual consumer. For example, an efficient external power supply for electronic equipment may save less than a dollar's worth of electricity a year, an amount unlikely to influence many consumers' purchase decisions. However, because about 12 million or so of these devices are sold in Texas each year, large energy savings are at stake.

Supply-Side Barriers

- *Limited stocking of efficient products:* Equipment distributors generally have limited storage space and therefore only stock equipment that is in high demand. This creates a "Catch-22" situation: users purchase inefficient equipment so distributors only stock inefficient equipment. Purchasing efficient equipment thus may require a special order, which takes more time. Most equipment that fails needs to be replaced immediately. Thus, if efficient equipment is not in stock, even customers who want efficient equipment are often stuck purchasing standard equipment (Nadel and Suozzo 1996).

- *Efficiency bundled into premium products only:* Often manufacturers will produce commodity-grade and value-added product lines. The commodity-grade line just meets efficiency standards and includes only basic features. The value-added line includes improved efficiency and other extra non-energy features at a significantly higher cost than commodity-grade products. A portion of the extra cost is for the improved efficiency but much of the extra cost is for the added “bells and whistles.” Consumers desiring improved efficiency without the extra features are out of luck.

- *Manufacturer price competition:* Since manufacturers are competing for market share, if a manufacturer voluntarily increases efficiency in a commodity product line, they may find it impossible to pass on even small product cost increases to consumers without risking loss of market share. A good example is compact audio equipment—energy savings could be achieved with very small incremental cost but manufacturers have been reluctant to participate in voluntary programs. The national market share of compact audio equipment that meets the voluntary ENERGY STAR® specification is only about 17%. In contrast, mandatory standards ensure a level playing field for all manufacturers.

Besides minimum-efficiency standards, a number of other program and policy options are available to overcome these barriers, including education programs, rebate programs, and building code requirements. However, none of these options have the energy-saving impact of minimum-efficiency standards because the options do not affect all purchase decisions. Education programs generally only reach a small fraction of decision-makers. For the products we recommend in this report, there either is no EPA/DOE ENERGY STAR program or ENERGY STAR products generally have a market share of much less than 50% (Nadel et al. 2003).[3] Utility incentive programs likewise generally reach less than 50% of the eligible market (Nadel, Pye, and Jordan 1994). For education programs or incentive programs to reach larger portions of the market would be prohibitively expensive in nearly all cases. Building codes generally apply only to new or substantially renovated buildings, leaving the large number of existing buildings unaffected. Also, building codes generally cover only products that are installed in buildings prior to occupancy (e.g., heating, cooling, and water-heating systems) and thus many products covered by standards are not covered by building codes. Thus, while these other programs and policy options have important benefits and complement efficiency standards (perhaps by encouraging higher-efficiency levels than efficiency standards), they are not a replacement for efficiency standards.

2. Efficiency Standards in Texas: Recommended Products and Standards, and Resulting Energy and Economic Savings

HB 2129 (79th Regular Session) includes the following directive:

> The state energy conservation office shall determine the feasibility and cost-benefit to consumers of setting appliance standards for appliances that are not currently regulated for energy efficiency in this state, if the office determines that

[3] The only exception is DVD players where ENERGY STAR has about a 64% market share due to the very low incremental cost for meeting the ENERGY STAR specification.

> the new standards would reduce the emission of air contaminants. The office may not consider the feasibility and cost-benefit to consumers of setting appliance standards for air conditioning systems under this section.

This legislative directive provides a strong basis for assessing the suitability of potential product standards for Texas based on feasibility, cost-effectiveness, and air contaminant reductions.

- *Feasibility:* We determined that product standards already in place in other states were likely to be feasible for Texas to implement since the technical standards already exist and mechanism for implementation are already in place elsewhere. We further assessed feasibility by researching the availability of compliant products. We determined that if products meeting the standard are readily available from multiple manufacturers, such standards were likely to be feasible for Texas to implement.
- *Cost-effectiveness:* We evaluated cost effectiveness by calculating benefit-cost ratios and simple paybacks. We determined that products for which the present value of energy savings exceeded the incremental cost of efficient technology would be cost-effective for Texas consumers.
- *Reduction of air contaminants:* We first estimated a marginal emissions reduction factor to determine the impact of savings energy on emissions of NOx from the power sector in Texas as well as carbon dioxide (CO_2). Because saving energy reduces power sector emissions, any energy saving standard would make some contribution to reduction of key pollutants. We took this consideration one step further by evaluating the magnitude of savings, focusing our evaluation on products that would potentially lead to significant energy savings and the related pollution reductions.

Using these criteria, we developed a list of ten recommended product standards culled from a larger list (i.e., products listed in Table 1.1). We did not consider products for which the state would have to request a waiver from federal preemption nor did we consider air conditioning products.

We find that Texas standards are both feasible and very cost-effective for each of the products listed in Table 2.1. These standards are feasible because at least one other state has already established standards for each of these products, and products complying with the recommended standards are readily available.[4] We show cost-effectiveness for each recommended standard in Section 2.2. In summary, using average energy prices in Texas, most of the recommended standards have simple paybacks of less than two years, with many having even shorter payback periods. Each of the recommended product standards has a benefit-cost ratio well in excess of one (i.e., benefits exceed costs.) Benefit-cost ratios range from 1.4 to 1 to more than 25 to 1, with the average about 7 to 1. Finally, we find that each of the standards would yield significant energy savings and that saving energy reduces marginal emissions from the power sector.

[4] While it would be feasible to establish standards for some federally regulated products, consideration of such products is beyond the scope of this study.

Table 2.1 Recommended Products for Texas Efficiency Standards

Residential products	*Commercial products*
Compact audio products	Bottle-type water dispensers
DVD players and recorders	Commercial hot food holding cabinets
Portable electric spas	Metal halide lamp fixtures
Residential pool pumps	Walk-in refrigerators and freezers
Single-voltage external power supplies	
State-regulated incandescent reflector lamps	

Section 2.1 describes the products and standards and then details how each of these basic criteria is met. Cost-effectiveness for the purchaser/user is addressed in Section 2.2. Section 2.3 provides the estimated statewide energy, environmental, and economic benefits for the recommended standards and Section 2.4 shows the current availability of products meeting the standards.

2.1 Product and Standard Descriptions

This section describes the twelve products recommended for standards in Texas. For each product, the recommended technical standard is described and its source identified. We summarize the energy and economic impacts for buyers and users. Products are covered in alphabetical order.

Bottle-Type Water Dispensers

THE PRODUCT: Bottled water dispensers are commonly used in both homes and offices to store and dispense drinking water. Designs include those that provide both hot and cold water and those that provide cold water only.

THE STANDARD: In 2000, the EPA issued a voluntary ENERGY STAR performance specification for standby energy use of 1.2 kWh per day and 0.16 kWh per day for "hot and cold" dispensers and "cold only" dispensers, respectively. In December 2004, the California Energy Commission adopted the standard for "hot and cold" dispensers manufactured after January 1, 2006. PG&E (2004a) found that the "cold only" standard did not result in significantly decreased energy consumption and thus did not recommend including those products in the standard. Rhode Island recently adopted this standard, which will be effective January 2008.

