Does Efficiency Still Deliver the Biggest Bang for Our Buck? A Review of Cost of Saved Energy for US Electric Utilities

Maggie Molina, American Council for an Energy-Efficient Economy
Grace Relf, American Council for an Energy-Efficient Economy

ABSTRACT

Past studies have examined the levelized cost of saved energy (LCSE) for utility energy efficiency (EE) programs and found that efficiency is one of the least-cost electricity resource options for utilities. As efficiency programs mature, and as some low-cost savings may no longer be viable, some observers assume that energy efficiency costs are increasing. Updated datasets are critical for stakeholders to understand efficiency costs and trends. We analyze a new dataset of LCSE for efficiency portfolios offered by the 49 largest electricity utilities in the United States for the 2015 program year. Comparing the aggregate results to past analyses (in real dollars), we find that utility LCSE has not increased for 2015 program data. The average utility/program administrator LCSE for 2015 was $.031 per kilowatt-hour (kWh) (net savings at the generator). We also examine costs with and without low-income (LI) programs. Excluding LI programs, LCSE in 2015 was $.028 per kWh, an average of 7% lower than total portfolio costs with LI programs included.

Efficiency continues to be among the least-cost electricity resources. As costs for wind and solar have declined in recent years, efficiency is on par with these resources on a levelized costs basis when wind and solar tax credits are excluded. However levelized costs are a simplified metric that tell only part of the story. For example, the time and locational value of energy efficiency resources will become increasingly important for utility system planning, and efficiency provides important peak demand benefits. We must build upon LCSE and continue to refine our metrics to convey the full benefits of efficiency.

Introduction

Past research has examined the levelized cost of saved energy (LCSE) for utility-sector programs and found that efficiency is one of the least-cost electricity resource options for utilities. For example, an American Council for an Energy-Efficient Economy (ACEEE) review of programs administered between 2009 and 2012 found that the simple average program administrator LCSE for about 20 states was $0.28 per kilowatt-hour (kWh) levelized for efficiency portfolios and ranged from $.016 to $.048 per kWh in 2011$ (Molina 2014).[1] That review includes all program costs and any applicable utility shareholder performance incentives, representing the cost of efficiency as a utility resource. Similarly, ACEEE later examined LCSE values for 14 of the leading US program administrators over several years of implementation (Baatz et al. 2016). The research found that the LCSE (with data for 107 program years) has

[1] ACEEE also conducted efficiency program cost reviews in 2004 and 2009. The 2004 study examined data from seven states and identified a range of LCSE from $.023 to $.044 per kWh, with a median value of $.03 per kWh (Kushler, York, and Witte 2004). The 2009 review of 14 states identified LCSEs ranging from $.016 to $.033 per kWh, with an average cost of $.025 per kWh (Friedrich, Eldridge, and York 2009).

remained relatively flat since 2010, even while total program spending and average spending per customer increased for most observations in the study. The average LCSE was $.034 per kWh. Lawrence Berkeley National Laboratory (LBNL) also has a large body of research on the cost of saved energy (CSE),[2] including a national examination of CSE for program administrators at the program and customer class levels (Billingsley et al. 2014), the total cost of saved energy including participant costs (Hoffman et al. 2015), and trends over time (Hoffman et al. 2017). A forthcoming LBNL report examines the largest dataset to date on CSE values.

Studies by ACEEE and LBNL of the program administrator CSE have taken slightly different approaches, but the results are largely consistent. For example, ACEEE examined cost of net savings, whereas LBNL examined gross savings. Second, ACEEE research generally reports costs at the portfolio level (rather than the program level) and includes performance or shareholder incentives when applicable. The LBNL research provides a granular and robust examination of program-level results and at the aggregate portfolio level has not included utility shareholder incentives. When adjusting for these factors, ACEEE and LBNL found that the results of the 2014 reviews were consistent (Billingsley et al. 2014; Molina 2014).

This paper builds on past research by examining a large dataset of utility energy efficiency program costs and savings for 2015. We also examine the data with and without low-income (LI) programs, which generally have the highest average LCSE values compared to other program sectors due to programmatic approach, e.g., addressing health and safety (Billingsley et al. 2014). LI programs serve a broader public policy purpose, and LCSE values should also be examined without LI programs.

Methodology

We analyze data collected by ACEEE as part of the *Utility Energy Efficiency Scorecard* (Relf, Baatz, and Nowak 2017). This dataset encompasses costs and savings data for energy efficiency portfolios offered by the 51 largest electricity utilities in the United States for the 2015 program year. While the *Scorecard* ranked utilities by numerous performance indicators including savings as a percentage of sales and normalized spending, it did not analyze the cost of saved energy by utility. Nor did it rank utilities on such a metric.

