Consensus National Efficiency Standards for Lamps, Motors, Showerheads and Faucets, and Commercial HVAC Equipment

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As of June 1992, the U.S. Congress was in the process of adopting new national efficiency standards on lamps, motors, showerheads and faucets, and commercial HVAC equipment. The "consensus standards" have the support of energy efficiency advocates as well as acceptance by equipment manufacturers. For most product categories, the legislation contains initial standards that will eliminate the production of less efficient products once the standards take effect. For other product categories, the legislation directs the U.S. Department of Energy to adopt standards if DOE determines that standards are technically feasible, economically justified, and will result in significant energy savings.

These standards should contribute more energy savings than any other provision in the comprehensive energy legislation moving through Congress. It is estimated that the standards will reduce projected national electricity demand by 1.5% and 2.1% in 2000 and 2010, respectively. Primary energy savings should reach about 0.7 Quads/yr by 2000 and over 1.2 Quads/yr by 2010, with 12.2 Quads of primary energy saved cumulatively during 1993-2010.

States and utilities should take a number of actions if the standards are enacted. Since the new federal standards will preempt state standards, states should focus on adopting their own standards for products left out of the national legislation (e.g., large air conditioning equipment) where such actions are warranted. Also, states can adopt performance standards that do not apply to specific products, such as lighting power density limits for commercial buildings.

Utilities and regulators should take account of the standards as they forecast electricity demand and conduct integrated resource planning. Also, utilities should adjust their DSM programs once the standards take effect (if not sooner) so that they are not promoting products that are required by the standards. Utilities should take advantage of the testing and labeling requirements for luminaires and office equipment by promoting efficient equipment through rebate programs and other means. Finally, utilities should encourage the development and commercialization of innovative, highly efficient technologies for the types of products covered in the legislation by participating in so-called "golden carrot" programs.

Introduction and Status

National minimum efficiency standards were adopted through the enactment of the National Appliance Energy Conservation Act of 1987 (NAECA). NAECA applies to refrigerators, freezers, air conditioners, water heaters, furnaces, and other residential appliances. Also, national efficiency standards were adopted in 1988 for fluorescent lighting ballasts. The standards, which apply at the point of manufacture or import, remove inefficient products from the market, thereby assuring that all consumers purchase products of moderate or high efficiency. Standards are typically set so that the vast majority of equipment purchasers save money on a life-cycle basis.

The national appliance and ballast standards followed the successful implementation of standards by California and other states. The national standards preempt state standards unless a state can demonstrate it has an emergency that necessitates its adoption of more stringent standards. Equipment manufacturers agreed to support national standards in order to avoid a growing patchwork of state regulations. Efficiency advocates and states prefer national standards as long as they are set at relatively stringent levels.

Existing national standards on electrical products are expected to save approximately 72 billion kWh/yr and cut peak power demand by 28,000 MW by 2000 according to one estimate (Geller 1987; Geller and Miller 1988). Overall, federal standards adopted as of mid-1990 are projected to save 21 Quads of primary energy during the 1990-2015 period, yielding $34-44 billion in net economic savings for consumers (McMahon et al. 1990). Additional energy and economic savings will result from revised standards which the U.S. Department of Energy is required to issue if it determines that more stringent standards are technologically feasible and economically justified.

It is reasonable to extend minimum efficiency standards to lamps, motors, showerheads, faucets, and commercial heating, ventilating, and air conditioning (HVAC) equipment. For these products, both standard and improved efficiency products are widely available; substantial energy savings can be realized; higher efficiency products are cost effective to end-users as a whole; and many consumers and businesses are now purchasing less-efficient products due to a wide range of factors. For example, only about 20% of motors and only about 20-40% of fluorescent lamps sold in the United States as of 1988 were high efficiency or energy-saving types (Nadel and Geller 1991).

National efficiency standards for these products were proposed by the American Council for an Energy-Efficient Economy in 1990. These standards were incorporated into H.R. 2451, the Energy Efficiency Standards Act of 1991 sponsored by Representative Markey and others. In spite of opposition from equipment manufacturers, the proposed standards were accepted to a large extent by the Energy and Power Subcommittee of the House of Representatives when it adopted comprehensive energy legislation in mid-1991.

Faced with the likelihood that energy legislation would include equipment efficiency standards, the manufacturers of these products decided to negotiate compromise standards with energy efficiency advocates. The negotiations centered around the details of initial standards, including the efficiency levels and effective dates, the list of excluded products, and the process for revising standards. Agreements were eventually reached with all relevant industry associations. The consensus standards were then incorporated into energy legislation as it moved through both the House of Representatives and Senate. The legislation is expected to be enacted into law in the second half of 1992.

