Leading the Way:
Continued Opportunities for
New State Appliance and Equipment Efficiency Standards

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EXECUTIVE SUMMARY

Appliance and equipment efficiency standards have been one of the most successful policies used by state governments and the federal government to save energy. These standards prohibit the production and import or sale of appliances and other energy-consuming products less efficient than the minimum requirements. These standards not only save energy but also reduce pollutants, improve electric system reliability, and save consumers and business owners significant amounts of money over the life of the equipment.

In the United States, minimum-efficiency standards for appliances and other equipment were initiated at the state level. California adopted the first appliance standards law in 1974 and in the early and mid-1980s, other states (including Florida, Kansas, Massachusetts, and New York) adopted standards on various products. These state standards led to acceptance of national standards, which were adopted by Congress in 1987, 1988, and 1992 and signed by Presidents Reagan and Bush to address market failures and replace a patchwork of state standards. These initial efficiency standards focused on the "low-hanging fruit"—major residential appliances (e.g., refrigerators, air conditioners, water heaters, washers and dryers, etc.) as well as the most common commercial equipment (e.g., fluorescent lamps, motors, furnaces, etc.) Since then, technology and programmatic advances provide the opportunity to extend the standards programs to additional products that are now "ripe" for the harvest of energy and economic savings. These developments include widespread availability of more advanced products; work on new standards by several states and Canada; development of ENERGY STAR® and other voluntary specifications for many products; updates of key industry (trade association) standards; and additional research on the energy savings potential, usage, cost, and availability of these products.

While the efficiency standards established to date have provided significant energy and economic savings, the United States is still experiencing overall growth in energy demand and an increasingly tight supply. Some other regions might become "the next California"—growth in electricity use is exceeding power plant construction in these regions and existing power surpluses could soon evaporate. Savings from new products that are now "ripe" for appliance and efficiency standards could reduce the need for additional power plants and ease electric load on already stressed transmission lines and transformers, significantly contributing to improved system reliability. In addition, natural gas prices have skyrocketed in the past year (e.g., average residential prices of $11.69 per million Btu in the first 9 months of 2004, up 34% relative to the same period in 2001). ACEEE researchers discovered that markets are so tight that just a modest 2–4% reduction in national gas use can reduce natural gas prices by 20% or more. Such savings can be achieved with the use of more efficient gas-fired equipment as well as through reduced electricity use, since in many regions of the United States, natural gas is the marginal fuel used for power generation. Coal prices have also been rising in the past year, which is affecting electricity prices. Prices have been increasing because demand is up (due in part to high oil and natural gas prices) and supplies are tight. Appliance and equipment efficiency standards, along with other efficiency actions, can reduce demand, softening markets and reducing energy prices as a result.

In 2001, ACEEE published a report entitled *Opportunities for New Appliance and Equipment Efficiency Standards: Energy and Economic Savings Beyond Current Standards Programs.* In that report we examined opportunities for state appliance and equipment efficiency standards for 14 products. Many states took advantage of it as they considered new appliance standards and regulations. Since its publication, legislation or regulations have been adopted in three states (California, Connecticut, and Maryland) based in substantial part on its recommendations. In addition, consensus national efficiency standards have been negotiated between manufacturers and efficiency supporters on nine products and the consensus agreements incorporated into pending federal energy legislation. However, this legislation has not passed due to controversies regarding other parts of the bill. Given the paralysis at the national level, we recommend that states adopt most of the consensus national standards as state standards. In addition, there are another nine products not included in federal legislation for which state standards are justified. The current report is intended to update the earlier one and present information on most of the current best opportunities for new state efficiency standards.

In this report, we describe opportunities for state governments to set minimum-efficiency standards for 18 appliances and other types of equipment currently not covered by federal standards. These are ceiling fan lights; commercial clothes washers; commercial refrigerators and freezers; commercial unit heaters; dehumidifiers; digital cable and satellite boxes; digital television adapters; exit signs; external power supplies; commercial ice-makers; incandescent reflector lamps; large commercial packaged air conditioners and heat pumps; low- and medium-voltage dry-type distribution transformers; metal halide lamp fixtures; pre-rinse spray valves; torchiere lighting fixtures; and traffic signals.

Table ES.1 summarizes the potential for energy and economic savings from adopting national minimum-efficiency standards for the above 18 products. Table ES.2 shows the potential peak load and emission reductions in 2020 and 2030 from adopting these standards (information on savings in 2010 can be found in Appendix B).

On a national basis, these new standards would save 65 terawatt-hours (TWh)[1] of electricity and about 0.8 quads[2] of primary energy[3] in the year 2020, while generating $59 billion in net savings for consumers and business owners for equipment purchased through 2030. The electricity savings amount to 2% of projected residential and commercial sector U.S. electricity use in 2020. Stated another way, these standards would reduce projected growth in residential and commercial electricity use over the next 2 decades by about 6%. These standards would also save natural gas, including, in 2020, about 100 billion cubic feet of direct natural gas use in buildings (i.e., savings from reduced gas use for space and water heating) and an additional 336 billion cubic feet of natural gas used in power plants. The

[1] One TWh is a billion kWh.
[2] A "quad" is a quadrillion Btus, where a quadrillion is 1,000 trillion. By way of comparison, the entire United States currently uses a total of just under 100 quads annually in all sectors of the economy.
[3] "Primary" energy includes the energy content of the fuel burned at the power plant and not just the energy content of electricity as it enters a home or factory. Typically, about three units of energy are consumed at the power plant in order to deliver one unit of energy to a home. The remaining energy is lost as waste heat from the power plant and losses along the transmission and distribution system.

primary energy savings (savings in all fuels) from new standards would be about one-fifth the savings from all existing federal standards, with an overall benefit-cost ratio of 9.3 to 1—far better than the 3 to 1 ratio for existing standards. All appliance and equipment efficiency standards are also incredibly cost-effective from a government perspective, with net benefits to consumers and businesses more than 2,000 times greater than the cost to state and federal governments to administer a standards program. In fact, the direct savings to state governments (due to more efficient products in state facilities) are generally greater than the government cost of these programs. Because nearly all of the standards recommended have already been adopted in at least one state, the cost for additional states to establish and implement such standards will be very small.

Table ES.1. Estimated Energy Savings and Economics of Proposed New Standards

Products	Effective Date	National Energy Savings in 2020		National Energy Savings in 2030		Cumulative Savings for Products Purchased thru 2030	NPV for Purchases thru 2030	Benefit-Cost Ratio
	(year)	(TWh)	(tril. Btu)	(TWh)	(tril. Btu)	(quads)	($ billion)	
Ceiling fan lights	2007	18.9	197	18.9	190	3.4	13.0	18.3
Commercial clothes washers	2007	0.3	9	0.3	9	0.2	0.9	3.7
Commercial ice-makers	2007	0.6	7	0.6	6	0.1	0.4	7.9
Commercial refrigerators & freezers	2010	2.4	25	2.4	24	0.4	1.3	10.9
Commercial unit heaters	2007	NA	39	NA	55	0.8	3.0	9.6
Dehumidifiers	2007	1.0	10	1.1	11	0.2	0.7	133.3
Digital cable & satellite boxes	2007	1.4	14	1.4	14	0.4	1.2	4.1
Digital television adapters	2007	0.3	3	0.0	0	0.2	1.1	7.4
Exit signs	2007	1.7	18	2.9	29	0.4	1.4	11.9
External power supplies	2007	4.9	51	4.9	49	1.0	3.3	4.6
Large commercial packaged AC & heat pumps	2010	1.5	16	2.2	22	0.3	0.9	6.6
Low-voltage dry-type transformers	2007	3.1	32	5.4	54	0.7	2.6	8.2
Medium-voltage dry-type transformers	2007	2.7	28	4.7	47	0.6	2.4	5.5
Metal halide lamp fixtures	2008	9.0	93	14.4	144	1.9	7.3	10.8
Pre-rinse spray valves	2007	NA	56	NA	56	1.2	8.0	428.0
Reflector lamps	2007	3.9	40	3.9	39	0.9	2.6	4.1
Torchiere lighting fixtures	2007	11.8	123	11.8	119	2.3	8.4	10.0
Traffic signals	2007	1.3	13	1.3	13	0.3	0.6	3.2
Total		64.8	772.6	76.2	879.9	15.4	59.3	9.3

Note: NPV is the value of energy savings due to standards minus the additional cost of more efficient products expressed in current dollars. A 5% real discount rate is used for these calculations.

Another significant benefit from appliance standards is their impact on summer peak load. We estimate that the proposed standards would save a total of over 19 gigawatts (GW)[4] of power in the year 2020. This is roughly equal to the generating capacity of 64 average power plants (i.e., 300 MW each). These standards would also save a significant amount of water by 2020, including 120 billion gallons of direct water savings per year from efficient commercial clothes washers and pre-rinse spray valves as well as an additional 32 billion gallons of water saved per year at power plants.

Emissions reductions from the reduced energy consumption would also be significant. In the year 2020, 14 million metric tons (MMT) of carbon would be reduced, which is equivalent to

[4] 19 GW = 19,000 MW.

the annual carbon emissions from over nine million "average" passenger cars.[5] In addition to carbon, emissions would be reduced significantly for smog-forming nitrogen oxides (NOx), sulfur oxides (SOx; the main component of acid rain), fine particulate matter, and mercury (the latter two contribute to substantial health problems).

Table ES.2. Estimated Summer Peak Load, Water and Pollutant Reductions from New Standards

	Summer Peak Load Reduction		Water Savings	Pollutant Reductions in 2020			
	In 2020 (GW)	In 2030 (GW)	In 2020 (billion gal)	Carbon (MMT)	NOx (1000 MT)	SOx (1000 MT)	PM_{10} (1000 MT)
Ceiling fan lights	6.2	6.2	9.5	3.6	10.0	47.4	0.5
Commercial clothes washers	0.1	0.1	16.3	0.1	0.4	0.8	0.0
Commercial ice-makers	0.1	0.1	0.3	0.1	0.4	1.5	0.0
Commercial refrigerators & freezers	0.6	0.6	1.2	0.5	1.4	5.8	0.1
Commercial unit heaters	NA	NA	NA	0.6	1.8	0.0	0.1
Dehumidifiers	0.3	0.4	0.5	0.2	0.5	2.4	0.0
Digital cable & satellite boxes	0.2	0.2	0.7	0.3	0.8	3.3	0.0
Digital television adapters	0.0	0.0	0.1	0.0	0.1	0.6	0.0
Exit signs	0.2	0.4	0.8	0.3	1.0	4.4	0.0
External power supplies	0.7	0.7	2.4	0.9	2.8	11.7	0.2
Large commercial packaged AC & heat pumps	1.6	2.3	0.8	0.3	0.7	3.8	0.0
Low-voltage dry-type transformers	0.4	0.7	1.6	0.6	1.8	8.1	0.1
Medium-voltage dry-type transformers	0.4	0.7	1.4	0.5	1.5	6.5	0.1
Metal halide lamp fixtures	2.9	4.7	4.5	1.7	5.1	21.3	0.3
Pre-rinse spray valves	NA	NA	103.5	0.8	2.2	0.0	0.2
Reflector lamps	1.3	1.3	1.9	0.8	2.2	9.1	0.1
Torchiere lighting fixtures	3.9	3.9	5.9	2.2	7.3	31.0	0.4
Traffic signals	0.2	0.2	0.6	0.2	0.8	3.3	0.0
Total	19.2	22.4	152.1	13.8	40.8	161.1	2.3

Note: Water savings include direct savings at the point of use as well as reductions in power plant water use.

Clearly, significant savings potential exists for these products at a small increase in first cost, resulting in large energy savings, economic savings, peak load reductions, water savings, and emission reductions over the life of the equipment. Given these benefits, we recommend that states adopt new efficiency standards on these products. This report provides specific recommendations that can be used to craft the appropriate legislation and regulations.

[5] A typical vehicle emits 12,000 lbs. of carbon dioxide each year (about 1,500 kg carbon), based on an average on-road fuel economy of 20 miles per gallon and average vehicle use of 12,000 miles per year.

1. INTRODUCTION

This report is an update and expansion of a 2001 ACEEE report entitled *Opportunities for New Appliance and Equipment Efficiency Standards: Energy and Economic Savings Beyond Current Standards Programs* (Kubo, Sachs, and Nadel 2001). The earlier report examined opportunities for state appliance and equipment efficiency standards on 14 products. The current report includes updated information on most of these products but also includes information on promising standards for six additional ones. Many states used the previous report as they considered new appliance standards and regulations. Since its publication, legislation or regulations have been adopted in three states (California, Connecticut, and Maryland) based in substantial part on its recommendations. We hope the current report is at least as useful, and provides the information that additional states need to adopt standards on the expanded list of 18 products covered here.

2. BACKGROUND

2.1 History of Standards in the United States

Appliance efficiency standards were first enacted by the state of California in 1974 when then-Governor Reagan signed the State Energy Resources Conservation and Development Act as part of the state's policy to "reduce wasteful, uneconomical, and unnecessary uses of energy, thereby reducing the rate of growth of energy consumption, prudently conserving energy resources, and assuring statewide environmental, public safety, and land use goals" (CEC 1983). Other rationales for standards were to save consumers money by lowering appliance operating costs and helping to overcome market barriers that inhibit the sale of efficient products.

California's original standards applied to refrigerators, freezers, room air conditioners, and central air conditioners. California subsequently expanded the scope of its standards to include space heaters, water heaters, plumbing fittings, fluorescent ballasts, and large air conditioners (CEC 1983). In the early and mid-1980s, other states (including Florida, Kansas, and New York) began to adopt standards on central and room air conditioners (Geller 1983). In 1986, Massachusetts adopted standards on refrigerators, room air conditioners, water heaters, fluorescent ballasts, and showerheads (Nadel 1994).

In 1986, with the likely development of additional state standards, appliance manufacturers became increasingly concerned about the impact of differing state standards on manufacturers' ability to do business on a national basis. To address these concerns, they offered to negotiate with energy efficiency advocates and states in order to reach consensus on national efficiency standards that would largely preempt individual state standards. The resulting agreement was adopted by Congress and signed by President Reagan as the National Appliance Energy Conservation Act of 1987 (NAECA) (U.S. Congress 1987). In 1988, Congress added fluorescent ballasts to NAECA (U.S. Congress 1988). And in 1992, Congress adopted and President Bush signed the Energy Policy Act (EPAct) (U.S. Congress 1992), which added standards for many of the most common types of light bulbs, electric motors, commercial heating and cooling equipment, and plumbing fittings. Each of these laws was based on consensus agreements between product manufacturers and efficiency advocates (Nadel and Pye 1996). The specific products covered by these different federal standards are summarized in Table 2.1.

Table 2.1. Products Subject to Existing Federal Appliance Efficiency Standards

Products Included in the National Appliance Energy Conservation Act	
Refrigerator-freezers	Clothes washers
Freezers	Clothes dryers
Room air conditioners	Dishwashers
Central air conditioners & heat pumps	Ranges & ovens
Furnaces & boilers	Pool heaters
Water heaters	Fluorescent lamp ballasts
Direct-fired space heaters	Televisions*
Products Added in the Energy Policy Act of 1992	
Fluorescent lamps	Showerheads
Incandescent reflector lamps	Faucets & aerators
Electric motors (1–200 hp)	Toilets
Commercial packaged air conditioners & heat pumps	Distribution transformers*
Commercial furnaces & boilers	Small electric motors (<1 hp)*
Commercial water heaters	High-intensity discharge lamps*

Source: Nadel and Pye 1996

* Specific standards were not set in the legislation but instead DOE was instructed to investigate whether standards are technically feasible and economically justified and to set standards where these criteria are met.

Since the original NAECA and EPAct standards were enacted, there have been several updates to the standard levels that have yielded/will yield significant additional energy and economic savings. The U.S. Department of Energy (DOE) was specifically instructed to update standards whenever "new available technology makes higher standard levels economically justifiable" (U.S. Congress 1987). These updates included new refrigerator, freezer, and room air conditioner standards published in 1997; new fluorescent ballast standards published in 2000; and new clothes washer, water heater, and central air conditioner and heat pump standards published in 2001 (in most cases, new standards take effect 3 years after final publication).

Recently, there have been developments in several states on appliance and equipment efficiency standards. In early 2002, California adopted new standards on ten products ranging from commercial clothes washers to traffic signal modules. In early 2004, the Maryland and Connecticut legislatures enacted efficiency standards on nine and eight products, respectively, drawing from the California energy standards, ENERGY STAR specifications, and other widely used specifications. Similar legislation has passed both houses of the New Jersey legislature and is likely to be enacted in early 2005 when the New Jersey House takes up the Senate version of the legislation. Pennsylvania is also close to enactment. In addition, Massachusetts, Minnesota, New York, and Oregon have adopted the National Electrical Manufacturers Association's Standard TP-1 (NEMA 1996) as the minimum-efficiency requirement for distribution transformers through the state building code and/or an equipment efficiency standard. In December 2004, the California Energy Commission adopted new standards on 19 additional products, including 15 products not previously regulated and four products that are currently regulated but for which revisions were made (CEC 2004a). In addition, California has standards on three products pending, with a decision scheduled for the first half of 2005 (CEC 2004b). Table 2.2 summarizes products now subject to state efficiency standards that are not preempted by federal standards, and also includes standards now pending in California.

Table 2.2. Products Covered by Adopted and Pending State Standards

Product	California	Connecticut	Maryland	Other
Boilers & central furnaces not covered by federal standards	X			
Ceiling fans and ceiling fan lights			X	
Commercial clothes washers	X	X	X	
Commercial hot food holding cabinets	X			
Commercial ice-makers	X			
Commercial reach-in refrigerators and freezers	X	X	X	
Commercial unit heaters	X	X	X	
Computer room air conditioners	X			
Consumer audio and video equipment	X			
Digital television adaptors	X			
Duct furnaces	X			
Exit signs	X	X	X	
External power supplies	X			
Freezers (residential, 30–39 cubic feet)	X			
General service incandescent lamps	XO			
Incandescent reflector lamps not federally regulated	O			
Large commercial packaged AC*	X	X	X	
Low-voltage dry-type distribution transformers	X	X	X	MA, MN, NY, OR
Metal halide lamp fixtures	XO			
Pool heaters not covered by federal standards	X			
Pool pumps	X			
Pre-rinse spray valves	X			
Refrigerated beverage vending machines	X			
Small water heaters not covered by federal standards	X			
Torchieres	X	X	X	
Traffic signal modules	X	X	X	
Under-cabinet light fixture ballasts	X			
Walk-in refrigerators & freezers	X			
Water dispensers	X			
Water & ground water-source heat pumps	X			
Wine chillers	X			

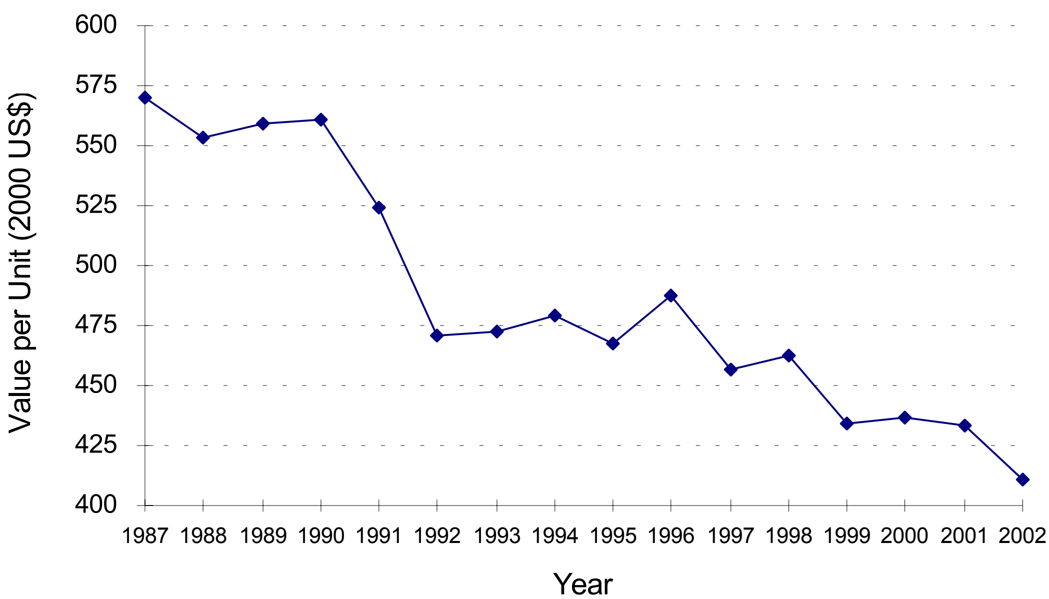
Key: X = standard adopted, O = standard pending, XO = standard adopted and revised standard pending

* Heat pumps are also included in this category; due to the small number sold, they are not mentioned specifically.