The data collection and comparison process for the *Utility Scorecard* was complicated by numerous challenges, including inconsistent reporting formats, nomenclature, and frequency and variation of energy savings evaluation approaches. We made the data as consistent as possible in the face of these challenges. For example, electricity savings data are presented as net savings estimates. Many program administrators reported gross savings alone with no net-to-gross ratio. In such cases we applied a standard net-to-gross factor of 0.817, which is consistent with ACEEE's approach in our *State Energy Efficiency Scorecard*. We used weighted-average measure lifetimes as reported by the program administrator if available, or we derived portfolio-wide measure lifetime averages by dividing lifetime energy savings estimates by annual energy savings estimates. If lifetime savings or measure life data were not reported by program

[2] We use *CSE* to refer to the body of research on both first-year CSE values and levelized CSE values (LCSE). We use *LCSE* when referring to levelized values specifically. See Molina (2014) for the equations for these values and a discussion of the difference between levelized and first-year costs. In general, both approaches provide meaningful information to planners. However ACEEE finds that levelized costs are the best way to compare efficiency program costs to supply options, and therefore we place more emphasis on this metric. By *levelized*, we mean that upfront investments are annualized over the life of the investment, assuming a real discount rate.

administrators, we assumed 11.1 years, which was the average value for the 39 utilities that did provide estimates.[3]

In general, we have found that most jurisdictions report energy savings at the meter, meaning it does not account for the additional savings from avoided transmission and distribution line losses, rather than at the generator, which would account for those avoided losses. Because of the more prevailing approach to reporting savings, past CSE research by ACEEE has presented values as cost per unit of electricity savings at the meter. However we have been shifting to reporting savings at the generator such as in the *Utility Scorecard.* In this paper we report the LCSE using both sets of savings approaches. To adjust savings from at the meter to at the generator in the *Utility Scorecard,* we applied an average loss factor to savings figures that were not already reported at the generator level. In cases where utility-specific loss factors were unavailable, we used 6%, which is the average of the Energy Information Administration's (EIA's) estimated US transmission and distribution losses for 2005–2015. If we were unable to determine the reporting level for a utility's savings data (generator versus meter), we assumed generator level to be conservative.

For program administrator cost data, we focused on total portfolio spending. This includes total program costs (e.g., participant rebates, technical assistance, program administration, marketing, evaluation, measurement, and verification [EM&V], program design, pilots, etc.) as well as applicable shareholder performance incentives or other performance management fees to a third-party administrator. The exclusion of participant costs in the LCSE is a departure from the total resource cost test (TRC), which does include participant costs. The methodology for this analysis is consistent with prior ACEEE LCSE analyses and is consistent with the utility or program administrator cost test (UCT/PACT).

Using program cost and energy savings data, we calculated the first-year acquisition costs as annual portfolio costs ($) divided by incremental annual net electricity savings (kWh). We then calculated the LCSE over the average lifetime of the portfolio. We consistently calculated the LCSE using a 5% real discount rate, and we kept all data in 2015$.

There were two outliers in the dataset of the 51 largest utilities. For these two jurisdictions (Duke Energy FL and Florida Power & Light), CSE values were four to eight times the median value of the rest of the dataset.[4] We removed these from the dataset and then examined the average, median, minimum, and maximum CSE values.

Next we examined the changes in LCSE portfolio values when low-income efficiency program costs and savings are removed. Research by LBNL finds that low-income programs generally have the highest LCSE values but have multiple public policy and nonenergy benefits. Because the energy system benefits (in kWh savings) are only one benefit of the programs and because they tend to have higher LCSE, we examined the impacts of presenting LCSE values for efficiency portfolios when low-income efficiency program costs and electricity savings are removed. Finally, we explored the LCSE values for utility energy efficiency programs compared to other electricity resource options and examined the pros and cons of using LCSE as a metric.

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[3] This value of 11.1 years differs from the assumption we used in *Utility Scorecard*, in which we assumed 11.5 years based on 2015 data from the Energy Information Administration and values collected in the *Scorecard* research.

[4] One likely reason for these high CSE values is that the utilities focus on peak load reduction. Their reporting may have aggregated demand response and efficiency program costs.

Results

Here we present the results for both first-year acquisition CSE and levelized CSE values for the dataset. We then present CSE results for portfolios excluding low-income efficiency program costs and savings.

Total Portfolio Costs

Table 1 shows both first-year and levelized CSE values expressed in dollars per net kWh saved. We present these values using savings both at the meter and at the generator.

