Energy-Saving States of America: How Every State Benefits from National Appliance Standards

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Abstract

National product standards apply to many of the most common devices that consume energy and water, assuring consumers and businesses that their purchases will meet a minimum level of efficiency performance. This white paper provides up-to-date estimates of the benefits of national efficiency standards for consumers and businesses in each state and for the United States as a whole.

The average American family saved nearly $500 on utility bills in 2015 due to efficiency standards for appliances, lighting, and plumbing products. Average household savings, by state, ranged from 11% to 27% of total consumer utility bills, with a national average of 16%. Businesses also saved. Total business utility bill savings from standards reached nearly $23 billion in 2015. Business energy bill savings equaled 8% of total business spending on electricity and natural gas. Many standards also save water: national water savings in 2015 reached 1.5 trillion gallons, enough to meet the needs of all the households in Texas, Oklahoma, Arizona, and Colorado combined.

Savings will continue to grow in the years ahead as more products in use meet current standards and additional updated standards take effect. Overall, accounting for products sold between 1987 and 2035 and for estimated product price increases, total net present value savings from national standards are $2.4 trillion for US consumers and businesses. Consumer benefits outweigh costs by at least 5 to 1.

Even as products have become more energy and water efficient to meet more rigorous standards, they have also gotten better. A consumer shopping for a new refrigerator or clothes washer, for example, has more choices of features and configurations than ever before. After purchasing the latest high-quality LED lightbulbs, a consumer may rarely change a lightbulb again—the new ones last 10 to 25 times longer than the energy-wasting bulbs they replace yet light up just as well and use 85% less energy.

Introduction

Many of the most common products that use energy and water in Americans' homes and businesses must be manufactured to meet national minimum efficiency performance standards. Products covered by national standards range from household refrigerators, water heaters, and air conditioners to large commercial-building air conditioners and boilers to industrial motors.[1]

This white paper provides up-to-date information on the consumer and business benefits achieved by all existing national standards, updating previous estimates by the Appliance Standards Awareness Project (ASAP) and the American Council for an Energy-Efficient Economy (ACEEE). Standards protect consumers by cutting energy and water waste in the products they use, which lowers their energy and water bills. Consumer and business savings add up to large benefits in each and every state, boosting local economies by putting money in consumers' and business owners' pockets. Energy savings reduce the need to site and pay for new power generation facilities, transmission lines, and pipelines, thereby helping to moderate energy prices, which further benefits all consumers and businesses. Less energy waste leads to less pollution, helping us meet clean air standards and protect public health, and less water waste eases pressure on overburdened water supplies.

Appendix A includes background on national standards and describes the processes by which new and updated standards are developed.

Consumer Savings Add Up

The savings from existing standards add up for individual households in every state. Average annual 2015 utility bill savings ranged from $360 in Washington State to almost $950 in Hawaii. These savings equaled 11% to 27% of total 2015 household utility bill spending. Existing standards saved the average US household approximately $500 on utility bills in 2015. Average household savings equaled 16% of total household utility bills.

Figure 1 shows average household bill savings in 2015 for all states. Total bill savings consist of electricity, gas and oil, and water and wastewater bill savings. As shown in the figure, electricity accounted for most of the bill savings, followed by water and wastewater and then gas and oil. The top 10 states for per-household bill savings are numbered according to their rank.

[1] Complete lists of products covered by existing standards and details on each can be found at energy.gov/eere/buildings/standards-and-test-procedures and www.appliance-standards.org/products. National minimum standards should not be confused with the ENERGY STAR® label. National standards apply to all products sold in the United States, whereas ENERGY STAR is a voluntary label used for distinguishing products that are among the top efficiency performers in the market.

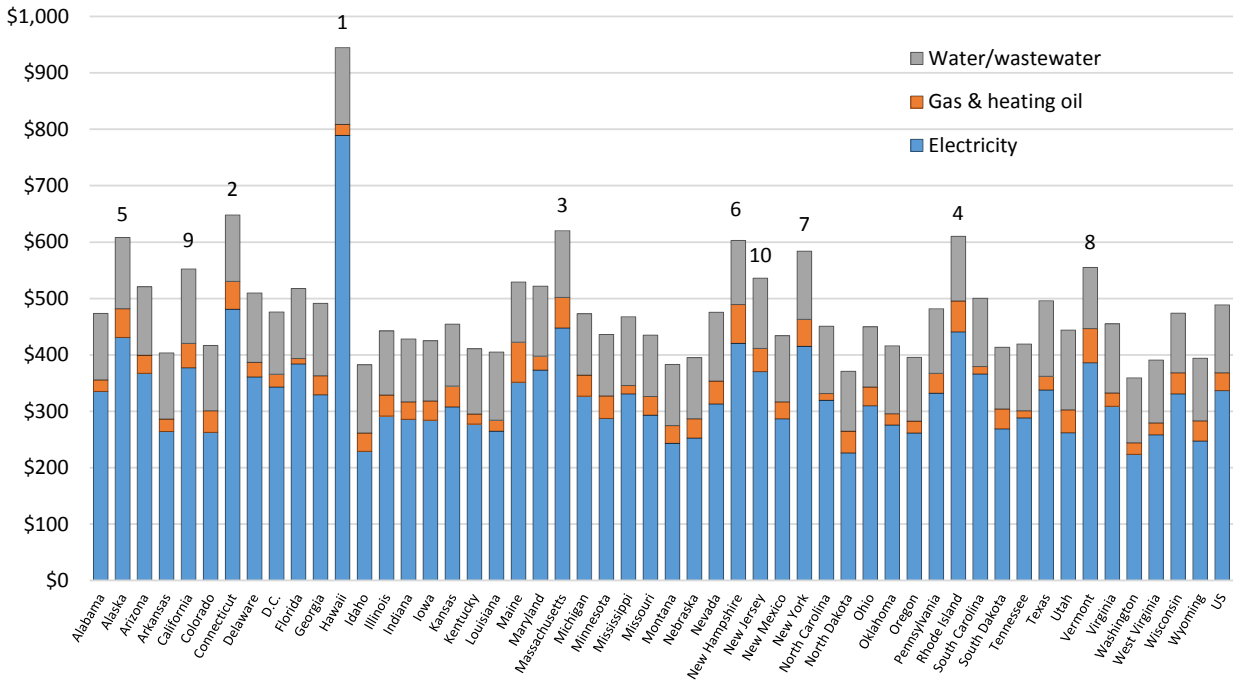

Figure 1. 2015 average household utility bill savings by state

Average annual savings for households will continue to grow as additional standards completed within the past few years take effect and more and more products in use in homes meet the latest standards. In 2030, annual per-household average savings will grow to a range of about $560 to $1,600, with a national average of about $840.

Savings varied by state according to factors such as the types of appliances consumers tend to purchase (e.g., electric versus gas water heaters), how much cooling and heating they use, and household size. Energy prices were the most important factors determining the states with the highest per-household utility bill savings. Consumers in these states tend to save the most because they tend to pay the most for energy. But savings were significant in every state, especially when considered as a percentage of average consumer utility bills. Table C1 in Appendix C gives details on per-household bill savings in every state plus the District of Columbia.

Most standards save electricity. Per-household electricity savings in 2015 ranged from 2,165 kilowatt-hours (kWh) per year in Colorado to a high of about 3,300 kWh in Florida. Figure 2 groups states based on average household electricity savings to show how the savings vary. The top 10 states are numbered by rank. Among all the states, average household electricity savings equaled 15% to 32% of 2015 average household usage.[2] For all US consumers, 2015 average household electricity savings reached about 2,560 kWh, or 21% of household electricity usage.

[2] Not including Hawaii.