2.2 Rationale for Standards

By setting a minimum-efficiency level, standards remove inefficient products from the market and ensure that efficiency improvements are incorporated into all new products. 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 because standards encourage manufacturers to focus on how to achieve efficiency improvements at minimum cost as manufacturers 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 product performance and design. For example, due to standards, all new refrigerators use high-efficiency motors and compressors, better insulation, and improved heat exchangers and are three times more energy efficient than refrigerators were in the 1970s. During this period, the average per unit value (average revenue received by manufacturers) of refrigerators actually **declined** (see Figure 2.1).

Figure 2.1. Per Unit Value of Refrigerators, 1987–2002 (in 1996 dollars)



Note: New federal standards took effect in 1990, 1993, and 2001.
Source: Census 2003 (and earlier years)

Clearly, appliance and equipment efficiency standards save energy—standards already in place will save 4.2 quads in 2020, equivalent to the annual energy use of 23 million U.S. households (further details provided below). In addition, efficiency standards also reduce pollutants, improve electric system reliability, and save consumers and business owners a significant amount of money during the life of the equipment from reduced energy bills. Due to these multiple benefits, it is important for the federal government, states, and utilities to include present and future standards in their energy use forecasts and plans and to take steps to ensure that state and federal appliance standards are regularly updated and expanded to cover additional products so that these many benefits can be realized.

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 market barriers include the following demand- and supply-side barriers.

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:* Even when the purchaser is aware of variations in energy efficiency, often he or she is too busy 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. In the commercial/industrial sector, many purchasing decisions are made by purchasing or maintenance staff who 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, bottling company, etc.) is responsible for purchasing equipment but someone else (e.g., tenant, operating department, store owner, 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:* It is very common that accounting processes in the commercial/industrial sector closely scrutinize capital costs and tend to favor purchase of inexpensive equipment while operating costs are generally not scrutinized as closely. 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 the 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 250 million or so of these devices are sold nationally each year, large energy savings are at stake for states or the nation as a whole.

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).

- *Manufacturer competition:* Since different manufacturers are competing for market share, if a manufacturer voluntarily increases efficiency, the small increases in retail cost to improve the efficiency of the product could adversely affect the business if there is little end-user demand for efficient products. A good example is beverage vending machines—the manufacturers agree in concept that energy savings could be achieved with very small incremental cost but they are not willing to participate in voluntary programs since purchasers (e.g., bottlers) only look at first cost. In contrast, mandatory standards ensure that the playing field is level 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 discussed here, 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).[6] 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. Thus, while these other programs and policy options have important benefits and complement efficiency standards (e.g., by encouraging higher-efficiency levels than can be mandated with efficiency standards), they are not a replacement for efficiency standards.

2.3 Savings from Current Standards

Several organizations have conducted studies on the impacts of efficiency standards to date on U.S. energy use. For example, both ACEEE and Lawrence Berkeley National Laboratory (LBNL) have periodically published estimates of the national impacts of specific federal

[6] Exit signs and traffic signals are the only exceptions to this statement. For these products, ENERGY STAR has a higher market share because of the large maintenance cost savings associated with the highest-efficiency products.

efficiency standards (Atkinson et al. 1992; Geller 1987, 1995; Geller and Miller 1988; Geller and Nadel 1992; LBL 1990; McMahon et al. 1990). These studies generally compared the efficiencies of appliances with standards to what efficiencies would have been if pre-standard efficiency trends had continued. Most recently, ACEEE compiled a list of savings estimates including electricity savings, primary energy savings, peak load reductions, and carbon reductions in the years 2000, 2010, and 2020 from all standards adopted so far (Geller, Kubo, and Nadel 2001, Table 1.3.1).

Table 2.3. Savings from Federal Appliance and Equipment Efficiency Standards

Enact Year	Standards	Electricity Savings (TWh/yr)			Primary Energy Savings (quads/yr)			Peak Load Reductions (GW)			Carbon Reductions (MMT)			Net Benefit ($billion)
		2000	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020	Thru 2030
1987	NAECA	8.0	40.9	45.2	0.21	0.55	0.61	1.4	14.9	16.5	3.7	10.0	10.1	46.3
1988	Ballasts	18.0	22.8	25.2	0.21	0.27	0.29	5.7	7.1	7.9	4.4	5.0	5.0	8.9
1989&91	NAECA updates	20.0	37.1	41.0	0.23	0.43	0.47	3.6	6.9	7.7	4.8	8.1	8.1	15.2
1992	EPAct (lamps, motors, etc.)	42.0	110.3	121.9	0.59	1.51	1.67	10.1	26.2	28.9	11.8	27.5	27.9	84.2
1997	Refrigerator/freezer update	0.0	13.3	28.0	0.00	0.13	0.28	0.0	1.7	3.6	0.0	2.9	5.5	5.9
1997	Room A/C update	0.0	1.3	2.1	0.00	0.01	0.02	0.0	1.0	1.6	0.0	0.3	0.4	0.6
2000	Ballasts update	0.0	6.2	13.7	0.00	0.06	0.13	0.0	1.8	3.0	0.0	1.3	2.7	2.6
2001	Clothes washer update	0.0	8.0	22.6	0.00	0.11	0.28	0.0	1.3	6.1	0.0	2.2	5.4	15.3
2001	Water heater update	0.0	2.5	4.9	0.00	0.08	0.13	0.0	1.5	3.6	0.0	1.4	2.2	2.0
2001	Central A/C&HP update	0.0	10.7	36.4	0.00	0.11	0.35	0.0	3.5	41.5	0.0	2.3	7.2	5.0
	TOTAL	**88**	**253**	**341**	**1.2**	**3.3**	**4.2**	**21**	**66**	**120**	**25**	**61**	**75**	**186**
	% of projected U.S. use	**2.5%**	**6.5%**	**7.8%**	**1.3%**	**2.9%**	**3.5%**	**2.8%**	**7.6%**	**12.6%**	**1.7%**	**3.4%**	**3.8%**	

Source: Geller, Kubo, and Nadel 2001

The overall savings from established appliance and equipment efficiency standards are enormous. As of 2000, appliance standards had already cut U.S. electricity use by 2.5% and U.S. carbon emissions from fossil fuel use by nearly 2%. The total electricity savings are projected to reach 253 and 341 billion kilowatt-hours (kWh) per year, or 6.5% and 7.8% of the projected total U.S. electricity use, in 2010 and 2020, respectively. The primary energy savings from these standards, including reductions in fuel use at power plants and in homes and businesses, should reach 4.2 quads in 2020—equivalent to the annual energy use of about 23 million American households. The peak load reduction is expected to reach 66,000 MW in 2010 and 120,000 MW in 2020, which is equivalent to the power produced by 400 average (i.e., 300 MW) fossil fuel power plants. The standards also will reduce carbon emissions by 61 MMT in 2010 and 75 MMT in 2020 (including both power plant and end-use savings). The latter value is equivalent to the annual carbon emissions from approximately 50 million "average" passenger cars (EPA 1997). These savings will occur while simultaneously the standards will provide a cumulative net benefit through 2030 of about $186 billion to U.S. consumers, about $1,750/household (Geller, Kubo, and Nadel 2001). These savings estimates are conservative because they only account for the savings resulting from federal standards and don't include the benefits from state standards that preceded the federal requirements. The estimates also are conservative because energy prices have increased faster in recent years than was generally assumed in the analysis.

Of particular interest in Table 2.3 are the six updates to NAECA issued by the Clinton Administration in 1997, 2000, and early 2001. These standards include refrigerators and freezers, room air conditioners (A/C), fluorescent ballasts, clothes washers, water heaters, and central A/C and heat pumps. These six standards combined are expected to reduce electricity use by 107 billion kWh/yr and peak electric demand by 59,000 MW by 2020, while saving consumers and businesses over $31 billion net through 2030. These savings represent a significant portion of the overall savings from appliance and equipment standards to date and illustrate the importance of regularly updating standard levels whenever new technology proves both feasible and beneficial.

Furthermore, from the point of view of government expenditures, standards are incredibly cost-effective. A 1995 analysis compared the costs and benefits of the federal standards program as of 1995 and concluded that benefits are more than 2,500 times greater than program costs (Geller 1995). A 2001 study of more recent experience under the federal standards program found benefits were more than 2,000 times greater than the costs of recent DOE rulemakings (Kubo, Sachs, and Nadel 2001). Costs for states to develop and implement standards have proven to be much, much lower than federal costs, with benefit-cost ratios somewhat higher as a result. This issue is discussed further in Section 3.5.

2.4 Opportunities for New and Updated Standards

The efficiency standards established to date have provided significant energy and economic savings, yet the United States is experiencing overall growth in energy demand and an increasingly tight supply. Some other regions might become "the next California"— growth in electricity use is exceeding power plant construction in these regions and existing power surpluses could soon evaporate. Savings from new products that are now ripe for appliance and efficiency standards could reduce the need for additional power plants and ease the electric load on already stressed transmission lines and transformers, significantly contributing to improved system reliability. Furthermore, natural gas prices skyrocketed in the past year (e.g., $11.69 per million Btu was the average residential price in the first eight months of 2004, up 34% relative to the same period in 2001) (EIA 2004d). ACEEE researchers discovered that markets are so tight that just a modest 2–4% reduction in national gas use could reduce natural gas prices by 20% or more (Elliott et al. 2003). Such savings could be achieved with the use of more efficient gas-fired equipment as well as through reduced electricity use, since in many regions of the United States, natural gas is the marginal fuel used for power generation. Coal prices have also been rising in the past year, affecting electricity prices, which have been increasing because demand is up (due in part to high oil and natural gas prices) and supplies are tight. Appliance and equipment efficiency standards, along with other efficiency actions, can reduce demand, softening markets and reducing energy prices as a result.

When NAECA and EPAct were established in 1987 and 1992, respectively, Congress focused on the most common residential appliances and commercial equipment that had significant energy and economic savings potential. Since then, there have been quite a few technical and programmatic developments that have created a new batch of "low-hanging fruit." These developments include work on new standards by several states and Canada;

development of ENERGY STAR specifications for many products; development and updates of key industrial standards (i.e., American Society of Heating, Refrigeration and Air-Conditioning Engineers [ASHRAE] and National Electrical Manufacturers Association [NEMA] consensus model standards); and additional research on the energy savings potential, usage, cost, and availability of these products (these developments are discussed in detail for specific products below).

Policy support for updating existing standards and broadening the coverage of efficiency standards to additional products comes from many quarters. The Interlaboratory Working Group (2000), the National Petroleum Council (2003), the State Public Interest Research Groups (2001), and the Bush Administration's National Energy Policy Development Group (2001—i.e., the administration's energy plan) have all stated support for new standards. New efficiency standards have also drawn bipartisan support in Congress. One of the least controversial elements of the pending federal Energy Policy Act, which stalled in Congress due to a variety of highly controversial provisions unrelated to standards, would have specified new efficiency standards for six categories of consumer and commercial products and directed DOE to undertake rulemakings on four additional products (U.S. Congress 2003).

Most recently, the National Association of Regulatory Utility Commissioners (NARUC) adopted resolutions in support of both upgraded national efficiency standards and expanded state efficiency standards. NARUC specifically urged DOE "to expeditiously promulgate and implement new national standards for commercial air conditioners and heat pumps; residential furnaces and boilers; and electric distribution transformers that achieve the greatest level of cost-effective energy savings" (NARUC 2004a). Separately, NARUC urged state policy makers to support "action where appropriate to establish State level energy efficiency standards that are cost effective for their respective states" and "to coordinate across State lines to the greatest extent practical in the development and implementation of such State standards (NARUC 2004b)." The Bush Administration's national energy plan, issued in 2001, noted that "standards will stimulate energy savings that benefit the consumer, and reduce fossil fuel consumption, thus reducing air emissions." The plan then recommended that the Secretary of Energy: (1) "support [the] appliance standards program for covered products, setting higher standards where technologically feasible and economically justified;" and (2) "expand the scope of the appliance standard program, setting standards for additional appliances where technologically feasible and economically justified." (National Energy Policy Development Group 2001). The following section briefly reviews key upgrades to existing federal standards that are due. The remainder of this report primarily focuses on recommendations for new state standards for 18 products not covered by current federal standards.

2.5 Savings from Updated Federal Standards

Several existing federal standards are now ready for updating. DOE is presently working on three products as high priorities—commercial air conditioners and heat pumps, residential furnaces and boilers, and electric distribution transformers (the last is not currently subject to a federal standard but DOE was directed to set standards under EPAct). For these three products, DOE issued Advanced Notices of Proposed Rulemakings (ANOPRs) in August 2004 and under DOE's regulations, final standards should be issued by early 2006. Additional information on these rulemakings can be found in a September 2004 report issued by the Appliance Standards Awareness Project (Nadel et al. 2004).

In addition, DOE is doing some limited work to prepare for revisions of other standards including residential dishwashers, commercial boilers, and commercial packaged terminal air conditioners and heat pumps. Research on incandescent reflector lamps is also taking place (DOE 2004a). Furthermore, some of the standards updated in 1997-2001 will be ready for another round of revisions later this decade because of opportunities for significant additional cost-effective savings beyond the current standards. Products that are likely to fall into this category are residential refrigerators, residential gas-fired water heaters, and residential central air conditioners and heat pumps. In June 2004, a coalition of states, utilities, and energy efficiency groups formally petitioned DOE to begin a new rulemaking on residential refrigerators. Table 2.4 summarizes additional updates to existing standards that DOE should act on in the next few years to harvest these available savings.

These updates to current federal standards will yield over 62 TWh of electricity savings and 0.8 quads of primary energy savings annually while generating net present value savings of approximately $49 billion for consumers and business owners. The benefit-cost ratio will be 3.5 to 1, slightly higher than the benefit-cost ratio of standards already in place (3 to 1). However, the cost-effectiveness in Table 2.4 is calculated using today's incremental equipment costs and thus the economics should significantly improve since equipment costs will likely come down as standards move efficient products from niche-market to mass-market status (see Section 2.2).

Table 2.4. Savings from Future Updates to NAECA and EPAct Standards

Products	Effective Date	National Energy Savings in 2020		Cumulative Savings for Products Purchased Thru 2030	Peak Load Reductions in 2020	NPV for Purchases Thru 2030	Benefit-Cost Ratio	Carbon Reductions 2020
	(year)	(TWh)	(tril. Btu)	(quads)	(GW)	($ billion)		(mMT)
Residential furnaces and boilers	2011	16	272	5.7	3.7	17.6	3.3	4.6
Residential refrigerators	2011	12	122	2.6	1.8	9.3	4.9	2.3
Residential dishwashers	2011	2	28	0.5	0.5	1.6	3.0	0.5
Residential central AC & HP	2012	27	281	5.9	29.4	16.5	3.0	5.1
Commercial boilers	2012	NA	10	0.2	NA	0.6	2.0	0.1
Commercial packaged AC & HP	2010	5	57	1.1	5.8	3.0	4.0	1.0
Commercial PTACs/PTHPs	2012	1	8	0.2	0.8	0.3	2.2	0.2
Total		62	778	16.1	42.0	48.9	3.5	13.8

Notes: PTACs are packaged terminal air conditioners and PTHPs are packaged terminal heat pumps. See Appendix A for assumptions and methodology.

2.6 Pending Federal Standards Legislation

The U.S. Congress has been considering comprehensive energy legislation since 2001. Legislation has passed both the House of Representatives and the Senate, including a section establishing efficiency standards on several new products. However, this legislation has yet to be enacted into law due to controversies regarding other parts of the legislation. As of this writing, it is likely that legislation will be reintroduced in 2005 but it is unclear whether the controversial issues will be dropped and therefore whether the legislation will be enacted.

In the most recent version of the legislation, new federal efficiency standards were established for six products, and DOE was directed to conduct standards rulemakings on five additional products. Products for which specific standards were set are compact fluorescent lamps (CFLs), exit signs, low-voltage dry-type distribution transformers, torchiere lighting fixtures, traffic signal modules, and unit heaters. These standards are the same or nearly the same as recent state efficiency standards for these products. In fact, it was enactment of state efficiency standards on most of these products (all but CFLs) that prompted manufacturers to agree to consensus federal standards. Products for which DOE was directed to set standards are battery chargers, ceiling fans, commercial reach-in refrigerators and freezers, external power supplies, and refrigerated beverage vending machines. Under the legislation, DOE would have had 3 years to conduct rulemakings on these products and the standards would have gone into effect 3 years after final rules were issued. However, DOE has a long history of delays, so these effective dates could have slipped.

To further complicate the picture, as states continue to work on standards, more manufacturers have become interested in consensus federal standards. As of this writing, consensus agreements have been reached between manufacturers and efficiency supporters to add specific standards to future federal legislation for four additional products—ceiling fans, dehumidifiers, commercial packaged air conditioners and heat pumps, and commercial reach-in refrigerators and freezers. Due to the broad support for these standards, they are likely to be added in the future to federal legislation.

2.7 Need for State Action

While significant progress is being made on the federal front, it is far from certain that federal legislation will be enacted due to controversies regarding portions of the federal energy bill besides appliance standards. States can and should enact standards on the products mentioned in the above section as insurance in case the federal government does not act, and also to achieve savings in the years before the federal standards take effect. In addition, there are many good opportunities for standards on products not included in pending federal legislation. State action on this latter category of products is particularly important as state standards on these products will save significant energy in-state and apply pressure for national consensus agreements. Also, DOE has never issued a standard for an unregulated product, despite Congressional authorization and for some products, Congressional deadlines. Therefore, states should not assume DOE will issue regulations for new products in the future, even if instructed to do so in legislation. The rest of this report discusses opportunities for state standards in more detail.

3. Products Meriting Consideration for State Efficiency Standards

3.1 Introduction

We used four basic criteria for determining which products are ready for state-level efficiency standards:

1. A standard would achieve significant energy savings;
2. A standard is known to be very cost-effective for purchasers and users of the product;
3. Products meeting the recommended standards are readily available today; and
4. A state standard could be implemented at very low cost to the state.

The following sections first describe the products and standards (Section 3.2) and then detail how each of these basic criteria is met. Cost-effectiveness for the purchaser/user is addressed in Section 3.3. Using national average energy prices, most of the recommended standards have simple paybacks of less than 3 years, with many having even shorter payback periods. Section 3.4 shows the current availability of products meeting the standards. In Section 3.5, we discuss how existing standards and voluntary programs smooth the way for very low-cost implementation by additional states establishing their own standards. Section 4 summarizes the energy, environmental, and economic benefits for each of the recommended standards and Appendix C shows the benefits for each of the Northeast states. This same data for each of the other states is available online at www.standardsASAP.org.

Federal standards do not currently cover any of the products included here; thus states are not subject to federal preemption with regard to setting efficiency standards for these products.[7]

3.2 Product and Standard Descriptions

We break the product and standard descriptions into five groups: products that are included in pending federal legislation; products likely to be added to federal legislation; products not included in federal legislation that are ready for state standards today in *all* states, products not included in federal legislation that are ready for state standards today in *some* states; and products for which a little more work is needed over the next year or so before they are ready for state standards. Within each category, we list products in alphabetical order. Categories and products are summarized in Table 3.1.

[7] Under federal law, when federal standards take effect, states are preempted from adopting state efficiency standards on the same products, unless they demonstrate a compelling state interest to DOE. The department is required or authorized to establish standards for some products listed here (such as transformers), but it has either failed to meet its legal deadlines (as is the case with transformers) for setting standards or has failed to exercise its authority (as is the case with furnace fans.) Therefore, states have stepped in where DOE has moved very slowly or failed to act. Altogether, DOE has missed legal deadlines for about 20 products for which it is legally required to review and issue new standards if technically feasible and economically justified.

Table 3.1. Products for State Standards by Category

Category	Products
Products in pending federal legislation that are also good targets for state standards	Commercial unit heaters Illuminated exit signs Low-voltage dry-type distribution transformers Torchiere lighting fixtures Traffic signals
Products likely to be added to pending federal legislation	Ceiling fans and ceiling fan lights Commercial refrigerators and freezers Dehumidifiers Large packaged commercial air conditioners
Products not in pending federal legislation that are recommended for state standards today in *all* +states	Commercial clothes washers Commercial ice-makers Digital cable and satellite set-top boxes Digital television adapters External power supplies Medium-voltage dry-type distribution transformers Metal halide lamp fixtures Pre-rinse spray valves Reflector lamps
Products not in pending federal legislation that are recommended for state standards today in *some* states	Pool pumps* Residential furnaces, boilers, and furnace fans* Other products covered by California standards*
Products needing some additional research before state standards can be adopted	Battery chargers Furnace fans Liquid-immersed distribution transformers Multi-function cable boxes

* Products discussed but not analyzed in this report.

3.2.1 Products in Pending Federal Legislation That Are Also Good Targets for State Standards

As noted above, both houses of Congress have passed legislation establishing standards on six products but this legislation is not yet law due to controversies on other parts of the bill. We recommend that states adopt standards on most of these products as an "insurance policy" in case this pending legislation never passes or continues to be delayed.