Table 1. Program administrator CSE for 2015 including LI ($ per kWh)

	At the meter		At the generator	
Utility/program administrator	First-year CSE ($ per kWh-net)	Levelized CSE ($ per kWh)	First-year CSE ($ per kWh-net)	Levelized CSE ($ per kWh-net)*
AEP OH	$0.15	$0.016	$0.14	$0.015
AEP TC	$0.27	$0.033	$0.26	$0.030
AL Power	$0.44	$0.052	$0.42	$0.049
Ameren IL	$0.25	$0.030	$0.24	$0.028
Ameren MO	$0.16	$0.016	$0.14	$0.015
APS	$0.16	$0.021	$0.15	$0.019
BGE	$0.33	$0.051	$0.31	$0.048
CenterPoint	$0.21	$0.026	$0.20	$0.023
ComEd	$0.17	$0.020	$0.16	$0.019
ConEd	$0.23	$0.027	$0.21	$0.026
Consumers	$0.33	$0.028	$0.31	$0.026
CPS	$0.42	$0.050	$0.40	$0.046
Dominion	$0.37	$0.035	$0.35	$0.033
DTE	$0.17	$0.020	$0.16	$0.018
Duke IN	$0.17	$0.028	$0.16	$0.026
Duke NC	$0.16	$0.029	$0.15	$0.027
Duke OH	$0.25	$0.032	$0.23	$0.030
Duke SC	$0.16	$0.029	$0.15	$0.027
Entergy AR	$0.26	$0.031	$0.25	$0.029
Entergy LA	$0.24	$0.029	$0.23	$0.026
Eversource CT	$0.44	$0.055	$0.41	$0.052
Eversource MA	$0.36	$0.039	$0.34	$0.036
GA Power	$0.18	$0.055	$0.17	$0.052
JCP&L	$0.27	$0.029	$0.25	$0.027
LADWP	$0.32	$0.030	$0.31	$0.028
LIPA	$0.26	$0.031	$0.24	$0.028
MidAm. IA	$0.25	$0.030	$0.23	$0.027
NG MA	$0.44	$0.053	$0.41	$0.050
NG NY	$0.15	$0.027	$0.14	$0.025
NPC	$0.22	$0.027	$0.21	$0.025

	At the meter		At the generator	
Utility/program administrator	First-year CSE ($ per kWh-net)	Levelized CSE ($ per kWh)	First-year CSE ($ per kWh-net)	Levelized CSE ($ per kWh-net)*
OG&E	$0.37	$0.039	$0.34	$0.036
OH Edison	$0.12	$0.013	$0.11	$0.012
Oncor	$0.40	$0.036	$0.37	$0.034
PacifiCorp UT	$0.24	$0.034	$0.22	$0.032
PECO	$0.41	$0.054	$0.38	$0.050
PG&E	$0.36	$0.029	$0.33	$0.027
PGE	$0.29	$0.030	$0.27	$0.028
PPL	$0.38	$0.044	$0.35	$0.041
Progress NC	$0.21	$0.042	$0.20	$0.040
PSE	$0.40	$0.048	$0.38	$0.044
PSE&G	$0.35	$0.036	$0.33	$0.034
SCE	$0.29	$0.061	$0.27	$0.057
SCE&G	$0.16	$0.019	$0.15	$0.017
SDG&E	$0.42	$0.050	$0.40	$0.047
SRP	$0.09	$0.013	$0.08	$0.013
We Energies	$0.25	$0.028	$0.24	$0.026
West Penn	$0.17	$0.027	$0.16	$0.025
Xcel CO	$0.21	$0.021	$0.20	$0.020
Xcel MN	$0.30	$0.036	$0.28	$0.033
Average**	$0.27	$0.033	$0.25	$0.031
Median	$0.25	$0.030	$0.24	$0.028
Minimum	$0.09	$0.013	$0.08	$0.012
Maximum	$0.44	$0.061	$0.42	$0.057

*We recommend this value, levelized cost of saved energy at the generator, as the best CSE value to represent energy efficiency as a utility resource. **Average values represent simple average of all utilities in the dataset, not a savings-weighted average.

Average first-year costs are $.27/kWh at the meter and $.25/kWh at the generator. These first-year "acquisition" costs are sometimes useful for program planners. However they do not represent the costs of energy efficiency as a resource over the life of the measures. Levelized CSE values are best for that purpose, and we find that average LCSE values were $.034/kWh at the meter and $.031/kWh at the generator. We recommend LCSE at the generator as the best way to convey the cost of efficiency as a resource among these options.

Most past research on LCSE values highlights values for savings reported at the meter, which is how most jurisdictions report savings values and LCSE values, in our experience. However a true representation of energy efficiency as a utility system resource should include avoided line losses. Therefore we recommend focusing on LCSE values at the generator. Average line losses were 6.7% for the dataset that reported average line loss factors (not including the assumed 6.0% for the 24 utilities from which we were not able to locate publicly reported line loss factors).