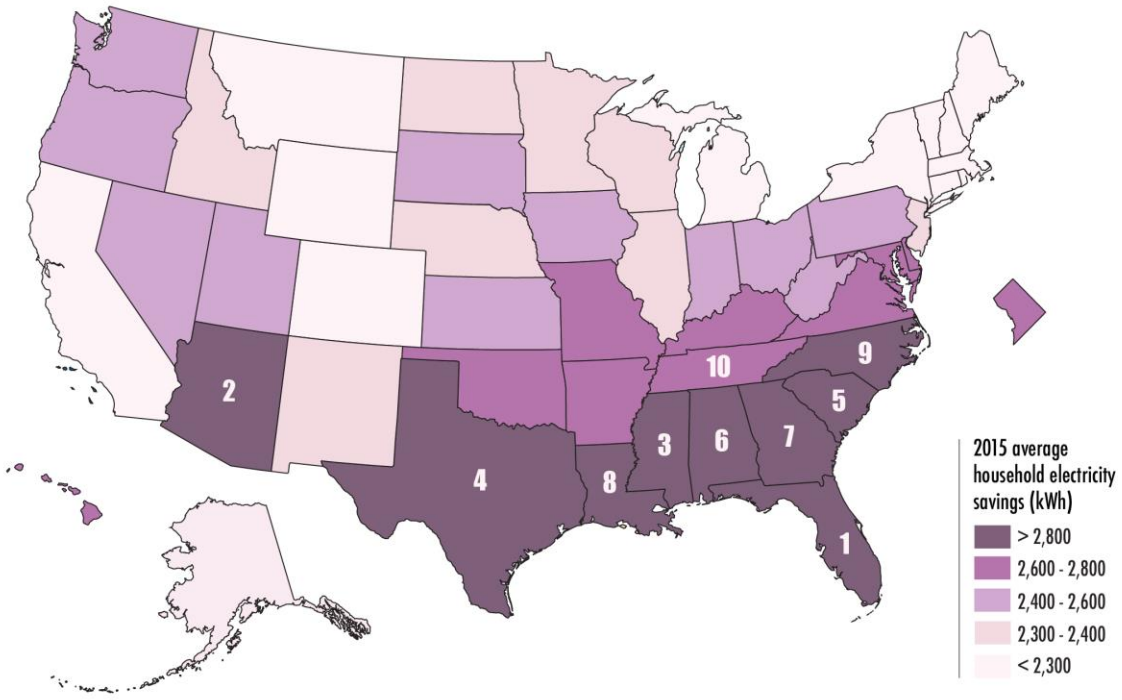

Figure 2. 2015 average household electricity savings by state

The states with the largest per-household electricity savings were the southeastern states plus Texas and Arizona. Consumers in these states have higher electricity usage from air-conditioning and also are more likely to have electric heat pumps and electric water heaters. Because they have more electric appliances and they need more air-conditioning, they save more electricity due to improved standards than do consumers in other states.

Among all the states, household gas and heating oil savings varied from 4% to 15% of 2015 household gas and oil use, with a US average of 6%, or about 3.0 MMBtus.[3] Gas and heating oil savings varied more by state than electricity and overall bill savings since in states where consumers need more heating, they are also more likely to have natural gas or oil heat. They are also more likely to have gas water heaters. Figure 3 groups states based on average household gas and heating oil savings to show how the savings vary. The top 10 states are numbered by rank. Alaska, New Jersey, Illinois, North Dakota, and Colorado had the highest savings.

[3] Not including Hawaii.

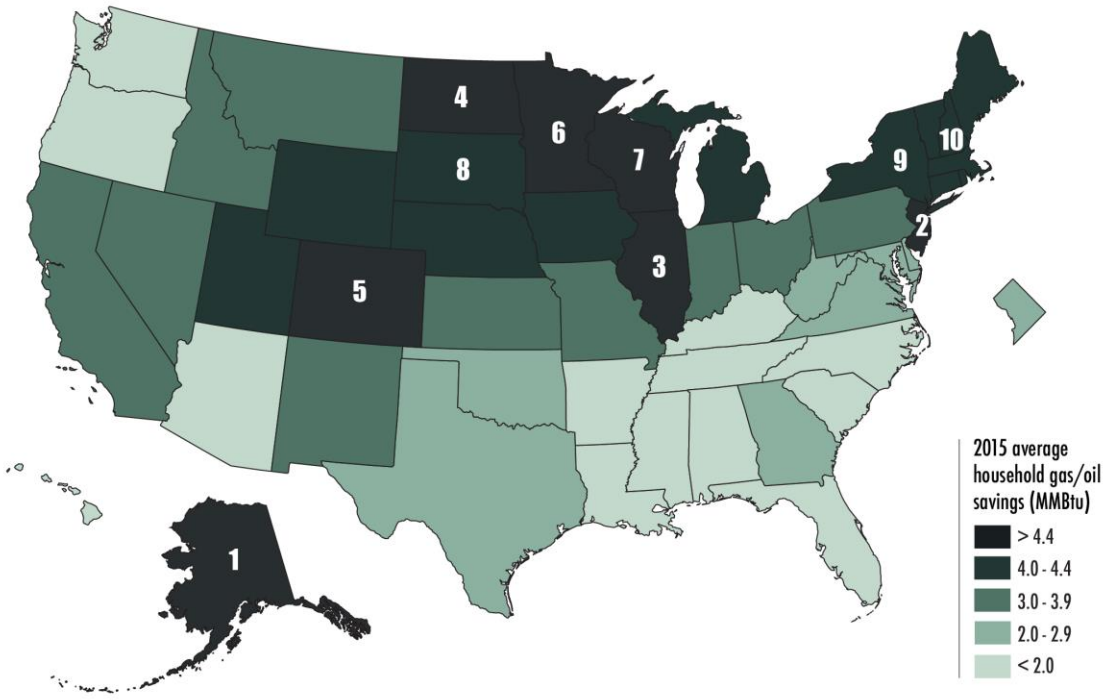

Figure 3. 2015 average household gas and heating oil savings by state

As shown in figure 4, per-household water savings in 2015 ranged from about 10,500 gallons per year in Maine to 14,500 gallons in Utah, with the highest savings in states with the largest average household sizes. Among all the states, household water savings varied from 7% to 23% of 2015 household water use. US average household savings were 14%, or about 12,000 gallons per year.

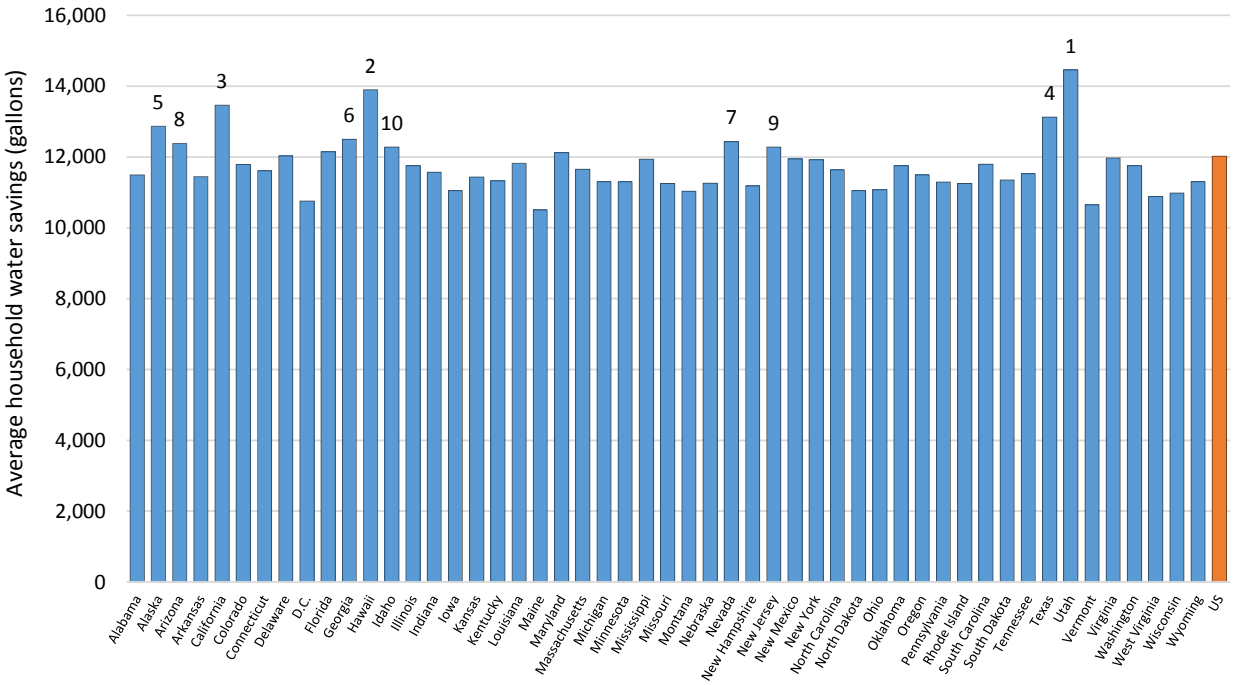

Figure 4. 2015 average household water savings by state

Table 1 shows state-by-state per-household electricity, gas and heating oil, and water savings for 2015.

