Peak Demand Savings from Efficiency: Opportunities and Practices

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January 7, 2020

This work was supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

Contents

Project Background

Why the Cost of Saving Electricity and Cost of Saving Peak Demand Matter

Program Administrator (PA) Cost of Saving Electricity (CSE) is expressed in dollars per kilowatt-hour ($/kWh)

PA Cost of Saving Peak Demand (CSPD) is expressed in dollars per kilowatt ($/kW)

The PA CSE and CSPD are **each** calculated based on the entire program administer program cost. This means the results cannot be combined because it would double the program cost. Each metric must be considered separately.

- To help ensure electricity system reliability at the most affordable cost as part of resource adequacy planning and implementation activities
- To project efficiency's impact on electricity load forecasts
- To benchmark utility's program results with regional and national estimates
- For initial screening of electricity resource alternatives for meeting future demand
- To evaluate how program cost performance are likely to change over time with funding levels and participation

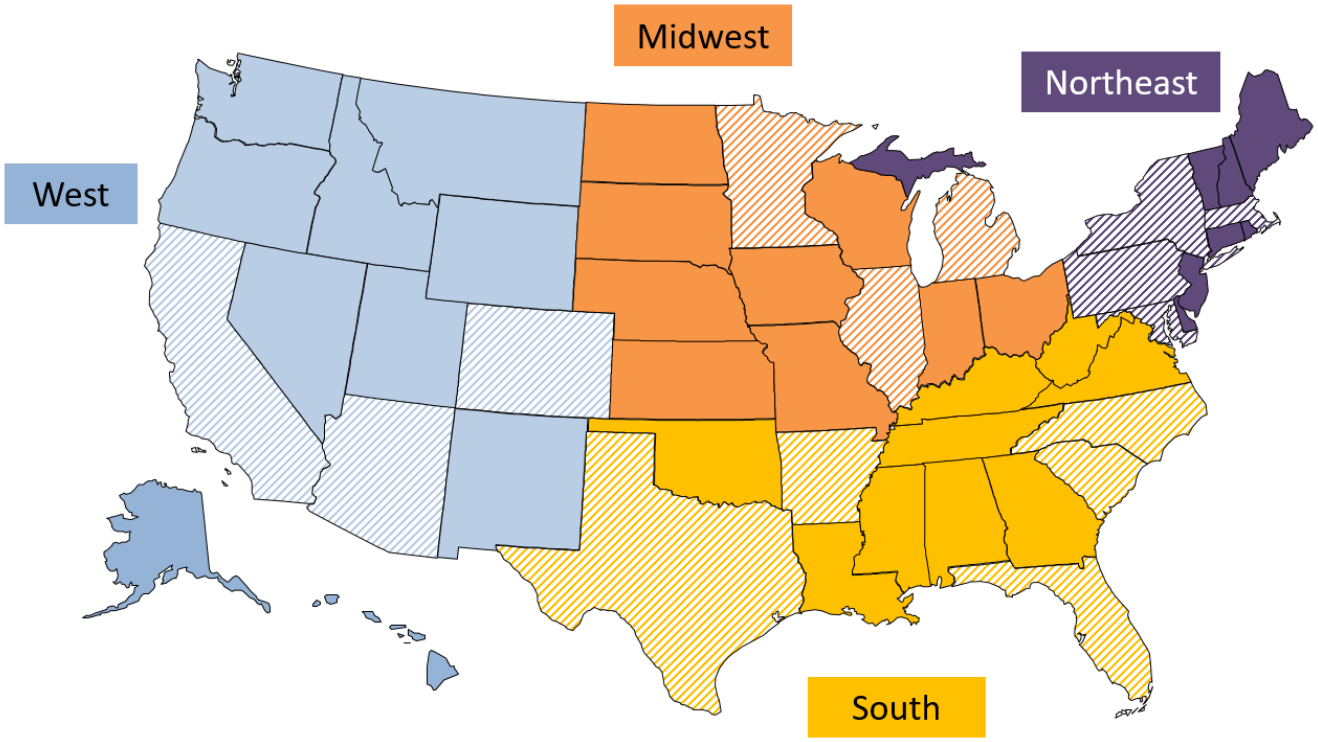
Berkeley Lab studies on Cost of Saving Energy

- Program typology (2013)
- First study on program administrator (PA) cost of saving energy (2014)
  - Natural gas and electric investor-owned utilities (IOUs)
  - Program administrator (PA) cost – cost to utility or third-party administrator
    - This metric does not include any contributions from program participants.
  - Analysis at program level
- Updated analysis for electricity in 2015, including total cost
  - Total cost = PA cost + participant cost contributions
- Most recent electricity analyses for IOUs
  - 116 PAs in 41 states, 2009-2015 (2018 study)
  - Cost of saving peak demand, 9 states, 2014-2017 (2019 study)
- Analysis for publicly owned electric utilities (2019)
  - 111 PAs, representing 219 publicly owned utilities in 14 states, 2012-17
  - Analysis at market-sector level
- Study on cost of saving gas, 12 states, 2012-2017 (2020)

https://emp.lbl.gov/projects/what-it-costs-save-energy

Project Approach

States Included in the 2020 Study



- States were selected based on several characteristics: geographic diversity, quantity of energy efficiency savings, peak demand reduction policy guidance and leveraging prior data collection.
- The 52 utilities/program administrators represent ~60% of annual national spending on energy efficiency and ~59% of peak demand reductions in 2018, based on annual savings reported by utilities to EIA.

Research Approach

- Building on Berkeley Lab's initial research on peak demand reductions from efficiency, collect new data from 15 states for 2014-2018 and add to our Cost of Saving Energy database
  - Program type
  - Program costs
  - Savings by program (kWh and kW)
  - Summer and winter kW recorded, where available
- Calculate CSE and CSPD by state, region and market sector for select efficiency program types
  - CSPD results are based on summer peak. Our sample did not include a winter peaking utility.
- Conduct sensitivity analysis on program costs and peak demand reductions
- Interview state representatives on data collection, quantification, and use of peak demand reductions from efficiency in electricity system planning
  - Interviews and review of PA reports informed our opportunities to improve peak demand reporting

Cost of Saving Electricity and Peak Demand

- We calculate average and median cost of saving electricity and cost of saving peak demand by portfolio and for seven program types.
  - The PA CSE calculation is levelized and takes into account the economic lifetime[1] of the actions taken as a result of a program.
  - In our initial (2019) peak demand report, we calculated first-year PA CSPD (hereafter referred to as *first-year CSPD*) and levelized CSE.

Program Administrator Cost of Saving Electricity *or* Peak Demand =

Capital Recovery Factor * (Program Administrator Costs)

Annual Electricity Savings (in kWh) *or*

Annual Peak Demand Saving (in kW)

where the Capital Recovery Factor (CRF) is:

$$CRF = \frac{r(1+r)^N}{(1+r)^N - 1}.$$

and

r = the discount rate

N = estimated program lifetime in years and calculated as the savings-weighted lifetime of measures or actions installed by participating customers in a program

- In this new study, we calculate the:
  - levelized CSE
  - first-year CSPD
  - ***levelized CSPD***

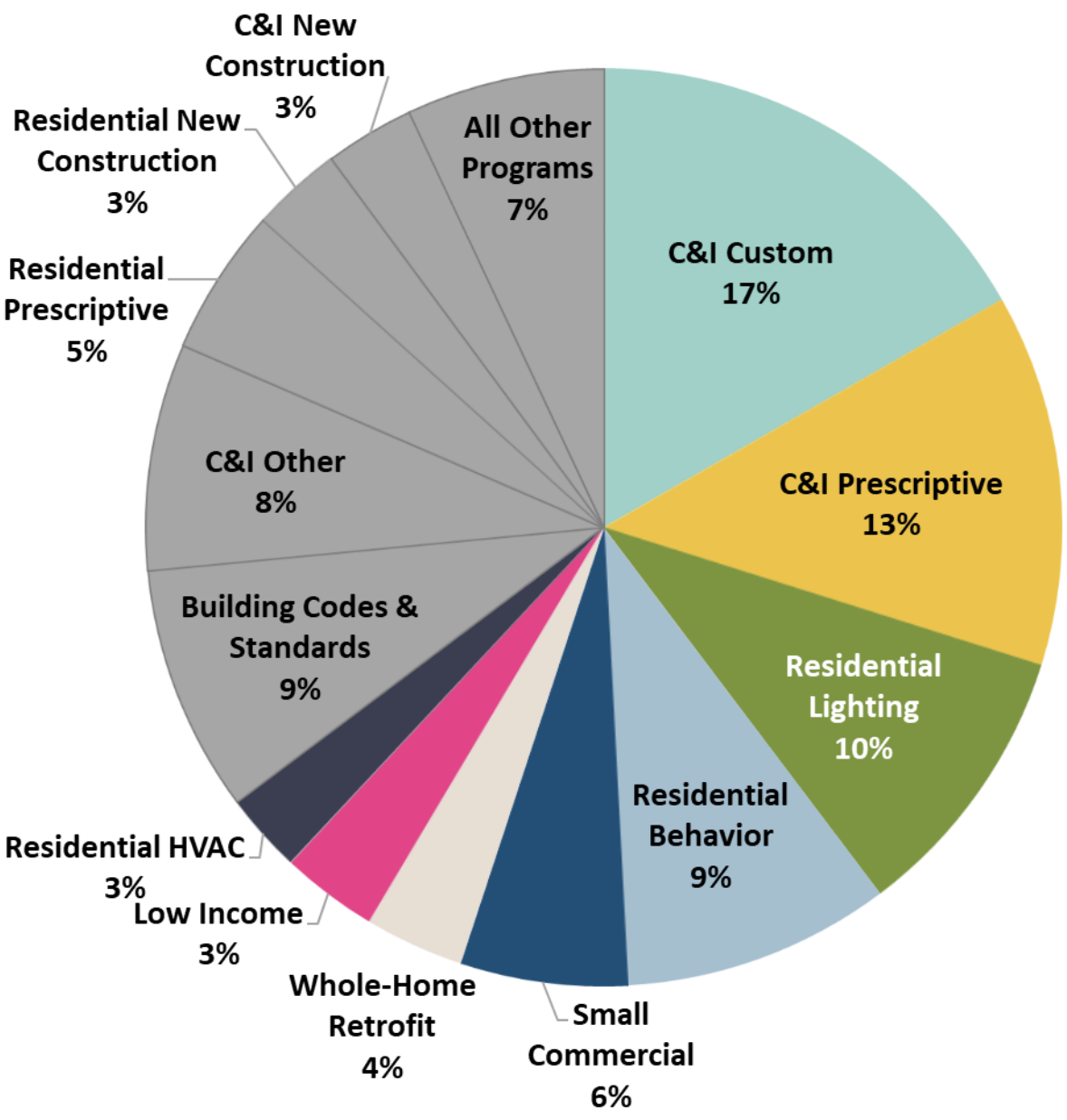
[1] *Measure life used in CSPD calculations in provided in final report.*