We can see these results for LCSE at the generator in Figure 1. Each dot represents an individual utility, and the line represents the average value of $.031/kWh. We then plotted the same data relative to electricity savings as a percentage of sales to examine whether utilities with higher relative savings levels had higher LCSE values (Figure 2). We do not observe any notable trend of CSE values correlated to savings performance, with an R-value of 0.08. This finding of no or low correlation between CSE values and savings as a percentage of sales is consistent with past analyses, which have demonstrated that utilities can meet aggressive savings levels while maintaining cost-effective EE portfolios (e.g., Molina 2014).

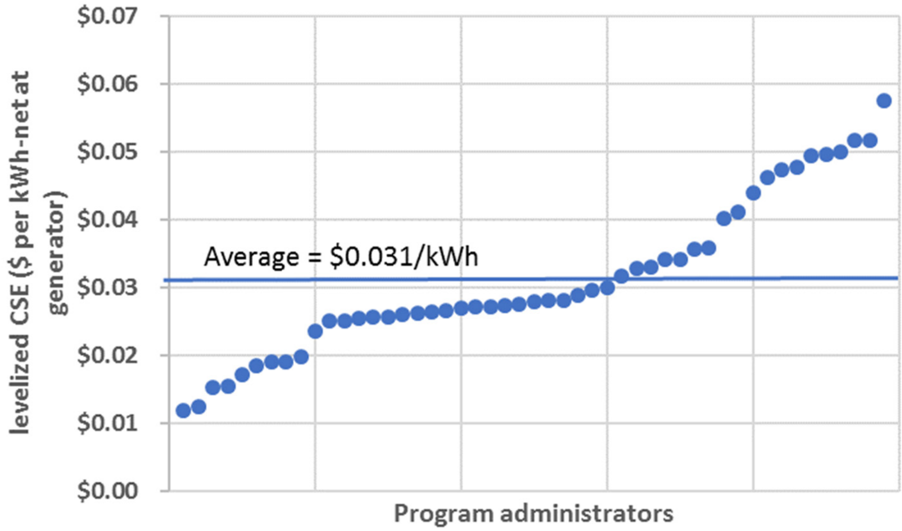

Figure 1. Levelized program administrator CSE for 2015 ($ per kWh-net at the generator).

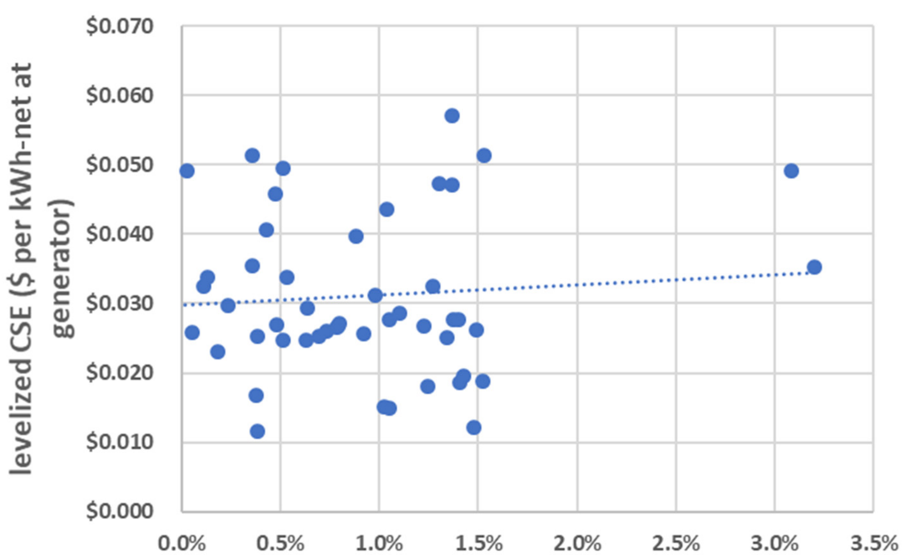

Figure 2. LCSE for 2015 relative to savings as a percentage of sales.

LCSE Analysis without Low-Income Programs

Low-income (LI) energy efficiency programs have long served an important role. They have recently gained renewed attention as an important policy to alleviate household energy burdens and keep energy bills low for residents, reduce utility arrearages, provide health, safety, and comfort, and save energy as a utility system resource. Energy savings are just one of the multiple benefits of these programs. ACEEE recently assessed a baseline of low-income energy efficiency programs for the 51 largest metropolitan regions in the country by surveying over 70 electric and natural gas utilities on their 2015 low-income program spending, energy savings, customer participation, and best practices. They found that the majority of these utilities do provide low-income programs (Drehobl and Castro-Alvarez 2017). However the offerings varied widely in terms of spending, savings, design, and delivery.