Source: Oasis

KEY FACTS: "Hot and cold" water dispensers tend to be much less efficient than "cold only" because they must maintain water tanks at two temperatures in a small space. The greatest factor determining energy efficiency is insulation of the water reservoirs. Older models of "hot and cold" dispensers often do not have insulated hot water tanks, which increases heat dissipation and standby energy waste. Adding insulation between the tanks and increasing existing insulation levels can reduce standby energy waste. PG&E (2004a) found that a reduction from the baseline "hot and cold" dispenser daily energy consumption of 1.93 kWh to the proposed 1.2 kWh would save nearly 38% of annual energy consumption. The slight cost (about $12) to improve a basic unit to meet the proposed standard would be earned back in lower energy costs within about 6 months at average energy prices in Texas. In 2005, 68% of water dispensers on the market met ENERGY STAR specifications (EPA 2006a).

Commercial Hot Food Holding Cabinets

THE PRODUCT: Hot food holding cabinets are used in hospitals, schools, and other settings for storing and transporting food at a safe serving temperature. They are freestanding metal cabinets with internal pan supports for trays. Most are made of stainless steel and are insulated; however, there are some models that are non-insulated and are often made of aluminum. The main energy-using components include the heating element and the fan motor.

Source: Carter-Hoffmann

THE STANDARD: The ENERGY STAR specification sets a maximum idle energy rate for hot food holding cabinets of 40 W per cubic foot of measured interior volume. In December 2004, the California Energy Commission (CEC) adopted this level as a statewide minimum standard, effective January 2006. Rhode Island also recently adopted this standard, effective January 2008.

KEY FACTS: Adequate insulation in hot food holding cabinets enables products to meet the proposed standard (PG&E 2004b). Insulated cabinets also have the advantage of quick preheat times, less susceptibility to ambient air temperatures, and a more uniform cabinet temperature. The incremental cost for insulation needed to meet the recommended standard is roughly $450 (PG&E 2004b). However, based on average Texas rates, the improved insulation will save about $160 per year on electricity bills, paying back the higher up-front cost in less than three years. Hot food holding cabinets last about fifteen years on average. Other features that can be used to reduce heat loss include automatic door closers, magnetic door gaskets, and Dutch doors (half-doors). The recommended standard (measured in maximum idle energy rate) results in a 78% annual energy savings of 1,856 kWh relative to a basic, inefficient model (PG&E 2004b). There is significant uncertainty of the current market share held by energy-efficient products. EPA estimates a 2005 market share of 10% (EPA 2006a). But other industry experts we have consulted estimate 40% to 75% of products already comply. For this report, we chose a midpoint market share estimate of about 40% compliant products.

Compact Audio Products

THE PRODUCT: Compact audio products include integrated systems that have more than one of the following functions: radio tuner, tape player, CD player, and MP3 player. The proposed standard does not cover component audio systems (separate receiver, CD player, etc.) or systems powered by batteries.

Source: Sharp

THE STANDARD: A standby power level of 2 W for compact audio products is listed under ENERGY STAR specifications. In late 2004, this standard was adopted by the CEC to be effective January 2007 for audio products without a permanently illuminated clock display. For products with a permanently illuminated clock display, the CEC standard is 4 W. In July 2005, New York followed California's lead, enacting the Appliance and Equipment Energy Efficiency Standards Act of 2005. Rather than set standards by statute, the New York legislature directed an agency to develop cost-effective standards for compact audio (and several other products). As of August 2006, the New York Department of State and the New York State Energy Research and Development Authority (NYSERDA) are working on an administrative rulemaking to determine the levels for a New York standard that most likely will be implemented in 2008. New York is primarily considering the existing standard.

KEY FACTS: Compact audio products, similar to other personal electronic devices, function at three main power modes: on, standby, and off. Many products spend a large amount of time in standby mode—not "on" but energized so they can receive a signal from a remote control. Only 17% of compact audio systems manufactured in 2005 met ENERGY STAR specifications (EPA 2006a). Efficiency measures to reduce standby power, however, are simple and inexpensive with an incremental cost of about $1, an amount earned back in lower energy bills in less than two months. Energy saving technologies include flash memory, LCD displays, low power data receivers and tuners, and monolithic ICs that incorporate subsections such as tuners and decoders into one device (PG&E 2004c).

DVD Players and Recorders

Source: Panasonic

THE PRODUCT: DVD (digital versatile disc) players are popular home electronics used to play DVDs storing audio-visual data such as movies. DVD recorders are devices used to record audio-visual signals onto a DVD.

THE STANDARD: In 2003, the EPA set an ENERGY STAR specification for a maximum standby energy level of 3 W during standby mode for DVD players and recorders. In 2004, the CEC adopted the ENERGY STAR level as a statewide appliance standard. This standard took effect in January 2006. As with compact audio products, New York agencies, as of August 2006, are conducting a rulemaking to develop a state standard for these products at the directive of the New York legislature. Thus far, New York is primarily considering the existing standard.

KEY FACTS: According to a DOE (2002) report, the average standby energy use of DVD players is 26.5 kWh per year. Power supply design accounts for most excess energy use during standby mode, which can be lowered using low standby power development kits such as Power Integrations' TinySwitch-II IC (PG&E 2004c). Other features that reduce energy use in both standby and active modes include flash memory, LCD displays, low power data receivers and tuners, and monolithic ICs. Simple changes to the power supply design that reduce standby energy use costs about $1, an amount earned back in energy savings in less than a year. EPA estimates that about 24% of DVD players and recorders met the ENERGY STAR specification in 2005 (EPA 2006a).

Metal Halide Lamp Fixtures

THE PRODUCT: Metal halide light fixtures are commonly used in industrial buildings and high-ceiling commercial applications such as big-box retail stores. Some street lights and other high-output outdoor applications also use these fixtures.

Source: Holophane

THE STANDARD: In recent years, a new type of metal halide lamp[5] called a "pulse start" lamp has been introduced that uses about 15% less energy than the older "probe start" lamp. Pulse start lamps use an igniter to start the lamp through a series of high-voltage pulses and do not need a starter electrode (or starting probe electrode) as in probe start lamps. The CEC developed standards for new metal halide fixtures, which will be implemented in two steps. The first step, adopted by the CEC in December 2004, disallows the use of the most inefficient ballast types (probe start ballasts) in the most common fixture types (those which operate in a vertical, base-up position). By addressing the ballast only and not the lamp, the standard only requires existing fixtures to be upgraded when ballasts fail. In 2006, the CEC finalized the second step of the standard, extending the initial standard to all fixtures, regardless of lamp position, including the less common horizontal, vertical base-down and "universal" positions, effective January 2008. As of July 2006, eight states had established standards eliminating probe start ballasts. Six states' standards apply to fixtures regardless of position, while the other two are limited to vertical position fixtures.[6]

KEY FACTS: Pulse start lamps and ballasts save an average of about 15%. Presently, about 20% of metal halide lamp fixture sales are pulse start, primarily in new construction. (PG&E 2004d). The additional cost of a pulse start lamp fixture is covered by lower energy bills within about a year. All of the major lighting manufacturers and many small manufacturers make pulse start lamps and nearly all of the ballast manufacturers make pulse start ballasts that can be used with the vertical base-up position lamps (PG&E 2004d). While there is currently limited availability of pulse start applications besides the vertical base-up position, discussions with manufacturers indicate that many additional products will be introduced soon to comply with standards pending in several states in 2007 and 2008.

Portable Electric Spas (Hot Tubs)

THE PRODUCT: Portable electric spas are self-contained hot tubs. They are electrically heated and are popularly used for relaxation and therapeutic effects. The most popular portable spas hold between 210 and 380 gallons of water; however, some models can hold as much as 500 gallons. "In-ground" spas are not included in this standard.