Description of Standards

The different standards established in the pending legislation are summarized in Table 1. More detailed information on the standards is described in the sections below.

Lamps

The proposed lamp standards are based on standards developed for Massachusetts. These standards were carefully developed and analyzed (Nadel et al. 1989), but were never issued due to political events in that state. The proposal includes initial standards on four-foot and eight-foot fluorescent lamps and incandescent reflector lamps, commonly referred to as flood and spot lights (see Table 2).

The standards are performance-based and are expressed in terms of minimum lumens of light output per watt of energy use (lumens per watt -- LPW). While it difficult to summarize the proposed regulations in a few sentences, the approximate impact is as follows:

Fluorescent lamps. Generally all reduced-wattage lamps (e.g., 34 watt four-foot lamps) as well as tri-phosphor, cathode cutout, and reduced diameter (i.e., T-8) lamps will comply.

Incandescent reflector lamps. Generally all tungsten halogen lamps as well as elliptical reflector lamps will comply.

Complying lamps have LPW values that are generally 2-20% higher than the standard lamps that will be eliminated when the standards take effect (Nadel and Geller 1991). In addition, many special purpose lamps, which are in limited use or for which there are presently no energy-saving substitutes, are exempted from the initial standards.

The initial standards will be periodically reviewed and, if warranted, revised by DOE. Under the legislation, DOE must complete this review process five years and ten after passage of the legislation; revisions to the standards take effect three years after they are issued.

Initial standards are not included in the legislation for ordinary incandescent lamps (known as general service incandescent lamps). In this category, manufacturers do produce some energy-saving lamps and halogen lamps that have higher LPW levels than standard lamps. The legislation calls for energy efficiency labeling to promote both improved incandescent lamps and compact fluorescent lamps. DOE is required to assess the effectiveness of this labeling program and then consider issuing standards on general service incandescent lamps. DOE must complete this rulemaking within five and a half years from the date of enactment of the legislation.

Table 1. Summary of New Standards by Product Type

Product	Standards in Bill?	Effective Date
Lamps:		
Labeling general service lamps	NA	1995
4 foot fluorescent lamps	Yes	1996
8 foot fluorescent lamps	Yes	1994
General service incandescent lamps	No	2001
Incandescent reflector lamps	Yes	1996
High intensity discharge lamps	No	1999
Motors:		
1-200 horsepower	Yes	1998*
Less than 1 horsepower	No	2002*
Commercial heating & cooling:		
Packaged air cooled A/C & HP	Yes	1994*
Packaged water cooled A/C & HP	Yes	1994*
Packaged terminal A/C & HP	Yes	1994
Water heaters	Yes	1994
Furnaces and boilers	Yes	1994
Showerheads	Yes	1993
Distribution transformers	No	Not specified
Luminaires (fluorescent lighting fixtures)	Labeling	1997-99
Office equipment	Labeling	1996

* For motors that must be UL certified, or that are used in UL certified equipment, an additional two years is allowed. For packaged air conditioners and heat pumps of 12-20 tons cooling capacity, the effective date is 1995.

Notes: For products for which no standards are contained in the bill, DOE will promulgate standards if standards are found to be technologically feasible and economically justified. Effective date assumes bill signed into law in the fall of 1992. Effective date rounded to the nearest New Year's Day.

Table 2. Summary of Lighting Minimum Efficiency Standards

Fluorescent Lamps			
Lamp Type	Nominal Lamp Wattage	Minimum CRI	Minimum Average Lamp Efficacy (LPW)
4-foot medium bi-pin	>35 W	69	75.0
	≤35 W	45	75.0
2-foot "U" shaped	>35 W	69	68.0
	≤35 W	45	64.0
8-foot slimline	65 W	69	80.0
	≤65 W	45	80.0
8-foot high output	>100 W	69	80.0
	≤100 W	45	80.0

Incandescent Reflector Lamps	
Nominal Lamp Wattage	Minimum Average Lamp Efficacy (LPW)
40-50	10.5
51-66	11.0
67-85	12.5
86-115	14.0
116-155	14.5
156-205	15.0

The legislation also requires DOE to consider adopting standards on high intensity discharge lamps within three years of enactment of the legislation. High intensity discharge lamps include mercury vapor, metal halide, and sodium vapor lamps. This rulemaking could prohibit further production of less efficient, mercury vapor lamps.

