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The Program Administrator Cost of Saved Energy for Utility Customer-Funded Energy Efficiency Programs

Megan A. Billingsley, Ian M. Hoffman, Elizabeth Stuart, Steven R. Schiller, Charles A. Goldman, Kristina LaCommare

Environmental Energy Technologies Division

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Prepared for the
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Disclaimer

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Acronyms and Abbreviations

ACEEE	American Council for and Energy-efficient Economy
C&I	commercial and industrial (private sector)
CCE	Cost of conserved energy
CEE	Consortium for Energy Efficiency
CSE	Cost of saved energy
DOE	U.S. Department of Energy
DSM	Demand-Side Management
EIA	Energy Information Administration
EERS	Energy Efficiency Resource Standards
HVAC	heating, ventilation, air conditioning
LCOE	Levelized cost of energy
MUSH	Municipal and state governments, universities and colleges, K-12 schools, and healthcare markets
WACC	Weighted average cost of capital

Executive Summary

End-use energy efficiency is increasingly being relied upon as a resource for meeting electricity and natural gas utility system needs within the United States. There is a direct connection between the maturation of energy efficiency as a resource and the need for consistent, high-quality data and reporting of efficiency program costs and impacts. To support this effort, LBNL initiated the Cost of Saved Energy Project (CSE Project) and created a Demand-Side Management (DSM) Program Impacts Database to provide a resource for policy makers, regulators, and the efficiency industry as a whole.

This study is the first technical report of the LBNL CSE Project and provides an overview of the project scope, approach, and initial findings, including:

- Providing a *proof of concept* that the program-level cost and savings data can be collected, organized, and analyzed in a systematic fashion;
- Presenting initial program, sector, and portfolio level results for the program administrator CSE for a recent time period (2009-2011); and
- Encouraging state and regional entities to establish common reporting definitions and formats that would make the collection and comparison of CSE data more reliable.

Cost of Saved Energy (CSE) vs. Cost Effectiveness

The program administrator's cost of saved energy is a useful metric for comparing the relative costs of efficiency programs and for comparing an energy efficiency option to other demand and supply choices for serving energy needs. The CSE is comparable to the levelized cost of energy (LCOE), which represents the per-kilowatt hour cost (in real dollars) of building and operating a generating plant over an assumed financial life and duty cycle.

The cost of saved energy is not a direct test of cost effectiveness, however, and is not a benefit-cost analysis, like the Program Administrator's Cost Test or Utility Cost Test, because it does not purport to capture the monetized value of efficiency to utility customers and shareholders.

The LBNL DSM Program Impacts Database includes the program results reported to state regulators by more than 100 program administrators in 31 states, primarily for the years 2009–2011. In total, we have compiled cost and energy savings data on more than 1,700 programs over one or more program-years for a total of more than 4,000 program-years' worth of data, providing a rich dataset for analyses. We use the information to report costs-per-unit of electricity and natural gas savings for utility customer-funded, end-use energy efficiency programs. The program administrator CSE values are presented at national, state, and regional levels by market sector (e.g., commercial, industrial, residential) and by program type (e.g., residential whole home programs, commercial new construction, commercial/industrial custom rebate programs).

In this report, the focus is on gross energy savings and the costs borne by the program administrator—including administration, payments to implementation contractors, marketing, incentives to program participants (end users) and both midstream and upstream trade allies, and evaluation costs.[1] We collected data on net savings and costs incurred by program participants. However, there were insufficient data on participant cost contributions, and uncertainty and variability in the ways in which net savings were reported and defined across states (and program administrators). As a result, they were not used extensively in this report. It is also important to note that savings metrics reported by program administrators draw heavily from estimated values.[2]

Key Definitions

Program administrator costs include administrative, education, marketing and outreach, and evaluation, measurement and verification (EM&V) costs as well as financial incentives paid to customers or contractors. The CSE values exclude participant costs, and program administrator performance incentives, and, thus, do not represent the total resource cost unless indicated otherwise.

Program savings are based on **claimed gross savings** reported by the program administrator unless indicated otherwise. For program administrators that only reported net savings values, we calculated gross savings values using net-to-gross ratios if those were available from the program administrator.

Savings values are also based on **savings at the end-use site** and not at the power plant or natural gas pumping station and thus do not account for transmission and distribution losses.

Lifetime energy savings, when not reported by the program administrator, were calculated per the protocol described in Chapter 2.

Cost of First-Year Energy Savings (First-Year CSE): The cost of acquiring a single year of annualized incremental energy savings through actions taken through a program/sector/portfolio. The cost of efficiency as a function of first-year energy savings may be useful for program design or budgeting to meet incremental annual savings targets.

Levelized Cost of Lifetime Energy Savings (Levelized CSE): The cost of acquiring energy savings that accrue over the economic lifetime of the actions taken through a program/sector/portfolio, amortized over that lifetime and discounted back to the year in which the costs are paid and the actions are taken.

[1] Researchers who have estimated the cost of saved energy for efficiency programs have typically focused on the program administrator's costs because data on participant costs are often not available (Friedrich et al. 2009). Gross savings are those associated with the program participants' efficiency actions, irrespective of the cause of those actions. Net savings is defined as the total change in energy use that is attributable to a program (for both program participants and non-participants).

[2] Savings metrics rely heavily on estimated values because "….energy and demand savings as well as non-energy benefits resulting from efficiency actions cannot be directly measured. Instead, savings and benefits are based on counterfactual assumptions. Using counterfactual assumptions implies that savings are estimated to varying degrees of accuracy by comparing the situation (e.g., energy consumption) after a program is implemented (the reporting period) to what is assumed to have been the situation in the absence of the program (the "counterfactual" scenario, known as the baseline). For energy impacts, the baseline and reporting period energy use are compared, while controlling (making adjustments) for factors unrelated to energy efficiency actions, such as weather or building occupancy. These adjustments are a major part of the evaluation process; how they are determined can vary from one program type to another and from one evaluation approach to another. " (SEE Action Network 2012)

Results

The CSE values presented in this study are retrospective and may not necessarily reflect future CSE for specific programs, particularly given updated appliance and lighting standards. The CSE values are presented as either (a) the savings-weighted average values; (b) as an inter-quartile range with median[3] values across the sample of programs; or (c) both.

Table ES-1 provides an overall indication of national, savings-weighted average program administrator CSE values by sector using two indicators (e.g., levelized CSE 6% real discount rate and first-year CSE).[4] Figure ES-1 indicates the savings-weighted averages, medians and inter-quartile ranges for levelized CSE values using a 6% discount rate.

Table ES-1. The program administrator CSE for electricity efficiency programs for 2009-2011 data in the LBNL DSM Program Impacts Database (2012$/kWh)

Sector	Levelized CSE ($/kwh; 6% discount rate)	First-Year CSE ($/kwh)
Commercial & Industrial (C&I)	$ 0.021	$ 0.188
Residential	$ 0.018	$ 0.116
Low Income	$ 0.070	$ 0.569
Cross Sectoral/Other	$ 0.017	$ 0.120
National CSE	**$ 0.021**	**$ 0.162**

Values in this table are based on the 2009-2011 data in the LBNL DSM Program Impacts Database. CSE values are for ***program*** *administrator costs and based on gross savings.*

[3] The *inter-quartile range* is the middle 50 percent of the range of program CSE values. The *median* is the numerical value separating the upper half of a data sample from the lower half.
[4] We calculated a levelized CSE using two discount rates that are rough proxies for different perspectives on energy efficiency investments: a 6% real discount rate that can reflect the utility weighted average cost of capital (WACC) and a 3% real discount rate that can be a proxy for a societal perspective.

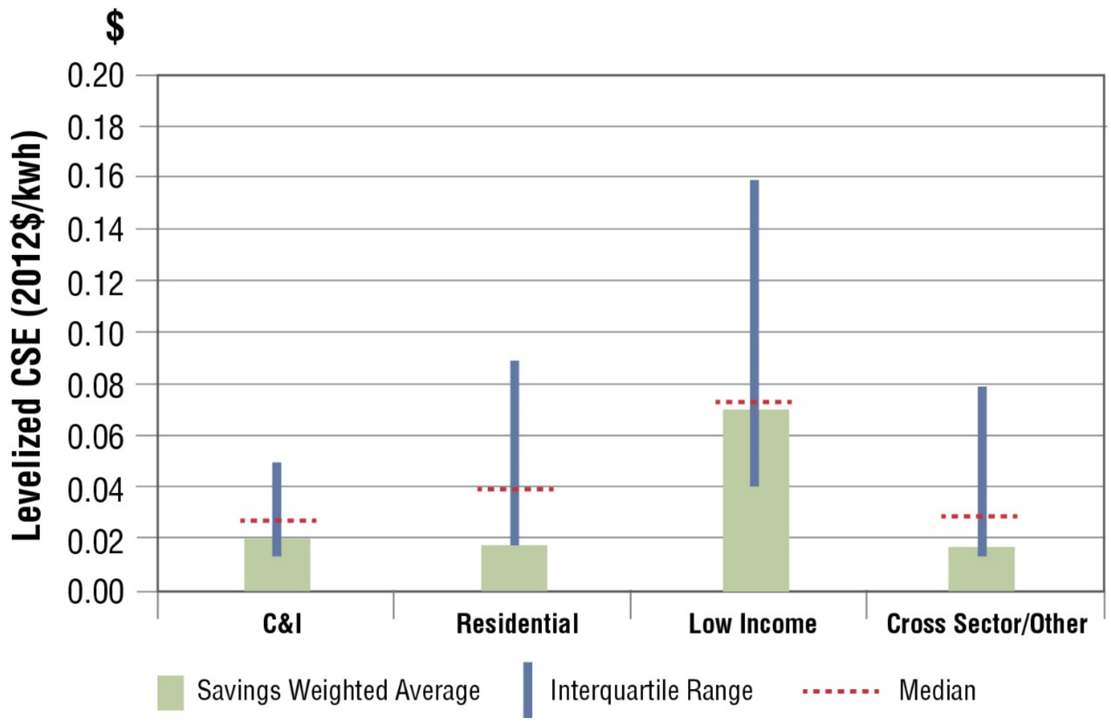

Figure ES-1. CSE for electricity efficiency programs by sector for 2009-2011 data in the LBNL DSM Program Impacts Database

Our key national and regional findings are:[5]

- The U.S. average levelized CSE was slightly more than two cents per kilowatt-hour when gross savings and spending is aggregated at the national level and the CSE is weighted by savings.
- Residential electricity efficiency programs had the lowest average levelized CSE at $0.018/kWh. Lighting rebate programs accounted for at least 44% of total residential lifetime savings with a savings-weighted average levelized CSE of $0.007/kWh. The residential CSE, when the lighting programs were removed, was $0.028/kWh. Low-income programs have an average levelized CSE at $0.070/kWh.
- Commercial, industrial and agricultural (C&I) programs had an average levelized CSE of $0.021/kWh.
- Not surprisingly, the levelized CSE varies widely, both among and within program types. We find that the median value is typically higher than the savings-weighted average for nearly all types of programs. One possible explanation is that our sample includes a number of very large programs and for any given program type, larger efficiency programs have lower CSE than smaller programs because administrative costs are spread over more projects (e.g., economies of scale).
- In reviewing regional results, efficiency programs in the Midwest had the lowest average levelized CSE ($0.014/kWh), while programs in northeast states had a higher

[5] Key findings in this section use savings-weighted average CSE values that include program administrator costs (in 2012$) and reported gross savings, which are levelized using a 6% real discount rate.

average CSE value ($0.033/kWh). Programs in western states are at $0.023/kWh and for the southern states included in the database, the comparable program CSE was $0.028/kWh.

- Natural gas efficiency programs had a national, program administrator savings-weighted average CSE of $0.38 per therm, with significant differences between the C&I and residential sectors (average values of $0.17 vs. $0.56 per therm, respectively).
- The cost of saved energy may vary across program administrator portfolios for reasons that have little to do with programmatic efficiency. In some jurisdictions, a policy mandate of acquiring all reasonably available cost-effective energy efficiency can lead to a focus on more comprehensive programs which will tend to have a higher CSE because they are serving more diverse constituencies and technologies. In other jurisdictions, the focus may be on acquiring the cheapest savings possible.

Program-level results

We also examined the cost of saved energy by program type for both residential and C&I programs (see Chapter 3). Figure ES-2 shows an example for the C&I programs, including savings-weighted average (pale green bar) CSE values, the inter-quartile ranges (blue line) and median (red dotted line) CSE values. The median value and inter-quartile ranges for CSE are based on calculations for each individual program and gives equal weighting to programs irrespective of their relative size in terms of either savings or costs.

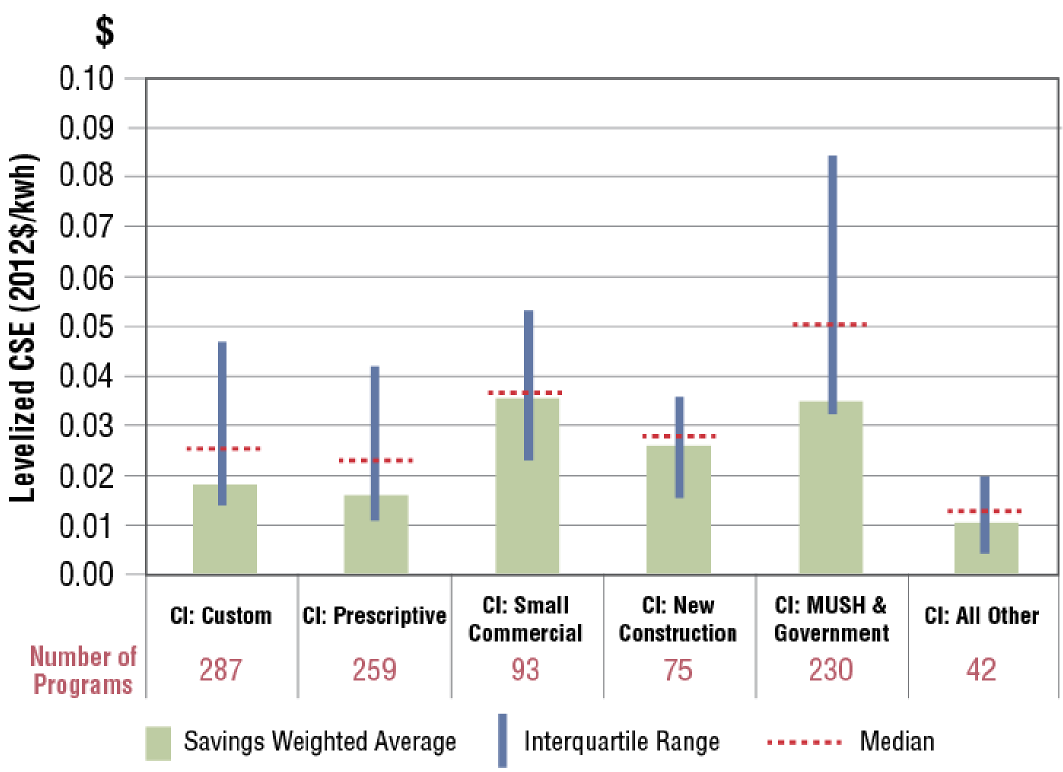

Figure ES-2. National levelized CSE for C&I sector simplified program categories

The simplified C&I programs have median values for program administrator CSE that range from $0.01/kWh to $0.05/kWh. It is worth noting that the savings-weighted average CSE values for custom and prescriptive rebate program categories are $0.018/kWh and $0.015/kWh, respectively. Since these two program categories account for almost 70% of C&I sector savings, they tend to drive the overall CSE results for the C&I sector (less than $0.02/kWh).

For the residential programs, several program categories have a relatively tight range of program CSE values (see Figure ES-3). For example, Consumer Product Rebate programs have an inter-quartile range of $0.01/kWh to $0.04/kWh and a low savings-weighted average (~$0.01/kWh). However, the residential prescriptive ($0.03/kWh to $0.11/kWh), new construction ($0.03/kWh to $0.11/kWh) and whole-home upgrade ($0.03/kWh to $0.21/kWh) program types have significantly larger ranges. There are several possible reasons for the range of CSE values in each of these program categories. The prescriptive simplified program category includes detailed program types that implement a wide variety of measures (e.g., HVAC, insulation, windows, pool pumps) as well as some generic "prescriptive" programs[6] that often include measures also found in the consumer product rebate category. This broad measure mix—and the variation in costs and measure lifetimes associated with those measures—are possible drivers for the wide range of CSE values for the prescriptive category.

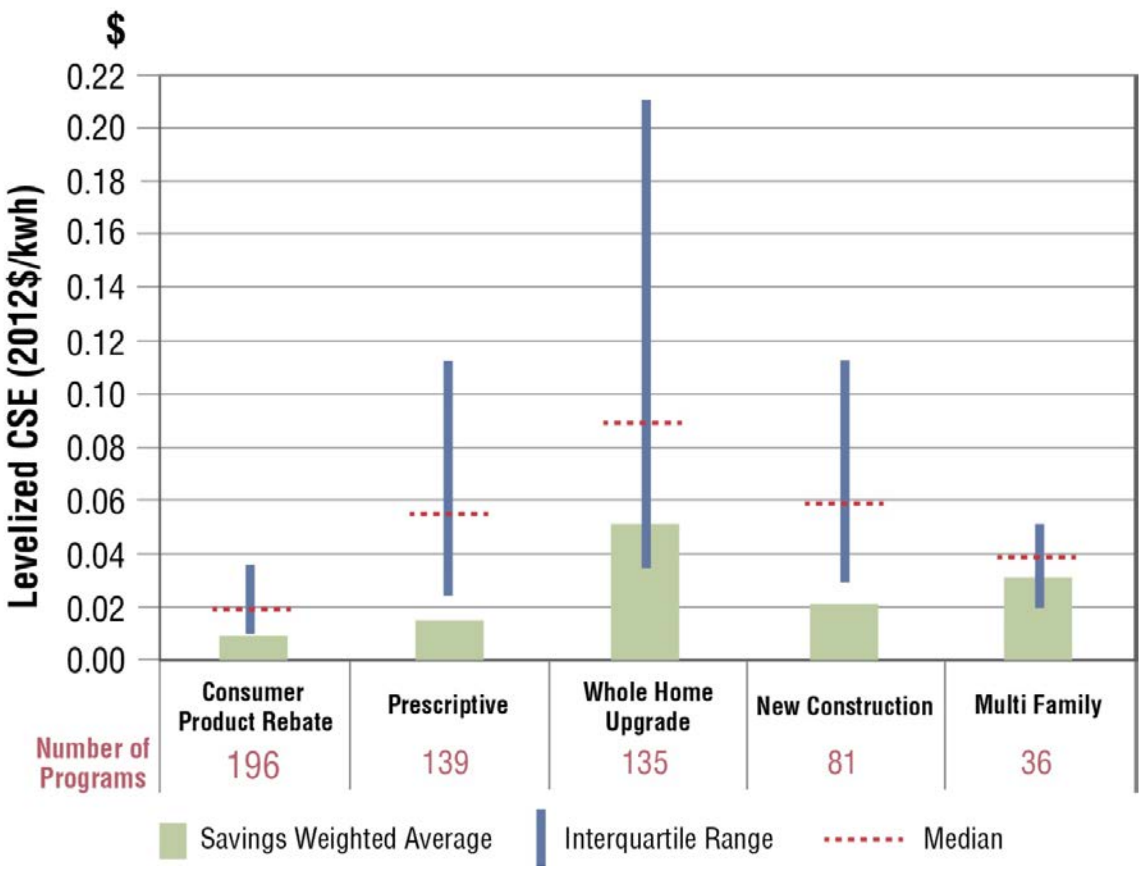

Figure ES-3. National levelized CSE for residential sector simplified program categories

[6] Some programs include all their rebated measures under the same program title and it is not possible to determine where the majority of the savings is coming from. In these cases, the programs were categorized as "Residential Prescriptive."

For the Whole-Home Upgrade program category, the broad range of program designs and delivery mechanisms (this category includes audit, direct install, and retrofit/upgrade programs) may help explain the relatively wide range of CSE values. Overall, most C&I program categories have a relatively smaller inter-quartile range of CSE values compared to residential program categories.

Total resource cost of saved energy

Although we focus on program administrator costs in this report, it is important to note that these metrics do not reflect a total cost perspective since program administrators infrequently report participant costs. We were able to collect participant cost data from a handful of program administrators. However, given small sample size and uncertainty in how participant costs were derived, it is difficult to confidently assess the "all-in" or total resource cost of efficiency or analyze potential influences on the total cost of the efficiency resource. For these reasons, in Figure ES-4, we compare the program administrator's levelized CSE vs. a total resource levelized CSE for illustrative purposes only. We calculate this total resource CSE for the simplified program categories where both program administrator and participant costs are available for more than 18 program years.[7]

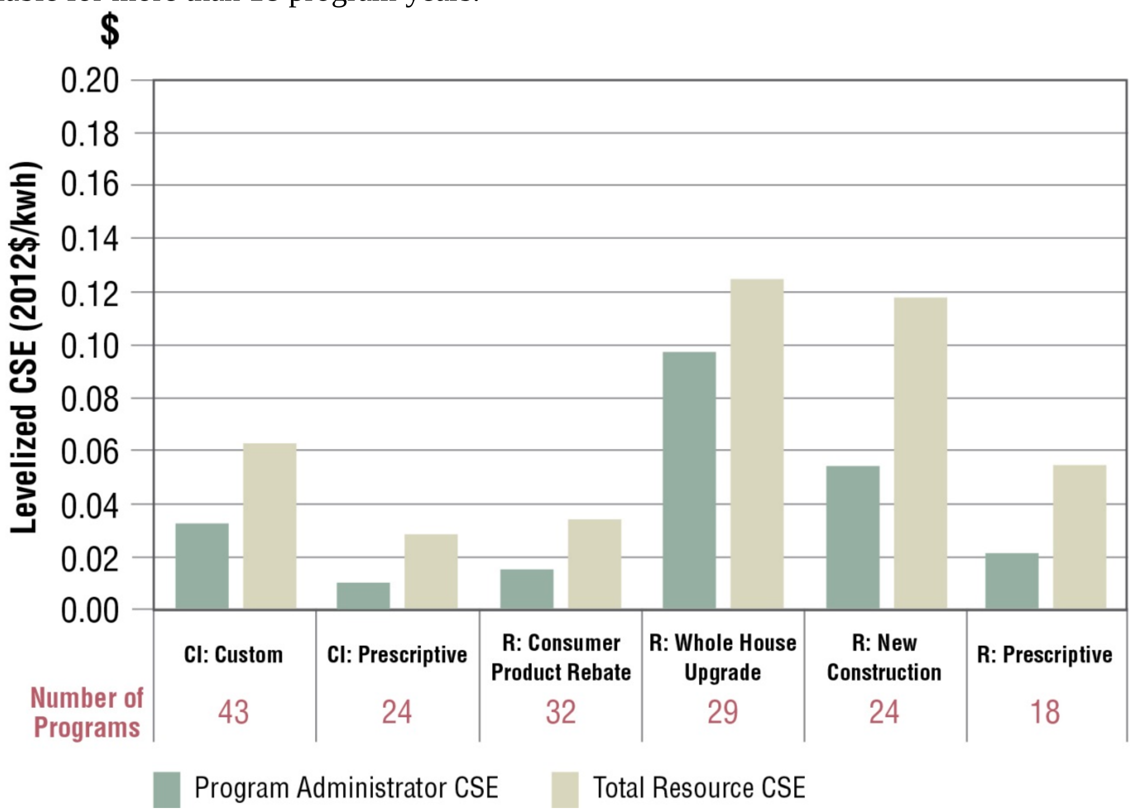

Figure ES-4. Levelized savings-weighted average CSE for electricity efficiency programs that include program administrator costs vs. total resource costs for select program categories[8]

[7] The "n" of 18 was selected because there was a natural break in the data and there were a meaningful number of programs from which to calculate average values.

[8] This chart includes a very small sample of programs from 11 states; thus, results may not reflect current practices in many jurisdictions.

For this small sample of programs, we found that the levelized total resource CSE values are typically double the program administrator CSE with the exception of the Residential Whole Home Upgrade program category (which has a savings-weighted total resource CSE that is about 25-30% higher than the program administrator CSE). Further data collection and analyses could better characterize the way in which the ratio of program administrator costs to participant costs varies as a function of sector, measure types, and market maturity; and how incentives and direct support might be optimized to pay no more than is necessary to meet a state's efficiency policy objectives.

Observations and Recommendations on Reporting

In calculating the CSE, we utilized information on program administrator costs, annual energy savings, estimated lifetime of measures installed in a program, and an assumed discount rate. However, with respect to current program reporting practices, we observed several challenges to the collection of this data for the purposes of calculating the CSE:

- Inconsistencies in the quality and quantity of the costs and savings data led LBNL to develop and attempt to apply consistent data definitions in reviewing and entering program data:
  - Program administrators in different states did not define savings metrics (e.g., varying definitions of net savings) and program costs consistently; and
  - Market sectors and program types were not characterized in a consistent fashion among program administrators.
- Many program administrators did not provide the basic data needed to calculate CSE values at the program level (i.e., program administrator costs, lifetime savings, or program-average measure lifetimes), which can introduce uncertainties into the calculation of CSE values (as we developed and utilized methods to impute missing values in some cases).

As a practical matter, the quality and quantity of program data reported by program administrators is an important factor in assessing energy efficiency as a resource in the utility sector. Additional rigor, completeness, standard terms, and consensus on at least essential elements of reporting could pay significant dividends for program administrators and increase confidence in energy efficiency savings among policymakers and other stakeholders—particularly in situations where efficiency is treated as a resource in utility procurement decisions, ISO/RTO forward capacity markets, or as an environmental compliance or mitigation option by state or federal environmental agencies.

Of the 45 states currently running utility-customer funded efficiency programs (Barbose et al. 2013), only 31 states provided reporting with sufficient transparency to complete a program-level CSE analysis, and almost all of the 31 states' data required some interpretation for purposes of regional or national comparison. With more consistent and comprehensive reporting of program results, additional insights can quite possibly be obtained on trends in the costs of energy efficiency as a resource as program administrators scale up efforts, what saving energy costs among an array of strategies, and what and how cost efficiencies might be achieved.

Therefore, we urge state regulators and program administrators to consider annually reporting certain essential data fields at a portfolio level and more comprehensive reporting of program-level data in order to facilitate the comparison of efficiency program results at state, regional, and national levels. A diagram illustrating this reporting hierarchy approach can be found in Chapter 5, Figure 5-1.

As part of the LBNL CSE Project, we intend to continue collecting energy efficiency program data and analyzing and reporting the CSE for efficiency actions funded by utility customers. We also plan to:

- Work with state, regional, and national stakeholders to encourage the collection of program cost and impact data using a common terminology and program typology as defined in this report and a companion policy brief (Hoffman et al. 2013). This is important for organizing program data into appropriate and consistent categories so that programmatic energy efficiency, as a regional and national resource, can be reliably assessed.
- Annually compile data reported by program administrators and state agencies from across the United States.
- Conduct additional analyses to help increase understanding of factors that influence EE program impacts, costs and the cost of saved energy.

1. Introduction

Demand side management (DSM), and end-use energy efficiency specifically, is increasingly being relied upon as a resource for meeting electricity and natural gas system needs within the United States, often because efficiency is quite cost-effective compared to other resource options. For example, 15 states have enacted long-term, binding energy savings targets, often called Energy Efficiency Resource Standards (EERS), and another five states have mandates that program administrators must acquire "all cost-effective energy efficiency."[9] In 2011, U.S. energy efficiency program administrators that manage utility customer-funded efficiency programs spent about $5.4 billion on electric and gas energy efficiency programs (CEE 2013), with spending projected to possibly more than double by 2025 (Barbose et al. 2013).

Electric and natural gas energy efficiency in the United States is pursued through a diverse mix of policies and programmatic efforts, which support and supplement private investments by individuals and businesses. These efforts include federal and state minimum efficiency standards for electric and gas end-use products; state building energy codes; a national efficiency labeling program (ENERGY STAR®); tax credits; and a broad array of largely incentive-based programs for consumers, funded primarily by electric and natural gas utility customers (Dixon et al. 2010) (Barbose et al. 2013).[10]

These utility customer-funded efficiency programs are overseen by state regulators and administered by more than 100 different entities (e.g., utilities, state energy agencies, non-profit and for-profit third parties) and are the focus of this study. Policymakers, regulators, program administrators and implementers rely on information about lifetime costs and savings of these customer-funded efficiency programs to assess efficiency's potential, to design and implement programs in a cost-effective manner or to improve program cost effectiveness. Given the expected growth in efficiency funding and the importance of understanding the cost of saved energy (CSE), we initiated this LBNL Cost of Saved Energy Project (CSE Project) to provide a resource for policy makers, regulators and the efficiency industry as a whole.

1.1 Assessing Energy Efficiency as a Resource

The cost and cost effectiveness of utility-customer funded end-use efficiency programs depend on perspective. From the perspective of a participant in a program, their cost is the cost of an efficiency project net of any incentives or support that might be provided by a program administrator. From the program administrator's perspective, it is the cost of planning, designing, and implementing a program and providing incentives to market allies and end users to take actions that result in energy savings; costs incurred by participants are not considered as part of the program administrator's costs. The total resource or societal cost perspective takes into

[9] States with an EERS as of the date of this report are: AZ, CA, CO, HI, IL, IN, MD, MI, MN, MO, NM, NY, OH, PA, and TX. Six states have a mandate to achieve all cost-effective savings: CA, CT, MA, RI, VT, and WA.

[10] For additional energy efficiency market background, please see: The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025. http://emp.lbl.gov/publications/future-utility-customer-funded-energy-efficiency-programs-united-states-projected-spend

account the costs paid by both the program administrator and the participant to implement the efficiency action.

Numerous researchers have estimated the CSE for efficiency programs funded by utility customers (see Appendix A for a description of past and current efforts). These researchers have typically focused on the program administrator perspective (i.e., the program administrator CSE), for two primary reasons. First, in some cases, participant costs are often not collected or reported by program administrators in annual reports (see Chapter 2). Second, when comparing efficiency with supply side resources, some consider that the proper metric is the money paid to obtain the resource by the program administrator as supply-side resources do not consider, or have, participant costs. For this report, primarily because of the first reason, we present program administrator CSE data and analyses.

Another consideration for assessing efficiency as a resource is whether CSE values are based on net or gross savings. Net savings are those attributed to a program (for both program participants and non-participants). Gross savings are those associated with the program participants' efficiency actions, irrespective of the cause of those actions. There is debate about the proper use of net and gross savings in CSE calculations (SEE Action 2012); however, since there is neither sufficient nor consistent data available on net savings, we present CSE values based on gross savings in this study.

1.2 Objectives and Scope

This CSE Project presents and analyzes the costs of acquiring energy savings for different efficiency program types and in different market sectors across the United States. Our objectives are to provide insight into the costs associated with saving a unit of energy and the potential factors that influence those costs. To this end, we hope our work will:

- Benefit policy makers, system planners and other stakeholders by providing continually improving CSE indicators that enable projections of future spending and savings.
- Enable more cost-effective efficiency programs by:
    - Benchmarking and comparing program implementation approaches across different markets (e.g., industrial, commercial, small commercial), delivery mechanisms (e.g., direct install versus do it yourself), and design approaches (e.g., prescriptive versus custom rebates);
    - Analyzing contextual factors that affect CSE, such as types of programs, measures, program administrator experience, changes in building energy codes and standards, labor costs, climate, state-level policies, and the scale of efficiency investments.

This study is the first technical report of the LBNL CSE Project and provides an overview of project scope, approach and initial findings, including:

- Providing a *proof of concept* that the program-level cost and savings data can be collected, organized and analyzed in a systematic fashion;

- Presenting initial program, sector and portfolio level results for the cost of saved energy for a recent time period (2009-2011); and
- Encouraging state and regional entities to establish common reporting definitions and formats that would make the collection and comparison of CSE data more reliable.

Specifically, this report includes and discusses elements of our approach, including the following:

- Developing the data collection, documentation, and analyses procedures LBNL used to calculate the CSE (Chapter 2);
- Defining program categories as well as cost and savings definitions that allow for consistent, standardized entry of program administrator data into a CSE database (Chapter 2);
- Developing a database of program-level data on energy efficiency program impacts and costs from states with significant utility customer-funded energy efficiency programs (Chapter 2);
- Presenting the range of regional-, state-, sector-, and portfolio-level energy-efficiency program administrator CSE and program-level CSE for a defined set of over 60 program categories (Chapter 3);
- Exploring potential relationships between the program administrator costs of saved energy for specific types of programs and climate zones and adopted building energy codes (Chapter 3);
- Conduct a preliminary statistical analysis that explores factors that may be associated with and influence the cost of saved energy at the portfolio or program level and set the stage for future analyses that will assess additional hypotheses and a broader, more refined range of factors (Chapter 4); and
- Present recommendations for future data collection and analyses (Chapter 5).

1.3 Report Organization

The remainder of this report is organized as follows. Chapter 2 provides an overview of approach used to collect data in the LBNL DSM Program Impacts Database and the challenges associated with collecting, organizing and analyzing the data in a consistent fashion. In Chapter 3, we present descriptive statistics on efficiency program costs and savings followed by presentation of CSE statistics at a national, sector, regional, and state level and for certain program types and in relation to climate zones and building code status. In Chapter 4, we discuss our efforts to define and statistically test some factors that may influence the CSE. Chapter 5 presents a discussion of the key findings and recommendations for regulators and program administrators to consider with respect to CSE-related data collection and reporting.

The appendices contain documentation on topics covered in the chapters, including tables of CSE metrics by region, sectors, and program types in Appendix E.

2. Approach

The state-by-state evolution of utility customer-funded energy efficiency programs has fostered diversity in these programs' oversight, design, administration and evaluation. Thus, not surprisingly, information provided to state regulators by program administrators on the impacts and costs of efficiency programs is diverse with respect to the level of specificity and detail required as well as terms and definitions used to describe the costs and impacts of individual programs. In this chapter, we summarize our assembled program data, discuss our approach to compiling, organizing and analyzing the data in a manner that addresses the diversity in reporting practices yet allows for consistent reporting on the cost of saved energy across the country and on the basis of region, market sector, and type of program. This approach included developing an energy efficiency program typology and adopting standard definitions for program characteristics, cost and savings data. We also discuss several major challenges associated with collecting and analyzing program cost and impact data and calculating CSE values given data quality issues.

2.1 Data Summary

The data for this study were drawn from annual reports, mostly for the years 2009–2011, which were prepared by program administrators of efficiency programs funded by the customers of U.S. investor-owned utilities in 31 states. Our energy efficiency program data set comprises expenditure, energy savings and program participation data (where available) reported by 107 program administrators, for a total of 4,184 program records (see Table 2-1).

We relied primarily on annual DSM or efficiency reports filed by program administrators with state regulatory agencies because they both typically include data for a portfolio of programs and are publicly available from state regulatory commission filings.[11] In some cases, when data were not found or were ambiguous in annual reports, we consulted other reports (e.g., other performance metrics reports filed by investor-owned utilities in California) or solicited additional information directly from the program administrator or regulatory staff. Where required data were not provided in a program administrator's filed annual report, but provided in third-party program evaluation reports that were included as attachments to the program administrator annual reports, we used data from both to populate what we are calling the LBNL DSM Program Impacts Database (database).[12,13]

[11] The states included in this analysis were selected based on the availability and transparency of program cost and savings data at the individual program level as identified by LBNL researchers in a recent review of customer-funded energy-efficiency programs (Barbose et al. 2013). To the extent that reports were accessible, we collected data for all investor-owned utilities (IOUs) in the target states. Many program administrators had not yet released 2012 program year results during the data collection period for this study; thus our analysis focuses on the 2009-2011 period. We did not include program data from publicly-owned electric utilities and rural electric cooperatives because these utilities often do not report program level data that is publicly available. Future efforts may include data collected from public utilities.

[12] We did not rely on individual impact evaluation studies of efficiency programs because the data of interest to this project are usually reported in relatively easily accessible summary form and per program in the annual reports filed with regulators. Moreover, evaluations of individual programs are not always publicly available nor do they always include program or portfolio-related costs.

[13] Appendix C describes data that was collected for this research effort, the database configuration, and the data quality assurance/quality control process and procedures.