Research by LBNL found that LI energy efficiency programs generally have the highest average LCSE values compared to other program sectors (Billingsley et al. 2014). This is largely because utilities often pay the full upfront cost of efficiency projects for LI households. The LBNL review found that LI programs had an average program administrator LCSE of $.070/kWh.[5] Given the many public policy reasons to pursue LI efficiency programs, many jurisdictions provide unique cost-effectiveness requirements, such as designing tests that consider the nonenergy benefits (NEBs) these programs provide through benefits adders. States may also exempt LI programs from traditional cost-effectiveness requirements.

With many public policy reasons to pursue LI programs, it may be more appropriate to examine the LCSE for efficiency portfolios without including LI programs. We examined the 2015 utility dataset by removing the spending and savings applicable to low-income efficiency programs. As shown in Table 2, we found an average LCSE for efficiency programs was $.029/kWh when LI programs are not included, which is 7% less on average than overall LCSE when LI programs are included. For most jurisdictions, the percentage change in LCSE when removing LI costs and savings was small, with half of utilities having a change of 4.5% or less. However two utilities faced changes of more than -30% (one up to -45%), and another seven utilities had changes of -10% or more. In other words, the LCSE values for these utilities are impacted more from LI efficiency programs. One possibility is that these jurisdictions allow more flexibility in how utilities deliver LI programs, and as a result they can deliver higher penetrations of savings even if the LCSE values are much higher than other residential programs. Another possibility is that the non-LI programs focus on lower-cost savings, and as a result the LI program costs have a relatively larger impact in these jurisdictions.

Table 2. Program administrator CSE for 2015 ($ per kWh) without low-income programs

	Levelized CSE ($ per kWh-net at generator) for portfolio without LI programs	Percentage change from total portfolio with LI programs
Average	$0.029	-7.0%
Median	$0.026	-4.5%
Minimum	$0.010	-45.0%
Maximum	$0.050	1.1%

[5] By comparison, residential programs had an average LCSE of $.018/kWh, and commercial, industrial, and agricultural programs had an average of $.021/kWh (Billingsley et al. 2014)

Discussion

Here we discuss the trends of energy efficiency LCSE over time and then compare the costs of efficiency to other electricity resource options, noting the pros and cons of LCSE as a metric for energy efficiency.

Trends Over Time

ACEEE previously compared utility LCSE values for 2009–2012 to past reviews and found that on average efficiency program costs were holding steady in terms of national average (Molina 2014). LBNL examined trends over time for the 2009–2013 period and similarly found that the cost to efficiency program administrators averaged $.028/kWh over the five-year period (Hoffman 2017). The average program administrator LCSE declined from $.044/kWh in 2009 to $.023/kWh in 2011 and then rebounded slightly to $.028/kWh in 2013. Baatz and Gilleo also explored trends over time for over a dozen individual jurisdictions from 2006 to 2014. This research found that while spending and savings levels have increased, the average levelized cost of saved energy has remained relatively flat since 2006 (Baatz and Gilleo 2016). The findings in this analysis, that in 2015 energy efficiency programs held steady on average at $.031/kWh, support this continued trend. Figure 3 provides a meta-review of these past ACEEE datasets, converting all to 2014$ and using net savings at the meter when available.