In conducting these rulemakings, DOE is instructed to use the criteria in the 1987 appliance standards legislation.

Motors

The proposed motor standards require the production of so-called energy-efficient motors for major types of motors in the range of 1-200 horsepower. The standards are based on accepted minimum efficiency values developed within the motor industry (see Table 3). The energy-efficient motors that will be required when the standards take effect are typically 2-10% more efficient than ordinary motors, depending on motor size (Nadel et al. 1991). Manufacturers will have five to seven years from date of enactment before the standards take effect. The long phase-in was requested by manufacturers who argued that thousands of motors will be affected and that testing and certification of new designs takes many years.

As with lamps, under the legislation DOE is required to complete reviews of the initial motor standards and opportunities for stronger standards five and ten years after passage of the legislation. New standards promulgated through this procedure take effect five to seven years after the final regulations are published.

The legislation also requires DOE to consider adopting efficiency standards on motors under 1 horsepower in size and to complete this rulemaking within four years from enactment of the legislation. If DOE issues standards on small motors, manufacturers will have five to seven years before the requirements take effect.

For both of these proceedings, DOE is instructed to use the criteria in the original appliance standards legislation.

Table 3. Summary of Motor Minimum Efficiency Standards

	Nominal Full-Load Efficiency					
	Open Motors			Closed Motors		
Number of Poles	6	4	2	6	4	2
1	80.8	82.5	--	80.0	82.5	75.5
1.5	84.0	84.0	82.5	85.5	84.0	82.5
2	85.5	84.0	84.0	86.5	84.0	84.0
3	86.5	86.5	84.0	87.5	87.5	85.5
5	87.5	87.5	85.5	87.5	87.5	87.5
7.5	88.5	88.5	87.5	89.5	89.5	88.5
10	90.2	89.5	88.5	89.5	89.5	89.5
15	90.2	91.0	89.5	90.2	91.0	90.2
20	91.0	91.0	90.2	90.2	91.0	90.2
25	91.7	91.7	91.0	91.7	92.4	91.0
30	92.4	92.4	91.0	91.7	92.4	91.0
40	93.0	93.0	91.7	93.0	93.0	91.7
50	93.0	93.0	92.4	93.0	93.0	92.4
60	93.6	93.6	93.0	93.6	93.6	93.0
75	93.6	94.1	93.0	93.6	94.1	93.0
100	94.1	94.1	93.0	94.1	94.5	93.6
125	94.1	94.5	93.6	94.1	94.5	94.5
150	94.5	95.0	93.6	95.0	95.0	94.5
200	94.5	95.0	94.5	95.0	95.0	95.0

Showerheads and Faucets

Numerous states have adopted maximum flow limits on showerheads and faucets. Reducing water flow means that less energy is consumed for water heating in addition to less water consumption. The proposed legislation contains flow rate standards for showerheads, kitchen faucets, and bathroom faucets of 2.5 gallons per minute (GPM) measured at a water pressure of 80 psi. For showerheads, this is the most restrictive requirement that any state has enacted and put into effect. For faucets, eleven states had previously adopted standards, with the required flow rates ranging from 2.0-3.0 gpm (Ranton 1991). A large number of showerheads and faucets now meet this standard and consumer acceptance is very high (BPA 1990; Nadel and Geller 1991). The national standard takes effect January 1, 1994.

Under the legislation, DOE cannot revise the showerhead and faucet standards on its own initiative. Instead, the initiative for developing new standards rests with the American Society of Mechanical Engineers (ASME). When ASME develops new standards, DOE is instructed to review and accept them as federal standards. However, if DOE concludes that more stringent standards are technically feasible and economically justified, it can waive preemption of state standards (but not issue stronger federal standards). Also, DOE can waive federal preemption of state standards on these products if ASME does not revise its standards within five years of the previous revision.

The national legislation also contains flow rate limits on toilets and urinals. This provision is intended primarily to conserve water, but it also will result in a some energy savings from reduced water pumping and wastewater treatment.

