SAVING ENERGY COST-EFFECTIVELY: A NATIONAL REVIEW OF THE COST OF ENERGY SAVED THROUGH UTILITY-SECTOR ENERGY EFFICIENCY PROGRAMS

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ABSTRACT

Energy efficiency is widely perceived to be cost-effective, and is frequently portrayed as the lowest-cost utility resource available. Many U.S. states are currently establishing aggressive energy efficiency goals that are likely to require significant increases in funding. The success of these programs relies in part on the assurance that programs are indeed being run cost-effectively.

In 2004, the American Council for an Energy-Efficient Economy (ACEEE) reviewed the cost-effectiveness results from nine leading states. On the reported costs of "saving" kilowatt-hours (kWh) through utility ratepayer-funded energy efficiency programs, the reported utility costs of saved energy (CSE) ranged from $0.023 to $0.044 per kWh (with a median value of 3 cents/kWh).

This report updates and expands that assessment, and finds that the energy efficiency programs from recent years in 14 states have utility CSEs ranging from $0.016 to $0.033 per kWh, with an average cost of $0.025 per kWh. The six natural gas efficiency programs covered in this report also saved energy cost-effectively — spending $0.27 to $0.55 per therm, with an average of $0.37 per therm.

At these costs of saved energy, energy efficiency is by far the least costly energy resource option available for utility resource portfolios. Saving a kilowatt-hour through energy efficiency improvements is easily one-third or less the cost of any new source of electricity supply, whether conventional fossil fuel or renewable energy source. In addition, the results of this research suggest that the cost of energy efficiency has remained very consistent over time.

Beyond these core results, we also observe that states and utilities have developed a range of energy efficiency program designs and evaluation techniques. Using more standardized reporting methods could provide many advantages, including making it easier to compare states and programs. We recommend greater consistency in reporting both costs and energy savings and encourage energy efficiency programs to coordinate their reporting strategies to achieve this goal.

In summary, this study has documented that states continue to find their utility-sector energy efficiency programs to be extremely cost-effective, with an average CSE across 14 states of $0.025 per kWh. Given these strong results, and in view of the many other environmental and job creation benefits, we are not surprised to see government organizations, regulators, and utilities supporting the creation and expansion of energy efficiency programs, and increasingly viewing energy efficiency as their "first fuel" of choice.

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GLOSSARY

Benefit/cost ratio: the total benefits of a program divided by its total costs. Program evaluators use differing methods to calculate these costs and benefits. (See Total Resource Cost test, Societal Cost test, and Utility Cost test.)

British thermal unit (Btu): the amount of energy required to raise the temperature of one pound of water by one degree Fahrenheit.

Cost of saved energy (CSE): Utilities use this cost to compare energy efficiency with other energy sources. The cost may be given in various units, including $/kWh, $/therm, or $/MWh. One version of the levelized cost equation for CSE is:

Cost of Saved Energy (in $/kWh) = (C x 10^6) x (Capital Recovery Factor)/(D x 10^3)

Capital Recovery Factor = [A*(1+A)^(B)]/[(1+A)^(B)-1]

Where:

A = Discount rate

B = Estimated measure life in years

C = Total program cost in millions of dollars

D = Total MWh saved that year by the energy efficiency program

Decatherm (Dkt): 10 therms or 1,000,000 Btu's

Environmental disclosure program (New York): a program that provides retail electric consumers with information regarding the generating fuel mix and air emission characteristics of the energy consumed in New York State (source: NYSERDA).

Externalities: An externality is an effect of a purchase or use decision by one set of parties on others who did not have a choice and whose interests were not taken into account (source: About.com Economics Glossary).

Gross savings: Energy savings that result directly from program-promoted actions (e.g., a home energy retrofit) taken by program participants.

Kilowatt-hour (kWh): basic unit of electrical energy; amount of energy consumed by 1 Watt for 1 hour (3,412 Btu)

Levelized cost: The level of payment necessary each year to recover the total investment and interest payments (at a specified interest rate) over the life of a measure

MWh: 1,000 kWh

Net savings: The portion of gross savings that is attributable to the program, subtracting the savings that is a result of other influences, such as customer self-motivation (e.g., spillover and free riders).

NYSERDA: New York State Energy Research and Development Authority

RD&D: research, development, and deployment

System benefits charge (SBC): A charge on a consumer's bill from an electric distribution company to pay for the costs of certain public benefit programs such as low-income bill assistance and energy efficiency programs (source: Electric Choice New Hampshire)

Supply-side resources: fuels used by utilities (including both fossil fuels and renewable energy)

Therm: 100,000 Btu

Total Resource Cost (TRC) test: A benefit-cost test that includes both the participants' and the utility's costs. The benefits for the TRC are avoided energy supply costs. Avoided credit and collection costs should also be included, as they are system costs. The costs in this test are the program costs (including equipment costs) paid by both the utility and the participants plus the increase in supply costs for any period in which load has been increased. Sometimes includes externalities: see Societal Cost test (source: Utility Deregulation Glossary).

Societal Cost test: The benefit-cost test that evaluates programs from a broad societal perspective. It is identical to the Total Resource Cost test except that the benefits include beneficial externalities and the costs can include negative externalities. Benefits can include avoiding environmental or social externalities (e.g., reduced pollutant emissions) and "non-price" benefits enjoyed by participants (improved comfort, aesthetic qualities, etc.). (For a definition of "externalities," see above.) (source: Utility Deregulation Glossary).

Utility Cost or Program Administrators Cost (PAC) test: A benefit-cost test that measures the net costs of a program based on the costs incurred by the utility (including incentive costs) and excluding any net costs incurred by the participant. The benefits for the Utility Cost test are the avoided supply costs of energy and demand. Avoided credit and collection costs should also be included, as they are system costs. The costs for the Utility Cost test are the program costs incurred by the utility, the incentives paid to the customer, and any increased supply costs (source: Utility Deregulation Glossary).

BACKGROUND

Historically, energy efficiency has been an under-tapped resource in the United States. Research has demonstrated consistently that energy efficiency is cost-effective (Cowart 2001; Kushler, York & Witte 2004; Kushler, York & Witte 2009; National Action Plan for Energy Efficiency 2006. However, the overall use of energy efficiency programs has remained relatively small compared to its potential for growth.

Funding for utility-sector[1] energy efficiency programs has generally been concentrated in a fraction of states — and, during the mid- to late 1990s, funding for programs suffered significant reductions in conjunction with electric utility industry restructuring and deregulation. While funding for energy efficiency has rebounded from the low point that it reached during industry restructuring, many states still lack well-funded, comprehensive energy efficiency programs (York & Kushler 2005; Eldridge et al. 2008).[2] This is particularly true for natural gas efficiency programs.

The number of states lacking programs is shrinking, however. ACEEE has observed recently that there are numerous additional states that are now either offering such programs or about to do so — states that either have never really had programs in place or have not had programs in place for many years. Recently, concerns about fuel price volatility, the expanding costs of power plant construction, shrinking reserve margins, financial challenges faced by large electric generation construction projects, and the threats posed by global warming have led to new interest in energy efficiency (Kushler, York & Witte 2009). These factors have led to numerous states establishing specific, aggressive energy savings goals for their energy efficiency programs that, in most cases, will require significant increases in funding.[3]

The success of energy efficiency programs relies in part on the assurance that programs are being run cost-effectively, hinging on robust program evaluation, measurement, and verification (EM&V). This process aims to assess the performance and implementation of programs to document and measure their effects, determine whether goals are being met, help program designers and implementers understand ways to improve current programs, and ensure that programs are cost-effective and remain so over time.