Table 1. 2015 average household electricity, gas and heating oil, and water savings

	2015 average household savings			2015 average household savings as % of 2015 household usage		
	Electricity (kWh)	Gas and heating oil (MMBtu)	Water (gallons)	Electricity	Gas and heating oil	Water
Alabama	2,864	1.5	11,497	17%	7%	16%
Alaska	2,173	5.5	12,868	27%	6%	13%
Arizona	3,029	1.9	12,379	22%	12%	8%
Arkansas	2,691	1.9	11,445	17%	5%	11%
California	2,221	3.9	13,461	32%	11%	11%
Colorado	2,165	4.8	11,788	24%	7%	11%
Connecticut	2,297	4.1	11,611	24%	5%	16%
Delaware	2,691	2.1	12,025	19%	4%	15%
District of Columbia	2,641	2.0	10,754	29%	4%	10%
Florida	3,315	0.5	12,144	20%	15%	14%
Georgia	2,856	2.4	12,498	18%	7%	15%
Hawaii	2,666	0.5	13,896	45%	28%	8%
Idaho	2,306	3.9	12,281	17%	8%	7%
Illinois	2,332	4.9	11,750	25%	5%	15%
Indiana	2,470	3.6	11,571	19%	6%	16%
Iowa	2,443	4.2	11,050	22%	6%	18%
Kansas	2,492	3.7	11,436	21%	6%	16%

	2015 average household savings			2015 average household savings as % of 2015 household usage		
	Electricity (kWh)	Gas and heating oil (MMBtu)	Water (gallons)	Electricity	Gas and heating oil	Water
Kentucky	2,708	1.7	11,327	18%	5%	18%
Louisiana	2,836	1.8	11,822	16%	8%	11%
Maine	2,251	4.4	10,508	27%	6%	22%
Maryland	2,701	2.1	12,125	21%	4%	12%
Massachusetts	2,258	4.3	11,654	29%	5%	19%
Michigan	2,266	4.4	11,298	26%	5%	15%
Minnesota	2,372	4.7	11,299	23%	6%	19%
Mississippi	2,937	1.5	11,934	17%	5%	12%
Missouri	2,615	3.0	11,252	18%	6%	14%
Montana	2,236	3.9	11,035	19%	5%	11%
Nebraska	2,381	4.0	11,258	18%	7%	13%
Nevada	2,454	3.5	12,435	20%	9%	9%
New Hampshire	2,272	4.4	11,186	26%	6%	17%
New Jersey	2,344	5.1	12,283	26%	6%	15%
New Mexico	2,300	3.6	11,942	26%	7%	13%
New York	2,240	4.4	11,921	32%	5%	15%
North Carolina	2,831	1.1	11,633	18%	5%	17%
North Dakota	2,354	4.8	11,048	15%	9%	15%
Ohio	2,423	3.6	11,077	22%	5%	18%
Oklahoma	2,721	2.0	11,754	18%	4%	14%
Oregon	2,451	1.8	11,491	21%	7%	11%
Pennsylvania	2,435	3.3	11,291	22%	4%	20%
Rhode Island	2,287	4.0	11,251	30%	4%	17%
South Carolina	2,915	1.0	11,797	18%	6%	12%
South Dakota	2,425	4.4	11,348	18%	8%	13%
Tennessee	2,798	1.4	11,525	17%	4%	15%
Texas	2,920	2.4	13,131	18%	9%	13%
Utah	2,407	4.3	14,457	24%	6%	7%
Vermont	2,260	4.3	10,647	28%	6%	19%
Virginia	2,714	2.1	11,970	18%	6%	16%
Washington	2,460	1.8	11,750	19%	6%	11%
West Virginia	2,563	2.1	10,886	17%	5%	15%
Wisconsin	2,346	4.5	10,978	25%	7%	23%
Wyoming	2,254	4.0	11,299	19%	5%	8%
United States	**2,562**	**3.0**	**12,022**	**21%**	**6%**	**14%**

Businesses Also Save Big

National product efficiency standards also protect business owners against energy and water waste. In 2015, businesses saved a total of nearly $23 billion on utility bills. Business energy bill savings equaled 8% of total business spending on electricity and natural gas. Business utility bill savings by state varied primarily according to state size: at the low end, businesses in Vermont saved $47 million, and at the high end, those in California saved $2.9

billion in 2015. Figure 5 shows consumer and business utility bill savings and total bill savings for each state for 2015. Data for each state are detailed in table C2 in Appendix C.

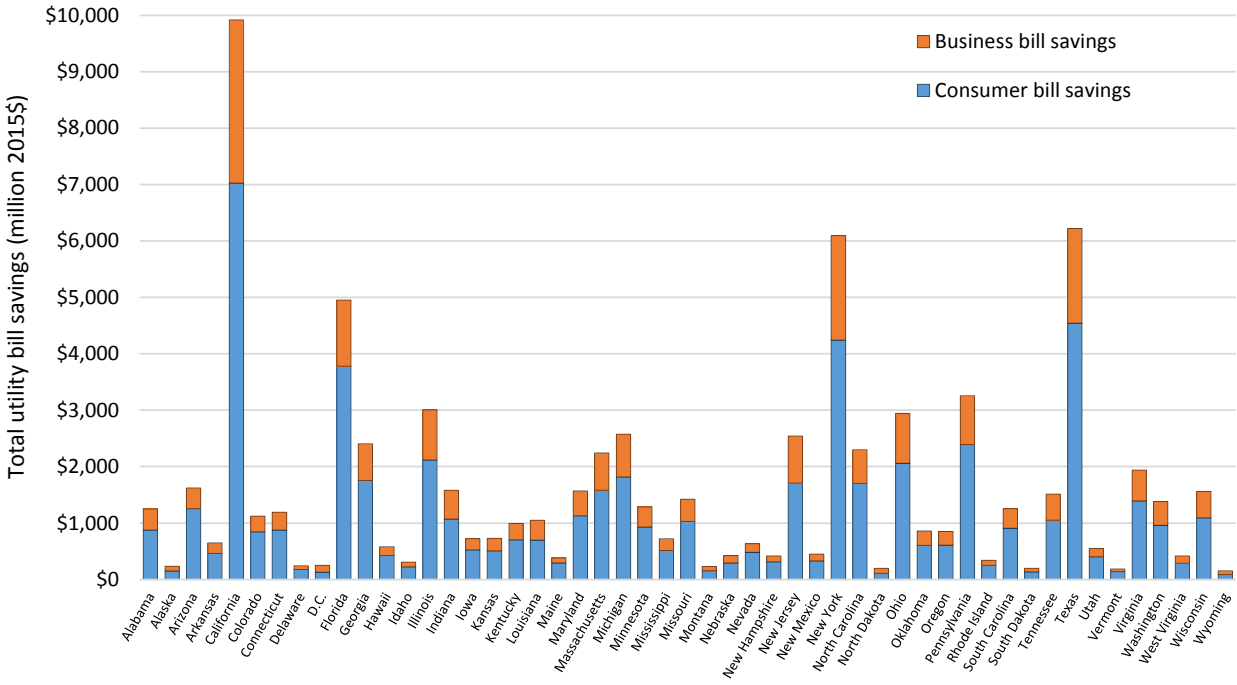

Figure 5. 2015 utility bill savings by state

These savings accrue to both small and large businesses. Small businesses like convenience stores and restaurants benefit from standards that have dramatically boosted efficiency for products such as commercial refrigerators, walk-in coolers, and lighting. Standards for commercial air conditioners and office lighting products have cut bills for office building occupants and owners. National standards for electric motors save energy in motor-driven equipment, which accounts for almost 70% of industrial electricity consumption (Scheihing et al. 1998).

