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Electricity Markets and Policy Group

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Overview

• Why the cost of saving electricity (CSE) matters

• LBNL cost of saving electricity project
  • Data and analytical approach and program typology
  • What's in the database – program spending and lifetime savings by market sector
  • Definitions

• Program administrator (PA) CSE results
  • National, regional and market sectors
  • Select residential and commercial & industrial (C&I) programs
  • Trends
  • Electricity efficiency cost curve

• Disaggregating costs: Administration and marketing costs as share of PA costs

• Total CSE results
  • National, regional and market sectors
  • Select residential and C&I programs
  • Trends

• Discussion and future research directions
Why the cost of saving electricity matters

• To help ensure electricity system reliability at the most affordable cost as part of resource adequacy planning and implementation activities
  • Increasing role of efficiency as an energy and capacity resource, driven in part by state policies
  • Spending on utility customer-funded programs grew ~20% from 2011-2016*
  • Declining costs for some supply-side resources sharpens discussion of type and market share of clean energy investments

• To project efficiency’s impact on electricity load forecasts
• To benchmark program results with regional and national estimates
• For initial screening of electricity resource alternatives
• To evaluate how program costs are likely to change over time with funding levels and participation

**LBNL Cost of Saving Electricity Project: Data and Analytical Approach**

**Approach**

- Collect & analyze reported annual energy efficiency (EE) program data

**LBNL DSM Program Database**

- Program Administrator CSE: 116 electricity EE administrators in 41 states
  - N = 8,790 program years (2009-2015)

- Total Cost of Saved Electricity: 67 administrators in 27 states
  - N = 4,590 program years

**Data Collected**

- Annual & lifetime savings
- Budgets & expenditure details
- Measure lifetimes for programs

**Standardization Is Critical**

- A common DSM lexicon and program typology
- LBNL program reporting tools for:
  - Investor-owned utilities
  - Public power utilities

![Map of U.S. showing data distribution by state]
LBNL Efficiency Program Typology

- Characterizes programs by market sector, technologies and delivery approaches
  - Reflects range of reporting detail and enables multiple levels of analysis
- Six sectors, 27 simplified programs and >60 detailed program types

See LBNL brief, *Energy Efficiency Program Typology and Data Metrics: Enabling Multi-State Analyses Through the Use of Common Terminology*

*Figure is illustrative. Not all program types are depicted.*
LBNL Energy Efficiency Reporting Tools

FOR MID-SIZED/EARLY STAGE PROGRAM ADMINISTRATORS

• Full-featured DSM reporting tool for PAs for programs funded by utility customers
• Flexible to accommodate the diverse data requirements in states while maintaining reporting consistency
• Program-level spending, savings, participation, cost-effectiveness and program design
• Screening questions allow PA or PUC to customize information that is to be reported
• Includes data glossary and program typology
• Reporting tool for public power
LBNL database includes 70-80% of national spending on electricity efficiency programs

- LBNL’s database covers a large and increasing share of national electricity efficiency program spending
  - 80% of spending for all utility programs in 2014 (including public power utilities), up from 24% in 2009
  - 70% of spending in 2015
Residential Program Spending and Lifetime Savings

- $8.3B in residential program spending from 2009 to 2015 in LBNL database
- Whole-home upgrades and prescriptive rebates together account for 44% of spending and 31% of lifetime savings
- Lighting rebate programs account for 20% of spending and 45% of lifetime savings

**Expenditures**
- Total = 8.3 Billion (2016$)

**Lifetime Gross Savings**
- Total = 436,770 GWh

- Lighting Rebate: 4%
- Whole Home Upgrade*:
- HVAC and Other Prescriptive Rebates: 12%
- New Construction: 9%
- Multi-Family: 6%
- Consumer Product Rebate: 5%
- Behavior/Education: 4%
- All Other Residential: 20%

* Including audits, retrofits, etc.
** Appliances, electronics and other non-lighting consumer goods.
C&I Program Spending and Lifetime Savings

- $13.4B in C&I program spending from 2009 to 2015 in LBNL database
- Custom rebate, prescriptive rebate, and small commercial programs account for about 3/4 of spending and lifetime savings

Expenditures
Total = 13.4 Billion (2016$)

- Small Commercial: 18%
- Prescriptive Rebate: 9%
- New Construction: 21%
- MUSH* & Government: 5%
- Custom Rebate: 10%
- All Other C&I: 37%

Lifetime Gross Savings
Total = 836,241 GWh

- Municipal/state governments, universities, K-12 schools and hospitals: 26%
- New Construction: 14%
- MUSH* & Government: 37%
- Custom Rebate: 10%
- All Other C&I: 3%
## Definitions: PA and Total Cost of Saving Electricity