Source: Gaumer

Commercial Unit Heaters

THE PRODUCT: Unit heaters are box-type heaters that usually hang from a ceiling and provide heating in open commercial and industrial spaces such as garage bays and warehouses. The recommended standard applies to natural gas and propane unit heaters only.

THE STANDARD: We recommend that states adopt a prescriptive standard[8] that requires intermittent ignition devices (instead of a continuously burning pilot light) and also power venting or an automatic flue damper, which are commonly available technologies that significantly reduce heat loss up the flue when the burner is idle. The 1992 federal standard for residential furnaces and the 2001 federal standard for conventional commercial furnaces effectively required these improvements, so the technology is the norm for other types of gas heating equipment. California, Connecticut, and Maryland adopted this standard in 2004.

KEY FACTS: Inefficient unit heaters typically have a seasonal efficiency of about 63%, whereas systems with seasonal efficiencies of 80% or more are common. These higher seasonal efficiency levels can be reached with power venting or an automatic flue damper. These technologies reduce the amount of heated air that escapes through the flue, thus reducing annual energy use by about 20%. The more efficient units' additional cost pays for itself in lower gas bills within 2 years; unit heaters typically last 19 years. About 50% of the unit heaters sold today (including products available from all manufacturers) meet the recommended standard (Sachs 2003).

Illuminated Exit Signs

THE PRODUCT: Illuminated emergency exit signs are required by fire codes to mark exits in all commercial and institutional buildings. This standard covers all of these signs.

Source: Isolite

THE STANDARD: In 1999, the EPA ENERGY STAR program established an energy and safety performance specification for illuminated exit signs. The standard is based on the efficiency achieved by light emitting diodes (LEDs). California, Connecticut, and Maryland have adopted this specification as a state standard, and we recommend that other states do the same. This standard requires that signs have an input power demand of 5 watts or less per illuminated face.

KEY FACTS: Many exit signs use incandescent bulbs (40 Watts is typical) and, since they are continuously illuminated, typically cost around $30 per year to operate. LEDs, originally used as indicator lights in electronics, have become much more common and affordable as a light source in recent years in products ranging from exit signs to traffic signals to large electronic billboards. LED-based exit sign designs consume about 3 Watts, reducing energy use by more than 90% relative to an incandescent sign. An LED exit sign typically pays off the cost difference between itself and a conventional sign in reduced electricity bills within

[8] Normally we prefer *performance* standards for products—standards that set an efficiency level and let manufacturers decide which features to use to meet these performance levels. In the case of commercial unit heaters, the only performance metrics available, such as from ASHRAE, are for efficiency when the burner is firing. This efficiency metric ignores the largest opportunity for energy savings, which is to reduce heat losses when the burner is not firing. The prescriptive standard we propose does reduce these heat losses substantially. It is easy to meet and has the support of manufacturers, who prefer this simple prescriptive standard to what is likely to be a difficult and expensive process to develop a seasonal efficiency performance metric.

1.5 years. In addition, LED exit signs require less frequent bulb changes, resulting in substantial maintenance cost savings. Nearly 500 exit signs made by 30 different manufacturers meet this standard today (EPA 2004a).

Low-Voltage Dry-Type Distribution Transformers

THE PRODUCT: Distribution transformers reduce electricity voltage from the high levels at which power is shipped over utility transmission and distribution lines to the lower levels required to power appliances, office equipment, and building machinery. Utilities own and operate the transformers on their systems including those seen on utility poles and cement pads throughout utility systems. These utility-owned transformers are typically "liquid-immersed" type equipment. Commercial buildings and some industrial customers typically buy power from utilities at higher voltages, and own and operate "low-voltage dry-type" transformers to reduce voltages for use in lighting, office equipment, and other applications. The recommended standard covers these low-voltage dry-type transformers only.

THE STANDARD: In the late 1990s, the National Electrical Manufacturers Association, the trade association for transformer manufacturers, developed a recommended standard (NEMA 1996) for all types of distribution transformers, including low-voltage dry-type transformers. California, Connecticut, Maryland, and Massachusetts have adopted the NEMA low-voltage dry-type distribution transformer standard as a mandatory standard and Minnesota, New York, and Oregon have incorporated the standard into their building codes. We recommend that other states adopt this standard as a minimum.[9] The specific standard requirements are listed in Table 3.2.

KEY FACTS: Transformers waste as much as 3% of their energy input as dissipated heat as they reduce voltage to lower levels. By moving to better designs and higher quality materials (e.g., copper instead of aluminum), this energy waste can be cut. The NEMA standard reduces the energy waste associated with this equipment by an average of about one-third, with the added cost of the more efficient equipment paid back in less than 2 years. Twenty-five makers of transformers have product lines where some or all meet the NEMA TP-1 standard (EPA 2004b).

[9] The federal Energy Policy Act of 1992 instructed DOE to develop federal standards for transformers, but it has not yet done so. Although DOE is working on this standard now, we recommend that states adopt their own state-level standards since the DOE process has proven to be very slow. Based on preliminary DOE economic analysis, the federal standard, if and when it is completed, will be *at least* as strong as the standard we recommend here.

Table 3.2. NEMA Standard TP-1 for Low-Voltage Dry-Type Distribution Transformers

Single Phase		Three Phase	
Rated Power Output in kVa	Minimum Efficiency %	Rated Power Output in kVa	Minimum Efficiency %
≥ 15 < 25	97.7	≥ 15 < 30	97.0
≥ 25 < 37.5	98.0	≥ 30 < 45	97.5
≥ 37.5 < 50	98.2	≥ 45 < 75	97.7
≥ 50 < 75	98.3	≥ 75 < 112.5	98.0
≥ 75 < 100	98.5	≥ 112.5 < 150	98.2
≥ 100 < 167	98.6	≥ 150 < 225	98.3
≥ 167 < 250	98.7	≥ 225 < 300	98.5
≥ 250 < 333	98.8	≥ 300 < 500	98.6
333	98.9	≥ 500 < 750	98.7
—	—	≥ 750 < 1000	98.8
—	—	1000	98.9

kVa = kilovolt amperes

Torchiere Lighting Fixtures

THE PRODUCT: Torchieres are portable lighting fixtures consisting of a base and post that hold a bowl-shaped reflector above eye level, which aims light upward, bouncing it off a ceiling to provide indirect lighting. In the 1990s, halogen lamp versions of these fixtures became very common due to their high light levels and low up-front costs. More recently, because of the fire hazard presented by the halogen-type lamps, many torchieres have shifted to high output but still very inefficient incandescent light bulbs.

Source: Altura

THE STANDARD: In early 2002, the California Energy Commission set a minimum-efficiency standard for torchiere lighting fixtures that caps energy use at 190 Watts. This standard eliminates high-wattage halogen torchieres from the market. Maryland and Connecticut adopted this standard in 2004. We recommend that states adopt at least the CEC standard for torchiere light fixtures. In addition, we recommend that states consider adopting a more stringent standard (such as a maximum energy use of 75 Watts) in order to eliminate most incandescent torchieres and encourage use of torchieres that employ compact fluorescent lighting sources.

KEY FACTS: These products are major energy hogs, and can be fire hazards as well. According to the U.S. Consumer Product Safety Commission, since 1992, more than 290 fires resulting in 25 deaths have been traced to halogen-bulb torchieres (CPSC 2003). The typical halogen torchiere lighting fixture consumes 300 Watts or more of power. Much more efficient torchieres based on high-output compact fluorescent designs use less than 75 Watts and can provide the same light output and light quality without creating a fire hazard. The more efficient units typically pay for themselves in energy savings in less than a year. About 160 compact florescent torchieres made by 15 different manufacturers are on the market today (EPA 2004c). Incandescent torchieres can also comply with the CEC standard provided they do not draw more than 190 Watts. However, to achieve the high lighting levels generated by 300 Watt halogen lamps, compact fluorescent technology must be used.

Traffic Signals

THE PRODUCT: State highway departments, counties, and municipalities typically own traffic signals. The recommended standard covers new red and green traffic signal modules including pedestrian signals. Yellow traffic lights are not covered. Because the standard covers new signal sales or installations, it does not prevent replacement of conventional light bulbs in existing traffic signals.

Source: GE Lighting

THE STANDARD: EPA ENERGY STAR published a specification based on LED technology in 2001. This specification covers red and green lights only, including pedestrian signals, since these account for the vast majority of traffic light energy use and have the most favorable economics.[10] California, Connecticut, and Maryland have adopted standards based on LED technology and we recommend that other states also adopt such standards. The specific standard is summarized in Table 3.3.

KEY FACTS: Most traffic signals use incandescent bulbs, but available LED signals reduce energy use by about 90% and have additional maintenance and safety benefits. Unlike incandescent lamps, LED lights operate for many years. When LEDs age, they just get dimmer until replaced, thus preventing the safety problems that develop when a lamp in a traffic light burns out. On average, the LED technology pays for itself in lower energy bills in less than 3 years; traffic signals usually last about 10 years. Many state highway departments have already begun the switch to LED signals because of their many benefits. Currently, ten traffic signal manufacturers offer product lines meeting the recommended standard (EPA 2004d).

Table 3.3. ENERGY STAR Specification for Traffic Signals

Module Type	Maximum Wattage (at 74°C)	Nominal Wattage (at 25°C)
12” red ball (or 300 mm circular)	17	11
8” red ball (or 200 mm circular)	13	8
12” red arrow (or 300 mm arrow)	12	9
12” green ball (or 300 mm circular)	15	15
8” green ball (or 200 mm circular)	12	12
12” green arrow (or 300 mm arrow)	11	11

mm = millimeter

[10] Yellow lights are not included since they generally are more expensive than red and green lights and have much lower operating hours, and therefore have much longer payback periods.

Compact Fluorescent Lamps

Pending federal legislation also includes a standard for compact fluorescent lamps (CFLs), requiring them to meet the major efficiency and quality provisions in the ENERGY STAR CFL specification. This standard is primarily a quality standard and is best implemented at the national level. Therefore, while we support national adoption of this standard, unlike the other products discussed in this section, we do not recommend state adoption.

3.2.2 Products Likely to Be Added to Pending Federal Legislation

In addition to the six new standards listed in pending federal legislation, there are four additional products for which consensus agreements have been reached to enact national standards. These standards are likely to be added to national legislation, but this step has not yet taken place. Until these standards are adopted at the national level, just as with the prior category of products, states should consider enacting standards on these products.

Ceiling Fans and Ceiling Fan Lights

THE PRODUCT: Two-thirds of U.S. homes have one or more suspended ceiling fans to circulate air and help occupants feel more comfortable. These fans have become very popular in recent years with many new homes having three or more such fans. About 90% of such fans are sold with a light fixture that attaches to the central base of the fan and provides general room lighting. For fans with lights, the light accounts for 70% of the appliance's energy use on average.

Source: GE Lighting

THE STANDARD: In 2001, EPA ENERGY STAR developed a program for ceiling fans that requires more efficient lighting, more efficient fan blade and motor design, and inclusion of certain controls (separate switches for fan and lights, multiple or adjustable fan speed settings, and a switch to reverse the direction of fan movement in order to switch between summer and winter operation). For fans with lights, 95% of the ENERGY STAR specification's savings derives from employing more efficient light bulbs. Manufacturers could have met the lighting portion of the 2001 ENERGY STAR specification by packaging screw-based compact fluorescent light bulbs with their ceiling fans or by designing their lights to use pin-based compact fluorescent bulbs. In 2003, EPA modified the ENERGY STAR specification to allow only pin-based bulbs to qualify. In early 2004, energy efficiency advocates, Home Depot (the largest retailer of ceiling fans), and a major ceiling fan manufacturer agreed to jointly support enactment of the 2001 ENERGY STAR ceiling fan light specification and some of the control requirements as a federal standard. The agreement deliberately cites the 2001 ENERGY STAR specification to allow the continued use of screw-based light bulbs. Maryland enacted a variation on this standard in January 2004.[11]

KEY FACTS: The 2001 ENERGY STAR specification effectively requires compact fluorescent light bulbs and thus cuts total energy use of the appliance by about 50%. The electricity savings from the more efficient light bulbs cover their additional cost within less than 1 year. Currently 19 models available from five different manufacturers are certified by EPA as meeting the more stringent 2003 ENERGY STAR lighting specification requiring pin-based lamps (EPA 2004e). Eighty-four lighting manufacturers offer ENERGY STAR-qualified screw-based compact fluorescent lamps that can be used for compliance with the recommended state standard (EPA 2004f). Because the ENERGY STAR-compliant screw-based bulbs are widely available at low cost, we expect that many manufacturers will choose to comply with a standard by including efficient screw-based light bulbs with their product rather that redesigning products for pin-based light bulbs.

Commercial Refrigerators and Freezers

THE PRODUCT: Commercial refrigerators and freezers include a wide range of products used in food stores, restaurants, hotels, and other commercial and institutional settings. The standard that we recommend concerns only one-, two-, and three-door units that are factory-assembled with all necessary components in a single package and shipped ready for immediate operation. The standard includes both solid-door and glass-door units such as those used to market bottled and canned beverages. It excludes large supermarket systems, walk-in units and other large site-assembled systems, and specialized products used for medical or research applications.

THE STANDARD: In early 2002, the California Energy Commission adopted a minimum standard based on the energy use of the average product on the market in 2001. Since then, many more products have been introduced with somewhat improved efficiency. Because significant further efficiency improvements are achievable and cost effective, in December 2004, the CEC adopted the current ENERGY STAR specification for solid-door units[12] and the Consortium for Energy Efficiency (CEE) Tier 1 standard for transparent-door units as new state standards Maryland and Connecticut enacted the 2002 California standard in 2004. In November 2004, product manufacturers (represented by the Air Conditioning and Refrigeration Institute) and efficiency supporters agreed to jointly recommend that Congress adopt national efficiency standards very similar to the new CEC standards. We recommend that states adopt these national consensus standards, summarized in Table 3.4.

[11] Maryland also included the air movement parts of ENERGY STAR, requirements that increase the energy savings by about 10% but that are opposed by fan retailers and manufacturers since they restrict use of small and/or decorative fans.
[12] ENERGY STAR developed this specification in 2001 to delineate the top 25% of the market at that time.

Table 3.4. Proposed Standards for Reach-In Refrigerators and Freezers

Equipment Type	Doors	Maximum Daily Energy Consumption (kWh)
Refrigerators	Solid	0.10V+ 2.04
	Transparent	0.12V+ 3.34
Freezers	Solid	0.40V + 1.38
	Transparent	0.75V + 4.10
Refrigerator-freezers	Solid	0.27AV – 0.71 (0.70 for products with an adjusted volume less than 5.2 cubic feet)
For transparent-door refrigerators and freezers that rapidly cool down warm products (i.e., pull-down a fully loaded cabinet at least 4.3°F/hour over a 12-hour period), the maximum energy use may be 5% higher.		
V = total Volume (ft^3) AV = Adjusted Volume = [1.63 x freezer volume (ft^3)] + refrigerator volume (ft^3)		

KEY FACTS: Current federal standards cover only residential refrigerators and freezers—as a result, a commercial refrigerator uses as much as four times as much energy as a comparably sized residential unit. The 2002 California standard reduces energy consumption by about 12%. For purchasers, electricity savings from products meeting the 2002 CEC standard cover the additional cost of the more efficient units in less than 1 year. Energy bill savings cover the additional cost of equipment meeting the CEC's more-stringent 2004 standard in about 1 year as well. The 2004 standard reduces energy use by another 17% (i.e., relative to basic units available today, it reduces energy consumption by 28%). In general, both standard levels can be achieved by incremental improvements in refrigerator design, insulation, and compressors. Most products sold today now meet the 2002 CEC standard. About 45% of solid-door products and about 22% of transparent-door products now being sold meet the tougher 2004 standards. Fifteen manufacturers offer products meeting the solid-door standards (EPA 2004g) and seven manufacturers offer products meeting the transparent-door standards (CEE 2004a).

Dehumidifiers

Source: Altura

THE PRODUCT: Dehumidifiers are used in many residences to reduce humidity levels in basements and other damp spaces. About 14% of U.S. homes use one, but these are concentrated in homes with humid climates but without central air conditioning.

THE STANDARD: In the spring of 2004, efficiency advocates and dehumidifier manufacturers reached agreement to jointly support federal legislation that would establish federal efficiency standards for dehumidifiers based on the current ENERGY STAR specification, effective October 2007, with a second tier standard 7 to 20% higher, effective October 2012. Hopefully, this standard will be enacted federally soon, but if the U.S. Congress fails to act on this recommendation in 2005, we recommend that states consider setting state standards using the same standard levels and effective dates. The specific recommended standards are summarized in Table 3.5.[13]

KEY FACTS: Historically, most dehumidifiers were not especially efficient, as units were primarily purchased on the basis of first cost. However, in January 2001, EPA launched an ENERGY STAR program for dehumidifiers, recognizing the most efficient units with the ENERGY STAR label. Recent EPA research indicates that more than 60% of products sold meet the ENERGY STAR levels. An EPA contractor's research found that ENERGY STAR products sell for virtually the same price as less efficient products (Schiller 2004).

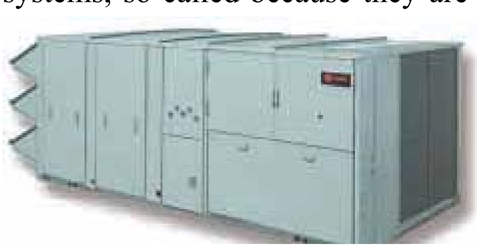
Table 3.5. Recommended Dehumidifier Efficiency Standard

Category	**Capacity**	**Tier I Federal Standards** *Effective 10/1/07 (in L/kWh)*	**ENERGY STAR Criteria** *Effective 10/1/07 (in L/kWh)*	**Tier II Federal Standard** *Effective 10/1/12 (in L/kWh)*
IA	Pints/day ≤ 25	1.0	1.2	1.2
IB	> 25 pints per day ≤ 35	1.2	1.3	1.3
IIA	> 35 pints per day ≤ 45	1.3	1.4	1.4
IIB	> 45 pints per day ≤ 54	1.3	1.5	1.5
III	> 54 pints per day < 75	1.5	1.6	1.6
IV	≥ 75 pints	2.25	2.5	2.5

Source: Agreement between Association of Home Appliance Manufacturers and energy efficiency supporters

Large Packaged Commercial Air Conditioners

THE PRODUCT: Most commercial buildings are cooled by packaged air conditioning systems, so called because they are assembled into a package in a factory and do not need onsite fabrication. The proposed standard covers only the largest packaged systems. These systems are typically used in medium and large low-rise commercial buildings. The very largest buildings typically rely on chiller systems for cooling. These chiller systems are not covered by this standard.



Source: Trane

THE STANDARD: In the 1990s, the Consortium for Energy Efficiency developed a voluntary efficiency specification for commercial packaged air conditioners including the largest systems. The CEE efficiency levels have been promoted by electric utilities in their voluntary programs for about a decade. This specification calls for an Energy Efficiency Ratio (EER) of 10.0. However, for heat pumps

[13] Efficiency supporters and dehumidifier manufacturers have agreed to pursue enactment of this standard at the national level in 2005. If the standard is not enacted nationally in 2005, we recommend that states adopt this standard in 2006.

and systems with gas heating units, we recommend a standard of 9.8 EER since these features generally cause a modest efficiency penalty. Current federal efficiency standards only cover commercial packaged air conditioners up to 240,000 Btu/hour cooling capacity, leaving regulation of larger systems up to the states. In 2004, Maryland, California, and Connecticut adopted standards based on the CEE specification. In November 2004, manufacturers and efficiency supporters agreed to jointly support national adoption of the EER 10/9.8 standard for equipment with a cooling capacity of 240,000 to 760,000 Btu/hour. Until Congress acts, we recommend that states adopt this standard.

KEY FACTS: These large units cost users thousands of dollars per year to operate. Equipment meeting the CEE specification reduces energy use by about 15%. The additional cost of the more efficient units is covered in lower energy bills within 2 years in most parts of the country while large air conditioners typically last 15 years or longer. Five major manufacturers of large packaged air conditioners market products meeting this standard (PG&E 2004f).

3.2.3 Products Not in Pending Federal Legislation that Are Recommended for State Standards Today in All States

There are also a number of products for which states are developing standards that are not in federal legislation. In this section we discuss nine of these products.

Commercial Clothes Washers

THE PRODUCT: Commercial clothes washers include large institutional-style equipment and smaller equipment that is similar to units used in homes. The standard that we recommend only covers the smaller equipment. This equipment is used in Laundromats and in apartment building laundry rooms. It often differs from residential equipment in several respects—addition of a coin box, use of heavier duty components due to greater wear-and-tear, and shorter cycles to permit more loads per day.