Interview Questions

- How does your utility or state define the peak demand period for energy efficiency program savings?
- Is the peak demand period for energy efficiency program impacts different than how the utility or state defines the peak demand period for other purposes (rates, planning)?
- Does your utility or state have a goal or requirement to reduce peak demand with efficiency or other DERs?
- What approach(es) is (are) used to estimate the peak demand savings from energy efficiency programs?
- How often are your estimated peak demand savings from energy efficiency programs updated?
- How are your peak demand savings from efficiency programs verified?
- Are the reported peak demand savings from energy efficiency programs used in utility planning processes?
- Are your peak demand savings used for performance incentives or count towards achieving energy goals?

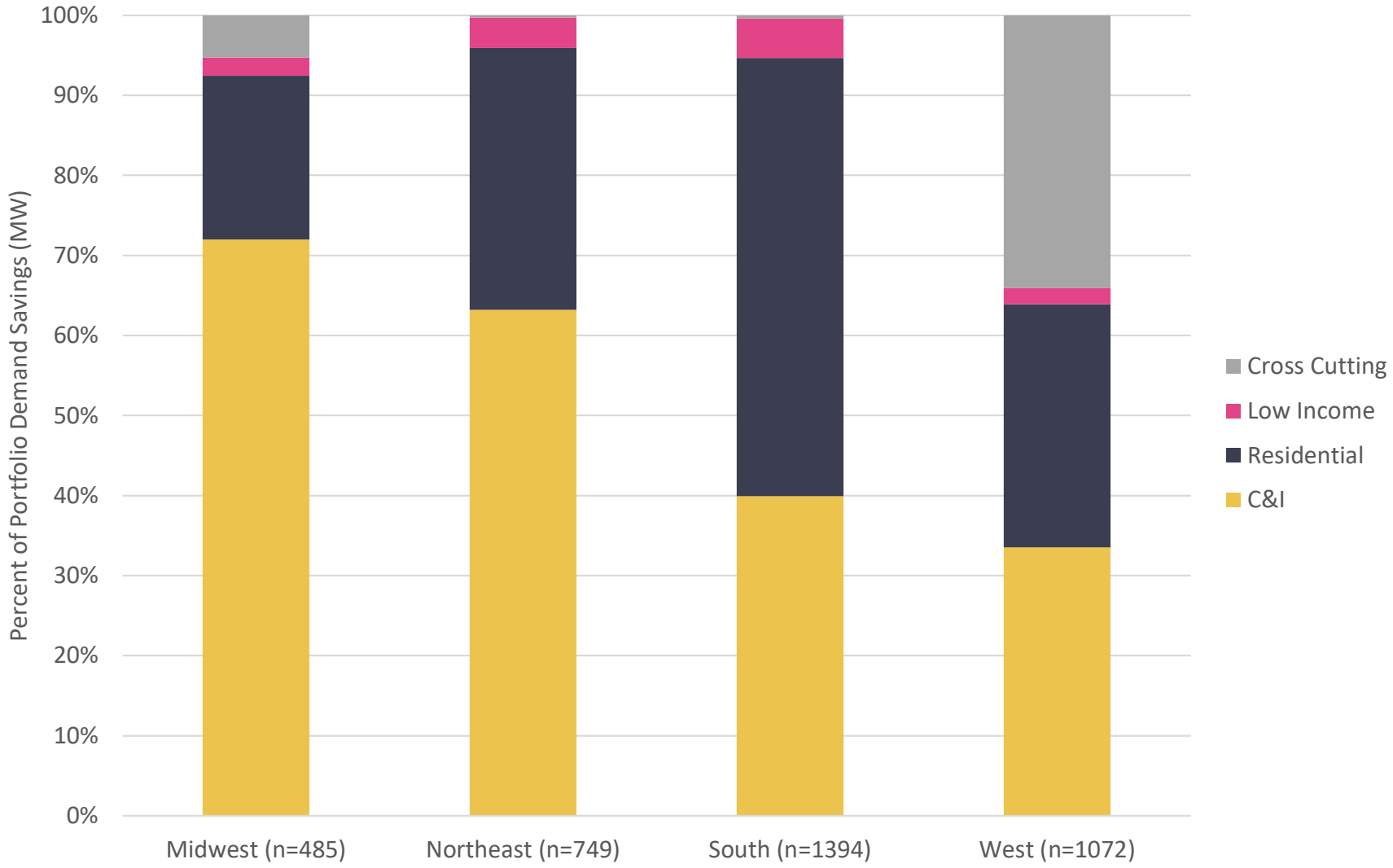
Results: Program Level Peak Demand Impacts

Peak Demand Savings by Program Type for 15 States



- Programs we focused on in our study (in color) represent 68% of peak demand savings for our 52-program administrator sample during the study period (2014-2018)

Peak Demand Savings Vary by Sector and Region



State-level Program Analysis

- To better understand what programs are reducing peak demand the most, we combined demand savings by program across the study period for each state as follows:

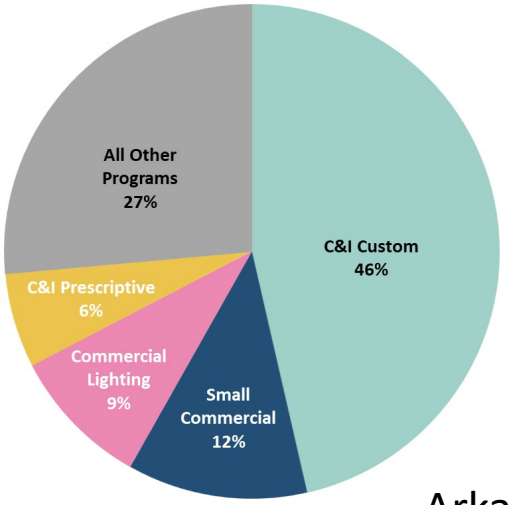
Demand reductions for a specific program type for all PAs in the state for all years of the study period / *All demand reductions for all PAs in the state for all years of the study period*

- The results indicate that program types producing large peak demand reductions as a percentage of portfolio demand reductions vary by state.
- Most programs do not reduce peak demand by a large percentage of total portfolio impacts.
  - For this dataset, the average value is 2.1%, the median is 0.6% and the mode is 0.4%.
- Residential behavioral and custom C&I programs produced the most peak demand reductions in eight of the states included in our study.
- Residential lighting programs account for more than 10% of demand savings in eight states, and commercial lighting programs account for more than 10% of demand savings in six states.