<table>
<thead>
<tr>
<th>Levelized Program Administrator Cost of Saving Electricity (PA CSE)</th>
<th>The cost to the <em>program administrator</em> for achieving electricity savings over the economic lifetime of the actions taken, discounted back to when the costs were paid and the actions occurred.</th>
</tr>
</thead>
</table>

Levelized PA CSE for EE programs calculated using the following assumptions and inputs:
- 6% discount rate (real)
- Estimated program average measure lifetime
- Total program cost, including incentives (2016$)
- Gross annual kWh saved

| Levelized Total Cost of Saving Electricity (Total CSE) | The costs incurred by program administrators and participants for achieving electricity savings over the economic lifetime of the actions taken, discounted back to when the costs were paid. Participant costs are net of any incentives paid by the program. |
Influences on PA and Total CSE

CSE may vary across program administrator portfolios for reasons other than programmatic efficiency.

- **Lower CSE**
  - Focus on low hanging fruit
  - Longer assumed program lifetimes
  - Solely incremental measure costs

- **Higher CSE**
  - High labor costs
  - Comprehensive programs
  - All cost-effective EE standard
  - Lower assumed program lifetimes
Program Administrator
Cost of Saving Electricity
Program Administrator Cost of Saving Electricity: National Results (2009-2015)

- U.S. savings-weighted average PA CSE for all programs: $0.025/kWh (2009-2015)
- PA CSE for residential programs: $0.021/kWh, influenced strongly by lighting rebate programs
- PA CSE for C&I programs: $0.025/kWh
- PA CSE for low-income programs: $0.105/kWh (account for 2% of savings, 9% of spending)

*Portfolio sample size includes planning and other support programs that do not directly generate savings. Source: LBNL Database
Program Administrator Cost of Saving Electricity: Regional Results (2009-2015)

- Savings-weighted PA CSE varied widely across regions: $0.015 to $0.033/kWh
- Comparable CSE values in South and West: $0.026/kWh
- Midwest markedly lower: $0.015/kWh. Many Midwest states ramped up programs between 2009 and 2015, with significant investment in low-cost programs.

Source: LBNL DSM Program Database
17 states with a PA CSE of ≤$0.02/kWh, concentrated in the Midwest, South and Intermountain West

PA CSE greater than $0.04/kWh in five states. Four of these states (CT, VT, MA, and NH), in the Northeast, have relatively high electricity prices, extensive history with EE and strong policy commitments.
2015 electricity savings expressed as % of 2015 retail sales
PA CSE values tend to be higher in states that achieve more aggressive savings levels. 23 states reported annual electricity savings ≥1% of retail sales
Nine states in NE and West >1.5% savings
Four states with >2% savings (ME, VT, RI, MA)
Program Administrator Cost of Saving Electricity: Select Residential Programs

- Wide range in residential PA CSE across programs: six-fold difference from lighting rebates ($0.011/kWh) to whole-home retrofits ($0.069/kWh)
- Lighting and consumer product rebates provide low-cost savings that allow PAs to offer other programs that are higher cost, but more comprehensive
Program Administrator Cost of Saving Electricity: Median Values and Ranges for Residential Programs

- Median PA CSE for residential sector: $0.042/kWh
- Low variability in PA CSE for lighting vs. other programs (HVAC, whole home retrofit, new construction) where variability in CSE values is greater — reflects diversity in program design and mix of measures

![Graph showing median PA CSE for different programs]

<table>
<thead>
<tr>
<th>Market Sector</th>
<th>Select Programs</th>
<th>(\text{Median PA CSE} (\text{$/kWh}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Res Programs ((n=2,818))</td>
<td>Lighting Rebate (n=369)</td>
<td>$0.042</td>
</tr>
<tr>
<td></td>
<td>Appliance &amp; Electronics Rebate (n=867)</td>
<td>$0.014</td>
</tr>
<tr>
<td></td>
<td>HVAC (n=373)</td>
<td>$0.010</td>
</tr>
<tr>
<td></td>
<td>Whole-Home Retrofit (n=308)</td>
<td>$0.012</td>
</tr>
<tr>
<td></td>
<td>Multi-Family (n=190)</td>
<td>$0.008</td>
</tr>
<tr>
<td></td>
<td>New Construction (n=364)</td>
<td>$0.010</td>
</tr>
<tr>
<td></td>
<td>Behavioral Feedback (n=153)</td>
<td>$0.006</td>
</tr>
</tbody>
</table>

- Median: ○
- Savings-Weighted Average: ⬤
- Interquartile Range: ─
Program Administrator Cost of Saving Electricity: Select C&I Programs