Commercial HVAC Equipment

Existing appliance standards cover heating and cooling equipment used in housing and small commercial buildings. The proposed legislation extends standards to certain types of larger air conditioning systems, heat pumps, furnaces, boilers, and water heaters (see Table 4). The initial minimum efficiency requirements are derived from ASHRAE standard 90.1, the most recent model commercial building standard issued by ASHRAE (ASHRAE

Table 4. Summary of Commercial HVAC Standards

Product	Minimum Efficiency Rating
Packaged air-cooled A/C & HP	
Less than 65 kBTUh	10.0 SEER (cooling mode)*
65,000-135 kBTUh	8.9 EER (cooling mode)
135-240 kBTUh	8.5 EER (cooling mode)
Packaged air-cooled HP	
Less than 65 kBTUh	6.8 HSPF (heating mode)*
65-135 kBTUh	3.0 COP (heating mode)
135-240 kBTUh	2.9 EER (heating mode)
Packaged water-cooled A/C & HP	
Less than 65 kBTUh	9.3 EER (cooling mode)*
65-135 kBTUh	10.5 EER (cooling mode)
135-240 kBTUh	9.6 EER (cooling mode)
Packaged water-cooled HP	
Less than 135 kBTUh	3.8 COP (heating mode)
Packaged terminal A/C & HP	
Cooling	10.0-(0.16 x capacity/1000) EER
Heating	1.3+(0.16 x min. cooling EER) COP
Furnaces and boilers	
Gas furnaces >= 225 kBTUh	80%
Oil furnaces >= 225 kBTUh	81%
Gas boilers >= 300 kBTUh	80%
Oil boilers >= 300 kBTUh	83%
Water heaters	
[Standard requires an entire table -- see ASHRAE 1992]	

Key: EER = energy-efficiency ratio
SEER = seasonal energy-efficiency ratio
COP = coefficient of performance
HSPF = heat season performance factor

* For single package units, the minimum SEER and HSPF are 9.7 and 6.6 respectively.

Notes: All efficiencies are at full load in accordance with applicable industry test procedures. Cooling efficiencies are generally measured at 95 degrees F. Heat pump efficiencies are generally measured at 47 degrees F.

1990). In the proposed legislation, the minimum efficiency requirements for HVAC equipment as of January 1, 1992 in ASHRAE 90.1 become national standards on January 1, 1994 for most types of products. In a few product categories, national standards do not take effect until January 1, 1995.

The HVAC standards can be updated after ASHRAE revises its model standards. DOE is directed to issue national standards based on the revised ASHRAE standards for HVAC equipment unless DOE determines that more stringent standards are technologically feasible, economically justified, and would result in significant additional energy savings. Such revised national standards would not take effect until two to three years after the effective date of the amended ASHRAE model standard (or four years if DOE adopts a standard that is stronger than ASHRAE's).

Very large air conditioning systems (known as chillers) and unitary systems greater than 20 tons in cooling capacity are excluded from the national standards. Even though these products are included in the ASHRAE model standard and consequently in some state building codes, manufacturers argued that large air conditioning systems are custom-designed and site-assembled rather than mass-produced, making them inappropriate for national standards that apply to manufacturers or importers.

In addition to large air conditioning systems, as a result of the give and take of negotiations between manufacturers and efficiency advocates, minimum efficiency standards were not established for several other categories of commercial HVAC equipment covered by ASHRAE 90.1 including unit heaters, duct heaters, and ground water-cooled heat pumps. Furthermore, for packaged cooling equipment, the ASHRAE standard establishes both full load and part load efficiency ratings. Only the full load values are included in the national legislation in the interest of keeping the standards simple and because the part load values included in the ASHRAE standard are set low enough that nearly all products that meet the full load values also meet the part load values.

Other Equipment

The proposed legislation requires DOE to consider issuing minimum efficiency standards on utility distribution transformers. Distribution transformers consume about 2% of electricity generated in the United States through core losses. High efficiency transformers can reduce these losses by 65-80% (Knight 1990). The legislation requires DOE to issue transformer efficiency standards if feasible within three years from date of enactment.

The proposed legislation also requires the development of uniform test procedures and labeling programs in two product areas: luminaires (i.e., fluorescent light fixtures) and office equipment (i.e., personal computers, printers, copiers, etc.). In both areas, standardized efficiency testing and rating is not yet occurring. Instituting testing and labeling will enable consumers to identify more efficient products, allow utilities to promote efficient equipment through rebate programs and other means, and should stimulate manufacturers to improve energy performance. The legislation allows two to three years for establishing the test procedures and labeling programs.