Table 2-1. Summary of energy efficiency program data in LBNL DSM Program Impacts Database[14]

State	First Year of Data	Last Year of Data	Total # of Years	Number of Program Administrators*	Number of Program Records
AZ	2010	2011	2	3	65
CA	2010	2012	3	4	1210
CO	2009	2011	3	1	110
CT	2009	2011	3	4	60
FL	2011	2011	1	5	88
HI	2009	2011	3	1	21
IA	2009	2011	3	3	171
ID	2010	2011	2	1	40
IL	2008	2011	4	2	85
IN	2009	2012	4	5	244
MA	2009	2011	3	11	403
MD	2010	2011	2	4	126
ME	2009	2011	3	2	22
MI	2009	2011	3	2	81
MN	2009	2011	3	2	141
MT	2011	2011	1	1	19
NC	2009	2011	3	2	37
NH	2009	2011	3	4	90
NJ	2009	2011	3	1	40
NM	2010	2011	2	4	101
NV	2009	2011	3	3	209
NY	2009	2011	3	11	111
OH	2009	2011	3	7	170
OR	2009	2011	3	2	16
PA	2009	2010	2	6	143
RI	2010	2011	2	2	36
TX	2010	2011	2	10	202

[14] "Number of Program Records" includes programs that produced energy savings (e.g., residential or commercial rebate programs), programs for which the program administrator did not claim savings (e.g., education and outreach programs or pilot programs), and, in some cases, sector- or portfolio-wide activities (e.g., marketing or internal program evaluation activities).

State	First Year of Data	Last Year of Data	Total # of Years	Number of Program Administrators*	Number of Program Records
UT	2009	2011	3	1	41
VT	2009	2011	3	1	18
WA	2010	2011	2	1	42
WI	2009	2011	3	1	42
	Totals			**107**	**4184**

** In some cases, program administrators who run both gas and electric programs are counted twice for the purposes of separating the reported effects of each program.*

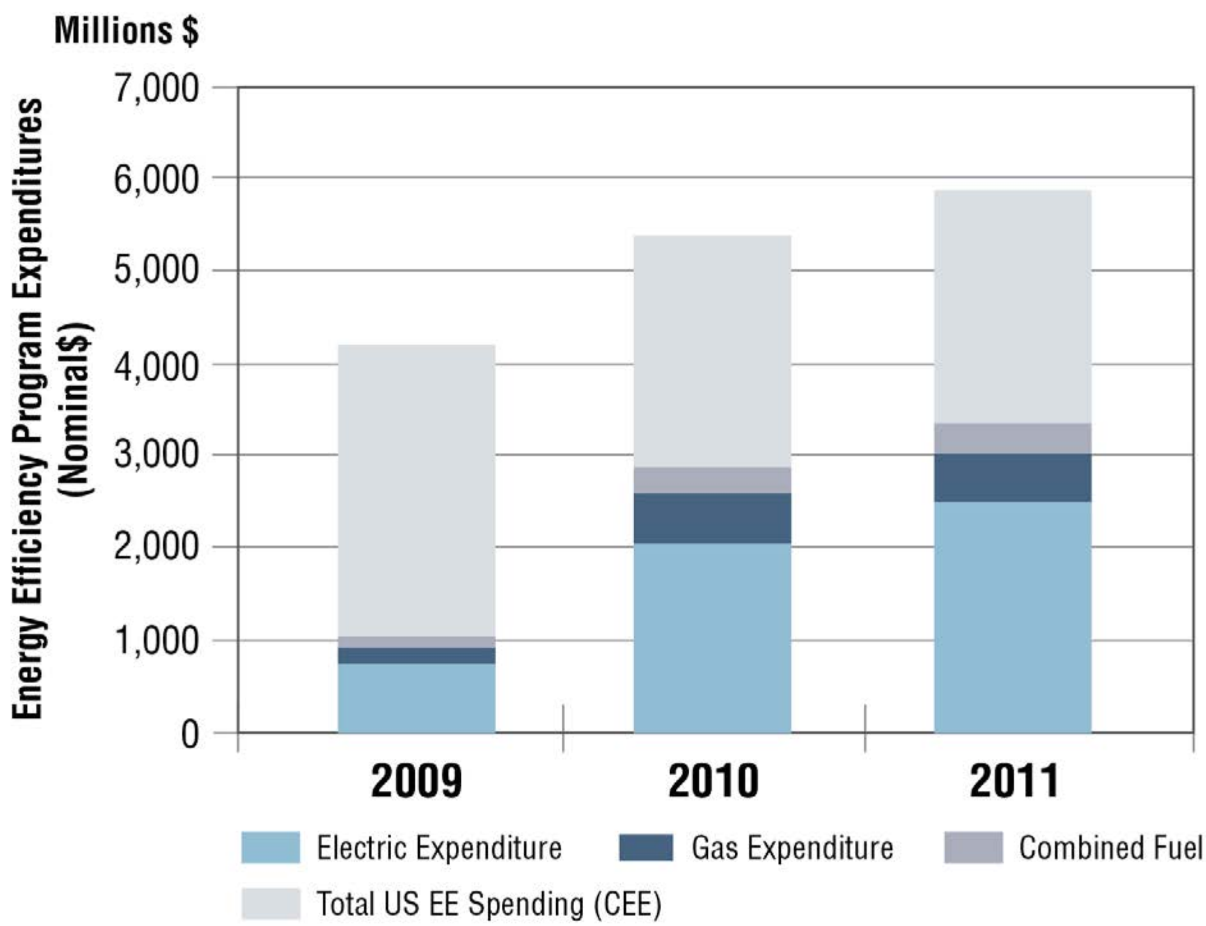

Figure 2-1. LBNL DSM Program Impacts Database coverage as compared to national efficiency spending reported by Consortium for Energy Efficiency (CEE)[15]

[15] CEE Annual Industry Reports can be found here: http://www.cee1.org/annual-industry-reports

The efficiency program data that were compiled by LBNL staff into the database represent a significant share of all efficiency programs funded by utility customers in the United States. The database contains programs with total program administrator expenditures of about $7.6 billion (see light and dark blue shading in Figure 2-1). Programs in the LBNL database represent about 25% ($1.1 billion) of 2009 national program expenditures by gas and electric utilities and about 50% of program expenditures in 2010 and 2011 ($2.9B in 2010 and $3.2B in 2011), compared to national efficiency spending as reported by the Consortium for Energy Efficiency (CEE) (see Figure 2-1).[16]

2.2 Program Typology and Standardized Definitions

We developed program categories in order to characterize and analyze similar types of efficiency program types, as defined by market sector and technology, action, delivery approach, or other common themes. Examples of program categories include commercial prescriptive HVAC programs, low-income programs, and residential whole home direct-install programs. Some program categories are relatively well defined and include a narrow set of technologies (e.g., high-efficiency windows or pool pumps), while other categories are cross-cutting, may span a wide variety of activities (e.g., statewide marketing, take-home energy efficiency kits), and/or target several market sectors (e.g., in-school education programs, lighting technology market transformation programs).

The typology grouped and classified energy efficiency programs into three tiers: (1) sector; (2) simplified program categories; and (3) detailed program categories. Figure 2-2 provides a partial snapshot of this three-tiered program typology approach: seven sectors (including one for demand response programs, which are not addressed in this report), 31 simplified efficiency program categories (27 for efficiency programs) and 66 detailed categories (62 for efficiency).[17] LBNL has prepared a policy brief that describes the typology in more detail as well as the standardized definitions (Hoffman et al 2013). Appendix B also includes the complete typology and set of definitions.

We determined that a three-tiered hierarchy was appropriate because it allowed for flexibility in grouping programs for comparison (e.g., single-measure versus comprehensive whole-building programs or by technology such as lighting vs. HVAC programs) and provides options for different levels of analysis. Moreover, in some cases, the detailed program category tier narrowed the range of installed measures for a program type, thus reducing the uncertainty in derivation of measure savings and lifetime savings across measures installed in that program. For example, we defined three detailed program categories that fall under the simplified program

[16] However, as noted below and in Chapter 3, some of the data were not utilized for the data presentations, CSE metrics and analyses due to missing data. For example, the programs indicated as Combined Fuel in this figure were not included in the cost of saved energy analyses, because the costs borne by electricity and gas utility customers could not be determined for this subset of programs. Without the useable data, the database still contains about 45-50% of the national spending estimate.

[17] The relatively large number of simplified and detailed categories was necessary to capture the wide range of common program offerings throughout the country. We also included some program types in the detailed typology because they have regional significance (e.g., pool pump programs in the Southwest, data center programs in New York, Washington and California), or the program types appear to be emergent (e.g., financing programs, residential behavior-based efficiency programs).

category of "Whole Home Upgrades": Whole Home Audit Programs; Whole Home Direct-Install Programs; and Whole Home Retrofit Programs.[18]

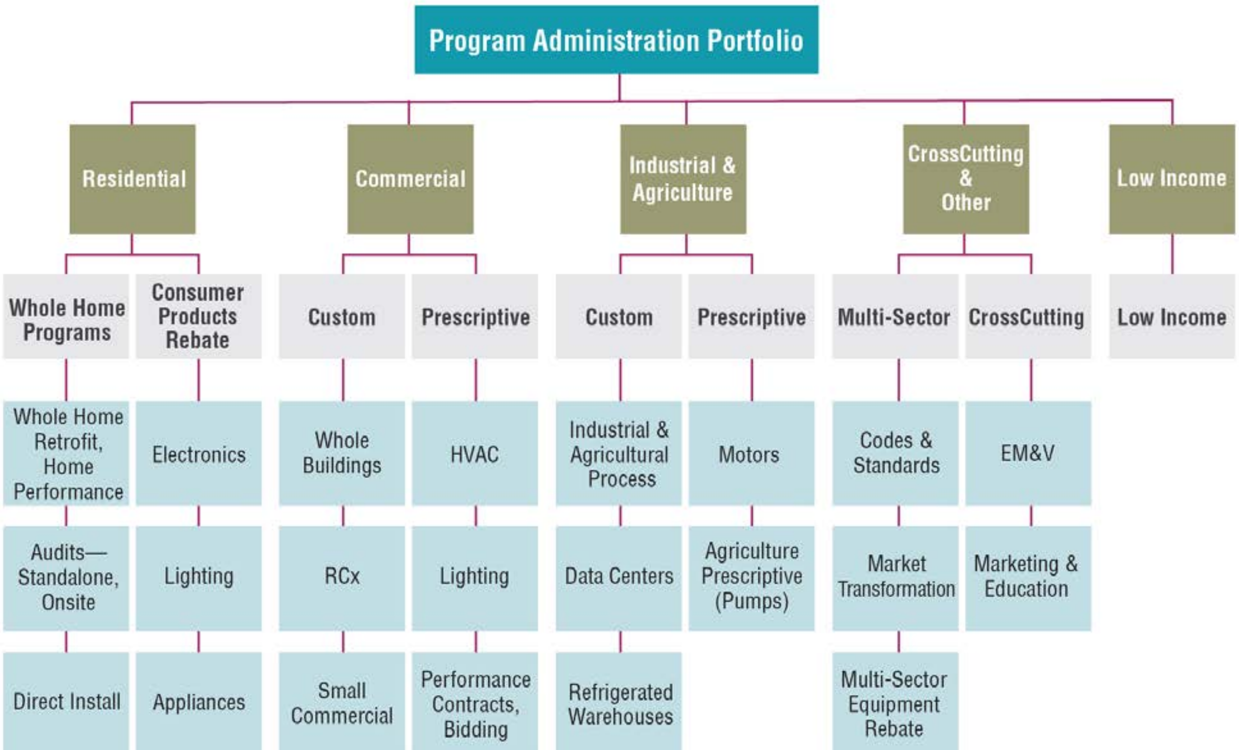

Figure 2-2. Selected program types in the LBNL program typology
Note: Not all sectors and simplified and detailed program categories are shown

We have relatively high confidence in the categorization of most programs. However, there are some programs where we were either not able to obtain much information about the measures offered under that program or where there was a wide array of measures offered under a single umbrella program. In both situations, programs were generally categorized under "prescriptive" or "other" categories. The mix of programs and measures in these two types of categories are likely to be less consistent than in other program categories.

The data fields and specification for the database and program categories were developed through an iterative process which included review of program administrator annual reports and review of several other sources that contain typologies and/or definitions, including the State and Local Energy Efficiency Action Network (SEE Action 2012), the Consortium for Energy Efficiency (CEE 2012), the Regional EM&V Forum of the Northeast Energy Efficiency

[18] We found that program names were not always indicative of the appropriate program category. Thus, in many cases, we reviewed program information as part of the process of classifying programs into program category. We defined a specific set of guidelines for classifying programs by type. For example, when the program name was ambiguous (e.g., EnergySaver) or when the program description indicated savings could fall into more than one detailed or simplified category (e.g., a single program that offered both prescriptive and custom rebates), we looked at the measure-level savings reported for that program (if available) and categorized the program according to the reported measure mix.

Partnerships (NEEP 2011), and the NEEP Regional Energy Efficiency Database (REED 2013). We shared a draft of our categories and definitions and had several discussions with representatives from CEE, NEEP and the American Council for an Energy-Efficient Economy (ACEEE); and made revisions based on their input. For the demand-response program categories, we relied on program categories defined by the Federal Energy Regulatory Commission (FERC) for its national surveys (FERC 2012), although demand-response program data are not included in this study.

We also defined program cost and energy savings (impacts) data fields as part of our effort to classify and report program information in a consistent fashion across program administrators and states.[19]

- **Program Administrator Costs:** The primary cost data used in this report are the *program administrator costs* which include: (1) program administration planning and delivery; (2) engineering or technical support; (3) services provided by implementation contractors; (4) marketing, education and outreach; (5) direct rebates or financial incentives to program participants; and (6) evaluation, measurement and verification costs (see Table 2-1).[20] Program administrator costs exclude participant costs and performance incentives for program administrators (e.g., utility shareholder incentives).[21] For each program we collected from one to four years of data.[22] We made inflation adjustments to the program cost data provided by program administrators so that all cost data are reported in 2012$.[23] We chose to use 2012 as our base year because 2012 is the most recent year for which an annual implicit price deflator for GDP is available from the U.S. Bureau of Economic Analysis. We would have preferred to also report CSE values based on participant, as well as program administrator, costs; however, we found that few program administrators reported participant costs in their annual reports (see Appendix C).
- **Program Savings:** The State and Local Energy Efficiency Action Network's Energy Efficiency Program Impact Evaluation Guide (SEE Action 2012) was the primary source used to describe and define the program energy savings indicators in a consistent fashion.[24] The SEE Action Guide was particularly important for providing

[19] Program cost and savings definitions tend to be consistent within a state, even if there are multiple program administrators.
[20] Some program administrators did not include program-level costs for activities such as marketing/outreach, education, and evaluation, but instead accounted for those expenditures at the sector or portfolio level.
[21] We did not report program administrator performance incentives because actual awards of performance incentives are not often included in annual reports filed by program administrators, and are frequently awarded at a significantly later date.
[22] Some program administrators included prior years' data in their reports in addition to the 2009–2011 period.
[23] Costs can be presented in nominal (or current) or real (or constant) dollar terms. Nominal values are economic units measured in terms of purchasing power of the date in question. Real dollar values are economic units measured in terms of constant purchasing power. A real value is not affected by general price inflation and can be estimated by deflating nominal values with a general price index, such as the implicit deflator for gross domestic product or the Consumer Price Index. From OMB *Circular A-94 Guidelines And Discount Rates For Benefit-Cost Analysis of Federal Programs.* We used the GDP implicit price deflator published regularly by the U.S. Bureau of Economic Analysis.
[24] The SEE Action Guide describes common terminology, structures, and approaches used for determining savings from energy efficiency programs guide. The definitions in the SEE Action Guide incorporated input from program

data definitions for net and gross energy savings and lifetime energy savings, which for this report are assumed to take place at the end-use site where the efficiency actions were implemented.

Table 2-2 provides abridged definitions for key program data in the Database (see Appendix B for the complete glossary of energy efficiency program data fields).

Table 2-2. Abridged definitions for selected program cost and savings data

Term	Definition
Program Administrator Costs	Program administrator costs include the costs of designing programs and portfolios; directing, managing and paying implementation contractors; marketing, education and outreach (ME&O); program and portfolio evaluations; and incentives to both program participants (or end users) and to both mid-stream and upstream allies in the market (e.g., financing and services such as installations or free audits).
Program Average Measure Lifetime	Weighted average economic lifetime (years) of all measures installed in a program year in a specified program.
Annual Gross Savings	Gross annual incremental savings (kWh or therm) as reported by the program administrator using their own staff or evaluation firm, after the subject energy efficiency activities have been completed. Gross savings are the change in energy consumption resulting from program-related actions taken by program participants regardless of why they participated. Note that these are annualized "full-year" savings, regardless of when measures were installed during the program year. Per the SEE Action reference (SEE Action 2012) these may be Claimed or Evaluated Savings.
Lifetime Gross Savings	The expected gross savings (GWh or therm) over the lifetime of the measures installed under the subject program. For our analysis, where available, we relied on lifetime savings reported by the program administrator.

The detailed program categories and data definitions described in this section have been adapted by CEE for its own 2013 annual surveys of the efficiency program industry.[25] We hope that other entities will consider using them as well and to support that objective, as part of the CSE Project, LBNL plans to gather feedback from stakeholders via an annual or biennial process to modify, add or subtract program categories as program offerings change or to address potentially needed clarifications in the definitions and categories.

administrators, state regulators, and other stakeholders from a number of states and regions and included a review and synthesis of definitions used in a broad set of energy efficiency glossaries.

[25] As part of its 2013 annual "State of the Industry" survey, CEE is collecting program-level energy efficiency and demand response program data from program administrators using the LBNL program categories described in this report as well as the definitions from the SEE Action guide.

2.3 Challenges in Consistent and Standardized Reporting of Program Data

When data are compiled from multiple states and program administrators, terminology differences can potentially make it difficult to conduct comparative analysis across states or program administrators. This was a primary rationale underlying our effort to develop a program typology and standardized definitions so that we could conduct a comparative analysis of energy efficiency program impacts and costs. However, even with the typology and definitions, there are two key data challenges.

First, we assume that all expenditure, savings and participation data reported by a program administrator are accurate. Given our time and resources, this is a reasonable starting assumption; however, it should be noted that the range of effort placed into documenting impacts by program administrators varies significantly among states (SEE Action 2012).

Second, in reviewing information on efficiency programs funded by U.S. utility customers, we found that program data are often not defined and reported consistently among states. Specifically, we identified three key concerns in compiling and analyzing program information on a regional or national basis, some of which are addressed by the common typology and standardized definitions:

1. ***Energy savings and program costs are not defined consistently.*** The most common discrepancies can be found in the definitions of net energy savings. Examples of other program data where differences are found across states include:
    - The term “annual energy savings” typically is understood as shorthand for annualized incremental energy savings, but some entities—including resource planners—apply a different meaning that includes savings resulting from prior years’ activities.
    - The definition of measure lifetime, how a program’s average measure lifetime is determined, and the estimated measure lifetime values for the same measures or program types varies among states.
    - Some program administrators report end-use site savings and others report savings at the power plant bus bar (for electricity efficiency programs).
    - Most program administrators do not count their own performance incentives among program costs, although some do. The definitions of other cost categories (e.g., marketing costs, general consumer education, and evaluation) also vary among states.
2. ***Program data are not reported consistently across states.*** For example, some states report just gross or net energy savings; others report both. Similarly, many efficiency annual reports only include first-year savings and not lifetime savings.[26] With respect to cost data, program administrators often classify costs differently among administration, marketing and outreach, incentives and participant costs. Some program administrators

[26] We found that only about a quarter of the program reports that were reviewed included information on measure lifetimes or lifetime savings, although this information is required to assess program cost effectiveness. See below, in the section on adjustments for missing data, for discussion of how measure lifetime variation creates uncertainty in the calculation of CSE.

also report certain costs (e.g., marketing, evaluation) at the portfolio or sector level, while others account for those costs at the program level.

3. ***Programs and sectors are not characterized in a standardized fashion.*** Programs targeting specific building types or consumers can be included under different sectors from state to state (e.g., multi-family residential structures are sometimes categorized as commercial programs). Moreover, the types of activities and measures that are included under the same program title (e.g., custom vs. combination custom/prescriptive programs) also vary.

We suggest that readers consider these above issues when utilizing the information in this report for their own uses and understanding of the cost of saved energy.

2.4 Calculating and Using the Cost of Saved Energy

The program administrator's CSE is a useful metric for comparing the relative costs of efficiency programs and for comparing an energy efficiency option to other demand and supply choices for serving electricity and natural gas needs[27]. However, the cost of saved energy is not a test of cost effectiveness (e.g., one of the screening tests used by program administrators) because: (1) it does not capture the full benefits to utility customers and shareholders (e.g., avoided generation capacity, avoided transmission and distribution investments, avoided environmental compliance costs); (2) benefits are not monetized but reflected simply in energy units of kilowatt hours or therms, the cost of which will vary by utility; and (3) energy is saved at the end use, not the power plant.[28]

In this report, we use gross energy savings (rather than net savings) in the CSE calculations primarily because of data availability and comparability reasons: (1) more administrators reported gross savings than net; and (2) net savings are defined relatively inconsistently, as compared to gross savings, among program administrators and states.
We also report savings at the end-user level (and not at the busbar or power plant source), because this is what most program administrators report. It is important to note that savings from electricity efficiency programs reported at the busbar would be higher than at the end-use level because we are accounting for distribution and transmission losses (losses also occur in the natural gas network as well).[29]

[27] According to the Energy Information Administration, "levelized cost is often cited as a convenient summary measure of the overall competiveness of different generating technologies. It represents the per-kilowatt hour cost (in real dollars) of building and operating a generating plant over an assumed financial life and duty cycle. Key inputs… include overnight capital costs, fuel costs, fixed and variable operations and maintenance (O&M) costs, financing costs, and an assumed utilization rate for each plant type.
http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

[28] The equation also is inverted, with costs in the numerator and benefits (in energy units) in the denominator—the reverse of the benefit/cost ratios that are a key determinant of cost effectiveness.

[29] This is an important consideration if the CSE values were to be compared with costs of electricity generation resources, which typically are indicated as busbar values.

We calculate the cost of saved energy (CSE) metrics in three ways: (1) a cost of lifetime saved energy; (2) a levelized cost of energy savings using two discount rates (3% and 6% real); and (3) a cost of first-year energy savings. See Table 2-3 for definitions of these CSE metrics and their common uses.

Table 2-3. Program administrator cost of saved energy metrics: definitions and potential uses

Program Administrator Cost Metric	Shortened Term	What is Measured	Potential Uses
Cost of Lifetime Energy Savings	Lifetime CSE	The cost of acquiring energy savings that accrues over the economic lifetime of the actions taken through a program/sector/portfolio. Calculated by dividing program administrators' costs by the gross savings.	• Used by program administrators for designing programs and portfolios, e.g., for depth of savings and cost effectiveness • Used by planners and other stakeholders to project efficiency as a resource, develop load forecasts, etc.
Levelized Cost of Energy Savings	Levelized CSE	The cost of acquiring energy savings that accrue over the economic lifetime of the actions taken through a program/sector/portfolio, amortized over that lifetime and discounted back to the year in which the costs are paid and the actions are taken	• Same uses as lifetime savings • Useful to program administrators, regulators and other stakeholders who want to compare particular demand-side options with other demand, and supply-side, resources
Cost of First-Year Energy Savings	First-Year CSE	The cost of acquiring a single year of annualized incremental energy savings through actions taken through a program/sector/portfolio. Calculated by dividing the program administrators' costs by the first year incremental savings.	• Useful for program administrators in program design

The cost of saved energy can be useful to various stakeholders. For example, state regulators can use both first-year and lifetime CSE values as quick metrics for assessing whether a program or portfolio looks like a reasonable expenditure of utility customer funds. A program administrator that is considering offering a comprehensive residential energy upgrade program may want to compare that program's estimated per-unit cost performance against average costs and the range of costs for similar programs. Based on the comparison, the program administrator may want to look at the design of comparable programs for potential cost efficiencies. Regulators and resource planners can use the levelized CSE in the initial screening analysis of various supply- and demand-side resources. Resource planners also can use the lifetime CSE to convert approved budgets for demand-side management plans into energy savings estimates that then can be used in scenario or sensitivity analysis of future load forecasts.

Finally, based on the limited participant cost data reported by program administrators, we calculate a total resource CSE for illustrative purposes in Chapter 3. This calculation presents the net total costs, including both program and participant costs, for the efficiency resource. A levelized total resource CSE might also be useful to program administrators, regulators and other stakeholders who want to compare particular demand-side options with other demand and supply-side resources.

2.4.1 Levelized Cost of Saved Energy

The lifetime cost of energy savings metric is a simple, straight-forward calculation although it ignores changes in the value of money between an initial investment and future energy savings. Meier (1982) included the time value of money (discount rate) to calculate the "cost of conserved energy" (CCE) or what we are calling the "levelized cost of saved energy". Meier found that inclusion of the discount rate raises the CCE because of discounting future benefits, yet provides a basis for comparing the CCE for measures that have different lifetimes and can be compared to retail rates and levelized costs of supply-side resources.[30] A similar accounting framework, the levelized cost of energy (LCOE), often is applied to assessing the economic competitiveness of diverse generation sources (U.S. Energy Information Administration 2013).

We calculated a levelized CSE using two discount rates[31] that are rough proxies for different perspectives on energy efficiency investments: a 6% real discount rate that can reflect the utility weighted average cost of capital (WACC) at present and a 3% real discount rate that can be a proxy for a societal perspective. The levelized CSE calculation is as follows:

$$Levelized\ CSE\ (in\ \$/unit\ energy, e.g., kWh, therm, Btu)$$
$$= (C\ x\ (Capital\ Recovery\ Factor))/(D)$$

$$Capital\ Recovery\ Factor\ =\ [A * (1 + A)\hat{}B]/[(1 + A)\hat{}B - 1]$$

Where:

A = Discount rate

[30] See Appendix A for further discussion of the history of efficiency CSE analyses

[31] Discount Rate: An interest rate applied to a stream of future costs and/or monetized benefits to convert those values to a common period, typically the current or near-term year, to measure and reflect the time value of money. It is used in benefit-cost analysis to determine the economic merits of proceeding with a proposed project, and in cost-effectiveness analysis to compare the value of projects. The discount rate for any analysis is either a nominal or a real discount rate. A nominal discount rate is used in analytic situations when the values are in then-current or nominal dollars (reflecting anticipated inflation rates). A real discount rate is used when the future values are in constant dollars and can be approximated by subtracting expected inflation from a nominal discount rate (SEE Action Network 2012).

B = Estimated program measure life in years

C = Total program cost in 2012$

D =Annual kWh saved that year by the energy efficiency program

This formula is the classic definition of a compound interest calculation used to calculate equivalent annual net disbursements.

The discount rate can have a significant impact on the calculated CSE. For example, for a program with an average measure lifetime of 20 years, a discount rate of 6% will indicate a levelized CSE that is about 30% higher than the same program if a discount rate of 3% were used. See Appendix D for further discussion of the factors considered in choosing these two illustrative interest rates.

2.5 Treatment and Adjustments for Missing Data

In calculating CSE for efficiency programs, we encountered several data completeness issues that needed to be resolved:

- Many programs' data included neither program measure lifetime nor gross lifetime savings. This information is necessary to calculate lifetime and levelized CSE;
- Some combined gas and electric program administrators reported separate savings for their electric and gas programs but did not separate their electric and gas program costs; and,
- Most program administrators reported end-use energy efficiency savings while others reported savings at the source of the electricity (generation or busbar savings). Natural gas savings are usually considered the same at the end-use site and at points along the gas distribution, although there is the potential for per unit losses from the natural gas source to the end user.

In addition, for the few program administrators that reported only net savings, we calculated gross savings by dividing reported net savings by a net-to-gross ratio[32] when this ratio was provided in related references for the subject programs.[33] Furthermore, some program reports provided no cost data and others provided no savings data; these programs were excluded from the CSE analysis. These adjustments resulted in program data from 100 program administrators in the database being utilized in calculating CSE values in this study.[34]

[32] The net-to-gross ratio is the net program impact (energy savings) divided by the gross program impact.

[33] In Massachusetts and New York, program administrators reported net savings and did not provide net-to-gross ratios in their annual efficiency reports. In these cases, we applied net-to-gross ratios reported in the 2011 REED database and applied the program level ratios to the previous two years included in this analysis (2009-2010). New Hampshire program administrators reported net lifetime savings for 2009-2010. We were not able to generate a gross lifetime or annual incremental savings values needed to calculate the CSE and therefore those years were dropped from the analysis.

[34] Data from 100 of the 107 program administrators whose data are in the LBNL DSM Program Impacts Database are included in this Chapter. The seven program administrators that were excluded represent about eight percent of the total costs for programs in the Database. Three program administrators are excluded because their combined gas and electric program costs could not be separated out by fuel type, three program administrators were excluded because they did not report expenditures at the program level, and one program administrator was excluded because it reported net savings in a manner that did not allow determination of gross savings. Two years of program data

2.5.1 Program Average Measure Lifetime

The CSE calculation takes into account the costs incurred to implement the measures, which in the database all occur during the program year,[35] and the savings that occur over the lifetime of the implemented measures. However, program administrators reported lifetime savings for only about 44% of the programs years in the collected annual reports (see Appendix C).[36] Another way to calculate the lifetime savings is to multiply the first-year savings by the program average measure lifetime (program lifetime)[37], which we interpret as the lifetimes of the various measures installed through a program weighted by their respective savings.

However, even fewer program administrators reported any form of a program lifetime—about 26% of electric and 30% of gas programs for the 2009–2011 period (see Appendix C). For the programs that did report a lifetime value, program average measure lifetimes varied widely within many of the detailed program categories.[38] For example, the median program lifetime for residential new construction programs is 18 years, with a program life of 14 and 25 years at the 25th and 75th percentile for programs in the database. Figure 2-3 shows the range, inter-quartile range, and median program lifetime values reported for a selected sample of detailed program categories.

Given the limited availability of lifetime savings and program lifetime values, we developed the following set of decision rules, or protocol, for defining lifetime savings for each program in the database:

1. When available, use the program lifetime savings reported for the program by the program administrator;
2. When program administrator did not report program lifetime savings, but did report program average lifetime value, we multiplied this value by the reported first-year savings to calculate the program's lifetime savings;[39]

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from three other program administrators were not used in the CSE analysis because these program administrators reported net savings in a manner that did not allow determination of gross savings; however, the third year of data for those three program administrators was used.

[35] Some project installations may be completed after the end of the program year but are accrued to the program year in which the project was initiated (e.g., customer has signed up, equipment installation has been scheduled, equipment installation has begun but not been completed). Some energy efficiency actions also may require ongoing, incremental operations and maintenance expenditures (compared to the baseline equipment), which are not considered in this study, which is consistent with most energy efficiency program assessments.

[36] There are more than 4,000 program years in the database, where we count each program in each year of implementation separately.

[37] Measure lifetime, also called effective useful life (EUL), is based on the lifetime of equipment installed or measures implemented and measure persistence (as opposed to savings persistence). In many energy efficiency programs, the estimated EUL takes into account both the expected remaining life of the measure being replaced and the expected changes in operational baselines over time (Mass Save 2011, SEE Action 2012).

[38] A number of factors may contribute to the variation in reported measure lifetimes including the unique mix of measures implemented for a program (particularly for programs that contain a wide range of longer- and shorter-lived measures) and different assumptions and/or methodologies used to determine measure lifetime used by program administrators.

[39] Some program administrators document the average measure lifetime for programs that installed a mix of measures. The most common approach used by program administrators is to weight the program average measure lifetime by respective measure savings. We applied this approach for all of the reported program measure lifetimes.

3. For programs where we did not have lifetime savings or measure lifetime data, we calculated a program average measure lifetime for similar programs in the database and used that imputed value along with the program's first-year savings to calculate program lifetime savings.[40]

For program categories that contained a broad unspecified mix of activities or too few data points to calculate a national program average measure lifetime values, we reviewed technical reference manual lifetime values for specific measures to generate a "national program average measure lifetime" value for that program.[41] Given the wide variation in reported measure lifetimes, our method of calculating a national program average measure lifetime and applying it to programs for which that data are not available introduces uncertainty into the final CSE calculation, particularly for program categories that contain mixes of measures with wide-ranging measure lifetimes. In Chapter 3, we include results of a sensitivity analysis that illustrates the impact of varying measure lifetime assumptions on CSE calculations.

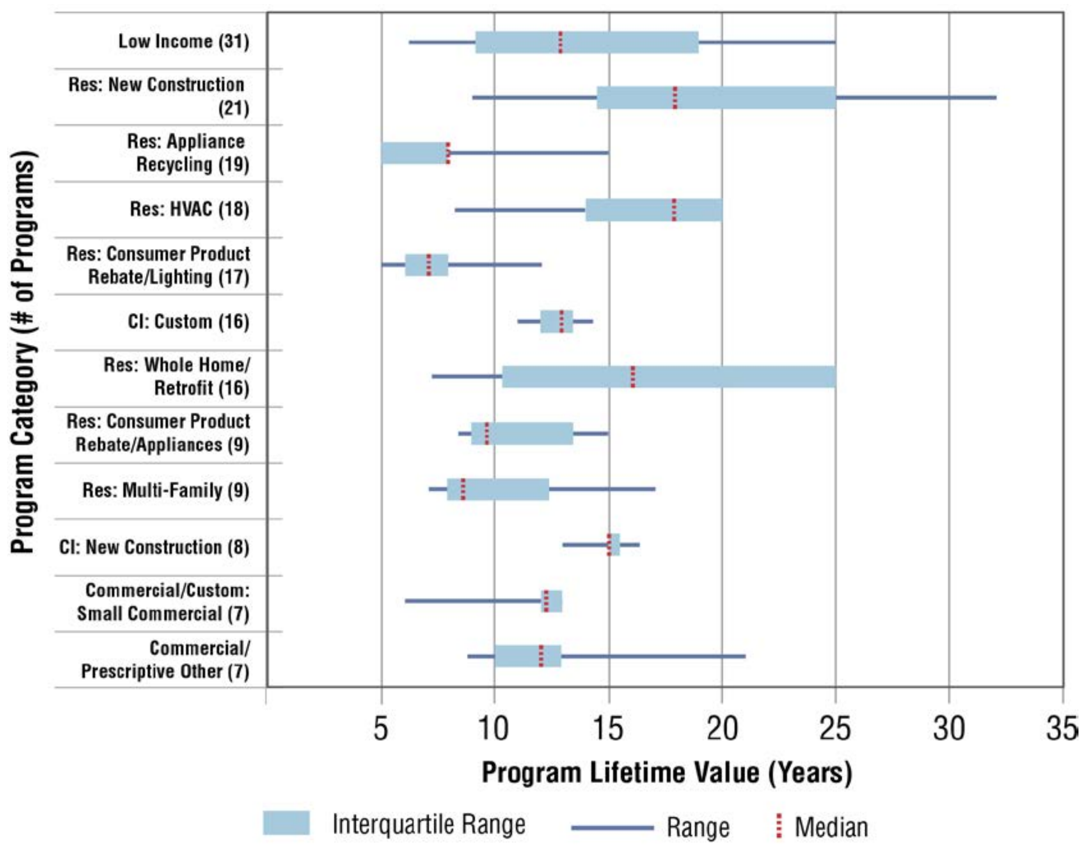

Figure 2-3. Range of reported program average measure lifetime values for select detailed program categories

The authors' experience indicates that the way in which measure lifetimes are defined, determined and reported are not consistent among program administrators.

[40]We calculated a national program average measure lifetime as follows: divide reported lifetime savings by first-year savings values for each program in the database that reported this information in order to generate a national (un-weighted) program average measure lifetime by program type.

[41] See Table C-3 in Appendix C for the national program average measure lifetime values calculated for each of the detailed program categories.

2.5.2 Cost Data for Combined-Fuel Programs

Some program administrators of combined-fuel programs reported separate electric and gas savings values but did not report separate costs for electric and gas programs or measures. For those program administrators where we could not reliably calculate the per-kWh and per-therm CSE from the reported data, we obtained additional information that enabled us to calculate reasonable estimates of the disaggregated electric and gas expenditures for the following combined fuel utility cases:

- The California combined-fuel utilities did not provide separate electric and gas cost data. However, one of the utilities provided program-level data on the net monetized benefits of the programs, allocated by fuel. We were then able to estimate that utility's combined electric and gas program costs by fuel (electricity and natural gas) based on the program's share of savings allocated to each fuel.
- A New England combined-fuel utility that had not reported separate gas and electric cost data later provided estimates of the ratio of gas and electric costs which were applied to that utility's data.