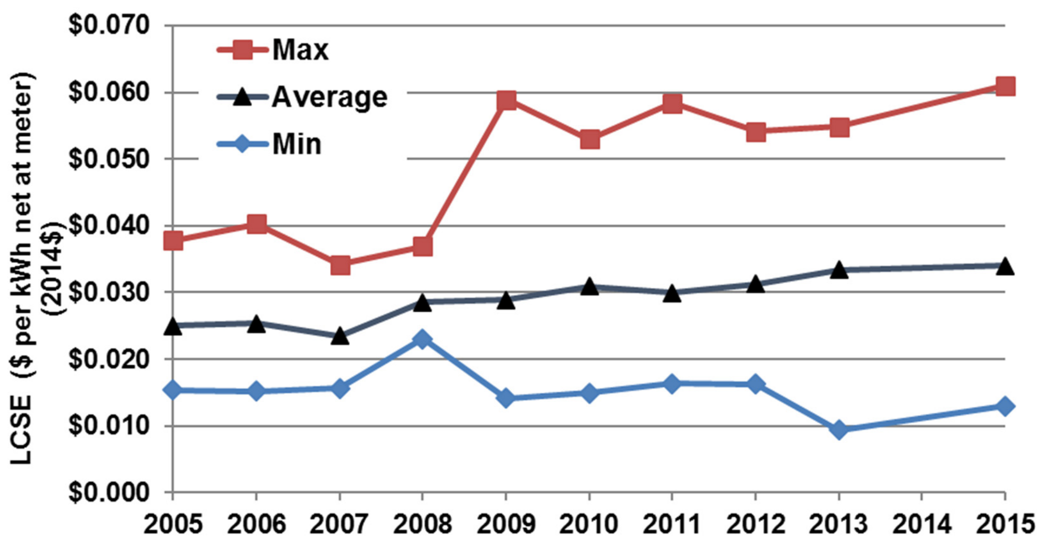

Figure 3. Levelized cost of saved electricity, 2005–2015 (2014$). *Source*: Data for 2005–2008 are from Friedrich et al. (2009). Data for 2009–2012 are from Molina (2014). Data for 2013 are from Baatz et al. (2016). Data for 2015 are from this analysis. Data for 2014 were not available. Note that slightly different approaches were used for each review.

Some caution is warranted in drawing direct comparisons between the results of the different reviews, since they used different datasets (i.e., the number and specific jurisdictions included) and slightly different methodologies. For example, the 2009 study did not review whether the LCSE captured net or gross energy savings, and it did not include utility shareholder incentives, both of which were addressed by Molina (2014), Baatz et al. (2016), and the current analysis.

Many observers expect the impending changes in federal lighting standards, which will cause fundamental changes to efficiency portfolios starting in about 2020, to have a significant impact on LCSE trends going forward. In 2014, LBNL examined the prevalence of lighting program savings in efficiency portfolios and cost of saved energy values for these programs and found that lighting rebate programs accounted for at least 44% of total residential lifetime savings (Billingsley 2014).[6] Because these savings are low cost, with a savings-weighted average LCSE of $.007/kWh, the residential LCSE increased from $.018/kWh to $.028/kWh when the lighting programs were removed.

Future work on LCSE should examine the impact of federal lighting standards on overall efficiency program costs. One the one hand, residential lighting programs account for a large portion of existing energy savings, and any significant changes would be expected to have changes on overall CSE values. On the other hand, the notion that all the "low-hanging fruit" of energy efficiency has been picked dates back years, and still the fruit keeps growing back as technology continues to improve and new energy management practices emerge. Innovations in smart homes and buildings, strategic energy management for commerce and industries, zero-net energy buildings, behavioral approaches, and geotargeted efficiency as a nonwires alternative provide several emerging areas for programs. However no silver bullet will replace the low-cost savings that lighting has dominated for years.

Comparing the Cost of Efficiency as a Utility Resource to Other Resource Options

Figure 4 shows the LCSE results from this analysis for 2015 alongside data from Lazard, an energy industry analysis firm, for national averages of new electricity generation options (Lazard 2017). The high (low) end for the efficiency range represents the portfolio-wide average for the utility with the maximum (minimum) LCSE values. An important caveat is that each jurisdiction's portfolio-wide average does not represent the full range of efficiency program costs. As LBNL research has shown, the ranges within a customer sector or within program types can vary widely (Billingsley et al. 2014). However portfolio-wide averages are a fair way to represent the costs of energy efficiency as a utility resource in aggregate.

On a levelized cost basis, new energy efficiency programs on average cost about 50% less than new natural gas combined cycle (NGCC) generation, are one-third the cost of community solar photovoltaic (PV), and significantly less than other new electricity generation resources such as coal integrated gasification combined cycle (IGCC) or nuclear. While utility-sector energy efficiency is still among the least-cost resources compared to other electricity resource options, the picture has changed in recent years as compared to new renewable resources. For example, levelized costs of electricity from solar and wind have fallen dramatically in recent years (Lazard 2017). Utility-scale solar costs have fallen 86% since 2009, from an average of about $.35/kWh to about $.05/kWh in 2017 (these are unsubsidized costs without federal tax credits).[7] On a levelized cost basis, efficiency is generally on par with the range of costs for wind or utility-scale solar, but the average efficiency cost of $.031 per kWh is less than that of wind or utility-scale solar.

Community and rooftop solar is a much different picture. With federal tax credits, community solar ranges from $.060 to $.119/kWh, and rooftop solar ranges from $.145 to

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[6] The authors noted "at least" 44% because other program types, such as whole-house programs, often also include lighting-related products.

[7] Utility-scale solar ranges from about $.035 to $.042/kWh with federal tax credits ($.043–$.053/kWh unsubsidized) (Lazard 2017).