Statewide and National Benefits

Appliance standards are clearly among the most effective policies for saving energy and reducing utility bills. As shown in figure 5, total annual utility bills in the states were millions to billions of dollars lower in 2015 because of existing standards. These statewide savings will grow as more standards take effect and more products meet the latest standards. Total national utility bill savings reached $80 billion in 2015 and will grow to nearly $150 billion by 2030.

The economic value of existing standards can also be expressed on a cumulative basis, counting both costs and benefits. Accounting for products sold between 1987 and 2035 and for estimated product price increases, total net present value savings from national

standards are $2.4 trillion for US consumers and businesses, or roughly enough to purchase about 70 million new cars.[4]

The utility bill savings from standards easily outweigh estimates of the cost to make products more efficient to meet standards. Benefits outweigh estimated costs by 5 to 1 using cost estimates made at the time the standards were established. In practice, actual product price increases may be considerably lower than those estimates due to economies of scale and innovation that tend to enable manufacturers to meet new standards more cost effectively than anticipated (Taylor, Spurlock, and Yang 2015). An analysis of nine product standards that took effect between 1998 and 2010 found that actual costs turned out to be only 10% of what DOE had estimated, on average (Nadel and deLaski, 2013). Although more recent DOE estimates may have done a better job of projecting product price impacts, it is reasonably likely that the benefits of existing standards will outweigh costs by even more than 5 to 1.

Not surprisingly, statewide savings are greatest in the states with the largest populations. Net present value benefits from existing standards are $287 billion in California, $208 billion in New York, $199 billion in Texas, and $154 billion in Florida. But even in states with small populations, the savings add up to billions of dollars. Savings for Wyoming consumers and businesses total $4.3 billion, and Vermonters, South Dakotans, and North Dakotans each save $5.5 billion on a net present value basis. Net present value savings for each state are shown in figure 6, and table C2 shows both net present values and annual bill savings.

[4] Based on an average new car price of $34,663 per Kelley Blue Book for October 2016.

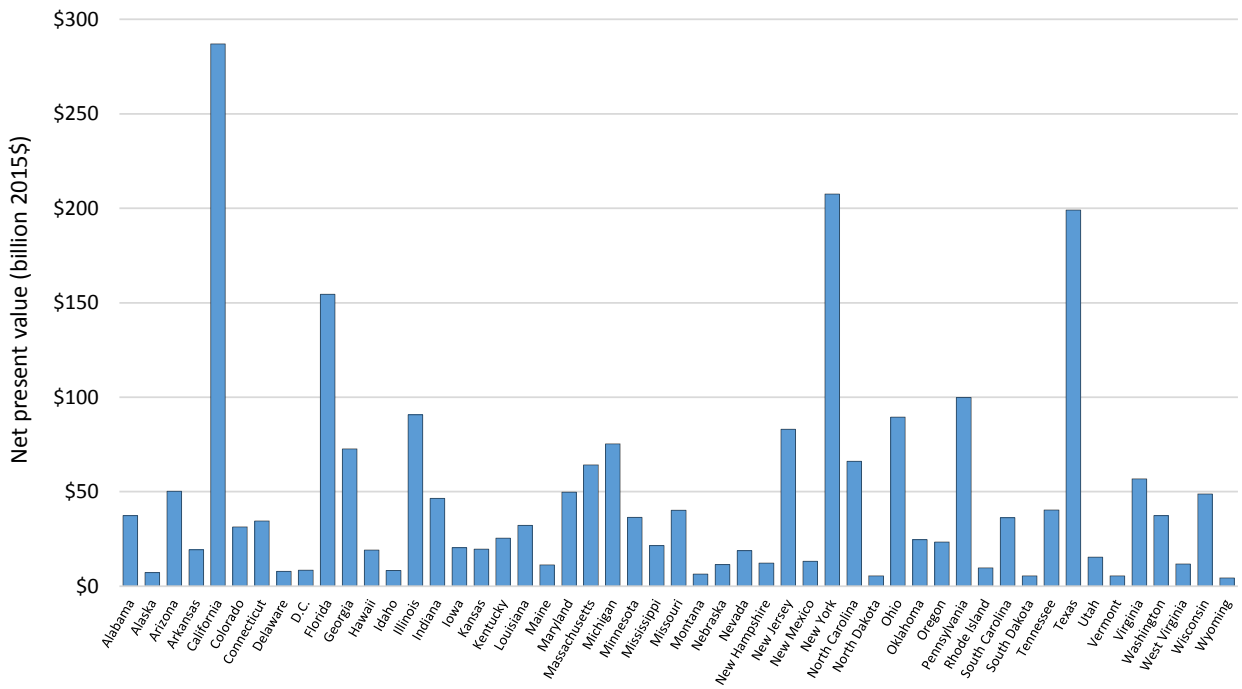

Figure 6. Net present value savings of sales through 2035 by state

An examination of savings as a portion of total consumption provides a useful way to put the savings into perspective and show state-level energy system and water conservation benefits. For example, state electricity savings in 2015 equaled 7% to 18% of 2015 total state electricity sales, and average savings for the nation was 13%. Figure 7 shows this electricity savings figure for all the states. Gas and heating oil savings ranged from 1% to 9% of total statewide end-use consumption in 2015, with a national average of 4% savings. Among the states, water savings in 2015 equaled 5% to 17% of total water supplied from public sources; the national average was 9%.

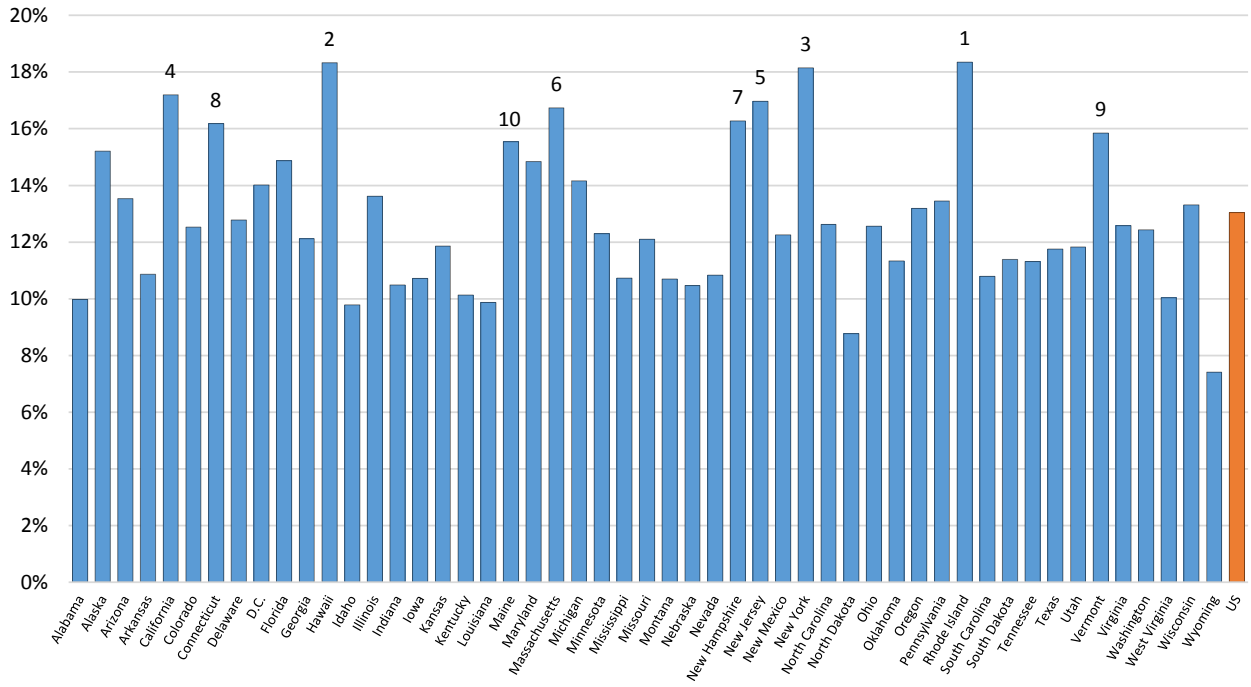

Figure 7. 2015 state electricity savings as a percentage of 2015 state electricity sales

Total electricity savings can also be compared with electricity used by households as a way to put the savings into perspective. For example, total electricity savings in Indiana in 2015 were enough to meet the electricity needs of 850,000 typical Indiana households; electricity savings in Colorado were enough to serve more than 750,000 Colorado households. Table C4 in Appendix C shows equivalent comparisons for every state.