In 2004, ACEEE estimated the cost-effectiveness of utility sector energy efficiency programs using data from nine states. The energy efficiency programs in that sample were very cost-effective. Estimated benefit/cost (B/C) ratios ranged from 1.0 to 4.3. Estimates of the utility cost of saved energy, or levelized cost, ranged from $0.023 to $0.044 per kWh, with a median value of $0.03 per kWh (Kushler, York & Witte 2004).

To update the 2004 review, ACEEE gathered data on energy efficiency program costs from 14 states — California, Connecticut, Iowa, Massachusetts, Minnesota, Nevada, New Mexico, New

[1] By "utility-sector" energy efficiency programs, we mean utility customer programs funded through utility rates (whether embedded in rates or as a separate tariff rider or demand-side management [DSM] surcharge) or associated "public benefits charges" and administered by utilities, government agencies, or third parties.
[2] By "well-funded, comprehensive" energy efficiency programs, we mean programs intended to directly facilitate and achieve the actual implementation of energy efficiency measures. Utilities that only provide simple "customer service" information, such as do-it-yourself online audits or brochures with "conservation tips," would not be categorized as having "well-funded, comprehensive" energy efficiency programs.
[3] Indeed, recent growth in energy efficiency program funding has been robust. The Consortium for Energy Efficiency (CEE) reported funding of $3,740 million in 2008 — an impressive change since its 2006 report, which reported $2,648 million. (These totals include load management and natural gas programs.) (CEE 2008)

Jersey, New York, Oregon, Rhode Island, Texas, Vermont, and Wisconsin. The results confirm that energy efficiency is an affordable resource well within the reach of states that are concerned about the rising costs of energy. We have added to our previous data by reviewing recent annual reports from 14 states and adding cost information on natural gas energy efficiency programs from seven states.

METHODOLOGY

We reviewed data on energy efficiency program costs from program annual reports, evaluation reports, and information compiled by individual contacts from programs in 14 states to mine information on the cost-effectiveness of electricity and natural gas programs. There are several different reporting mechanisms used by states and program administrators to present costs and savings data for efficiency programs and several different methods of evaluating energy efficiency program cost-effectiveness. For overviews of these topics, see the National Action Plan for Energy Efficiency's primers on program evaluation and cost-effectiveness (National Action Plan for Energy Efficiency 2007, 2008).

Cost of Saved Energy or Levelized Costs

When available, we report the cost of saved energy data as reported by programs, since program evaluators have access to detailed information about the lifetimes, costs, and savings of individual measures. However, program-reported CSE results were often not given in annual reports or evaluations, and in a few instances the methods taken to estimate CSE differed from the standard approach. For example, a couple of program reports show a CSE, but did not discount costs over the lifetime of the efficiency measures. In these cases, we calculated estimates of the costs of saved energy using the appropriate, available data. We used the same "levelized" cost or CSE equation that utilities typically employ to compare energy efficiency with supply-side resources, as shown below.

Cost of Saved Energy (in $/kWh) = (C x 10^6) x (Capital Recovery Factor)/(D x 10^3)

Capital Recovery Factor = [A*(1+A)^(B)]/[(1+A)^(B)-1]

Where:

A = Discount rate

B = Estimated measure life in years

C = Total program cost in millions of dollars

D = Incremental annual MWh saved that year by the energy efficiency program

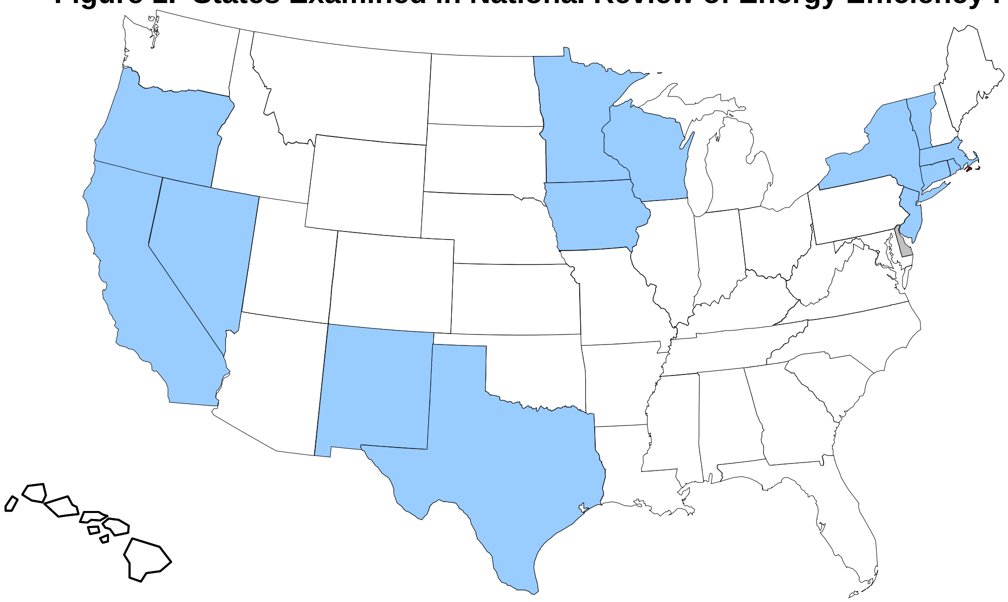
Our analyses use utility costs in this calculation (i.e., the "Utility Cost test" or "Program Administrators Cost test") for two primary reasons. First, the Utility Cost test is more comparable to the way utilities assess other supply resources than other tests are. Second, many states do not report customer costs and/or non-energy benefits in their summary reports, thus making it impractical to try to base these calculations on a Total Resource Cost perspective, which includes both customer and utility program costs.

In the next section, however, we do provide estimates of customer costs for energy efficiency programs where available. While utility system administrators and regulators require an understanding of utility costs for efficiency programs in order to make utility resource decisions, an understanding of the total resource cost for efficiency programs is also useful. Policy development relies on an understanding of the total costs and benefits, both to the customers and utilities, for energy efficiency investments.

We use a 5% real discount rate[4] and an estimated measure life of 10–15 years for electricity programs and 15–20 years for natural gas programs, depending on the average measure life of that program's energy efficiency portfolio in a given year. Most programs reported a portfolio-average measure lifetime or provided data that allowed us to calculate an average lifetime. For programs without an average measure lifetime, however, we use 13 years for electricity and 19 years for natural gas, which are the average measure lifetimes from the 10 program portfolios that provided measure lifetime estimates (see Table A-2).

As shown in Appendix A, we collected annual data for recent years from the 14 states. In Table A-1, we report the average of these annual data. The average and median we report here are calculated using the averages derived for each state. We used this method so that each state's results would have an equal influence on the calculation. We do not adjust the results for variations in state size or population because data quality was uneven and we did not want our summary results to be overly influenced by just a few data points.