Other program data from program administrators for which we could not disaggregate electric and gas program costs were included in the overview of program spending and savings presented at the beginning of Chapter 2, but excluded from the dataset used to calculate CSE.[42]

2.5.3 End-Use versus Source and Busbar Energy Savings

Most state program administrators reported end-use energy efficiency savings; however, there were a few program administrators that reported both end-use and busbar, and a handful that only reported busbar savings. For the purposes of this report, we followed the following decision rules:

- Where program administrators reported both end-use and busbar savings, we used end-use savings;
- Where program administrators are not clear, or do not explicitly state that the savings is end-use, we treat the savings values as end-use savings;

  Where program administrators only reported a busbar savings value, we identified a line loss estimate and calculated that end-use savings.[43]

[42] Wisconsin's single statewide program administrator was included in the program spending and savings overview but excluded from the CSE results because the program administrator did not provide disaggregated electric and gas program expenditures data.
[43] For a discussion on line losses, please see: http://www.raponline.org/ document/download/id/4537

3. Results—Utility Customer-Funded Programs: Costs and Savings

In this chapter, we first present a national overview of electric and gas energy end-use efficiency program administrator expenditures and savings, including summaries by market sector and region for the programs in the LBNL DSM Program Impacts Database (database). We then present ranges of program administrator cost of saved energy (CSE) values, mostly for electricity efficiency programs (as they represent about 80% of program expenditures), on a national, regional, and state basis. Some CSE values are presented at the sector and program level as well. We also include sensitivity analyses on the impact of assumed measure lifetimes on the CSE (one of the data issues raised in Chapter 2). Finally, we present CSE results for those programs where program administrators reported program administrator costs and participant costs (what some refer to as the total resource cost).

Attributes of Information Reported in this Chapter

Costs refer to **program administrator costs** only; the CSE values exclude participant costs unless specifically indicated otherwise.

Savings are based on **gross savings** reported by the program administrator unless specifically indicated otherwise. For program administrators that only reported net savings values, we calculated gross savings values using net-to-gross ratios. Savings values are also based on **savings at the end-use site** and not at the power plant or natural gas pumping station and thus do not account for transmission and distribution losses. See Chapter 2 for more detailed explanation.

Lifetime energy savings, when not reported by the program administrator (which was the case for about 50% of the programs), were calculated per the protocol described in Chapter 2.

The results presented in this chapter represent a significant portion of the efficiency programs funded by customers of U.S. investor-owned utilities during 2009, 2010, and 2011. However, when using the information, the reader should recognize that they are not necessarily a representative sample, particularly for some regions of the country where annual reporting is not prevalent.

3.1 Energy Efficiency Program Administrator Expenditures and Savings

3.1.1 Electric Programs

Program administrator expenditures for identifiable electricity efficiency programs[44] in the database, for the years 2009–2011, totaled just under $5.3 billion (in 2012$) with commercial/industrial programs (C&I) programs representing about 60% of expenditures and residential programs comprising about 30% of the expenditures (see Table 3-1).

In terms of how electricity savings vary by sector for the programs in the database, the answer depends on whether first year or lifetime savings are considered (see Figure 3-1). The savings accruing from C&I sector programs accounted for 53% of the aggregate first-year savings and 62% of the aggregate lifetime savings. Residential programs' share of first-year savings was higher than their share of expenditures; residential programs made up 29% of expenditures but garnered 40% of first-year savings and 31% of lifetime savings. On the other hand, low-income programs represent 6% of the total expenditures and 2% of first-year and lifetime savings.

[44] Eighty-eight program administrators reported electric program data.

Table 3-1. Program administrator expenditures for 2009–2011 electricity efficiency programs

Market Sector	Share of Total Program Administrator Expenditures	Total Program Administrator Expenditures (million 2012$)
C&I	61%	$3,214
Residential	29%	$1,515
Low Income	6%	$332
Cross Sector/Other	4%	$213
TOTAL	**100%**	**$5,274**

We also examined residential expenditure and savings data by simplified program type and found that consumer product rebate programs,[45] prescriptive rebate programs[46] and whole home programs[47] were the top three contributors to expenditures and lifetime electricity savings in the LBNL DSM Program Impacts Database. Combined, these three programs represented 84% of total expenditures and 90% of the lifetime savings for residential programs in our database (see Figure 3-2).

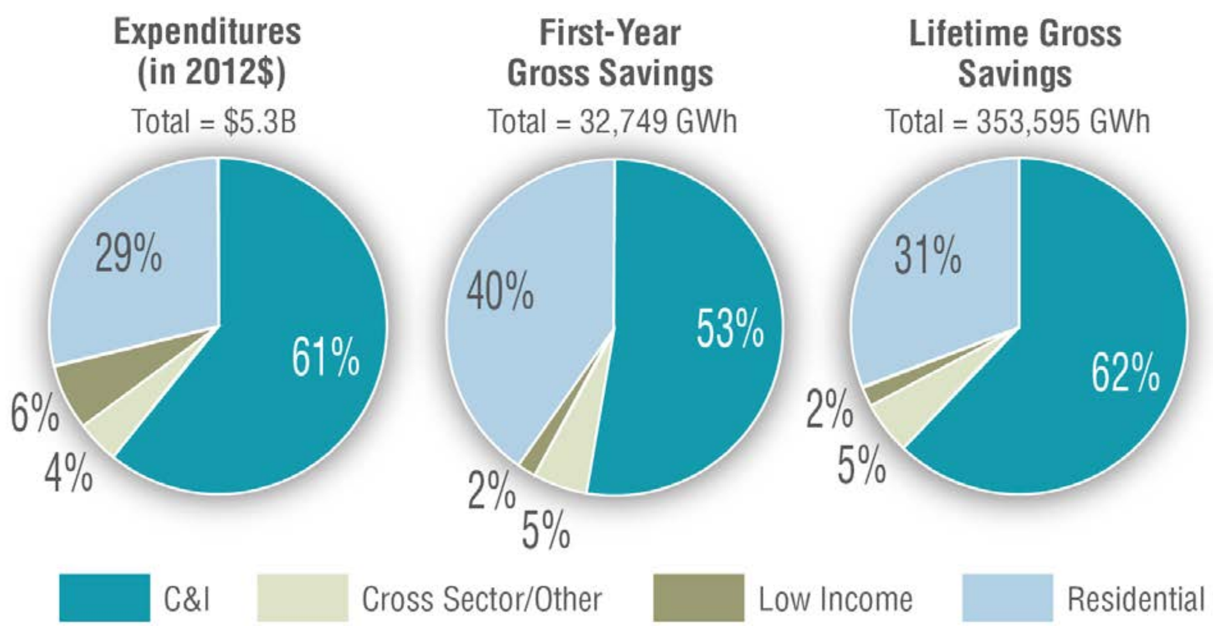

Figure 3-1. Program administrator expenditures, first year and lifetime gross savings for 2009–2011 electricity efficiency programs

[45] Programs that encourage use of more efficiency products such as appliances, electronics, lighting products, etc.
[46] Programs that provide pre-defined incentives for installation of cost efficient products such as insulation, windows, water heaters, etc.
[47] Programs that offer direct install services, audits or incentives for comprehensive packages of efficient products.

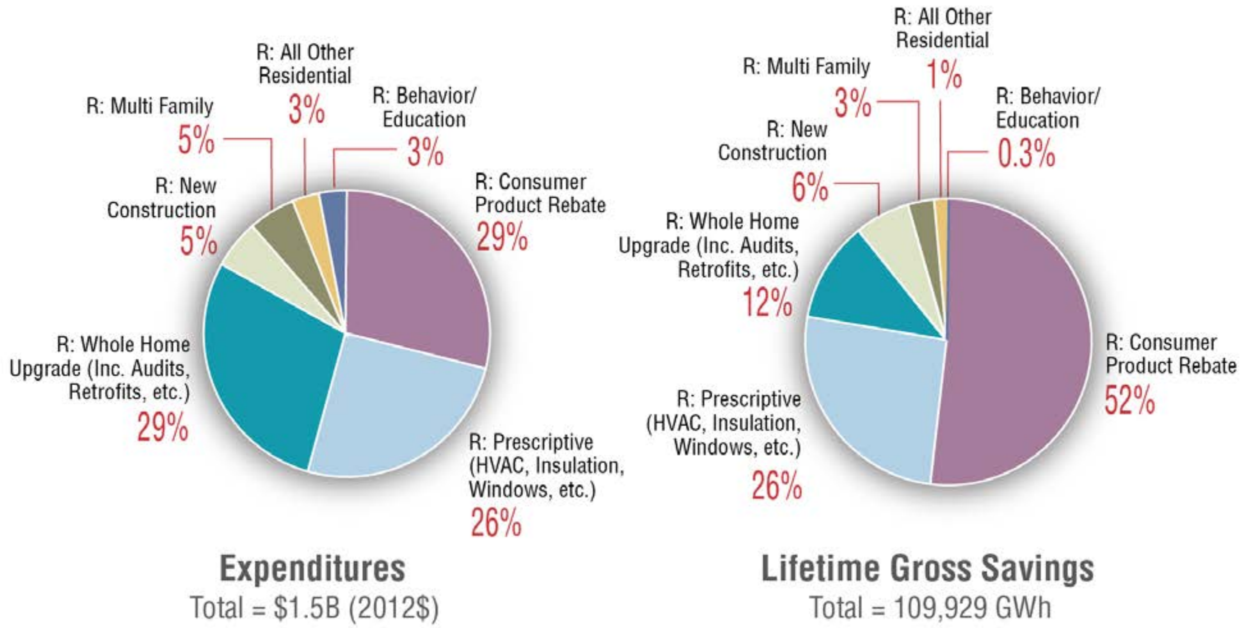

Figure 3-2. Program administrator expenditures and lifetime gross savings by simplified program category for 2009–2011 residential electricity efficiency programs

Other observations from the database's residential electricity program data, as shown in Figure 3-2, are:

- Consumer Product Rebates accounted for about 29% of total residential program expenditures, but over half of the lifetime savings;
- Residential Prescriptive programs accounted for similar percentages of expenditures and lifetime savings, both 26%;
- Whole Home Upgrade programs represented about 29% of aggregated expenditures and12% of the lifetime electricity savings;
- New Construction programs accounted for 5% of residential program expenditures and 6% of the sector's lifetime savings,
- Multifamily programs accounted for 5% of expenditures and 3% of lifetime savings, and
- Behavior and Education programs make up 3% of expenditures but less than 1% of lifetime savings.

To illustrate the power of a program-level database, we analyzed the four detailed program types that are included in the residential Consumer Product Rebate program category that covers 52% of the residential lifetime electricity savings (see Figure 3-3). This analysis indicated that lighting rebate programs accounted for over 80% of all gross electricity savings attributed to the consumer product rebates in the program administrator program reports we compiled. This means that lighting rebates represent at least 44% of total residential lifetime savings.[48] Appliance Recycling programs (which we also included in the product rebate category)

[48] We indicate at least 44% because other program types also can, and often do, include lighting related products.

accounted for 6% and appliance rebates made up 2% respectively of all residential sector lifetime gross savings. Consumer Electronics programs, the fourth detailed program type in the consumer product rebate category, garnered less than 1% of residential sector savings.

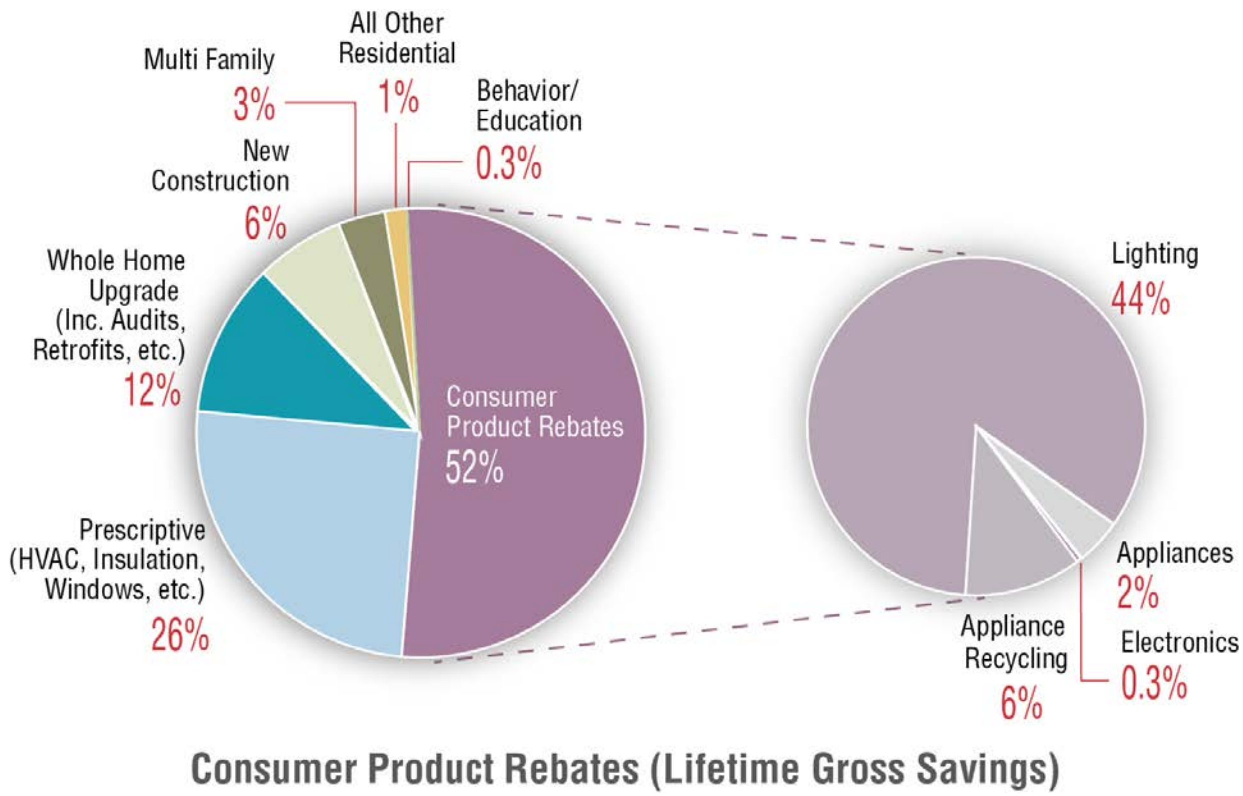

Figure 3-3. Lifetime gross electricity savings for 2009-2011 residential consumer product rebate programs

We also analyzed C&I sector expenditure and savings data by simplified program type (see Figure 3-4) and found the following:

- At 36%, custom programs represented the largest share of all C&I expenditures as well as the largest share of all C&I total lifetime savings at 38%.
- Prescriptive and small commercial programs accounted for comparable shares of C&I expenditures at about 21% each; although reported lifetime savings were much greater for prescriptive programs (30% of all savings) compared to small commercial programs (11% of all C&I savings).
- Commercial new construction programs accounted for 12% of C&I expenditures and 10% of the sector's savings.
- Programs specifically targeting the institutional market (municipal and state governments, universities, colleges, K-12 schools and hospital/healthcare facilities, also collectively known as the MUSH market) made up 7% of total C&I program expenditures and 4% of the savings, although it should be noted that institutional sector customers can and do participate in many other types of C&I programs as well.

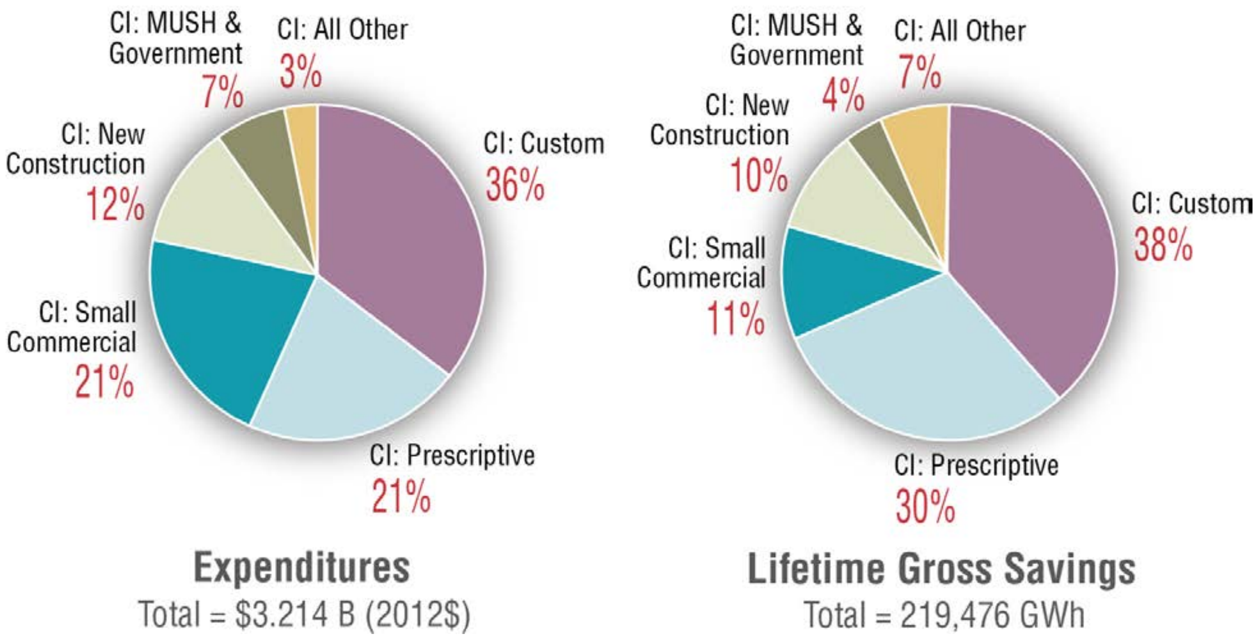

Figure 3-4. Program administrator expenditures and gross lifetime savings for 2009-2011 commercial and industrial electricity efficiency programs

We also created a region data field and coded efficiency program data provided by program administrators into the appropriate region, using U.S. Census region definitions (see Table 3-2). As can be seen from Table 3-2, we have a limited number of states (four) with program-level data from the South region as well as a relatively limited number of efficiency programs in total from southern states in the database.

Table 3-2. U.S. Census Regions and states in the LBNL DSM Program Impacts Database[49]

Region	States in the LBNL DSM Program Impacts Database
Midwest	MI, MN, IL, IA, OH, WI, IN
Northeast	PA, VT, CT, ME, NH, NY, RI, NJ, MA
South	MD, NC, FL, TX
West	CA, WA, MT, ID, OR, HI, CO, NV, UT, AZ, NM

For the programs in the database, program administrator costs for electricity programs were highest for the West at $2.0 billion, followed closely by the Northeast at just over $1.9 billion.

[49] U.S. Region Definitions may be found at:
http://www.census.gov/econ/census07/www/geography/regions_and_divisions.html

Program administrator expenditures totaled just under $1 billion in the Midwest and about $505 million in the South (see Figure 3-5).

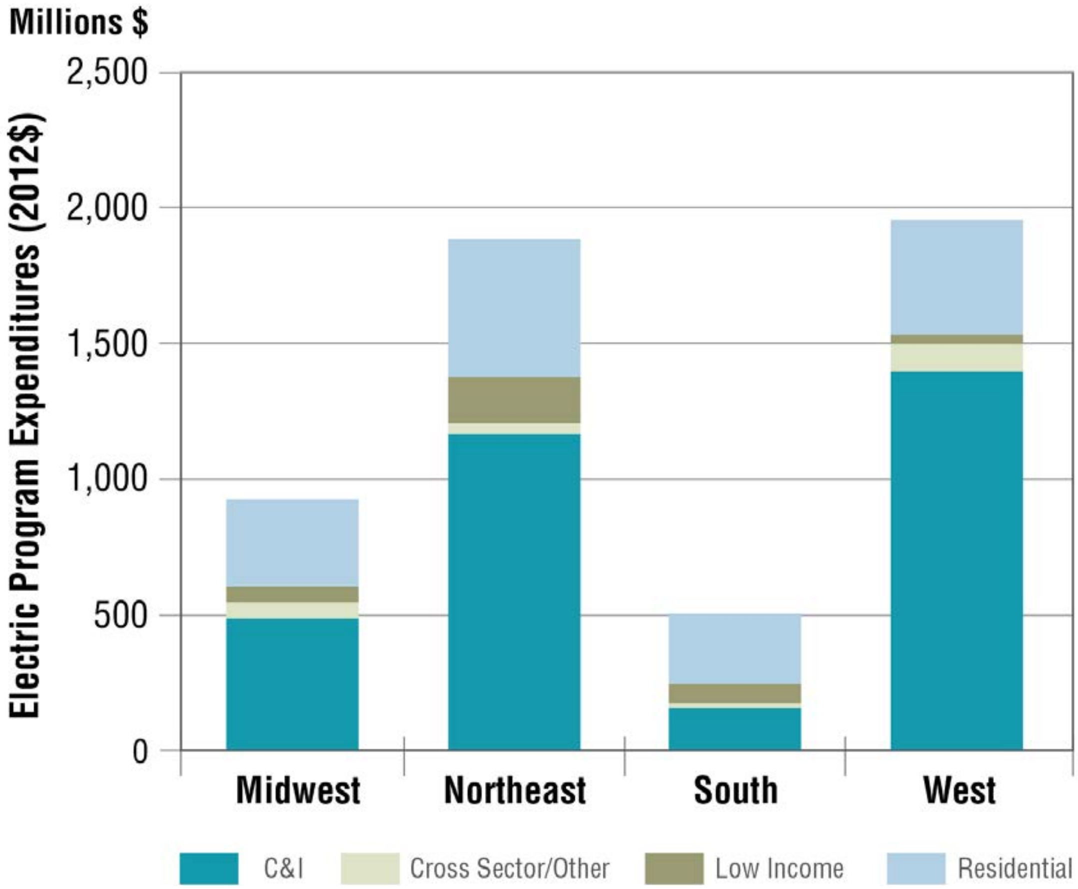

Figure 3-5. Program administrator expenditures by region for 2009-2011 electricity efficiency programs

The regional breakdown of lifetime savings for programs in the database looks much different compared to expenditures (see Figure 3-6). Program administrators in the Midwest reported about 20% more lifetime electricity savings than program administrators in the Northeast and about 75% of the savings for program administrators in the West, although expenditures in the Midwest were less than half of those in the West or Northeast.

As can be seen from Figure 3-5 and Figure 3-6, savings reported by program administrators come predominantly from the C&I sector, except for the South where residential and C&I program savings are more balanced. In the Midwest, C&I programs accounted for a little more than half of the region's total expenditures, but C&I programs accounted for nearly 70% of the savings. In the West, the expenditure and savings proportions were more comparable; C&I programs accounted for about 60% of total expenditures and about 65% of the savings, while 27% of expenditures and 21% of savings occurred in the residential sector. Low-income program expenditures were significantly higher in the Northeast than in the other regions.

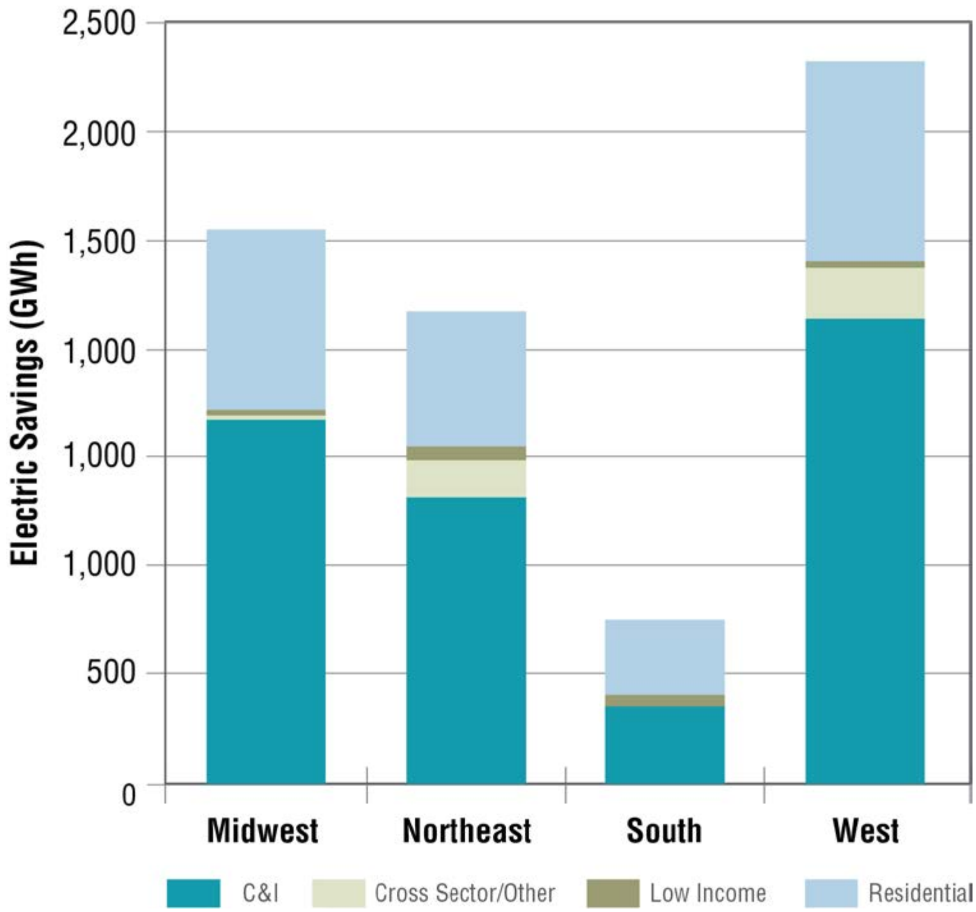

Figure 3-6. Program administrator lifetime savings by region for 2009-2011 electricity efficiency

3.1.2 Gas Program Expenditures and Savings

Program administrator expenditures for identifiable natural gas programs[50] in the LBNL DSM Program Impacts database for the years 2009–2011 totaled just under $1.3 billion, about 20% of program administrator expenditures for electric programs (see Table 3-3). Residential programs accounted for about 60% of aggregated gas program expenditures, while C&I programs accounted for about a quarter of total program expenditures, which is the converse of spending breakdown in electric efficiency programs (i.e., C&I programs account for 60% and residential programs about 30% of total spending).

[50] Fifty program administrators reported natural gas program data.

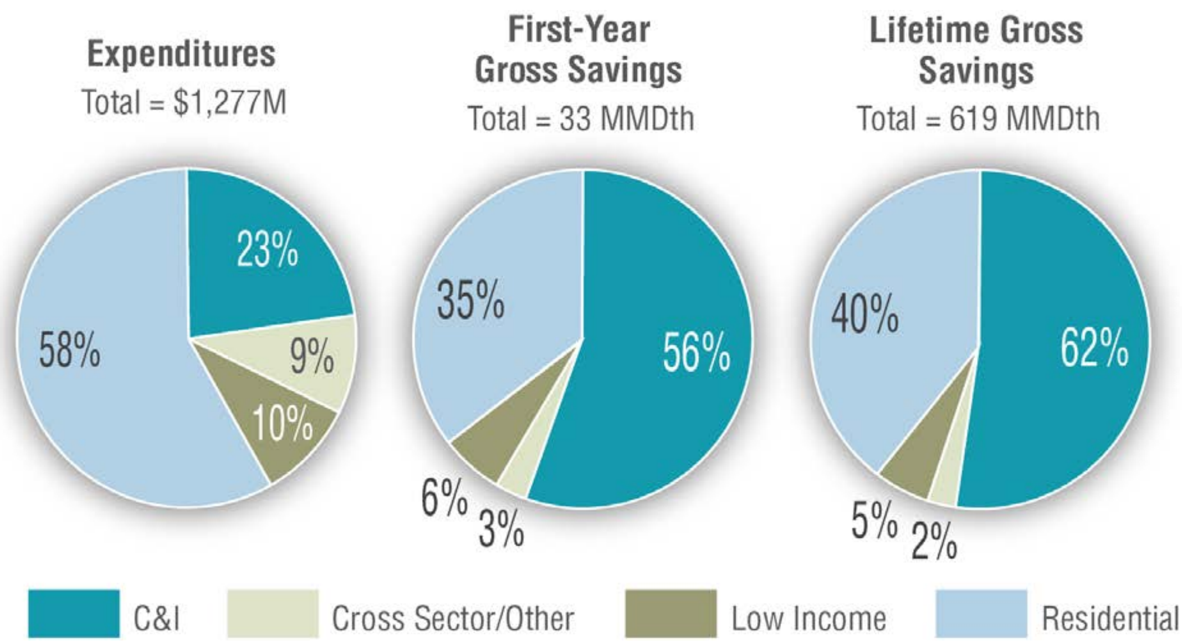

Figure 3-7. Program administrator expenditures, first- year and lifetime gross savings for 2009–2011 natural gas efficiency programs

As with the residential sector programs, we compared the share of total program administrator expenditures with the share of first-year and lifetime savings for each market sector (see Figure 3-7). Expenditures for the C&I sector accounted for about a quarter of total gas program expenditures, yet C&I programs generated more than half of total gas program savings (56% of first-year savings and 62% of the lifetime gross savings), indicating the importance of this sector for natural gas energy efficiency.

Table 3-3. Program administrator expenditures for 2009-2011 natural gas efficiency programs

Market Sector	Share of Total Program Administrator Expenditures	Total Program Administrator Expenditures (million 2012$)
Residential	58%	$742
C&I	23%	$291
Low Income	10%	$123
Cross Sector/Other	9%	$121
TOTAL	**100%**	**$1,277**

On the other hand, while residential programs made up about 60% of total gas program expenditures, they garnered 35% of first-year savings and 40% of the total lifetime savings for all programs. Low income gas programs follow a similar pattern as low-income electricity efficiency programs, accounting for 10% of total expenditures and 6% of first-year and 5% lifetime savings.

3.2 Observations on the Cost of Saved Energy

3.2.1 National Observations

CSE values are presented as either (a) savings-weighted average values; (b) as an inter-quartile range with median[51] values; or (c) both.[52] The savings-weighted average CSE is calculated using all savings and expenditures at the level of analysis (e.g., region, sector, program category).[53] For example, the national savings-weighted average CSE for the residential sector includes all the residential program portfolio costs in the database (even for programs without reported savings) divided by all the savings reported for the residential sector; thus "weighting" the CSE of larger programs more than small programs. The inter-quartile range and median CSE values are based on calculations for each individual program; thus giving equal weighting to all programs irrespective of their relative size (either in terms of savings or costs). The inter-quartile range and median CSE values exclude programs where a CSE cannot be calculated.[54]

CSE values are reported using three different metrics: a cost of lifetime saved energy, a levelized cost of energy savings using two discount rates (3% and 6% real), and a cost of first-year energy savings (see Table 2-2 for definitions of these CSE metrics). Appendix E contains detailed national and regional levelized CSE values by sector, simplified program type and detailed program type; tables in Appendix E show the savings-weighted average CSE, the first quartile, the median, and the third quartile levelized CSE values and the total number of programs for each category.

Table 3-4 shows national saving-weighted average CSE values for the identifiable electricity efficiency programs[55] in the database. Figure 3-8 depicts the lifetime and levelized CSE values ($/kWh) by sector. The national CSE values for electricity efficiency programs rounds to approximately $0.02/kWh for the levelized CSE using both the 3% and 6% real discount rates and a lifetime CSE (without discounting) of $0.015/kWh.

[51] The *inter-quartile range* is the middle 50 percent of the range of program CSE values. The *median* is the numerical value separating the higher half of a data sample from the lower half.

[52] The CSE values in this section are based on *program administrator costs* and *gross energy savings*. When used, the lifetime energy savings may be based on reported values or values derived from estimates of program average measure lifetime. See Chapter 2 for a discussion of the basis for using program administrator costs and gross savings, the protocol for calculating lifetime energy savings, and discussion of the limitations in the efficiency program data used to calculate CSE values.

[53] We have observed that program administrators are not consistent in how they report program support costs (i.e. administration, EM&V, marketing & education, etc.). Some program administrators reported those costs at the program level, others reported those costs at the sector or portfolio level, and several reported those costs as, effectively, separate programs. For the purposes of this report, costs associated with specific programs stay associated with those programs. Costs that occur at the portfolio or sector levels are included in the analysis as separate programs. This allows us to account for those costs at the sector and portfolio levels but may appear as though individual programs within the same category cost less than their counterparts who report costs at the program level.

[54] Some programs did not report savings (e.g., education/information programs) and others were not designed to achieve savings (i.e. programmatic support programs including EM&V, marketing). Where savings are not reported, it was not possible to calculate a CSE for that particular program.

[55] Eighty-eight program administrators reported electric program data.

Table 3-4. The program administrator CSE for electricity efficiency programs by sector: national savings-weighted averages

Sector	Levelized CSE (6% Discount) ($/kwh)	Levelized CSE (3% Discount) ($/kwh)	Lifetime CSE ($/kwh)	First Year CSE ($/kwh)
Commercial & Industrial (C&I)	$ 0.021	$ 0.018	$ 0.015	$ 0.188
Residential	$ 0.018	$ 0.016	$ 0.014	$ 0.116
Low Income	$ 0.070	$ 0.059	$ 0.049	$ 0.569
Cross Sectoral/Other	$ 0.017	$ 0.014	$ 0.012	$ 0.120
National CSE	**$ 0.021**	**$ 0.018**	**$ 0.015**	**$ 0.162**

Values in this table are based on the 2009-2011 data in the LBNL DSM Program Impacts Database. CSE values are for program administrator costs and based on gross savings. Values are savings-weighted average CSE calculated using all savings and expenditures at the level of analysis.

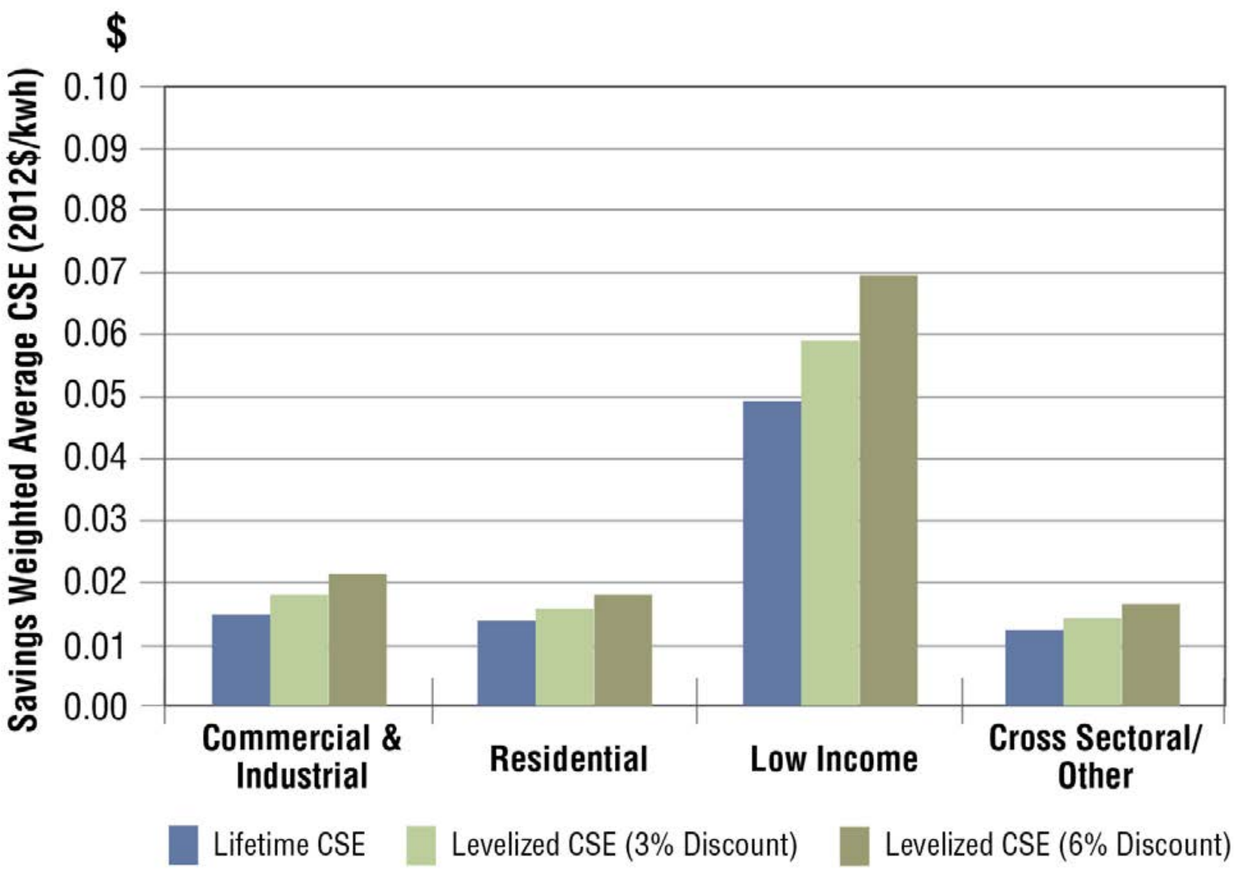

Figure 3-8. National savings-weighted average CSE for electricity efficiency programs by sector

Table 3-5 shows national saving-weighted average CSE values for the natural gas efficiency programs in the LBNL DSM Program Impacts Database. Figure 3-9 depicts the lifetime and levelized CSE values ($/therm) for gas efficiency programs by sector.[56,57] Gas efficiency programs targeted at C&I customers had a significantly lower CSE ($0.17/therm; 6% discount rate) than programs targeting residential ($0.56/therm) and low-income ($0.59/therm) customers, indicating the importance of the C&I sector for natural gas programs.