Nationally, total electricity savings in the residential, commercial, and industrial sectors reached 490 billion kWh in 2015, or about enough to meet the electricity needs of more than 40 million average American households—nearly one out of every three. Savings will grow to nearly 890 billion kWh in 2030. The 2015 national electricity savings were equal to the power generated by about 200 large power plants and will increase to the amount generated by 370 power plants in 2030.[5]

Total gas and heating oil savings reached more than 700 TBtu in 2015 and will grow to nearly 930 TBtu in 2030. Gas and heating oil savings in 2015 were enough to heat every gas- and oil-heated home in New York and Illinois for a year. Total annual water savings in 2015 reached 1.5 trillion gallons, or enough to meet the needs of all the households in Texas, Oklahoma, Arizona, and Colorado combined. Annual water savings will grow to 1.7 trillion gallons in 2030.

[5] Assuming a 500 megawatt power plant that operates at the average capacity factor of US coal and gas plants (55%).

Table C3 shows statewide electricity, gas and heating oil, and water savings in 2015 and 2030 for each of the states.

Product Impacts

Appliance standards save consumers and businesses money by eliminating inefficient products in the market and encouraging manufacturers to develop and bring to market products with improved efficiency performance. Typically, when a new standard takes effect, manufacturers strive to surpass the standard so they can feature high efficiency in "premium" products and have merchandise that qualifies for ENERGY STAR® or other programs that recognize and promote efficient performance.

Appliances, lighting, and equipment that meet today's standards do so without sacrificing performance or features. Refrigerators provide the best-known example of how standards have reduced energy consumption, at the same time as prices have come down and more features have become available to consumers. As shown in figure 8, a typical new refrigerator uses just 25% as much electricity as one sold in the 1970s, yet new refrigerators are larger and have more features, such as automatic defrost and ice-making. Refrigerators sold today are also cheaper in real dollar terms: an average refrigerator in 2010 cost only half as much as in the mid-1970s. A series of improved efficiency standards, first at the state level and, after 1987, at the national level, drove this tremendous efficiency improvement. Other products ranging from clothes washers to commercial rooftop air conditioners have also seen large efficiency gains as standards have taken effect, while product performance has stayed the same or improved, manufacturers have offered new features, and in many cases prices have remained stable or declined (Mauer et al. 2013; Taylor, Spurlock, and Yang 2015).

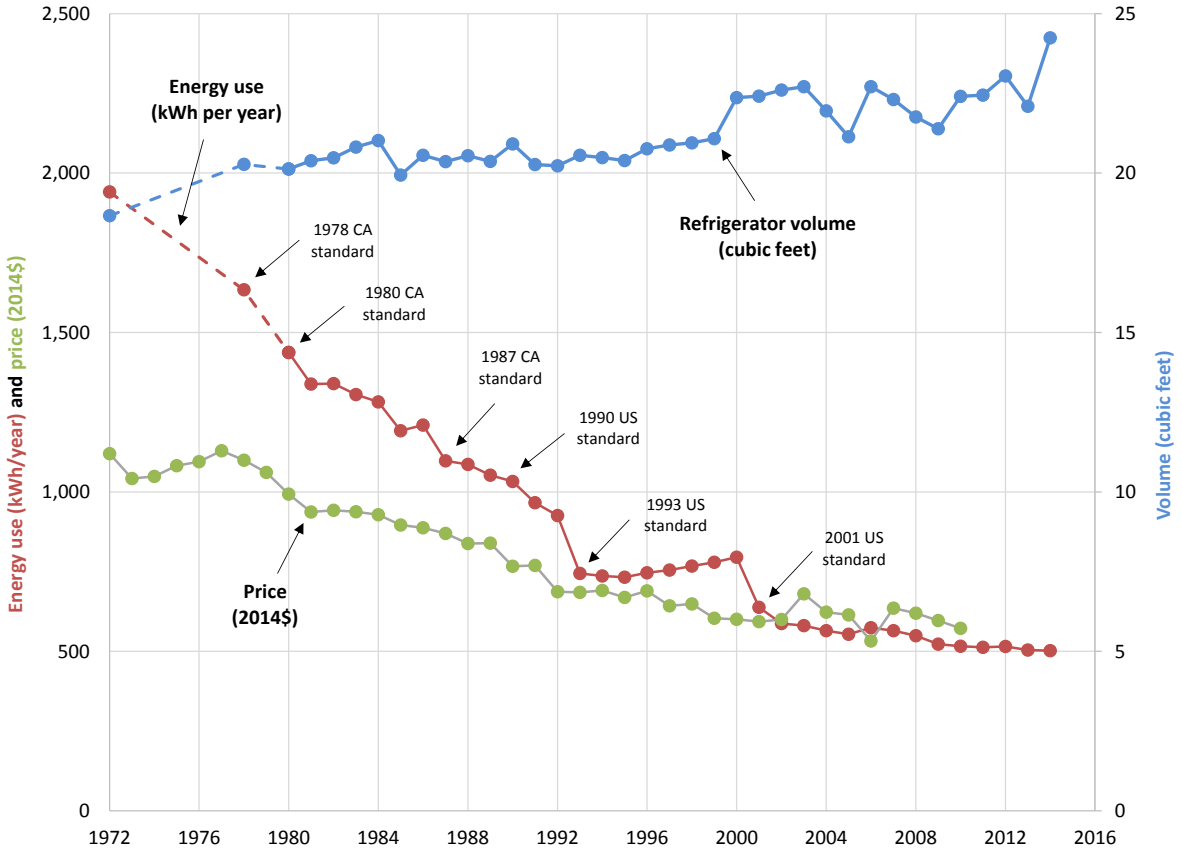

Figure 8. Average household refrigerator energy use, volume, and price over time. Data include standard-size and compact refrigerators. Energy consumption and volume data reflect the current DOE test procedure. Volume is adjusted volume, which is equal to fresh food volume + 1.76 times freezer volume. Prices represent the manufacturer selling price (i.e., excluding retailer markups) and reflect products manufactured in the United States. *Sources:* Association of Home Appliance Manufacturers (AHAM); US Census Bureau.

Lightbulbs provide another prominent example. Old incandescent light bulbs, an ingenious invention nearly 140 years ago, wasted (as heat) 95% of the electricity they used. In response to standards enacted in 2007, manufacturers developed a new generation of incandescent lightbulbs using halogen technology that cut energy use by 25–30%. Now, in anticipation of stronger standards enacted as part of the 2007 law and slated to take effect in 2020, another round of innovation has thrust LED lightbulbs into a market leadership position. LEDs, which cost $20 just a few years ago, now sell for as little as $2 per bulb and will save a consumer $50–150 over the life of the product. New, high-quality LED lightbulbs not only light up like old-style bulbs while using 85% less energy, but also last up to 25 times as long. Some even change color at the user's command. The latest market data show that LED lightbulbs now account for about one-third of all lightbulb sales (NEMA 2017). These examples show how products subject to standards have gotten better even as, or in some cases because, standards have been strengthened.