Figure 1. States Examined in National Review of Energy Efficiency Program Costs



[4] Real discount rates include the cost of capital but exclude the impact of inflation. When a real discount rate is used, results are expressed in terms of the value of a dollar in a specific year. Our data is most commonly based on 2007 costs and thus these costs of saved energy are in terms of 2007 dollars. We do it this way as most readers think in terms of the present value of a dollar, not some future value. Some analysts prefer to use nominal discount rates that include inflation, with the result that the cost of saved energy is the same in 2007 dollars as in 2020 dollars, since inflation is already accounted for. When nominal discount rates are used, for an average 13-year measure life, and assuming 3% average annual inflation, the cost of saved energy is about 18% higher than the results we report here.

Benefit/Cost Ratios

In addition to CSE values, we also gathered data on benefit/cost ratios from annual reports and program evaluations to compare to results from our 2004 review. There are several types of tests employed by program administrators to evaluate the cost-effectiveness of energy efficiency programs. Here, we only show values as they are reported by program cost-benefit analyses, including Total Resource Cost, Societal Cost, and Utility Cost tests, and state-specific variations on these. Cost-benefit analyses are estimated for the total portfolio of programs, combining electricity and natural gas programs, whereas CSE values are shown separately.

RESULTS: COSTS OF SAVED ENERGY AND BENEFIT-COST RATIOS

In Table 1 and Figure 2 we present results for the cost of saved energy as reported or calculated by ACEEE for electricity programs. We show results for natural gas efficiency programs in Table 2. Finally, we present the results of benefit/cost analyses as reported by efficiency program evaluation documents, noting the type of cost-effectiveness test used.

The average levelized cost of saved energy for electricity efficiency programs is $0.025 per kWh saved, with a range of $0.016–0.033 and a median value of $0.027 (see Table 1). The average cost of natural gas programs, based on the reported data, is $0.34 per therm and the median is $0.32 per therm. Overall, the results show many states are achieving costs of saved energy similar to or lower than the costs they had attained before 2004, when ACEEE found a CSE range of $0.023–0.044 and a median value of $0.030 per kWh saved. This downward trend in cost per kWh over time is similar to other recent meta-reviews of energy efficiency programs (see Takahashi and Nichols 2008).

Variations among CSE values are a result of numerous differences in the characteristics of energy efficiency program portfolios. Although beyond the scope of this report to try to examine the quantitative effects of program characteristics on CSE values, we do offer several regulatory and market-driven trends that may results in the variation. For example, the mix of customer sectors that are included in a program portfolio can affect cost, because residential and low-income program investments typically cost more per unit of energy saved than non-residential programs. Also, the ratio of participant costs to program costs can affect utility cost-effectiveness, since programs that leverage greater customer spending for every dollar of program costs will reap the same energy savings at a lower program cost. There is also much discussion surrounding net versus gross energy savings. Using differing assumptions regarding the calculation of net savings can produce differences in estimates of levelized costs, which can make comparisons between individual states difficult. See the Discussion section for additional differences among states that may result in varying CSE values. Readers should note, however, that the clear trend revealed in this meta-review is an overall cost-effectiveness of efficiency as a resource around the country.

Table 2 reports the cost of saved energy for natural gas, which ranges from 27 to 55 cents per therm, with an average of 37 cents per therm and a median of 32 cents per therm.

Table 1. Average Program Costs of Saved Energy Reported or Calculated by ACEEE for Electricity Efficiency Programs

State	CSE ($/kWh)	Sources and Notes
California	$0.029	Reported: average of figures in 2006 and 2007 Annual Reports for investor-owned utilities (IOUs): SCE, PGE, and SDGE (CPUC 2007a-d)
Connecticut	$0.028	Calculated with data from the Energy Conservation Management Board (ECMB) annual reports on the Connecticut Energy Efficiency Fund (ECMB 2006, 2007, 2008, 2009). Data include limited-income programs. The CSE estimate is the average of program years 2005–2008. Average measure lifetime is 13 years, based on lifetime and annual energy savings estimates from reports.
Iowa	$0.017	Calculated annual estimates for 2001 through 2007-year IOU programs in the state (IUB 2009). This is the average of those, using the program estimate of a 15-year average measure lifetime for energy efficiency measures (IUB 2009).
Massachusetts	$0.031	Average of figures in MA DER (2007) for program years 2003–2005 (reported) and for program years 2006 and 2007 (calculated) with data from MA DER (2009). Low-Income programs are included. Savings are net and average lifetime is about 13 years (MA DER 2007).
Minnesota	$0.021	Calculated annual estimates for 2006- and 2007-year electric utility energy efficiency and conservation programs, assuming the average 13-year measure lifetime because state-specific data was not available (MN DOC 2009).
Nevada	$0.019	Calculated with data for the Nevada Power Company and Sierra Pacific Power Company, the two IOUs in the state that supply 88% of electricity used in the state (Geller & Schlegel 2008). This is the average for 2006–2008 program data, assuming an average 13-year measure lifetime.
New Jersey	$0.026	Calculated with data for NJ Clean Energy Program (NJ BPU 2004–2007; Ambrosio 2009). Includes costs for energy efficiency programs only (including low-income programs), not renewable energy programs. Energy savings are gross. This is the average we calculate for program results from 2003–2006, for which the range is $0.022–0.037 per kWh. The average measure lifetime is 14 years.
New Mexico	$0.033	Calculated with data for PNM, the state's largest electricity provider, for efficiency programs in 2008 (PNM 2009). Average lifetime assumed is 9 years, which is derived from the 2008 annual report, and savings are net.
New York	$0.019	Calculated with data from the 2008 NYSERDA annual report (NYSERDA 2008) for program years 2004, 2005, and 2006. Costs are for electricity efficiency programs, including low-income programs and excluding R&D costs. NYSERDA estimates electricity program costs at 85% of total efficiency costs, with 15% estimated for natural gas. This is the average we calculate for three program years, assuming a portfolio average efficiency measure life of 15 years based on NYSERDA estimates.
Oregon	$0.016	Reported: Average of figures reported in 2005–2008 annual reports by the Energy Trust of Oregon (ETO 2006–2009). Electricity savings are net savings and average lifetime estimate for electricity measures for the program is 12 years.
Rhode Island	$0.030	Calculated with cost and savings data from the *2007 DSM Year-End Report* for National Grid (National Grid 2008a). Average measure lifetime is 11 years, based on lifetime and annual electricity savings estimate from the report.