Source: Sundance

[5] The lighting industry commonly uses the term "lamps" to refer to light bulbs, rather than light fixtures.

[6] Metal halide fixtures can be further improved with highly efficient electronic ballasts. These electronic ballasts recently have come down in price and improved in quality and are now ready for widespread adoption. California's standards require electronic ballasts or the very best magnetic ones effective in 2008.

THE STANDARD: In December 2004, the CEC adopted a maximum standby energy consumption standard of 5 * ($V^{2/3}$) Watts (i.e., five times the volume in gallons raised to the two-thirds power) for portable electric spas. Standby energy consumption refers to consumption after the unit has been initially brought up to a stable temperature at the start of the season and when it is not being operated by the user. It represents about 75% of the energy used by electric spas (PG&E 2004e). The energy consumption calculation adopted by the CEC approximates total spa surface area, which is directly related to standby energy use. A maximum standby energy indexed to total spa surface area thus requires spas of all sizes to be equally efficient.

KEY FACTS: Over half the energy consumed by a typical electric spa is used for its heating system (PG&E 2004e). Heat is lost directly during use and through the cover and shell during standby mode. Improved covers and increased insulation levels are key measures for improving efficiency and can decrease standby energy use by up to 30% for a spa of average to low efficiency (PG&E 2004e). Another measure is the addition of a low-wattage circulation pump or improvements to pump efficiency that would generally save 15% of standby energy consumption of an average-efficiency spa. Automated programmable controls, which would allow users to customize settings based on predicted usage patterns, are a third measure to improve efficiency and could save roughly 5% of a spa's standby energy use. The California standard is a modest initial effort and is probably met by the majority of spas now being sold (PG&E 2004e). The CEC estimates that the products meeting the standard cost $100 more than basic models. In Texas, this additional cost is covered within about four years.

Residential Pool Pumps

THE PRODUCT: Residential pool pumps are used to circulate and filter swimming pool water in order to maintain clarity and sanitation (PG&E 2004f).

Source: SpaSupport

THE STANDARD: In late 2004, the CEC adopted a standard with two parts. The first part bans the use of low-efficiency split-phase motors and capacitor start-induction run motors. The second phase requires two-speed pumps and controls. Two-speed operation saves large amounts of energy while still filtering the same amount of pool water because pumps operate much more efficiently at lower water flow rates. High-speed operation is only required intermittently (e.g., to run pool sweepers). The California standard, with minor modifications, is provided in Table 2.2.

Table 2.2. Proposed Standard for Swimming Pool Pumps

Effective Date	Requirements
January 1, 2006	Motor efficiency: new pool pump motors may not be split-phase, shaded-pole, or capacitor start–induction run types.
January 1, 2008	(i) Pump motors of 1 horsepower or more shall have the capability of operating at two or more speeds with a low speed having a rotation rate that is no more than one-half of the motor's maximum rotation rate. (ii) Pump controls shall have the capability of operating the pool pump at least at two speeds. The default circulation speed shall be the lowest speed, with a high speed override capability being for a temporary period not to exceed 120 minutes.[7]

KEY FACTS: In a warm state such as Texas (i.e., where pools are in operation much of the year), pool pumps can be among the largest electricity uses in the residential sector. For individual homes with pools, the pool pump is usually by far the single largest electricity user. For example, in California, pool pumps consume on average 2,600 kWh per year, an amount equal to 44% of the annual electricity consumption of a typical California household. Eliminating the least efficient types of pump motors (i.e., the first part of the California standard, effective 2006) would save about 260 kWh per year per unit on average. The typical efficient pool pump costs about $85 more, but saves about 260 kWh per year. Even larger savings can be achieved by shifting to two-speed pumps and controls (the second part of the California standard, effective 2008). This standard would cut electricity use by at least about 40% on average, or by about 1,040 kWh per year in the California example. Two-speed motors and pumps are available from at least six manufacturers. Five manufacturers are known to market controls for two-speed pump operation. The combination of two-speed pumps and controls is estimated to cost about $580. Based on Texas average electricity prices, these improvements pay for themselves in lower bills within less than 5 years. Pool pumps and motors last about 10 years on average (PG&E 2004f). This analysis does not include peak demand reduction benefits, which can be significant for pool pumps.

Single-Voltage External AC to DC Power Supplies

THE PRODUCT: External power supplies are the small black boxes typically attached to the power cord of many types of electronic products such as cordless phones, cell phones, computer speakers, telephone answering machines, and laptop computers. Power supplies convert AC supply voltage (around 120 volts in the United States) to the lower AC or DC voltages on which many electronic products operate. Typically the power supply plugs into an electric outlet and an electrical cord comes out of the power supply to bring power to the product.

Source: Ecos Consulting

[7] California specifies "one normal cycle" but does not define this term. We use 120 minutes here to be clearer. Cycles will generally be shorter than 120 minutes so the use of 120 minutes is probably conservative.

THE STANDARD: The California Energy Commission developed initial standards for these products, which take effect beginning in January 2007.[8] As of July 2006, six additional states (Arizona, Massachusetts, Oregon, Rhode Island, Vermont, and Washington) had enacted external power supply standards based on the initial CEC standards and a rulemaking to establish similar standards was pending in New York. EPA developed efficiency levels similar to the CEC's initial standard for a voluntary ENERGY STAR labeling program, which began January 1, 2005. EPA plans to introduce a stronger specification later in 2006. The initial state standard included approximately the top 25% most efficient products on the market at the time. Table 2.3 summarizes the technical standard.

Table 2.3. California Standards on External Power Supplies

Nameplate Output	**Minimum Efficiency in Active Mode**
< 1 Watt	0.49 * Nameplate Output
≥ 1 Watt and ≤ 49 Watts	0.09 * Ln(Nameplate Output) + 0.49
> 49 Watts	0.84
	Maximum Energy Consumption in No-Load Mode
≤ 10 Watts	0.5 Watts
> 10 Watts ≤ 250 Watts	0.75 Watts
Where Ln(Nameplate Output) is the natural logarithm of the nameplate output expressed in Watts.	

KEY FACTS: The typical, basic power supply is only 25% to 60% efficient (i.e., 40% to 75% of power is dissipated as heat). Power supplies also generally use several watts of standby power, even when the device being powered is off. More efficient power supplies typically use electronic rather than magnetic components and can be 90% efficient in the active mode and have standby power levels of less than 1 W. Additional benefits include less weight and smaller size, helping to reduce the "wall wart" or power strip congestion problem. PG&E (2004g) found that the more efficient power supplies have an incremental cost of about 50 cents. Recent materials price trends have probably driven this cost differential even lower. Energy bill savings quickly recoup the minor additional cost for the consumer. While the costs and saving are probably inconsequential for any one power supply, the sheer volume of these products being sold today are helping to drive overall energy use up. Electronics manufacturers do not make their own power supplies, but rather source them from other companies. Nearly all power supplies are made in low-wage countries in Asia and are purchased primarily on the basis of first cost. There are many major manufacturers of efficient power supplies and several manufacturers of the key power supply components that these manufacturers rely on (PG&E 2004g).