Energy System and Public Health Benefits

The energy savings from standards play an important role in meeting every state's overall energy needs: without the current standards reining in demand levels, significant additional

and costly pipelines, power plants, transmission lines, and other hard-to-site infrastructure would be needed. Lower demand for energy helps reduce upward pressure on energy prices, which benefits all consumers and businesses. For example, the Northwest Power and Conservation Council, an interstate agency charged by Congress to ensure an economical and reliable power system across four Northwest states, estimates that federal efficiency standards adopted since 2008 will reduce the annual growth in electricity demand by nearly 25%.[6]

Saving electricity also reduces emissions of pollutants—such as mercury, nitrogen oxides, sulfur dioxide, and carbon dioxide—resulting from fossil fuel combustion. These emissions threaten air and water quality, public health, and the climate. Moreover, fossil fuel and nuclear power plants use large amounts of water for cooling; saving energy reduces water withdrawals for power production and power plant discharges of heated water into rivers, lakes, and coastal waters.

Potential for Future Standards

Even with the enormous savings to date, much more can be accomplished. In a 2016 report, ASAP and ACEEE showed that the potential national savings from updates to existing appliance efficiency standards that are feasible by 2024 could save another 335 billion kWh and reduce consumer and business utility bills by another $65 billion per year by 2050 (deLaski et al. 2016). These potential additional savings would represent a 70–80% increase in the savings achieved in 2015. Additional water savings could reach 850 billion gallons per year, or about a 50% increase over 2015 water savings. The potential for future standards to save consumers and businesses money shows that standards remain an essential element of a successful and low-cost energy strategy for consumers, businesses, the states, and the nation.

[6] From the Northwest Power and Conservation Council's Seventh Power Plan: "Taken together, the Council forecasts that improvements in federal and state appliance standards reduce forecasted power loads by around 1,300 average megawatts by 2035 . . . an approximately 5% reduction in total regional consumption" (NWPCC 2016).

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Appendix A. How Are Standards Developed?

Most national standards started out in the states. Beginning in the 1970s, individual states established minimum standards to help meet state energy needs and protect consumers by eliminating wasteful products from the market. In 1987, President Ronald Reagan signed into law the original 13 national appliance standards covering everyday household appliances. Expanded in laws signed by George H.W. Bush in 1992 and George W. Bush in 2005 and 2007, national standards now cover more than 50 categories of products used in homes, businesses, and industry.

These national standards generally preempt the state-level standards that preceded them, providing a consistent national set of efficiency rules. Manufacturers and national retailers strongly prefer national regulation to a patchwork of state standards. In exchange for preemption of state authority, the federal laws require the US Department of Energy (DOE) to keep standards up-to-date as technological innovations advance efficiency. Originally, Congress set the review schedule for each product individually, but the most recent major amendments to the law, enacted in 2007, created a consistent process for all products. DOE must review each standard every six years to determine if an update is warranted, and if so, a revised standard is due two years later.

DOE reviews standards and develops new and revised efficiency requirements using a public regulatory process. This process, which typically takes three years or longer, includes in-depth analysis by technical consultants and multiple rounds of input from manufacturers, efficiency proponents, utility companies, state government representatives, and the general public. In recent years, DOE has made increased use of formalized negotiated rulemakings for some of the more difficult rulemaking dockets. This approach has been very successful, usually but not always yielding a consensus recommendation for the new standard levels. The law requires that new standards achieve the maximum level of energy and/or water efficiency that is technologically feasible and economically justified, as determined by the secretary of energy. To be economically justified, the benefits of a standard must exceed its burdens, taking into account, among other things, the economic impacts on manufacturers and the people who buy and use the affected products, as well as any impacts on product performance and competition. Standards that would degrade consumer utility (e.g., cause product performance to deteriorate significantly or result in the loss of important features) are not permitted. In a review, DOE can decide to leave a standard unchanged. Four recent regulatory processes have concluded with that result, including a fall 2016 decision to leave the dishwasher standard unchanged.

States continue to play a major role in standards development. In fall 2016, California completed the first-ever standards for computers and displays. States have also begun to set standards for plumbing products once again. Federal preemption of state plumbing product standards expired in 2010 because national standards were not updated.[7] Since then, several

[7] This legal provision causing preemption to expire if DOE fails to update standards currently applies only to certain plumbing products.

states, including Texas and Georgia, have established their own plumbing product standards that save more than the federal minimums.

Appendix B. Methodology

For this paper, we derived national savings estimates for standards in NAECA 1987 and 1988, EPAct 1992, and DOE rulemakings through 1997 based on Geller and Goldstein (1999). For plumbing products (faucets, showerheads, and toilets), we relied on estimates from Koomey, Dunham, and Lutz (1994). Finally, we used previous ACEEE/ASAP analyses and information from DOE rulemakings to estimate savings from standards in EPAct 2005 and EISA 2007 and DOE rulemakings from 1998 through 2016.

Our general methodology for estimating savings and costs was based on sales of the affected products. We used estimates of annual shipments, average product lifetimes, per-unit energy and/or water savings, per-unit incremental costs, and the portion of sales already meeting the standard level. To simplify the analysis, we assumed that both annual shipments and the portion of sales that would have met the standard level without the standard remain constant over time. In reality, both shipments and base case efficiency tend to increase over time. Thus, we implicitly assumed that these two factors cancel each other out. We calculated net present value as the difference between the present value of savings and the present value of costs. We discounted future costs and savings to 2016 using a real discount rate of 5%, and we inflated past costs and savings to 2016 using a real interest rate of 5%.

We calculated state-by-state energy and water savings and incremental costs by allocating national product sales to each state and, where appropriate, making state-by-state adjustments to per-unit savings. We assumed that the portion of sales already meeting the standard level is the same in all states due to a lack of data on state-level base case efficiency. For products used in multiple sectors (e.g., linear fluorescent lamps and ballasts, electric motors), we first allocated total sales to the various sectors based on information from DOE rulemakings. We then allocated sales in each sector to each of the states.

For residential products for which product saturation does not vary significantly by region (e.g., refrigerators, lightbulbs, microwave ovens), we used the number of households in each state to allocate product sales. For residential products for which saturation does vary significantly by state/region (e.g., central air conditioners, electric and gas water heaters, boilers, dehumidifiers), we used data on equipment saturation from the Residential Energy Consumption Survey (RECS) 2009 to allocate sales (EIA 2011).[8] For residential heating and cooling products, we adjusted per-unit energy savings for each state based on average heating degree days and cooling degree days from NOAA and average heated or cooled square footage from RECS 2009 (NOAA 2017; EIA 2011). For products that save hot water (faucets, showerheads, clothes washers, and dishwashers), we made adjustments to per-unit savings based on the prevalence of electric and gas/oil water heaters in each state, based on

[8] The RECS regional data (for HI, AK, OR, and WA) does not represent the breakdown of space and water heating fuels in Alaska and Hawaii. Therefore for Alaska we used EIA data on the number of households using gas and oil for space heating and an end-use study to allocate sales of space and water heating equipment (EIA 2017c; AEA 2012). For Hawaii, we used data on water heater fuel type in that state to allocate electric and gas/oil water heater sales (R. Brown, energy engineer, Hawaii Energy, pers. comm., February 2, 2017). We also assumed no gas or oil space heating in Hawaii.

RECS 2009 (EIA 2011). Finally, for products for which per-household consumption is correlated with household size (faucets, showerheads, toilets, water heaters, clothes washers, clothes dryers, and dishwashers), we made adjustments to per-unit savings based on average household size.