State	CSE ($/kWh)	Sources and Notes
Texas	$0.017	Calculated with data for 2004–2007 efficiency programs run by IOUs in Texas (PUCT 2008). No estimate of measure lifetime is provided, so we assume a 13-year measure lifetime.
Vermont	$0.027	Calculated with annual costs and net savings data from Efficiency Vermont (EVT) annual reports (2003–2008). The CSE range for annual programs is $0.024–0.032. Assumes 10–15 year measure lifetime based on annual EVT program reporting.
Wisconsin	$0.033	Reported value for efficiency programs from June 2001 through July 2007 (PA Consulting 2007). Electricity savings estimates are net verified savings and average lifetime estimate is 12 years based on program data.
Mean	**$0.025**	Average of reported and calculated CSE state averages.
Median	**$0.027**	Median of reported and calculated CSE state averages.
Range	**$0.016–0.033**	

Note: CSE figures calculated by ACEEE assume a 5% discount rate and an average measure lifetime according to data reported by the programs, ranging from 10 to 15 years. For programs without an estimate of measure lifetime, we assume 13 years, which is the average lifetime from the other program portfolios that provided estimates. Costs include those incurred by utilities or other agencies to run energy efficiency programs, including program incentives and administrative costs, but excluding customer costs. See the next section for a discussion of customer costs for energy efficiency. We report annual costs as reported by programs, not adjusting for inflation, and use state averages to calculate the mean and median values.

Figure 2. Average State Values for Utility Cost of Saved Energy — Electricity Programs

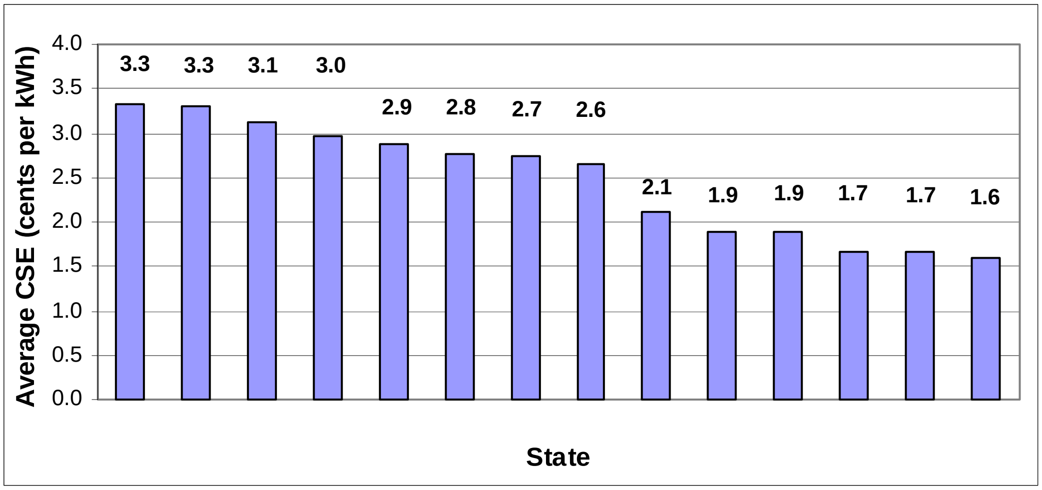


Table 2. Average Program CSE Reported or Calculated for Natural Gas Efficiency Programs

State	CSE ($/therm)	Sources and Notes
California	$0.32	Average of figures reported in 2006 and 2007 Annual Reports for SCG, PGE, and SDGE (CPUC 2007a-d). Individual utilities report values in the range of $0.23–0.52 per therm.
Connecticut	$0.55	Costs and savings data are calculated from the Energy Conservation Management Board's (ECMB) annual report on the Connecticut Energy Efficiency Fund (ECMB 2009). The CSE estimate is for program year 2008 only. Average measure lifetime is 16 years, based on lifetime and annual energy savings estimates from the annual report.
Iowa	$0.27	Calculated with data from the Iowa Utilities Board on energy efficiency programs operated by Iowa's investor-owned utilities. This is the average of annual values calculated for 2001–2007 program years. Average lifetime for the program is estimated to be 19 years.
New Jersey	$0.45	Calculated with data for NJ Clean Energy Program (NJ BPU 2004–2007; Ambrosio 2009). Includes costs for energy efficiency programs only (including low-income programs). This is the average we calculate for program results from 2003–2006, for which the range is $0.36–0.53 per therm. The average measure lifetime is 18 years based on program estimates.
Wisconsin	$0.31	Reported by Focus on Energy Evaluation (PA Consulting 2007) for program years 2001 through 2007. The average measure lifetime is 20 years based on program estimates.
Oregon	$0.34	Average of figures reported in 2005–2008 annual reports by the Energy Trust of Oregon (ETO 2006–2009). Savings are net and average lifetime estimate for natural gas measures is 23 years.
Mean	**$0.37**	Average of reported and calculated CSE figures from each state.
Median	**$0.33**	Median of reported and calculated CSE figures from each state.
Range	**$0.27–0.55**	

Table 3. TRC or Societal Tests Reported for Energy Efficiency Programs

State	Benefit/Cost Ratio	Cost-Effectiveness Test Used	Sources and Notes
California	2.3	TRC	This is the average TRC figure for the portfolio of California natural gas and electricity IOU efficiency programs (PGE, SCE, SDGE, SCG) from 2006, as shown in annual IOU reports. When 2007 data were available (PGE), they were factored into an average. Individual utility results range from 1.9 to 2.7
Iowa	2.2	Societal Test	This is the average of data for the two major IOUs in the state, Alliant and MidAmerican, for electricity and natural gas energy efficiency programs in 2007 and 2008 (IUB 2009). Load management programs are not included. The average B/C ratio for electricity programs only is 2.4 and 1.6 for natural gas programs.
Massachusetts	3.6	TRC	Average of 2003–05 value and 2006–07 value for ratepayer-funded utility electricity programs (MA DER 2007; 2009).
New Jersey	2.9	TRC	TRC result is for the portfolio of electricity and natural gas efficiency programs run by New Jersey Clean Energy from 2003 through 2006 (Rutgers 2008).
New York (NYSERDA)	2.6	TRC[5]	TRC results are cumulative for the **New York Energy $mart[SM]** portfolio of electric energy efficiency programs from 1998 through 2008 programs (NYSERDA 2009).
Oregon	2.4	Societal	TRC estimate is an average of the Energy Trust of Oregon's reported benefit/cost ratios for individual programs from 2005–2008 (ETO 2006–2009)
Wisconsin	2.2	Test by Focus on Energy (Similar to TRC or Societal Test)[6]	Results are for Focus on Energy's energy efficiency programs only, cumulative for programs 2001 through July 2007. Derived from the FY2007 Interim Benefit-Cost Analysis (PA Consulting 2007). Savings are net verified savings.
Average TRC B/C Ratio	**2.6**		

Note: State averages were used to calculate the mean and median values, but not the minimum and maximum values.

[5] NYSERDA uses three different scenario approaches for its TRC test. Scenario 1 includes (a) resource benefits associated with reduced electricity generation and capacity and reduced use of natural gas and water; and (b) capacity market price effects from curtailable load programs. Scenario 2 builds upon Scenario 1 by adding non-energy impacts. Scenario 3 builds upon Scenario 2 by including macroeconomic impacts. Here we report the B/C ratio (2.6) for Scenario 2. Scenarios 1 and 3 yield B/C ratios of 1.8 and 6.0, respectively. See the New York Energy $mart Program's Evaluation and Status Reports for more information: http://www.nyserda.org/Energy_Information/evaluation.asp.

[6] See the Focus on Energy Statewide Evaluation (PA Consulting 2007) for more information.