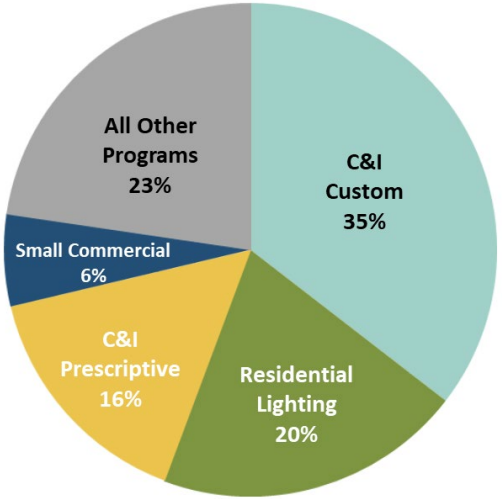
Custom C&I Programs Produced the Largest Peak Demand Savings in Many States Studied

Peak Demand Impact by Program Type as Percentage of Portfolio, All Years

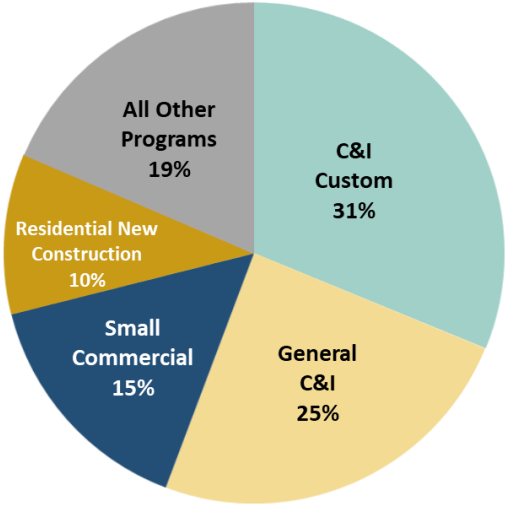
Illinois



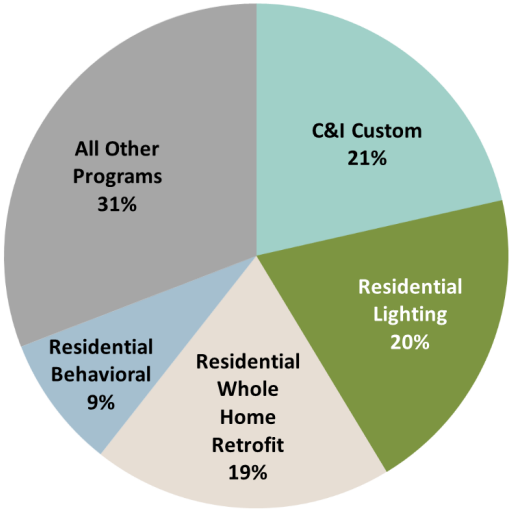
Michigan



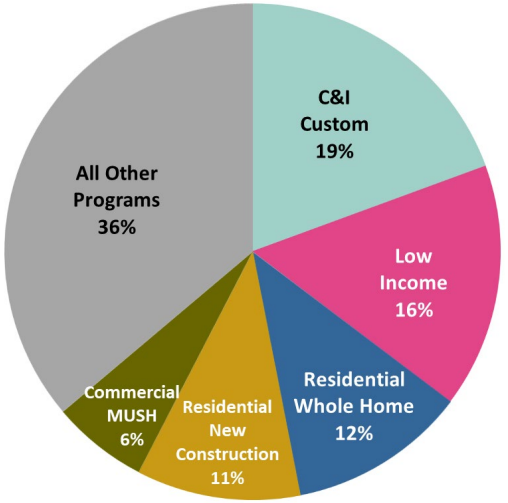
New York



Arkansas



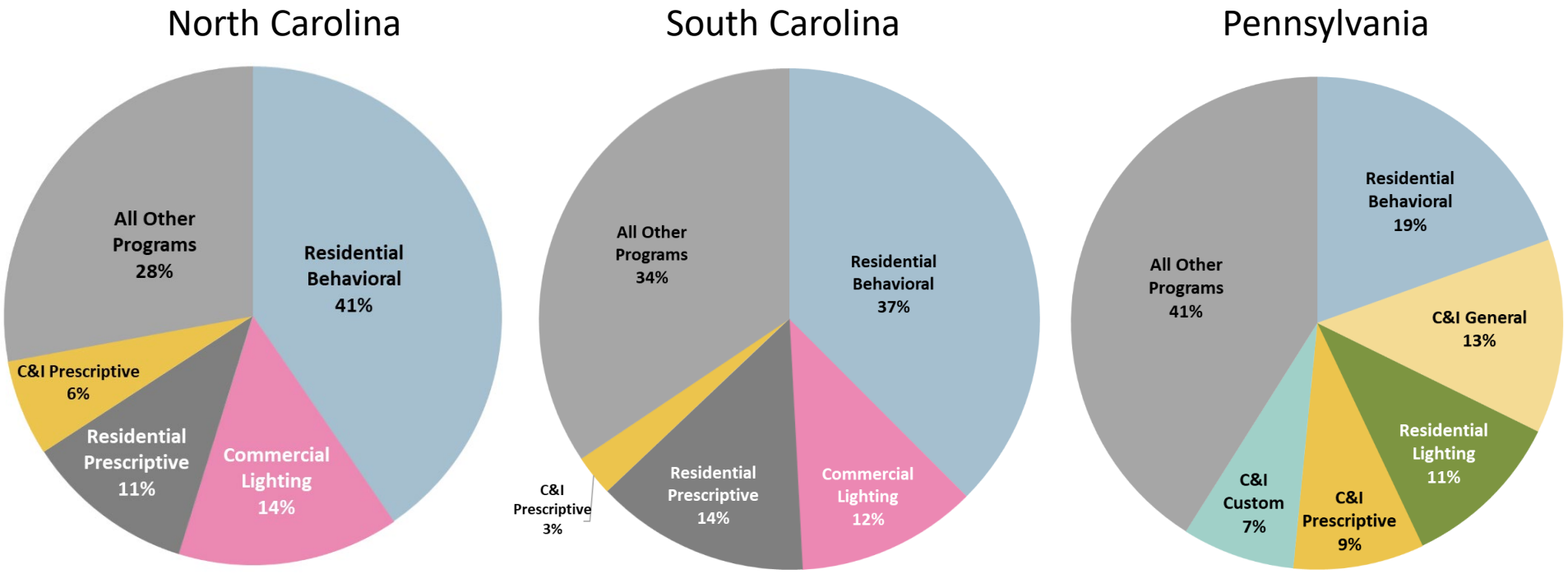
Texas



MUSH – Municipal, universities, state, hospitals

Residential Behavioral Programs Produced the Most Peak Demand Savings in Three States Studied

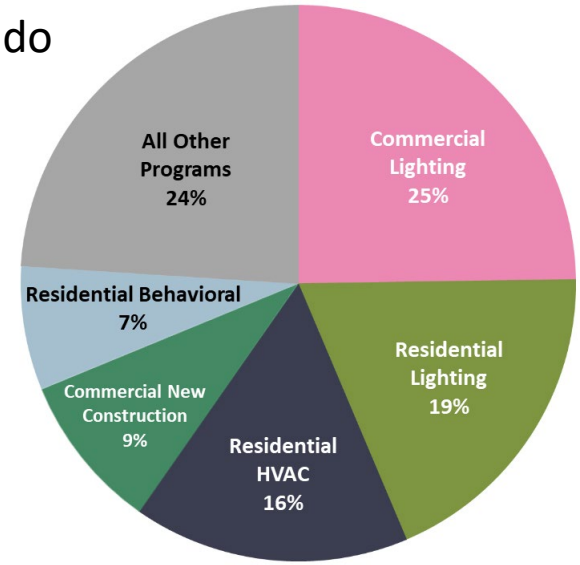
Peak Demand Impact by Program Type as Percentage of Portfolio, All Years



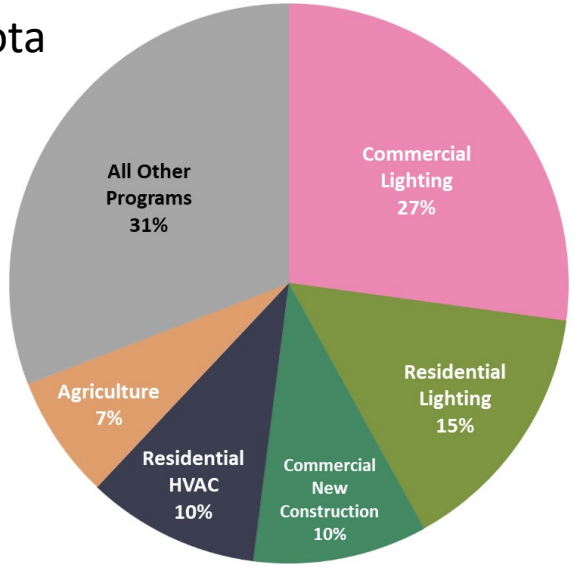
Commercial and Residential Lighting are Significant Drivers of Peak Demand Savings