Table 3-5. The program administrator CSE for gas efficiency programs by sector: national savings-weighted averages ($/therm)

Sector (Natural Gas)	Levelized CSE (6% discount) ($/therm)	Levelized CSE (3% discount) ($/therm)	Lifetime CSE ($/therm)	First Year CSE ($/therm)
C&I	$ 0.17	$ 0.14	$ 0.11	$ 1.61
Residential	$ 0.56	$ 0.43	$ 0.32	$ 6.44
Low Income	$ 0.59	$ 0.47	$ 0.36	$ 6.26
Cross Sectoral/Other	$ 1.78	$ 1.55	$ 1.34	$ 12.37
National CSE	**$ 0.38**	**$ 0.31**	**$ 0.24**	**$ 3.93**

Values in this table are based on the 2009-2011 data in the LBNL DSM Program Impacts Database. CSE values are for program administrator costs and based on gross savings. Values are savings-weighted average CSE calculated using all savings and expenditures at the level of analysis.

[56] Fifty program administrators reported natural gas program data.
[57] There are a number of combined fuel programs that have reported interactive effects on natural gas. These impacts are not included in program level CSE calculations; however, they are included in portfolio and sector level calculations.

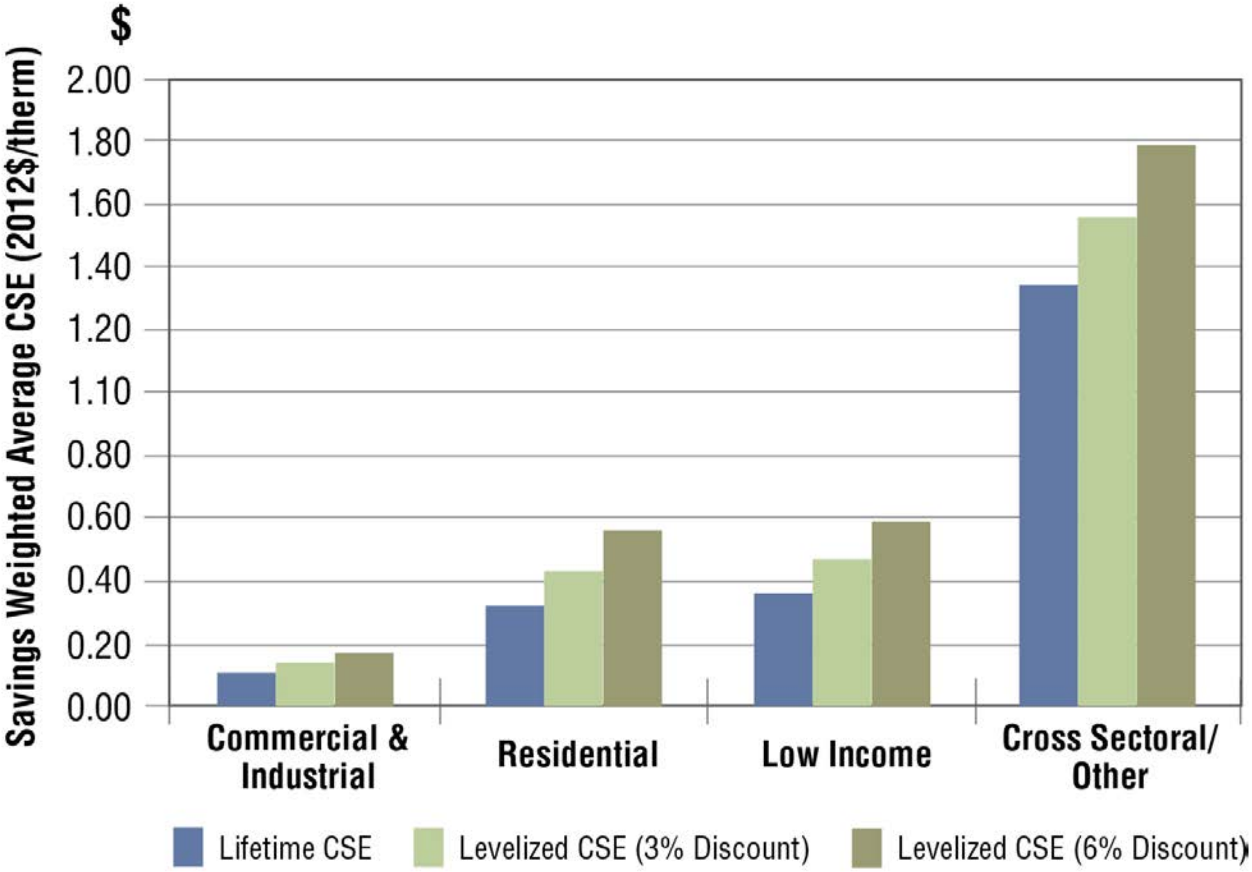

Figure 3-9. CSE for natural gas efficiency programs by sector

3.2.2 Sector and Program Level Observations for Electricity Efficiency Programs

We present CSE values at the sector and program level in this section. For simplicity, the remainder of this chapter presents CSE values using the levelized CSE for a 6% (real) discount rate (except where otherwise indicated).[58]

Figure 3-10 presents the levelized CSE results on a national basis, depicting the savings-weighted average, median and inter-quartile range for each sector. We found that both C&I and residential electricity efficiency programs included in our database had an average levelized CSE of about \$0.02/kWh. Looking at these sectors in more detail shows that the residential sector had a slightly lower weighted-average CSE than the commercial sector but a higher median CSE (~\$0.04/kWh). The CSE values for residential sector programs also had a larger inter-quartile range than commercial sector programs (e.g., inter-quartile range of CSE values ran from just

[58] We use a levelized CSE because we believe it is technically more appropriate for comparing resources. The 6% real discount rate is representative of a typical utility cost of capital. Lower discount rates result in lower CSE values. For example, for a program with an average measure life of 10 years for installed measures, a 6% discount rate results in a CSE that is about 15% higher than a 3% discount rate. There is significant interaction between discount rates and assumed measure lives. For example, the CSE value is 50% lower if we assume a 10 year measure life and 6% discount rate compared to a 20 year measure life and a 3% discount rate. See Appendix D for additional discussion of this issue.

under $0.02 to $0.09/kWh for residential programs vs. $0.015 to $0.05/kWh for commercial programs). We suspect that this is due to the very wide range of program types in the residential sector.

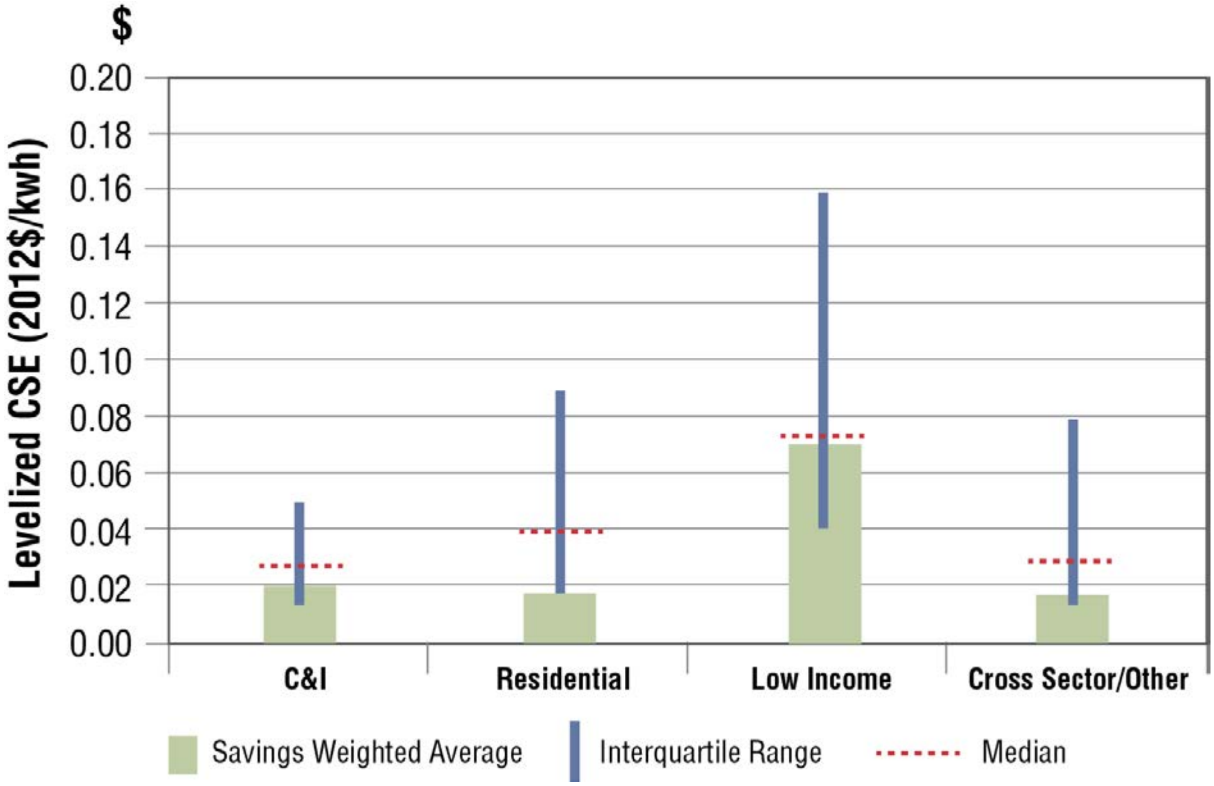

Figure 3-10. National levelized CSE for electricity efficiency programs by sector

Low-income programs have much higher savings-weighted average and median values for the program administrator CSE (on the order of $0.07 to $0.08/kWh). Low-income programs typically have a higher program administrator CSE for several reasons. Most notably, these programs are designed to achieve specific social policy objectives in addition to energy resource acquisition goals. These programs can include a variety of health and safety actions (correct structural issues, window replacement, mold removal, etc.) that need to be completed prior to completing any efficiency upgrades, adding to the program costs. Finally, low-income programs are often delivered at little or no cost to participants; thus the CSE for low-income programs is more comparable to an all-in or total resource cost perspective (i.e., including both program administrator and participant costs).

The cross sector/other program category, illustrated in Figure 3-10, is quite broad and includes a diverse mix of program types (e.g., equipment rebate programs that include both residential and non-residential customers, workforce development and training programs). Thus, at a high level, it is difficult to draw conclusions for the sample of programs included in this category.

At a national level, we observe a wide variation in CSE values for programs in most sectors (e.g., CSE values for programs in a sector have an inter-quartile range that varies by a factor of three to five). We also find that the savings-weighted average CSE was typically lower than the median value for CSE for a sector or program category (see Figure 3-11 and Figure 3-12). This suggests that much of the savings for each sector is coming from programs or program types on the low end of the CSE range for that program or sector.

Figure 3-11 and Figure 3-12 show levelized CSE values for the simplified program categories for C&I and residential sectors, respectively.[59]

The simplified C&I program categories had median values for the program administrator's CSE that range from $0.01/kWh to $0.05/kWh. It is worth noting that the savings-weighted average CSE for custom and prescriptive rebate program categories were $0.018/kWh and $0.015/kWh, respectively. Since these two program categories accounted for almost 70% of C&I sector savings (see Figure 3-4), they tended to drive the overall CSE results for the C&I sector: program administrators had an average levelized CSE of less than $0.02/kWh in the C&I sector. The C&I programs (Figure 3-11) also had a relatively smaller inter-quartile range of CSE values compared to the residential program categories (Figure 3-12).

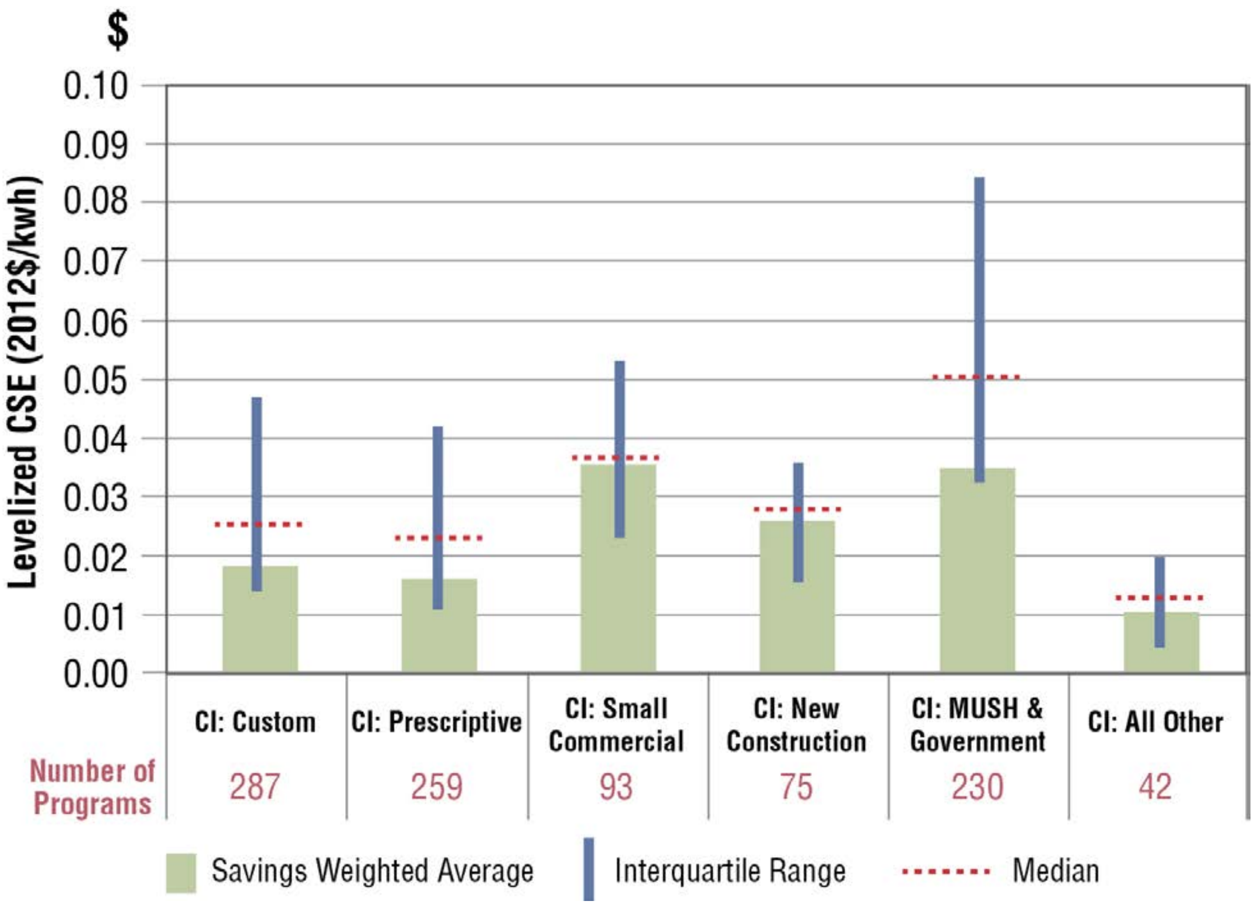

Figure 3-11. National levelized CSE for commercial and industrial sector simplified program categories

[59] Note that the y-axis scales for CSE are different in Figures 3-11 and 3-12, illustrating differences in the range of CSE values in C&I and residential sector programs.

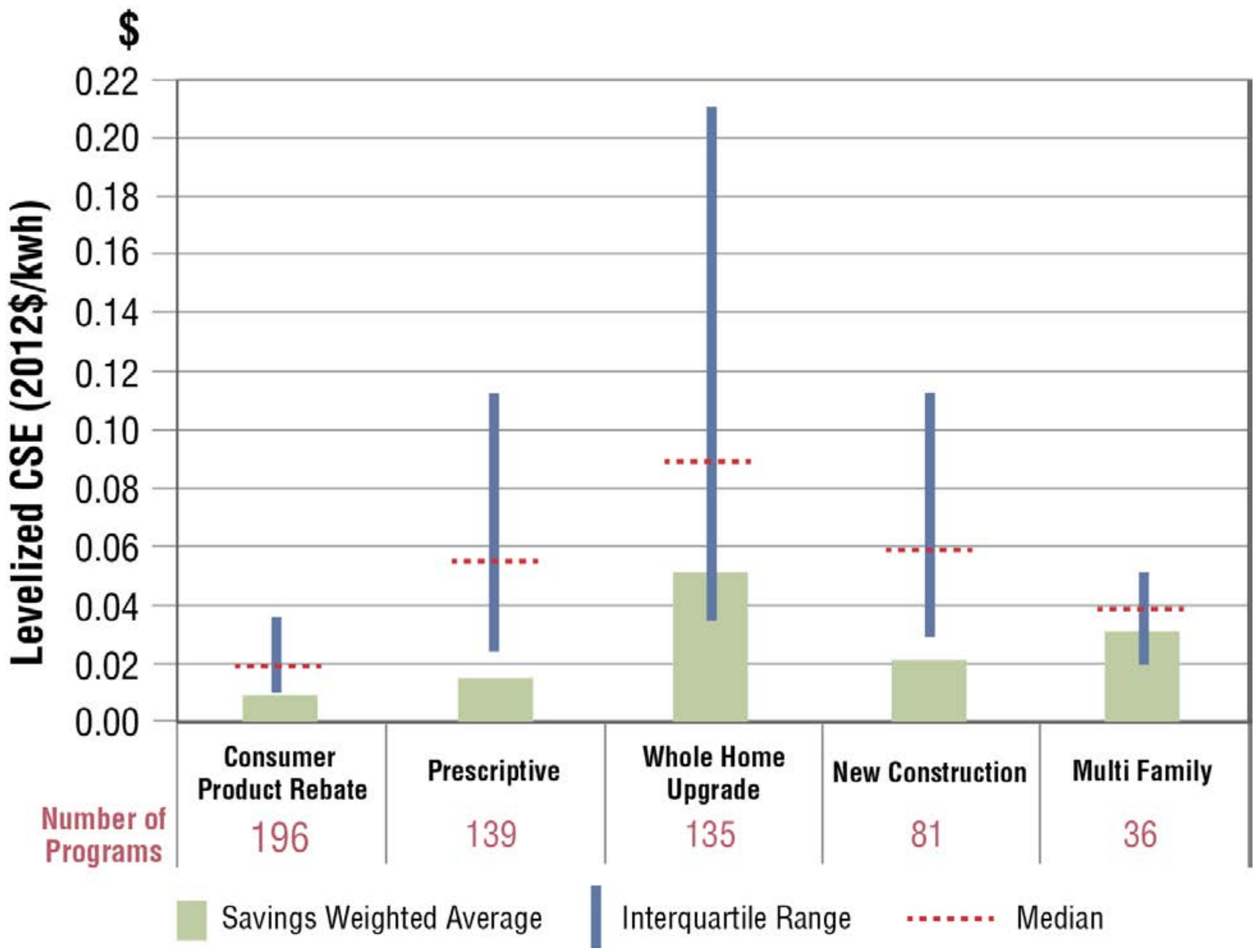

Figure 3-12. National levelized CSE for residential sector simplified program categories

For the residential programs, several program categories had a relatively tight range of program administrator CSE values. For example, Consumer Product Rebate programs had an inter-quartile range of $0.01/kWh to nearly $0.04/kWh and a low savings-weighted average (~$0.01/kWh). However, the Residential Prescriptive ($0.03/kWh to $0.11/kWh), New Construction ($0.03/kWh to $0.11/kWh) and Whole-Home Upgrade (slightly more than $0.03/kWh to $0.21/kWh) program types had significantly larger ranges. There are several possible reasons for the larger range of CSE values in each of these program categories. The prescriptive simplified program category includes detailed program types that implement a wide variety of measures (e.g., HVAC, insulation, windows, pool pumps) as well as some generic "prescriptive" programs[60] that often include measures also found in the Consumer Product Rebate category. This broad measure mix and the variation in costs and measure lifetimes associated with those measures are possible drivers for the wide range of CSE values for the prescriptive category.

[60] Some programs include all their rebated measures under the same program title and it is not possible to determine where the majority of the savings is coming from. In these cases, the programs were categorized as "Residential Prescriptive."

For the Whole-Home Upgrade program category, the broad range of program designs and delivery mechanisms (this category includes audit, direct install, and retrofit/upgrade programs) may help explain the relatively wide range of CSE values. Figure 3-13[61] shows program administrator CSE values for detailed program categories under the Whole-Home Upgrade program category. We observe that the inter-quartile range of CSE values for both direct install and whole-home upgrade programs ranged from about $0.03/kWh to about $0.26/kWh, with median values of $0.06/kWh and $0.12/kWh, respectively. Whole home audit programs have a much smaller inter-quartile range, from $0.03/kWh to $0.11/kWh, and a median value of $0.07/kWh.

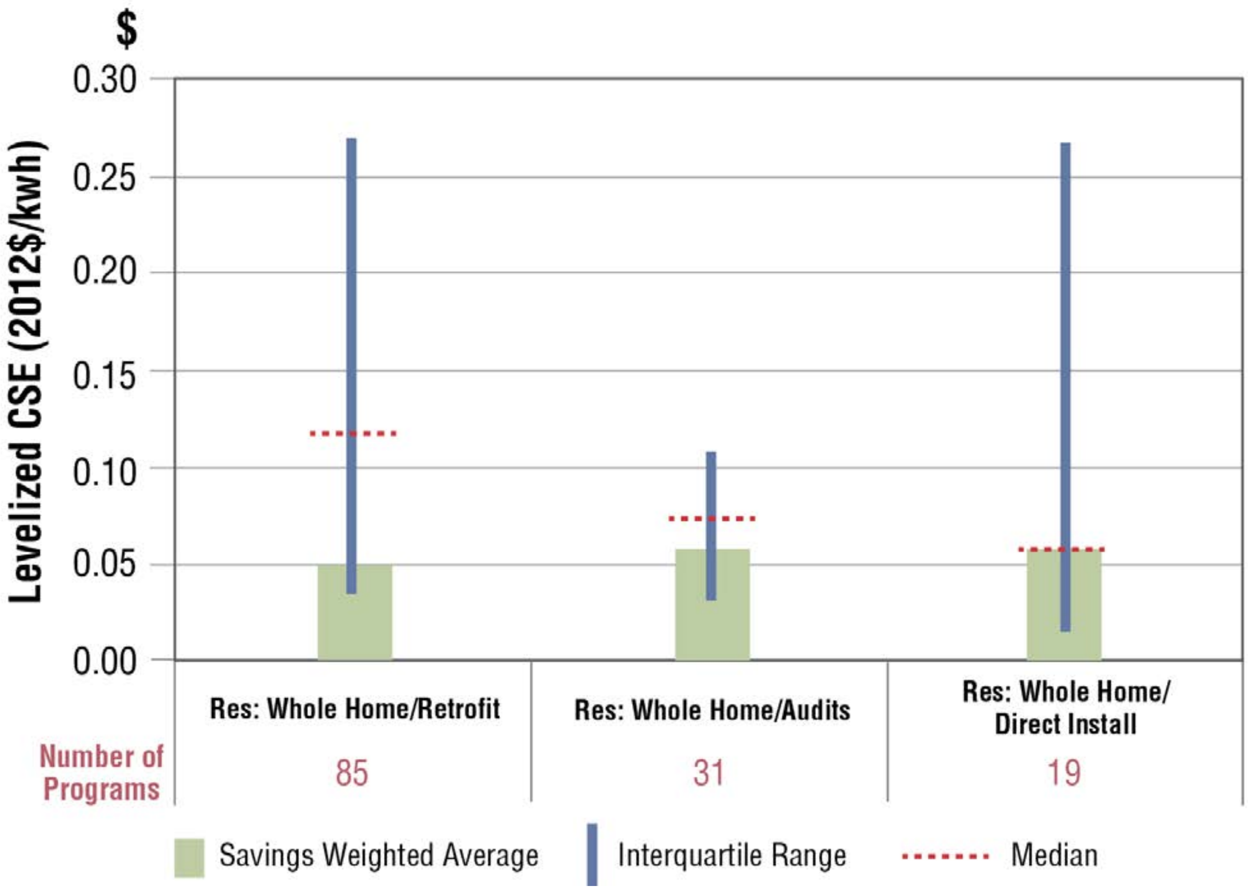

Figure 3-13. National levelized CSE for residential whole home detailed program category

Recall that about 44% of the residential sector lifetime gross savings came from lighting rebate programs that are part of the Consumer Product Rebate simplified program category (see Figure 3-13). Thus, we took a closer look at the CSE results for the four detailed program types within this category (see Figure 3-14).

The median and average levelized CSE values for lighting rebate programs were quite low (about $0.01/kWh) with a small inter-quartile range (see Figure 3-14). Future investigation of these programs' CSE values, savings estimates, and drivers is probably warranted given that a

[61] Note that the y-axis scale in Figure 3-13 has higher CSE values than other figures in this chapter.

large percentage of savings came from lighting measures and that lighting CSE may rise as baselines (and thus perhaps savings) are lowered for many of these measures given implementation of more aggressive lighting equipment standards.

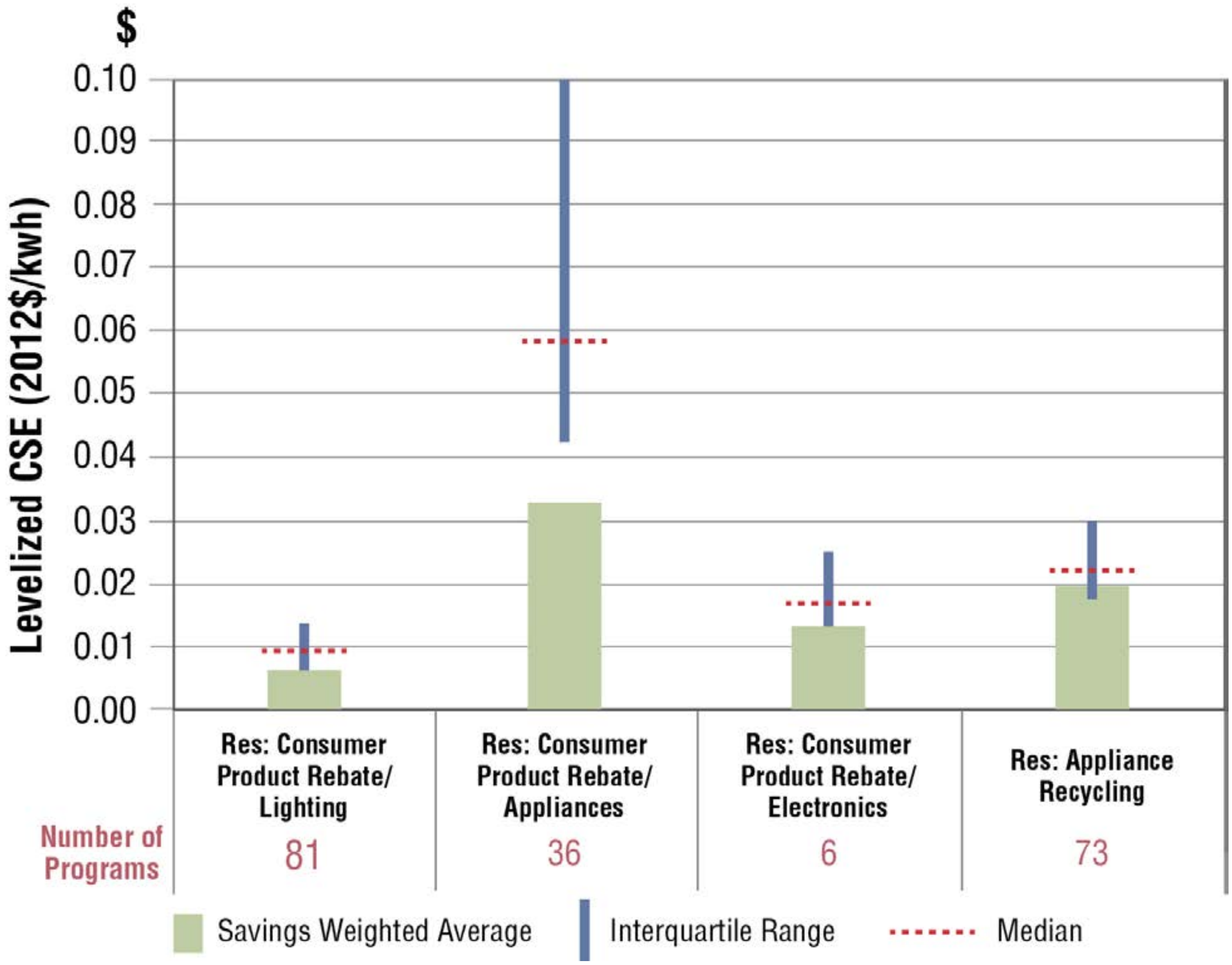

Figure 3-14. National levelized CSE for residential consumer product rebate detailed program categories

3.2.3 Regional Observations in Electricity Efficiency Programs

In this section, we examine some of the potential underlying drivers of CSE, including region (i.e., geographic location), climate, and baseline building efficiency requirements. Figure 3-15 presents regional CSE values for programs in the database (see Table 3-2 for assignment of states to region).

Across all programs, the savings-weighted average CSE ($0.014/kWh) and median CSE ($0.019/kWh) values were lowest in the Midwest. This is consistent with the information in Figure 3-5 and Figure 3-6, which shows that program administrators in the Midwest in aggregate reported relatively low expenditures and relatively high savings (compared to other regions). Possible explanations for this phenomenon include the relative “newness” of the Midwest energy efficiency programs and savings targets. Most of the states in this region enacted their first EERS targets in the late 2000s (Barbose et al. 2013). As a result, most of these states are perhaps still able to achieve significant savings from programs targeting low cost measures (i.e., lighting rebate programs). Another possible explanation is that gross savings values and/or measure lifetimes are higher because of baseline conditions or because EM&V practices are less mature in some states.

In contrast, many states in the Northeast region have consistently been running efficiency programs for many years, have much higher savings targets (e.g., "all cost effective" efficiency mandates) and relatively well established and rigorous savings evaluation requirements. In aggregate, program administrators in the Northeast have a higher savings-weighted CSE ($0.033/kWh) and a much wider range of CSE values among types of programs, which possibly indicates that there was a broader mix of program designs and delivery mechanisms, as well as desire to achieve more comprehensive savings driven by state policy objectives (e.g., regulatory decisions or legislation that directs program administrators to achieve all cost-effective efficiency).

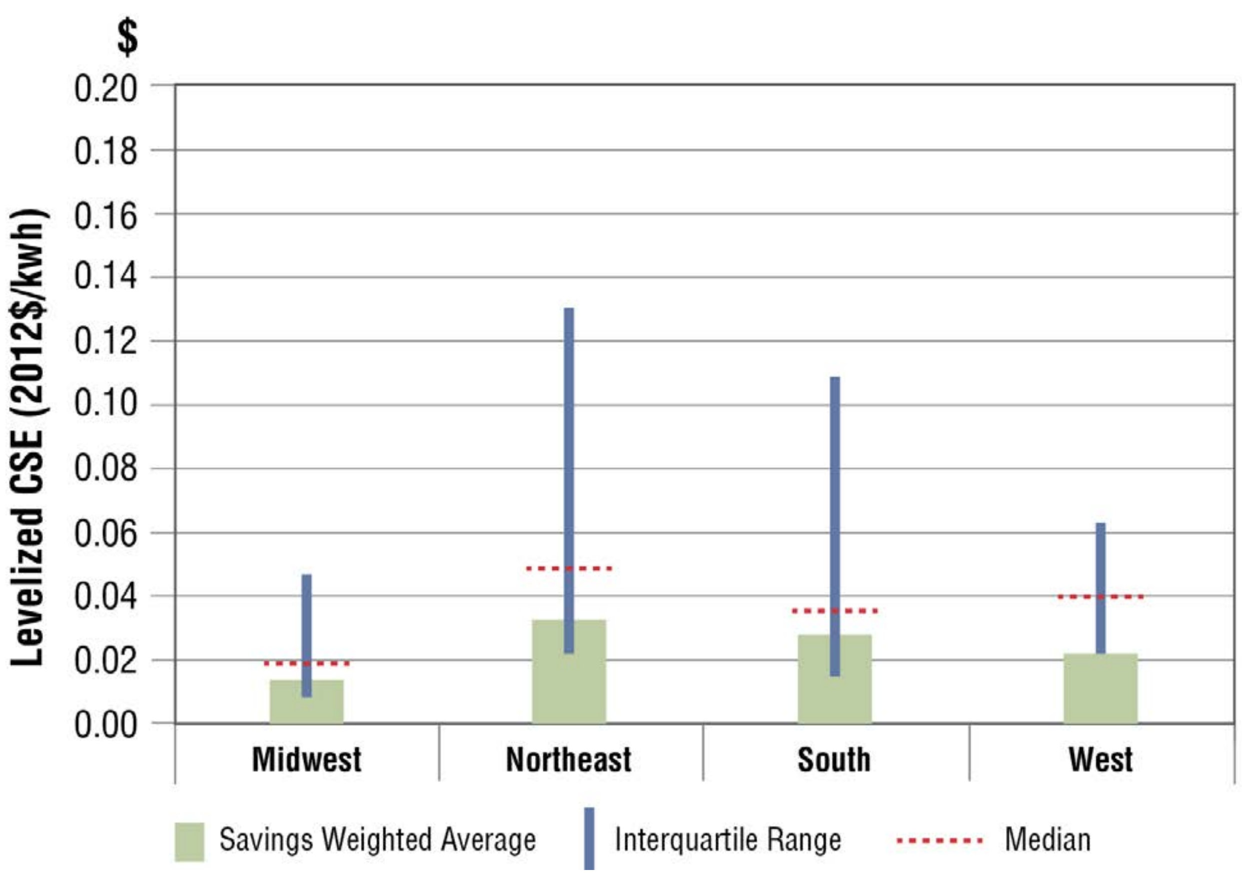

Figure 3-15. Levelized CSE for electricity efficiency programs by region

We also looked at average CSE values for all C&I and residential programs (excluding low-income programs) among program administrators in states (see Figure 3-16). Low-income programs were excluded for several reasons: (1) not all states either offer or reported information on their low-income programs; (2) the policy rationale(s) for low-income efficiency programs differs among states: some states require low-income programs to pass cost-effectiveness screening tests while other states use multiple criteria to assess budgets and design of low-income programs (e.g., equity reasons, cost-effectiveness); and (3) the scale of low-income programs varies significantly among states. Thus, including low-income program data has the potential to skew state by state observations in CSE.

With several exceptions, we observe some clustering of average CSE values for efficiency programs for states in a region (see Figure 3-16) with several exceptions (e.g., FL, PA, NJ). It is worth noting that Massachusetts and Vermont have all cost-effective efficiency mandates and both of those states had a savings-weighted average CSE over $0.04. Conversely, Pennsylvania has many characteristics that are typical of other states in the Midwest (e.g., relatively new efficiency programs, similar climate, economies) and had an average savings-weighted CSE more similar to program administrators in the Midwest than the Northeast. At this time, we cannot definitively explain the higher savings-weighted average CSE for program administrators in Florida.