Energy Savings Analysis

Methodology

We have made a preliminary estimate of the approximate energy savings that will result from the new standards. The analysis is based on a simple spreadsheet model that estimates energy and demand savings in 2000 and 2010 as the product of:

1. Projected annual sales of each product type;

2. Estimates of the fraction of new sales covered by the standards once they take effect;

3. Estimates of the fraction of covered products that are influenced by the standards (i.e., accounting for products that will be energy efficient in the year standards take effect even if the standards were not adopted);

4. The number of years product sales will be affected by standards (i.e. the difference between the effective year of the standard and the last year in the analysis [2000 or 2010], up to the average life of each type of equipment;

5. Estimated peak power savings per product caused by the standards;

6. The average annual operating hours of each type of equipment (used only for estimating annual energy savings).

In developing input assumptions for the spreadsheet models, data were obtained from many sources. Projected annual sales were generally based on sales in recent years as reported by the U.S. Census Bureau in its Current Industrial Reports series. The other assumptions in the analysis were based on discussions with industry experts and on published reports on these issues. Major sources for these estimates were as follows: lamps -- Nadel et al. (1989); motors -- Nadel et al. (1991); commercial HVAC equipment -- Chiu and Zaloudek (1987), Tecogen (1986), and Block (1992); showerheads and faucets -- Maddaus (1987) and Vickers (1989); office equipment -- Norford et al. (1990). Additional details on the analysis and the sources for specific assumptions can be found in Moskovitz, Nadel and Geller (1991).

In conducting this analysis of energy savings from the standards, we included both products where specific standards are established in the legislation and products for which standards will be established through DOE rulemaking. In estimating savings from standards established by rulemaking, our estimates use the effective dates established in the legislation and assume standards of modest stringency. The actual standards promulgated by DOE may range from no standard to a standard substantially stronger than we have estimated.

In all of our estimates we do not include or make any assumptions about revised standards that may be promulgated by DOE in the future to replace the initial standards. In this respect our analysis is conservative since it applies to 1993-2010, a time period during which revised standards are likely for many of the products.

Results

Table 5 summarizes the energy savings estimates. For the electrical products, savings of nearly 50 billion kWh/yr are projected by 2000, increasing to over 85 billion kWh/yr by 2010. These values represent 1.5% and 2.1% of projected national electricity consumption in 2000 and 2010, respectively (EIA 1992). The reduction in peak power demand reaches 20,000 MW by 2000 and 31,000 MW by 2010. It should be noted, however, that these estimates are non-coincident among products as well as with overall peak electrical loads experienced by utilities. Among the covered products, fluorescent lamps contribute the most savings. Incandescent lamps, showerheads (in buildings with electric water heating), and motors also provide considerable electricity savings.

For the oil- and gas-fired products, the projected savings reach nearly 120 trillion Btus/yr by 2000 and 260 trillion Btus/yr by 2010. Showerheads and faucets (in buildings with fuel-fired water heating) contribute about three-quarters of the oil and gas savings while commercial heating equipment contribute the remaining savings.

When electricity use is converted to primary energy using a conversion factor of 11,500 Btus/kWh (to account for generation, transmission, and distribution losses), the total primary energy savings for all the products reach 0.7 Quads/yr by 2000 and over 1.2 Quads/yr by 2010. The estimated cumulative energy savings during 1993-2010 is 12.2 Quads, equivalent to 52 days of national energy use at the current rate. Furthermore, the standards should contribute more energy savings than any other provision in the comprehensive energy legislation moving through Congress (Geller et al. 1992).

Opportunities for Efficiency Improvements on Affected Equipment

The initial efficiency standards established by the legislation are generally not very stringent. As shown in Table 5, for most types of covered equipment, a substantial segment of current sales meets the standards. In many cases, equipment is on the market which exceeds the standards by a significant degree.

For example, T8 fluorescent lamps have an efficacy of 90 lumens per watt -- 20% better than the minimum efficiency standard. Similarly, halogen infrared reflecting lamps have an efficacy of approximately 20 lumens per watt -- up to 40% better than the minimum efficiency standard (Nadel and Geller 1991).

Motors using conventional technologies are sold today with efficiencies of 85.5% (one horsepower) to 96.2% (200 horsepower) -- 1-3% better than the minimum efficiency standards (Nadel et al. 1991). Furthermore, motors now entering the market based on unconventional designs, such as brushless DC motors and switched reluctance motors can improve part-load motor efficiencies by up to 20% (Nadel et al. 1991).

The top-rated air-cooled commercial packaged cooling systems on the market in 1992 have an EER efficiency rating of 9.6 -- 7% better than the standard (Block 1992). However, utilities are now planning to offer rebates for units with EERs of 12 or more, and manufacturers have indicated that with sufficient lead time and market size, they can produce the desired equipment (Personal communication with D.J. Fitzpatrick, Pacific Gas and Electric Co., 1992.)