State-Regulated Incandescent Reflector Lamps

THE PRODUCT: Reflector lamps are the very common cone-shaped light bulbs most typically used in "recessed can" light fixtures.[9] The cone is lined with a reflective coating to direct the light. "Bulged" reflector (BR) lamps are specific types of reflector lamps with a slight bulge at the base. "Blown" PAR (parabolic reflector) lamps (BPAR) are reflector lamps designed to be a

[8] A second-phase, more stringent California standard, effective July 2008, further reduces maximum no-load consumption for all output wattages to 0.5 W. Texas may want to consider adopting the more stringent California standard to reap additional savings.
[9] Recessed cans are low-cost light fixtures that mount flush with a ceiling such that the socket and bulb are recessed into the ceiling. They are very common in residential and commercial construction.

low-cost substitute for widely used PAR lamps. Use of BR lamps has increased to more than half of reflector lamps sales in recent years as manufacturers have taken advantage of a loophole that exempts them from federal standards. BPAR lamp sales have also increased.

THE STANDARD: Under the federal Energy Policy Act of 1992, many reflector lamps need to meet specified efficacy requirements (i.e., lumens/Watt need to exceed specified minimum values). The federal law's intent was to substitute halogen and other more efficient lamp types for the most common type of inefficient reflector lamp known as "R lamps." However, the federal law exempted ellipsoidal reflector (ER) lamps because they have a special light distribution that allows lower wattage lamps to be used in recessed fixtures and BR because the sole manufacturer (a small market player) of these lamps said they were "just like" ER lamps. In fact, BR lamps have essentially the same light distribution as R lamps and the market share of these lamps has increased from less than 1% of reflector lamp sales prior to the federal law's passage to about 50% today as the major manufacturers have moved to exploit this loophole. It is unclear whether BPAR lamps are covered by the federal law or not; we include them here just to be certain they are covered at either the federal or state level. R20 (2" diameter standard reflector lamps) were excluded from the federal standard since at the time there were no efficient substitutes (a situation that has since changed). Starting in early 2005, several states including Massachusetts, Oregon, Washington, and Vermont moved to close these federal loopholes by requiring that BR, BPAR, ER, and R20 lamps meet the same efficacy requirements as R lamps (see Table 2.4).[10] Some states have incorporated exemptions agreed to by the lamp manufacturers and efficiency advocacy organizations in 2005. These are noted in Table 2.4.[11] In 2006, the CEC adopted the recommended standard by rulemaking. As with several other products, New York agencies are currently conducting a rulemaking to establish standards for these lamps. Manufacturers and efficiency advocates have recommended that New York adopt the standard in the form and with the coverage most recently enacted by other states and summarized here.

Source: GE Lighting

KEY FACTS: The halogen and other lamp types that substitute for BR lamps generally reduce energy use by more than 10%. The energy bill savings quickly cover the additional cost ($0.20 to $4.00) of the more efficient lamps. All major manufacturers and many smaller manufacturers make lamps that comply with the standards (PG&E 2004h). The proposed exemptions were a negotiated compromise in Massachusetts. The National Electrical Manufacturers Association (NEMA), which represents the manufacturers, and ACEEE have agreed to ask Congress to adopt this standard with the negotiated exemptions as a federal standard. Since Congress is not presently considering energy legislation, it is unclear how many years this process will take.

[10] DOE is now studying whether to subject BR lamps to the same standards as R lamps. However, DOE rulemakings generally take 3 or more years. A rulemaking is scheduled for completion in June 2009, with the standard taking effect three years later.

[11] Oregon and Washington did not include all of the exemptions we recommend here, as they adopted standards prior to the NEMA/ACEEE agreement.

Table 2.4. Proposed Standards on Many BR and ER Lamps Plus Some R Lamps

Wattage	Minimum Efficacy (lumens per Watt)
40–50	10.5
51–66	11.0
67–85	12.5
86–115	14.0
116–155	14.5
156–205	15.0

Recommended exemptions: BR30, BR40, ER30, and ER40 of less than or equal to 50 W; BR30, BR40, and ER40 of 65 W; R20 of equal to or greater than 45 W.

Walk-In Refrigerators and Freezers

THE PRODUCT: Walk-in refrigerators and freezers are used in restaurants, hospitals, convenience stores, supermarkets, and other locations for food, beverage, and ice storage. Walk-in units are essentially small insulated rooms that are maintained either just above freezing (for a refrigerator) or significantly below freezing (for a freezer). They have a large door through which people can walk that is large enough to also accommodate a hand cart and a stack of boxes. The refrigeration system is located either on top of the walk-in or at a nearby location outdoors. In the latter case, the refrigeration system and the walk-in room are connected via pipes for refrigerant circulation.

THE STANDARD: In December 2004, the California Energy Commission adopted a standard for walk-in refrigerators and freezers. This standard included a variety of prescriptive requirements including insulation levels, motor types, and use of automatic door-closers (CEC 2004). Ideally a standard would specify a level of performance (e.g., $kWh/ft^3/day$) but this is difficult to do in practice as walk-ins are large and difficult to test and only limited test data are available. A major research project is needed to develop a performance standard; in the meantime, a prescriptive standard will provide large energy savings. The California standard provides a good foundation for a Texas standard, but we recommend that it be modified in three respects. First, the language needs to be clarified to make clear that doors must be insulated as should freezer floors. Second, freezer insulation levels need to be refined slightly so they can be reached with 4-inch thick panels. Third, an efficacy requirement for walk-in lighting should be included as many walk-ins use incandescent lights that are left on 24 hours per day. Rhode Island recently adopted a standard for walk-ins with these recommended changes, effective January 2008.

Source: U.S. Cooler

KEY FACTS: According to a report on commercial refrigeration prepared for DOE, walk-ins account for about 18% of U.S. commercial refrigeration energy use (ADL 1996). Several other types of commercial refrigeration systems are covered by national standards (e.g., reach-in refrigerators and freezers, and ice-makers), leaving walk-ins as the largest category under the jurisdiction of the states. Analysis of data gathered for California (PG&E 2004i) indicates that the recommended standard will reduce walk-in energy use by an average of more than 40%. The very large per unit electricity savings (more than 8,000 kWh per year) will pay for the higher up-front cost (about $1,000) for the average Texas user in a little over a year. While the current market share of complying products is low, virtually all manufacturers can order complying components and meet the standards without difficulty.

2.2 Consumer Savings from Efficiency Standards

We estimate that, by 2030, the ten recommended energy efficiency standards can save Texas consumers nearly two billion dollars on their energy bills. As shown in Table 3.7, each recommended standard shows clear and significant savings for consumers and businesses. For most products, simple payback is less than 2 years, meaning that customers would earn back their initial investment in a more efficient product in this short time period. Afterwards customers would see net savings on their energy bills for the duration of the product's life. Many of the products have an average life of 10 years or greater; customers will see continued savings for several years after the initial investment is recovered. For these calculations of consumer savings, we use the average retail price of residential and commercial electricity in Texas in 2005 and assume that these prices remain the same through 2030. Higher electricity prices would result in even greater savings.

Table 2.5. Consumer Economics of Recommended Standards

Product	Incremental Cost	Annual Per Unit Savings (kWh)	Annual Per Unit Economic Savings*	Average Product Life (years)	Benefit/ Cost Ratio**	Simple Payback (years)
Bottle-type water dispensers	$12	266	$24	8	12.9	0.5
Commercial hot food holding cabinets	$453	1,815	$161	15	3.7	2.8
Compact audio products	$1	53	$6	5	25.2	0.2
DVD players and recorders	$1	11	$1.16	5	5.1	0.9
Metal halide lamp fixtures	$30	307	$27	20	11.5	1.1
Portable electric spas (hot tubs)	$100	250	$27	10	2.1	3.7
Residential pool pumps	$664	1,260	$137	10	1.4	4.8
Single-voltage external AC to DC power supplies	$0.49	4	$0.45	7	5.4	1.1
State-regulated incandescent reflector lamps	$0.73	61	$7	1	6.8	0.1
Walk-in refrigerators & freezers	$957	8,220	$727	12	6.9	1.3

* These calculations are based on average Texas electricity prices in 2005.
** Benefit-cost ratios take into account a 5% real discount rate.