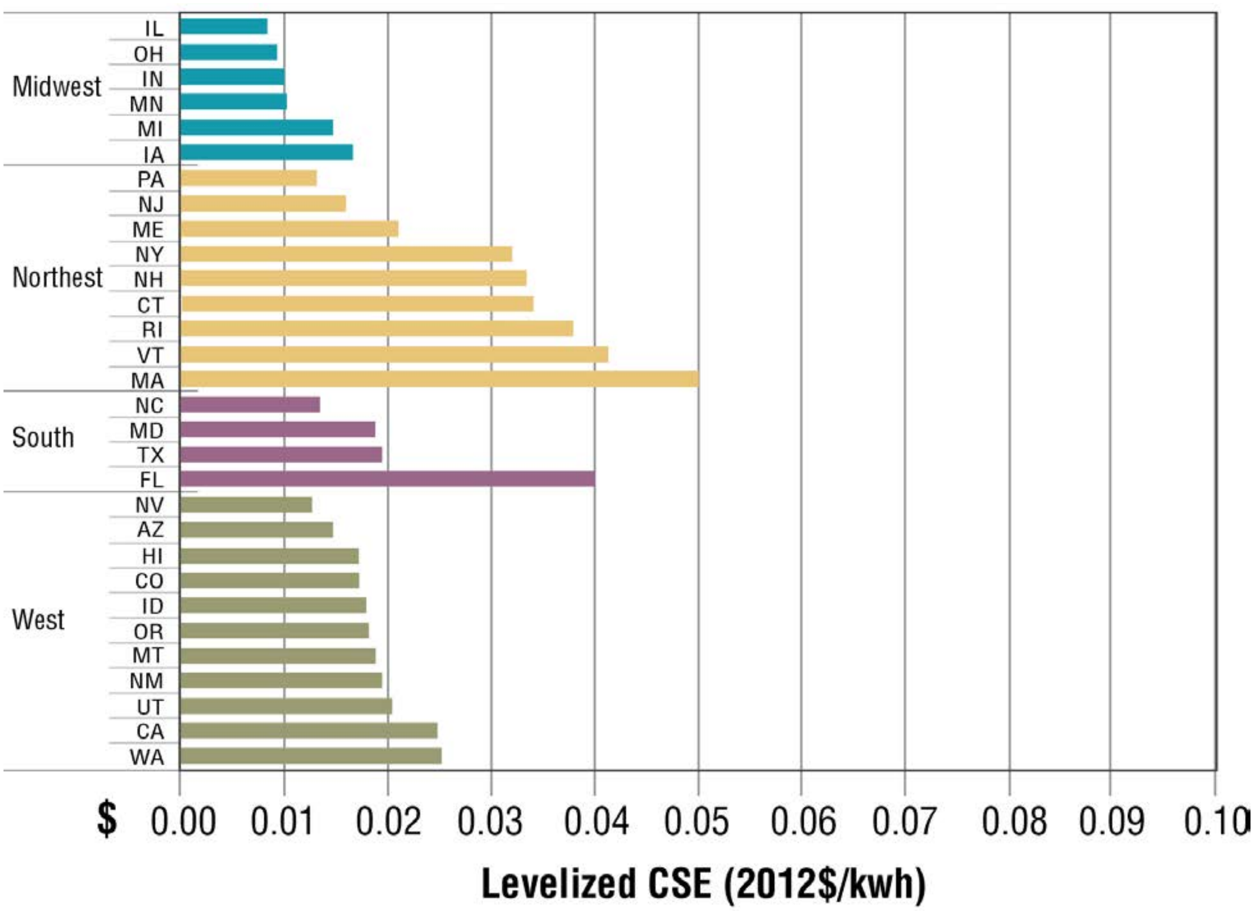

Figure 3-16. CSE values by state for electricity efficiency programs (excluding low-income programs)

A number of factors may influence the observed variation in the program-level CSE, including those that program administrators can influence (e.g., how program administrators report program costs, program design, incentive levels, and measure mix) and those largely outside of program administrator control (e.g., climate, area labor rates, building stock, regulatory requirements). We conducted exploratory analysis that examined two potential factors that may influence program-level CSE values: climate and building codes. First, we calculated the percentage of each region's lifetime gross savings by savings-weighted program administrator CSE and climate zone for all program categories in the database (see Figure 3-16). The size of the bubbles in Figure 3-17 represents the percentage of the total regional lifetime savings that falls within the respective climate zone in which the program was administered. For example, for the West, there are more savings in the database in the warm climate zone that includes much of California.

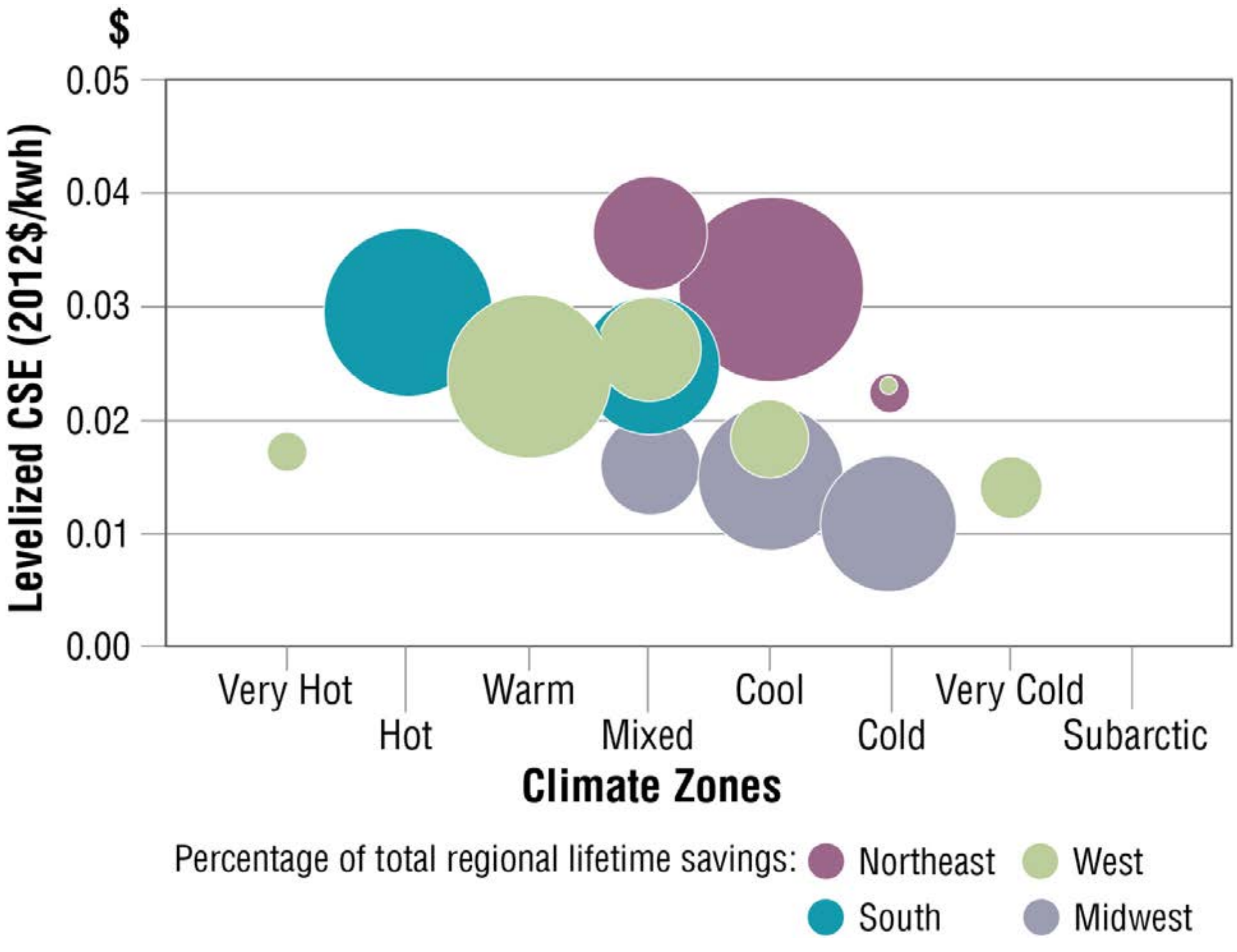

Figure 3-17. Percent of regional lifetime savings by climate zone and levelized CSE for electricity efficiency programs[62]

[62] States were assigned to climate zones adopted for the International Energy Conservation Code (IECC), in which the climate zones are delineated geographically as regions defined by certain historical averages for temperature, humidity and precipitation. A single zone was assigned to each state based on where the majority of the state's population—and presumably load—is concentrated. This method is imperfect but useful as a proof-of-concept test for an approximate relationship with levelized CSE. A description for the climate zones was adapted from the

In each region, we observe a pattern that as the climate gets cooler, the savings-weighted average CSE decreases for electricity efficiency programs. However, we also see that the savings-weighted average CSE varied significantly within a climate zone (see mixed and cool). Had climate been a significant driver for CSE, we would expect to see more agreement on the CSE by climate zone, even in different regions. This indicates that there are probably other factors that have more impact on the regional CSEs than climate zone. Additional analyses may be required to focus only on program types with climate dependent measures (e.g., cooling and heating system retrofits) or conduct more detailed analysis of participant costs and incentives which can vary by climate zone as cost effectiveness varies (e.g., a cooling system retrofit would be more cost-effective in a very hot climate than a cool one, possibly justifying higher incentives, but also perhaps not requiring them since the participant benefit to cost ratio would also be higher).

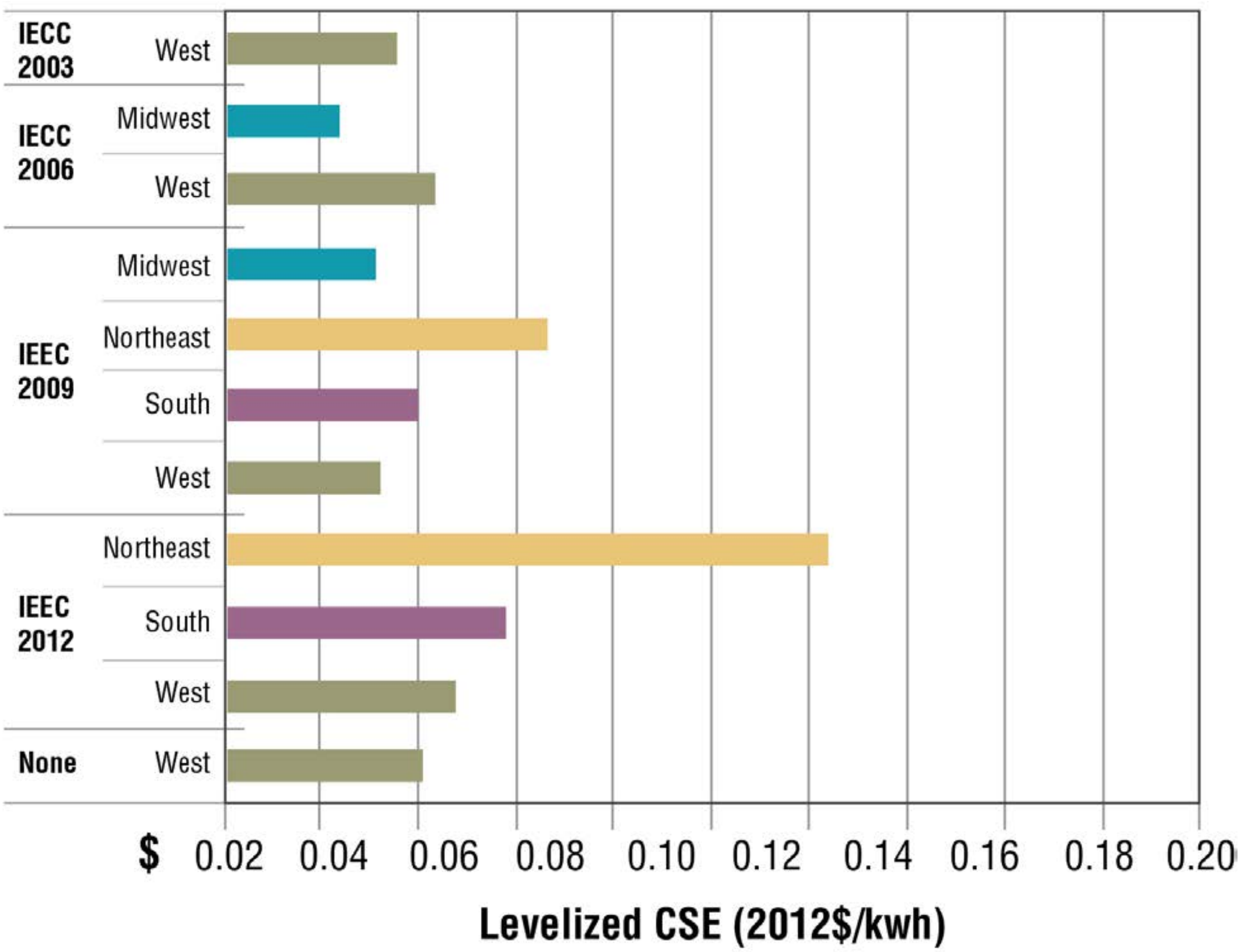

Figure 3-18. Levelized CSE for residential new construction programs compared to residential building energy codes adopted by states in each region[63]

Building America discussion of IECC and Building America climate zones found here: http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_climateguide_7_1.pdf

[63] U.S. DOE. 2013. Building Energy Codes Program. Washington, DC. Accessed at: http://www.energycodes.gov/status-state-energy-code-adoption in September 2013.

Another potential influence on CSE values is differences in baseline building efficiency across states and regions. In Figure 3-18 and Figure 3-19, we examine the savings-weighted average CSE for new construction programs in the residential and commercial sectors, respectively. For the residential programs, we calculate the savings-weighted average electric levelized CSE for new construction programs in each region plotted against each state's current International Energy Conservation Code (IECC) status.[64,65] The newer the adopted code, the lower the assumed baseline energy consumption, which tends to reduce the incremental electricity savings for any given efficiency action. For example, the gross savings calculated for a fixed set of measures for a building than meets the 2006 IECC code would be greater than for the same set of measures for a building that meets the 2012 IECC code. Note that the West, as a region, has the most diversity among states in terms of building energy code requirements.

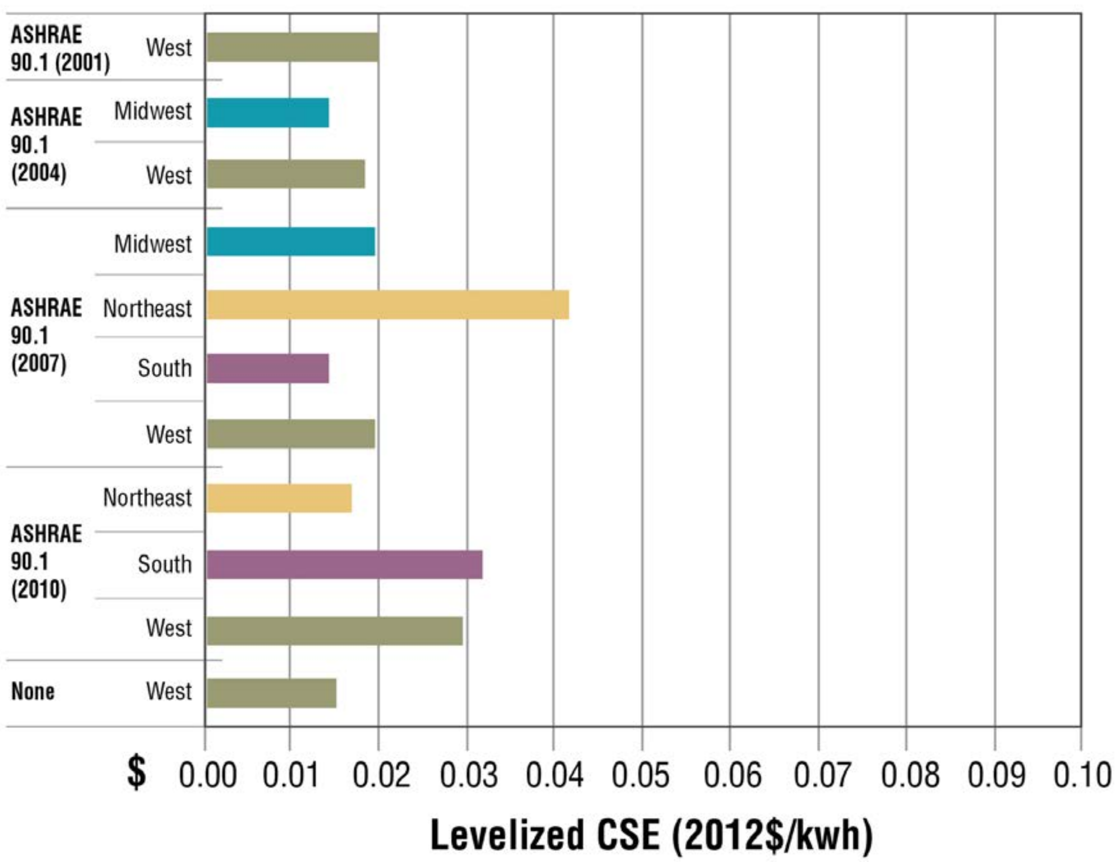

Figure 3-19. Regional levelized CSEs for commercial new construction programs compared to commercial building energy codes adopted by states in each region[66]

[64] The IECC (http://www.iccsafe.org/gr/Pages/IECC-Resource.aspx) is a national model energy code for the United States. It sets minimum requirements for energy efficiency that new buildings—as well as additions and renovations to existing buildings—must meet wherever the code has been adopted into law, usually on state-by-state basis. The IECC is updated on a 3-year cycle, and the most recent version is 2012.

[65] By using current (2103) IECC code adoption status, we do not directly reflect the baseline status at time of program implementation (2009-2011). However, we expect that this approach may still be indicative of relative baseline status while not requiring state-by-state, year-by-year analysis of code status.

[66] U.S. DOE. 2013. Building Energy Codes Program. Washington, DC. Accessed at: http://www.energycodes.gov/status-state-energy-code-adoption in September 2013.

It might be reasonable to expect that the CSE would increase as the codes for new buildings set more stringent baseline efficiency requirements (e.g., incremental savings opportunities are less for any given investment). Some evidence for this pattern can be observed in the average CSE values for Midwest, Northeast and South residential programs segmented by the year of the building energy codes. However, the expected pattern in average CSE values does not readily emerge for states in the West that offer residential new construction programs.

The picture is even less clear when looking at the savings-weighted CSE for commercial new construction programs plotted against commercial codes (see Figure 3-19). CSE values do not follow the expected pattern for states in either the West or Midwest. The savings-weighted average CSE values for states in the Northeast seems to have been lower where more stringent codes exist, although there are a limited range of code requirements among states in the Northeast. Thus, the effects of code status on CSE values require further inquiry.

3.2.4 Sensitivity Analysis: Impact of Measure Lifetime

In Chapter 2, we discussed data gaps and inconsistent criteria for reporting lifetime energy savings (and by extension efficiency measure lifetimes), noting that lifetime savings (or program average measure lifetime) were not reported for about 50% of the program years in the database.[67] In this section, we illustrate and discuss results of a sensitivity analysis that explores the impact of varying assumptions regarding program measure lifetime on CSE values reported by program administrators.

Figure 3-20 compares the "LBNL approach" used to estimate lifetime savings for those programs that did not report this information to two other potential approaches in which we apply the minimum and maximum reported program average lifetimes for each detailed program type to all programs of that type.

The minimum and maximum values for each program type (see the light and dark green bars in Figure 3-20) dramatize the impact on levelized CSE values of varying assumptions for the average measure lifetime of efficiency programs. For five of the 12 reported program categories, if we use the minimum reported program average lifetime (and apply it to all other programs in that category), the levelized CSE values more than doubles compared to the CSE values using the LBNL measure lifetime approach. This underscores the importance of understanding and accurately reporting the average measure lifetime of measures installed in programs since it significantly impacts the cost of saved energy (and the underlying cost-effectiveness of efficiency actions).

[67] For those programs, we calculated a program-average measure lifetime by detailed program category and applied those values to the reported gross first-year savings to calculate lifetime savings.

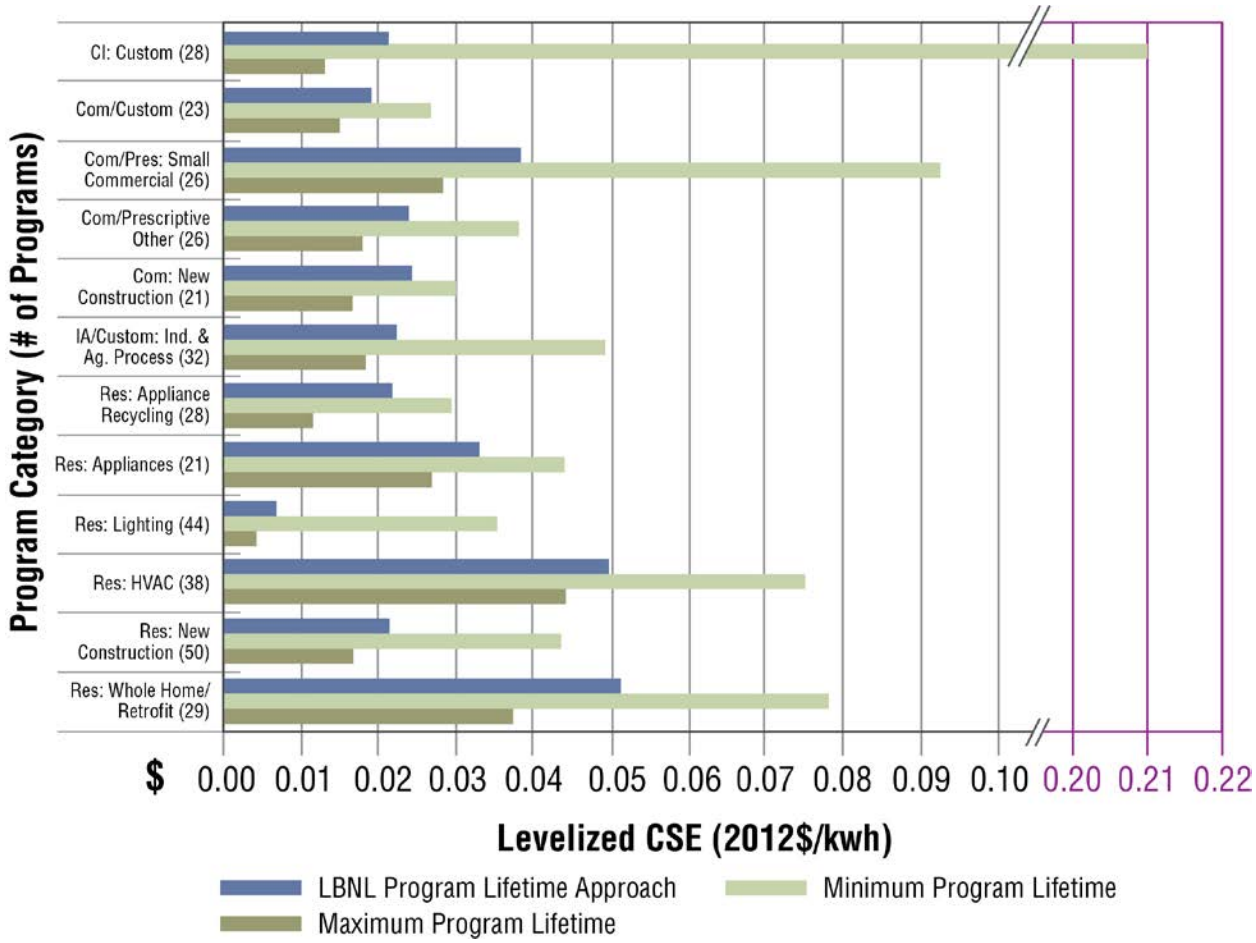

Figure 3-20. Impact of different program average measure lifetime assumptions on the levelized CSE for electricity efficiency programs

3.2.5 Program Administrator and Participant Cost Analysis: The Total Resource Cost of Saved Energy

This study focuses primarily on the program administrator CSE because participant costs were not consistently reported. We collected participant costs at the program level when reported, although this information was available for only 265 electric programs years (less than 10% of the programs in the database) in 11 states.[68] When reported, participant costs are subject to at least two additional sources of uncertainty: (1) whether the participant costs are based upon full program measure costs or incremental program measure costs; and (2) whether participant costs are based upon customer receipts and/or supplier invoices (i.e., actual participants paid those full costs) or whether incremental participant costs are based upon deemed values drawn from various sources (e.g., supplier surveys).

[68] In some of the 11 states, participant costs are only reported for select programs and not the entire portfolio.

Given small sample size and uncertain reporting of participant costs, it is difficult to assess the "all-in" or total resource cost of efficiency or analyze potential influences on the total cost of the efficiency resource. For these reasons, in Figure 3-21, we compare the program administrator's levelized CSE vs. a total resource CSE for illustrative purposes only. We calculate this total resource CSE for the simplified program categories where both program administrator and participant costs were available for more than 18 program years.[69]

For the small sample of programs, we found that the levelized total resource CSE values are typically double for most program types with the exception of the Residential Whole Home Upgrade program category (where the total resource CSE is about 25%–30% higher than the program administrator CSE). Further data collection and analyses could help understand how the ratio of program administrator to participant costs varies as a function of sector, measure types, and market maturity; and how incentives and direct support might be optimized to pay no more than is necessary to meet efficiency uptake objectives.

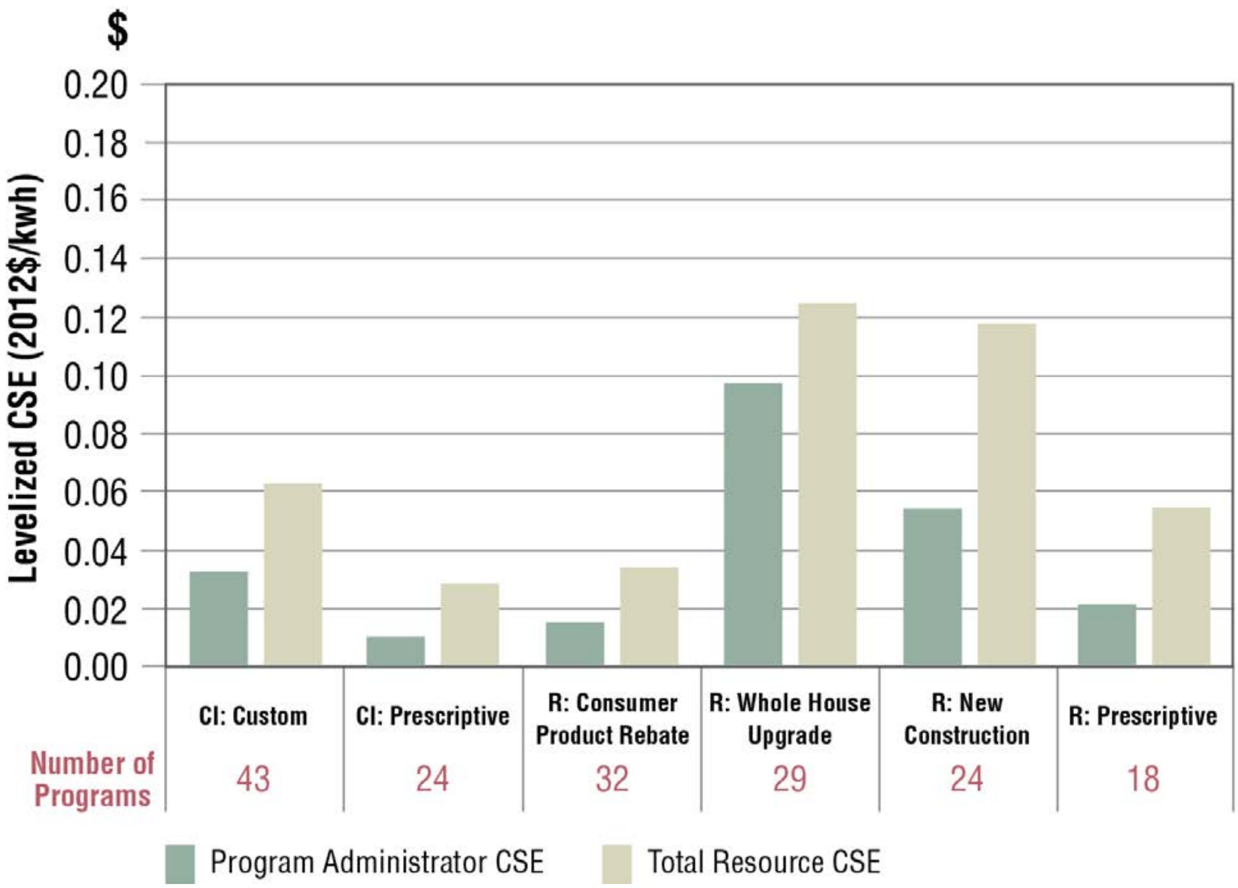

Figure 3-21. Levelized savings-weighted average CSE for electricity efficiency programs that include program administrator costs vs. total resource costs for select program categories[70]

[69] The "n" of 18 was selected because there was a natural break in the data and also that criteria resulted in only including results for which there was a meaningful number of programs from which to calculate average values.
[70] This chart includes a very small sample of programs from 11 states; thus, results may not reflect current practices in many jurisdictions.

4. Testing Influences on the Costs of Saved Energy

As shown in Chapter 3, we observe a wide range of values for the program administrator CSE from virtually every perspective—nationally, and across regions, states, portfolios, and sectors. Moreover, we find significant variability within the different types of programs. The inter-quartile range of CSE values (the "middle" 50% of programs) for the first-year CSE can vary by a factor of 10 or more within a program category. In this chapter, we explore some factors that may be associated with this variability in the CSE. We describe the results of statistical analyses aimed at quantifying the relationship of CSE and a few, selected independent variables.

To initiate these analyses, we postulated three sets of potential explanations for these ranges of CSE values:

- Differences internal to the programs themselves and over which program administrators have at least some influence (e.g., the mix of measures in programs and thus the adoption patterns of consumers, the scale of programs, the maturity of the programs, program design, and program implementation);
- Differences external to the programs and over which program administrators have very little or no influence (e.g., climate, labor costs, and the policy framework within which programs operate).
- Incorrect information arising from problems with the primary data or faulty categorization of programs, or both (e.g., if gross energy savings are inaccurately reported in the source reports).[71]

We suspect that most or all of these factors influence the CSE values, interacting in ways that can be difficult to disentangle. In this chapter, we focus on the first two explanations (i.e., potential internal and external program influences) in order to see if their hypothesized influences on CSE are observed or not, using the programs in the database.[72]

In the long run, we hope the collected data and this type of statistical analyses can:

- Inform policymakers and other stakeholders about the variability of the CSE to distinguish between controllable and uncontrollable sources of variability and, ideally, to identify ways of reducing costs or otherwise improving program design and delivery; and
- Lead to predictive models that specify and quantify major influences on CSE values and thus could inform cost or savings projections for use by portfolio planners, regulators, and resource planners.

[71] See Chapter 2 for a discussion of data issues and Appendix C for a description of the quality control procedures implemented for this project.

[72] As noted in Chapter 3, CSE values are derived as follows: Program costs refer to program administrator costs only; the CSE values exclude participant costs. Savings are *gross savings* as reported by the program administrator. When program administrators only reported net savings values and we either had or could derive program-specific net-to-gross ratios, we used those ratios to calculate gross savings values from reported net savings. Savings values are based on savings at the end-use site and not at the power plant or natural gas pumping station and thus do not account for transmission and distribution losses.

4.1 Hypotheses

Table 4-1 indicates five hypotheses postulated as part of this research effort. We present results for three of these hypotheses in this report (shown in black).[73] Future reports may provide more in-depth results for these hypotheses and analyses of other hypotheses (shown in gray), both indicated in Table 4-1 and under development.

Table 4-1. Factors that may influence the cost of saved energy

Factors that May Influence the Cost of Saved Energy	Hypotheses	Proxy Variables	Level at which Variable Was Tested	Sources for Proxy Variable Data
Program Administrator Experience	**Program administrators with more experience learn to deliver programs more effectively and efficiently, with resulting lower CSE**	**Years of energy efficiency program spending from 1999-2012[74] above a *de minimis* threshold**	**Portfolio and sector levels**	**U.S. Energy Information Administration Form 861 survey[75] data, 1999-2012**
Scale of Program	**Larger programs reap economies of scale and thus have lower CSE**	**Number of program participants**	**Sector and simplified and detailed program level**	**LBNL DSM Program Impacts Database**
Labor Costs	**Areas with higher labor costs have higher CSE because labor is a significant component of both administrative and (indirectly) incentive costs.**	**State average wages for the construction industry**	**Portfolio, sector, and simplified and detailed program levels**	**U.S. Bureau of Labor Statistics**
State Policy Environment	Strong efficiency policies can both raise the baseline for energy savings potential and drive program administrators to reach deeper into the economy for savings; over time, both factors	Estimated statewide savings targets, as a percent of retail sales	Portfolio, sector, and program levels	Various reports by LBNL and ACEEE State Scorecards

[73] We plan to explore other hypotheses in future reports.

[74] This period was chosen largely because reporting of energy efficiency program spending and savings to EIA was less consistent in the early 1990s. See subsection on preliminary findings on program administrator experience for a discussion of the implications of selecting this period.

[75] We measured experience as the number of years that each program administrator has funded program portfolios at 0.1 percent of retail revenues for that program administrator or for utilities in that program administrator's territory. Where a time series of program funding could not be obtained (e.g., through gaps in reporting or delayed recognition of a non-utility program administrator in the survey data), we used the launch date for a multi-sector portfolio by that program administrator or, in a few cases, relied upon in-house knowledge of the level of energy-efficiency activity by that program administrator.

	are likely to result in higher CSE.			
Retail Rate Environment	Higher retail energy costs result in lower CSE because the higher energy costs encourage more customers to invest in energy savings, thus lowering the program administrator's costs of securing participation and savings	Residential, commercial and industrial retail rates	Commercial and Industrial (C&I) and residential sectors	U.S. EIA 826 and 861 reports (the Monthly Electric Sales and Revenue Report with State Distributions Report and the Annual Electric Power Industry Report)

Through the exercise of developing the hypotheses and identifying associated independent variables, it became clear that several of our theorized influences on the CSE interact in complex ways. Several variables operate in synergistic or countervailing ways. For example, some policies that are generally supportive of saving energy (e.g., energy savings targets) may dampen the costs of saving energy for program administrators in some circumstances and yet increase those costs under other circumstances. Further, the resulting effects may not operate uniformly or in the same direction from one market sector to another or across program types. Thus, the identification of potential influences on the CSEs, development of testable hypotheses and identification of valid independent variables is an iterative process, the early phases of which are described below.

4.2 Approach

For our dependent variable, we chose the first-year electric CSE, which is simply the program administrator cost (2012$) divided by first-year gross electricity savings (in kWh). The primary advantage of using first-year savings (versus lifetime savings) is eliminating uncertainties associated with the measure lifetime data; see Chapters 2 and 3 for discussion of limitations of lifetime energy savings data.

Statistical Regressions

Statistical regressions do not necessarily imply causality. Regressions can establish correlation or a probability that changing one or more independent variables is significantly associated with a quantifiable change in the dependent variable (e.g., the CSE).

The disadvantage of using first-year savings is the inability to examine the ways that potential influences on CSEs vary for shorter- versus longer-lived efficiency measures, as using a levelized or lifetime CSE might allow. Since energy resources are generally evaluated over their economic lifetime, we anticipate analyzing factors that may be associated with levelized CSE values.

We identified and collected data on the independent variables as proxies for the factors chosen to represent the potential influences over CSE. We then performed single-variable ordinary least squares regressions to screen independent variables, followed by a limited number of multivariate regressions to test the correlation between variables and the relative contributions of the variables. Appendix F describes our data collection procedures for the independent variables, the statistical analysis process and contains a table of these preliminary regression results.

4.3 Preliminary Results: Analysis of Factors that May Influence the Cost of Saved Energy

Our preliminary results to date suggest that many factors influence the CSE, and the degree of those influences varies across market sectors and programs. In the following subsections, we present an illustrative sampling of preliminary results and also discuss some of the challenges in identifying valid independent variables and interpreting results.

4.3.1 Program Administrator Experience

We hypothesized that program administrators with more experience would, to some demonstrable degree, have optimized the efficacy of program implementation and thus have lower CSE values for their portfolio of programs after an initial period. Experienced program administrators might realize these cost savings by one or more mechanisms, including having already established the necessary program infrastructure and trade alliances, identifying cost efficiencies in overhead expenses, and learning what measures and marketing approaches tend to elicit more customer participation or deeper savings.

We defined the program administrator experience variable as follows: each year of spending above a minimum program spending threshold (0.1% of revenues) as reported to the Energy Information Administration counted as a year of experience administering efficiency programs.[76] Years of experience were summed up for all years where spending exceeded the threshold to the program year for the data being tested. For example, utility X offered an informational energy audit program to customers in 2004 and expanded their programs in subsequent years such that spending exceeded 0.1% of revenues in 2006. Thus, we assumed that this utility had four years of experience for their 2010 programs and five years of experience for their 2011 programs.

The nature of the relationship between first-year CSE values and program administrator experience is depicted in Figure 4-1. The blue dots in Figure 4-1 represent CSE values for the portfolio of programs offered each year by individual program administrators**.** The cost of first-year gross electricity savings is plotted on the y-axis, the years of program administrator experience are shown on the x-axis.