Source: Speed Queen

THE STANDARD: In early 2002, the California Energy Commission adopted a minimum energy and water efficiency standard for commercial washers. The energy use specification is identical to the federal requirement for residential washers (i.e., calling for a Modified Energy Factor [MEF] of 1.26 or more). However, there is no federal requirement for water efficiency in residential washers, so the CEC based its efficiency requirement on a level developed by the Consortium for Energy Efficiency that had been promoted by utilities for more than a decade. This specification calls for a Water Factor (WF) of 9.5 or more. We recommend that states adopt the 2002 CEC standard.[14] Maryland and Connecticut enacted this standard in 2004.

[14] The ENERGY STAR program for commercial clothes washers uses an energy efficiency specification identical to the CEC standard, but does not require water efficiency.

KEY FACTS: The recommended energy standard reduces energy use by at least 35% relative to a typical washer sold today. The water use standard reduces the amount of water used by clothes washers by at least 20%, which reduces operating costs and also helps municipalities to avert or postpone expensive expansions to their water supplies and wastewater treatment infrastructure. The energy and water savings pay for the additional upfront cost of an efficient washer in 2 years or less. However, for washing machines used in apartment buildings, contracts between building owners and machine providers (called "route operators") may need to be modified to give the route operator a greater share of the coin receipts since the route operator will need to pay more for the equipment while the building owner will benefit from the lower energy and water bills. More than 150 models including both top-loading and front-loading designs are available from ten different brands, including many from two of the market leaders in this segment of the commercial laundry machine market, Maytag and Speed Queen (CEE 2004b).

Commercial Ice-Makers

THE PRODUCT: Commercial ice-makers are commonly used in hotels, motels, and restaurants to produce ice in large quantities. Ice-makers use a substantial amount of energy in order to freeze water, and then keep the ice cold.

Source: Manitowoc

THE STANDARD: In 2002, the Consortium for Energy Efficiency developed two efficiency tiers to identify efficient ice-makers. Tier 1 identifies the 20 to 25% most efficient products on the market. Tier 2 identifies the very best units on the market. The Federal Energy Management Program (FEMP) has also developed a specification that is similar to CEE Tier 1. In December 2004, California adopted a state efficiency standard based on CEE Tier 1. We recommend that other states also adopt the new CEC standard (see Table 3.6).

KEY FACTS: Products now on the market vary substantially in efficiency, with the most efficient products typically using about 30% less energy than the least efficient. Products meeting the standard save about 11% relative to the most basic equipment. The additional cost for more efficient equipment is earned back in lower energy bills within 1 year. Three of the five major manufacturers have complete or virtually complete product lines meeting the recommended standard level, while the other two major manufacturers have current products meeting the standard in only certain equipment sizes (CEE 2004c).

Table 3.6. CEC 2004 Standard

Equipment Type	Type of Cooling	Harvest Rate (lbs. ice/24 hrs.)	Maximum Energy Use (kWh/100 lbs. ice)	Maximum Condenser Water Use (gallons/100 lbs. ice
Ice-making head	Water	< 500	7.80 – .0055H	200 – .022H
		≥500<1436	5.58 – .0011H	200 – .022H
		≥1436	4.0	200 – .022H
Ice-making head	Air	450	10.26 – .0086H	Not applicable
		≥450	6.89 – .0011H	Not applicable
Remote condensing but not remote compressor	Air	< 1000	8.85 – .0038	Not applicable
		≥1000	5.10	Not applicable
Remote condensing and remote compressor	Air	< 934	8.85 – .0038H	Not applicable
		≥934	5.3	Not applicable
Self-contained models	Water	<200	11.40 – .0190H	191 – .0315H
		≥ 200	7.60	191 – .0315H
Self-contained models	Air	< 175	18.0 – .0469H	Not applicable
		≥ 175	9.80	Not applicable

Note: H = harvest rate in pounds per 24 hours

Digital Cable and Satellite Set-Top Boxes

THE PRODUCT: Cable and satellite set-top boxes convert signals from cable or satellite service providers for viewing programs on TVs.

THE STANDARD: In 2001, EPA ENERGY STAR adopted maximum standby power use specifications for cable and satellite set-top boxes that call for a maximum standby power use of 15 Watts for most products (some additional power use is allowed for wireless receivers). We recommend that states adopt the 2001 ENERGY STAR specification as a standard for digital cable and satellite set-top boxes. Although the ENERGY STAR specification also sets limits for other set-top box products, we recommend that states limit coverage to single-function, digital cable boxes and their satellite system equivalents only. We recommend that states exclude analog boxes (since these are gradually being phased-out in the market) and multifunction boxes (e.g., cable boxes that also record or serve as an Internet access device—these need further research, as discussed in Section 3.2.4).

Source: Dish Network

KEY FACTS: For cable TV, the cable company typically purchases the box and rents it to the consumer. For satellite TV, the service provider often "gives" the box away to customers who sign up for an initial period of service. In both cases, the companies have little incentive to purchase more efficient boxes if they cost even pennies more than conventional ones. Because reducing energy use requires improved system design, rather than more or better materials or more complicated fabrication, we expect the long-term additional cost to make more efficient set-top boxes will be close to zero. Digital set-top cable boxes meeting the recommended standard save about 30% of the energy used by typical set-top boxes. Assuming the additional cost in the near term is about $5, the energy bill savings will cover that cost in about 1 year. Currently, Pace Micro Technology has certified products to EPA to meet the recommended digital cable box standard and Hughes, Sony, Motorola, and LG have certified products to meet the satellite set-top box standard (EPA 2004h). Because cable and satellite TV companies are unlikely to demand efficient set-top boxes from manufacturers until they are required by state standards, wider product availability may require that states adopt such standards.

Digital Television Adapters

THE PRODUCT: The Federal Communications Commission (FCC) has ordered that all over-the-airwaves broadcast TV shift to digital formats as of January 2007.[15] In order for the tens of millions of analog TVs currently in homes to receive over-the-airwaves broadcasts after January 2007, they will need digital television adapters. Analog TVs hooked up to digital cable systems or satellite systems will not need a converter box separate from their cable or satellite box as the cable or satellite box will also generally serve the converter function.

Source: Funai Corp.

THE STANDARD: In 2003, the European Union drafted a voluntary Code of Conduct for digital TV converters that called for this equipment to use no more than 8 Watts of power in active modes and 1 Watt in standby mode.[16] In December 2004, the California Energy Commission adopted these levels as a mandatory standard. The Australian government is moving in the same direction. We recommend that other states follow California and adopt the same standard.

KEY FACTS: We estimate that consumers will purchase television adapters for about one in five TVs currently in use between now and 2010. There will be a one-time spike in sales and energy consumption from these products as the FCC order goes into effect in a given market. The recommended standard ensures that this flood of new electronic equipment is relatively efficient by setting a maximum standby energy use level. Manufacturers can reduce standby energy use through electronics circuitry design and by powering down unneeded components when the product is not in use. Because reducing standby energy use requires improved design, rather than more or better materials or more complicated fabrication, we expect the long-term additional cost to make more efficient products will be close to zero. Assuming the additional cost in the near term is about $5, the energy bill savings will cover the additional cost for a box in about 1 year. LG and Sylvania currently list qualified digital converters with ENERGY STAR (EPA 2004h) while other electronics manufacturers already market efficient converters in Europe and are expected to offer U.S. products as the 2007 conversion to digital broadcasts approaches.

[15] While the FCC may move to phase in the digital conversion instead of requiring the entire nation to change over at once in 2007, digital converters will flood the market in the last part of this decade.

[16] The European Union has since changed this standard to 7 Watts active power and 2 Watts standby power, but the change was made too late for California to follow. We recommend that states follow California and not Europe.

External 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 rechargeable tools, 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 a small cord comes out of the power supply to bring power to the product.

Source: Ecos Consulting

THE STANDARD: The California Energy Commission recently developed standards for these products and adopted them in December 2004. EPA is developing similar efficiency levels for a voluntary ENERGY STAR labeling program, which will likely begin a year before the mandatory California standard takes effect. The CEC's initial standard will include approximately the top 25% most efficient products on the market. The California standards are summarized in Table 3.7. Other states should follow California's lead and adopt the same standards.

Table 3.7. 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 Watt. PG&E (2004a) found that the more efficient power supplies have an incremental cost of less than $1. Energy bill savings recoup the minor additional cost for the consumer very quickly. 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 2004a).

Medium-Voltage Dry-Type Distribution Transformers

Source: MIDWEST

THE PRODUCT: As discussed above under low-voltage transformers, distribution transformers reduce electricity voltage from the high levels at which power is shipped over utility transmission and distribution lines to the lower levels required to power equipment and machinery. Utilities own and operate the transformers on their systems including those seen on utility poles and cement pads throughout utility systems. These utility-owned transformers are typically "liquid-immersed"-type equipment. Large industrial and commercial enterprises typically buy power from utilities at higher voltages, and own and operate "medium-voltage dry-type" transformers to reduce voltages for their own use. The recommended standard covers these medium-voltage dry-type transformers only.

THE STANDARD: In the late 1990s, the National Electrical Manufacturers Association developed a recommended standard (NEMA standard TP-1) for all types of distribution transformers, including medium-voltage dry-type transformers. NEMA is the trade association for transformer manufacturers. About two-thirds of medium-voltage dry-type transformers meet the NEMA standard. Recently, DOE published an analysis of medium-voltage dry-type distribution transformers indicating that efficiency levels 0.3 efficiency points higher than TP-1 are cost-effective for most purchasers. We recommend that states adopt these levels as a mandatory standard.[17] The specific standard is summarized in Table 3.8.

KEY FACTS: Transformers waste as much as 3% of their energy input as dissipated heat as they reduce voltage to lower levels. By moving to better designs and higher quality materials (e.g., better steel cores), this energy waste can be cut. The proposed standard reduces the energy waste associated with this equipment by an average of about one-third, with the added cost of the more efficient equipment paid back in 3–5 years, which is very attractive considering that DOE estimates that this equipment has an average life of 32 years. Most makers of transformers have product lines that meet the proposed standard or can modify existing product lines to meet the standard.

[17] The federal Energy Policy Act of 1992 instructed DOE to develop federal standards for transformers, but it has not yet done so. Although DOE is working on this standard now, we recommend that states adopt their own state-level standards since the DOE process has proven to be very slow. Based on preliminary DOE economic analysis, the federal standard, if and when it is completed, is likely to be similar to the standard we recommend here.

Table 3.8. Recommended Standard for Medium-Voltage Dry-Type Distribution Transformers

Single Phase			Three Phase		
Rated Power Output in kVa		Minimum Efficiency %	Rated Power Output in kVa		Minimum Efficiency %[18]
≥ 15	< 25	97.9	≥ 15	< 30	97.1
≥ 25	< 37.5	98.2	≥ 30	< 45	97.6
≥ 37.5	< 50	98.4	≥ 45	< 75	97.9
≥ 50	< 75	98.5	≥ 75	< 112.5	98.2
≥ 75	< 100	98.7	≥ 112.5	< 150	98.4
≥ 100	< 167	98.8	≥ 150	< 225	98.5
≥ 167	< 250	99.0	≥ 225	< 300	98.7
≥ 250	< 333	99.1	≥ 300	< 500	98.8
≥ 333	< 500	99.2	≥ 500	< 750	99.0
≥ 500	< 667	99.3	≥ 750	< 1000	99.1
≥ 667	< 883	99.3	≥ 1000	< 1500	99.2
883		99.4	≥ 1500	< 2000	99.3
			≥ 2000	< 2500	99.3
			2500		99.4

Metal Halide Lamp Fixtures

THE PRODUCT: Metal halide light fixtures are commonly used in industrial buildings and high-ceiling commercial applications such as gymnasiums and 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[19] called a "pulse start" lamp has been introduced that uses about 15% less energy than the an older "probe start" lamp. Pulse start lamps use electronic pulses to start the lamps and do not need to heat a cathode as in probe start lamps. In addition, in the past year, electronic ballasts for metal halide lamps have come down in price and improved in quality and are now ready for widespread adoption. To address these two opportunities for energy savings, the California Energy Commission has developed standards for new metal halide fixtures, which they are adopting in two steps. The first step, which was adopted by the CEC in December 2004, will limit sales of new fixtures for the most common lamp types to those that operate only pulse start lamps and not probe start ones. The second step will extend the pulse start standard to new fixtures for additional lamp types and will also establish metal halide ballast efficiency levels for new fixtures that only electronic and other highly efficient ballasts can meet. The CEC expects to finish adoption of the second step in mid-2005.

[18] The TP-1 standard provides for slightly more stringent standards for transformers with low Basic Impulse Insulation (BIL) levels. To keep our proposal simple, we ignore this distinction and use the less stringent standards for both high and low BIL products.
[19] The lighting industry commonly uses the term "lamps" to refer to light bulbs, rather than light fixtures.

We recommend that other states initially adopt the requirement that new fixtures be designed to operate only pulse start lamps. Due to the limited current availability of high-efficiency metal halide ballasts, we recommend that all but the most ambitious states consider the ballast requirement at a later date. The specific standards developed by California are summarized in Table 3.9. For other states, it is probably simpler to just specify that the initial standard requiring pulse start operation take effect in 2008 for all lamp types, rather than have two different effective dates as California is doing. One other option might be to place such a new fixture requirement in the state building code—such a requirement would apply to fixtures in new buildings but, depending on the specifics of the underlying state code, may not apply to new fixtures in existing buildings.

Table 3.9. California Standards on Metal Halide Lamp Fixtures

Lamp Position	Included Lamp Wattages	Effective Date	Requirements
Vertical	150–500	Jan. 1, 2006	Luminaires shall not contain a probe start metal halide ballast
All	150–500 that are not subject to the row above	Jan. 1, 2008	Luminaires shall not contain a probe start metal halide ballast
All	150–500	Jan. 1, 2008	Luminaires (except "exempted outdoor luminaires" and luminaires operating at 480V) shall contain a metal halide ballast with minimum lamp/ballast system efficiency = (0.0002 * Lamp Watts) + 0.864

Notes: Fixtures are covered if they are capable of operating lamps that fall within the range of included lamp wattages. Vertical includes both base-up and base-down products, and those rated for use within 15^{o} of vertical.

KEY FACTS: Pulse start lamps save an average of about 15% and efficient ballasts can cut electricity use by another 11%. Presently, about 20% of metal halide lamp sales are pulse start, primarily in new construction. About 2% of metal halide ballast sales are electronic (PG&E 2004d). The additional cost of a pulse start lamp is covered by lower energy bills within about 1 year and the efficient ballast requirements earn back their additional cost within about 2 years. All of the major lighting manufacturers and many small manufacturers make pulse start lamps. Six ballast manufacturers make electronic ballasts for metal halide lamps (PG&E 2004d). The National Electrical Manufacturers Association claims federal law preempts state standards, but (in our opinion) their claim is unlikely to hold up in court.[20]

Pre-Rinse Spray Valves

THE PRODUCT: Pre-rinse spray valves are hand-held devices used to wash food particles off dishes and flatware prior to sending them through an automatic dishwasher. They generally use hot water and hence more efficient products save both energy and water.

[20] NEMA's claim applies to lamps whereas we propose to regulate fixtures. And even their claim that lamp standards are preempted are based on a presumption of Congressional intent and not specific words in the statute.

Source: KWC Faucets Inc.

THE STANDARD: In December 2004, the California Energy Commission finalized a minimum-efficiency standard that sets a maximum flow rate of 1.6 gallons per minute. We recommend that other states adopt California's new standard.

KEY FACTS: This efficiency level has been promoted for several years by California water and energy utilities and qualified products have been given away due to their outstanding energy and water savings. They have been well-received by consumers. These devices use a substantial amount of hot water, typically more than 3 gallons per minute. Fortunately, lower flow models are available, typically less than 1.6 gallons per minute, that also do a good job of cleaning dishes. On average, an efficient pre-rinse spray valve saves about 57,000 gallons of water per year and 336 therms of natural gas when used with natural gas water heating. When used with electric water heating, it would save about 7,600 KWh per year (SBW Consulting 2004). The more efficient valves typically cost $5 to $25 more, but the energy and water savings pay back this additional cost within 2 weeks to 2 months of typical operation. Three manufacturers, including most of the major manufacturers, offer very energy- and water-efficient products.

Reflector Lamps

Source: GE Lighting

THE PRODUCT: Reflector lamps are the very common cone-shaped light bulbs most typically used in "recessed can" light fixtures.[21] The cone is lined with a reflective coating to direct the light. Bulged reflector (BR) lamps are specific types of reflector lamps. Use of BR lamps has mushroomed in recent years as manufacturers have taken advantage of a loophole in federal that which exempts them from federal standards.

THE STANDARD: Under the federal Energy Policy Act of 1992, many reflector lamps need to meet specified efficacy requirements (e.g., 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." Ellipsoidal reflector (ER) lamps were exempted because they have a special light distribution that allows lower wattage lamps to be used in recessed fixtures. BR lamps were exempted because one small manufacturer of these lamps said they were "just like" ER lamps and major manufacturers did not produce them. In fact, as we have since discovered, 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. R20 (2" diameter standard reflector lamps) were excluded from the standard since at the time

[21] 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.

there were no efficient substitutes (a situation that has since changed). We recommend that states close these loopholes by requiring that BR, R20, and certain types of ER lamps meet the same efficacy requirements as R lamps (see Table 3.10).[22] In 2004, California Energy Commission proposed such a standard. They expect to finalize this standard in mid-2005. NEMA claims that federal law preempts state standards on BR and related lamps. However, NEMA's claim is dubious since it ignores the fact that BR, ER, and certain R lamps are specifically excluded from the law's definition of incandescent reflector lamps.

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 slight additional cost (about $1) of the more efficient lamps. All major manufacturers and many smaller manufacturers make lamps that comply with the standards (PG&E 2004c).

Table 3.10. Pending California Standards on BR, Most ER, and 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

3.2.4 Products Not in Pending Federal Legislation That Are Recommended for State Standards Today in Some States

There are a few products where state standards may make sense in some states but not others. The biggest reason for differences between states is climate. For example, pool pump standards make sense in states with average to longer-than-average swimming seasons because the energy savings justify the extra cost of improved pumps and controls. Likewise, state furnace standards make sense in the North because the heating season is long enough to justify stronger standards than for the country as a whole. In addition, DOE has just released a report on mercury vapor lighting that shows that standards eliminating new mercury vapor light fixtures would be highly cost-effective. States interested in taking the lead should consider such a standard. Finally, there are a few products for which California has just set standards that ambitious states should consider. We discuss each of these opportunities in the sections below.

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 2004k).

[22] DOE is now studying whether to subject BR lamps to the same standards as R lamps. However, DOE rulemakings generally take about five years, so the earliest a federal standard is likely is 2010, with the standard taking effect three years later.

Source: SpaSupport

THE STANDARD: In late 2004, the California Energy Commission 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). Our specific recommended standard is provided in Table 3.11.

Table 3.11. Proposed Standard for Swimming Pool Pumps

Effective Date	Requirements
January 1, 2006	Motor efficiency: new pool pump motors may not be split-phase 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 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.[23]

KEY FACTS: In warmer states (i.e., where pools are in operation all or most of the year), pool pumps can be among the largest consumers of electricity 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. Based on analysis in California, eliminating the least efficient types of pump motors (i.e., the phase one California standard) will 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. At national average electricity prices, these savings cover the additional cost in a little less than 4 years. Even larger savings can be achieved by shifting to two-speed pumps and controls (the phase two standard in California). This standard will 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 national average energy prices, these improvements pay for themselves in lower energy costs in about 6.7 years. Pool pumps and motors last about 10 years on average (PG&E 2004k). In addition to California, this standard will be very cost-effective in states like Arizona, Florida, Nevada, and Texas. This standard

[23] 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.

may also be of particular interest in high-growth states where swimming pools are common with high-end new housing.

Residential Furnaces, Boilers, and Furnace Fans

This product class presents a special case for three reasons. First, heating is the largest residential energy use in most states and of growing concern due to recent increases in natural gas prices and home heating oil prices. Many homeowners have seen their heating bills double in the last few years. Second, residential furnaces and boilers are covered by federal standards that preempt state standards. Whether this preemption applies to furnace fans is a legal gray area.[24] Under the rules of this federal preemption, states can only implement standards more stringent than federal requirements if they apply for and are granted a waiver from federal preemption by DOE. Third, DOE is working on updated national standards for residential furnace and boilers. However, this rulemaking is badly delayed (it was legally due for completion in 1994)[25] and DOE recently announced decisions that will severely limit the benefits from an eventual national standard. In its Advance Notice of Proposed Rulemaking published in August 2004, DOE said it would not address the electric efficiency of furnace fans and would not consider setting two national standard levels for fuel efficiency—a tougher one for cold states where improved efficiency is cost-effective and a weaker one for states where furnaces operate relatively few hours per year.[26]

Source: Carrier

Because of the combination of potentially large energy and economic savings and poor prospects for a timely and/or adequate federal standard, we recommend that individual states pursue standards for residential furnaces and boilers. This standard will be of particular interest to states with cold climates due to their higher heating loads and furnace operating hours, which improves the cost-effectiveness of efficiency improvements. We make this recommendation even though, unlike all of the other standards recommended in this report, states will have to apply for waivers from federal preemption for all or part of a state furnace and boiler standard. There are two key aspects to saving energy with improved furnaces: improving furnace fan or air handler efficiency and improving the efficiency with which the

[24] DOE's current standard for furnaces only counts the fuel use (i.e., natural gas, oil or propane) of a furnace, disregarding the substantial electricity used by furnace air handlers. DOE's General Counsel's office recently expressed an opinion that DOE lacks the legal authority to set furnace fan efficiency requirements. A logical conclusion is that if DOE lacks authority, that authority must reside with the states. Federal preemption with no federal efficiency requirement would be unprecedented. However, because a furnace fan is a necessary component of a furnace, arguably preemption applies to the furnace as a whole and all its components, whether or not the component's energy use is included in the federal efficiency standard.