- Savings-weighted PA CSE for C&I programs with largest savings — custom, prescriptive rebates, and new construction: $0.019/kWh to $0.026/kWh
- Savings are more evenly distributed across C&I program types, and average CSE varies only by a factor of two

<table>
<thead>
<tr>
<th>Market Sector</th>
<th>Select Programs</th>
<th>Share of Lifetime Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial, Industrial &amp; Agricultural</td>
<td>Custom Rebate (n=1,002)</td>
<td>37%</td>
</tr>
<tr>
<td></td>
<td>Prescriptive Rebate (n=863)</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>New Construction (n=242)</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Small Commercial (n=414)</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>MUSH &amp; Other Gov’t (n=481)</td>
<td>3%</td>
</tr>
</tbody>
</table>
• Median PA CSE for C&I sector: $0.028/kWh

• Lower variability in PA CSE values among major program types (e.g., range of 2.1 vs. 3.4 for C&I vs. residential new construction)
Trends in the PA CSE: 2010-2015

- 51 PAs with continuous data for 2010-2015
  - Average PA CSE increasing over time
- Divided into three groups based on annual savings
  - Average CSE increasing over time for highest and middle group of annual savers (larger PAs); decreasing over time for lowest savers (smaller PAs)
  - Average CSE for individual PAs is rising for higher savers, flat for middle savers, declining for lower savers

<table>
<thead>
<tr>
<th>PA Group</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>CAGR: Savings-Weighted Average</th>
<th>CAGR: Mean Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 51 PAs</td>
<td>$0.022</td>
<td>$0.025</td>
<td>$0.024</td>
<td>$0.025</td>
<td>$0.028</td>
<td>$0.026</td>
<td>3.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Highest Third</td>
<td>$0.021</td>
<td>$0.026</td>
<td>$0.023</td>
<td>$0.023</td>
<td>$0.027</td>
<td>$0.025</td>
<td>3.5%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Middle Third</td>
<td>$0.020</td>
<td>$0.023</td>
<td>$0.021</td>
<td>$0.030</td>
<td>$0.029</td>
<td>$0.028</td>
<td>7.0%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Lower Third</td>
<td>$0.032</td>
<td>$0.026</td>
<td>$0.027</td>
<td>$0.029</td>
<td>$0.033</td>
<td>$0.031</td>
<td>-0.6%</td>
<td>-2.8%</td>
</tr>
</tbody>
</table>

CAGR = compound annual growth rate
Program Administrator Cost of Saving Electricity: 2010-2015 Trends in Acquisition Cost

- Balanced panel of 51 PAs with continuous data, 2010-2015
- More formal statistical measurement
  - Fitted across all years, not just beginning and end years
- Moderate rate of increase, ~2.5% per year
Program Administrator Cost of Saving Electricity: Program Savings Cost Curve

- Programs ordered by actual cost performance on x-axis; width scaled to represent lifetime savings
- Reinforces program analysis: Residential programs (blue) are least (and most) expensive; C&I programs (green) are steadier producers of savings
Disaggregating Program Costs: Administration and Marketing Costs for Select Program Types

Median and average values for ratio of administration and marketing costs to overall PA costs:

- Residential
  - 33% to 36% for lighting and whole home retrofit programs
  - >40% for appliance/equipment rebate programs
- Commercial
  - 27% to 37% for prescriptive and custom rebate programs
Total Cost of Saving Electricity
Total Cost of Saving Electricity: National Results (2009-2015)

- Savings-weighted average Total CSE: $0.05/kWh for 67 program administrators in 27 states
- Residential programs: $0.039/kWh (lowest-cost sector); low-income programs: $0.145/kWh
- C&I programs: $0.055/kWh

Source: LBNL DSM Program Database
Total Cost of Saving Electricity:  
Regional Results

- Average Total CSE very similar in West and Northeast (~$0.053/kWh and ~56%/44% ratio of PA to participant cost shares)
- Total CSE is similar in South and Midwest ($0.042 vs. 0.045/kWh), but very different ratios of PA to participant costs: 40%/60% in Midwest; 65%/35% in South

### Regional Cost Breakdown

<table>
<thead>
<tr>
<th>Region</th>
<th>All Programs (n=4,508)</th>
<th>Midwest (n=688)</th>
<th>South (n=449)</th>
<th>West (n=1,936)</th>
<th>Northeast (n=1,435)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>$0.028</td>
<td>$0.018</td>
<td>$0.027</td>
<td>$0.029</td>
<td>$0.030</td>
</tr>
<tr>
<td>Midwest</td>
<td>$0.027</td>
<td>$0.027</td>
<td>$0.015</td>
<td>$0.024</td>
<td>$0.023</td>
</tr>
<tr>
<td>South</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: LBNL DSM Program Database
Total Cost of Saving Electricity: State-level Results