There may be a quadratic relationship, such that program administrator experience and the cost of first-year savings may trace a curve in which first-year CSE declines as program administrators gain experience and then, beyond a certain number of years, costs increase, as

[76] See Appendix F for a more detailed explanation of the basis for determining program administrator years of experience. Response rates vary among program administrators from year to year in providing EIA Form-861 information. Third-party program administrators were not included in the EIA datasets until very recently. The names and parent companies for some program administrators changed over time. Some EIA survey data terms and definitions have changed over time and program administrators may have interpreted those terms (e.g., direct vs. indirect spending) in different ways. These limitations increase as the data reaches back to the early years of the EIA survey. We therefore chose to limit the count of years above the spending threshold to a period from 1999 to 2012. We recognize that bounding our metric for program administrator experience to this 14-year period imposes an artificial ceiling on the level of experience for the most mature program administrators. This may affect the correlation between program administrator maturity and the cost of saved energy. However, this impact is likely to be limited because 80% of the program administrator s in our dataset have spent above the designated spending threshold for 10 or fewer years.

saturation of low cost measures increases and program administrators offer programs that include more costly measures or target harder to reach market segments. However, a regression analysis with a quadratic specification using the first-year CSE values at the portfolio level does not show a statistically significant relationship,[77] and the magnitude of the effect, if it exists, is small (see a table of regression results in Appendix F). We plan to gather additional data, refine our method to estimate program administrator experience variable, and re-examine evidence for this relationship.

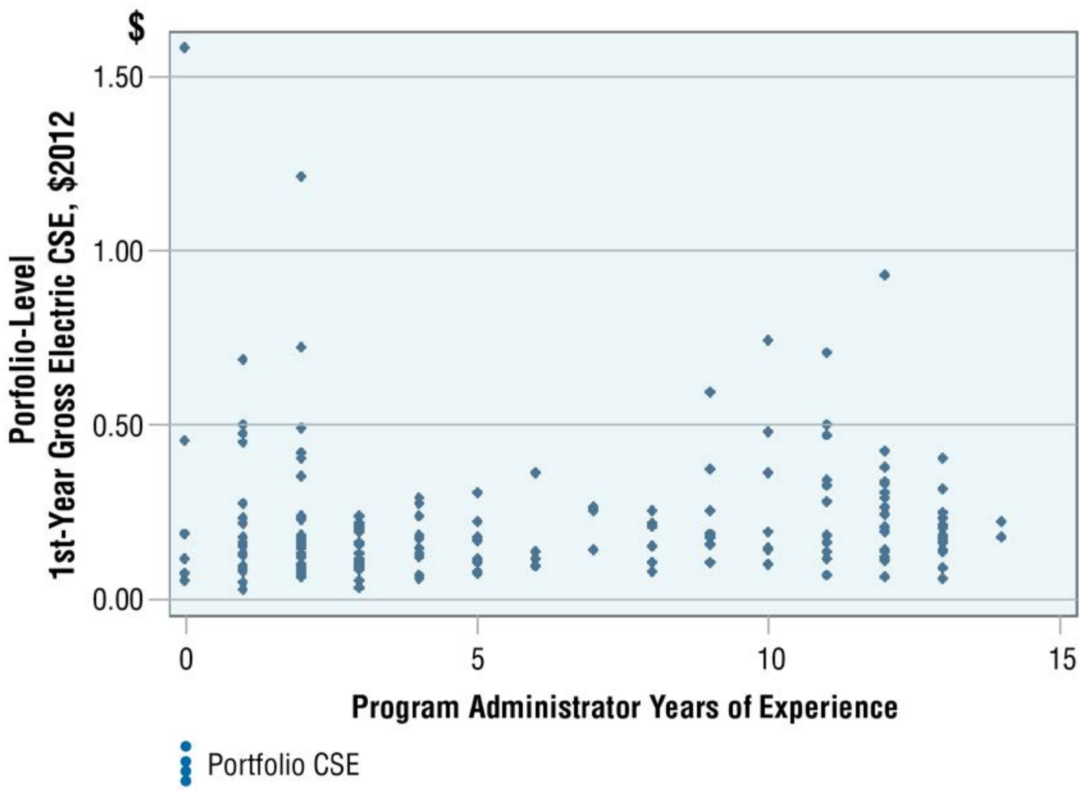

Figure 4-1. First-year portfolio-level CSE and program administrator experience, as measured by years of program spending above a minimal level.

4.3.2 Scale of Program

Based on economic theory, we would expect to see increasing economies of scale (i.e., lower CSE values as program fixed overhead costs are spread among more participant projects) at least up to a certain point. We found that the size of a program, as measured by number of participants, is often, but not always, indirectly associated with a decline in costs for some program types. This result is statistically significant for only certain program types. More reporting of participation levels could help determine, for different program types, when scaling up a program is likely to reduce the cost of saved energy.

As an example, Figure 4-2 depicts the relationship of participant count to first-year CSE for residential appliance recycling programs. The blue dots in Figure 4-2 represent first-year CSEs

[77] We use a 5% level as a threshold for statistical significance.

and reported participation for individual program years for appliance recycling programs. The red line is a linear fit across the data points, with the slope of the line indicating the predicted relationship between first-year cost performance and participation. For appliance recycling programs in our database, a doubling, or 100% increase, in the number of participants would, on average, be associated with about 0.01% of a reduction in the first-year CSE. This effect is statistically significant at the 5% level.

However, we also found that this effect is not statistically significant[78] for many other program types.

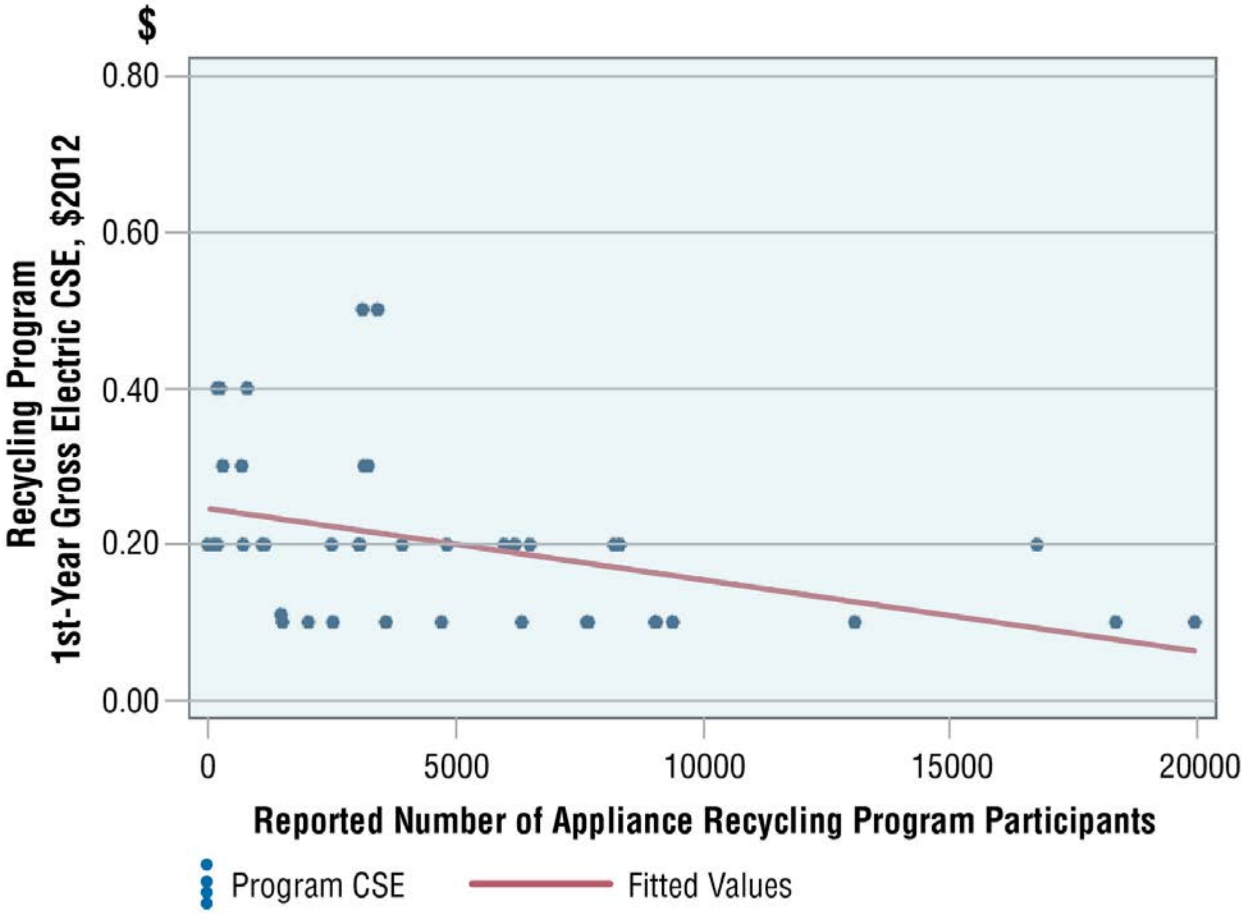

Figure 4-2. First-year CSE for appliance recycling programs and the reported number of recycling program participants

[78] The relationship between participation and first-year gross CSE for some other residential programs is statistically significant at the 20% level.

4.3.3 Labor Costs

We also theorized that higher labor costs result in higher CSE values (see Table 4-1). We present portfolio-wide CSE values as a function of state average hourly wages for construction industry employees in Figure 4-3. The blue dots represent CSE values for individual program administrator portfolios with the cost of first-year gross electricity savings plotted on the y-axis and the average hourly construction wages for the state in which the portfolios are administered on the x-axis.

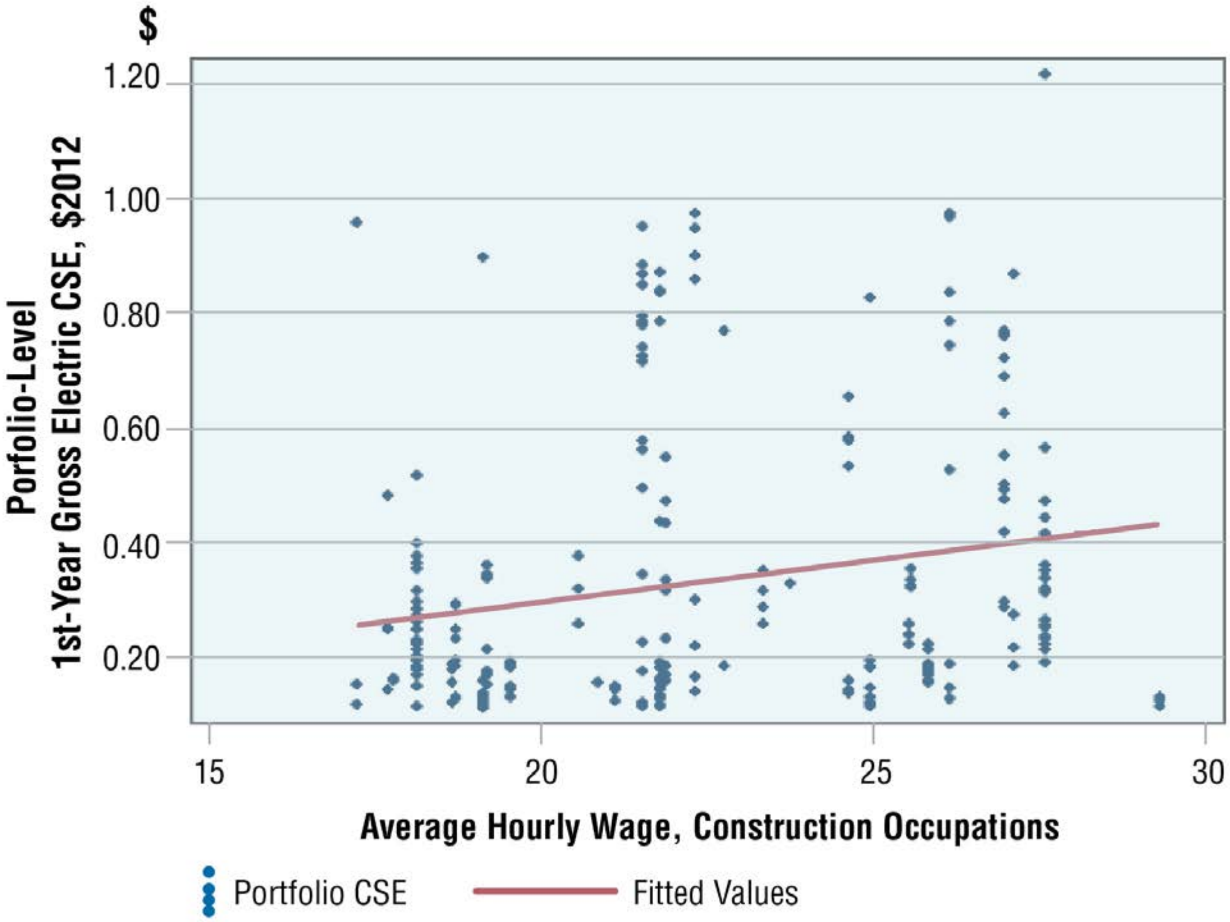

Figure 4-3. First-year portfolio-level CSE values and state average wages for construction industry employees ($/hour)

We selected construction hourly wages at the state level as our independent variable because research on the makeup of the energy-efficiency program workforce suggests that the construction industry is generally representative of that workforce (Goldman et al., 2010; Carol Zabin, UC-Berkeley Labor Center, personal communication). Our analysis shows that there is a positive correlation between construction wages and portfolio-level first-year gross CSEs. This result is statistically significant at a 5% level. However, the demonstrated effect is generally small, as can be seen from the fairly shallow slope of the fitted line in Figure 4-3. The effect is also neither uniform nor statistically significant across individual program types. As an aside, we also tried state average per capita income as the independent variable and found that the results are similar to those using construction hourly wages; this seems to indicate that labor costs are likely to play some role in the cost of saving energy.

4.4 Analytical Challenges

We also conducted exploratory analysis of other hypotheses (e.g., policy and retail price environments in which programs operate) and found that results varied substantially by market sector and program type. Many of these theorized relationships with the CSE are significant only at the 10%-15% level; further study is warranted.

The statistical analysis results described in this chapter depend critically on defining valid independent variables as well as the quality and quantity of the primary data underlying both the independent and dependent variables. Some of the difficulty in parsing these effects is a function of limitations in the underlying data for the independent variables. Drawing on an example noted earlier, we used data that program administrators voluntarily reported to the Energy Information Agency (EIA) to develop proxies for years of administrator experience. Program administrators sometimes do not report spending for every year or have interpreted EIA survey questions in different ways. More work is needed to minimize these and other sources of error or uncertainty in values for the independent variables.

Another challenge is specifying independent variables that are not highly correlated with other variables, that is, some proxies for influences on CSE can be overlapping in effect. For example, program administrators with more experience usually are required to achieve higher levels of savings. States that have higher labor costs also often have higher retail rates.

Likewise, it can be difficult to examine economies-of-scale questions when participation data are not provided. No participation data are reported for more than two-thirds of the program years in the database. In other cases, the data may be incorrect (numbers identified as participants are actually units sold or assumed installed) or ambiguous (unit and participant numbers are co-mingled or undifferentiated). Finally, many other questions pertinent to program design and delivery could be tested if spending breakdowns were available by program (i.e., program expenditures disaggregated into customer incentives, various categories of administration, marketing and outreach, and evaluation).

The primary data contained in the database have limitations, as discussed earlier. For the regression analysis, our total sample size was 2,035 data points. Many of the program years in the database are for gas-only programs, which are not included in an analysis of electricity program CSEs. Moreover, for some programs, the administrator did not report a key value (e.g., did not include program-level spending or allocate program costs by fuel for combination electric-gas programs).

5. Discussion of Key Findings and Recommendations

In this chapter, we summarize key findings from this initial report of the LBNL CSE Project and discuss opportunities for improving information provided by program administrators on the costs and impacts of efficiency programs.

5.1 Key Findings

We calculated the administrator costs of saving a unit of natural gas or electricity and reported the CSE in several ways, through first-year savings, lifetime savings and levelized savings. It is important to note that the CSE values presented in this report are retrospective and may not necessarily reflect future CSE for specific programs, particularly given updated appliance and lighting standards. The cost of efficiency as a function of first-year energy savings may be useful for budgeting to meet incremental annual savings targets. The cost of lifetime energy savings captures the efficiency that accrues throughout the effective lifetime of the implemented measures and therefore is more broadly applicable in designing programs and portfolios. In this study, we focused more attention on the program administrators' levelized cost of energy savings based on gross savings because relatively few program administrators reported the cost contributions of participants (or incremental measure costs) or net savings values. In future reports, our goals are to also provide the "all-in" or total resource CSE and to include CSE values based on net savings as well.

Key findings from this study are:[79]

- The U.S. average electricity CSE was slightly more than two cents per kilowatt-hour in the period 2009-2011 when gross savings and spending are aggregated at the national level and the CSE is weighted by savings.[80] This levelized CSE is somewhat lower than reported by other previous studies. In a 2009 study, for example, Friedrich et al. found an average program administrator levelized CSE of $0.025/kWh in constant 2007 dollars or $0.027/kWh in constant 2012 dollars—about 29% higher than is reported here.[81] The LBNL DSM Program Impacts Database contains a larger sample of program administrators, many of whom may have used longer program measure lifetimes that could affect CSE values. Moreover, nearly 40% of the program administrators in the database that administer electric efficiency programs have offered programs for less than four years and so may be early in accessing energy savings in their respective state economies or be targeting the least costly savings opportunities first.[82]
- Other findings for electricity efficiency programs include:

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[79] All values reported here are program administrator CSEs for gross energy savings, levelized at a 6% real discount rate and given in constant 2012 dollars.

[80] This average value is based on the efficiency program portfolios of 100 electric and electric-gas program administrators that represent just less than half of the program spending in the United States during 2009 through 2011. These PAs are a large and diverse group in terms of geography, baseline efficiency, and historic levels of program activity.

[81] Friedrich et al. used a slightly lower discount rate (5 percent vs. 6 percent used in this report), so that the actual difference is larger.

[82] See Appendix A for summary of current and previous CSE research.

- Residential electricity efficiency programs had the lowest average levelized CSE at $0.018/kWh. Commercial, industrial and agricultural (C&I) programs had a slightly higher average levelized CSE at $0.021/kWh. Low-income programs show an average levelized CSE at $0.070/kWh.
- In reviewing regional results, the Midwest programs had the lowest average levelized CSE ($0.014/kWh) and the Northeast programs the highest ($0.033/kWh). The average levelized CSE values for programs in the West and South, to the extent sufficient reporting was found, were $0.023/kWh and $0.028/kWh, respectively.
- The database provides a valuable resource for understanding the composition and the CSE for various efficiency measures and program types. For example, at least 44% of the reported gross savings in the residential sector came from dedicated lighting programs and lighting rebate programs had a savings-weighted average CSE of $0.007/kWh with a small inter-quartile range.

* Natural gas efficiency programs had a national, program administrator savings weighted CSE range of $0.24 (lifetime CSE) to $0.38 per therm (levelized CSE, 6% discount rate), with significant differences between the commercial/industrial and residential sectors ($0.11–$0.17 vs. $0.32–$0.56 per therm respectively).
* Not surprisingly, the levelized CSE varied widely both among program types and within program types. We found that the median value was typically higher than the savings-weighted average for nearly all types of programs. One possible explanation is that our sample includes a number of very large programs and for any given program type, larger efficiency programs have lower CSE than smaller programs because administrative costs are spread over more projects (e.g., economies of scale). Some of our statistical analyses tend to demonstrate this relationship; however, other factors are probably at work as well.
* The "all-in" or total resource cost of energy savings is subject to the uncertainties and very limited availability of information on participant costs. Based on our small sample of programs that reported participant costs, we found that the program administrator costs account for about a third to a half of the total CSE (including program administrator and participant costs). One exception is residential Whole-Home Upgrade programs in our database, for which the median value for the program administrator's CSE is closer to three-quarters of the median CSE value that includes both program administrator and participant costs.
* We developed several hypotheses regarding factors that may influence the variability in the cost of saved energy. Preliminary statistical analyses of cost of first year energy savings suggest that myriad factors both internal and external to program design and implementation play some role in influencing the CSE:
  - Program administrator experience and the cost of first-year savings may show a curve where first-year CSE declines as new program administrators gain experience and then, beyond a certain number of years, costs increase, consistent with administration of portfolios that have matured beyond acquiring the least expensive resources. However, the demonstrated effect is generally small and not statistically significant at this time.

  - Higher construction labor costs are associated with higher costs of energy savings at the portfolio level. However, the demonstrated effect is generally small and is not uniform (or statistically significant) across all types of programs.
  - The size of a program, as measured by the number of participants, is associated with a decline in costs for some types of programs, suggesting that certain programs (e.g., Appliance Recycling programs) can achieve economies of scale by spreading fixed overhead across more projects. However, we also found that this result is not statistically significant for many other types of efficiency programs. More reporting of participation data could help determine when scaling up a program is likely to reduce costs and for what program types.

5.2 Discussion: Program Data Collection and Reporting

Program administrator annual reports are typically the product of state regulatory requirements or traditional practices that have evolved over time. In compiling and analyzing more than 4,000 program-years of data, we discovered a wide spectrum in the level of detail and completeness in annual program reporting. Barbose et al. (2013) found that over 45 states are running utility customer-funded efficiency programs. Many program administrators report program-level data at a very high level of completeness and transparency. However, we also found many examples of annual reports from program administrators that do not provide a complete picture of the impacts or costs of the efficiency investments at the program level. Although these reports may meet regulatory requirements in their state, they were not sufficient for the purposes of CSE analysis and therefore we were not able to include results from program administrators in many states.

With respect to current program reporting practices, we found:

- Inconsistencies in the quality and quantity of the costs and savings data which led LBNL to develop and attempt to apply consistent data definitions in reviewing and entering program data:
  - Program administrators in different states did not define savings metrics (e.g., varying definitions of net savings) and program costs consistently; and
  - Market sectors and program types were not characterized in a consistent fashion among program administrators.
- Many program administrators did not provide the basic data needed to calculate a CSE at the program level (i.e., program administrator costs and annual and lifetime savings), which introduced uncertainties into the calculation of CSE values.

This project brought into sharp relief the challenges of creating a program spending and savings database and calculating reliable, internally consistent metrics for assessing programmatic energy efficiency. For example, program measure lifetimes are essential for converting annual to lifetime savings while participant costs are essential for calculating the total resource costs of energy savings. We believe that nearly all program administrators must collect this information in order to satisfy cost-effectiveness screening requirements, yet many program administrators did not include this information in their annual efficiency reports:

- Less than 45% of electric program administrators reported lifetime savings;
- About 25% of electric program administrators reported program measure lifetimes;

- Only about half of electric program administrators reported both net and gross annual savings; and
- Less than a third of electric program administrators reported participant costs.

As a practical matter, the quality and quantity of program data reported by program administrators is an important factor in assessing energy efficiency as a resource in the utility sector. Therefore, we encourage further efforts to improve consistency in program administrator reporting of this information.

Regional and national policymakers have also expressed increasing interest in integrating energy efficiency as a resource and the value of transparent and complete reporting of program metrics as a foundation for increasing their confidence in this resource.[83] For example, ISO-New England, New York ISO and PJM Interconnection are collecting, or are considering collecting, demand-side spending and savings data from program administrators.[84] One objective is to develop better load forecasts in order to inform transmission planning, market development and operations. A second objective is to gain visibility into the future for wholesale energy and capacity markets. More rigorous and consistent reporting can help energy markets count and confidently value energy efficiency resources. Finally, all stakeholders that are engaged in any aspect of the efficiency effort share an interest in making energy-efficiency portfolios as cost effective as possible; consistent and more standardized reporting of efficiency program data and metrics are a prerequisite for this to occur.

We believe that there is a direct connection between the maturation of energy efficiency as a utility and national resource and increased consistency in periodic reporting of efficiency program costs and impacts. Additional rigor, completeness, standard terms, and consensus on at least essential elements of reporting could pay significant dividends for program administrators and increase confidence among policymakers and other stakeholders. With more consistent and comprehensive reporting of program results, we may obtain additional insights on trends in the costs of energy efficiency as a resource as program administrators scale up efforts, why those costs might vary from place to place and year to year, what saving energy costs among an array of strategies and what cost efficiencies might be achieved.

[83] The Northeast Energy Efficiency Partnerships' (NEEP) Regional Evaluation, Measurement and Verification Forum (EM&V Forum) supports the development and use of common, consistent protocols to evaluate, measure, verify, and report the savings, costs, and emission impacts of energy efficiency. The EM&V Forum has developed the Regional Energy Efficiency Database (REED), launched in early 2013, which includes data from eight states, soon to be nine states and the District of Columbia. REED was informed by the Forum's "Common Statewide Energy Efficiency Reporting Guidelines," which were adopted by the Forum's Steering Committee in 2010. See http://neep.org/emv-forum/about-the-emv-forum/index.

[84] The NY ISO and ISO NE develop projections on efficiency program impacts based on future program budgets and cost information about past program performance. See, e.g., the NY ISO 2013 Gold Book (http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2013_GoldBook.pdf) and the 2014 Energy-Efficiency Data Review by the ISO NE Energy-Efficiency Working Group at http://www.iso-ne.com/committees/comm_wkgrps/othr/enrgy_effncy_frcst/2014mtrls/final_2014_eefwg_data_review.pdf

Therefore, we urge state regulators and program administrators to consider annually reporting certain essential data fields at a portfolio level and more comprehensive reporting of program-level data in order to facilitate benchmarking of efficiency program results at state, regional, and national levels. The reporting hierarchy in Figure 5-1 illustrates this approach.

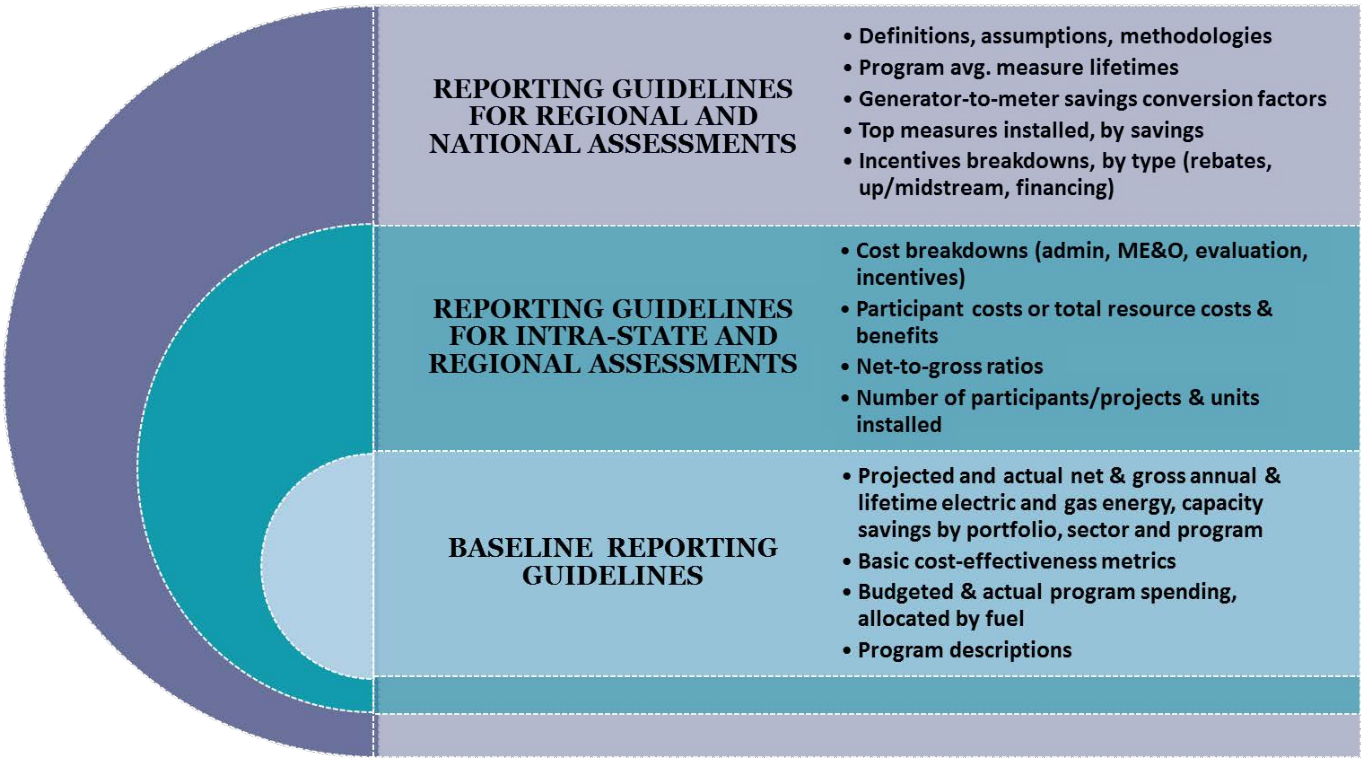

Figure 5-1. Components of annual energy efficiency program reporting

The program information included in each circle above correspond to gradually increasing visibility into program performance, increasing confidence in the reported values and potential relevance to policymakers and more stakeholders across broader geographic areas. The most basic level of reporting (light blue background) provides information that state regulators can use to ensure that programs are available to all customer classes and are cost-effective as implemented. The next level of reporting (teal background) provides critical information for calculating the CSE, assessing program efficacy and market penetration, and ensuring savings are attributable to program activities. The third level of reporting (purple background) enables comparisons of programs and cost performance in different states, reinforces assessments of program efficacy, and allows visibility into key assumptions to ensure those assumptions are valid and comparable to those used by other program administrators.[85]

[85] The components of annual reporting in Figure 5-1 are not exclusive. A number of states require significantly more, including indicators of performance on multiple fronts. Examples include estimates of market penetration; estimates of economic impacts; and cost breakdowns by internal spending, payments to or for external evaluations, payments to implementation contractors, payments to installation contractors, etc.

If program administrators were to report, at a minimum, the data under the baseline guidelines, this analysis would include nine additional program administrators among the 31 states included in this study, and programs from at least an additional 14 states. This would facilitate a more comprehensive national analysis of the impact of utility-customer funded energy efficiency.

We also encourage program administrators, regulators and other stakeholders to provide feedback on our efforts to encourage consistent reporting of efficiency program results, particularly the program typology and data definitions. We will be soliciting input more formally as we move forward with the next phases of this project. Given sufficient interest and resources, it is our hope to update the LBNL DSM Program Impacts Database on a periodic basis and prepare comprehensive reports and policy briefs that are publicly available that explore key issues in energy efficiency programs.

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The Program Administrator Cost of Saved Energy for Utility Customer-Funded Energy Efficiency Programs

APPENDICES

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Appendix A: Research into the Costs of Saved Energy

Efforts to quantify the cost of saving energy date to the earliest significant programs in the 1970s. In the latter part of that decade, Arthur Rosenfeld, Amory Lovins and others developed a levelized cost of lifetime energy savings metric, in which costs were amortized over the economic life of efficiency measures. This approach treated measure costs as though they were financed with a loan, with a repayment term equal to the economic life of the measures. The levelized costs of efficiency then could be compared with a utility's levelized cost of energy from a power plant that also is considered financed. Alan Meier, Janice Wright and Rosenfeld refined those concepts and improved the accounting of costs and savings (Meier et al 1982) in order to construct conservation "supply" curves for individual measures.[1]

These early calculations of levelized efficiency costs were based strictly on the costs of purchasing and installing more efficient measures. They therefore are best understood as demonstrating technical and economic potential: what measures can deliver what quantity of savings at an incremental measure cost below the price of energy supply?

Once utility programs began to proliferate in the 1980s, however, the reports and impact evaluations of program administrators added a new dimension to understanding the costs of energy efficiency. Utility program data provided insight into what it cost at the time to get customers to take efficiency actions (i.e., the cost of administering programs, identifying and promoting energy saving measures to customers, providing incentives and verifying the savings, among other expenses). The more common cost-performance metrics for program administrators were the costs of first-year and lifetime savings, from the perspective of the utility.

Numerous researchers have noted the incompleteness, uneven consistency and lack of standardization in reported program data (see, e.g., Hirst and Goldman 1989, Joskow and Marrow 1992). The total resource costs of energy efficiency (including both administrator and participant costs), on a $/kilowatt-hour or therm basis, were especially difficult for external analysts to calculate because most utilities either did not have or did not report participant costs (Nadel 1991). Several observers have commented on the challenges that these data gaps impose on fully accounting for the costs of efficiency and comparing energy efficiency with supply-side resources for the purposes of utility planning. Some have suggested that these deficiencies contribute to significantly understating the costs of energy efficiency (Joskow and Marron 1992).

Some efforts were made in the early 1990s to rectify these deficiencies and calculate the full, total resource costs of energy efficiency for comparison with the utility costs of energy supply (Eto et al. 1994, 1995; Goldman and Kito 1995). These efforts required substantial inquiries beyond the reported data, including consultation of financial filings and oral interviews with utility DSM staff, regulators, or energy services companies.

Since then, researchers have tended to rely primarily upon administrator costs of saved energy as the primary metrics of program cost performance. With the exception of several program-level studies (e.g., Joskow and Marron 1992; Eto et al. 1994, 1995, 2000), most recent studies have analyzed and reported the cost of saved energy at the portfolio level or by market sector (e.g.

[1] The levelized cost of conservation has since been applied to a number of resources, such as water.

residential, commercial/industrial). In the most recent and largest national studies to date, Friedrich et al. (2009) analyzed utility electricity programs in 14 states, and natural gas programs in seven states, using information from program reports, evaluations, and other sources. This levelized CSE is somewhat lower than reported by other previous studies. In a 2009 study, for example, Friedrich et al. found an average administrator levelized CSE of $0.025/kWh in constant 2007 dollars or $0.027/kWh in constant 2012 dollars—about 29% higher than is reported here. Friedrich et al. used a slightly lower discount rate (5% vs. 6% used in this report), so that the actual difference is larger.

The remaining differences have several possible explanations. The LBNL DSM Program Impacts Database contains a larger sample of program administrators, many of whom may have used longer program measure lifetimes or other assumptions that could affect savings values. A substantial number of the program administrators in the database also operate in states that are relatively new to exploiting energy savings as a resource. Nearly 40% of the electricity program administrators in the database have administered substantial programs for less than four years and so may be early in accessing energy savings in their respective state economies or targeting the least costly savings opportunities first.

The many research efforts detailed above have been useful for indicating overall trends and costs of efficiency. The work also has underscored persistent deficiencies in the reported program data, particularly for calculating the "all-in" or total resource costs of efficiency.

Recently, several organizations have collected information that facilitates analysis of the administrator cost of saved energy using various methods and definitions. These organizations and their efforts include:

- Consortium for Energy Efficiency's (CEE) annual industry reports. Since 2006, CEE has surveyed efficiency program administrators in order to document the industry's budgets, expenditures and savings.[2]
- The Northeast Energy Efficiency Partnerships' (NEEP) Regional Evaluation, Measurement and Verification Forum (EM&V Forum) supports the development and use of common, consistent protocols to evaluate, measure, verify, and report the savings, costs, and emission impacts of energy efficiency. The EM&V Forum has developed the Regional Energy Efficiency Database (REED), launched in early 2013, which includes data from eight states, soon to be nine states and the District of Columbia. REED was informed by the Forum's "Common Statewide Energy Efficiency Reporting Guidelines," which were adopted by the Forum's Steering Committee in 2010.[3]
- The American Council for an Energy-Efficient Economy (ACEEE) has conducted industry surveys for many years and, as noted above, multi-state studies in 2004 and 2009 of the cost of energy saved through efficiency programs.
- U.S. Energy Information Agency (EIA) has collected data on energy efficiency programs administered by electric utilities on a voluntary basis for many years through their 861 Form. EIA (2013) has also released a "State Energy Efficiency

[2] See http://www.cee1.org/annual-industry-reports.
[3] See http://neep.org/emv-forum/about-the-emv-forum/index.

Program Evaluation Inventory" that supported the National Energy Modeling System (NEMS) and provided information from state-mandated energy efficiency program evaluations.[4]

[4] See http://www.eia.gov/efficiency/programs/inventory/

Appendix B. Energy Efficiency Program Typology and Data Glossary

In this appendix, we describe and define simplified and detailed program categories for seven sectors: residential; commercial; industrial/agricultural; commercial/industrial; cross-cutting and other; low income; and demand response programs (see Tables B-1 to B-7).[5] For each sector, the left hand column of the table lists the detailed program category names, with detailed program definitions in the middle column, while the right-hand column indicates the corresponding simplified program category.[6]

We also include a glossary of reported data, in which we provide definitions for reporting various types of energy efficiency program data: number of participants, program activity (e.g. number of measures installed, buildings retrofitted), budgets, committed spending, actual expenditures grouped into various categories of program costs, measure lifetimes, and energy savings.