[25] In December 2004, DOE announced yet another delay to the furnace standard. By the latest DOE schedule, it will not be complete until fall 2007 and implemented eight years later!

[26] A detailed discussion of the federal standard opportunity for furnaces can be found in a recent report by Nadel et al. 2004.

furnace or boiler turns oil or gas into usable heat. We address each aspect of furnace efficiency separately here.

Furnace fans (or furnace air handlers)

THE PRODUCT: Furnace fans circulate air heated by the furnace through a home's duct system into the living space. For homes with central air conditioning, the furnace fan also serves to circulate air during the cooling season. Furnace fans operate on electricity. (For the purposes of this report, we use the terms "furnace fan" and "furnace air handler" interchangeably. The air handler consists of the fan and motor, a housing, controls, and other necessary elements.)

THE STANDARD: Several metrics for ranking furnace electricity efficiency have been developed in the past few years including one developed for the California Energy Commission, one developed for gas utility programs in Massachusetts, and one developed by the furnace manufacturers' trade association (Gas Appliance Manufacturers Association, GAMA) in collaboration with the Consortium for Energy Efficiency. Some voluntary programs have prescriptively required that furnace fans use high-efficiency motors. We recommend that states use the efficiency metric and threshold developed by GAMA and CEE. This program recognizes furnaces with electricity use that is no more than 2% of the total energy use of the appliance. Products can meet this standard by switching to energy-efficient motors such as permanent magnet motors, although other improvements in the air handler may also improve overall electrical efficiency.

KEY FACTS: Furnace fans are among the largest users of electricity in a typical household, consuming around 1,250 kWh of electricity per year on a national average basis, or more than 12% of the average U.S. household's electricity use. About 770 kWh of this total is consumed during the heating season and the remainder (480 kWh) is used to circulate cooled air in the summertime. Furnace fans in colder than average states will use more electricity during the heating season and those in warmer states more during the cooling season than the average. Air handler efficiency improvements can reduce electricity consumption by about 65%, making improved furnace air handlers one of the largest potential sources of residential electricity use reduction. For a colder climate such as New England, such improvements would save about 550 kWh per year during the heating cycle and another 130 kWh per year for homes with central air conditioners (Sachs and Smith 2003). The savings on the heating cycle alone are about equal to the *total* annual energy consumption of a typical new refrigerator and pay back the cost of the more efficient fan (about $100 in mass production), within about 2 years in New England. In colder states, between 8 and 16% of current furnaces are already sold with high-efficiency fans. At least 285 furnace models from multiple manufacturers are available today with efficient fans. However, this technology is almost always bundled with premium products only (Sachs and Smith 2003).

Furnaces and boilers—fuel efficiency

THE PRODUCT: Furnaces and boilers are the most common type of heating equipment in the United States. Furnaces burn natural gas, propane or oil for heat and distribute the heat through a duct system. Boilers burn fuel to heat water or create steam that is distributed through radiators for heating a home.

THE STANDARD: States first set standards for furnaces in the 1970s and 1980s. Some of these state standards included both electrical consumption and fuel consumption. Under the 1987 national standard established by Congress, furnace efficiency is measured in Annual Fuel Utilization Efficiency (AFUE), which only accounts for fuel use. AFUEs vary according to equipment type and fuel. We developed detailed recommendations for new national AFUE levels in a separate report published in the fall of 2004 (Nadel et al. 2004). We recommend slightly lower standards here for most technology types (see Table 3.12). A national standard is set with a long lead time before implementation and should be set at a level that maximizes cost-effective improvements. Also, national standards affect a much larger market, resulting in economies of scale in equipment design and production, reducing costs to levels often not possible for state standards. For these reasons, a national standard can be more stringent than what a state might establish.

Table 3.12. Recommended Furnace and Boiler Standards

Equipment Type	Current DOE Standard (AFUE)	Recommended State Standard (AFUE)
Natural gas and propane furnaces	78%	90%
Natural gas and propane hot water boilers	80%	84%
Oil-fired furnaces	78%	83%
Oil-fired hot water boilers	80%	84%
Gas and propane steam boilers	75%	82%
Oil-fired steam boilers	80%	82%
Furnace fan efficiency	none	Electricity use must be less than or equal to 2% of overall furnace site energy use.

KEY FACTS: For most of the country, the largest energy savings would come from requiring 90% or better AFUE gas furnaces. This level is identical to the current ENERGY STAR level for gas furnaces. The standards for oil furnaces and boiler deliver potentially significant oil savings where this equipment type is most common (i.e., Northeast states). Gas furnaces meeting the 90% AFUE standard are more expensive than typical furnaces which have an AFUE of about 80%. However, because using such furnaces can eliminate the need for a chimney, in new construction, they can be *cheaper* than conventional furnaces. Even in replacement and retrofit situations, these furnaces typically pay back their increased cost in 5 to 8 years in colder than average states—much less than their typical 18 year life. In 2001, about 28% of current national sales meet the 90% gas furnace standard. However, in colder than average states, 40% to 80% of furnace sales met this standard. Depending on equipment type, between 15% and 75% of 2001 national sales met the standards we recommend for gas and oil-fired boilers and oil fired furnaces. Market shares in colder states tend to be higher (Kendall 2002). In colder than average states, the incremental cost of oil furnaces and boilers and gas boilers meeting the recommended standards pays back in lower energy bills within 1 to 5 years depending on the equipment type.

Mercury Vapor Lamp Fixtures

THE PRODUCT: Mercury vapor lamps were commonly used for street lights and other outdoor lighting, and in large factories for many decades. These lamps produce 25–50 mean lumens of light output per Watt of power input (25–50 LPW). In the 1980s and 1990s, other higher-efficiency light sources (40–125 LPW), such as metal halide lamps and high pressure sodium lamps, replaced mercury vapor lamps in the majority of applications. Still, approximately three million mercury vapor lamps are sold annually (DOE 2004c).

THE STANDARD: According to a recent DOE report, more efficient lamp types are cost-effective in most applications, including retrofits of existing fixtures and new fixture purchases (DOE 2004c). To take advantage of this opportunity, we recommend that states prohibit the sale of new mercury vapor ballasts, including ballasts sold in new fixtures and ballasts sold separately. Replacement mercury vapor lamps could still be sold for existing fixtures, but as existing fixtures and ballasts age they would gradually be replaced, so after about 20 years, mercury vapor lamps would no longer be in use. This gradual approach to phasing out mercury vapor lamps would minimize costs to users and minimize application problems relative to a strategy that requires existing mercury vapor fixtures to be upgraded when a lamp burns out.

Source: Angelfire

KEY FACTS: Mercury vapor lamps now represent about 10% of U.S. sales of high-intensity discharge lamps (HID—a category that includes mercury, metal halide, and high-pressure sodium). Existing mercury vapor lamps and ballasts are often replaced when they burn out since mercury products are a little less expensive than high-pressure sodium and metal halide products. And new mercury vapor fixtures continue to be sold, primarily because they have lower first costs than other HID lamp types. Common applications of new mercury vapor fixtures are for outdoor security lighting (e.g., a fixture attached to a barn) and street lights. Banning new mercury vapor ballasts would generally result in increased sales of high-pressure sodium and metal halide fixtures and ballasts. For example, according to the DOE analysis (DOE 2004c), instead of a new 175 Watt mercury vapor fixture costing $65, a 70 Watt high-pressure sodium fixture could be purchased for $87. DOE estimates a 0.6 year payback on this upgrade at residential electric rates. Similarly, for street lights, DOE estimates that using a 70 Watt high-pressure sodium fixture instead of a 175 Watt mercury vapor fixture would have a simple payback of 0.3 to 1.1 years, depending on the electric rate. When an existing mercury vapor ballast burns out, both the ballast and lamp will need to be replaced. The DOE analysis finds that the most cost-effective substitute, which is sometimes high-pressure sodium and sometimes pulse-start metal halide, would have a 1- to 3-year simple payback to the consumer. High-pressure sodium and metal halide fixtures, ballasts, and lamps are available from virtually all manufacturers that sell mercury vapor products; in fact, today high-pressure sodium and metal halide lamps and ballasts are even more widely available than mercury vapor lamps and ballasts. Overall, DOE estimates that at a national level, eliminating mercury vapor lamps would reduce U.S. electricity use by about 48 billion kWh over the 2011–2035 period, saving consumers more than $0.5 billion (net present value savings minus costs) over this period (DOE 2004c).

Other Products

In December 2004, the CEC adopted standards on several other products not evaluated for this report. Some of these products, such as portable spas (hot tubs), are primarily of regional concern and states with high market share of these items should consider the California standards. Several other product standards adopted by California may merit consideration by other states, including general service incandescent light bulbs (PG&E 2004h), water dispensers (PG&E 2004i), commercial hot food holding cabinets (PG&E 2004l), walk-in refrigerators and freezers (PG&E 2004b), and pedestrian traffic signals.

3.2.5 Products Needing Some Additional Research Before State Standards Can Be Adopted

In addition to the products discussed above, several additional products are probably good targets for state efficiency standards following some additional research. Promising products include battery chargers, furnace fans, and multi-function cable boxes. We discuss each of these briefly in the following paragraphs.

Battery Chargers

A typical home may have four to five rechargable devices such as cellular phones, cordless phones, and cordless tools (e.g., drills and hand vacuums). Each of these devices generally has its own battery charger, many of which continue to draw substantial amounts of power even when the battery is fully charged or disconnected from the charger. Smart circuits and other devices can substantially reduce the energy needed to maintain battery charge. Battery chargers differ from external power supplies (discussed above) in that external power supplies can serve many types of products, including some (but not all) battery chargers. The external power supply standard will regulate the efficiency of power provided to many battery chargers but will not regulate the efficiency of the charger itself. Pacific Gas & Electric and the California Energy Commission have begun research on the energy used by different types of battery charges in different modes (e.g., active charging, maintaining charge, and standby with no battery connected). Additional research is planned, leading ultimately to a proposal for test procedures and standards for these products. Other states should monitor this work and consider standards based on its results.

Liquid-Immersed Distribution Transformers

Liquid-immersed distribution transformers use oil as coolant and are generally used outdoors, unlike the dry-type transformers discussed earlier that are generally used indoors. Liquid-immersed transformers are primarily owned and used by utility companies and large industrial firms. Due to utility deregulation, many utilities have reduced the efficiency of transformers they purchase, arguing that under deregulation they have no incentive to purchase efficient transformers (EEI 2004). To address this market failure and achieve significant energy savings, standards on liquid-immersed distribution transformers should be set. NEMA standard TP-1 specifies a set of voluntary efficiency guidelines for these products that is cost-effective in nearly all applications and has been adopted as a minimum-efficiency standard in Massachusetts. Higher efficiency levels appear to be cost-effective as well according to a DOE analysis (DOE 2004b), but DOE overestimated the average cost of liquid-immersed transformers in its analysis. Until this is corrected, it will be difficult to determine the optimum efficiency level for a state or national standard. DOE is expected to revise its analysis in 2005 and when this analysis is complete, we recommend that states adopt standards at the efficiency level that minimizes life-cycle costs.

Multi-Function Cable Boxes

In the preceding section, we discussed single-function digital cable boxes and recommended a specific standard for them. However, multi-function cable and satellite boxes are becoming more common (e.g., boxes with digital video recorders, such as TiVo, that record programs and/or other functions) and over time are likely to predominate. There are already around a dozen types of multi-function boxes on the market, with more types likely. Some of these boxes use more than 50 Watts of power in standby mode, using nearly as much electricity as an average new refrigerator. Additional research is needed to consider the range of products and appropriate energy use limits for each. For example, the European Union has developed a voluntary Code of Conduct that includes a power allowance for basic boxes, and then specific adders for different features up to a maximum level (EC 2003). This and other options need to be researched in order to identify the best approach for regulating multi-function cable boxes. Ultimately, the energy savings possible from standards on multi-function cable boxes are likely to be greater than the savings from standards on single-function cable boxes.

3.3 Economics of Proposed Standard Levels

In the sections above, we have briefly summarized the consumer economics for each of the products for which we recommend specific standards. Table 3.13 provides the data behind these calculations and reports the benefit-cost ratio and simple payback period, on average, for each of the products. As can be seen, simple paybacks range from 0 to 2.4 years, with most of the products having a payback of less than 2 years. In other words, energy savings recoup any increase in product cost within 1 or 2 years. Afterwards, the consumer realizes net savings. The benefit-cost ratios calculated here take into account a 5% real discount rate. These calculations are based on national average electricity and natural gas prices for 2003. For areas with higher than average prices, paybacks will be shorter; where costs are lower, paybacks will be longer. For products with energy use that varies with climate (e.g., large commercial packaged air conditioners, unit heaters), savings and payback period will vary with climate as well.

Table 3.13. National Average Consumer Economics of New Standards

Product	Incremental Cost ($)	Annual Per Unit Savings (kWh unless noted)	Annual Per Unit Economic Savings ($)	Average Product Life (years)	Benefit/Cost Ratio	Simple Payback (years)
Ceiling fans (with lights)	6	132	$11	13	18.3	0.5
Commercial clothes washers	137			8	3.7	
electric installation		1009	$82			1.2
natural gas installation		41 therms	$34			2.0
water		9850 gals.	$34			
Commercial ice-makers	30	419	$34	8.5	7.9	0.9
Commercial refrigerators & freezers (2004 CEC standard)						
transparent door	90	1727	$140	8.5	10.9	0.6
solid door	66	1234	$100	9	11.2	0.7
Dehumidifiers	0	156	$14	15	**	0.0
Digital television adapters	5	61	$5	7	7.4	0.9
Exit signs	20	223	$18	25	11.9	1.1
External power supplies	0.50	4.1	$0.36	7	4.6	1.5
Incandescent reflector lamps	0.75	20	$1.74	1.9	4.1	0.4
Large commercial packaged A/C	1176	9541	$776	15	6.6	1.5
Low-voltage dry-type transformers (e.g., 15 kVa)	45	330	$27	30	8.2	1.7
Medium-voltage dry type transformers (e.g., 15 kVa)	89	375	$30	30	5.5	2.9
Metal halide lamp fixtures	30	307	$25	20	10.8	1.2
Pre-rinse spray valves (total)	5		$331	5	428	0.0
natural gas		336 therms	$327			
water		57,000 gals.	$4			
Torchiere lamps	20	288	$25	10	10.0	0.8
Traffic signal modules	85	431	$35	10	3.2	2.4
Unit heaters (natural gas)	277	267 therms	$221	19	9.6	1.3

3.4 Product Availability

Each of the products for which we recommend near-term state standards is readily available from multiple manufacturers. By only relying on standard levels that multiple manufacturers achieve today, a state 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 3.14 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., pre-rinse spray valves, reflector lamps), this particular industry is very concentrated with few overall suppliers. The product and standard descriptions in Section 3.2 provided narrative detail about product availability not captured in this summary table.

Current market share varies widely—from a low of 10% to a high of 63%. 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 have benefited from voluntary programs that have worked to build market share through education and/or purchase incentives (e.g., dehumidifiers, traffic signals). As shown in Section 3.2, 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 2.2.

Table 3.14. Availability of Products Meeting Proposed Standards

Product	Number of Manufacturers with Compliant Products	Estimated National Market Share of Compliant Product
Ceiling fans and ceiling fan lights	5, 84[a]	15%
Commercial clothes washers	10	13%
Commercial ice-makers	5	22%
Commercial refrigerators & freezers	7, 15[b]	22%, 45%
Dehumidifiers	7	60%
Digital television adapters	NA[c]	NA
Exit signs	30	63%
External power supplies	20+	32%
Incandescent reflector lamps not federally regulated	3+[d]	50%
Large commercial packaged AC	5	17%
Low-voltage dry-type distribution transformers	25	10%
Medium-voltage dry-type transformers	Most	10%
Metal halide lamps lamp fixtures	5[e]	20%
Pre-rinse spray valves	3	10%
Torchieres	15	62%[f]
Traffic signal modules	10	35%
Unit heaters	6	50%

[a] The first number refers to the number of ceiling fans with lights certified by EPA, the second is the number of makers of light bulbs that could be packaged with ceiling fans to make them compliant.
[b] The first number applies to transparent-door units, the second number to solid-door units.
[c] Digital television adapters are not yet widely sold in the United States. This standard is widely met by products sold in Europe today.
[d] The three dominant manufacturers all have products. In addition, some of the smaller manufacturers have products.
[e] Five lamp manufacturers produce complying lamps. Many fixture manufacturers in turn put these lamps into fixtures.
[f] Includes CFL torchieres as well as incandescent torchieres using less than 190 W.

3.5 Keeping Costs to the State Very Low

3.5.1 Introduction

The standards recommended here were chosen in part because they can be adopted and implemented by a state at very low cost. Potential state responsibilities consist of standards development and adoption; state efforts to foster good compliance; and enforcement. State 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. Because these existing compliance mechanisms result in the standards largely being self-enforcing, state enforcement actions will be rare. The low costs incurred by states 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 of the state responsibilities in a standards program can be achieved at zero to minimal cost.

State costs for standards development are close to zero because all of the recommended technical standards come from either existing state standards such as those adopted by California, Connecticut, or Maryland, 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. There is no need for other states to repeat this standard or test method development work. Most recent state legislation has directly written technical standards into law or referenced existing standards. thereby effectively eliminating state agency responsibilities to develop initial standards.

3.5.2 State Enforcement

States foster compliance with state standards through two primary mechanisms: certification and labeling. 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.[27] Certification typically must include brand name, model number information, efficiency performance, and a signed statement of compliance. This publicly available certification serves two purposes. First, it encourages compliance since manufacturers will be very hesitant to certify false values to a state and 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.

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[27] 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.

California has the most extensive and thorough certification program in place today. Fortunately for other states, the California Energy Commission publishes lists of certified products meeting its efficiency standards on the World Wide Web. CEC staff has been eager to coordinate with other states interested in "piggy-backing" off its certification databases (Martin 2004; Wilson 2004). These databases represent a significant investment by the CEC, both for developing the databases and inputting the certification information received from manufacturers. It makes little sense for other states to duplicate this effort. Rather, other states should allow certification and listing in the California database to suffice for their own certification purposes. If some modification is needed for a particular state's purpose, CEC staff has expressed a willingness to work with other states to find ways to address their needs. Finally, relying on the California database saves money not only for state government, but also for manufacturers, allowing them to certify once rather than to each individual state with standards.[28,29]

Some states have chosen to bolster their effort to achieve good compliance by supplementing certification requirements with labeling. A simple label or mark can indicate that a product has been tested and meets a given efficiency level. California requires a limited number of products to carry a label (e.g., exit signs, torchieres, transformers, pre-rinse spray valves). Maryland's statute requires that all covered products 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, states can avoid a proliferation of additional labeling requirements and avoid 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, certification, and labeling cost provided that other states choose the low-

[28] States with standards that vary in small ways from the California standards are still likely to find that the CEC database largely meets their purpose because of the thoroughness of CEC's certification requirements. Nevertheless, individual states may still need an alternate certification path for manufacturers that choose not to sell in California. A state might thus have an expanded version of the CEC database for its purposes, or choose to maintain a small supplemental list of certified products.

[29] Maryland's initial regulations published in late 2004 provide for an entirely new certification process. Several commenters have urged the Maryland Energy Administration to scrap its go-it-alone approach and work collaboratively with the existing California program. Connecticut has yet to write its regulations.

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 can be sufficient for solving the problem (Martin 2004). Some states 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 CEC suspects a product has been falsely certified, the agency can test the product in question. If a product fails to meet the standard, CEC can request that the manufacturer withdraw the model from the market and, if the manufacturer refuses, the CEC can "delist" the product from its database, making it illegal for sale in the state. 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).

These authorities 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 and/or expand the scope to additional products. In these states, agencies could incur costs associated with such future rulemakings. However, in most states, 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.