Peak Demand Impact by Program Type as Percentage of Portfolio, All Years

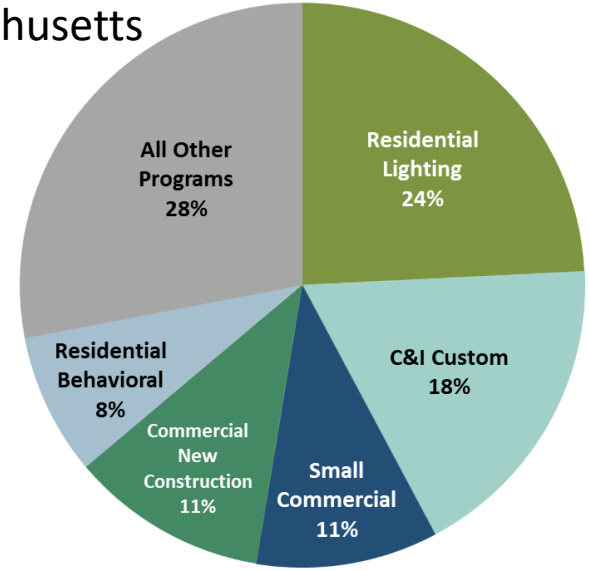
Colorado



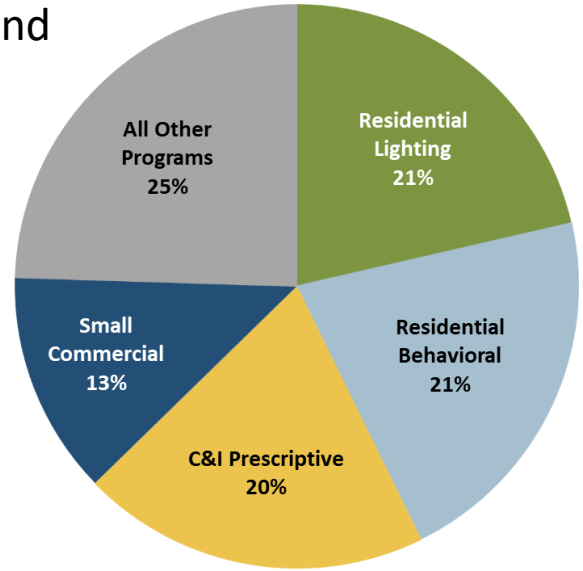
Minnesota



Massachusetts

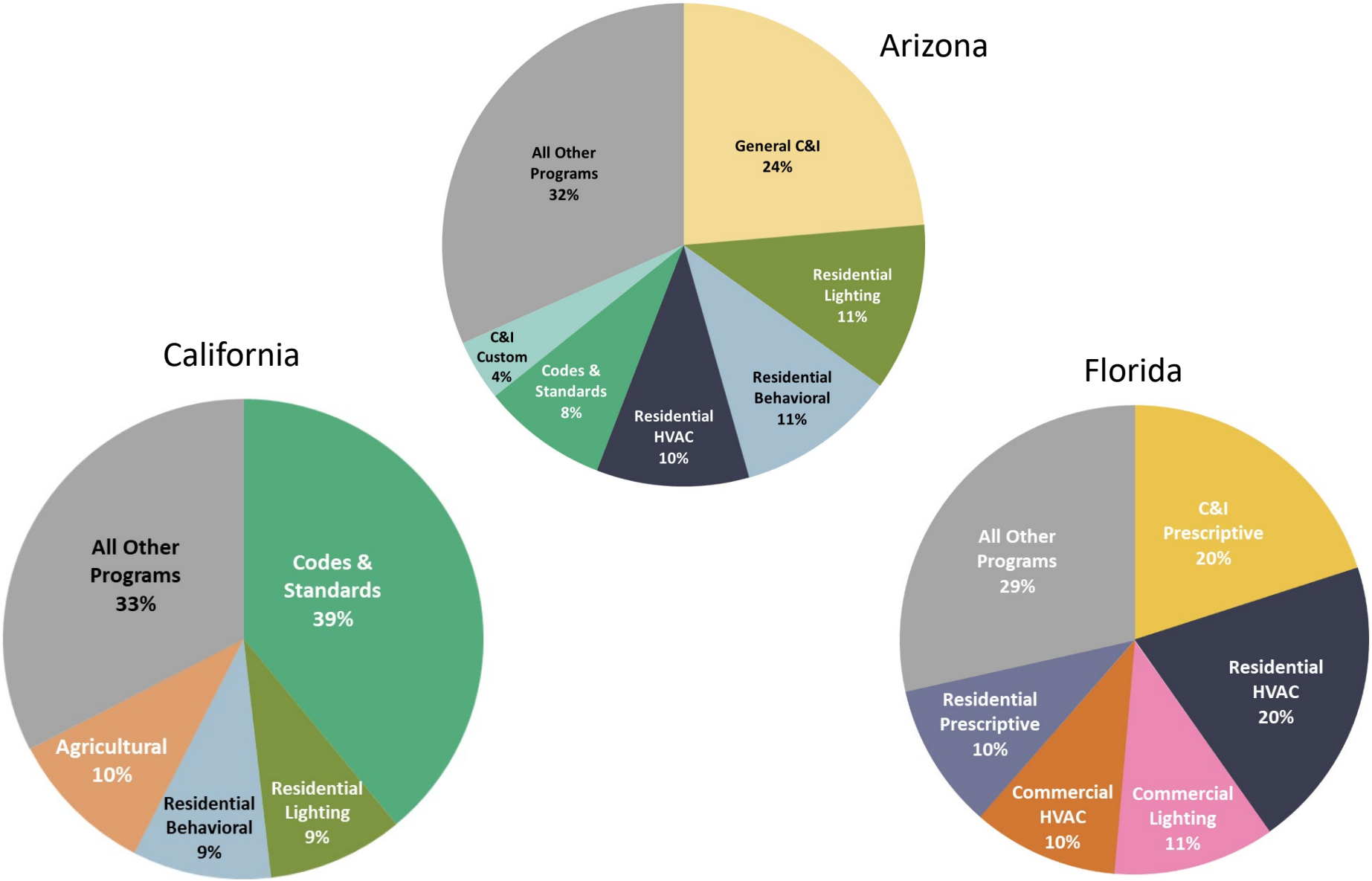


Maryland



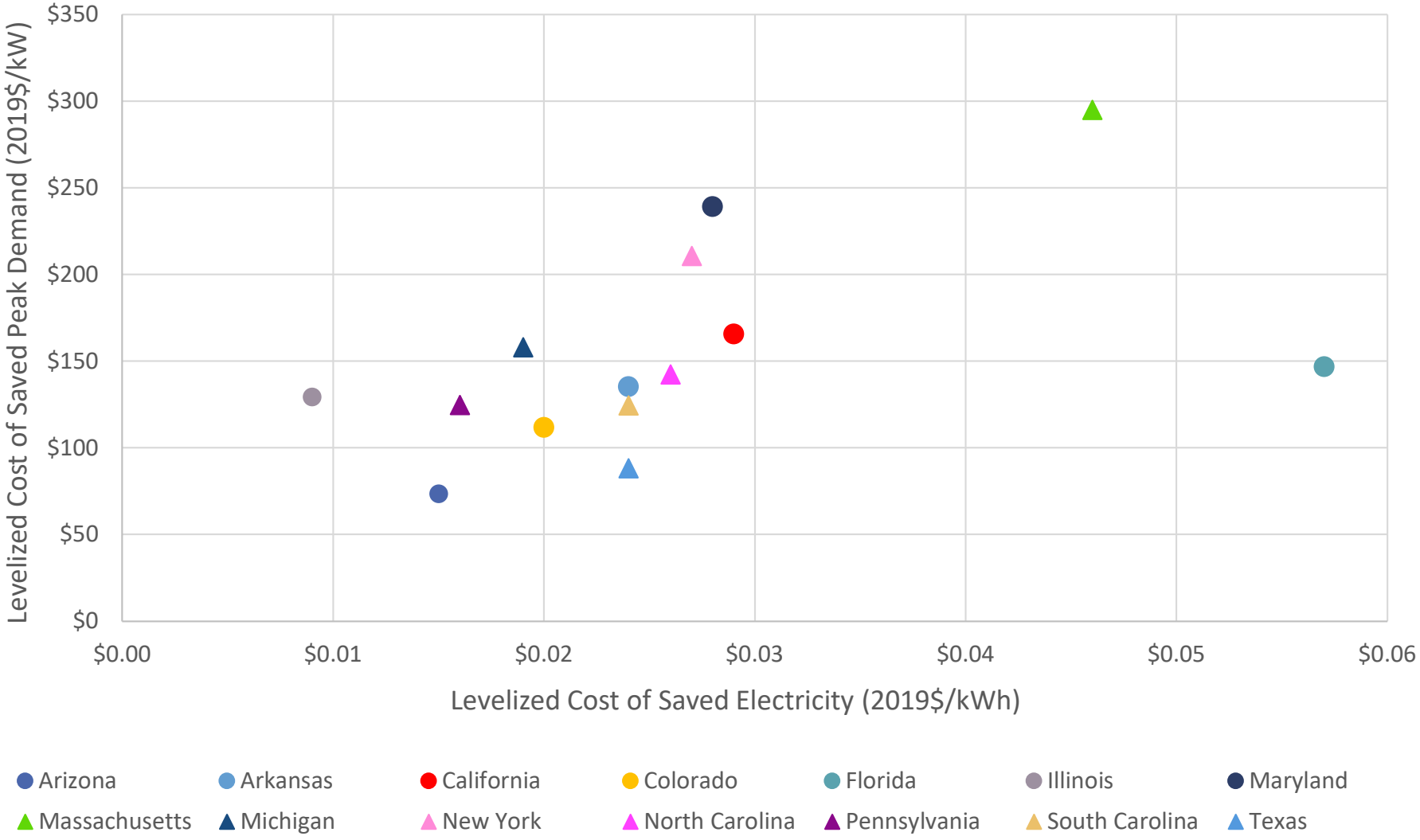
In a Few States, Some Programs Achieved Notably Higher Peak Demand Savings than in Other States