Similarly, showerheads with flow rates of 2.0 or less (20% better than the standard) are produced by a number of manufacturers, and have received high satisfaction ratings from consumers (BPA 1990).

The availability of this equipment shows that there are substantial opportunities for utility DSM programs and other voluntary programs to promote efficiency improvements. Furthermore, there may be substantial opportunities to tighten the minimum efficiency standards in the future.

Table 5. Savings from National Efficiency Standards and Labeling Requirements in 1992 Energy Legislation

Type of Equipment	Annual Sales (10^6)	Percent Covered by Stds	Percent Complying w/o Stds	Avg. Life (yrs)	Watts Saved Per Unit	Avg. Annual Op.Hrs.	Total Savings in 2000 (MW)	Total Savings in 2000 (GHw/yr)	Total Savings in 2010 (MW)	Total Savings in 2010 (GWh/yr)
Lamps										
Fluorescent	461	87%	50%	5	7	3,500	7,020	24,570	7,020	24,570
Reflector incandescent	100	90%	20%	1	28	2,000	2,020	4,040	2,020	4,040
Gen'l service incand.*	793	90%	30%	1	9.2	1,000	4,600	4,600	4,600	4,600
HID*	19.8	95%	60%	6	67	3,500	1,010	3,540	3,020	10,570
Motors										
1-200 horsepower	1.85	64%	30%	15	280	2,676	700	1,870	3,020	8,080
<1 horsepower*	113	50%	5%	10	51	250	0	0	2,560	6,850
Commercial HVAC										
Unitary A/C										
< 65 kBTU	0.387	100%	75%	15	751	1,100	440	480	1,090	1,200
65-135 kBTU	0.086	100%	50%	15	1,901	1,100	490	540	1,220	1,340
135-250	0.032	100%	50%	15	3,522	1,100	280	310	850	940
Air-source heat pumps	0.016	100%	50%	15	958	2,200	50	110	120	260
Water-source heat pumps	0.098	100%	95%	15	522	2,200	20	40	40	90
Packaged terminal A/C	0.135	100%	75%	15	130	1,100	30	30	70	80
Packaged terminal HP	0.098	100%	75%	15	209	2,200	30	70	80	180
Incand. lamp labeling	793	90%	NA	1	1.8	1,000	1,280	1,280	1,280	1,280
Luminaire labeling	45	90%	NA	16	0.72	3,500	170	600	470	1,650
Office equipment labeling										
PC's	12.3	100%	NA	5	10	2,000	620	1,200	620	1,240
Printers	8.8	100%	NA	5	7.5	1,500	330	500	330	500
Copiers	1.4	100%	NA	5	18	3,000	130	400	130	390
Distribution transformers*	1.2	100%	20%	13	80	8,760	230	2,010	1,000	8,760
Plumbing - electric wtr htrs						(W/day)				
Showerhds: old --> 3 gpm	0.94	100%	36%	18	1,143	365	350	2,000	780	4,560
Showerhds: 3 --> 2.5 gpm	0.94	100%	18%	18	381	365	150	900	330	1,930
Faucets	1.89	100%	29%	17	248	365	150	900	350	2,040
TOTAL - Electricity							20,100	49,990	31,000	85,150
Commercial heating stds					(BTUh)		(MMBTUh) (10^9 BTU)		(MMBTUh) (10^9 BTU)	
Gas furnace > 300 kBTUh	0.011	100%	50%	16	52,636	1,500	1,760	2,600	4,690	7,040
Oil furnace > 300 kBTUh	0.004	100%	50%	16	42,889	1,500	480	700	1,290	1,940
Gas boiler > 300 kBTUh	0.008	100%	50%	16	97,723	1,500	2,270	3,400	6,070	9,110
Oil boiler > 300 kBTUh	0.009	100%	50%	16	138,562	1,500	3,560	5,300	9,490	14,240
Gas & oil water heaters	0.244	100%	50%	10	8,517	4,000	6,230	24,900	10,390	41,560
Plumbing - oil & gas					(BTU/dy)		(MMBTUd)		(MMBTUd)	
Showerhds: old --> 3 gpm	3.55	100%	36%	18	6,598	365	120,020	43,800	270,040	98,560
Showerhds: 3 --> 2.5 gpm	3.55	100%	18%	18	2,199	365	51,260	18,700	115,330	42,100
Faucets	7.11	100%	29%	17	1,432	365	3,160	18,500	7,680	44,850
TOTAL - Fuels								117,900		259,400

* Products which DOE will study, and if justified, set standards.