3.5.3 Costs and Benefits to a State

Since these standards can be implemented at such low costs, they are incredibly cost-effective from a government perspective. This can be illustrated with the following rough calculations. A number of states where legislation has been introduced have estimated the state cost to implement a standards program. Most estimates range between zero and $70,000 (Elnecave 2004).[30] These estimates are consistent with our analysis that standards

[30] Estimates of zero cost take into account that the state saves money on its own energy bills due to many of these standards.

can be implemented at very low cost. We estimate that, for a typical state, developing and implementing the standards recommended here would require about half a person-year of staff time to write the regulations establishing the state standards and compliance mechanisms, and perhaps a quarter person-year to implement them. For example, Maryland brought in a lawyer on a special detail for a few months to draft the regulations, and then is assigning implementation to regular staff. Assuming $150,000 per person-year (including salary and overhead), this works out to a 10-year cost (undiscounted) of roughly $412,500 (beyond 10 years, costs should be very low as the market will have transformed and little implementation support will be needed). As noted in Table 4.1 below, national net benefits from these standards would be approximately $63 billion, or an average of more than $1.2 billion per state (more for large states, less for small states). These benefits are about 3,000 times greater than our estimate of direct costs to a state government, and even allowing for the very rough nature of these calculations, it is clear that these new standards will be highly cost-effective from a governmental perspective.

Furthermore, these standards will directly reduce state government energy bills. For example, prior analyses have found that standards for just two products, exit signs and low-voltage distribution transformers, would directly save the Florida and Illinois state governments $800,000 and $850,000 per year, respectively, once the equipment stock turned over (deLaski, Metcalf, and Nadel 2003; FPIF 2003).

4. OVERALL SAVINGS AND ECONOMICS

Table 4.1 summarizes the overall energy savings potential and economics from minimum-efficiency standards for the above products. Table 4.2 shows the estimated peak load reduction and emission reductions from the proposed standards. For the methodology and sources we used to estimate these savings, see Appendix A. Data on energy and demand savings in 2010 are provided in Appendix B. State-specific savings data for the Northeastern states are provided in Appendix C.

Table 4.1. Estimated Energy Savings and Economics of Proposed New Standards

Products	Effective Date	National Energy Savings in 2020		National Energy Savings in 2030		Cumulative Savings for Products Purchased Thru 2030	NPV for Purchases Thru 2030	Benefit-Cost Ratio
	(year)	(TWh)	(tril. Btu)	(TWh)	(tril. Btu)	(quads)	($ billion)	
Ceiling fan lights	2007	18.9	197	18.9	190	3.4	13.0	18.3
Commercial clothes washers	2007	0.3	9	0.3	9	0.2	0.9	3.7
Commercial ice-makers	2007	0.6	7	0.6	6	0.1	0.4	7.9
Commercial refrigerators & freezers	2010	2.4	25	2.4	24	0.4	1.3	10.9
Commercial unit heaters	2007	NA	39	NA	55	0.8	3.0	9.6
Dehumidifiers	2007	1.0	10	1.1	11	0.2	0.7	133.3
Digital cable & satellite boxes	2007	1.4	14	1.4	14	0.4	1.2	4.1
Digital television adapters	2007	0.3	3	0.0	0	0.2	1.1	7.4
Exit signs	2007	1.7	18	2.9	29	0.4	1.4	11.9
External power supplies	2007	4.9	51	4.9	49	1.0	3.3	4.6
Large commercial packaged AC	2010	1.5	16	2.2	22	0.3	0.9	6.6
Low-voltage dry-type transformers	2007	3.1	32	5.4	54	0.7	2.6	8.2
Medium-voltage dry-type transformers	2007	2.7	28	4.7	47	0.6	2.4	5.5
Metal halide lamp fixtures	2008	9.0	93	14.4	144	1.9	7.3	10.8
Pre-rinse spray valves	2007	NA	56	NA	56	1.2	8.0	428.0
Reflector lamps	2007	3.9	40	3.9	39	0.9	2.6	4.1
Torchiere lighting fixtures	2007	11.8	123	11.8	119	2.3	8.4	10.0
Traffic signals	2007	1.3	13	1.3	13	0.3	0.6	3.2
Total		64.8	772.6	76.2	879.9	15.4	59.3	9.3

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

On a national basis, these new standards could save 65 TWh of electricity and about 0.8 quads of primary energy in the year 2020, while generating $59 billion in net savings for consumers and business owners for equipment purchased through 2030 (primary energy savings include reductions in fuel use in buildings plus reductions in fuel used at power plants). These standards also save natural gas including, in 2020, about 100 billion cubic feet of direct natural gas use in buildings (i.e., savings from reduced gas use for space and water heating) and an additional 336 billion cubic feet of natural gas used in power plants.[31] The primary energy savings from new standards is about one-fifth the projected savings from all existing federal standards including the most recent updates. The overall benefit-cost ratio is 9.3 to 1, far better than the 3 to 1 ratio for existing standards. Clearly, significant savings potential exists for these products at a small increase in first cost, resulting in large energy and economic savings over the life of the equipment.

[31] Power plant savings assume that half the power saved would be generated with natural gas. The Energy Information Administration estimates that in 2020, 23% of power will come from natural gas fired plants. However, it also estimates that 90% of the generating capacity built between now and 2020 will use natural gas as a fuel (EIA 2004c). Our 50% assumption is roughly midway between these two figures.

Table 4.2. Estimated Summer Peak Load, Water, and Pollutant Reductions from New Standards

	Summer Peak Load Reduction		Water Savings	Pollutant Reductions in 2020			
	In 2020 (GW)	In 2030 (GW)	In 2020 (billion gal)	Carbon (MMT)	NOx (1000MT)	SOx (1000MT)	PM10 (1000MT)
Ceiling fan lights	6.2	6.2	9.5	3.6	10.0	47.4	0.5
Commercial clothes washers	0.1	0.1	16.3	0.1	0.4	0.8	0.0
Commercial ice-makers	0.1	0.1	0.3	0.1	0.4	1.5	0.0
Commercial refrigerators & freezers	0.6	0.6	1.2	0.5	1.4	5.8	0.1
Commercial unit heaters	NA	NA	NA	0.6	1.8	0.0	0.1
Dehumidifiers	0.3	0.4	0.5	0.2	0.5	2.4	0.0
Digital cable & satellite boxes	0.2	0.2	0.7	0.3	0.8	3.3	0.0
Digital television adapters	0.0	0.0	0.1	0.0	0.1	0.6	0.0
Exit signs	0.2	0.4	0.8	0.3	1.0	4.4	0.0
External power supplies	0.7	0.7	2.4	0.9	2.8	11.7	0.2
Large commercial packaged AC	1.6	2.3	0.8	0.3	0.7	3.8	0.0
Low-voltage dry-type transformers	0.4	0.7	1.6	0.6	1.8	8.1	0.1
Medium-voltage dry-type transformers	0.4	0.7	1.4	0.5	1.5	6.5	0.1
Metal halide lamp fixtures	2.9	4.7	4.5	1.7	5.1	21.3	0.3
Pre-rinse spray valves	NA	NA	103.5	0.8	2.2	0.0	0.2
Reflector lamps	1.3	1.3	1.9	0.8	2.2	9.1	0.1
Torchiere lighting fixtures	3.9	3.9	5.9	2.2	7.3	31.0	0.4
Traffic signals	0.2	0.2	0.6	0.2	0.8	3.3	0.0
Total	19.2	22.4	152.1	13.8	40.8	161.1	2.3

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

Another significant benefit from appliance standards is their impact on summer peak load. We estimate that the proposed standards would save a total of over 19 GW of power in the year 2020. This is roughly equal to the generating capacity of 63 average power plants (i.e., 300 MW). This could significantly contribute to improved electric system reliability by eliminating the need for additional power plants and reducing the load on already stressed transmission and distribution systems.

These standards will also save a significant amount of water by 2020, including 120 billion gallons of direct water savings per year from efficient commercial clothes washers and pre-rinse spray valves as well as an additional 32 billion gallons of water saved per year at power plants.

Emissions reductions from the reduced energy consumption would also be significant. In the year 2020, over 14 MMT of carbon could be reduced, which would help the United States meet the global goal of reducing greenhouse gas emissions. The 14 MMT of carbon is equivalent to the annual carbon emissions from over 9 million "average" passenger cars (EPA 1997). These standards would also contribute to better air quality by reducing over 40,000 metric tons of smog-forming NOx, 160,000 MT of SOx (the main component of acid rain), and 2,300 tons of fine particulate matter that contributes to asthma and various lung diseases. There would also be significant reductions in airborne emissions of mercury, another serious health hazard that is about to be subject to federal emissions standards.

5. CONCLUSION

For each of the equipment types discussed in this report, there are substantial opportunities to save energy by promoting more efficient equipment. Use of high-efficiency equipment is cost-effective for most consumers but due to a variety of market imperfections, many consumers are not purchasing the efficient equipment. In order to capture the substantial energy savings that are available from the use of improved-efficiency equipment, state governments and/or the federal government should consider setting minimum-efficiency standards on many of these products. Efficiency standards can make a significant contribution towards bringing U.S. energy supply and demand into better balance, thereby improving the long-term reliability of our electric grid while also helping our environment, our overall economy, and individual consumer pocketbooks.

There are many products among the new batch of "low-hanging fruit" that are ripe for state and federal action. An estimated 0.8 quads of primary energy would be saved nationally in the year 2020 by setting standards for the products described in this report, equivalent to about 2% of U.S. residential and commercial energy use projected for that year. Stated another way, these standards could reduce projected growth in residential and commercial electricity use over the next 2 decades by about 6%. These savings are about one-fifth of the savings from standards established to date since 1987, with a benefit-cost ratio of more than 9 to 1, better than the 3 to 1 ratio for existing standards.

In most cases, voluntary or state standards have been developed that states can immediately adopt. In a few other cases, significant energy savings exist but additional research is needed before specific energy efficiency criteria can be set, due to lack of a testing standard and/or comparative data. DOE, state energy offices, and standard-setting organizations should work together to overcome these barriers in order to realize the additional savings from these products.

Finally, this type of research should be repeated in a few years to assess whether there are additional opportunities for standards, including products described in Sections 3.2.4 and 3.2.5 as well as new or under-appreciated products not discussed in this report.

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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.4 at the end of this appendix.

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 are discussed later in the appendix. The energy and peak demand savings then drove the calculation of the economic savings and emissions reductions achieved nationally and in each state.

Economic savings were calculated on a consumer basis, by multiplying energy savings by **average retail rates for each individual state** (residential or commercial rates, as appropriate). We used retail rates from 2003 data compiled by the U.S. Energy Information Administration (EIA 2004a, 2004b). These rates are presented in Table A.2. 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 2003 using a 5% real discount rate.

Similarly, we derived emissions reductions by multiplying the primary energy savings by average **marginal emissions factors for the country**. We derived emission factors for electricity from runs of the National Energy Modeling System with and without efficiency improvements. Emissions factors for direct combustion of natural gas and fuel oil come from EPA.

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

Product	Assumed standard (max energy use or minimum effic.)	Basis for standard	Avg. life of equipment (years)	Average per unit annual energy savings	Incremental equipment cost
Ceiling fan lights	Use CFLs	E* lamps	13	132 kWh	$6
Commercial clothes washers	Min. 1.26 MEF, max. 9.5 WF	Same as Resid. +WF	8	197 kWh 33 therms 9849 gals. water	$137
Commercial ice-makers	Varies w/ type & size	CEE Tier 1	8.5	419 kWh	$30
Commercial refrigerators & freezers	Varies w/ type & size	Energy Star & CEE T1	9	1234 kWh	$65
Commercial unit heaters	Power burner & electronic ignition	Power draft	19	267 therms	$277
Dehumidifiers	Varies w/ capacity	Energy Star	15	156 kWh	$1
Digital cable & satellite boxes	15 W max. standby power	Energy Star Tier 1	5	50 kWh	$5
Digital television adapters	Max. 1 W standby, 8 W active	Based on pro. to CEC	7	61 kWh	$5
Exit signs	Max. 5 W/face	E-Star (LED)	25	223 kWh	$20
External power supplies	Varies with size	Ecos proposal, tier 1	7	4 kWh	$0.49
Large commercial packaged AC	Min. 9.8 or 10 EER (depends on htg unit)	CEE Tier 2	15	9541 kWh	$1,176
Low-voltage dry-type transformers	Varies with size	TP-1	30	22 kWh/kVa	$3/kVA
Medium-voltage dry-type transformers	Varies with size	ORNL avg loss	30	25 kWh/kVa	$6/kVA
Metal halide lamp fixtures	Pulse-start ballast	Pulse start ballast	20	307 kWh	$30
Pre-rinse spray valves	Min. 1.6 gal./minute	Based on pro. to CEC	5	336 therms 56940 gals. water	$5
Reflector lamps	Varies with size	EPAct std	1.9	20 kWh	$0.73
Torchiere lighting fixtures	Max. 190 W	<190W (mostly CFL)	10	288 kWh	$20
Traffic signals	Max. 11-17 W depending on size & color	E-Star (LED)	10	431 kWh	$85

Detailed Methodology

Calculation of national energy and peak demand savings

We obtained national energy savings from proposed new standards by multiplying annual national sales figures for each appliance by per-unit energy savings. The analysis is static and assumes that equipment sales remain at 2001 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 2010 and 2020:

(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

Similarly, we used one of the following equations to calculate end-use natural gas (NG) savings in 2010 and 2020:

(a) NG savings = annual sales volume x (years from effective date - 0.5) x per-unit NG savings

(b) NG savings = annual sales volume x average product life x per-unit NG savings

In each case, we used equation (a) when the average product lifetime is longer than the number of years from the effective date. 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 10,752 Btu/kWh for 2010 and 10,377 Btu/kWh for 2020 (EIA 2004c). We use a 0.91 T&D loss factor—a 9% T&D loss (EIA 2003b).

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.3 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.

For overall water savings we considered both direct and indirect water savings. Direct water savings are reduced water use for efficient products such as commercial clothes washers and pre-rinse spray valves. These savings were calculated using the same methodology as for energy savings. Indirect water savings are water used at the power plant as part of the generation of electricity. For these calculations we assumed 0.5 gallons of water saved per kWh of electricity, which in turn is based on an assumption that about half of the displaced generation is coal-fired and about half is gas-fired. Data on water use for coal and gas generation comes from data collected by the Southwest Energy Efficiency Project (SWEEP 2002).

2) State Allocation Factors

For most residential products, the state allocation factor is the ratio of households in the state 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. For example, the number of households in Massachusetts is 2.35% of the national total, but the overall allocation factor for central heat pumps for Massachusetts is 0.44%, due to lower saturation and usage compared to the national average. We found the data that supports saturation and usage rates in the Residential Energy Consumption Survey 1997 and 2001 (EIA 1999b, 2003a) and the Commercial Building Energy Consumption Survey (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 ceiling fans, regional saturations and energy use came from a study on ceilings fans—data and citation can be found in Table A.3.
- For low-voltage building transformers, straight commercial sector energy use was the indicator. For medium-voltage transformers, we used total state electricity use to allocate national savings among the states.
- For traffic lights, which are neither a residential or commercial-sector product, we used urban population as a fraction of total state population to estimate the population of traffic lights.
- For commercial 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 set-top boxes (digital cable and satellite boxes and digital television converters), data on saturations and energy use came from the National Cable Telecommunications Association and other industry reports as compiled for a recent study on set-top boxes (Amann 2004). Savings were then allocated to states based on the number of households in each state.
- For dehumidifiers, we allocated sales to the different regions based on discussions with manufacturers, the Association of Home Appliance Manufacturers, and other industry experts.

3) Calculating Economic Costs and Savings

We calculated societal cost savings using the following formula:

Societal savings = State end-use electricity savings (kWh) x power pool avoided electricity costs + State peak demand savings (kW) x power pool avoided peak demand costs + NG savings x national average NG price

We calculated consumer bill savings using the following formula:

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

For commercial clothes washers and pre-rinse spray valves, additional economic savings were calculated from water savings. For electricity and natural gas prices used for this analysis, see Table A.2. For water savings, we assumed an average commercial water price of $3.50 per 1000 gallons (Kubo, Sachs, and Nadel 2001).

We calculated expected investment using the following formula:

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

We discounted present value (PV) calculations to 2003 assuming a 5% real discount rate. The net present value (NPV) of expected investment aggregates the present value of annual investments from the effective date of each standard through 2030. The NPV 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.

Table A.2. Average 2003 Retail Energy Costs by State

State	Electricity (cents/kWh) Residential	Electricity (cents/kWh) Commercial	Natural Gas ($/1000 cubic feet) Residential	Natural Gas ($/1000 cubic feet) Commercial
U.S. Average	**8.71**	**8.13**	**9.50**	**8.26**
Alabama	7.3	6.8	11.74	10.15
Alaska	12.6	13.5	4.39	3.48
Arizona	8.3	7.3	11.39	7.75
Arkansas	7.4	5.7	10.34	7.75
California	11.9	12.6	9.17	8.05
Colorado	8.0	6.5	6.63	5.84
Connecticut	11.3	9.7	13.09	10.51
Delaware	8.6	7.3	10.52	9.00
District of Columbia	8.3	7.3	13.11	12.15
Florida	8.6	7.1	17.07	10.94
Georgia	7.7	6.6	11.96	9.75
Hawaii	16.6	15.1	25.16	19.52
Idaho	6.3	5.5	7.57	6.94
Illinois	8.4	8.0	8.65	8.37
Indiana	7.0	6.1	9.40	8.49
Iowa	8.5	6.7	9.25	7.73
Kansas	7.8	6.5	8.85	8.61
Kentucky	5.8	5.5	9.21	8.73
Louisiana	7.9	7.4	10.31	8.82
Maine	12.9	9.3	13.06	11.32
Maryland	7.8	7.8	10.99	8.09
Massachusetts	11.5	10.3	12.55	10.85
Michigan	8.5	7.3	7.25	6.95
Minnesota	7.7	6.1	8.53	7.58
Mississippi	7.7	7.2	9.48	7.35
Missouri	7.0	5.8	9.49	8.72
Montana	7.6	6.5	7.08	7.05
Nebraska	6.8	5.7	7.80	6.85
Nevada	9.0	8.8	8.96	7.25
New Hampshire	12.0	10.2	11.47	10.68
New Jersey	10.7	9.0	8.40	8.01
New Mexico	8.6	7.5	8.37	6.77
New York	14.2	13.1	11.44	8.79
North Carolina	8.3	6.6	11.38	9.78
North Dakota	10.8	10.1	7.50	7.00
Ohio	8.3	7.7	9.07	8.11
Oklahoma	7.5	6.7	8.71	8.38
Oregon	7.1	6.3	9.84	7.90
Pennsylvania	9.6	8.6	10.86	9.33
Rhode Island	11.6	9.7	11.86	10.34
South Carolina	7.9	6.8	11.93	9.97
South Dakota	7.5	6.5	8.49	7.15
Tennessee	6.5	6.6	9.79	8.65
Texas	9.2	7.9	9.21	7.66
Utah	6.8	5.6	7.33	5.98
Vermont	12.8	11.2	10.05	8.00
Virginia	7.8	5.9	11.86	9.53
Washington	6.2	6.1	8.45	7.37
West Virginia	6.2	5.4	8.77	8.24
Wisconsin	8.6	6.9	9.28	8.02
Wyoming	7.0	5.7	7.16	5.72

Sources: EIA 2004a, 2004b

4) Calculating Emission Reductions

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

> *Emission reductions = end-use electricity savings ÷ T&D loss factor x marginal emission factor*s

We used marginal emission factors rather than straight emissions factors from the projected generation fuel mix. This gives a more accurate estimate of emissions reductions from new standards. For example, coal-fired power plants are often base load plants—they are the dirtiest, but also cheapest to operate under current regulatory conditions, so are likely to remain in operation. For electricity, projections from the National Energy Modeling System (NEMS) were used to develop the emission factors used in the analysis. We calculated emissions factors as the change in total emissions divided by the change in total generation when moving from the NEMS base case to an ACEEE policy case based on improved energy efficiency (Geller, Bernow, and Dougherty 1999). For additional details, see Thorne, Kubo, and Nadel (2000a). Carbon emissions savings for natural gas are based on DOE projections (EIA 2000). Nitrogen oxides, sulfur dioxide, and particulate emissions reductions are based on data from the EPA Office of Air Quality Planning and Standards (EPA 1998). Specific emissions factors used are summarized in Table A.3.

Table A.3. Emissions Factors

	Carbon	**NOx**	**SO_2**	**PM_{10}**
Electricity (tons/GWh)	177.34	0.53	2.45	0.03
Natural Gas and Oil (MMT/Quad)	14.76	41.80	0.27	3.38

Sources: See paragraph above.