As part of the ongoing LBNL Cost of Saved Energy Project, we intend to solicit input from industry stakeholders and regularly update the program typology and definitions.

[5] The rationale and process for developing the program typology and data glossary are described in Chapter 2, but more detail is provided in an August 2013 policy brief that is devoted to the subject. The brief, titled "Energy Efficiency Program Typology and Data Metrics: Enabling Multi-State Analyses Through the use of Common Terminology," may be accessed at http://emp.lbl.gov/sites/all/files/lbnl-6370e.pdf.
[6] The detailed program categories could be organized in other ways, such as by technology.

Table B-1. Residential programs

Detailed Category	Detailed Program Definition	Simplified Category
Behavioral/ Online Audit/ Feedback	Residential programs designed around directly influencing household habits and decision-making on energy consumption through quantitative or graphical feedback on consumption, sometimes accompanied by tips on savings energy. These programs include behavioral feedback programs (in which energy usage reports compare a consumer's household energy usage with those of similar consumers); online audits that are completed by the consumer; and in-home displays that help consumers assess their usage in near real time. This program category does not include on-site energy assessments or audits.	**Behavior/ Education**
Consumer Product Rebate/ Appliances	Programs that incentivize the sale, purchase and installation of appliances (e.g., refrigerators, dishwashers, clothes washers and dryers) that are more efficient than current standards. Appliance recycling and the sale/purchase/installation of HVAC equipment, water heaters and consumer electronics are accounted for separately.	**Consumer Product Rebate**
Consumer Product Rebate/ Electronics	Programs that encourage the availability and purchase/lease of more efficient personal and household electronic devices, including but not limited to televisions, set-top boxes, game consoles, advanced power strips, cordless telephones, PCs and peripherals specifically for home use, chargers for phones/smart phones/tablets. A comprehensive efficiency program to decrease the electricity use of consumer electronics products includes two focuses: product purchase and product use. Yet not every consumer electronics program will seek to be comprehensive. Some programs will embark on ambitious promotions of multiple electronics products, employing upstream, midstream, and downstream strategies with an aggressive marketing and education component. At the other end of the continuum, a program administrator may choose to focus exclusively on consumer education.	
Consumer Product Rebate/Lighting	Programs aimed specifically at encouraging the sale/purchase and installation of more efficient lighting in the home. These programs range widely from point-of-sale rebates to CFL mailings or giveaways. Measures tend to be CFLs, fluorescent fixtures, LED lamps, LED fixtures, LED holiday lights and lighting controls, including occupancy monitors/switches.	
Appliance Recycling	Programs designed to remove less efficient appliances (typically refrigerators and freezers) from households.	
Multi-Family	Multi-family programs are designed to encourage the installation of energy efficient measures in common areas, units or both for residential structures of more than four units. These programs may be aimed at building owners/managers, tenants or both.	**Multi Family**
New Construction	Programs that provide incentives and possibly technical services to ensure new homes are built or manufactured to energy performance standards higher than applicable code (e.g., ENERGY STAR Homes). These programs include new multi-family and new/replacement mobile homes.	**New Construction**

Detailed Category	Detailed Program Definition	Simplified Category
HVAC	Programs designed to encourage the distribution, sale/purchase, proper sizing and installation of HVAC systems that are more efficient than current standards. Programs tend to support activities that focus on central air conditioners, air source heat pumps, ground source heat pumps, and ductless systems that are more efficient than current energy performance standards, as well as climate controls and the promotion of quality installation and quality maintenance.	**Prescriptive**
Insulation	Programs designed to encourage the sale/purchase and installation of insulation in residential structures, often through per-square-foot incentives for insulation of specific R-values versus an existing baseline. Programs may be point-of-sale rebates or rebates to insulation installation contractors.	
Pool Pump	Programs that incentivize the installation of higher efficiency or variable speed pumps and controls, such as timers, for swimming pools.	
Prescriptive	Residential programs that provide or incentivize a set of pre-approved measures not included in, or distinguishable from, the other residential program categories (e.g., direct install, HVAC, lighting). For example, if a residential program features rebates for a large set of mixed, pre-approved offerings (e.g., insulation, HVAC, appliances, lighting), yet the relative contribution of each measure to program savings is unclear or no single measure accounts for a large majority of the savings, then the program should be classified as a residential prescriptive program.	
Water Heater	Programs designed to encourage the distribution, sale/purchase and installation of electric and/or gas water-heating systems that are more efficient than current standards, including high efficiency water storage tank and tankless systems.	
Windows	Programs designed to encourage the sale/purchase and installation of efficient windows in residential structures.	
Whole Home/ Direct Install	Direct-install programs provide a set of pre-approved measures that may be installed at the time of a visit to the customer premises or provided as a kit to the consumer, usually at modest or no cost to the consumer and sometimes accompanied by a rebate. Typical measures include CFLs, low-flow showerheads, faucet aerators, water-heater wrap and weather stripping. Such programs may also include a basic, walk-through energy assessment or audit, but the savings are principally derived from the installation of the provided measures. Education programs that supply kits by sending them home with school children are not included in this program category; they are classified as education programs.	**Whole Home Upgrade (Incl. audits, retrofits, etc.)**
Whole Home/ Audits	Residential audit programs provide a comprehensive, standalone assessment of a home's energy consumption and identification of opportunities to save energy. The scope of the audit includes the whole home although the thoroughness and completeness of the audit may vary widely from a modest examination and simple engineering-based modeling of the physical structure to a highly detailed inspection of all spaces, testing for air leakage/exchange rates, testing for HVAC duct leakage and highly resolved modeling of the physical structure with benchmarking to customer utility bills.	

Detailed Category	Detailed Program Definition	Simplified Category
Whole Home/ Retrofit	Whole-home energy upgrade or retrofit programs combine a comprehensive energy assessment or audit that identifies energy savings opportunities with house-wide improvements in air sealing, insulation and, often, HVAC systems and other end uses. The HVAC improvements may range from duct sealing to a tune up to full replacement of the HVAC systems. Whole-home programs are designed to address a wide variety of individual measures and building systems, including but not limited to: HVAC equipment, thermostats, furnaces, boilers, heat pumps, water heaters, fans, air sealing, insulation (attic, wall, and basement), windows, doors, skylights, lighting, and appliances. As a result, whole-home programs generally involve one or more rebates for multiple measures. Whole-home programs generally come in two types: comprehensive programs that are broad in scope and less comprehensive, prescriptive programs sometimes referred to as "bundled efficiency" programs. This category addresses all of the former and most of the latter, but it excludes direct-install programs that are accounted for separately.	**Whole Home Upgrade (Incl. audits, retrofits, etc.)** *(continued from previous page)*
Financing	Programs designed to provide or facilitate loans, credit enhancements or interest rate reductions/buy downs. As with other programs, included costs are utility costs, including the costs of any inducements for lenders, e.g., loan loss reserves, interest rate buy-downs, etc. Where participant costs are available for collection, these ideally will include the total customer share, i.e., both principal (the participant payment to purchase and install measures) and interest on that debt. Most of these programs will be directed toward enhancing credit or financing for residential structures.	**All Other Residential**
Other	Programs designed to encourage investment in energy efficiency activities in residences but are so highly aggregated (e.g., Existing Homes programs that include retrofits, appliances, equipment, etc.) and undifferentiated that they cannot be sorted into the residential program categories that are detailed in this document.	

Table B-2. Commercial programs

Detailed Category	Detailed Program Definition	Simplified Category
Audit	Programs in which an energy assessment is performed on one or more participant commercial facilities to identify sources of potential energy waste and measures to reduce that waste.	Custom
Custom	Programs designed around the delivery of site-specific projects typically characterized by an extensive onsite energy assessment and identification and installation of multiple measures unique to that facility. These measures may vary significantly from site to site. This category is intended to capture "whole-building" approaches to commercial sector efficiency opportunities for a wide range of building types and markets (e.g., office, retail) and wide range of measures.	
Commissioning/Retro-Commissioning	Programs aimed at diagnosing energy consumption in a commercial facility and optimizing its operations to minimize energy waste. Such programs may include installation of certain measures (e.g., occupancy monitors and switches), but program activities tend to be characterized more by tuning or retuning, coordinating and testing the operation of existing end uses, systems and equipment for energy efficient operation. The construction of new commercial/industrial facilities that includes energy performance commissioning should be categorized as "Com: New Construction". The de novo installation of energy management systems with accompanying sensors, monitors and switches is regarded as a major capital investment and should be categorized under "Com: Custom".	
Govt./Nonprofit/ MUSH	MUSH (Municipal, University, School & Hospital) and government and nonprofit programs cover a broad swath of program types generally aimed at public and institutional facilities and which include a wide range of measures. Programs which focus on specific technologies (e.g., HVAC and lighting) have their own commercial program categories Examples include incentives and/or technical assistance to promote energy efficiency upgrades for elementary schools, recreation halls and homeless shelters. Street lighting is accounted for as a separate program category.	MUSH & Govt.
Street Lighting	Street lighting programs include incentives and/or technical support for the installation of higher efficiency street lighting and traffic lights than the current baseline.	
New Construction	Programs that incentivize owners or builders of new commercial facilities to design and build beyond current code or to a certain certification level (e.g., ENERGY STAR or LEED).	New Construction
HVAC	C&I HVAC programs encourage the sale/purchase and installation of heating, cooling and/or ventilation systems at higher efficiency than current energy performance standards, across a broad range of unit sizes and configurations. Most of these programs will be directed toward commercial structures.	Prescriptive
Lighting	C&I lighting programs incentivize the installation of efficient lighting and lighting controls. Typical measures might include T-8/T-5 fluorescent lamps and fixtures; CFLs and fixtures; LEDs for lighting, displays, signs and refrigerated lighting; metal halide and ceramic lamps and fixtures; occupancy controls; daylight dimming; and timers.	

Detailed Category	Detailed Program Definition	Simplified Category
Performance Contracting/ DSM Bidding	Programs that incentivize or otherwise encourage energy services companies (ESCOs) and participants to perform energy efficiency projects, usually under an energy performance contract (EPC), a standard offer or other arrangement that involves ESCOs or customers offering a quantity of energy savings in response to a competitive solicitation/bidding process with compensation linked to achieved savings.	**Prescriptive** *(continued from previous page)*
Prescriptive/IT & Office Equipment	Programs aimed at improving the efficiency of office equipment, chiefly commercially available PCs, printers, monitors, networking devices and mainframes not rising to the scale of a server farm or floor.	
Prescriptive/ Grocery	Grocery programs are prescriptive programs aimed at supermarkets and are usually designed around indoor and outdoor lighting and refrigerated display cases.	
Other	Prescriptive programs that encourage the purchase and installation of some or all of a specified set of pre-approved measures besides those covered in other measure-specific prescriptive programs (e.g., HVAC and Lighting).	
Custom	Custom programs applied to small commercial facilities. (See definition of custom programs for additional detail.)	**Small Commercial**
Prescriptive	Prescriptive programs applied to small commercial facilities. (See definition of prescriptive programs for additional detail.) Such programs may range from a walk-through audit and direct installation of a few pre-approved measures to a fuller audit and a fuller package of measures. Audit only programs have their own category.	
Financing	Programs designed to provide or facilitate loans, credit enhancements or interest rate reductions/buy downs. As with other programs, included costs are utility costs, including the costs of any inducements for lenders, e.g., loan loss reserves, interest rate buy-downs, etc. Where participant costs are available for collection, these ideally will include the total customer share, i.e., both principal (the participant payment to purchase and install measures) and interest on that debt. Most of these programs will be directed toward enhancing credit or financing for commercial structures.	**All Other Commercial**
Other	Programs not captured by any of the specific commercial program categories but are sufficiently distinct to the commercial sector to not be treated as a "Commercial/Industrial Other" program. Example: An EE program aimed specifically at the commercial subsector but is not clearly prescriptive or custom in nature.	

Table B-3. Industrial/agricultural programs

Detailed Category	Detailed Program Definition	Simplified Category
Audit	Programs in which an energy assessment is performed on one or more participant industrial or agricultural facilities to identify sources of potential energy waste and measures to reduce that waste.	**Custom**
Custom	Programs designed around the delivery of site-specific projects typically characterized by an extensive onsite energy assessment and identification and installation of multiple measures unique to that facility. These measures may vary significantly from site to site. This category is intended to capture "whole-facility" approaches to industrial or agricultural sector efficiency opportunities for a wide range of building types and markets	
Custom/ Data Centers	Data center programs are custom-designed around large-scale server floors or data centers that often serve high-tech, banking or academia. Projects tend to be site-specific and involve some combination of lighting, servers, networking devices, cooling/chillers, and energy management systems/software. Several of these may be of experimental or proprietary design.	
Custom/Ind. & Ag. Process	Industrial programs deliver custom-designed projects that are characterized by an onsite energy and process efficiency assessment and a site-specific measure set focused on process related improvements that may include, for example, substantial changes in a manufacturing line. This category includes all EE program work at industrial or agricultural sites that is process focused and not generic (and thus would be in the custom category) and not otherwise covered by the single-measure prescriptive programs below (e.g., lighting, HVAC, water heaters).	
Custom/ Refrigerated Warehouses	Warehouse programs are typically aimed at large-scale refrigerated storage facilities and often target end uses such as lighting, climate controls and refrigeration systems.	
New Construction	Programs that incentivize owners or builders of new industrial or agricultural facilities to design and build beyond current code or to a certain certification level, e.g., ENERGY STAR or LEED.	**New Construction**
Prescriptive Industrial	Prescriptive programs that encourage the purchase and installation of some or all of a specified set of pre-approved industrial measures besides those covered in other measure-specific prescriptive programs on this list, e.g., industrial compressor programs.	**Prescriptive**
Prescriptive/ Agriculture	Farm- and orchard-based agricultural programs that primarily involve irrigation pumping and do not include agricultural refrigeration or processing at scale.	
Prescriptive/ Motors	Motors programs usually offer a prescribed set of approved higher efficiency motors, with industrial motors programs typically getting the largest savings from larger, high powered motors (>200 hp).	
Financing	Programs designed to provide or facilitate loans, credit enhancements or interest rate reductions/buy downs. As with other programs, included costs are utility costs, including the costs of any inducements for lenders, e.g., loan loss reserves, interest rate buy-downs, etc. Where participant costs are available for collection, these ideally will include the total customer share, i.e., both principal (the participant payment to purchase and install measures) and interest on that debt. Most of these programs will be directed toward enhancing credit or financing for industrial and/or agricultural facilities.	**All Other IA**

Detailed Category	Detailed Program Definition	Simplified Category
Self Direct	Industrial programs that are designed and delivered by the participant, using funds that otherwise would have been paid as ratepayer support for all DSM programs. These programs may be referred to as "opt out" programs, among other names.	**All Other IA** *(continued from previous page)*
Other	Programs not captured by any of the specific industrial/agricultural categories but are sufficiently distinct to the industrial and/or agricultural sectors to not be treated as a "Commercial/Industrial Other" program. Example: An efficiency program aimed specifically at the industrial and agricultural sectors but is not clearly prescriptive or custom in nature might be classified as Other	

Table B-4 includes program categories and definitions for those commercial and industrial programs that were highly aggregated to target all C&I markets and, based upon the limits of the reported data, could not be characterized as obtaining the large majority of their savings from either the commercial or industrial sector.

Table B-4. Commercial/industrial programs

Detailed Category	Detailed Program Definition	Simplified Category
Custom	Programs designed around the delivery of site-specific industrial and commercial projects typically characterized by an extensive onsite energy assessment and identification and installation of multiple measures unique to that facility. This category is for programs that address **both** the commercial and industrial sectors and cannot be relegated to one sector or another for lack of information on participation or savings.	**Custom**
New Construction	Programs that incentivize owners or builders of new commercial and industrial facilities to design and build beyond current code or to a certain certification level, e.g., ENERGY STAR or LEED. This category should be used sparingly for those programs that cannot be identified with either the commercial or industrial sector on the basis of information available about participation or the source(s) of savings.	**New Construction**
Prescriptive	Prescriptive programs that encourage the purchase and installation of some or all of a specified set of pre-approved industrial and/or commercial measures but which cannot be differentiated by sector based upon the description of the participants or nature or source of the savings.	**Prescriptive**
Self Direct	Generally large commercial and industrial programs that are designed and delivered by the participant, using funds that otherwise would have been paid as ratepayer support for all DSM programs. This category is to be used for self-direct or opt-out programs that address both large commercial and industrial entities but which cannot be differentiated between these sectors because the nature and source of the savings is not available or is also too highly aggregated.	**All Other C&I**
Mixed Offerings	Programs that cannot be classified under any of the specific commercial or industrial program categories and span a large variety of offerings aimed at both the commercial and industrial sectors.	
Other	Programs not captured by any of the specific commercial/industrial categories but are sufficiently distinct to the industrial and/or agricultural sectors to not be treated as a "Commercial/Industrial Other" program	

Table B-5. Cross-cutting & other programs

Detailed Category	Detailed Program Definition	Simplified Category
Codes & Standards (C&S)	In C&S programs, the program administrator may engage in a variety of activities designed to advance the adoption, application or compliance level of building codes and end-use energy performance standards. Examples might include advocacy at the state or federal level for higher standards for HVAC equipment; training of architects, engineers and builder/developers on code compliance; and training of building inspectors in ensuring the codes are met.	**Codes & Standards**
Market Transformation (MT)	Programs that encourage a reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects that is likely to last after the intervention has been withdrawn, reduced, or changed. MT programs are gauged by their market effects (e.g., increased awareness of energy efficient technologies among customers and suppliers); reduced prices for more efficient models; increased availability of more efficient models; and ultimately, increased market share for energy efficient goods, services and design practices. Example programs might include upstream incentives to manufacturers to make more efficient goods more commercially available; and point-of-sale or installation incentives for emerging technologies that are not yet cost effective. Workforce training and development programs are covered by a separate category. Upstream incentives for commercially available goods are sorted into the program categories for those goods (e.g., consumer electronics or HVAC).	**Market Transformation**
Workforce Development	Workforce training and development programs are a distinct category of market transformation program designed to provide the underlying skills and labor base for deployment of energy-efficiency measures.	
Marketing, Education, Outreach (ME&O)	ME&O programs include most standalone marketing, education and outreach programs (e.g., statewide marketing, outreach and brand development). In-school energy and water efficiency programs are also included in this category, including those that supply school children with kits of prescriptive measures such as CFLs and low-flow showerheads for installation at home.	**Marketing, Education, Outreach**
Other	This category is intended to capture all programs that cannot be allocated to a specific sector (or are multi-sectoral) and cannot be allocated to a specific program type.	**Multi-Sector and Other**
Planning/ Evaluation/ Other Programmatic Support	Non-ME&O support programs include the range of activities not otherwise accounted for in program-specific costs but needed for planning & designing a portfolio of programs and otherwise complying with regulatory requirements for DSM activities outside of program implementation. These activities generally are focused on the front and back end of program cycles, in assessing prospective programs; designing programs and portfolios; assessing the cost effectiveness of measures, programs and portfolios; and arranging for, directing or delivering reports and evaluations of the process and impacts of those programs - where those costs are not captured in program costs.	

Detailed Category	Detailed Program Definition	Simplified Category
Voltage Reduction/Transformers	Programs that support investments in distribution system efficiency or enhance distribution system operations by reducing losses. The most common form of these programs involve the installation and use of conservation voltage regulation/reduction (CVR) or optimization systems and practices that control distribution feeder voltage so that utilization devices operate at their peak efficiency, which is usually at a level near the lower bounds of their utilization or nameplate voltages. Other measures may include installation of higher efficiency transformers. These programs generally are not targeted to specific end users but typically involve changes made by the electricity distribution utility.	**Multi-Sector and Other** *(continued from previous)*
Shading/ Cool Roofs	Shading/reflective programs include programs designed to lessen heating and cooling loads through changes to the exterior of a structure (e.g., tree plantings to shade walls and windows, window screens and cool/reflective roofs). These programs are not necessarily specific to a sector.	
Multi-Sector Rebates	Multi-sector rebate programs include providing incentives for commercially available end-use goods for multiple sectors (e.g., PCs, HVAC).	
Research	These programs are aimed generally at helping the program administrator identify new opportunities for energy savings (e.g., research on emerging technologies or conservation strategies). Research conducted on new program types or the inclusion of new, commercially available measures in an existing program are accounted for separately under cross-cutting program support.	**Research**

Table B-6. Low-income programs

Detailed Category	Detailed Program Definition	Simplified Category
Low Income	Low-income programs are efficiency programs aimed at lower income households, based upon some type of income/means testing or eligibility. These programs most often take the form of single-family weatherization, but a variety of other program types also are included in this program category (e.g., multi-family/affordable housing weatherization, low-income direct-install programs).	**Low Income**

Table B-7 includes program categories for demand-response programs. These categories were included chiefly to enable the Consortium for Energy Efficiency, which shares the program categories with LBNL, to collect demand-response spending and savings data and to enable LBNL to include demand-response data in the future. At this time, however, demand-response programs have not been collected and integrated into the LBNL database.

Table B-7. Demand response programs

Detailed Category	Detailed Program Definition	Simplified Category
Time-of-Use Pricing	Demand-side management that uses a retail rate or Tariff in which customers are charged different prices for using electricity at different times during the day. Examples are time-of-use rates, real time pricing, hourly pricing, and critical peak pricing. Time-based rates do not include seasonal rates, inverted block, or declining block rates.	**Pricing**
Critical Peak Pricing	Demand-side management that combines direct load control with a pre-specified high price for use during designated critical peak periods, triggered by system contingencies or high wholesale market prices.	
Critical Peak Pricing with Load Control	Demand-side management that combines direct load control with a pre-specified high price for use during designated critical peak periods, triggered by system contingencies or high wholesale market prices.	
Real-Time Pricing	Demand-side management that uses rate and price structure in which the retail price for electricity typically fluctuates hourly or more often, to reflect changes in the wholesale price of electricity on either a day-ahead or hour-ahead basis.	
Peak Time Rebate	Peak time rebates allow customers to earn a rebate by reducing energy use from a baseline during a specified number of hours on critical peak days. Like Critical Peak Pricing, the number of critical peak days is usually capped for a calendar year and is linked to conditions such as system reliability concerns or very high supply prices.	**Rebate**
Other	Load management programs that are not captured by the specific DR categories named on this list.	**Other**

Program Data Glossary

 # Participants: Total number of consumers participating in the subject program. For new construction programs, we classify "number of homes or buildings" as the number of participants. In some programs, the number of participants will be the number of structures or multifamily units that received efficiency measures through a program.

 # Units: Total number of measures installed or credited with savings in the subject program (e.g., number of CFLs for which savings are claimed in a lighting program). If the number of units reported for a new construction or retrofit program is defined as structures built or retrofitted to a higher level of energy performance, then these are not counted as units but as participants.

Administration Costs ($): Actual spending by the program administrator on costs associated with planning, designing and implementing an energy efficiency program in a defined geographic area, unless some of those costs are specifically accounted for elsewhere. In general, these costs pay for the salaries, training and equipping of internal program administrator staff to administer and implement a program or oversee the work of an outside contract implementer. If evaluation, compliance and marketing, outreach & education costs are not reported separately, then they typically are included under program administration costs. When a program is being terminated, shut-down costs also should be included in administration costs.

Annual Incremental Savings: Annual incremental savings are the savings acquired or planned to be acquired as a result of energy efficiency activities in that program year. Note that these are annualized, "full-year" savings, regardless of when measures were installed during the program year; the cost of first-year savings is derived for a full, 12-month first year.

Average Measure Lifetime (Years): Average measure lifetime is the weighted average economic lifetime of all measures installed in a program year.

Detailed Program Categorization: One of about 70 unique and specific program categories described in detail in the Detailed Program Category Definitions.
Evaluation Costs ($): Evaluation costs are program administrator spending on any form of Evaluation, Measurement & Verification (EM&V) activity, whether internal, external or pass-through funding for regulator-guided EM&V. EM&V includes impact and process evaluations and may include an allocation of portfolio-level EM&V down to each program.

Gross Savings: Gross savings are the change in energy consumption that results directly from program-related actions taken by participants in an energy efficiency program, regardless of why they participated.

Lifetime Electric Gross Savings (GWh): The expected gross electricity savings over the lifetime of the measures installed as part of the subject program. For the purposes of this collection effort, these values are reported by the program administrator.

Lifetime Electric Net Savings (GWH): The expected net electricity savings over the lifetime of the measures installed as part of the subject program. These savings may be calculated by multiplying the annual energy use reduction associated with those measures by the lifetime of the measures. For the purposes of this collection effort, these values are reported by the program administrator.

Lifetime Gas Gross Savings (therm): The expected gross natural gas savings over the lifetime of the measures installed as part of the subject program.

Lifetime Gas Net Savings (therm): The expected net natural gas savings over the lifetime of the measures installed as part of the subject program.
Marketing/Education/Outreach Costs ($): Marketing, Education & Outreach (ME&O) costs are actual program administrator spending on efforts to gain access to potential participants (e.g., through recruitment of community leaders), the promotion of a program or the education of participants in conservation/efficiency behaviors as a part of a program. Note that in some cases, program administrators treat ME&O as its own program or may have a separate statewide ME&O effort that is not program specific and addresses branding for the program administrator or portfolio of programs.

Market Sector: Market sector is the segment of the economy that is the source for most of the acquired savings of the program.

Net Savings: Net savings are the change in energy consumption that is attributable to a particular energy efficiency program. This change in energy use and/or demand typically includes some consideration of free riders but also may include, implicitly or explicitly, consideration of participant and non-participant spillover and induced market effects. These factors may be considered in how a baseline is defined (e.g., common practice) and/or in adjustments to gross savings values.

Other Costs ($): Other costs include those categories of spending that may not fit well into the other categories (i.e., are not administration, incentives, ME&O or evaluation costs).

Participant Costs ($): Participant costs are the spending by program participants who receive incentives, technical assistance, product installations, training, energy efficiency information or other services, or items from a program in a given program year. These participant costs are the participant share of the costs of a measure installation or project; they may also take the form of fees. In the case of financed projects, they should include principle and interest.

Participant Incentive Costs ($): Actual spending by the program administrator on financial strategies intended to encourage a change in behavior related to energy use. Incentives can take various forms, e.g., rebates, subsidies, financing, prizes. Customer incentives are commonly used in energy efficiency programs as rebates for individual measures or as buy-downs in more custom-oriented projects, although incentives can be monetary inducements to manufacturers, distributors, contractors, or retailers to increase the availability and affordability of energy efficient goods and services in the market.

Program Administrator Name: Name of the entity that administers the energy efficiency programs for which the data is provided. These entities include utilities; energy efficiency and clean energy utilities (e.g., the District of Columbia's Sustainable Energy Utility); hybrid governmental/quasi-governmental/third-party administrators agencies (e.g., NYSERDA); and non-profit and for-profit third-party administrators (e.g., Hawaii Energy).

Program Name: Name of the program as used in the report or evaluation.

Resource Program: A resource program is a program intended and designed for directly acquiring energy savings.

Simplified Program Categorization: One of about 30 general program categories that represent a higher level of aggregation among programs and a lower level than market sector. In general, simplified program categories are characterized by a more detailed breakdown of sector (e.g., Residential) vs. C&I) an indication of whether the program targets individual measures or comprehensive set of measures, and prescriptive versus custom in its design.

Total Claimed Gross Annual Electric Savings (KWh): Gross annual incremental electricity savings as reported by an implementer or administrator, using their own staff and/or an evaluation consulting firm, after the subject energy efficiency activities have been completed in the defined geographic area (e.g., a utility territory within a state).

Total Claimed Gross Annual Gas Savings (therm): Gross annual incremental natural gas savings as reported by an implementer or administrator after the subject energy efficiency activities have been completed.

Total Claimed Net Annual Electric Savings (KWh): Net annual incremental electricity savings as reported by an implementer or administrator after the subject energy efficiency activities have been completed in the defined geographic area (e.g., a utility territory within a state).

Total Claimed Net Annual Gas Savings (therm): Net annual incremental natural gas savings as reported by an implementer or administrator.

Total Electric Budget ($): Total dollar amount that a program administrator budgeted or was projected to spend on an electric energy efficiency program over the defined program year in the defined geographic area where the program is to be implemented. The total program budget includes all program administrative costs, incentive costs, marketing & outreach costs and evaluation costs. Performance incentives are not considered part of the program budget and should be excluded.

Total Electric Committed Spending ($): Total electric committed spending is program spending associated with measures and projects that are approved, contracted and often implemented during the program year but the actual outlay (e.g., payment of a rebate after installation) occurs after the program year has ended.

Total Electric Expenditures ($): Total dollar amount that a program administrator actually spent on an electric energy efficiency program over the defined program year in the defined geographic area where the program is implemented. Total program expenditures include all program administrative costs, incentive costs, marketing & outreach costs and evaluation costs. Performance incentives are not considered part of the program costs and should be excluded.

Total Gas Budget ($): Total dollar amount that a program administrator plans to spend on a natural gas energy efficiency program over the defined program year in the defined geographic area where the program is to be implemented. The total program budget includes all program administrative costs, incentive costs, marketing & outreach costs and, often, evaluation costs. Performance incentives are not considered part of the program budget and should be excluded.

Total Gas Committed Spending ($): Total gas committed spending is program spending associated with measures and projects that are approved, contracted and often implemented during the program year but the actual outlay, e.g., payment of a rebate after installation, occurs after the program year has ended.

Total Gas Expenditures ($): Total dollar amount that a program administrator actually spends on a natural gas energy efficiency program over the defined program year in the defined geographic area where the program is implemented. Total program expenditures include all program administrative costs, incentive costs, marketing & outreach costs and, often, evaluation costs. Performance incentives are not considered part of the program costs and should be excluded.

Total Projected Gross Annual Electricity Savings (KWh): Gross annual incremental electricity savings as estimated by an implementer or administrator before the subject energy efficiency activities have been implemented. Projected savings are typically estimates prepared for program/portfolio design and planning purposes, based in turn upon estimates made before the program year begins of such factors as per-unit savings values, operating hours, installation rates, and savings persistence rates.

Total Projected Gross Annual Gas Savings (therm): Gross annual incremental gas savings as estimated by an implementer or administrator before the subject energy efficiency activities have been implemented. Projected savings are typically estimates prepared for program/portfolio design and planning purposes, based in turn upon estimates made before the program year begins of such factors as per-unit savings values, operating hours, installation rates, and savings persistence rates.

Total Projected Net Annual Electricity Savings (KWh): Net annual incremental electricity savings as estimated by an implementer or administrator before the subject energy efficiency activities have been implemented. Projected savings are typically estimates prepared for program/portfolio design and planning purposes, based in turn upon estimates made before the program year begins of such factors as per-unit savings values, operating hours, installation rates, and savings persistence rates.

Total Verified Gross Annual Electricity Savings (KWh): Annual incremental gross electricity savings estimates are generated by an independent, third-party evaluator after the subject energy efficiency activities have been implemented and an impact evaluation has been completed in the defined geographic area (e.g., a utility territory within a state).

Total Verified Gross Annual Gas Savings (therm): Annual incremental gross natural gas savings estimates are generated by an independent, third-party evaluator after the subject energy efficiency activities in a specific geographic area (e.g., a utility territory within a state) have been implemented and an impact evaluation has been completed.

Total Verified Net Annual Electricity Savings (KWh): Annual incremental net electricity savings estimates are generated by an independent, third-party evaluator after the subject energy efficiency activities have been implemented and an impact evaluation has been completed.

Total Verified Net Annual Gas Savings (therm): Annual incremental net natural gas savings estimates are generated by an independent, third-party evaluator after the subject energy efficiency activities have been implemented and an impact evaluation has been completed.

Appendix C: LBNL DSM Program Impacts Database and Quality Assurance/Control Approach

This appendix provides information about the program cost and savings data that were collected by LBNL for this research effort based on annual reports and evaluations filed by program administrators, how LBNL organized that information in the LBNL DSM Program Impacts Database, and the quality assurance/control processes that LBNL utilized in order to compile program data in a consistent fashion.

Data Collection

Table C-1 provides a summary of the number of program administrators that reported various types of savings data (e.g., gross vs. net, projected, claimed or verified), estimated measure lifetimes for programs, and participation data for their programs. Over 95% of program administrators reported gross annual *claimed* electricity or natural gas savings. However, less than half of the program administrators reported *projected* annual savings or verified savings. Less than 60% of administrators reported claimed lifetime gross electricity or gas savings.

Table C-2 provides a summary of the number of program administrators that reported information on program costs (e.g. budgets, actual expenditures, committed expenditures) by cost category (e.g., administration/management costs, customer incentive costs, education/marketing/outreach costs) for each of the program years 2009-2011. Up to 60% of program administrators provided some disaggregation of program costs into various cost categories. Based on the comprehensiveness of administrator's reporting of various data fields, this initial report relies primarily on total program administrator costs, gross savings, and in the cases of combined gas and electricity efficiency programs, only data for those programs where costs could be allocated to electricity or natural gas savings.

Program Impacts Database Development

The LBNL DSM Program Impacts Database is structured as an Excel spreadsheet in which each row contains all of the program cost and savings data associated with an individual program for a specific year. We manually entered program data for the data fields described in Table C-1 and Table C-2 for each administrator from one or more annual reporting documents.[7] Each program was given a unique alphanumeric identifier in the database, and further organized by state, program administrator and program year. Programs that were implemented over multiple years were matched and coded as a series to enable time series analysis.

We reviewed and then classified and assigned programs based on the detailed program categorization (see program typology in Appendix B). Where program names did not obviously indicate the appropriate program category, we reviewed the program narratives, which most often provided enough information to make a clear choice of category. For programs that included a wide range of activity or otherwise did not break neatly into one of the desired program category or sectors, we reviewed the detailed program results for an indication of where the bulk of savings came from and categorized accordingly. Where that information was not

[7] Program data were provided in a variety of formats: PDF, MS Word and MS Excel files.

available, we categorized the program in the sector-specific “other” category or in the cross-cutting category as applicable. For example, a residential program that included a broad range of sub-program activities such as education, appliances and retrofits was categorized under Residential Other.

Table C-1. Program Administrators reporting of energy savings data*

Metric	PAs that Report Electric Values		PAs that Report Gas Values	
	Number of PAs Reporting this Data	Percentage of PAs that reported this data	Number of PAs Reporting this Data	Percentage of PAs that reported this data
Average measure lifetime (yrs.)	23	26%	15	30%
Claimed Lifetime Gross Savings	39	44%	29	58%
Claimed Lifetime Net Savings	20	23%	18	36%
Claimed Gross Annual Savings*	86	98%	48	96%
Evaluated Gross Annual Savings	24	27%	7	14%
Projected Gross Annual Savings	47	53%	17	34%
Claimed Net Annual Savings	45	51%	35	70%
Evaluated Net Annual Savings	17	19%	12	24%
Projected Net Annual Savings	19	22%	19	38%
Program Participation (# of Participants)	75	85%	22	44%
Program Participation (# of equipment units)	36	41%	15	30%

NOTE: A PA is counted as reporting a value if at least one of the programs has that data reported. Not all PAs report the same data for every program. I.e. sometimes measure lifetime is only reported for a few programs but not all.

* In some cases, where the PA only provided net values, we were able to track down net to gross values and calculate Gross values. This count includes those PAs.

Table C-2. Program administrator reporting of cost data: Budget, expenditures, committed

Metric	PAs that Report Electric Values		PAs that Report Gas Values	
	Number of PAs Reporting this Data	Percentage of PAs that reported this data	Number of PAs Reporting this Data	Percentage of PAs that reported this data
Total Administrator Program Costs				
Total Electric Budget	53	60%	N/A	N/A
Total Electric Expenditures	84	95%	N/A	N/A
Total Electric Committed[1]	11	13%	N/A	N/A
Total Gas Budget	N/A	N/A	29	58%
Total Gas Expenditures	N/A	N/A	44	88%
Total Gas Committed	N/A	N/A	2	4%
Administrator Program Cost Breakdown				
Administration/ Management Costs	54	61%	30	60%
Customer Incentive Costs	56	64%	29	58%
Education/Marketing/ Outreach Costs	39	44%	25	50%
Evaluation Costs	36	41%	25	50%
Other Costs[2]	24	27%	18	36%
Non-administrator Costs				
Participant Costs	26	30%	10	20%

[1] "Committed" spending is program spending associated with measures and projects that are approved, contracted and often implemented during the program year but the actual outlay, e.g., payment of a rebate after installation, occurs after the program year has ended.