$.24/kWh in the residential sector and $.066 to $.15 in the commercial and industrial (C&I) sector (not shown in Figure 4). While utility EE costs are much lower than these options, one could argue that the full costs of efficiency including participant costs are a more appropriate comparison to residential or commercial, customer-sited solar resources such as rooftop PV. When adding participant costs, one should also add a full set of participant benefits of these resources. Future analysis should examine this customer-level cost comparison.

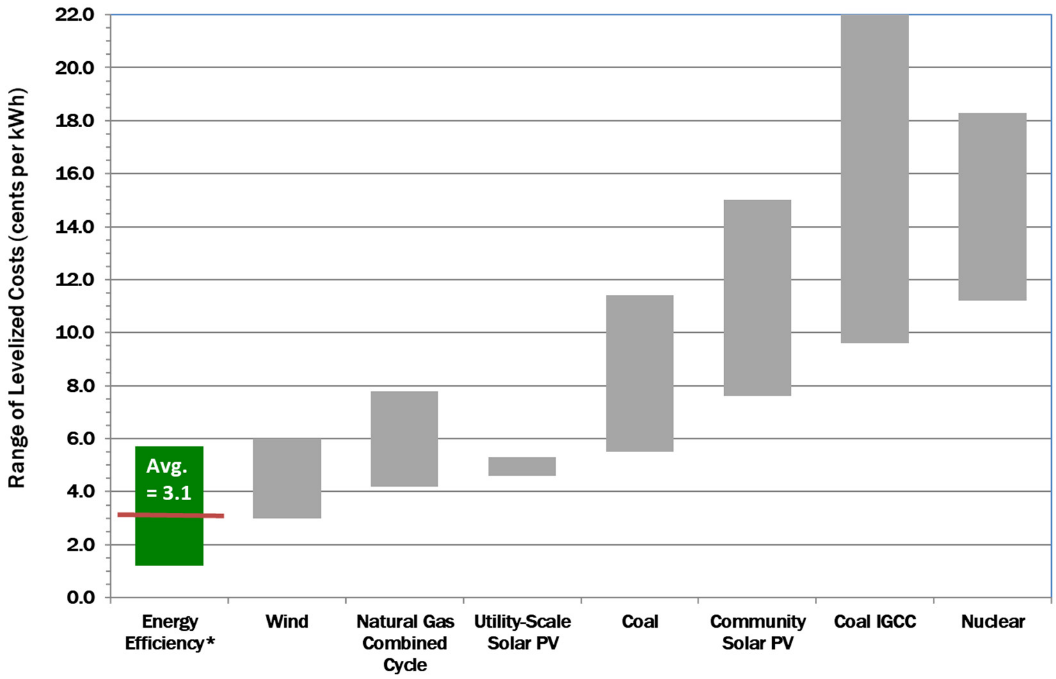

Figure 4. Levelized electricity resource costs. *Energy efficiency costs are utility/program administrator costs for 2015 and do not include participant costs. High-end range of coal includes 90% carbon capture and compression. *Source:* Energy efficiency program portfolio data from Molina and Relf 2018; the rest of the data are from Lazard 2017 and show unsubsidized costs.

Levelized costs of electricity is only one metric to compare energy resource options and has important limitations for comparing both demand- and supply-side options. For example, as EIA points out for supply-side resources, plant investment decisions are affected by the specific technological and regional characteristics of a project, which involve numerous other factors not reflected in levelized cost of energy (LCOE) values such as the projected utilization rate, the existing resource mix, and capacity values (EIA 2017). EIA further notes that (page 2) "the direct comparison of LCOE across technologies is often problematic and can be misleading as a method to assess economic competitiveness of various generation alternatives…" and that (page 3) "Conceptually, an alternative assessment of economic competitiveness between generation technologies can be gained by considering the avoided cost, a measure of what it would cost the grid to generate the electricity that would be displaced by a new generation project." The same limitation applies for demand-side projects and is why utilities and regulators use cost-benefit tests to evaluate EE cost effectiveness.

The time and locational value of energy resources, including energy efficiency, will increasingly become important as the utility industry undergoes a transformation to cleaner and more distributed energy resources. For example, solar and wind are variable resources that provide ample capacity at certain hours of the day. EE can and should play an important but evolving role in utility distributed resource planning, for example providing peak demand benefits and supporting renewable energy integration. Recent research by ACEEE found that most utilities are not using EE in distribution system planning, but several states are pursuing new approaches to using efficiency to displace traditional distribution infrastructure upgrades and integrate more renewables into the grid (Baatz et al. 2018). These states provide clear examples of how EE can be used as a resource on the distribution system.