- Total CSE varied by more than a factor of three between the lowest and highest cost states ($0.026/kWh vs. >$0.08/kWh)
- Total CSE <0.04/kWh for one-third of states
- Relative share of Total CSE paid by PAs vs. participants varied significantly among states
- Midwest program participants tend to pay a greater share than PAs; opposite trend in South
Total Cost of Saving Electricity: Results for Select Residential Programs

- Total CSE for residential sector: $0.039/kWh
- Nearly half of savings from lighting rebate programs ($0.027/kWh), with participants paying 55% of costs; drove sector results
- For other programs, ranged from $0.074/kWh for multifamily to $0.14/kWh for HVAC

Source: LBNL DSM Program Database
Total Cost of Saving Electricity: Median Values and Ranges for Residential Programs

- Median value for Total CSE was much higher ($0.077/kWh) than savings-weighted average ($0.039/kWh) for residential programs.

- Wider ranges in Total CSE for most challenging markets: whole-home retrofits, new construction and HVAC.

Source: LBNL DSM Program Database
Total Cost of Saving Electricity: Select C&I Programs

- Average Total CSE for C&I sector: $0.055/kWh — ~40% higher than residential average
- Custom retrofits ($0.056/kWh), prescriptive rebates ($0.049/kWh) and new construction ($0.045/kWh) account for 76% of C&I savings
- Participants in C&I custom programs invest moderately more than the PA — 55% vs. 45%

Source: LBNL DSM Program Database
Total Cost of Saving Electricity:
Median Values and Ranges for C&I Programs

- Narrower ranges for Total CSE values for C&I programs compared to residential programs
- Closeness of medians and savings-weighted average values indicate similar performance among large and small PAs

![Graph showing median values and ranges for C&I programs](chart.jpg)

Source: LBNL DSM Program Database
Trends in the Total Cost of Saving Electricity: 2010-2015

- Total CSE data available for 21 PAs between 2010 and 2015
- Very moderate growth in both Total CSE and PA CSE in this sample of PAs
- Total CSE increased by 3% per year over 2010-2015 period, driven primarily by increase in PA CSE (4.8%/year)

Source: LBNL DSM Program Database
Discussion: Key Findings and Potential Implications

- Cost of saving electricity remains low. Average cost to utilities is $0.025/kWh.
- Significant variation in CSE by region, with lower CSE values in South and Midwest.
- Average PA CSE values increased by 3.5% per year between 2010 and 2015 for 51 PAs with complete program data.
- National “cost curve” for existing electricity efficiency programs reveals these insights:
  - Low-cost savings from residential lighting and consumer products reduce costs for the overall portfolio, accounting for 45% of lifetime savings in residential sector and 19% for national portfolio.
  - Combined impact of increased market penetration of LEDs and federal lighting standards that will take effect in 2020 could reduce opportunities to acquire low-cost savings in residential lighting.
  - C&I core programs — rebates for custom projects, prescriptive measures and new construction — deliver nearly half of lifetime savings. Bulk of savings come from larger C&I customers.
  - If more states allow large C&I customers to opt out of efficiency programs, PAs may rely more on savings from small and mid-size C&I customers. A shrinking C&I market may put upward pressure on CSE values in the C&I sector.
- Contraction in savings potential for lighting and core C&I savings can have large impacts on where savings come from and program cost-effectiveness, and therefore how much efficiency can be acquired.
- Behavioral feedback programs have proliferated and help achieve annual savings targets. However, their role as a significant electricity system resource is less apparent under current EM&V practices.
Program Data Reporting: Progress and Challenges

• Progress
  - Program-level reporting of electricity efficiency costs and impacts is increasing
  - Granularity and quality of reporting are improving
  - More PAs are reporting participant costs (54% in our database)
  - More detail on program costs by cost category

• Challenges
  - Consistency, completeness and transparency of program data - Still significant room for improvement
  - Program average measure lifetimes - Only 27% of PAs in our database report measure lifetimes or lifetime savings, with significant variability in lifetimes for similar programs.
  - Participant costs - Challenging area, more transparency needed regarding PA practices
  - Net savings definitions and values
  - A few utilities and states continue to withhold or redact program data.

• Full, detailed reporting is important for grid operators, utilities, and public utility commissions to increase confidence in energy efficiency as an electricity system resource and to make better informed decisions.
Future Research Directions

• Broaden scope to include public power utilities
• Develop metrics to report on peak demand impacts
• Update the cost of saving natural gas
• Estimate CSE values based on net savings
• Improve understanding of CSE by cost category
• Compare cost performance trends of efficiency and supply-side resources