[2] Other costs incurred by some program administrator include sales costs, technical assistance and training.

Measure Lifetime Assumptions

As a result of the limited reporting of lifetime savings and program average measure lifetimes by program administrators discussed in Chapter 2, LBNL calculated program average measure lifetime values for each detailed program type and used those values to calculate the program CSE. The electricity and natural gas national program average measure lifetime values used for programs that did not report either lifetime savings or the program specific average measure lifetime are summarized by detailed program type and fuel in Table C-3.

Table C-3. Electric and natural gas national program average measure lifetime values calculated for each of the detailed program categories

Sector	Detailed Program Category	Electric Measure Lifetime	Gas Measure Lifetime
C&I	CI: Custom	17	16
C&I	CI: General C&I	13	16
C&I	CI: New Construction	16	19
C&I	CI: Other	13	13
C&I	CI: Prescriptive	13	20
C&I	CI: Self Direct	13	
Commercial	Com/Custom	13	14
Commercial	Com/Custom: Commissioning/Retro-Commissioning	9	12
Commercial	Com/Custom: Sm. Commercial	12	17
Commercial	Com/Pres: Grocery	14	10
Commercial	Com/Pres: HVAC	13	11
Commercial	Com/Pres: IT & Office Equipment	5	
Commercial	Com/Pres: Lighting	12	5
Commercial	Com/Pres: Performance Contract/DSM Bidding	14	20
Commercial	Com/Pres: Sm. Commercial	10	11
Commercial	Com/Prescriptive Other	12	15
Commercial	Com: New Construction	17	15
Commercial	Com: Audit	9	11
Commercial	Com: Financing		
Commercial	Com: Govt./Nonprofit/MUSH	12	17
Commercial	Com: Other	15	
Commercial	Com: Street Lighting	11	
Cross Sectoral/Other	CS: Codes & Standards	8	6

Sector	Detailed Program Category	Electric Measure Lifetime	Gas Measure Lifetime
Cross Sectoral/Other	CS: Market Transformation	7	8
Cross Sectoral/Other	CS: Marketing, Education, Outreach	1	1
Cross Sectoral/Other	CS: Multi-Sector Rebates	12	14
Cross Sectoral/Other	CS: Other	1	1
Cross Sectoral/Other	CS: Planning/Eval/Other Prog Support		
Cross Sectoral/Other	CS: Research	18	18
Cross Sectoral/Other	CS: Shading/Cool Roofs	22	19
Cross Sectoral/Other	CS: Voltage Reduction/Transformers	15	
Cross Sectoral/Other	CS: Workforce Development	1	1
Industrial/Ag	IA/Custom: Data Centers	14	
Industrial/Ag	IA/Custom: Ind. & Ag. Process	14	14
Industrial/Ag	IA/Custom: Refrigerated Warehouses	16	16
Industrial/Ag	IA/Pres: Agriculture	11	11
Industrial/Ag	IA/Pres: Motors	17	
Industrial/Ag	IA: Financing		
Industrial/Ag	IA: Self Direct	13	
Industrial/Ag	IA: Audit	3	3
Industrial/Ag	IA: Custom	13	15
Industrial/Ag	IA: New Construction		
Industrial/Ag	IA: Other	12	11
Industrial/Ag	IA: Prescriptive	10	6
Low Income	Low Income	12	18
Residential	Res: Appliance Recycling	7	5
Residential	Res: Behavioral/Online Audit/Feedback	1	1
Residential	Res: Consumer Product Rebate/Appliances	11	15
Residential	Res: Consumer Product Rebate/Electronics	7	

Sector	Detailed Program Category	Electric Measure Lifetime	Gas Measure Lifetime
Residential	Res: Consumer Product Rebate/Lighting	7	10
Residential	Res: Financing		
Residential	Res: General	4	22
Residential	Res: HVAC	15	16
Residential	Res: Insulation	22	22
Residential	Res: Multi-Family	12	15
Residential	Res: New Construction	21	21
Residential	Res: Other	14	25
Residential	Res: Pool Pump	10	
Residential	Res: Prescriptive	11	17
Residential	Res: Water Heater	12	15
Residential	Res: Whole Home/Audits	10	16
Residential	Res: Whole Home/Direct Install	11	19
Residential	Res: Whole Home/Retrofit	15	21
Residential	Res: Windows	20	20

Data Quality Assurance and Quality Control

Our analysis relies on data provided by energy efficiency program administrators to their state regulatory agencies. Thus, ours is a secondary data research project, one that involves the gathering and use of existing data for purposes other than those for which they were originally collected. Often, the program administrator's primary purpose was to fulfill a state reporting requirement to provide cost and savings data to public utilities commissions and other stakeholders and not necessarily to support multi-state aggregation and comparative analysis.

In order to address potential data quality issues arising from the variation in the content, format and definitions of the reported data from multiple states and administrators, as well as data entry errors, we developed data quality assurance (QA) guidance for the data entry process, and implemented quality control (QC) steps to assure the entered data met the QA plan standards.
Quality Assurance

To inform the development of our QA guidance, we identified four classes of potential errors with respect to the use of the data for this project:

- **Potential errors, gaps, inconsistencies or changes in the source data.** We found examples of reported data that were incorrectly defined, calculated, reported, or otherwise documented in the source report or updated information became available (e.g., in the form of errata sheets or a revised report from a program administrator);
- **Potential errors in manual data input.** During our QA/QC process, not surprisingly, we found transcription errors where LBNL staff did not correctly enter

data from a source report into the LBNL DSM Program Impacts Database spreadsheet (e.g., erroneously taking from a different line than the desired data or incorrect unit conversions);[8]

- **Questions or potential errors in interpretation of the data.** During the QA/QC process, we found examples where LBNL staff that reviewed initial data entry decided that an individual program had not been properly categorized based on the LBNL program typology or that a cost had been misclassified. Classifying programs into detailed program categories or assigning certain highly detailed costs into LBNL-defined cost categories often involved judgment calls and additional research by LBNL staff.
- **Potential intermediate calculation errors** within the database spreadsheet that may affect data cells, e.g., net-to-gross savings conversions, unit conversions (e.g., mcf to therms) or allocating costs between fuels for combined-fuel program administrators.

The QA guidance included the following key provisions:

- Archive all source reports and document the name, date and original source location of all source reports.
- Use annual energy efficiency reports filed by program administrators as the primary data source. Evaluation reports and portfolio plans were consulted on a very limited basis used to fill in gaps in the program administrator report, e.g., by supplying net-to-gross ratios, budgets or projected savings estimates.
- Collect data from all energy efficiency programs including resource programs and non-resource programs, regardless of whether they report cost and savings data.
- Exclude all renewable energy (including solar hot water), demand response/load management, and combined heat and power programs for this initial report.
- Flag all data that are difficult to interpret appropriately. All data entered must conform to the typology and metrics definitions.
- Document decisions made to resolve interpretation questions (e.g., program categorization or definition of a program's savings data (e.g., net vs. gross, reported vs. verified).

Quality Control

The QC process attempted to address each of the four identified classes of potential error. It is important to note that we made the general assumption that the primary data was correct and accurate, as we did not have the resources to validate the information reported by program administrators. Moreover, program reports rarely indicated the level of potential error or uncertainty in the reported data, thus we cannot discern how much uncertainty this may have added to our analysis results.

[8] For example, some programs report lifetime electric savings in MWH, some in GWH and some in kWh, so the researcher transferring data from primary source into the database must make the correct unit conversion.

The following QC activities were conducted to address each of the four classes of potential sources of data errors:

- **Errors, gaps, inconsistencies or changes in the source data.** Reviewing of program data for inconsistencies or unreasonableness. In a few cases we identified errors in the reported data (e.g., incorrect/inconsistent unit listed, or the same data presented in different tables in a single report not matching), and, based on a review of other information in the report, made a determination on the appropriate values to use.
    - Identification and exclusion of programs that are not energy efficiency programs (i.e., renewable energy, demand response, combined heat and power).
    - Flagging programs that did not report energy savings or program expenditures or either. In many cases these were non-resource program types (e.g., education, research) for which the administrator does not claim savings. These were coded for analysis at the portfolio-level only, and were excluded from the program-level analysis.
    - Flagging programs for which the appropriate categorization was not readily apparent. These programs were discussed by the research team and informed the final categorization scheme.
    - Following the initial data entry process, a revision process was completed that included a search for errata sheets or revised reports.

- **Errors in manual data input.** Where feasible, each administrator's costs and savings data were summed and compared to the reported portfolio-level energy efficiency costs and savings for the applicable categories to create "check sums." 9 For example, the gross savings for all residential programs of one administrator were summed and compared against the total savings reported by that program administrator for their residential portfolio. This was not possible in some cases (e.g., where a program administrator included residential demand response and efficiency programs in their sector totals).
    - Following the initial data entry process, a revision process was completed by each LBNL researcher, which included a review of all data entered to check for completeness and errors and check that categorization and cost data matched LBNL definitions. In addition, the analyst indicated the level of confidence that the program was categorized correctly.
    - Pivot tables were set up in the database spreadsheet to make preliminary calculations of the CSE which enabled quick identification of data outliers. LBNL researchers then traced these entries back to the source document to determine

[9] Not all program administrators report energy efficiency program only totals; some include expenditures and/or savings from non-efficiency programs (i.e. renewable energy, demand response, or combined heat and power). Where this is the case, expenditures and savings totals may not add up to reported expenditures and savings. Additionally, in some cases, there may be programs that were categorized according to the LBNL program typology that differ from the way a program administrator categorized the program (i.e. a low income may have been included in the program administrators residential sector summary. However, LBNL analysts will have identified that as a low income program and it is reported in a separate sector summary. Under these circumstances, the project manager examined each non-standard case and verified that the cost or savings totals were accurate and made sense.

whether a data entry error was made. We did not eliminate outliers from the database and with the exception of obvious errors in the source data, we assumed that the reported data was correct.

    - To further reduce the risk of data entry errors, a subsequent quality control (QC) process was completed in which the research team reviewed each others' entries, reviewing all of the data and program categorizations for a minimum of two program administrators from two different years, in each of the 31 states. If significant discrepancies were found, the second researcher conferred with the first to see whether there was a rationale for the discrepancy. If no rationale existed for the discrepancy, data was corrected to the satisfaction of the researchers.

- **Errors in interpretation of the secondary data.** Researchers referred to the LBNL categorization scheme and data metrics definitions to verify interpretation of the data for the initial data entry and two review rounds. The definitions and differences between (a) net and gross savings and (b) verified and claimed savings as reported in data sources were not necessarily consistent among different program administrators. Researchers reviewed any available definitions in the reporting documents to ensure the savings data entered for net/gross and reported/verified matched the LBNL project definitions. Any discrepancies were resolved by discussion amongst the researchers.

- **QAQC for potential calculation errors.** Potential intermediate calculation errors in the inputted data were reviewed during the QAQC process by a second staff person, and any discrepancies or concerns were resolved and fixed as necessary.
    - All formulas used to calculate or report results within the database were reviewed by at least two staff, to verify that the correct data was being referenced and that the formula was correct.
    - In some cases, results were verified by recalculating the values.

Updating the Program Typology and Data Metrics

We believe that the program category typology and data definitions will be most useful if they are adopted by program administrators that report the data. We expect that this naming convention and definition consistency can reduce the effort and improve the quality of the efficiency industry's efforts to compile, analyze and report energy efficiency program information. To this end, we have reviewed these categories and definitions with the CEE, NEEP/REED, and ACEEE staff that are collecting and analyzing data for their own efforts. We also have shared the definitions with EIA for their consideration in future efficiency program inventories they may undertake.

As part of the ongoing LBNL Cost of Saved Energy Project, we intend to continue collecting annual data on programs implemented throughout the United States and to use the program categories and metric definitions for organizing, reporting and analyzing the information. We expect that the program typology and data definitions will not be static. Existing programs will evolve in design or implementation. New program types will emerge. New information and additional data will become available to refine the typology. Therefore, prior to the start of the next data collection cycle, we intend to send out a request for comments to stakeholders and use input from stakeholders to inform revisions to the sector and program typology and definitions. Possible changes include additions or subtractions of categories due to program changes in the market, corrections of errors, and improvements or clarifications in descriptions and definitions. We plan to repeat this input solicitation and update process periodically.

Appendix D. Selection of Discount Rates for Calculating Levelized Costs of Saved Energy

This appendix provides considerations and background information that informed our choice of discount rates to use in calculating the levelized cost of saved energy.

Several sources and analyses were reviewed in order to survey a range of values and rationales for their use, including:

- Energy Information Administration (EIA) documentation for the 2013 Annual Energy Outlook. EIA used a real discount rate of 6.6% for calculating the levelized cost of new generation resources. This value is intended to represent a real, after-tax, weighted-average cost of capital for investors in new generators.[10]
- White House Office of Management and Budget (OMB) guidance for federal agencies engaging in regulatory analyses. In Circular A-94, OMB advises using real discount rates of 7% and 3%, respectively, as proxies for the costs of capital to the private sector (weighted among all consumers) and the "social rate of time preference" or societal discount rate. According to the circular:

  "If we take the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around 3 percent in real terms on a pre-tax basis. For example, the yield on 10-year Treasury notes has averaged 8.1 percent since 1973 while the average annual rate of change in the CPI over this period has been 5.0 percent, implying a real 10-year rate of 3.1 percent."

- Friedrich, et al. (2009), a survey of program administrator costs of efficiency and therefore one of the most recent analogues for this study, used a real discount rate of 5% for calculating levelized costs. The authors noted:
  "…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."

- The Northeast Energy Efficiency Partnership offers the following in their 2010 Common Statewide Energy Efficiency Reporting Guidelines:[11]
  "There is a range of discount rates that can be used to determine levelized cost of

[10] EIA Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013, January, 2013 http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

[11] http://neep.org/Assets/uploads/files/emv/emv-products/EMV%20Forum_Statewide_EE_Reporting_Guidelines_12-30-10.pdf NEEP chose to use 2.46% real as its discount rate.

savings, including:

  - *a utility's weighted average cost of capital or weighted cost of debt and equity;*
  - *a 12-month rolling average rate on the 10-year T-note;*
  - *an average homeowner's discount rate; and/or*
  - *some average of all of these."*

- In its own review of DSM portfolio plans, cost-effectiveness reporting and cost-of-capital proceedings, LBNL finds a range of nominal, after-tax WACCs for electric utilities during the time frame for most of the program data concentrated around 7.5%. Correcting for inflation would result in a real utility WACC of about 6%.

We observed that higher costs of capital generally were used when the assumed investor is characterized by multiple economic actors with different rates for equity and debt interest, e.g., the selection of 7% real by OMB to represent the cost of capital for the private sector or 6.6% by EIA to represent the cost of capital for all investors in power plants.

Based on our review, we selected real discount rates of 3% and 6% in calculating levelized costs of saved energy.

Appendix E: Cost of Saved Energy Results for Sectors and Types of Programs

In this appendix, we present the CSE values underlying the figures and charts presented in Chapter 3. The following tables present the national and regional levelized CSE values by sector, simplified program type and detailed program type. Each table includes the savings weighted average CSE, the 1st quartile, the median, and the 3rd quartile levelized CSE values. The number of programs indicates only the programs in the LBNL DSM Impacts Database for which a program specific CSE can be calculated (i.e., that program reports both savings and expenditures). The savings-weighted average CSE may include programs where there are expenditures but little to no savings.

Table E-1 shows the national levelized CSE by sector, calculated using both the 3% and 6% discount rates. Table E-2 shows the regional levelized CSE, calculated using both the 3% and 6% discount rates. The median values for the regions range from $0.016 to $0.041 per kwh using the 3% discount rate.

Table E-1. National levelized CSE for electricity efficiency programs by sector

Levelized CSE (3% discount) (2012$/kwh)	Savings Weighted Average	1st Quartile	Median	3rd Quartile	Number of Programs
C&I	$ 0.018	$ 0.012	$ 0.022	$ 0.042	986
Cross Sector/Other	$ 0.014	$ 0.011	$ 0.024	$ 0.070	96
Low Income	$ 0.059	$ 0.033	$ 0.062	$ 0.134	200
Residential	$ 0.016	$ 0.015	$ 0.032	$ 0.074	618

Levelized CSE (6% discount) (2012$/kwh)	Savings Weighted Average	1st Quartile	Median	3rd Quartile	Number of Programs
C&I	$ 0.021	$ 0.014	$ 0.027	$ 0.049	986
Cross Sector/Other	$ 0.017	$ 0.013	$ 0.028	$ 0.080	86
Low Income	$ 0.070	$ 0.040	$ 0.073	$ 0.159	200
Residential	$ 0.018	$ 0.018	$ 0.038	$ 0.089	618

Values in this table are based on the 2009-2011 data in the LBNL DSM Program Impacts Database. CSE values are for administrator costs and based on gross savings. Savings are levelized at 6% real discount rate. The savings-weighted average CSE is calculated using all savings and expenditures at the level of analysis. The inter-quartile range and median CSE values are based on calculations for each individual program.

Table E-2. Regional levelized CSE for electricity efficiency programs

Levelized CSE (3% discount) (2012$/kwh)	Savings Weighted Average CSE	1st Quartile	Median	3rd Quartile	Number of Programs
Midwest	$ 0.011	$ 0.008	$ 0.016	$ 0.041	399
Northeast	$ 0.028	$ 0.019	$ 0.041	$ 0.105	427
South	$ 0.022	$ 0.013	$ 0.029	$ 0.092	290
West	$ 0.020	$ 0.019	$ 0.033	$ 0.054	792

Levelized CSE (6% discount) (2012$/kwh)	Savings Weighted Average CSE	1st Quartile	Median	3rd Quartile	Number of Programs
Midwest	$ 0.014	$ 0.009	$ 0.018	$ 0.047	399
Northeast	$ 0.033	$ 0.022	$ 0.049	$ 0.131	427
South	$ 0.028	$ 0.015	$ 0.036	$ 0.109	290
West	$ 0.023	$ 0.023	$ 0.040	$ 0.063	792

Values in this table are based on the 2009-2011 data in the LBNL DSM Program Impacts Database. CSE values are for administrator costs and based on gross savings. Savings are levelized at 6% real discount rate. The savings-weighted average CSE is calculated using all savings and expenditures at the level of analysis. The inter-quartile range and median CSE values are based on calculations for each individual program.

Table E-3 shows the residential levelized CSE using a 6% discount rate at both the simplified and detailed program categories. At the detailed program category level, the median values range from $0.009 (Consumer Product Rebate: Lighting) to $0.116 (Whole Home: Retrofit) per kwh.

Table E-4 shows the commercial and industrial levelized CSE using a 6% discount rate at both the simplified and detailed program categories. At the detailed program category level, the median values range from $0.004 (CI: Self Direct) to $0.324 (Industrial/Agriculture: Audit) per kWh.

Table E-3. Residential levelized CSE for electricity efficiency programs; simplified and detailed program categories

Levelized CSE (6% discount) (2012$/kwh)	Savings Weighted Average	1st Quartile	Median	3rd Quartile	Number of Programs
R: All Other Residential	$ 0.040	$ 0.021	$ 0.024	$ 0.040	8
R: Behavior/Education	$ 0.161	$ 0.040	$ 0.062	$ 0.081	23
R: Consumer Product Rebate	$ 0.009	$ 0.010	$ 0.019	$ 0.035	196
R: Multi Family	$ 0.031	$ 0.020	$ 0.039	$ 0.051	36
R: New Construction	$ 0.021	$ 0.029	$ 0.058	$ 0.112	81
R: Prescriptive	$ 0.016	$ 0.024	$ 0.055	$ 0.112	139
R: Whole Home Upgrade (Inc. audits, retrofits, etc.)	$ 0.051	$ 0.034	$ 0.089	$ 0.212	135

Levelized CSE (6% discount) (2012$/kwh)	Savings Weighted Average	1st Quartile	Median	3rd Quartile	Number of Programs
Res: Consumer Product Rebate/Lighting	$ 0.007	$ 0.007	$ 0.009	$ 0.014	81
Res: Consumer Product Rebate/Appliances	$ 0.033	$ 0.042	$ 0.058	$ 0.101	36
Res: Consumer Product Rebate/Electronics	$ 0.014	$ 0.013	$ 0.017	$ 0.025	6
Res: Behavioral/Online Audit/Feedback	$ 0.161	$ 0.040	$ 0.062	$ 0.081	23
Res: General	$ 0.040	$ 0.024	$ 0.025	$ 0.026	2
Res: HVAC	$ 0.024	$ 0.044	$ 0.081	$ 0.159	85
Res: Insulation	$ 0.019	$ 0.009	$ 0.015	$ 0.044	8
Res: Multi-Family	$ 0.031	$ 0.020	$ 0.039	$ 0.051	36
Res: New Construction	$ 0.021	$ 0.029	$ 0.058	$ 0.112	81
Res: Other	$ 0.039	$ 0.021	$ 0.024	$ 0.051	6
Res: Pool Pump	$ 0.035	$ 0.029	$ 0.033	$ 0.043	4
Res: Prescriptive	$ 0.011	$ 0.011	$ 0.018	$ 0.025	33
Res: Water Heater	$ 0.065	$ 0.013	$ 0.034	$ 0.060	6
Res: Appliance Recycling	$ 0.019	$ 0.017	$ 0.022	$ 0.030	73
Res: Whole Home/Retrofit	$ 0.053	$ 0.039	$ 0.116	$ 0.271	85
Res: Whole Home/Audits	$ 0.052	$ 0.033	$ 0.072	$ 0.107	31
Res: Windows	$ 0.027	$ 0.032	$ 0.046	$ 0.052	3
Res: Whole Home/Direct Install	$ 0.061	$ 0.019	$ 0.060	$ 0.264	19

Values in this table are based on the 2009-2011 data in the LBNL DSM Program Impacts Database. CSE values are for administrator costs and based on gross savings. Savings are levelized at 6% real discount rate. The savings-weighted average CSE is calculated using all savings and expenditures at the level of analysis. The inter-quartile range and median CSE values are based on calculations for each individual program.

Table E-4. Commercial and Industrial levelized CSE for simplified and detailed program categories (6% discount rate)

Levelized CSE (6% discount) (2012$/kwh)	Savings Weighted Average	1st Quartile	Median	3rd Quartile	Number of Programs
CI: Custom	$ 0.020	$ 0.014	$ 0.025	$ 0.047	287
CI: Prescriptive	$ 0.015	$ 0.011	$ 0.023	$ 0.042	259
CI: Small Commercial	$ 0.035	$ 0.022	$ 0.036	$ 0.053	93
CI: New Construction	$ 0.026	$ 0.015	$ 0.027	$ 0.036	75
CI: MUSH & Govt.	$ 0.034	$ 0.032	$ 0.050	$ 0.084	230
CI: All Other	$ 0.010	$ 0.004	$ 0.011	$ 0.018	42

Levelized CSE (6% discount) (2012$/kwh)	Savings Weighted Average	1st Quartile	Median	3rd Quartile	Number of Programs
CI: Custom	$ 0.020	$ 0.011	$ 0.018	$ 0.034	65
CI: General C&I	$ 0.015	$ 0.011	$ 0.014	$ 0.017	10
CI: New Construction	$ 0.026	$ 0.021	$ 0.029	$ 0.036	24
CI: Other	$ 0.015	$ 0.012	$ 0.023	$ 0.024	5
CI: Prescriptive	$ 0.010	$ 0.008	$ 0.010	$ 0.019	39
CI: Self Direct	$ 0.004	$ 0.002	$ 0.004	$ 0.009	9
Com/Custom	$ 0.019	$ 0.011	$ 0.021	$ 0.032	66
Com/Custom: Commissioning/Retro-Commissioning	$ 0.021	$ 0.013	$ 0.025	$ 0.041	36
Com/Custom: Sm. Commercial	$ 0.039	$ 0.029	$ 0.047	$ 0.060	31
Com/Pres: Grocery	$ 0.027	$ 0.004	$ 0.027	$ 0.032	9
Com/Pres: HVAC	$ 0.030	$ 0.018	$ 0.034	$ 0.053	44
Com/Pres: IT & Office Equipment	$ 0.022	$ 0.022	$ 0.025	$ 0.032	4
Com/Pres: Lighting	$ 0.013	$ 0.009	$ 0.012	$ 0.026	42
Com/Pres: Performance Contract/DSM Bidding	$ 0.016	$ 0.011	$ 0.019	$ 0.025	12
Com/Pres: Sm. Commercial	$ 0.038	$ 0.021	$ 0.035	$ 0.052	62
Com/Prescriptive Other	$ 0.023	$ 0.018	$ 0.027	$ 0.052	61
Com: New Construction	$ 0.024	$ 0.015	$ 0.024	$ 0.034	51
Com: Audit	$ 0.035	$ 0.025	$ 0.108	$ 0.227	12
Com: Govt./Nonprofit/MUSH	$ 0.036	$ 0.033	$ 0.050	$ 0.078	225
Com: Other	$ 0.008	$ 0.008	$ 0.009	$ 0.011	2
Com: Street Lighting	$ 0.083	$ 0.008	$ 0.096	$ 0.109	5
IA/Custom: Data Centers	$ 0.038	$ 0.048	$ 0.053	$ 0.059	5
IA/Custom: Ind. & Ag. Process	$ 0.022	$ 0.021	$ 0.033	$ 0.045	68
IA/Custom: Refrigerated Warehouses	$ 0.029	$ 0.028	$ 0.028	$ 0.034	3
IA/Pres: Agriculture	$ 0.024	$ 0.022	$ 0.027	$ 0.037	17
IA/Pres: Motors	$ 0.013	$ 0.009	$ 0.014	$ 0.032	25
IA: Self Direct	$ 0.006	$ 0.002	$ 0.008	$ 0.022	16
IA: Audit	$ 0.330	$ 0.317	$ 0.324	$ 0.354	6
IA: Custom	$ 0.017	$ 0.013	$ 0.018	$ 0.046	26
IA: Prescriptive	$ 0.031	$ 0.028	$ 0.031	$ 0.032	6

Values in this table are based on the 2009-2011 data in the LBNL DSM Program Impacts Database. CSE values are for administrator costs and based on gross savings. Savings are levelized at 6% real discount rate. The savings-weighted average CSE is calculated using all savings and expenditures at the level of analysis. The inter-quartile range and median CSE values are based on calculations for each individual program.

Appendix F. Regression analysis of potential influences on the cost of saved energy: conceptual framework and data

This appendix discusses our approach used to explore possible relationships between the cost of saved energy (CSE) and various factors that we hypothesized were influences on variability in the CSE (see Chapter 4). The selection of variables as proxies for these theorized influences are described, as well a preliminary statistical analysis of these relationships.

For our dependent variable, we chose the first-year electric CSE, which is simply the program administrator cost ($2012) divided by first-year gross electricity savings (in kilowatt hours. With the cost of saved energy metric selected, we identified and collected independent variables as proxies for the factors identified as potential influences over the cost of saved energy.

Figure F-1 summarizes the process and steps used to conduct this initial exploratory analysis. Topics discussed in this appendix are highlighted in a darker shade.

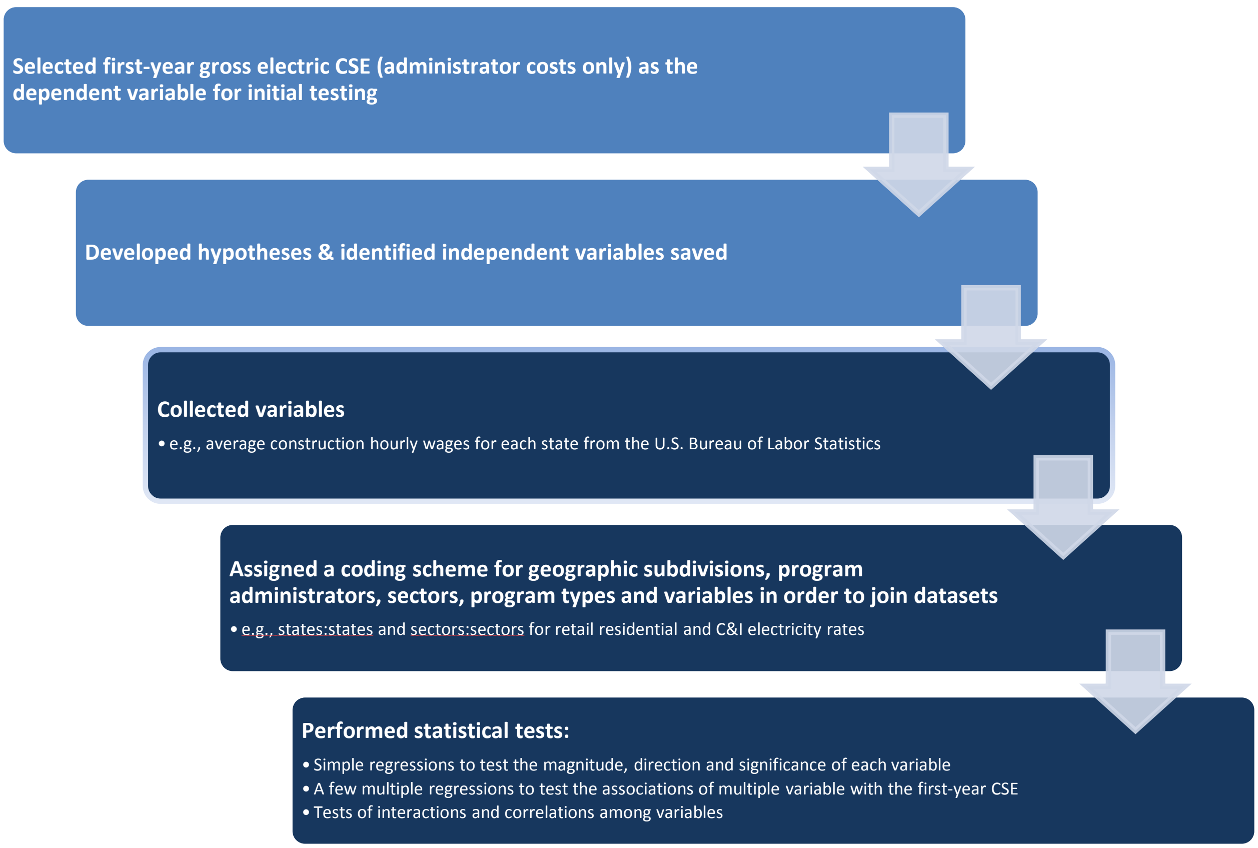

Figure F-1. Statistical testing process used to analyze potential influences on the cost of first-year gross electric savings.

We developed data for the proxy variables from a number of sources, which are shown in the last column of Table F-1. Additional independent variables, drawn from these and other sources, are expected to be analyzed in more depth in subsequent reports of the LBNL CSE Project.

Table F-1. Hypothetical influences on the costs of saved energy and the variables selected for testing those hypotheses. Hypotheses and variables analyzed for this report are shown in black.

Theorized Influences over the Cost of Saved Energy	Hypothesis	Proxy Variable[12]	Level at Which Variable Was Tested	Source for Proxy Variable Data
Program Administrator Experience	Program administrators with more experience learn to deliver programs more effectively and efficiently, with resulting cost reductions.	Years of energy efficiency program spending from 1999-2012 above a *de minimums* threshold	Portfolio and sector levels	U.S. Energy Information Administration Form 861 survey[13] data, 1999-2012
Scale of Program	Larger programs reap economies of scale and thus have lower relative costs.	Number of participants	Program level	LBNL CSE database
La bo r Co st s	Acquiring energy savings in areas with higher labor costs tend to be more costly because labor is a significant component of both administrative and (indirectly) incentive costs.	State average wages for the construction industry	Portfolio, sector, and program levels	U.S. Bureau of Labor Statistics
State Policy Environment	Strong efficiency policies can both raise the baseline for energy savings potential and drive program administrators to reach deeper into the economy for savings, both factors that over time are likely to result in costlier savings.	Estimated statewide savings targets, as a percent of retail sales	Program administrator (portfolio), sector, and program levels	Reports by LBNL, the Regulatory Assistance Project (RAP) and ACEEE
Retail Rate Environment	Higher retail energy costs encourage more customers to invest in energy savings, thus lowering the administrators' costs of securing participation and	Residential, commercial and industrial retail rates	Commercial and Industrial (C&I) and residential sectors	U.S. EIA 826, 861 reports (Monthly Electric Sales and Revenue Report with State Distributions and the Annual Electric

[12] The listed variables are not exclusive but provided for illustrative purposes. Additional variables were tested for some hypotheses.

[13] We measured experience as the number of years that each administrator has funded program portfolios at 0.1 percent of retail revenues for that administrator or for utilities in that administrator's territory. Where a time series of program funding could not be obtained (e.g., through gaps in reporting or a belatedly recognized program administrator), we used the launch date for a multi-sector portfolio by that administrator or, in a few cases, relied upon in-house knowledge of the level of energy-efficiency activity by that administrator.

	savings.			Power Industry Report)

These data were coded by geography or program administrator in order to be merged with program data from the LBNL cost of saved energy database.[14] For example, each state was identified by the two-digit code developed by the American National Standards Institute (ANSI), which is commonly used by the Census Bureau and several other federal agencies and which closely mirrors the former Federal Information Processing Standards (FIPS) codes that other federal agencies retain in legacy databases. We combined these ANSI codes with codes that the U.S. Department of Energy's Energy Information Administration has assigned to utilities and DSM program administrators in order to generate a unique identifier for each program administrator. These codes supplied common identifiers for joining datasets on years of program spending, retail rates, and state average hourly wages for the construction industry.

Using a widely available software package designed for statistical analysis,[15] we performed simple ordinary least squares (OLS) regressions and a limited number of multivariate regressions. OLS quantifies the degree to which the dependent variable (e.g., the first-year gross electric CSE) varies in response to changes in the independent variable, holding constant all other included independent variables.[16]

The following regression specification was used:

$$CSE_i = \alpha + \beta 1 x_1 \ + \ etc. + \epsilon_i$$

Where:

- CSE_i is the dependent variable for each program (the first-year gross electric cost of saved energy);
- x_1, x_2, etc., are independent variables, estimators or regressors, which are the factors posited to be associated with changes in the dependent variable;
- β1, β2, etc., are the coefficients that estimate the relationship of the independent variables with the dependent variable;
- εi is an error term that captures the variability of the dependent variable that is unexplained by the linear prediction based upon the regressors.

The magnitude and sign of the coefficient on each independent variable x indicate the estimated size and direction (reduction or increase) in y, all other things being equal. A t-test and the associated P-value indicates the statistical significance of an independent variable. When $P < 0.05$, the tested relationship is said to be statistically significant at the 5 percent level, which means that there is only a 5 percent chance that we would see our estimate if there were truly no relationship between the dependent and independent variable.

[14] Not all data for independent variables are listed here. Participation data already was associated with programs for which those numbers were reported and so did not require additional coding.
[15] STATA version 12.1, developed by StataCorp LP, 4905 Lakeway Drive, College Station, Texas.
[16] OLS accomplishes this by minimizing the sum of the squares of the distances between actual and predicted linear values for the dependent variable.

We performed linear-linear regressions (e.g., a one unit change in x_i would be associated with a β_i unit change in y); log-linear regressions (a one unit change in x_i would be associated with a 100 * β_i percent change in y); and log-log regressions (a one percent change in x_i would be associated with a β_i percent change in y).

We conducted regression analyses at three levels: the level of program administrators' portfolios or full suite of programs, at the level of targeted sector (e.g., commercial or residential), and at the level of individual program types and programs. Where possible, we took advantage of the large sample sizes afforded by certain, highly common program types. In some cases, however, we aggregated and analyzed data at the portfolio and sector level in order to examine larger scale influences and to moderate the influence of portfolios with many programs in a sector (e.g., California supplied more than 1,000 program years of data and so account for more than 25 percent of our dataset, compared to tens of program years of data from smaller states). By aggregating program data up to the sector or portfolio level, for example, CSE data from California has equal weight with data from Vermont, such that cost variability for a given sector is not skewed by the predominance of data from larger states in the sample.

Table F-2 summarizes the regression results described in the main body of the report for this preliminary analysis.

Table F-2. Summary of statistical regression results

Theorized Influence over the Cost of Saved Energy	Proxy Variable	Correlation Coefficient	P-value	Level of Statistical Significance
Program Administrator Experience	Years of program administrator spending above a de minimis threshold	-0.0211731	0.196	20%
	Years of program administrator spending ^2	0.0016974	0.147	15%
Scale of Program	Number of participants in refrigerator recycling programs	-9.41E-06	0.035	5%
Labor Costs	State average construction hourly wages	0.01468	0.001	1%