Table 4. Utility Cost Tests Reported for Energy Efficiency Programs

State	B/C Ratio	Cost-Effectiveness Test Used	Sources and Notes
California	3.4	PAC	PAC result is for the entire portfolio of California IOU programs from 2006 annual reports (and 2007 if available). Individual utility results range from 3.0 to 3.8.
New Jersey	2.9	PAC	PAC result is for the portfolio of electricity and natural gas efficiency programs run by New Jersey Clean Energy from 2003 through 2006 (Rutgers 2008).
New York (NYSERDA)	5.6	PAC	PAC results are cumulative for 1998 through 2008 programs (NYSERDA 2009).
Oregon	4.8	Utility System Benefit-Cost Ratio	Utility estimate is an average of the Energy Trust of Oregon's reported benefit/cost ratios for individual programs from 2005–2008 (ETO 2006–2009)
Rhode Island	3.6	Similar to Utility Cost Test	National Grid (2008b)
Average Utility Cost Test Ratio	**4.0**		

CUSTOMER COSTS FOR ENERGY EFFICIENCY

The results presented above on utility costs of saved energy represent only the costs to utilities or other entities to run energy efficiency programs, including program incentives, planning, delivery, marketing, evaluation, and administration costs. Customers who participate in these programs typically incur additional costs. For some programs, customer costs make up the difference between the incremental cost of energy efficiency measures and any program incentives such as rebates. For other programs, customers incur the entire cost while the program administrator provides other incentives such as technical assistance.

The incremental cost of an efficiency measure is defined as the difference in cost between an efficient product or system and a standard product or system. Incremental costs vary depending on the type of efficiency measures introduced by a program. For example, some programs replace equipment "on burnout." If customers are in the market for new refrigerators because their old ones have reached the end of their lifetimes, then those customers plan to purchase new refrigerators whether or not they are participating in an efficiency program. In this case, if $100 is the "incremental cost" of the more efficient refrigerator compared to a standard or baseline unit, the customers may get $50 rebates from their utility, making each customer's net contribution toward the incremental cost $50. The net customer contribution of $50 is the participant cost as defined by energy efficiency program evaluations. In a retrofit measure, however, the baseline measure to compare to is simply taking no action. For example, for customers adding insulation to their homes, the efficiency measure costs are the full costs of the installation and labor.

Program evaluators must estimate the customer (also called participant) costs for the purposes of the Total Resource Cost test or the Participant Cost test. Our review finds customer cost estimates range from about 25–70% of total (TRC) costs. We estimate that, on average, participants pay 45% of total costs; in other words, the ratio of customer costs to program costs is 0.83:1. Table 5 summarizes these findings. When we account for customer costs in the cost of saved energy calculations for energy efficiency programs, we estimate an average TRC test-based cost of saved energy of $0.046 per kWh.[7] Similarly, natural gas programs have an average TRC cost of saved energy of $0.68 per therm using this ratio of customer costs to program costs.

The method of reporting customer costs varies from state to state and within program portfolios. For example, residential program customer costs are often estimated using a "deemed savings" approach, which uses pre-determined, validated estimates of energy savings for particular efficiency measures. Larger commercial or industrial efficiency program participants, however, often report actual customer costs. The data in Table 5 are therefore a mix of estimated and actual customer costs.

Table 5. Comparison of Customer Costs and Program Costs

Program	Program Years and Notes	Program Costs* (Million $)	% of Total Costs	Customer/ Participant Costs (Million $)	% of Total Costs	Total Costs (Million $)	Ratio of Customer Costs to Program Costs
New York (NYSERDA)	July 2006–Dec. 2008	$251	32%	$552	68%	$774	2.1: 1
Massachusetts (electric utilities)	2003–2005	$372	74%	$132	26%	$504	0.4 : 1
New Jersey (Clean Energy Program — Efficiency)	2006	$81	65%	$44	35%	$125	0.5 : 1
Wisconsin (Focus on Energy)	2001–2007 programs	$202	48%	$217	52%	$419	1.1 : 1
Iowa (Interstate P&L)	2009–2013 Plan	$344	58%	$248	42%	$592	0.7 : 1
Vermont (Efficiency Vermont)	Total for 2002–2008 program years	$121	54%	$103	46%	$224	0.9 : 1
Average			55%		45%		0.83 : 1

*Program costs include incentives, admin/planning/operations, and evaluation.

PROGRAM SPENDING BY SECTOR AND COST TYPE

Opportunities for improving end-use energy efficiency exist across the full range of customer classes, from individual homeowners to large industrial customers. Portfolios of energy efficiency programs generally include programs that provide services and opportunities for all types of customers.

[7] Note that CSE including customer costs is not particularly useful for comparing alternative utility resource investments, because cost estimates for other resource options (e.g., utility purchased power agreements for distributed generation, customer-sited renewable energy, demand response resources, etc.) do not attempt to incorporate customer costs, they merely reflect the contracted cost to the utility for the purchased power. The "utility cost" based CSE is the appropriate metric for that type of utility comparison.

However, the allocation of spending among programs serving different customer classes varies among different program portfolios. In recent research on leading state energy efficiency programs, ACEEE examined how selected states allocate their spending (Kushler, York & Witte 2009). Table 6 presents these results, which demonstrate the relative emphasis placed on different customer sectors. Some states allocate available resources relatively equally between residential and non-residential programs. On the other hand, some states allocate higher percentages of their funding to commercial/industrial programs, while other states allocate more of their funding to the residential sector. Such allocations reflect differences in program objectives and other factors governing decision-making. The data in Table 6 are for electric energy efficiency programs only.

Table 6. Electric Energy Efficiency Spending by Sector

State	Program	Year	Residential Expenditures	Non-Residential Expenditures
Connecticut		2007	29%	71%
Vermont	Efficiency Vermont	2007	49%	51%
Wisconsin	Focus on Energy: Second Half of FY 2007	2007	39%	61%
	Focus on Energy: Cumulative, 2001–2007	2007	45%	55%
New York	NYSERDA	2007	50%	50%
Northwest Region	Regional data: WA, OR, ID and western MT	2007	40%	60%
New Jersey		2007	64%	36%
Texas	Texas IOUs	2007	64%	36%
Iowa		2006	43%	57%
Rhode Island		2007	38%	62%
Mean			46%	54%
Median			44%	56%

Source: Kushler, York & Witte (2009)

Efficiency program spending also varies in its allocation to administrative or operating costs versus incentives provided to customers. Table 7 shows average allocations for these costs in a few states.

Table 7. Program Expenses for Customer Incentives Compared to Administrative Costs (Million $)

State	Program Years Shown	Program Incentives	% of Total Program Costs	Admin & Planning, Delivery, Marketing, Evaluation	% of Total Program Costs	Total Program Cost
California	2006	$235	71%	$95	29%	$329
Connecticut	2005–2008	$319	89%	$40	11%	$359
Massachusetts	2006–2007	$157	68%	$74	32%	$231
Texas	2007	$69	92%	$6	8%	$76
Vermont*	2002–2008	$74	62%	$45	38%	$119
Average			76%		24%	

*Note: Efficiency Vermont's program incentives include technical assistance.