Implications for States and Utilities

State Issues

Regarding federal preemption of states' authority to set standards on the products covered in the proposed legislation, in general the legislation follows the 1987 NAECA law. Once the law is enacted, states are preempted from setting more stringent standards on the products for which there are federal standards. Existing state standards are grandfathered and new state standards may be enforced up to the effective date of the federal law. Also, states can adopt their own standards on general service incandescent lamps, HID lamps, small motors, and distribution transformers if they act before the federal government adopts specific standards on these products. Of course states can still adopt efficiency standards on large air conditioning equipment and other products left out of the national legislation.

As mentioned previously, the HVAC equipment standards included in the bills are based on the values in the ASHRAE 90.1 model standard. States, however, are allowed to adopt building codes that contain the HVAC equipment standards recommended by ASHRAE prior to their becoming federal law.

Utility Issues

As noted in the previous section, the standards are expected to have a non-trivial impact on national electricity use. It will be important for utilities and energy planning authorities to take account of the standards as they forecast electricity demand and conduct integrated resource planning. The standards should permit utilities to avoid or defer numerous new power plants; in fact society will not realize the full economic benefits of the standards unless this plant construction is avoided.

The standards also have implications for utility DSM programs. Utilities should stop promoting some of the energy-efficient products required by the standards (e.g., energy-saving fluorescent lamps and energy-efficient motors) as the effective dates approach or occur. Utilities might find it cost effective and beneficial to continue promoting T8 lamps and other products that are significantly more efficient than the initial minimum standards. In general, utilities should carefully monitor market trends and conservation opportunities on a product-by-product basis.

The testing and labeling requirements for luminaires and office equipment should open new areas for utility DSM activity. Once standardized efficiency testing begins, utilities will be able to promote the purchase of more efficient products through rebate programs and other means. Assuming the legislation is enacted later this year, comprehensive data on luminaire and office equipment efficiency should become available in approximately 1995.

Utilities also can encourage the development and commercialization of innovative, highly efficient technologies in the areas covered in the legislation. This can be done through so-called "golden carrot" programs, whereby a number of utilities promise rebates if products are introduced that meet certain performance criteria. The development and introduction of these highly efficient products then facilitates the adoption of more stringent standards when DOE conducts its review. A number of utilities are now participating in an initial golden carrot program for refrigerators (L'Ecuyer 1992). Similar programs may be possible in the areas of commercial HVAC equipment and motors. Moreover, the House bill directs DOE to support the planning of golden carrot programs.

Conclusion

National minimum efficiency standards for lamps, motors, showerheads and faucets, and commercial HVAC equipment are on the horizon. Standards on distribution transformers also could be adopted along with testing and labeling requirements for luminaires and office equipment. It is likely that the standards and other requirements will be enacted in 1992 as part of comprehensive energy legislation. If the bill fails to be enacted this year (due to issues besides the equipment standards), the standards are likely to be adopted in the near future since they were agreed to by manufacturers and energy efficiency advocates.

Initial requirements, including those in the legislation and those left to DOE to promulgate, should result in significant energy savings. We estimate that the standards will reduce projected national electricity demand by 1.5% and 2.1% in 2000 and 2010, respectively. Primary energy savings should reach about 0.7 Quads/yr by 2000 and over 1.2 Quads/yr by 2010, with 12.2 Quads of primary energy saved cumulatively during 1993-2010. The savings could be even greater if DOE revises the initial standards following the procedures and timetables set out in the agreements.

A relatively simple methodology was used to generate these energy savings estimates. More sophisticated analysis of energy savings as well as economic, utility, and environmental impacts should be performed. Models comparable to those used to assess the national appliance efficiency standards are needed for this purpose. Developing these models and performing the assessments of standards specified in the bill will require a significant effort on the part of the U.S. DOE.

States and utilities should take a number of actions if the standards are enacted. Since the new federal standards will preempt state standards, states should focus on adopting standards on products left out of the national legislation such as large air conditioning equipment. Utilities and regulators should take account of the standards as they forecast electricity demand and conduct integrated resource planning. Also, utilities should adjust their DSM programs once the standards take effect (if not sooner) so that they are not promoting products that would be produced and sold anyway.

Testing and labeling requirements for luminaires and office equipment, included along with the efficiency standards, should open the door for education, promotion, and incentive programs on these products as well as tracking of progress in efficiency improvement. If these strategies are not successful in removing inefficient, uneconomical products from the marketplace, then DOE, the Congress, or states should consider adopting minimum efficiency standards.