For products used in the commercial sector for heating, cooling, refrigeration, lighting, and computing (uninterruptable power supplies), we allocated commercial sector sales to each state based on regional energy consumption by end use from the Commercial Buildings Energy Consumption Survey (CBECS) 2012 and state-by-state commercial electricity and natural gas use from EIA. We first allocated product sales to the nine US Census divisions based on end-use consumption, and then allocated regional sales to individual states based on commercial electricity use (for cooling, refrigeration, lighting, and computing products) or commercial natural gas use (for heating products) (EIA 2015; EIA 2016g; EIA 2016d). For products used in the commercial sector for which energy use is more closely correlated with population (e.g., commercial clothes washers, traffic signals), we allocated sales based on population. For the portion of motors, pumps, and compressors used in the commercial sector, we allocated sales based on commercial electricity use, and for distribution transformers we allocated sales based on total electricity use. Finally, for the portion of motors, pumps, compressors, and fluorescent lamps and ballasts used in the industrial sector, we allocated sales based on industrial electricity use.

We calculated energy bill savings using state-by-state historical electricity and natural gas prices for the residential, commercial, and industrial sectors through 2015 (EIA 2016c; EIA 2016e). We used price projections from EIA's 2016 *Annual Energy Outlook* to calculate future prices relative to 2015 prices (EIA 2016a). For both historical and future water and wastewater prices, we used regional prices derived from AWWA/Raftelis and water price trends (DOE 2016).

For comparisons of 2015 household savings with 2015 household energy and water consumption, we calculated current household consumption by dividing state-level residential energy and water consumption by the number of households in each state. For state-level residential electricity, natural gas, and heating oil consumption we used data from EIA (2016g; 2016d; 2016b), and for state-level residential water consumption we used data from USGS (Maupin et al. 2014). For state-level residential propane/LPG consumption we used data from RECS 2009 with a few adjustments (EIA 2011). For states for which RECS data are reported as regional data, we allocated regional propane/LPG consumption to individual states in the region based on the portion of propane/LPG used for space heating, the number of households using propane/LPG for space heating, and average heating degree days (EIA 2011; EIA 2017c; NOAA 2017). We also took into account changes in the number of households using propane/LPG for space heating and heating degree days between 2009 and 2015 (EIA 2017b; NOAA 2017). We calculated 2015 average household utility bills by multiplying average household electricity, natural gas, propane, fuel oil, and

water consumption by respective state-level average prices (EIA 2016c; EIA 2016e; EIA 2017a; DOE 2016).[9]

For comparisons of 2015 state-level savings with 2015 statewide energy and water consumption, we used data on state-level electricity sales, gas and oil end-use consumption, and public water supply (EIA 2016g; EIA 2016d; EIA 2016f; Maupin et al. 2014). Finally, to compare 2015 business energy bill savings with 2015 business energy bills, we calculated business energy bills by multiplying 2015 commercial and industrial electricity and natural gas consumption by respective prices (EIA 2016g; EIA 2016d; EIA 2016c; EIA 2016e).

[9] For propane and fuel oil we used the average of weekly prices for 2015. For states for which propane and/or heating oil prices were not available, we used US average prices.

Appendix C. Data Tables

The tables below show the data discussed in this white paper for all 50 states and the District of Columbia and for the United States as a whole.

Table C1. Average household savings and household savings as a percentage of household utility bills

	Average household utility bill savings (2015$)		2015 average household utility bill savings as % of 2015 utility bills
	2015	2030	
Alabama	474	867	15%
Alaska	608	950	17%
Arizona	521	1,000	15%
Arkansas	403	712	13%
California	552	833	20%
Colorado	417	641	14%
Connecticut	648	987	16%
Delaware	510	965	15%
District of Columbia	476	905	16%
Florida	518	987	18%
Georgia	491	887	15%
Hawaii	945	1,599	27%
Idaho	382	591	11%
Illinois	442	776	17%
Indiana	428	757	15%
Iowa	425	664	17%
Kansas	455	706	16%
Kentucky	411	647	15%
Louisiana	405	723	13%
Maine	529	813	17%
Maryland	522	991	15%
Massachusetts	620	947	17%
Michigan	473	778	17%
Minnesota	436	678	17%
Mississippi	468	838	14%
Missouri	435	735	14%
Montana	383	593	12%
Nebraska	395	616	14%
Nevada	476	807	14%
New Hampshire	603	924	17%
New Jersey	536	991	17%
New Mexico	434	735	17%
New York	584	1,091	18%
North Carolina	451	781	16%
North Dakota	371	572	13%
Ohio	450	798	16%
Oklahoma	416	702	14%
Oregon	395	617	15%
Pennsylvania	482	876	15%
Rhode Island	610	930	16%
South Carolina	500	879	15%
South Dakota	414	643	14%
Tennessee	419	651	15%
Texas	496	938	16%
Utah	444	690	12%
Vermont	555	849	16%
Virginia	455	800	15%

	Average household utility bill savings (2015$)		2015 average household utility bill savings as % of 2015 utility bills
	2015	2030	
Washington	360	556	14%
West Virginia	391	695	14%
Wisconsin	474	870	20%
Wyoming	394	610	11%
United States	**489**	**843**	**16%**

Table C2. Total consumer and business economic savings

	Annual utility bill savings in 2015 (million 2015$)			Annual utility bill savings in 2030 (million 2015$)			Net present value savings of sales through 2035 (billion 2015$)
	Consumer	Business	Total	Consumer	Business	Total	
Alabama	876	374	1,249	1,602	834	2,436	37.3
Alaska	153	84	236	238	167	405	7.2
Arizona	1,257	365	1,622	2,413	787	3,200	50.2
Arkansas	459	193	652	810	440	1,250	19.2
California	7,025	2,896	9,921	10,589	5,373	15,961	287.0
Colorado	843	280	1,123	1,298	552	1,851	31.4
Connecticut	877	318	1,195	1,335	577	1,912	34.5
Delaware	175	68	244	332	157	489	7.8
District of Columbia	130	121	251	247	288	535	8.4
Florida	3,780	1,176	4,955	7,202	2,636	9,838	154.4
Georgia	1,756	653	2,409	3,172	1,465	4,637	72.6
Hawaii	426	158	583	720	316	1,037	19.2
Idaho	225	84	309	348	166	514	8.3
Illinois	2,117	893	3,010	3,714	1,853	5,568	90.7
Indiana	1,072	510	1,582	1,895	1,094	2,989	46.4
Iowa	525	197	722	821	380	1,201	20.4
Kansas	506	223	729	787	416	1,203	19.7
Kentucky	702	292	994	1,105	561	1,666	25.4
Louisiana	700	353	1,053	1,249	815	2,065	32.2
Maine	293	91	384	450	163	613	11.3
Maryland	1,131	443	1,574	2,147	1,034	3,181	49.7
Massachusetts	1,582	662	2,244	2,415	1,196	3,610	64.2
Michigan	1,816	760	2,575	2,990	1,528	4,518	75.4
Minnesota	927	359	1,286	1,441	688	2,129	36.4
Mississippi	513	214	727	919	468	1,387	21.5
Missouri	1,028	395	1,423	1,738	816	2,554	40.1
Montana	157	71	228	243	142	384	6.4
Nebraska	291	135	426	454	260	714	11.4
Nevada	484	152	635	820	305	1,125	18.9
New Hampshire	314	108	422	481	195	676	12.2
New Jersey	1,710	835	2,545	3,160	1,820	4,979	83.0
New Mexico	331	121	452	562	260	822	13.2
New York	4,243	1,853	6,096	7,922	4,041	11,963	207.6
North Carolina	1,702	599	2,300	2,947	1,282	4,229	66.1
North Dakota	111	86	197	171	166	338	5.5
Ohio	2,062	880	2,941	3,661	1,885	5,546	89.5
Oklahoma	606	255	860	1,022	544	1,566	24.6
Oregon	606	247	853	946	487	1,434	23.4
Pennsylvania	2,390	869	3,259	4,344	1,767	6,111	99.8
Rhode Island	251	92	342	382	165	547	9.7
South Carolina	908	347	1,255	1,595	750	2,345	36.3