PROFILES OF SELECT STATES

In this section, to illustrate the magnitude and diversity of program costs, we present short profiles of states that provided cost breakdowns in their annual reports. Although we had hoped to be able to gather and report program costs consistently across all 14 states, using key categories (e.g., administration, marketing, and incentives), we found that programs do not necessarily use these categories to track their costs. There is considerable variability in how states categorize the costs that they report. Nevertheless, the following state profiles provide some examples of relative program costs. Table 8 summarizes the relative percentages of funding that California and Massachusetts commit to customer incentives, administration, evaluation, and marketing.

California

In California, utilities offer many energy efficiency opportunities to their electric and natural gas customers. The state continues to be a leader in this field. See Table 8 for a breakdown of utility program costs by category for electricity and natural gas program portfolios in 2006, as reported by the utilities to the CPUC.

Table 8. Cost of Energy Efficiency Programs in California in 2006 (Million $)

Utility	Admin/ Marketing	% of Total	Program Incentives	% of Total	EM&V	% of Total	Total Cost
SCG	$8	38%	$12	61%	$0.2	1.0%	$20
SDG&E	$7	21%	$27	78%	$0.2	0.7%	$34
PG&E	$40	28%	$103	72%	$0.6	0.4%	$143
SCE	$38	29%	$93	70%	$1.2	0.9%	$132
Total	$92	28%	$235	71%	$2.3	0.7%	$329

Source: Annual Reports to CPUC for 2006 programs. See CPUC (2007a, 2007b, 2007c, 2007d); http://eega2006.cpuc.ca.gov/.

Massachusetts

Massachusetts has a strong track record of investing in energy efficiency. A breakdown of program and participant costs is shown in Table 9.

Table 9. Cost of Energy Efficiency Programs in Massachusetts in 2003–2005 (Million $)

Category	Cumulative Costs 2003–2005	% of Total Costs*
Customer Incentives	$217	43%
Administration	$33	7%
Technical Assistance	$65	13%
Advertising	$18	4%
Shareholder Incentives	$28	6%
Evaluation	$11	2%
Participant Costs	$132	26%
Total	$504	100%

*Note: Totals may not sum to 100% due to rounding.

New York (NYSERDA)

NYSERDA has a well-funded commercial and industrial program and also invests significantly in residential energy efficiency programs, including low-income programs. Program data, which are reported cumulatively over the 10-year lifetime of the System Benefit Charge (SBC) programs, are summarized in Table 10.

Table 10. Cumulative Costs of NYSERDA's *New York Energy $mart Program* through 2008 (Million $)

Category	SBC Funds Spent (1998–2006)	SBC Funds Spent (1998–2007)	SBC Funds Spent (1998–2008)	% of Spending (1998–2008)*
Commercial & Industrial	265.5	308.4	351.2	32%
Residential	177.6	205.3	238.2	22%
Low-Income	101.9	137.9	179.3	16%
RD&D**	117.6	144.6	167.3	15%
Awareness/Marketing	16.7	19.3	21.1	2%
Program Administration	65.6	79.1	94.8	9%
Metrics & Evaluation	15.5	18.3	21.5	2%
NYS Cost Recovery Fee	10.4	12.7	15.9	1.5%
Total	$772	$926	$1,089	100%

Notes: *Totals may not sum to 100% due to rounding.
**RD&D funding is not included in the cost/benefit calculations for NYSERDA.
Sources: NYSERDA (2007, 2008, 2009)

Vermont

Table 11 shows that Efficiency Vermont's programs, while on a smaller scale than those of some other states, have a solid track record. Efficiency Vermont's compact fluorescent light bulb program, for example, provides a model that may be useful to program developers in other states.

Table 11. Annual Costs of Energy Efficiency Programs by Efficiency Vermont (Million $)

Category	2002	2003	2004	2005	2006	2007	2008**
Operating Costs	$4.4	$5.3	$5.5	$5.9	$6.4	$8.0	$9.6
Op. Costs as % of Total Costs	24%	25%	25%	20%	22%	20%	17%
Program Incentives*	$4.6	$5.2	$5.6	$5.9	$5.1	$7.3	$14.7
Incentives as % of Total Costs	25%	24%	20%	20%	18%	18%	25%
Technical Assistance	$1.9	$2.5	$2.9	$3.3	$3.3	$4.1	$7.2
Tech. Assistance as % of Total Costs	11%	12%	11%	11%	12%	10%	12%
Subtotal: Costs to EVT	$12.0	$13.0	$14.0	$15.1	$14.8	$19.3	$31.4
Costs to EVT as % of Total Costs	65%	61%	51%	50%	52%	49%	54%
Customer Costs	$6.3	$8.2	$13.3	$14.9	$13.6	$20.4	$26.4
Customer Costs as % of Total Costs	35%	39%	49%	50%	48%	51%	46%
Total Costs to EVT and Customers	$18.3	$21.2	$27.3	$30.0	$28.5	$39.8	$57.8

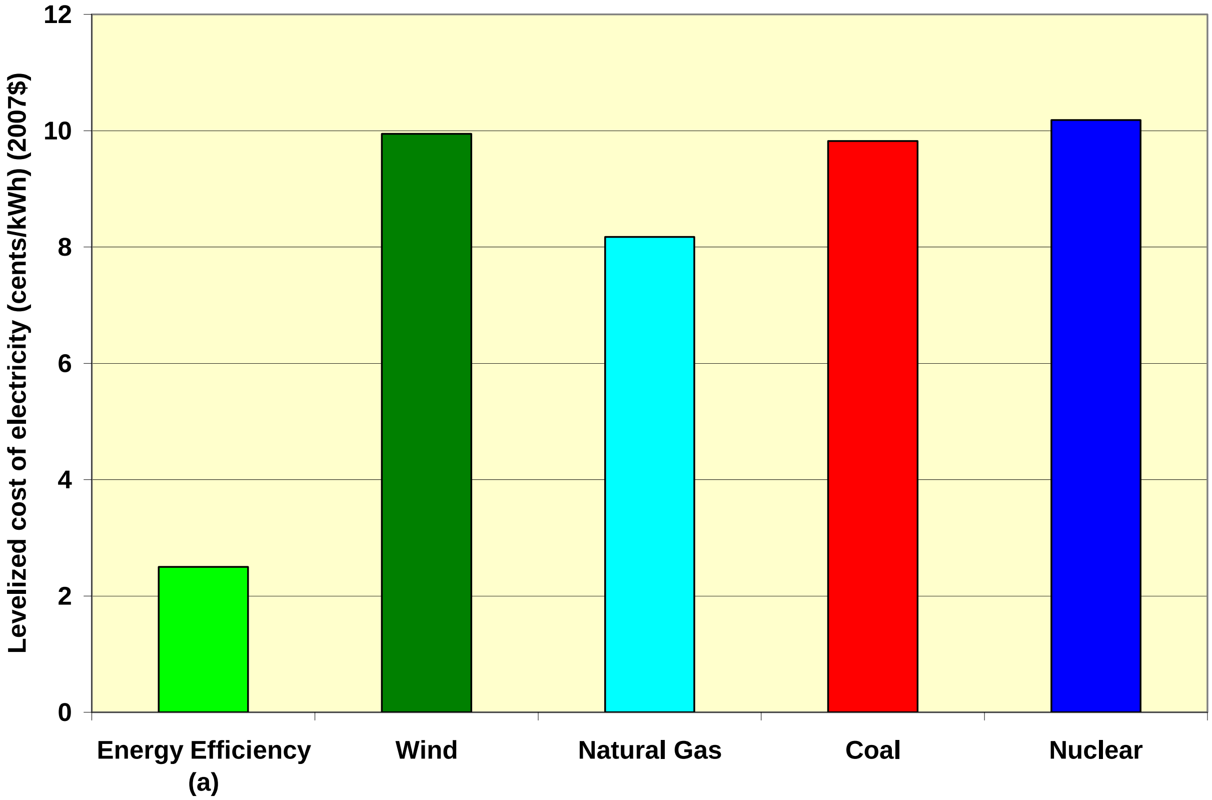
*Includes incentives to customers and to trade allies
** 2008 figures are preliminary (EVT 2009)