Table A.4. Sources for Key Assumptions

Products	2001 Sales	Current Standard or Baseline	New Standard or Average Use	Average Product Life	Per Unit Incremental Cost	Coincident Peak Factor
Ceiling fan lights	Confidential negotiations with industry experts	deLaski 2003	deLaski 2003	DOE 2004a	ACEEE estimate based on 3 CFLs minus cost of incandescent lamps they replace	EIA 2000a
Commercial clothes washers	CEE 2001	PG&E 2001	PG&E 2001	PG&E 2001	ACEEE estimate based on PG&E 2001	EIA 2000a
Commercial refrigerators & freezers	ADL 1996	CEC 2004a	PG&E 2004b	ADL 1996	Nadel 2002	Average of EIA 2000a and 1/8760
Commercial unit heaters	GAMA 2004	Kraus, Hewitt & Lobenstein 1992	Kraus, Hewitt & Lobenstein 1992	GRI 1997	ACEEE estimate based on web price postings	NA
Dehumidifiers	AHAM 2000	ADL 1998	EPA 2004i	Based on Cadmus 1999	ACEEE estimate based on Cadmus 1999	EIA 2000a
Digital cable & satellite boxes	ACEEE estimate based on discussions with industry experts	Rosen, Meier & Zandelin 2001	EPA 2004h	ACEEE estimate based on discussions with industry experts	Suozzo & Nadel 1998	1/8760 hrs/yr
Digital television adapters	Same as above	NAEEEC 2004; Harrison 2004	PG&E 2004g	Same as above	Suozzo & Nadel 1998	1/8760 hrs/yr
Exit signs	E Source 1994	ACEEE estimate based on discussions with industry experts	Suozzo & Nadel 1998	Suozzo & Nadel 1998	EPA 2001	1/8760 hrs/yr
External power supplies	PG&E 2004a	PG&E 2004a	PG&E 2004a	PG&E 2004a	PG&E 2004a	1/8760 hrs/yr
Ice-makers	PG&E 2004b	PG&E 2004b	PG&E 2004b	ADL 1996	Nadel 2002	Average of EIA 2000a and 1/8760
Large commercial packaged AC	ARI 2004	ACEEE estimate based on data used to develop ASHRAE 90.1-1999	ACEEE estimate based on data used to develop ASHRAE 90.1-1999	ASHRAE 2003	PG&E 2004f	Thorne. Kubo & Nadel 2000a
Low-voltage dry-type transformers	ORNL 1997	ORNL 1997	ORNL 1997	ORNL 1997	ORNL 1997	1/8760 hrs/yr
Medium-voltage dry-type transformers	ORNL 1997	ORNL 1997	ORNL 1997	ORNL 1997	ORNL 1997	1/8760 hrs/yr
Metal halide lamp fixtures	PG&E 2004d	PG&E 2004d	PG&E 2004d	PG&E 2004d	PG&E 2004d	EIA 2000a
Pre-rinse spray valves	PG&E 2004e	PG&E 2004e	PG&E 2004e; SBW Consulting 2004	PG&E 2004e	PG&E 2004e	NA
Reflector lamps	PG&E 2004c	PG&E 2004c	PG&E 2004c	PG&E 2004c	PG&E 2004c	EIA 2000a
Torchiere lighting fixtures	Calwell 2004	Ihrig et al. 2002	Ihrig et al. 2002	ACEEE estimate based on discussions with industry experts	Elnecave 2004	EIA 2000a
Traffic signals	ACEEE estimate based on DOT data	ACEEE estimate based on discussions with industry experts	ACEEE estimate based on discussions with industry experts	ACEEE estimate based on discussions with industry experts	NYOGS 2001	1/8760 hrs/yr

APPENDIX B. ENERGY AND PEAK DEMAND SAVINGS FROM STANDARDS IN 2010

	National Energy Savings in 2010 (TWh)	(tril. Btu)	Summer Peak Load Reduction in 2010 (GW)
Ceiling fan lights	5.1	55	1.7
Commercial clothes washers	0.1	4	0.0
Commercial ice-makers	0.3	3	0.1
Commercial refrigerators & freezers	0.1	1	0.0
Commercial unit heaters	NA	10	NA
Dehumidifiers	0.3	3	0.1
Digital cable & satellite boxes	1.4	15	0.2
Digital television adapters	2.3	25	0.3
Exit signs	0.4	5	0.1
External power supplies	2.4	26	0.3
Large commercial packaged AC	0.1	1	0.1
Low-voltage dry-type transformers	0.8	9	0.1
Medium-voltage dry-type transformers	0.7	8	0.1
Metal halide lamp fixtures	1.8	19	0.6
Pre-rinse spray valves	NA	63	NA
Reflector lamps	3.9	41	1.3
Torchiere lighting fixtures	4.1	45	1.4
Traffic signals	0.5	5	0.1
Total	24.2	336.6	6.3

APPENDIX C. SAVINGS AND COSTS IN INDIVIDUAL STATES IN THE NORTHEAST

Energy Efficiency Standards Benefits -- Model Bill

Connecticut

Summary of Benefits by Product				2010			2020						
											Emissions Reductions		
Products	**Annual Savings per Unit**	**Incre-mental Cost per Unit**	**Annual Energy Savings from One Year's Sales**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Value of Bill Savings[1]**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Water Savings**	**Value of Bill Savings[1]**	**Carbon**	**NOx**	**SO2**
	kWh [therms]	**$**	**GWh [Billion BTU]**	**GWh [Billion BTU]**	**MW**	**$Million**	**GWh [Billion BTU]**	**MW**	**Million Gallons**	**$Million**	**1000 MT**	**Metric Tons**	**Metric Tons**
Ceiling Fan Lights	132	6	11.0	38.5	12.6	4.4	143.0	46.8	NA	16.2	31.4	132.7	173.1
Commercial Clothes	985		0.6	2.0			4.5						
Washers[3, 4]	[41]	137	[9.5]	[33.1]	0.7	0.9	[75.7]	1.5	227.0	2.0	2.3	9.2	5.5
Commercial Ice-Makers	334	30	0.9	3.2	0.7	0.3	7.7	1.8	NA	0.7	1.7	7.1	9.3
Commercial Refrigerators & Freezers	1,176	77	3.4	1.7	0.4	0.2	29.4	6.9	NA	2.9	6.5	27.3	35.6
Commercial Unit Heaters[4]	[268]	277	[39.3]	[137.6]	NA	1.4	[530.7]	NA	NA	5.6	8.8	35.3	0.1
Dehumidifiers	237	2	0.7	1.4	0.4	0.1	8.3	2.7	NA	0.8	1.8	7.7	10.0
Digital Cable & Satellite Boxes	50	5	3.7	16.9	2.3	1.9	16.9	2.3	NA	1.9	3.7	15.7	20.5
Digital Television Adapters	61	5	6.3	28.5	3.9	3.2	3.2	0.4	NA	0.4	0.7	2.9	3.8
Exit Signs	223	20	1.0	3.5	0.5	0.3	13.4	1.9	NA	1.3	2.9	12.4	16.2
External Power Supplies	4	0.5	8.7	30.4	4.2	3.4	60.9	8.4	NA	6.9	13.4	56.5	73.7
Reflector Lamps	20	1	24.0	46.7	15.3	4.5	46.7	15.3	NA	4.5	10.2	43.3	56.5
Large Commercial Packaged AC (>20 Tons)	5,549	1,176	1.2	0.6	0.5	0.1	13.0	9.5	NA	1.3	2.8	12.0	15.7
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	3.3	11.5	1.6	1.1	44.5	6.1	NA	4.3	9.8	41.3	53.8
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	2.5	8.8	1.2	0.9	33.8	4.7	NA	3.3	7.4	31.3	40.9
Metal Halide Lamp Fixtures	307	30	8.7	21.7	7.1	2.1	108.7	35.6	NA	10.6	23.8	100.8	131.6
Pre-Rinse Spray Valves[4, 5]	[336]	5	[135.2]	[473.2]	NA	7.8	[676]	NA	1,146.0	11.1	11.2	44.9	0.1
Torchiere Lighting Fixtures	288	20	16.6	58.2	19.1	6.6	166.3	54.4	NA	18.8	36.5	154.3	201.3
Traffic Signals	431	85	2.2	7.7	1.1	0.7	21.9	3.0	NA	2.1	4.8	20.3	26.5
Total			**95**	**281**	**72**	**40**	**722**	**201**	**1,373**	**95**	**180**	**755**	**874**
[natural gas]			**[184]**	**[644]**			**[1282]**						

Notes:

[1] Value of energy savings is based on energy savings and average state energy prices. This value does not take account of the incremental cost of more efficient products.

[2] Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product cost incurred by purchasers as a result of the standards over the same period expressed in current dollars.

[3] "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

[4] Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

[5] Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

Maine

Summary of Benefits by Product				2010			2020				Emissions Reductions		
Products	**Annual Savings per Unit**	**Incre-mental Cost per Unit**	**Annual Energy Savings from One Year's Sales**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Value of Bill Savings[1]**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Water Savings**	**Value of Bill Savings[1]**	**Carbon**	**NOx**	**SO2**
	kWh [therms]	**$**	**GWh [Billion BTU]**	**GWh [Billion BTU]**	**MW**	**$Million**	**GWh [Billion BTU]**	**MW**	**Million Gallons**	**$Million**	**1000 MT**	**Metric Tons**	**Metric Tons**
Ceiling Fan Lights	132	6	4.3	15.1	4.9	1.9	56.1	18.4	NA	7.2	12.3	52.1	67.9
Commercial Clothes	985		0.2	0.8			1.8						
Washers[3, 4]	[41]	137	[3.7]	[13]	0.3	0.4	[29.7]	0.6	89.0	0.8	0.9	3.6	2.2
Commercial Ice-Makers	334	30	0.3	0.9	0.2	0.1	2.3	0.5	NA	0.2	0.5	2.1	2.7
Commercial Refrigerators & Freezers	1,176	77	1.0	0.5	0.1	0.0	8.7	2.0	NA	0.8	1.9	8.1	10.5
Commercial Unit Heaters[4]	[268]	277	[11.6]	[40.6]	NA	0.5	[156.5]	NA	NA	1.8	2.6	10.4	0.0
Dehumidifiers	237	2	0.3	0.5	0.2	0.0	3.2	1.1	NA	0.3	0.7	3.0	3.9
Digital Cable & Satellite Boxes	50	5	1.5	6.6	0.9	0.9	6.6	0.9	NA	0.9	1.5	6.2	8.0
Digital Television Adapters	61	5	2.5	11.2	1.5	1.4	1.2	0.2	NA	0.2	0.3	1.2	1.5
Exit Signs	223	20	0.7	2.3	0.3	0.2	9.0	1.2	NA	0.8	2.0	8.3	10.9
External Power Supplies	4	0.5	3.4	11.9	1.6	1.5	23.9	3.3	NA	3.1	5.2	22.2	28.9
Reflector Lamps	20	1	9.0	17.5	5.7	1.6	17.5	5.7	NA	1.6	3.8	16.2	21.1
Large Commercial Packaged AC (>20 Tons)	4,145	1,176	0.2	0.1	0.0	0.0	1.6	0.9	NA	0.2	0.4	1.5	2.0
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	1.0	3.4	0.5	0.3	13.1	1.8	NA	1.2	2.9	12.2	15.9
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	1.0	3.4	0.5	0.3	13.3	1.8	NA	1.2	2.9	12.3	16.0
Metal Halide Lamp Fixtures	307	30	3.3	8.1	2.7	0.8	40.7	13.3	NA	3.8	8.9	37.7	49.3
Pre-Rinse Spray Valves[4, 5]	[336]	5	[50.6]	[177.1]	NA	3.1	[253.1]	NA	429.0	4.4	4.2	16.8	0.0
Torchiere Lighting Fixtures	288	20	6.5	22.8	7.5	2.9	65.3	21.4	NA	8.4	14.3	60.5	79.0
Traffic Signals	431	85	0.3	1.1	0.2	0.1	3.1	0.4	NA	0.3	0.7	2.9	3.8
Total			**35**	**106**	**27**	**16**	**267**	**74**	**518**	**37**	**66**	**277**	**324**
[natural gas]			**[66]**	**[231]**			**[439]**						

Notes:

[1] Value of energy savings is based on energy savings and average state energy prices. This value does not take account of the incremental cost of more efficient products.

[2] Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product cost incurred by purchasers as a result of the standards over the same period expressed in current dollars.

[3] "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

[4] Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

[5] Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

Massachusetts													
Summary of Benefits by Product				2010			2020						
											Emissions Reductions		
Products	Annual Savings per Unit	Incre-mental Cost per Unit	Annual Energy Savings from One Year's Sales	Energy Savings	Summer Peak Capacity Reduction	Value of Bill Savings[1]	Energy Savings	Summer Peak Capacity Reduction	Water Savings	Value of Bill Savings[1]	Carbon	NOx	SO2
	kWh [therms]	$	GWh [Billion BTU]	GWh [Billion BTU]	MW	$Million	GWh [Billion BTU]	MW	Million Gallons	$Million	1000 MT	Metric Tons	Metric Tons
Ceiling Fan Lights	132	6	20.8	72.6	23.8	8.4	269.8	88.3	NA	31.1	59.2	250.2	326.6
Commercial Clothes	985		1.1	3.7			8.6						
Washers[3, 4]	[41]	137	[17.8]	[62.5]	1.2	1.7	[142.8]	2.8	428.0	3.9	4.3	17.4	10.4
Commercial Ice-Makers	334	30	1.6	5.5	1.3	0.6	13.3	3.1	NA	1.4	2.9	12.3	16.1
Commercial Refrigerators & Freezers	1,176	77	5.8	2.9	0.7	0.3	50.9	11.8	NA	5.3	11.2	47.2	61.6
Commercial Unit Heaters[4]	[268]	277	[68]	[237.8]	NA	2.6	[917.4]	NA	NA	10.0	15.2	60.9	0.1
Dehumidifiers	237	2	1.4	2.6	0.8	0.3	15.6	5.1	NA	1.6	3.4	14.5	18.9
Digital Cable & Satellite Boxes	50	5	7.0	31.8	4.4	3.7	31.9	4.4	NA	3.7	7.0	29.6	38.7
Digital Television Adapters	61	5	11.9	53.7	7.4	6.2	6.0	0.8	NA	0.7	1.3	5.5	7.2
Exit Signs	223	20	1.7	6.0	0.8	0.6	23.2	3.2	NA	2.4	5.1	21.5	28.1
External Power Supplies	4	0.5	16.4	57.4	7.9	6.6	114.9	15.9	NA	13.2	25.2	106.6	139.1
Reflector Lamps	20	1	44.8	87.0	28.5	9.0	87.0	28.5	NA	9.0	19.1	80.7	105.3
Large Commercial Packaged AC (>20 Tons)	5,070	1,176	0.8	0.4	0.3	0.0	8.8	6.4	NA	0.9	1.9	8.1	10.6
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	0.3	1.0	0.1	0.1	4.0	0.6	NA	0.4	0.9	3.8	4.9
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	4.7	16.5	2.3	1.7	63.7	8.8	NA	6.6	14.0	59.1	77.1
Metal Halide Lamp Fixtures	307	30	16.2	40.5	13.3	4.2	202.6	66.3	NA	20.9	44.4	188.0	245.3
Pre-Rinse Spray Valves[4, 5]	[336]	5	[252]	[882.2]	NA	14.8	[1260.2]	NA	2,136.0	21.2	20.9	83.7	0.2
Torchiere Lighting Fixtures	288	20	31.4	109.8	35.9	12.7	313.7	102.7	NA	36.2	68.8	291.0	379.8
Traffic Signals	431	85	4.1	14.5	2.0	1.5	41.4	5.7	NA	4.3	9.1	38.4	50.1
Total			**170**	**506**	**131**	**75**	**1,255**	**354**	**2,564**	**173**	**314**	**1,319**	**1,520**
[natural gas]			**[338]**	**[1182]**			**[2320]**						

Notes:

[1] Value of energy savings is based on energy savings and average state energy prices. This value does not take account of the incremental cost of more efficient products.

[2] Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product cost incurred by purchasers as a result of the standards over the same period expressed in current dollars.

[3] "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

[4] Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

[5] Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

New Hampshire

Summary of Benefits by Product				2010			2020						
											Emissions Reductions		
Products	Annual Savings per Unit	Incre-mental Cost per Unit	Annual Energy Savings from One Year's Sales	Energy Savings	Summer Peak Capacity Reduction	Value of Bill Savings[1]	Energy Savings	Summer Peak Capacity Reduction	Water Savings	Value of Bill Savings[1]	Carbon	NOx	SO2
	kWh [therms]	$	GWh [Billion BTU]	GWh [Billion BTU]	MW	$Million	GWh [Billion BTU]	MW	Million Gallons	$Million	1000 MT	Metric Tons	Metric Tons
Ceiling Fan Lights	132	6	3.9	13.7	4.5	1.6	51.0	16.7	NA	6.1	11.2	47.3	61.7
Commercial Clothes	985		0.2	0.7			1.6						
Washers[3, 4]	[41]	137	[3.4]	[11.8]	0.2	0.3	[27]	0.5	81.0	0.7	0.8	3.3	2.0
Commercial Ice-Makers	334	30	0.3	0.9	0.2	0.1	2.3	0.5	NA	0.2	0.5	2.1	2.8
Commercial Refrigerators & Freezers	1,176	77	1.0	0.5	0.1	0.1	8.7	2.0	NA	0.9	1.9	8.1	10.6
Commercial Unit Heaters[4]	[268]	277	[11.7]	[40.8]	NA	0.4	[157.5]	NA	NA	1.7	2.6	10.5	0.0
Dehumidifiers	237	2	0.3	0.5	0.2	0.0	2.9	1.0	NA	0.3	0.6	2.7	3.6
Digital Cable & Satellite Boxes	50	5	1.3	6.0	0.8	0.7	6.0	0.8	NA	0.7	1.3	5.6	7.3
Digital Television Adapters	61	5	2.3	10.2	1.4	1.2	1.1	0.2	NA	0.1	0.2	1.0	1.4
Exit Signs	223	20	0.5	1.7	0.2	0.2	6.7	0.9	NA	0.7	1.5	6.2	8.1
External Power Supplies	4	0.5	3.1	10.9	1.5	1.3	21.7	3.0	NA	2.6	4.8	20.1	26.3
Reflector Lamps	20	1	8.7	16.9	5.5	1.7	16.9	5.5	NA	1.7	3.7	15.7	20.5
Large Commercial Packaged AC (>20 Tons)	4,459	1,176	0.3	0.2	0.1	0.0	3.5	2.4	NA	0.4	0.8	3.3	4.3
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	1.0	3.4	0.5	0.4	13.2	1.8	NA	1.4	2.9	12.2	16.0
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	0.9	3.1	0.4	0.3	12.0	1.7	NA	1.2	2.6	11.2	14.6
Metal Halide Lamp Fixtures	307	30	3.2	7.9	2.6	0.8	39.4	12.9	NA	4.0	8.6	36.6	47.7
Pre-Rinse Spray Valves[4, 5]	[336]	5	[49.1]	[171.7]	NA	2.9	[245.3]	NA	416.0	4.1	4.1	16.3	0.0
Torchiere Lighting Fixtures	288	20	5.9	20.8	6.8	2.5	59.3	19.4	NA	7.1	13.0	55.0	71.8
Traffic Signals	431	85	0.5	1.7	0.2	0.2	5.0	0.7	NA	0.5	1.1	4.6	6.0
Total			**33**	**99**	**25**	**15**	**252**	**70**	**497**	**35**	**62**	**262**	**305**
[natural gas]			**[64]**	**[224]**			**[430]**						

Notes:

[1] Value of energy savings is based on energy savings and average state energy prices. This value does not take account of the incremental cost of more efficient products.

[2] Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product cost incurred by purchasers as a result of the standards over the same period expressed in current dollars.