	Annual utility bill savings in 2015 (million 2015$)			Annual utility bill savings in 2030 (million 2015$)			Net present value savings of sales through 2035 (billion 2015$)
	Consumer	Business	Total	Consumer	Business	Total	
South Dakota	137	60	197	213	114	327	5.5
Tennessee	1,050	466	1,516	1,632	888	2,520	40.3
Texas	4,541	1,678	6,219	8,578	3,994	12,572	199.1
Utah	403	148	551	625	291	916	15.3
Vermont	143	47	190	218	86	304	5.5
Virginia	1,394	547	1,941	2,450	1,169	3,618	56.8
Washington	960	420	1,380	1,485	830	2,315	37.3
West Virginia	290	128	417	515	283	797	11.7
Wisconsin	1,090	473	1,563	1,999	1,066	3,065	48.9
Wyoming	89	69	159	138	136	274	4.3
United States	**57,154**	**22,844**	**79,999**	**98,540**	**47,693**	**146,233**	**2,403**

Table C3. Statewide electricity, gas and heating oil, and water savings

	Annual savings in 2015			Annual savings in 2030		
	Electricity (billion kWh)	Gas & heating oil (TBtu)	Water (billion gallons)	Electricity (billion kWh)	Gas & heating oil (TBtu)	Water (billion gallons)
Alabama	8.9	5.8	22.8	16.6	7.3	25.5
Alaska	0.9	3.2	3.5	1.6	4.1	3.9
Arizona	10.5	8.5	32.0	20.1	10.9	35.9
Arkansas	5.1	6.0	14.0	9.3	7.8	15.6
California	44.9	78.2	183.4	78.2	101.2	205.6
Colorado	6.8	15.4	25.6	11.6	20.2	28.7
Connecticut	4.8	10.9	16.8	8.2	15.4	18.9
Delaware	1.5	1.8	4.4	2.7	2.4	5.0
District of Columbia	1.6	2.0	3.2	3.0	2.7	3.5
Florida	35.1	12.0	95.0	67.3	15.5	106.5
Georgia	16.5	14.4	47.9	31.2	18.0	53.7
Hawaii	1.7	0.6	6.7	3.0	0.8	7.5
Idaho	2.3	4.1	7.8	4.0	5.0	8.7
Illinois	18.9	51.0	60.3	33.5	67.1	67.5
Indiana	11.0	19.3	31.0	19.7	24.7	34.8
Iowa	5.1	10.0	14.6	9.0	12.9	16.4
Kansas	4.7	7.4	13.6	8.5	9.3	15.3
Kentucky	7.7	6.7	20.7	14.3	8.5	23.2
Louisiana	9.0	6.0	21.9	16.9	7.7	24.5
Maine	1.8	3.6	6.2	3.1	5.2	7.0
Maryland	9.2	11.1	28.1	17.1	14.7	31.6
Massachusetts	9.1	21.7	31.8	15.7	30.7	35.7
Michigan	14.5	38.4	46.5	25.4	49.7	52.1
Minnesota	8.2	19.1	25.7	14.4	24.6	28.8
Mississippi	5.2	3.9	14.0	9.8	5.0	15.7
Missouri	9.9	13.4	28.5	17.6	16.8	32.0
Montana	1.5	3.5	4.8	2.7	4.4	5.4
Nebraska	3.1	5.9	8.9	5.5	7.4	10.0
Nevada	3.9	6.7	13.5	7.0	8.6	15.2
New Hampshire	1.8	3.4	6.2	3.1	4.9	7.0
New Jersey	12.8	32.0	42.0	22.7	44.3	47.1
New Mexico	2.8	5.3	9.8	5.0	6.7	10.9
New York	27.0	62.6	92.8	46.4	87.2	104.0
North Carolina	16.9	10.1	47.1	31.5	12.8	52.8

	Annual savings in 2015			Annual savings in 2030		
	Electricity (billion kWh)	Gas & heating oil (TBtu)	Water (billion gallons)	Electricity (billion kWh)	Gas & heating oil (TBtu)	Water (billion gallons)
North Dakota	1.6	2.7	3.5	2.9	3.4	4.0
Ohio	18.7	38.1	54.4	33.4	48.8	61.0
Oklahoma	7.0	6.5	18.3	12.9	8.3	20.5
Oregon	6.2	5.8	18.9	10.9	7.3	21.2
Pennsylvania	19.7	31.8	60.0	34.8	42.4	67.2
Rhode Island	1.4	2.9	5.0	2.4	4.1	5.5
South Carolina	8.8	4.5	22.9	16.5	5.8	25.7
South Dakota	1.4	2.5	4.0	2.4	3.2	4.5
Tennessee	11.3	9.2	30.9	20.7	11.6	34.7
Texas	46.1	38.5	128.7	86.3	49.2	144.3
Utah	3.6	7.5	14.0	6.3	9.5	15.7
Vermont	0.9	1.8	2.9	1.5	2.6	3.3
Virginia	14.1	13.3	39.3	26.9	17.1	44.1
Washington	11.2	10.7	33.6	19.7	13.5	37.7
West Virginia	3.2	3.6	8.6	6.0	4.8	9.7
Wisconsin	9.1	22.1	27.0	16.1	28.4	30.3
Wyoming	1.3	2.1	2.7	2.3	2.7	3.1
United States	**490**	**707**	**1,506**	**888**	**928**	**1,688**

Table C4. Comparison of savings with total consumption

	2015 electricity savings as % of 2015 electricity sales	2015 gas & heating oil savings as % of 2015 end-use consumption	2015 water savings as % of 2015 public supply	2015 household electricity use equivalence (# of households)
Alabama	10%	2%	7%	510,000
Alaska	15%	7%	11%	120,000
Arizona	14%	9%	6%	760,000
Arkansas	11%	3%	8%	310,000
California	17%	5%	7%	6,390,000
Colorado	13%	6%	7%	750,000
Connecticut	16%	6%	10%	500,000
Delaware	13%	3%	14%	100,000
District of Columbia	14%	6%	n/a	170,000
Florida	15%	6%	10%	2,080,000
Georgia	12%	4%	10%	1,040,000
Hawaii	18%	7%	6%	300,000
Idaho	10%	5%	8%	170,000
Illinois	14%	5%	10%	2,020,000
Indiana	10%	3%	12%	850,000
Iowa	11%	3%	9%	450,000
Kansas	12%	3%	9%	400,000
Kentucky	10%	3%	9%	500,000
Louisiana	10%	1%	7%	500,000
Maine	16%	4%	17%	220,000
Maryland	15%	6%	9%	730,000
Massachusetts	17%	6%	12%	1,160,000
Michigan	14%	5%	11%	1,670,000
Minnesota	12%	5%	12%	800,000
Mississippi	11%	2%	9%	310,000
Missouri	12%	5%	9%	690,000

	2015 electricity savings as % of 2015 electricity sales	2015 gas & heating oil savings as % of 2015 end-use consumption	2015 water savings as % of 2015 public supply	2015 household electricity use equivalence (# of households)
Montana	11%	5%	9%	130,000
Nebraska	10%	4%	7%	240,000
Nevada	11%	7%	6%	320,000
New Hampshire	16%	5%	17%	210,000
New Jersey	17%	6%	10%	1,400,000
New Mexico	12%	6%	9%	330,000
New York	18%	6%	10%	3,850,000
North Carolina	13%	4%	12%	1,100,000
North Dakota	9%	4%	12%	100,000
Ohio	13%	5%	10%	1,670,000
Oklahoma	11%	2%	7%	450,000
Oregon	13%	5%	9%	520,000
Pennsylvania	13%	4%	11%	1,790,000
Rhode Island	18%	5%	12%	180,000
South Carolina	11%	3%	9%	530,000
South Dakota	11%	3%	8%	100,000
Tennessee	11%	4%	8%	680,000
Texas	12%	2%	8%	2,900,000
Utah	12%	5%	5%	350,000
Vermont	16%	5%	17%	110,000
Virginia	13%	5%	14%	940,000
Washington	12%	5%	9%	880,000
West Virginia	10%	5%	12%	210,000
Wisconsin	13%	6%	14%	990,000
Wyoming	7%	3%	7%	110,000
United States	**13%**	**4%**	**9%**	**40,810,000**