DISCUSSION

These data are consistent with results from our 2004 review of energy efficiency program costs, showing that energy efficiency remains very cost-effective. The 2004 review found a median cost of about 3 cents per kWh saved for efficiency programs and this update identifies an average cost of 2.5 cents per kWh saved. This finding demonstrates that energy efficiency is a consistently highly cost-effective energy resource across a range of programs, states, and regions. These high-level summaries also provide some evidence that as programs grow, costs remain approximately the same *per unit of energy saved* and may even decrease over time. As energy efficiency programs around the country scale up, overall program funding will need to keep pace. However, the finding from this meta-review suggests that each dollar invested in efficiency will continue to reap the same energy savings, if not more with economies of scale. Another recent meta-review also points to the trend that program CSE seems to decrease as program scale and impacts grow (Takahashi and Nichols 2008). This general trend information is useful, though more research is needed to directly track program costs over time.

Our findings show an average utility cost of saved energy of $0.025 per kWh. In contrast, recent conventional energy supply-side options have typically cost between $0.07 and $0.15 per kWh — at least three times the cost of energy efficiency investments (Lazard Ltd. 2008). In 2008, pulverized coal cost between $0.07 and $0.14 per kWh, combined-cycle natural gas cost between $0.07 and $0.10 per kWh, and wind cost between $0.04 and $0.09 per kWh (Lazard Ltd. 2008). Furthermore, as energy supply-side resource costs are highly volatile, energy efficiency remains a financially stable, long-term investment. In the near future, this cost picture will likely be very similar. Figure 3 shows estimates of supply-side resource costs in 2020 (EIA 2009). The figure also includes our estimate of recent utility energy efficiency program costs. Similar to recent cost trends, future cost estimates for conventional and renewable energy supply-side resources are three or four times higher than current energy efficiency program costs (see Figure 3).

Figure 3. Levelized Electricity Resource Cost Estimates for 2020



Source: EIA 2009, except for (a): Energy efficiency program costs are the estimate of current utility efficiency program CSE, as described in this national review.

Energy Efficiency by Customer Class

Allocation of energy efficiency spending among different customer classes and categories of program expenditures reveals additional information about program strategies and administration. Our results show that, generally, states are spending slightly more on non-residential electricity programs than they are spending on residential electricity programs. The allocation decisions seem to be driven by both a regulatory concern for equity among customer classes and by the costs and availability of energy efficiency measures in a given customer class. The greater levels of spending on non-residential programs suggest that energy efficiency resources are more accessible and affordable in these sectors than they may be in the residential sector.

Many factors contribute to the variation in cost-effectiveness of energy efficiency programs. These include regulatory and market-driven factors, which are discussed in the data issues section below. For example, any regulatory requirements that affect the distribution of program funds across customer sectors can affect cost, because residential and low-income program investments typically cost more per unit of energy saved than non-residential programs. Also, the ratio of participant costs to program costs can affect utility cost-effectiveness, since programs that leverage greater customer spending for every dollar of program costs will reap the same energy savings at a lower program cost.

Data Issues

This meta-review revealed several data issues related to evaluation, measurement, and verification of energy efficiency that result in confusion among program administrators and are at the center of national discussion on energy efficiency programs. For example, how programs estimate net versus gross energy savings, attribute costs to electricity and natural gas efficiency programs, and use estimated or actual participant costs are all issues that pose challenges to program administrators and evaluators.

The states and utilities surveyed in this review use multiple methods to calculate program savings and benefit/cost ratios. While we recognize that this variation in methodology results in data that are not always directly comparable, averaging these values still serves as a reasonable method to capture typical cost-effectiveness results within the full range of values.

Nationally or regionally standardized reporting methods could provide many advantages. Consistent evaluation techniques would allow states to compare their achievements accurately. This would also create a reliable blueprint for states seeking to meet a federal energy efficiency resource standard (EERS) successfully.

Variations in reported cost of saved energy can stem from differences in several areas, including: (1) weather and climate; (2) investment in different sectors and technologies; and (3) evaluation and reporting methods. This last issue — evaluation and reporting differences — can arise from multiple sources, including: (1) measurement conditions (e.g., measurement at the generation level versus at the customer meter level); (2) avoided cost calculation methods; and (3) choices about how to estimate net savings.

The equations that program evaluators use to calculate benefit/cost ratios and costs of saved energy are not typically included in program annual reports. Evaluators use lifetimes specific to given technologies or end-uses within a broad total program portfolio; naturally, these lifetimes vary in length. Evaluators determine overall program portfolio cost-effectiveness by summing up individual program costs ands benefits to derive aggregate values of total costs and benefits. Individual states have also developed their own categories for cost reporting, making it difficult to aggregate detailed data across different states. Estimates of total program cost-effectiveness generally are made on the basis of either a “total resource cost” perspective or a “utility cost” perspective.

We recommend greater consistency in reporting both costs and energy savings and encourage energy efficiency programs to coordinate their reporting strategies to achieve this goal. For example, several programs do not currently report estimated lifetimes of the measures they undertake. Some programs publish cumulative data; other programs report annual totals. Some programs combine load management data and renewable energy program data with energy efficiency data. More regional and/or national efforts are needed to develop consistency in program evaluation and reporting. For example, the Northeast Energy Efficiency Partnerships (NEEP) is currently facilitating an Evaluation, Measurement and Verification Forum (EM&V Forum).[8] This project was launched in July 2008 with the goal of developing

[8] See http://www.neep.org/EMVinfo.html for more information.

common/consistent EM&V protocols for energy efficiency and other demand-side resources to support energy and environmental policies in the Northeast and Mid-Atlantic region.

Setting goals for a national Energy Efficiency Resource Standard should include a review of the individual policies and practices of leading states and assessing how well they can be generalized to other regions. Consistent evaluation would be an essential component of this process.

CONCLUSION

The results of this more expansive review of the costs of saving electricity and natural gas are very consistent with the results we have observed and reported over the past five years. Utility sector energy efficiency programs are achieving electricity savings at an average cost of approximately 2.5 cents per kWh and natural gas savings at an average cost of approximately 37 cents per therm. These results serve to confirm that the costs of saved energy are far less than the costs of new conventional fossil fuels and alternative energy sources and remain consistent over time.