Peak Demand Impact by Program Type as Percentage of Portfolio, All Years

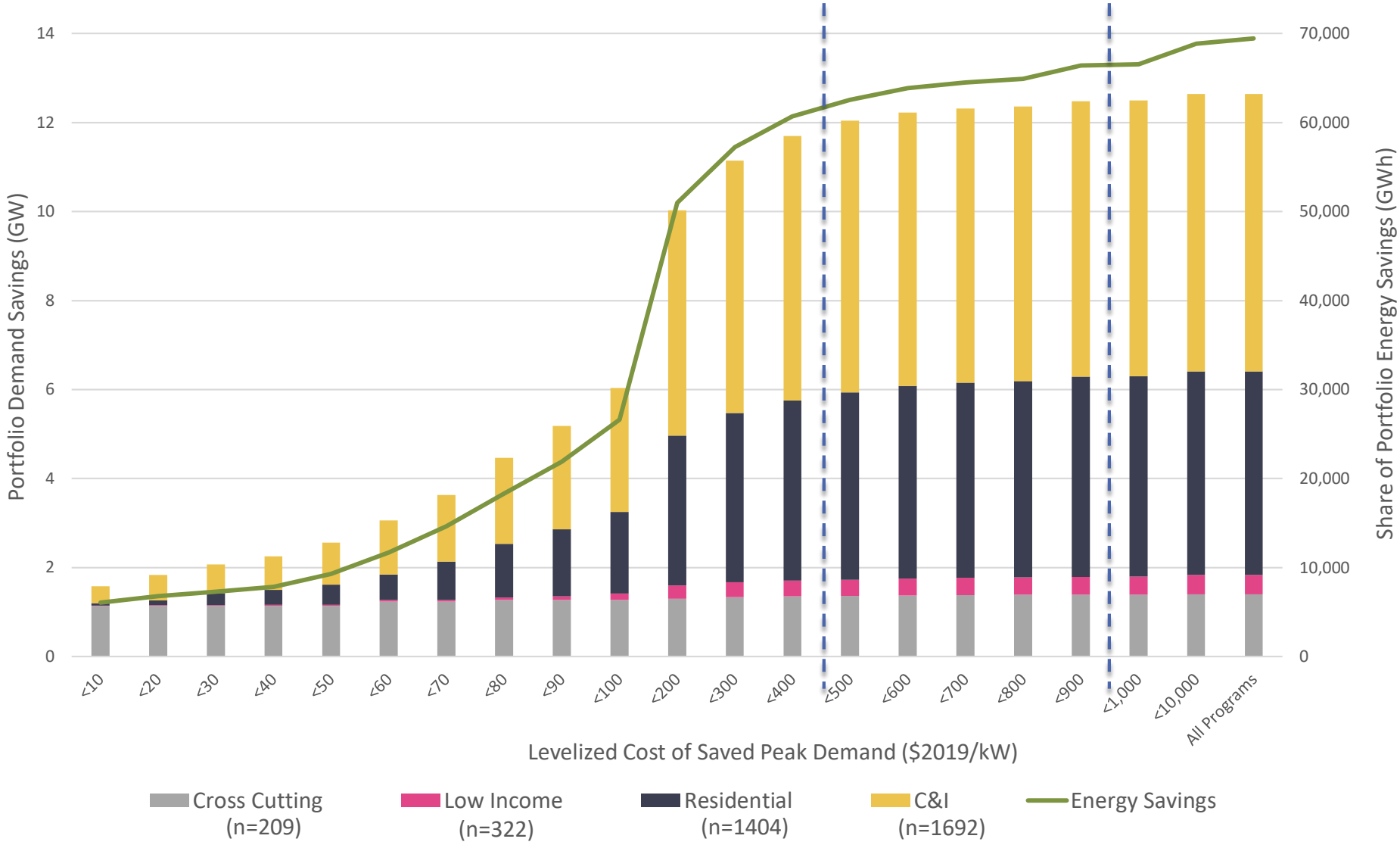


Results: CSPD and CSE by State, Market Sector and for Select Programs

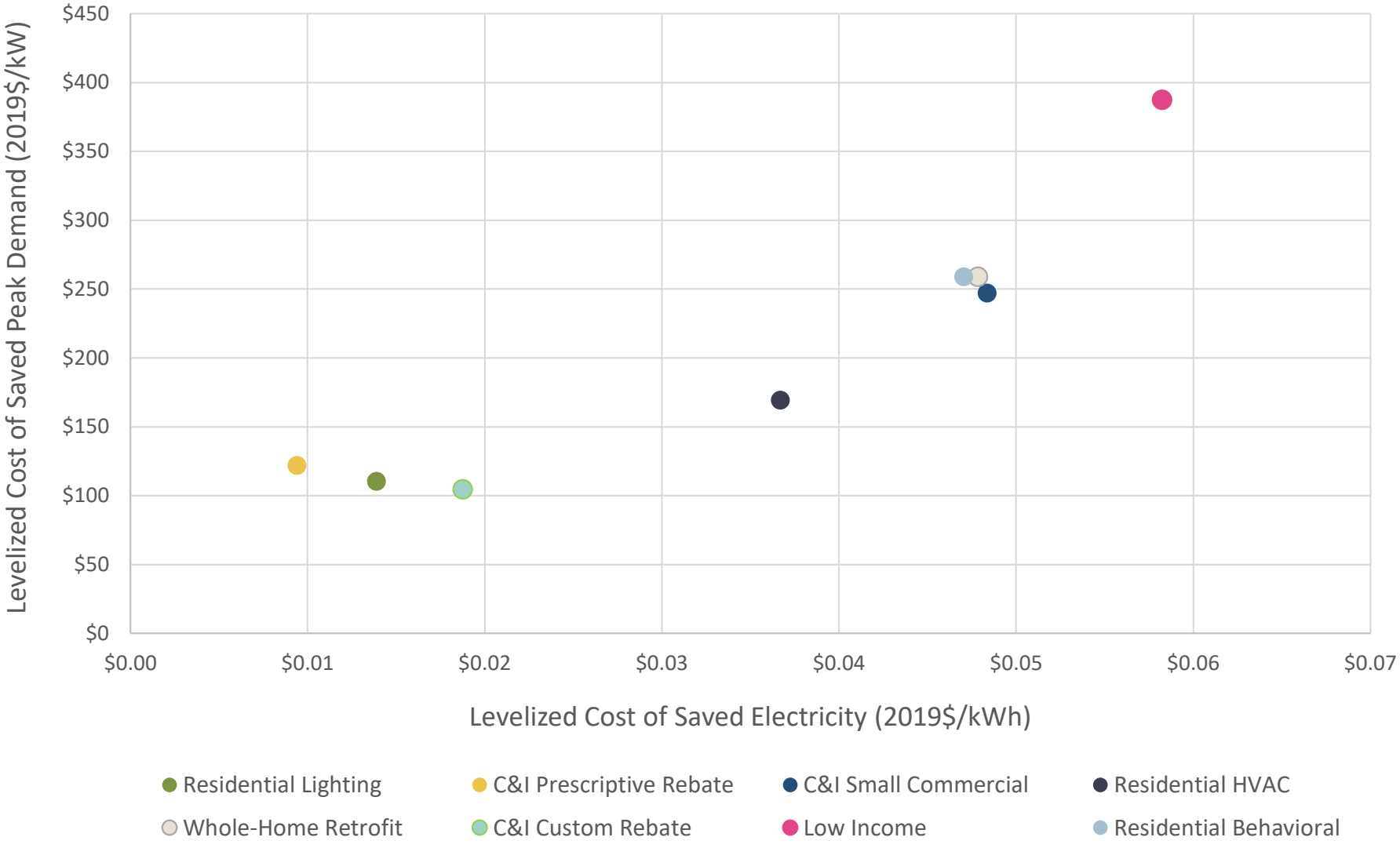
Levelized CSPD and CSE, by State



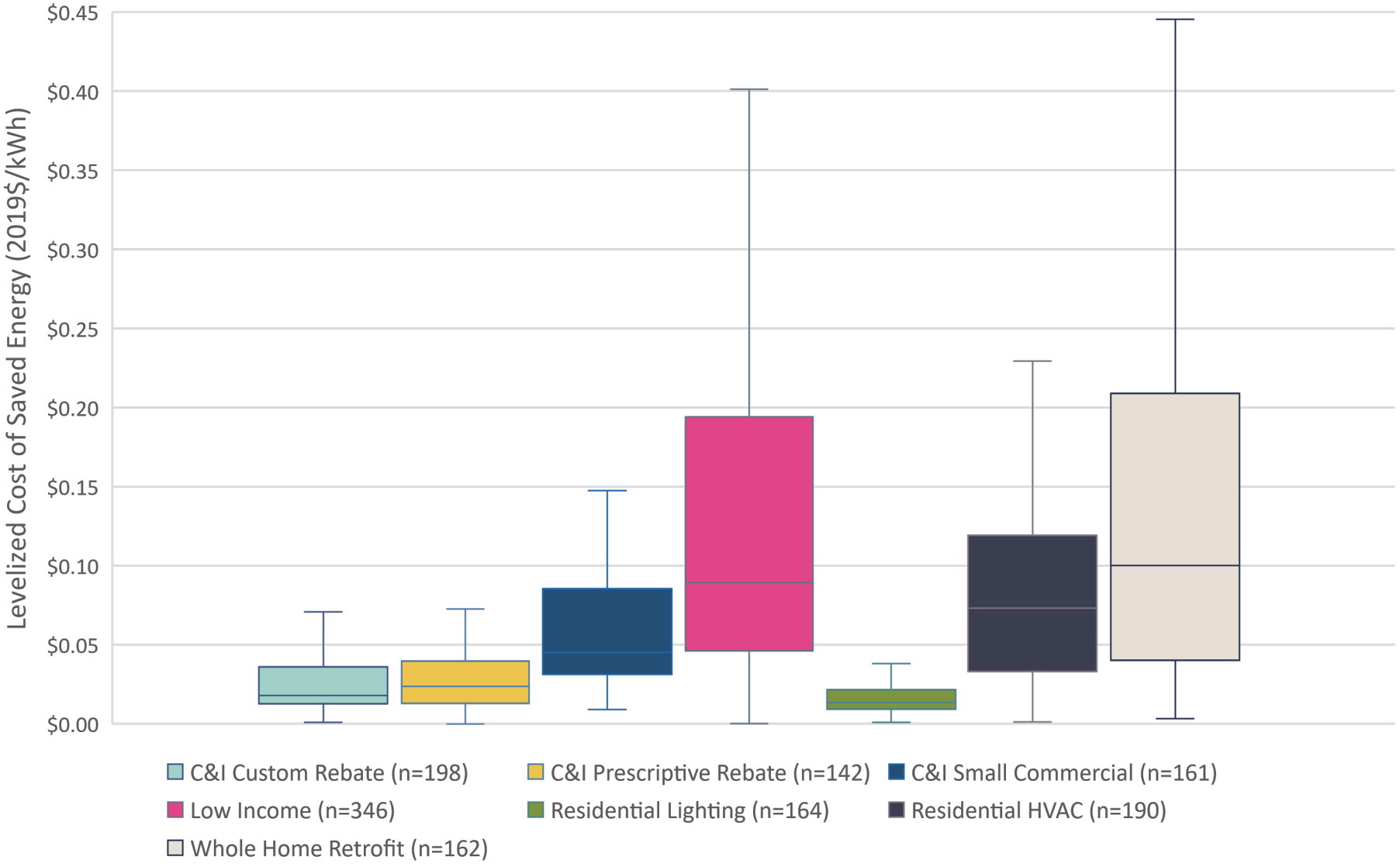