The benefit-cost ratios calculated here, which take into account a 5% real discount rate, range from 1.4:1 to 25:1 with an average benefit-cost ratio of about 8:1. This means that with the adoption of all recommended standards in 2008, Texas consumers would save on average about $8 on utility bills for every dollar invested in more efficient appliances. Products with low incremental costs and relatively high energy savings show the greatest benefit-to-cost ratios. For example, efficient compact audio products, such as home stereos, require a very modest incremental cost of $1, which is earned back in about 2 months and results in net savings of about $25 over the 5-year life of the product.

2.3 Overall Statewide Savings

As the leader in the generation and consumption of electricity in the U.S., Texas is in a unique position to greatly offset its energy demand with appliance efficiency standards. In 2004, the state of Texas ranked number one in the U.S. in net summer capability (MW), net generation (MWh), and total retail sales of electricity (MWh) (EIA 2006a). While saving consumers and businesses money on energy bills, appliance efficiency standards can also help Texas significantly reduce its electricity demand and enhance electric reliability.

Table 2.6 highlights total statewide electric savings in Texas in 2020 and 2030 from the ten recommended minimum efficiency standards if they take effect in 2008. Appliance standards would lower electricity sales by about 2,500 GWh annually in 2020 and nearly 3,000 GWh in 2030. Based on a 2.6% annual increase in electricity consumption in Texas (an estimation by the Electric Reliability Council of Texas [ERCOT]), the total reduction in electricity sales in 2020 would offset the projected annual growth in the same year by about 20%. In 2030, Texas could also lower energy demand and reduce its summer peak capacity by 725 MW, which would offset ERCOT's expected annual capacity growth by 90% (Collins 2006). Put another way, this annual reduction would offset the need for two to three average-sized power plants. Given TXU Corporation's plan to build 11 new coal power plants by 2010 that would have a total generating capacity of about 9,000 MW, the reduction in electric demand from efficiency standards would be significant.

Appliance efficiency standards in Texas would also save natural gas. Natural gas is the primary energy source for generating electricity in Texas: about 50% of electricity is generated at natural gas-fired power plants (EIA 2006a). Reducing energy demand through appliance standards saves gas indirectly by reducing the need for electricity generated from natural gas. In 2030, efficiency standards would eliminate the need for nearly 20 billion cubic feet of natural gas in Texas, which is equivalent to a 2% reduction in the expected consumption of natural gas in Texas in that year.[12] Given the current tight natural gas market, these savings could have a significant impact on the reduction of natural gas prices.

As shown in Table 2.7, the recommended efficiency standards would save Texas ratepayers about $230 million dollars annually in 2020 and $263 million in 2030. The standards would generate a total of about $1.8 billion dollars in net savings for consumers and business owners for equipment purchased through 2030. The greatest savings would come from standards for metal halide lamp fixtures and residential pool pumps.

[12] Based on AEO's 2006 estimate of a 0.5% annual growth rate in natural gas consumption by 2030 in the West South Central region of the U.S.

Table 2.6 Statewide Summer Peak Demand and Total Energy Savings in 2020 and 2030 from Appliance Standards

Products	Annual Energy Savings in 2020			Annual Energy Savings in 2030			Cumulative Savings for Products Purchased Thru 2030
	Electricity Savings	Indirect Natural Gas Savings	Summer Peak Capacity Reduction	Electricity Savings	Indirect Natural Gas Savings	Summer Peak Capacity Reduction	
	(GWh)	(mil. CF)	(MW)	(GWh)	(mil. CF)	(MW)	(tril. Btu)
Bottle-type water dispensers	20	99	3	20	99	3	3.9
Commercial hot food holding cabinets	28	140	9	33	169	11	5.4
Compact audio products	120	610	17	120	610	17	26
DVD players and recorders	17	88	2	17	88	2	3.7
Metal halide lamp fixtures	666	3371	218	1065	5393	348	144
Portable electric spas (hot tubs)	20	100	5	20	100	5	3.7
Residential pool pumps	472	2389	108	472	2389	108	88
Single-voltage external AC to DC power supplies	341	1727	47	341	1727	47	69
State-regulated incandescent reflector lamps	427	2164	105	427	2164	105	100
Walk-in refrigerators and freezers	341	1726	79	341	1726	79	60
Total	**2,451**	**12,415**	**593**	**2,856**	**14,466**	**726**	**505**

Note: See Appendix A for assumptions, methodology, and sources.

Table 2.7 Value of Savings in 2020 and 2030 from Efficiency Standards

Products	Value of Savings in 2020	Value of Savings in 2030	NPV for Purchases Thru 2030*
	($Million)	($Million)	($ Million)
Bottle-type water dispensers	1.7	1.7	15
Commercial hot food holding cabinets	2.5	2.9	18
Compact audio products	13.1	13.1	129
DVD players and recorders	1.9	1.9	16
Metal halide lamp fixtures	58.9	94.2	636
Portable electric spas (hot tubs)	2.1	2.1	10
Residential pool pumps	41.7	41.7	125
Single-voltage external AC to DC power supplies	37.0	37.0	295
State-regulated incandescent reflector lamps	37.8	37.8	365
Walk-in refrigerators and freezers	30.2	30.2	226
Total	**227**	**263**	**1,834**

* NPV stands for net present value and is a measure of the cumulative value of the standards policy (benefits minus costs) in current dollars.

Emissions reductions from the adoption of efficiency standards would be significant (see Table 2.8). In 2020, about 1.6 million metric tons (MT) of carbon dioxide could be reduced, the equivalent of taking about 300,000 passenger vehicles off the road. These standards would also contribute to better air quality in Texas by reducing 1,000 metric tons of smog-forming NOx and nearly 3,000 tons of sulfur dioxide (SO_2) in 2020.

Table 2.8 Emissions Reductions in 2020

Products	CO_2 (1000 MT)	NOx (Metric Tons)	SO_2 (Metric Tons)
Bottle-type water dispensers	13.1	7.9	22.1
Commercial hot food holding cabinets	18.6	11.3	31.4
Compact audio products	80.8	49.0	136.4
DVD players and recorders	11.7	7.1	19.7
Metal halide lamp fixtures	446.1	270.6	753.3
Portable electric spas (hot tubs)	13.2	8.0	22.3
Residential pool pumps	316.2	191.8	533.8
Single-voltage external AC to DC power supplies	228.6	138.7	386.0
State-regulated incandescent reflector lamps	286.4	173.7	483.7
Walk-in refrigerators and freezers	228.4	138.6	385.7
Total	1,643.1	996.6	2,774.4

Note: See Appendix A for Texas emission factors used to estimate emission reductions in 2020.

2.4 Product Availability

Each of the products for which we recommend standards is readily available from multiple manufacturers. This assures that there will be competition among suppliers once the new standards go into effect. Furthermore, with multiple states adopting these standards, we expect that additional manufacturers will move quickly to develop product offerings that can compete with the more efficient products on the market rather than cede market share.

Table 2.9 provides summary data of the number of manufacturers and estimated national market share for products complying with the standards. For most of these products, a majority of the major manufacturers offer compliant products. Where there are examples with few manufacturers (e.g., reflector lamps), this particular industry is very concentrated with few overall suppliers.