[3] "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

[4] Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

[5] Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

Rhode Island													
Summary of Benefits by Product				**2010**			**2020**						
											Emissions Reductions		
Products	**Annual Savings per Unit**	**Incre-mental Cost per Unit**	**Annual Energy Savings from One Year's Sales**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Value of Bill Savings[1]**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Water Savings**	**Value of Bill Savings[1]**	**Carbon**	**NOx**	**SO2**
	kWh [therms]	**$**	**GWh [Billion BTU]**	**GWh [Billion BTU]**	**MW**	**$Million**	**GWh [Billion BTU]**	**MW**	**Million Gallons**	**$Million**	**1000 MT**	**Metric Tons**	**Metric Tons**
Ceiling Fan Lights	132	6	3.4	11.8	3.9	1.4	43.9	14.4	NA	5.1	9.6	40.7	53.2
Commercial Clothes	985		0.2	0.6			1.4						
Washers[3, 4]	[41]	137	[2.9]	[10.2]	0.2	0.3	[23.2]	0.5	70.0	0.6	0.7	2.8	1.7
Commercial Ice-Makers	334	30	0.2	0.7	0.2	0.1	1.8	0.4	NA	0.2	0.4	1.6	2.1
Commercial Refrigerators & Freezers	1,176	77	0.8	0.4	0.1	0.0	6.7	1.6	NA	0.7	1.5	6.2	8.1
Commercial Unit Heaters[4]	[268]	277	[9]	[31.4]	NA	0.3	[121.1]	NA	NA	1.3	2.0	8.0	0.0
Dehumidifiers	237	2	0.2	0.4	0.1	0.0	2.5	0.8	NA	0.2	0.6	2.4	3.1
Digital Cable & Satellite Boxes	50	5	1.1	5.2	0.7	0.6	5.2	0.7	NA	0.6	1.1	4.8	6.3
Digital Television Adapters	61	5	1.9	8.7	1.2	1.0	1.0	0.1	NA	0.1	0.2	0.9	1.2
Exit Signs	223	20	0.2	0.8	0.1	0.1	3.1	0.4	NA	0.3	0.7	2.8	3.7
External Power Supplies	4	0.5	2.7	9.3	1.3	1.1	18.7	2.6	NA	2.2	4.1	17.3	22.6
Reflector Lamps	20	1	7.4	14.4	4.7	1.4	14.4	4.7	NA	1.4	3.2	13.3	17.4
Large Commercial Packaged AC (>20 Tons)	5,173	1,176	0.1	0.1	0.0	0.0	1.2	0.8	NA	0.1	0.3	1.1	1.4
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	0.8	2.6	0.4	0.3	10.2	1.4	NA	1.0	2.2	9.4	12.3
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	0.8	2.7	0.4	0.3	10.4	1.4	NA	1.0	2.3	9.6	12.6
Metal Halide Lamp Fixtures	307	30	2.7	6.7	2.2	0.7	33.5	10.9	NA	3.3	7.3	31.0	40.5
Pre-Rinse Spray Valves[4, 5]	[336]	5	[41.6]	[145.7]	NA	2.4	[208.1]	NA	353.0	3.4	3.5	13.8	0.0
Torchiere Lighting Fixtures	288	20	5.1	17.9	5.8	2.1	51.1	16.7	NA	5.9	11.2	47.4	61.8
Traffic Signals	431	85	0.6	2.3	0.3	0.2	6.5	0.9	NA	0.6	1.4	6.0	7.9
Total			**28**	**85**	**22**	**12**	**211**	**58**	**423**	**28**	**52**	**219**	**256**
[natural gas]			**[53]**	**[187]**			**[352]**						

Notes:

1 Value of energy savings is based on energy savings and average state energy prices. This value does not take account of the incremental cost of more efficient products.

2 Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product cost incurred by purchasers as a result of the standards over the same period expressed in current dollars.

3 "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

4 Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

5 Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

Vermont													
Summary of Benefits by Product				2010			2020						
											Emissions Reductions		
Products	Annual Savings per Unit	Incre-mental Cost per Unit	Annual Energy Savings from One Year's Sales	Energy Savings	Summer Peak Capacity Reduction	Value of Bill Savings[1]	Energy Savings	Summer Peak Capacity Reduction	Water Savings	Value of Bill Savings[1]	Carbon	NOx	SO2
	kWh [therms]	$	GWh [Billion BTU]	GWh [Billion BTU]	MW	$Million	GWh [Billion BTU]	MW	Million Gallons	$Million	1000 MT	Metric Tons	Metric Tons
Ceiling Fan Lights	132	6	2.0	7.1	2.3	0.9	26.4	8.6	NA	3.4	5.8	24.5	31.9
Commercial Clothes Washers[3, 4]	985 [41]	137	0.1 [1.7]	0.4 [6.1]	0.1	0.2	0.8 [14]	0.3	42.0	0.4	0.4	1.7	1.0
Commercial Ice-Makers	334	30	0.1	0.5	0.1	0.1	1.2	0.3	NA	0.1	0.3	1.1	1.5
Commercial Refrigerators & Freezers	1,176	77	0.5	0.3	0.1	0.0	4.7	1.1	NA	0.5	1.0	4.4	5.7
Commercial Unit Heaters[4]	[268]	277	[6.3]	[22]	NA	0.2	[85]	NA	NA	0.7	1.4	5.6	0.0
Dehumidifiers	237	2	0.1	0.3	0.1	0.0	1.5	0.5	NA	0.2	0.3	1.4	1.8
Digital Cable & Satellite Boxes	50	5	0.7	3.1	0.4	0.4	3.1	0.4	NA	0.4	0.7	2.9	3.8
Digital Television Adapters	61	5	1.2	5.3	0.7	0.7	0.6	0.1	NA	0.1	0.1	0.5	0.7
Exit Signs	223	20	0.2	0.6	0.1	0.1	2.1	0.3	NA	0.2	0.5	2.0	2.6
External Power Supplies	4	0.5	1.6	5.6	0.8	0.7	11.2	1.5	NA	1.4	2.5	10.4	13.6
Reflector Lamps	20	1	4.3	8.3	2.7	0.9	8.3	2.7	NA	0.9	1.8	7.7	10.1
Large Commercial Packaged AC (>20 Tons)	4,339	1,176	0.2	0.1	0.0	0.0	1.6	1.0	NA	0.2	0.4	1.5	2.0
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	0.5	1.8	0.3	0.2	7.1	1.0	NA	0.8	1.6	6.6	8.6
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	0.5	1.6	0.2	0.2	6.2	0.9	NA	0.7	1.4	5.8	7.5
Metal Halide Lamp Fixtures	307	30	1.6	3.9	1.3	0.4	19.4	6.4	NA	2.2	4.3	18.0	23.5
Pre-Rinse Spray Valves[4, 5]	[336]	5	[24.2]	[84.6]	NA	1.2	[120.8]	NA	205.0	1.7	2.0	8.0	0.0
Torchiere Lighting Fixtures	288	20	3.1	10.7	3.5	1.4	30.7	10.0	NA	3.9	6.7	28.5	37.1
Traffic Signals	431	85	0.1	0.4	0.1	0.0	1.2	0.2	NA	0.1	0.3	1.1	1.4
Total			**17**	**50**	**13**	**8**	**126**	**35**	**247**	**18**	**31**	**132**	**153**
[natural gas]			**[32]**	**[113]**			**[220]**						

Notes:

1 Value of energy savings is based on energy savings and average state energy prices. This value does not take account of the incremental cost of more efficient products.

2 Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product cost incurred by purchasers as a result of the standards over the same period expressed in current dollars.

3 "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

4 Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

5 Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

New Jersey

Summary of Benefits by Product				2010			2020				Emissions Reductions		
Products	**Annual Savings per Unit**	**Incre-mental Cost per Unit**	**Annual Energy Savings from One Year's Sales**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Value of Bill Savings[1]**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Water Savings**	**Value of Bill Savings[1]**	**Carbon**	**NOx**	**SO2**
	kWh [therms]	**$**	**GWh [Billion BTU]**	**GWh [Billion BTU]**	**MW**	**$Million**	**GWh [Billion BTU]**	**MW**	**Million Gallons**	**$Million**	**1000 MT**	**Metric Tons**	**Metric Tons**
Ceiling Fan Lights	132	6	25.8	90.4	29.6	9.7	335.7	109.8	NA	36.0	69.0	305.6	800.3
Commercial Clothes Washers[3, 4]	985 [41]	137	1.3 [22.2]	4.7 [77.7]	1.5	1.9	10.7 [177.6]	3.5	533.0	4.3	5.0	21.3	25.5
Commercial Ice-Makers	445	30	3.1	11.0	2.6	1.0	26.7	6.2	NA	2.4	5.5	24.3	63.6
Commercial Refrigerators & Freezers	1,568	77	11.7	5.9	1.4	0.5	102.3	23.8	NA	9.3	21.0	93.2	244.0
Commercial Unit Heaters[4]	[201]	277	[92.3]	[323.2]	NA	2.6	[1246.5]	NA	NA	10.0	19.4	81.3	0.3
Dehumidifiers	237	2	2.1	3.9	1.3	0.4	23.6	7.7	NA	2.1	4.9	21.5	56.3
Digital Cable & Satellite Boxes	50	5	8.7	39.6	5.5	4.2	39.8	5.5	NA	4.3	8.2	36.2	94.8
Digital Television Adapters	61	5	14.9	66.8	9.2	7.2	7.4	1.0	NA	0.8	1.5	6.8	17.7
Exit Signs	223	20	4.4	15.2	2.1	1.4	58.8	8.1	NA	5.3	12.1	53.5	140.1
External Power Supplies	4	0.5	20.4	71.5	9.9	7.7	142.9	19.7	NA	15.3	29.4	130.1	340.8
Reflector Lamps	20	1	59.3	115.3	37.7	10.4	115.3	37.7	NA	10.4	23.7	105.0	274.9
Large Commercial Packaged AC (>20 Tons)	7,035	1,176	2.2	1.1	0.8	0.1	23.2	17.2	NA	2.1	4.8	21.2	55.4
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	9.0	31.6	4.4	2.9	121.9	16.8	NA	11.0	25.1	111.0	290.6
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	5.9	20.6	2.8	1.9	79.3	10.9	NA	7.2	16.3	72.2	189.0
Metal Halide Lamp Fixtures	307	30	21.5	53.7	17.6	4.9	268.6	87.9	NA	24.3	55.2	244.5	640.3
Pre-Rinse Spray Valves[4, 5]	[336]	5	[334]	[1169.1]	NA	16.3	[1670.2]	NA	2,830.0	23.3	26.0	108.9	0.4
Torchiere Lighting Fixtures	288	20	39.0	136.6	44.7	14.6	390.4	127.7	NA	41.9	80.2	355.4	930.7
Traffic Signals	431	85	5.7	19.9	2.7	1.8	56.9	7.8	NA	5.1	11.7	51.8	135.5
Total			**235**	**688**	**174**	**89**	**1,803**	**492**	**3,363**	**215**	**419**	**1,843**	**4,300**
[natural gas]			**[449]**	**[1570]**			**[3094]**						

Notes:

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3 "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

4 Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

5 Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

New York

Summary of Benefits by Product				2010			2020				Emissions Reductions		
Products	**Annual Savings per Unit**	**Incre-mental Cost per Unit**	**Annual Energy Savings from One Year's Sales**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Value of Bill Savings[1]**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Water Savings**	**Value of Bill Savings[1]**	**Carbon**	**NOx**	**SO2**
	kWh [therms]	**$**	**GWh [Billion BTU]**	**GWh [Billion BTU]**	**MW**	**$Million**	**GWh [Billion BTU]**	**MW**	**Million Gallons**	**$Million**	**1000 MT**	**Metric Tons**	**Metric Tons**
Ceiling Fan Lights	132	6	60.2	210.7	69.0	30.0	782.7	256.1	NA	111.4	107.6	741.0	2,127.5
Commercial Clothes Washers[3, 4]	985 [41]	137	3.1 [51.8]	10.9 [181.2]	3.6	4.9	24.9 [414.3]	8.1	1,243.0	11.2	7.7	51.6	67.7
Commercial Ice-Makers	445	30	4.8	16.7	3.9	2.2	40.6	9.4	NA	5.3	5.6	38.4	110.3
Commercial Refrigerators & Freezers	1,568	77	17.9	8.9	2.1	1.2	155.7	36.2	NA	20.4	21.4	147.4	423.3
Commercial Unit Heaters[4]	[201]	277	[140.5]	[491.8]	NA	4.3	[1897.1]	NA	NA	16.7	19.8	128.6	0.5
Dehumidifiers	237	2	5.0	9.1	3.0	1.2	55.1	18.0	NA	7.2	7.6	52.1	149.6
Digital Cable & Satellite Boxes	50	5	20.3	92.3	12.7	13.1	92.7	12.8	NA	13.2	12.7	87.8	252.0
Digital Television Adapters	61	5	34.6	155.9	21.5	22.2	17.3	2.4	NA	2.5	2.4	16.4	47.1
Exit Signs	223	20	6.6	23.2	3.2	3.0	89.4	12.3	NA	11.7	12.3	84.7	243.1
External Power Supplies	4	0.5	47.6	166.6	23.0	23.7	333.3	46.0	NA	47.4	45.8	315.5	905.9
Reflector Lamps	20	1	133.8	260.1	85.1	34.0	260.1	85.1	NA	34.0	35.8	246.2	706.8
Large Commercial Packaged AC (>20 Tons)	6,365	1,176	4.1	2.0	1.4	0.3	42.7	28.5	NA	5.6	5.9	40.4	116.0
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	2.2	7.6	1.0	1.0	29.3	4.0	NA	3.8	4.0	27.7	79.6
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	13.7	47.9	6.6	6.3	184.8	25.5	NA	24.2	25.4	175.0	502.4
Metal Halide Lamp Fixtures	307	30	48.5	121.1	39.6	15.8	605.7	198.2	NA	79.2	83.3	573.3	1,646.2
Pre-Rinse Spray Valves[4, 5]	[336]	5	[753.3]	[2636.7]	NA	38.8	[3766.7]	NA	6,383.0	55.5	39.2	255.4	1.0
Torchiere Lighting Fixtures	288	20	91.0	318.6	104.3	45.3	910.3	297.9	NA	129.6	125.2	861.7	2,474.2
Traffic Signals	431	85	11.7	40.9	5.6	5.4	117.0	16.1	NA	15.3	16.1	110.7	317.9
Total			**505**	**1,493**	**386**	**253**	**3,742**	**1,057**	**7,626**	**594**	**578**	**3,954**	**10,171**
[natural gas]			**[946]**	**[3310]**			**[6078]**						

Notes:

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[2] Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product cost incurred by purchasers as a result of the standards over the same period expressed in current dollars.

[3] "Annual Savings per Unit" for washers provides separate estimates for a natural gas water heating and drying installation and an electric water heating and drying installation. The two annual savings per unit figures are not additive. Value of Bill Savings includes total bill savings in natural gas, electricity, water and wastewater.

[4] Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

[5] Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

Pennsylvania													
Summary of Benefits by Product				2010			2020						
											Emissions Reductions		
Products	**Annual Savings per Unit**	**Incre-mental Cost per Unit**	**Annual Energy Savings from One Year's Sales**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Value of Bill Savings[1]**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Water Savings**	**Value of Bill Savings[1]**	**Carbon**	**NOx**	**SO2**
	kWh [therms]	**$**	**GWh [Billion BTU]**	**GWh [Billion BTU]**	**MW**	**$Million**	**GWh [Billion BTU]**	**MW**	**Million Gallons**	**$Million**	**1000 MT**	**Metric Tons**	**Metric Tons**
Ceiling Fan Lights	132	6	41.1	143.7	47.0	13.8	533.8	174.7	NA	51.2	109.7	485.9	1,272.6
Commercial Clothes	985		2.1	7.4			16.9						
Washers[3, 4]	[41]	137	[35.3]	[123.6]	2.4	3.1	[282.5]	5.5	847.0	7.1	7.9	33.8	40.5
Commercial Ice-Makers	445	30	2.4	8.4	2.0	0.7	20.4	4.7	NA	1.7	4.2	18.6	48.6
Commercial Refrigerators & Freezers	1,568	77	9.0	4.5	1.0	0.4	78.2	18.2	NA	6.7	16.1	71.2	186.5
Commercial Unit Heaters[4]	[201]	277	[70.6]	[247.1]	NA	2.3	[953]	NA	NA	8.9	14.8	62.1	0.2
Dehumidifiers	237	2	3.4	6.2	2.0	0.5	37.5	12.3	NA	3.2	7.7	34.2	89.5
Digital Cable & Satellite Boxes	50	5	13.9	62.9	8.7	6.0	63.2	8.7	NA	6.1	13.0	57.5	150.7
Digital Television Adapters	61	5	23.6	106.3	14.7	10.2	11.8	1.6	NA	1.1	2.4	10.8	28.2
Exit Signs	223	20	4.5	15.7	2.2	1.3	60.7	8.4	NA	5.2	12.5	55.3	144.8
External Power Supplies	4	0.5	32.5	113.6	15.7	10.9	227.3	31.4	NA	21.8	46.7	206.9	541.9
Reflector Lamps	20	1	86.6	168.3	55.1	14.4	168.3	55.1	NA	14.4	34.6	153.2	401.3
Large Commercial Packaged AC (>20 Tons)	6,547	1,176	2.6	1.3	1.0	0.1	27.6	20.4	NA	2.4	5.7	25.1	65.7
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	6.9	24.2	3.3	2.1	93.2	12.9	NA	8.0	19.2	84.8	222.2
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	9.3	32.7	4.5	2.8	126.0	17.4	NA	10.8	25.9	114.7	300.5
Metal Halide Lamp Fixtures	307	30	31.4	78.4	25.7	6.7	392.0	128.3	NA	33.6	80.6	356.8	934.6
Pre-Rinse Spray Valves[4, 5]	[336]	5	[487.5]	[1706.4]	NA	26.0	[2437.7]	NA	4,131.0	37.2	38.0	158.9	0.6
Torchiere Lighting Fixtures	288	20	62.1	217.3	71.1	20.8	620.7	203.1	NA	59.5	127.6	565.1	1,480.0
Traffic Signals	431	85	7.1	24.9	3.4	2.1	71.1	9.8	NA	6.1	14.6	64.7	169.4
Total			**338**	**1,016**	**260**	**124**	**2,549**	**712**	**4,978**	**285**	**581**	**2,560**	**6,078**
[natural gas]			**[593]**	**[2077]**			**[3673]**						

Notes:

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4 Commercial clothes washers, pre-rinse spray valves and unit heaters save natural gas. Gas savings are expressed in Btus or therms and enclosed in brackets to distinguish from electricity savings.

5 Bill savings for pre-rinse spray valves include natural gas savings and water savings.

Energy Efficiency Standards Benefits -- Model Bill

Maryland													
Summary of Benefits by Product				2010			2020						
											Emissions Reductions		
Products	**Annual Savings per Unit**	**Incre-mental Cost per Unit**	**Annual Energy Savings from One Year's Sales**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Value of Bill Savings[1]**	**Energy Savings**	**Summer Peak Capacity Reduction**	**Water Savings**	**Value of Bill Savings[1]**	**Carbon**	**NOx**	**SO2**
	kWh [therms]	**$**	**GWh [Billion BTU]**	**GWh [Billion BTU]**	**MW**	**$Million**	**GWh [Billion BTU]**	**MW**	**Million Gallons**	**$Million**	**1000 MT**	**Metric Tons**	**Metric Tons**
Ceiling Fan Lights	132	6	40.2	140.8	46.1	11.0	523.1	171.2	NA	40.7	107.5	476.2	1,247.3
Commercial Clothes	985		0.9	3.0			6.9						
Washers[3, 4]	[41]	137	[14.4]	[50.3]	1.0	1.2	[115.1]	2.3	345.0	2.7	3.2	13.8	16.5
Commercial Ice-Makers	412	30	1.4	4.7	1.1	0.4	11.5	2.7	NA	0.9	2.4	10.5	27.4
Commercial Refrigerators & Freezers	1,453	77	5.1	2.5	0.6	0.2	44.2	10.3	NA	3.4	9.1	40.2	105.4
Commercial Unit Heaters[4]	[159]	277	[30.8]	[107.8]	NA	0.9	[415.7]	NA	NA	3.4	6.5	27.1	0.1
Dehumidifiers	237	2	3.8	7.0	2.3	0.6	42.7	14.0	NA	3.3	8.8	38.9	101.8
Digital Cable & Satellite Boxes	50	5	5.6	25.6	3.5	2.0	25.7	3.6	NA	2.0	5.3	23.4	61.4
Digital Television Adapters	61	5	9.6	43.3	6.0	3.4	4.8	0.7	NA	0.4	1.0	4.4	11.5
Exit Signs	223	20	2.7	9.6	1.3	0.7	37.0	5.1	NA	2.9	7.6	33.7	88.2
External Power Supplies	4	0.5	13.2	46.3	6.4	3.6	92.6	12.8	NA	7.2	19.0	84.3	220.7
Reflector Lamps	20	1	37.3	72.6	23.8	5.7	72.6	23.8	NA	5.7	14.9	66.1	173.1
Large Commercial Packaged AC (>20 Tons)	8,994	1,176	3.5	1.8	2.0	0.1	36.9	42.1	NA	2.9	7.6	33.6	88.0
Low-Voltage Dry-Type Transformers	22/kVA	3/kVA	7.0	24.3	3.4	1.9	93.9	13.0	NA	7.3	19.3	85.5	223.9
Medium-Voltage Dry-Type Transformers	25/kVA	6/kVA	3.8	13.3	1.8	1.0	51.3	7.1	NA	4.0	10.6	46.7	122.4
Metal Halide Lamp Fixtures	307	30	13.5	33.8	11.1	2.6	169.0	55.3	NA	13.2	34.7	153.9	403.1
Pre-Rinse Spray Valves[4, 5]	[336]	5	[210.3]	[735.9]	NA	10.3	[1051.3]	NA	1,782.0	14.7	16.4	68.5	0.2
Torchiere Lighting Fixtures	288	20	25.3	88.5	29.0	6.9	252.8	82.7	NA	19.7	52.0	230.1	602.8
Traffic Signals	431	85	3.3	11.7	1.6	0.9	33.3	4.6	NA	2.6	6.9	30.4	79.5
Total			**176**	**529**	**141**	**53**	**1,498**	**451**	**2,127**	**137**	**333**	**1,467**	**3,573**
[natural gas]			**[255]**	**[894]**			**[1582]**						

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