Distribution of Peak Demand and Energy Savings, by Levelized CSPD Bin and Market Sector



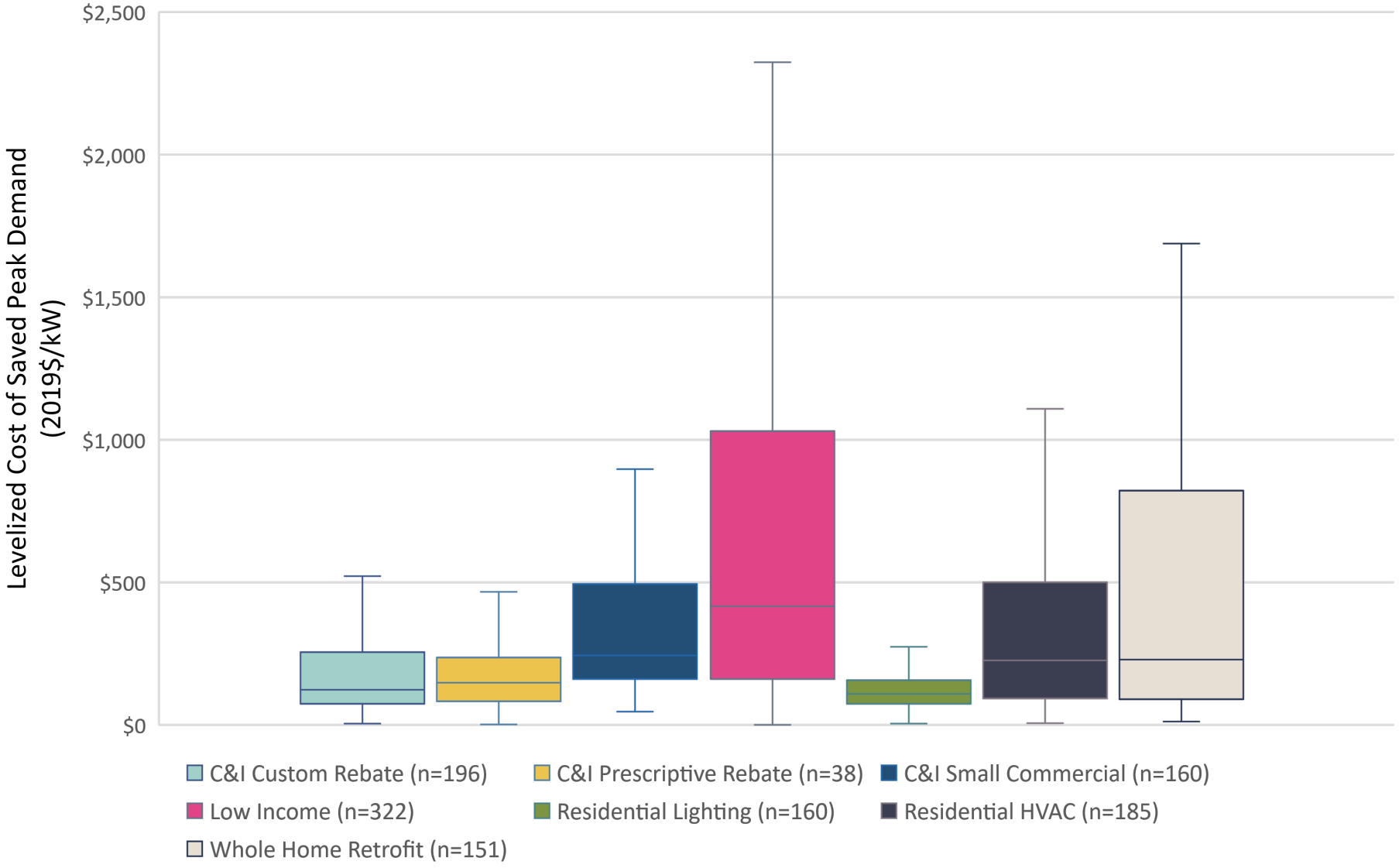
CSPD and CSE for Select Programs



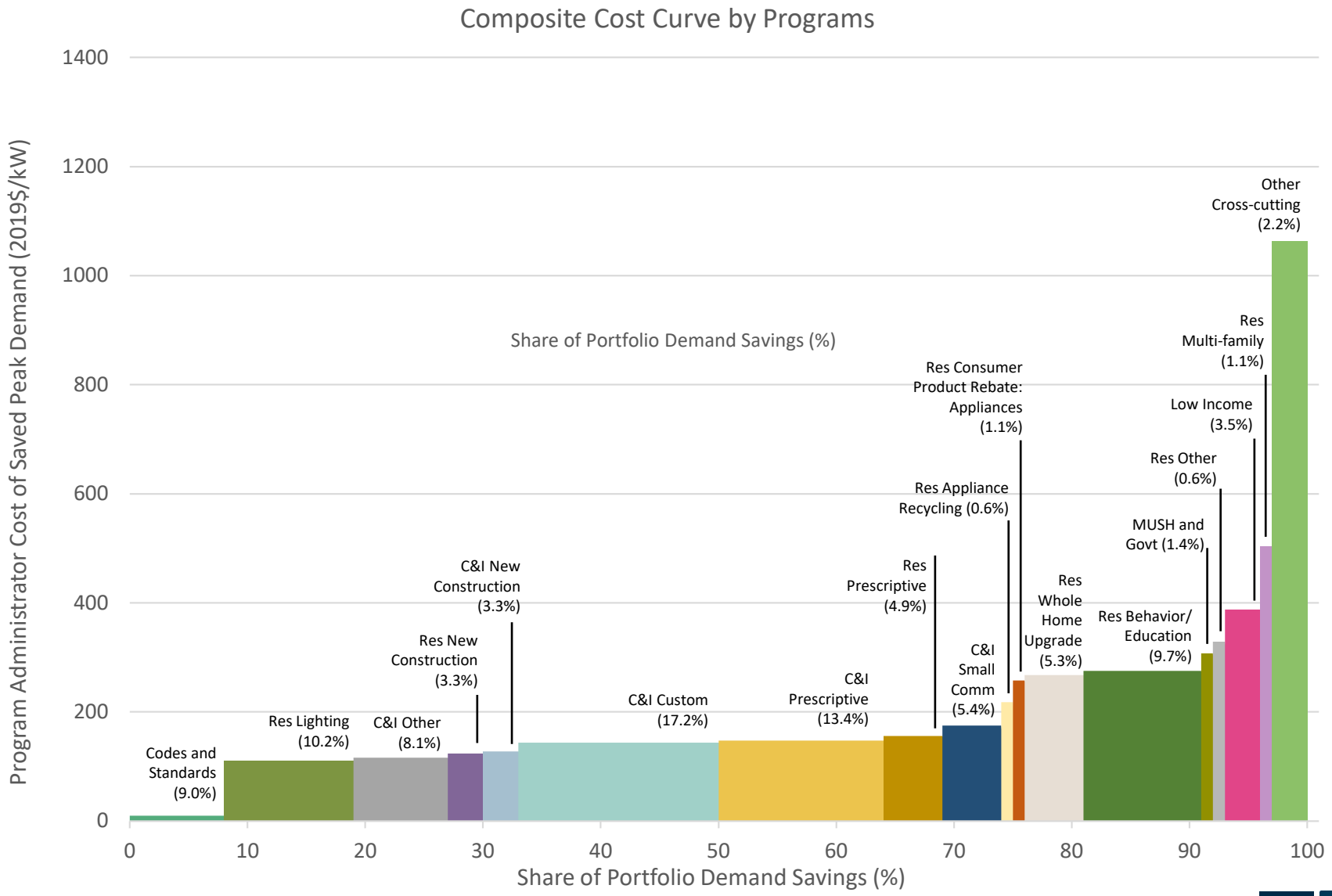
Median Value and Interquartile Range for Levelized CSE for Select Efficiency Programs