Current market share varies widely—from a low of 10% to a high of 80%. We report here the most recent data and estimates available from a wide variety of sources. Nevertheless, some of these estimates are a few years old and market share of efficient products has grown. In general, products with higher market shares either have modest proposed standards (e.g., portable spas) and/or have benefited from voluntary programs that have worked to build market share through education and/or purchase incentives (e.g., DVD players). As shown in Section 2.2, the consumer economics for purchasing all of these products is quite favorable, so it is not surprising that products meeting the standards have a significant and in some cases, growing market share.

However, market share tends to reach a plateau because of the significant market-based barriers to efficiency described in Section 1.2.

Table 2.9. Availability of Products Meeting Proposed Standards

Product	Number of Manufacturers with Compliant Products	Estimated National Market Share of Compliant Product
Bottle-type water dispensers	11	68%
Commercial hot food holding cabinets	10	40%
Compact audio products	10	17%
DVD players and recorders	16	24%
External power supplies	20+	32%
Metal halide lamp fixtures	5+*	20%
Portable electric spas (hot tubs)	80	80%
Residential pool pumps	4	2%
State-regulated incandescent reflector lamps	3+**	55%
Walk-in refrigerators and freezers	most	low

Sources: Manufacturer information comes from ENERGY STAR's product lists (EPA 2006a), the California Energy Commission Appliance Database (CEC 2006), and discussions with the manufacturers. Estimated national market share comes from EPA estimates of ENERGY STAR market penetration (EPA 2005, 2006a) and discussions with manufacturers.

* Five lamp manufacturers produce complying lamps and at least six ballast makers offer ballasts that operate compliant lamps. Many fixture manufacturers in turn put these ballasts and lamps into fixtures; all manufacturers can.

** The three dominant manufacturers all have products. In addition, some of the smaller manufacturers have products.

3. Minimizing State Implementation Costs

Appliance and equipment standards are among the lowest cost policies to improve energy efficiency. This section will describe how implementation costs can be kept to a minimum.

3.1 Introduction

The standards recommended here were chosen in part because they can be adopted and implemented at a very low cost to the Texas government. Potential responsibilities consist of standards development and adoption, efforts to foster good compliance, and enforcement. Costs to carry out these responsibilities will be low because the technical standards are already developed and compliance can be encouraged in conjunction with standards already existing in other states and voluntary programs. For example, five states are participating in a collaborative project designed to streamline state implementation by utilizing existing certifications already in place in California. Because these existing compliance mechanisms result in the standards largely being self-enforcing, enforcement actions will be rare. The low costs incurred by Texas to establish and enforce standards are easily offset by the fact that the state itself is a major energy user—direct energy bill savings to the state can be greater than the costs of administering a standards program. The paragraphs below further explain how each responsibility in a standards program can be achieved at zero to minimal cost.

Nearly all of the recommended technical standards come from either existing state standards such as those adopted by California and other states or from well-established voluntary programs such as ENERGY STAR. Where a test method is necessary for consistent measurement of efficiency performance, such methods already exist. These other state or voluntary programs have in some instances invested considerable resources in developing appropriate technical standards and, in some cases, test methods. Other test methods have been developed by various trade associations and national or international testing organizations.

3.2 Compliance and Enforcement

There are two primary mechanisms to foster compliance with standards: certification and labeling. Currently, all states with standards programs have required manufacturer self-certification of compliance. Manufacturers are responsible for testing their own products and then certifying compliance to the state.[13] Certification typically must include brand name, model number information, efficiency performance, and a signed statement of compliance. States make lists of certified products publicly available. This certification and public listing of products certified for sale in the state serves two purposes. First, it encourages compliance since manufacturers will be very hesitant to certify false values to a state or deliberately sell into the state non-certified products. Second, it provides a central place for sellers, purchasers, competitors, and others interested in good compliance to see which products are certified for sale. The weakness in certification is that it is impossible from simply looking at a product to tell whether it meets a state's standards. Rather, model numbers must be checked against a public database. This weakness can be addressed by labeling.

Labeling can indicate that a product has been tested and meets a given efficiency level. California, for example, requires a limited number of products to carry a label (e.g., exit signs, torchieres, transformers, and pre-rinse spray valves). Maryland's statute requires that all covered products sold at retail carry a label but state regulations allow existing labels (e.g., California labels, ENERGY STAR labels, and industry program labels) that indicate performance at least as good as that required by state law to suffice. Labels have several benefits. First, they are readily viewed, allowing product sellers, purchasers, competitors, and anyone checking for compliance to easily tell if a product is in compliance. Second, like certification, they discourage cheating on a standard. Manufacturers will be very hesitant to deliberately label a non-compliant product. Distributors and retailers will be much more conscious of a visible label than they will be of a certification database. The downside to labels is that, for manufacturers, labels can be more costly than certification. Typically, manufacturers do not make items for specific states, so they will have to label all units, regardless of which state they ultimately are sold in. However, by relying on existing labels, a proliferation of additional labeling requirements can be avoided as can additional costs imposed on manufacturers. If a state sets a labeling requirement where one does not currently exist, the state should require a generic mark that can be used by other states subsequently adopting the same standard.

The "self-enforcing" nature of the standards is achieved by the combination of certification and labeling combined with the competitive pressures of the market. The burden of testing and then certifying and/or labeling falls to the manufacturer, not the state. (Even this burden is minimal since once one state has established such requirements, there should be no additional testing,

[13] For prescriptive standards (e.g., the requirement that unit heater have an intermittent ignition), no testing is required, but manufacturers still must certify that the prescriptive requirement is met.

certification, and labeling cost provided that other states choose the low-cost implementation path of piggy-backing off of existing requirements.) Manufacturers have a strong incentive to ensure their competitors are complying with the law. Potential compliance problems fall into two categories: manufacturers selling products into a state that have not been certified, and manufacturers providing false certifications. With regard to the first potential problem, in the extensive experience of the CEC, if the agency learns of products being sold that have not been certified, typically a warning letter and a dialog with the manufacturer are sufficient to solve the problem (Martin 2004). Some states, including Maryland and Washington, also have authority to conduct inspections of distributors and retailers to check that only compliant products are available. In the past, California has used summer interns to conduct spot-checking of products in stores. Regular staff only got involved when the interns found potential enforcement problems (CEC 1983). To address the potential problem of products being sold with false certifications, most state laws provide authority for spot-testing products. For example, if a state suspects a product has been falsely certified, the agency can test the product in question. If a product fails to meet the standard, the state can request that the manufacturer withdraw the model's certification and, if the manufacturer refuses, the state can reject the certification and "delist" the product from the database of certified products, making it illegal to sell in the state. Several states include provisions allowing the state to charge manufacturers for the cost of testing their products if the product certifications are found to be inaccurate. In the 30 years that California has had standards, CEC has only had to initiate formal enforcement actions on a few occasions and has never had to "delist" a product (Martin 2004).

Authority for state inspections and state testing of products are important because they represent a credible threat that a state may actively enforce standards if manufacturers are willfully disobeying state laws. But in practice state testing authority and inspection authority should be used very rarely, if at all. States can achieve reasonably good rates of compliance by encouraging compliance rather than by penalizing non-compliance. Information provided by the market and competitors can help identify potential problem areas. For example, in recent years, California has not had a budget for testing or inspections (Wilson 2004).