In summary, important new equipment efficiency standards and testing/labeling requirements were negotiated and are likely to be enacted in the near future. Successful implementation of these provisions will require the cooperation and support of equipment manufacturers, the federal government, states, and utilities.

References

ASHRAE. 1990. ASHRAE/IES Standard 90.1-1989, *Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings*. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Atlanta, GA.

ASHRAE. 1992. ASHRAE/IES 90.1b, *Addendum to ASHRAE/IES 90.1-1989*. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Atlanta, GA.

Block, J. 1992. "Analysis of Commercial HVAC Equipment Efficiencies." Report prepared for the American Council for an Energy-Efficient Economy. EnerLogic, Alvin, TX.

BPA. 1990. "Low Flow Shower Head Consumer Acceptance Study Final Report." Bonneville Power Administration, Portland, OR.

Chiu, S.A. and F.R. Zaloudek. 1987. *R&D Opportunities for Commercial HVAC Equipment*. Pacific Northwest Laboratory, Richland, WA.

EIA. 1992. *Annual Energy Outlook with Projections to 2010*. DOE/EIA-0383(92). U.S. Department of Energy, Washington, D.C.

Geller, H.S. 1987. "Energy and Economic Savings from National Appliance Efficiency Standards." American Council for an Energy-Efficient Economy, Washington, D.C.

Geller, H.S. and P.M. Miller. 1988. "1988 Lighting Ballast Efficiency Standards: Analysis of Electricity and Economic Savings." American Council for an Energy-Efficient Economy, Washington, D.C.

Geller, H., S. Nadel, M. Hopkins, and B. Howard. 1992. "Energy Savings Estimates from the Energy Efficiency Provisions in the Senate and House Energy Bills", American Council for an Energy-Efficient Economy, Washington, D.C.

Knight, D.E. 1990. "Amorphous Metal Distribution Transformers - A Cost Effective Conservation Opportunity." Allied-Signal Inc., Parsippany, NJ.

L'Ecuyer, M., G. Fernstrom, D. Goldstein, S. Nadel, and H. Sachs 1992. "Stalking the Golden Carrot: Accelerating the Introduction of Super-Efficient, CFC-Free Refrigerators Through a Utility Consortium Approach". *Proceedings of the 1992 ACEEE Summer Study on Energy Efficiency in Buildings*. American Council for an Energy-Efficient Economy, Washington, D.C.

McMahon, J. et al. 1990. "Impacts of U.S. Appliance Energy Performance Standards on Consumers, Manufacturers, Electric Utilities, and the Environment." *Proceedings from the ACEEE 1990 Summer Study on Energy Efficiency in Buildings*. Vol. 7, pp. 7.107-7.116. American Council for an Energy-Efficient Economy, Washington, D.C.

Maddaus, W.O. 1987. "The Effectiveness of Residential Water Conservation Measures." *Journal AWWA*, March, pp. 52-58.

Moskovitz, D., S. Nadel and H. Geller. 1991. "Increasing the Efficiency of Electricity Production and Use: Barriers and Strategies". American Council for an Energy-Efficient Economy, Washington, D.C. Table 10.

Nadel, S. and H. Geller. 1991. "Efficiency Standards for Lamps, Motors, Commercial HVAC Equipment and Showerheads: Recommendations for State Action". American Council for an Energy-Efficient Economy, Washington, D.C.

Nadel, S., H. Geller, F. Davis and D, Goldstein. 1989. *Lamp Efficiency Standards for Massachusetts: Analysis and Recommendations*. American Council for an Energy-Efficient Economy, Washington, D.C.

Nadel, S., M. Shepard, S. Greenberg, G. Katz and A. de Almeida. 1991. *Energy-Efficient Motors Systems*. American Council for an Energy-Efficiency Economy. Washington, D.C.

Norford, L., A. Hatcher, J. Harris, J. Roturier, and O. Yu. 1990. "Electricity Use in Information Technologies," *Annual Review of Energy 15:423-453.*

Ranton, J. 1991. "Water Efficient Plumbing Fixture Legislation, A Poll of States with Legislation Adopted". City of Portland Bureau of Water Works, Portland, OR.

Tecogen. 1986, *Commercial Appliance Energy Use Update*. Gas Research Institute, Chicago, IL.

Vickers, A. 1989. "Potential Water Savings and Related Benefits from Proposed National Water Use Efficiency Standards for Plumbing Fixtures." Paper presented at the 1989 American Water Works Association Annual Conference and Exposition, Los Angeles, CA.