Median Value and Interquartile Range for Levelized CSPD for Select Efficiency Programs

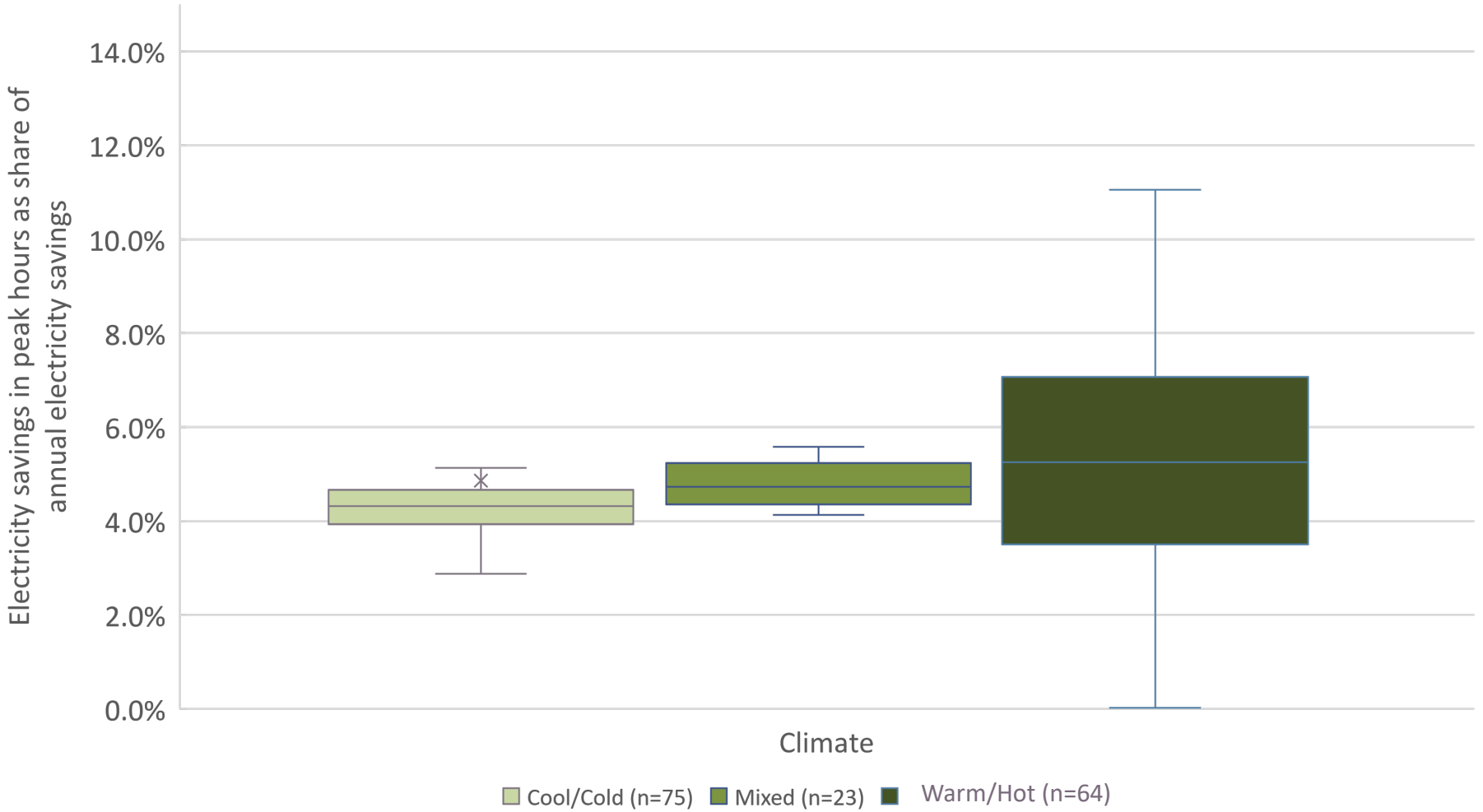


Program Cost for Cost of Saving Peak Demand



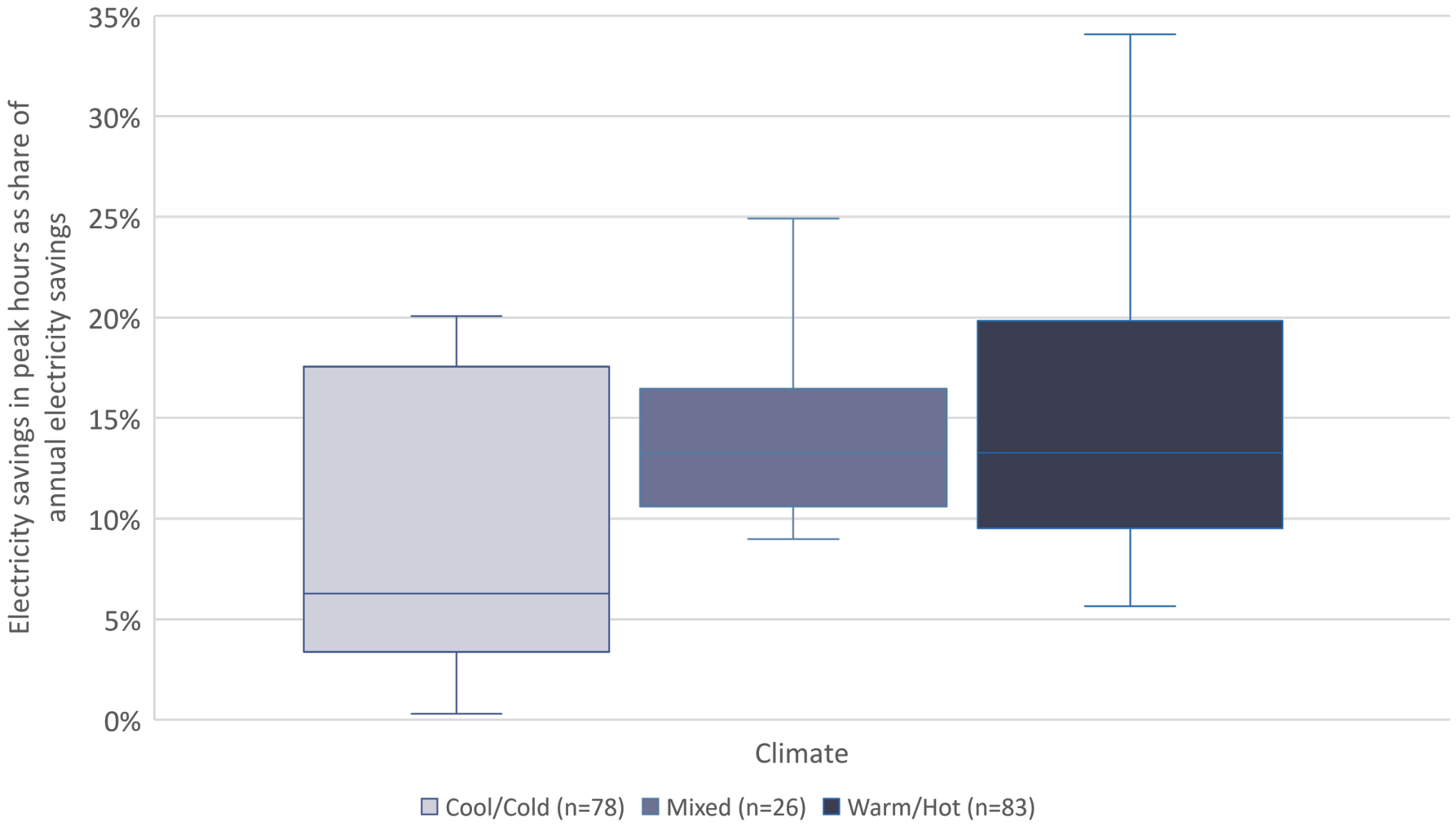
Results: CSPD Using a Standard Peak Period

Residential Lighting Programs: Ratio of Peak to Annual Electricity Savings *Using Standard Peak Period*