Finally, some state laws provide for agency authority to review and upgrade existing standards (e.g., New York and Connecticut) and/or expand the scope to additional products (e.g., Connecticut). In these states, agencies could incur costs associated with such future rulemakings. For example, in January 2006, New York issued a $150,000 request for proposals for technical assistance for setting its initial standards not specified in state law. However, in most instances, such rulemakings are optional. If pursued in the future, states should work collaboratively on updated or additional standards. Technical support for future standards development could be provided by utility ratepayer-based efficiency programs. For example, Pacific Gas and Electric Company provided extensive technical support to the latest round of new standards developed in California.

4. Conclusion

In accordance with the Texas legislature's directive in HB 2129 to determine the feasibility and cost-benefit to consumers of setting new appliance standards, we have identified ten efficiency standards that are both cost-effective to consumers and to the state, feasible to implement, and would improve air quality by reducing emissions of pollutants. Consumers that purchase the products would see benefits that far exceed costs: on average, consumers would save $8 on utility bills for every dollar invested toward a more efficient appliance. Further, each standard has already been adopted in at least one state and multiple manufacturers make products complying with the standard, making it feasible for the state to implement.

Collectively, this package of efficiency standards would generate significant benefits to the state of Texas. Savings would start with implementation and grow year-by-year as more and more appliances and equipment purchased and installed meet the minimum standards. In 2030, the standards would save the state about 3 billion kWh and reduce peak demand by 725 MW. This is enough to power about 250,000 average Texas households while offsetting the need for 2 to 3 average-sized power plants. Reduced energy demand would also enhance reliability of the electric grid. By 2030, cumulative savings would amount to about 0.5 quads of primary energy, which would offset projected growth in primary energy consumption in Texas over the next two decades by about 4%. Investment in efficiency standards would also directly benefit the environment by reducing the emission of pollutants at power plants. About one thousand metric tons of smog-forming NOx and nearly 3,000 tons of SO_2 would be taken out of the air in 2020.

Appliance efficiency standards are a very feasible, cost-effective energy policy tool for Texas that can be adopted immediately. The benefits are considerable: consumers would save energy and money; the state would reduce its energy demand and enhance electric reliability; and the environment would benefit from improved air quality.

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Appendix A. Methodology, Assumptions, and Sources

The analysis discussed in this report is based on the methodology ACEEE used for several recent national and regional studies on appliance and equipment efficiency standards (Kubo, Sachs, and Nadel 2001; Nadel et al. 2004; Raynolds and deLaski 2002). Table A.1 shows key assumptions regarding the effective date of standards, equipment lifetimes (and thus annual rate of equipment replacement), per-unit energy savings, and incremental unit equipment costs.

The sources for those and other assumptions—such as annual equipment sales and baseline equipment efficiency assumptions—are documented in Table A.2.

Overview of Analysis Methodology

To calculate the potential energy savings of new standards for the products discussed in this report, we started with national estimates of equipment sales, energy use, energy savings, and peak demand and allocated or adjusted these figures based on available data for each state and region. The specific state and regional allocation and adjustment factors for Texas are discussed later in this appendix. The energy and peak demand savings then drove the calculation of the economic savings and emissions reductions achievable in Texas.

Economic savings were calculated on a consumer basis by multiplying energy savings by **average retail rates for Texas** (residential or commercial rates, as appropriate). We used retail rates from 2005 data compiled by the U.S. Energy Information Administration (EIA 2006b). We assumed retail rates remain constant through 2030.

We calculated economic costs by multiplying the per-unit incremental cost for each product by the number of units sold. Cumulative costs and cumulative savings cover the period from the effective date of the standard to 2030, and we discounted them to 2005 using a 5% real discount rate.

Similarly, we derived emissions reductions by multiplying the primary energy savings by **average emissions factors for Texas**. We derived emission factors for electricity from projections of total emissions and total electricity generation in 2020.

Table A.1. Effective Dates, Assumed Equipment Life, Annual Per-Unit Energy Savings, and Incremental Costs

Product	Assumed standard (max. energy use or min. efficiency)	Basis for standard	Avg. life of equipment	Average per unit annual energy savings	Incremental equipment cost
Bottle-type water dispensers	Max. 1.2 kWh/day standby energy	ENERGY STAR & CEC Title 20	8	266 kWh	$12
Commercial hot food holding cabinets	Max. idle energy rate 40 W/ft^3	ENERGY STAR & CEC Title 20	15	1,815 kWh	$453
Compact audio products	Max. 2.0 W standby energy	ENERGY STAR & CEC Title 20	5	53 kWh	$1
DVD players and recorders	Max. 3.0 W standby energy	ENERGY STAR & CEC Title 20	5	11 kWh	$1
Metal halide lamp fixtures	Pulse-start ballast	Pulse-start ballast	20	307 kWh	$30
Portable electric spas (hot tubs)	Max. 5 V$^{(2/3)}$ standby energy	CEC Title 20	10	250 kWh	$100
Residential pool pumps	No split-phase or capacitor start–induction run types; 2-speeds	2-speed pump	10	1,260 kWh	$664
Single-voltage external power supplies	Varies with size	CEC Title 20 (Tier 1) and other states' standards	7	4.1 kWh	$0.49
State-regulated incandescent reflector lamps	Varies with size	EPAct 1992 standard with MA exemptions	0.94	61 kWh	$1
Walk-in refrigerators and freezers	Typical installation from CEC case study	CEC Title 20 with a few modifications	12	8,220 kWh	$957

Detailed Methodology

1) <u>Calculation of national energy and peak demand savings</u>

We obtained national energy savings from proposed new standards by multiplying annual national sales figures for each appliance by per-unit energy savings. Per unit savings are the difference between a product just meeting the proposed standard and a typical basic efficiency new product. (We assume the distribution of efficiency levels above the current baseline and above a future standard are the same, except we assume zero savings for sales that currently meet the proposed standards. We account for current market share of equipment meeting the proposed standard at the state level.) The analysis is static and assumes that equipment sales remain at current levels for all products. We also assumed that, in the absence of standards, efficiency levels remain at present levels. In actuality, product sales and efficiency are gradually increasing, even in the absence of standards. Thus, it is implicitly assumed that these factors counterbalance each other.

We used one of the following equations to calculate end-use electricity savings in 2020 and 2030:

(a) End-use electricity savings = annual sales volume x (years from effective date - 0.5) x per-unit electricity savings
(b) End-use electricity savings = annual sales volume x average product life x per-unit electricity savings

In each case, we used equation (a) when the average product lifetime is longer than the number of years from the effective date. For most products, we assumed an effective date of January 1, 2008. Otherwise, we used equation (b) in order to avoid double counting the savings from replacements after 100% saturation. We subtracted 0.5 from the number of effective years to account for sales throughout the purchase year, so the savings from units installed during the year will be equivalent to only half-year sales times annual savings per unit.

For heat rates to calculate primary energy savings (primary energy input required to generate a unit of electricity, in Btu/kWh), we use 10,764 Btu/kWh for 2010, 10,424 Btu/kWh for 2020, and 10,056 for 2030 (EIA 2005a). We use a 1.10 T&D loss factor (EIA 2005b). That is, power saved at the source of generation is 10% more than power saved at homes and businesses due to losses in the transmission and distribution system.

To calculate peak generation savings, we multiplied electric generation savings by a peak factor (kilowatt per kilowatt-hour) that quantifies the fraction of a product's annual hours of usage that occur during times of peak system demand. Table A.2 provides the sources of the peak factors used in the analysis.