Given the increasingly temporal and locational level of utility system planning, communicating the value of efficiency must evolve beyond a large focus on efficiency as the least-cost electricity resource. LCSE has always been a simplistic metric to convey the least-cost energy value that EE can provide to the utility system. Cost-effectiveness testing provides a more comprehensive approach to assessing the multiple attributes of efficiency, and while the application of those tests has varied by jurisdiction, recent efforts through the new National Standard Practice Manual (NSPM) indicate new momentum to improve tests and ensure they align with state policies.[8] Efficiency provides many benefits to the utility system, including capacity and peak demand reductions and reliability benefits, for example, and to society at large through environmental and economic benefits. The simplified LCSE metric is insufficient to convey these benefits. Full and balanced cost-effectiveness testing, using NSPM principles, should be used.

Conclusions and Future Research

By examining a new, large dataset for electric utility–sector EE programs, we find an average cost of $.031/kWh (net at the generator). We also find an average LCSE of $.029/kWh when low-income programs are not included, 7% less than total LCSE on average. Comparing these results to past results, we find that LCSE values for efficiency are holding steady as a least-cost electricity resource. However past trends are not necessarily an indication of future trends. Given the impending lighting program changes due to federal standards, LCSE values may increase. On the other hand, a growing set of EE strategies may provide sufficient opportunities to meet savings targets without an increase in average LCSE.

Efficiency has often been described as the least-cost electricity resource on a simple levelized cost basis. While this generally remains true as its average cost is lower than other resources, the steady decline in prices for solar and wind means that efficiency is often on par with these resources on a levelized cost basis. From a utility system planning perspective, the picture is much more complicated. The time and locational value of electricity resources is expected to play an increasing role in utility system planning, and EE data must evolve to meet the needs. For example, the Northwest Energy Efficiency Alliance is launching an end-use load research effort to help fill data gaps on the time value of energy consumption.[9] Other regions should pursue similar efforts.

Another area for further research is to determine lifetime values for efficiency measures, which have a large impact on the LCSE values and which varied widely in the dataset. Second, the shift of program portfolios away from a reliance on residential lighting programs will likely affect LCSE values and should be examined. Finally, we need to build upon LCSE, which is a simplified way to express energy efficiency costs, by refining metrics that easily communicate the broader set of attributes and full value of EE as a utility system resource.

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[8] nationalefficiencyscreening.org/national-standard-practice-manual/
[9] neea.org/get-involved/end-use-load-research

References

Baatz, B., A. Gilleo, and T. Barigye. 2016. *Big Savers: Experiences and Recent History of Program Administrators Achieving High Levels of Electric Savings*. Washington, D.C.: American Council for an Energy-Efficient Economy (ACEEE).

Baatz, B., G. Relf, and S. Nowak. 2018. The Role of Energy Efficiency in a Distributed Energy Future. Washington, D.C.: American Council for an Energy-Efficient Economy (ACEEE).

Billingsley, M., I.M. Hoffman, E. Stuart, S.R. Schiller, C.A. Goldman, and K. Hamachi LaCommare. (2014). *The Program Administrator Cost of Saved Energy for Utility Customer-Funded Energy Efficiency Programs.* Lawrence Berkeley National Laboratory.

Drehobl, A. and F. Castro-Alvarez. 2017. *Low-Income Energy Efficiency Programs: A Baseline Assessment of Programs Serving the 51 Largest Cities.* Washington, D.C.: American Council for an Energy-Efficient Economy (ACEEE).

EIA. 2017. "Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017." April. www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf

Friedrich, K., M. Eldridge, and D. York. 2009. *Saving Energy Cost-Effectively: A National Review.* Washington, DC: ACEEE.

Hoffman, I.M., G. Leventis, and C.A. Goldman. 2017. *Trends in the Program Administrator Cost of Saving Electricity for Utility Customer-Funded Energy Efficiency Programs.* Lawrence Berkeley National Laboratory. LBNL-1007009. January.

Hoffman, I.M., G.M. Rybka, G. Leventis, C.A. Goldman, L.C. Schwartz, M.A. Billingsley, and S.R. Schiller. 2015. *The Total Cost of Saving Electricity Through Utility Customer-Funded Energy Efficiency Programs: Estimates at the National, State, Sector and Program Level. Lawrence Berkeley National Laboratory*. April.

Kushler, M., D. York, and P. Witte. 2004. *Five Years In: An Examination of the First Half-Decade of Public Benefits Energy Efficiency Policies.* Washington, DC: ACEEE.

Lazard. 2017. www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf

Molina, M. 2014. *The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs.* Washington, D.C.: ACEEE.

Relf, G., B. Baatz and S. Nowak. *The 2017 Utility Energy Efficiency Scorecard.* aceee.org/research-report/u1707. Washington, D.C.: ACEEE.