We encourage government organizations, regulators, and utilities to support the creation and expansion of energy efficiency programs and to view energy efficiency as their “first fuel” of choice. Energy efficiency is a cost-effective solution to many problems facing both utilities and society, including the growing economic and environmental costs of carbon dioxide emissions. Also, energy efficiency goals can often be accomplished using existing technology, so programs can deliver results relatively quickly — in much less time than it takes to construct a new power plant. Finally, energy efficiency projects generate local jobs in many fields, including the building trades. Studies show that expanding utility energy efficiency programs will result in a net increase in jobs in local economies (Laitner & McKinney 2008). For all of these reasons, energy efficiency programs are receiving increased policymaker and regulator support across the country.

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APPENDIX A.

Table A-1. Annual Values by State for Electricity and Natural Gas Programs

State	Year	CSE for Electricity ($/kWh)	CSE for Natural Gas (I$/therm)	Reported TRC Benefit/Cost Ratio	Reported PAC Benefit/Cost Ratio	Cost of Efficiency Programs (million $)	Savings (MWh)	Savings (Dkt)
California (IOUs)	2006 (SCG)	NA	$0.23	1.9	3.4	$20	NA	1,100,000
	2006 (SDG&E)	$0.030	$0.25	2.4	3.3	$34	161,000	200,000
	2006 (PG&E)	$0.030	$0.52	2.1	3.0	$143	784,000	1,076,000
	2006 (SCE)	$0.030	NA	2.4	3.4	$132	798,000	NA
	2007 (PG&E)	$0.025	$0.26	2.7	3.8	$301		
	Average	**$0.029**	**$0.32**	**2.3**	**3.4**			
Connecticut (CT Energy Efficiency Fund)	2005	$0.025	NA			$80	318,000	NA
	2006	$0.022	NA			$62	249,000	NA
	2007	$0.031	NA	NA	NA	$98	355,400	NA
	2008	$0.034	$0.55			$86	249,900	NA
	Average	**$0.028**	**$0.55**					
Iowa (IOUs)	2001	$0.020	$0.25			$42	111,395	578,166
	2002	$0.019	$0.27			$41	117,339	508,899
	2003	$0.017	$0.29			$51	161,518	620,201
	2004	$0.016	$0.28			$55	198,034	660,884
	2005	$0.015	$0.26			$63	222,064	872,142
	2006	$0.014	$0.29	(Societal)	NA	$71	274,975	867,331
	2007	$0.014	$0.28	2.1		$70	281,897	806,018
	2008	NA	NA	2.2		NA	NA	NA
	Average	**$0.017**	**$0.27**	**2.2**				
Massachusetts	2003	$0.038	NA			$166	318,000	NA
	2004	$0.033	NA	2.8 ('03-'05)		$174	442,000	NA
	2005	$0.032	NA		NA	$164	455,000	NA
	2006	$0.030		4.5		$120	417,030	NA
	2007	$0.024		4.2		$111	489,623	NA
	Average	**$0.031**	NA	**3.6**				

State	Year	CSE for Electricity ($/kWh)	CSE for Natural Gas (l$/therm)	Reported TRC Benefit/Cost Ratio	Reported PAC Benefit/Cost Ratio	Cost of Efficiency Programs (million $)	Savings (MWh)	Savings (Dkt)
Minnesota	2006	$0.023	NA	NA	NA	$99	411,999	2,095,047
	2007	$0.022				$108	463,543	1,917,144
	Average	**$0.022**						
Nevada	2006	$0.016	NA	NA	NA	$30	216,000	NA
	2007	$0.021	NA	NA	NA	$38	206,000	NA
	2008	$0.023	NA	NA	NA	$54	260,000	NA
	Average	**$0.020**						
New Jersey (Clean Energy Program)	2003	$0.024	$0.47	NA	NA	$87	285,577	409,154
	2004	$0.022	$0.44	NA	NA	$91	328,513	432,759
	2005	$0.025	$0.36	NA	NA	$87	242,659	617,261
	2006	$0.035	$0.53	4.4	NA	$81	128,252	640,179
	Average	**$0.026**	**$0.45**	**4.4**				
New Mexico	2008	**$0.033**	NA	**2.7**	NA	$8	35,211	NA
New York (NYSERDA)	2004	$0.027	NA		4.4	$113	347,000	626,000
	2005	$0.017	NA		6.9	$128	621,000	1,357,000
	2006	$0.013	NA		9.0	$109	671,000	1,276,000
	Thru 2008	**$0.019**	NA	**2.6**	**5.6**	NA	NA	NA
Oregon (Energy Trust of Oregon)	2005	$0.013	$0.28	2.7	4.3	$51	343,129	139,912
	2006	$0.016	$0.28	2.0	4.2	$45	223,292	229,460
	2007	$0.014	$0.33	2.6	6.0	$46	308,352	230,000
	2008	$0.021	$0.45	2.3	4.7	$65	281,371	257,313
	Average	**$0.016**	**$0.34**	**2.4**	**4.8**			
Rhode Island	2007	**$0.030**	NA	NA	**3.6**	$16	64,995	NA
Texas (IOUs)	2004	$0.018	NA	NA	NA	$88	546,896	NA
	2005	$0.018	NA	NA	NA	$79	509,075	NA
	2006	$0.016	NA	NA	NA	$58	397,305	NA
	2007	$0.019	NA	NA	NA	$76	457,807	NA
	Average	**$0.018**	NA	NA	NA			

State	Year	CSE for Electricity ($/kWh)	CSE for Natural Gas (l$/therm)	Reported TRC Benefit/Cost Ratio	Reported PAC Benefit/Cost Ratio	Cost of Efficiency Programs (million $)	Savings (MWh)	Savings (Dkt)
Vermont (Efficiency Vermont)	2003	$0.024	NA	NA	NA	$13	51,200	NA
	2004	$0.027	NA	NA	NA	$14	51,900	NA
	2005	$0.030	NA	NA	NA	$15	57,100	NA
	2006	$0.032	NA	NA	NA	$15	56,070	NA
	2007	$0.024	NA	NA	NA	$19	102,914	NA
	2008	$0.027	NA	NA	NA	$31	149,661	NA
	Average	**$0.027**	NA	NA	NA			
Wisconsin (Focus on Energy)	2001–2007	**$0.033**	**$0.31**	2.2		$419	441,117	922,925
AVERAGE		**$0.025**	**$0.37**	**2.5**	**4.6**			
MEDIAN		**$0.027**	**$0.33**	**2.3**	**4.8**			
MIN		**$0.016**	**$0.27**	**1.8**	**3.4**			
MAX		**$0.033**	**$0.55**	**3.6**	**5.6**			

Table A-2. Average Measure Lifetime Estimates as Estimated by Programs*

State	Electricity Measures (years)	Natural Gas Measures (years)
Connecticut	13	16
Iowa	15	20
Massachusetts	13	N/A
Oregon	12	23
New Jersey	14	18
New Mexico	9	N/A
New York	15	N/A
Rhode Island	11	N/A
Vermont	12	N/A
Wisconsin	12	20
Average	**13**	**19**

*These values are the average of the annual measure lifetime estimates provided for the program years listed in Table A.