We calculated peak capacity savings as:

Peak capacity savings = end-use electricity savings ÷ T&D loss factor x peak factor x reserve factor

The analysis assumed a conservative 10% reserve margin. Thus the reserve factor in the formula is 1.1. Historically, a reserve margin of 20% was typical, but utilities have cut down their margins during restructuring of the electric utility industry.

2) State Allocation Factors for Texas

For most residential products, the state allocation factor is the ratio of households in Texas to total national households (Census 2001). For most commercial products, we calculated the allocation factor in two steps: the factor started as the ratio of commercial building square footage to total building square footage in each census division, then we adjusted it using the ratio of state commercial sector energy use to commercial sector energy use in that census division (EIA 1999a). We further adjusted the allocation factors for each appliance according to the saturation and usage of each by census region and division. We found the data that supports saturation and usage rates in the Residential Energy Consumption Survey (RECS) 1997 and 2001 (EIA 1999b, 2003) and the Commercial Building Energy Consumption Survey (CBECS) (EIA 1999c).

Using the following formulas, we derived state allocation factors:

For residential products:

a) Allocation factor = (state households ÷ national households)
x (saturation% in region/division ÷ national avg. saturation%)
x (usage in region/division ÷ national avg. usage)

For commercial products:

b) Allocation factor = (building square footage in census division ÷ national building square footage) x (state commercial electricity ÷ commercial electricity use in census division)
x (saturation% in census division ÷ national average saturation%)
x (usage in census division ÷ national average usage)

Exceptions to this methodology were:

- For commercial walk-in refrigerators and freezers, the energy intensity data in CBECS is heavily influenced by built-up refrigeration systems used in places such as supermarkets. The energy use of this equipment is heavily influenced by climate since the condenser units are located outdoors. Packaged systems generally have the condensers indoors (they are part of the packaged unit) and are much less climate dependent. To adjust for this difference, we reduced the factor for variation from the national average in half. Thus, if in CBECS, a state has 84% the refrigeration intensity of the national average (e.g., intensity factor of 0.84), we reduced the variation in half (e.g., we used an intensity factor of 0.92).
- For reflector lamps, water dispensers, and hot food holding cabinets, population was used as a better indicator for allocating sales by state.

For all products, we discount Texas savings totals according to current sales estimated to meet the proposed standard. For example, if 35% of sales already meet the proposed standard for a given product, the analysis credits the standards policy with savings from the other 65% of sales.

3) Calculating Economic Costs and Savings

We calculated consumer bill savings using the following formula:

Consumer bill savings = end-use electricity savings x Texas average electricity price+ natural gas savings x Texas average natural gas price

We calculated expected investment using the following formula:

Expected investment = annual sales volume x per-unit incremental cost

We used 2005 average residential rates of 10.8 cents per kWh and commercial rates of 8.9 cents per kWh (EIA 2006b). We discounted present value (PV) calculations to 2005 assuming a 5% real discount rate. The PV of expected investment aggregates the present value of annual investments from the effective date of each standard through 2030. The PV of savings aggregates the present value of societal savings/consumer bill savings from the effective date of the standard through the year in which products installed through 2030 die out. Essentially, these two measures give the cumulative costs and benefits of standard-complying products installed through 2030. Subtracting the PV of investments from the PV of savings yields the net present value (NPV) of the standards policy.

4) Calculating Emission Reductions

We calculated carbon dioxide, nitrogen oxides, and sulfur dioxide reductions for electric products using the following equation:

Emission reductions = end-use electricity savings x T&D loss factor x Texas emission factor

The emissions displaced by improved efficiency standards results from existing plants running less than they otherwise would and some projected plants not getting built. Under current market and regulatory conditions, natural gas plants present the highest marginal cost of operation, thus are the first to run less if power use declines. However, over the longer term, power plant developers will build fewer plants if energy use grows at a slower rate than projected: thus efficiency can displace projected new generation. In Texas, most new projected generation is coal-based. Although emission rates for natural gas-fired power plants have typically determined marginal emission rates, the proposed new electric generation from coal-fired power plants in Texas means that marginal generation is a mixture of existing natural gas and new coal over the analysis period.

We developed projected average emission factors for Texas based on total emissions and electricity generation projected to 2020. We used projected average emission rates because we found that they are a very good representation of marginal rates for the analysis period. We estimated 2020 overall emissions based on current emissions (data came from EPA's Acid Rain Program data (EPA 2006b)) and announced plans for additional generation in Texas. Announced plans include up to 17 new coal plants, new nuclear plants and significant new wind generation (TCEQ 2006; Smith 2006). We used current electricity generation data for Texas from EIA (EIA 2006a) and calculated 2020 electricity generation using ERCOT's projected annual growth rate (Collins 2006). Our emissions estimates are based on actual emissions from power generation in 2004 (46% natural gas, 40% coal, 14% nuclear and 2% renewables) plus the addition of the emissions from 12,100 MW of planned new coal plants to the existing generation mix. Significant expansions of renewable generation and, possibly, nuclear generation are also planned but would not add to the emissions totals. Combining existing emissions with the projected emissions and dividing by projected total generation yields 2020 emission factors of .62 metric tons CO_2 per MWh, .37 metric tons NOx per GWh, and 1.03 tons SO2 per GWh. For comparison, 2004 average emission rates were .64 metric tons CO_2 per MWh, .47 tons NOx per GWh, and 1.39 tons SO_2 per GWh. Thus, in effect, we project that the power displaced is somewhat cleaner on average than power generated in Texas today.

Table A.2. Sources for Key Assumptions

Products	Recent Year Sales	Current Standard or Baseline	New Standard or Average Use	Average Product Life	Per Unit Incremental Cost	Coincident Peak Factor
Bottle-type water dispensers	PG&E 2004a	PG&E 2004a	PG&E 2004a	PG&E 2004a	PG&E 2004a	1/8760 hrs/yr
Commercial hot food holding cabinets	PG&E 2004b	PG&E 2004b	PG&E 2004b	PG&E 2004b	PG&E 2004b	1/8760 hrs/yr
Compact audio products	PG&E 2004c	PG&E 2004c	PG&E 2004c	PG&E 2004c	PG&E 2004c	1/8760 hrs/yr
DVD players and recorders	PG&E 2004c	PG&E 2004c	PG&E 2004c	PG&E 2004c	PG&E 2004c	1/8760 hrs/yr
Metal halide lamp fixtures	PG&E 2004d	PG&E 2004d	PG&E 2004d	PG&E 2004d	PG&E 2004d	EIA 2000
Portable electric spas (hot tubs)	PG&E 2004e	PG&E 2004e	PG&E 2004e	PG&E 2004e	PG&E 2004e	Avg. of EIA 2000 and 1/8760 hrs/yr
Residential pool pumps	PG&E 2004f	PG&E 2004f	PG&E 2004f	PG&E 2004f	PG&E 2004f	PG&E 2004f
Single-voltage external power supplies	PG&E 2004g	PG&E 2004g	PG&E 2004g	PG&E 2004g	PG&E 2004g	1/8760 hrs/yr
State-regulated incandescent reflector lamps	PG&E 2004h	PG&E 2004h	PG&E 2004h	PG&E 2004h	PG&E 2004h	EIA 2000
Walk-in refrigerators and freezers	PG&E 2004i	PG&E 2004i	PG&E 2004i	PG&E 2004i	PG&E 2004i	Avg. of EIA 2000 and 1/8760 hrs/yr