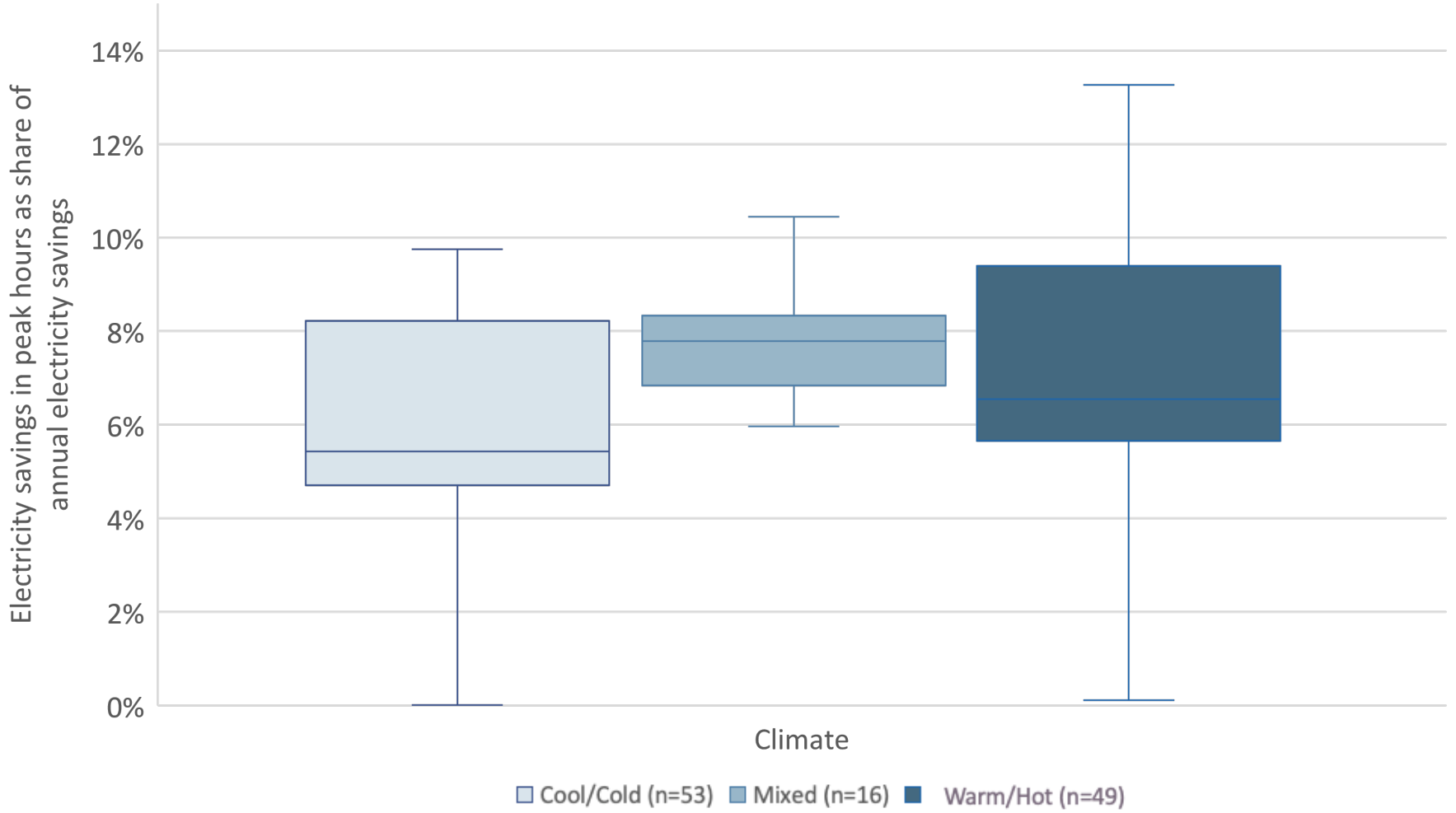


Climate zone source: ASHRAE 2017.

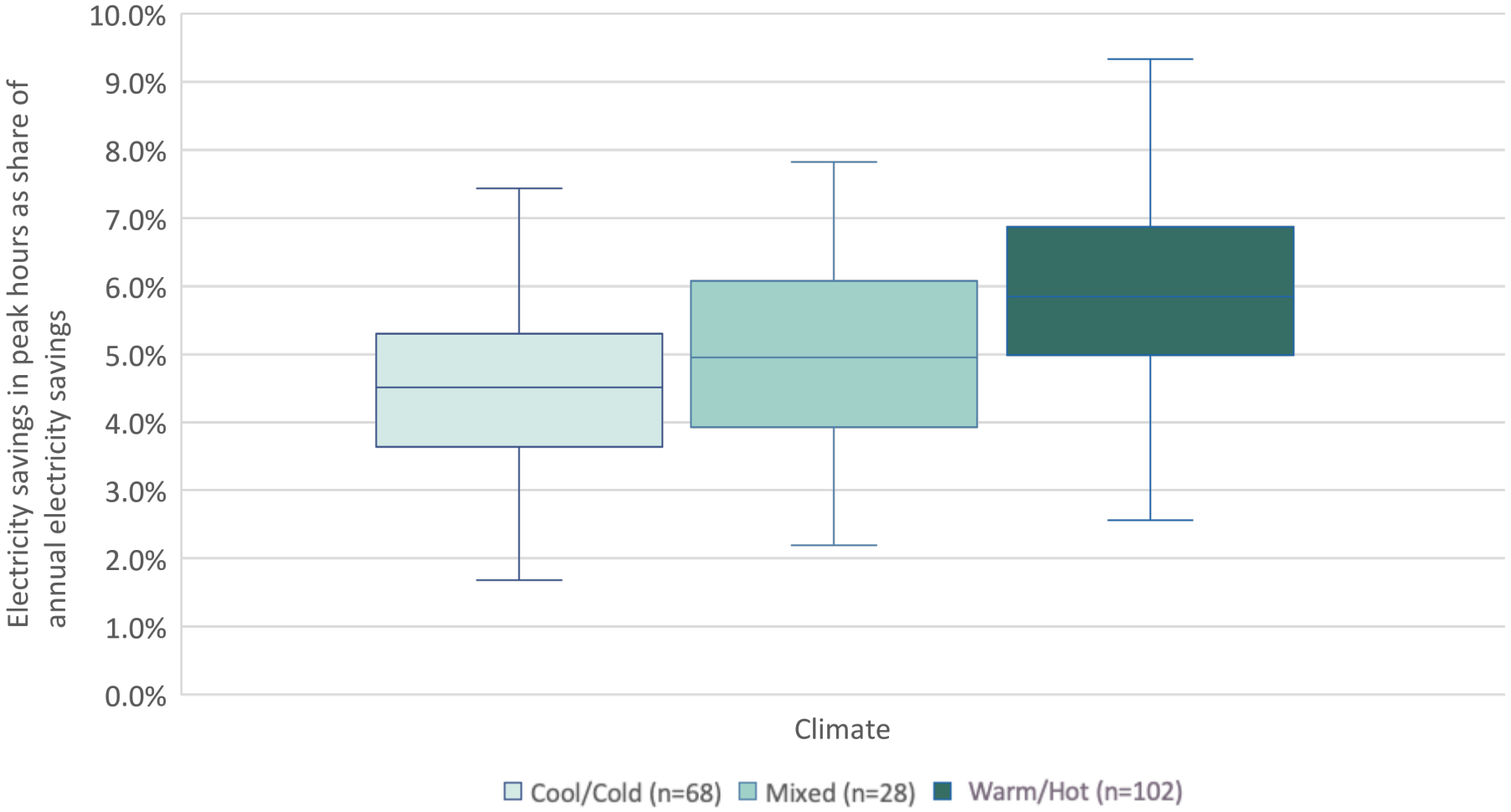
Residential HVAC Programs: Ratio of Peak to Annual Electricity Savings *Using Standard Peak Period*



Residential Behavioral Programs: Ratio of Peak to Annual Electricity Savings *Using Standard Peak Period*



C&I Custom Programs: Ratio of Peak to Annual Electricity Savings *Using Standard Peak Period*



Opportunities to Improve and Standardize Peak Demand Reporting

Program Characteristics and Metrics (1)

- Berkeley Lab established a typology for energy efficiency programs in 2013.
  - A common categorization of program types and definitions of metrics that define program characteristics and performance are necessary to compare efficiency program data across states and better understand trends in sector and program level savings.
  - The Consortium for Energy Efficiency and some states use this typology.
- We identified two key concerns when collecting peak demand savings data for energy efficiency programs.
  - Peak demand periods are often not defined.
    - The peak period definition can be challenging to locate in efficiency program documentation. The relationship between the energy efficiency peak period and the electricity system peak is rarely discussed. (See CPUC 2018 for an example of the peak period being linked to resource adequacy.)
  - Data are not reported in a consistent manner.
    - Some utilities do not report peak demand savings for all or some of their energy efficiency programs, often without explaining why.
    - Some utilities report summer or winter peak demand or both; others do not specify a season.
- We created a typology for utilities and other energy efficiency PAs to better understand peak demand reductions from energy efficiency programs, including key characteristics and metrics for defining peak demand savings.

Program Characteristics and Metrics (2)

- Clear documentation and reporting of the following five program characteristics will improve comparisons of peak demand reductions from efficiency programs across utilities and geographic regions.

1. Program impacts
   - *What approach is used to estimate or measure peak demand savings (e.g., engineering/deemed, metered)? If applicable, what is the source of the estimate? How frequently are peak demand savings estimates updated?*
   - Metrics
     - Peak period definition (for both summer and winter, if applicable) used to determine program impacts, and whether the impacts are the average over the period or the peak during the period.
       - Peak period start hour
       - Peak period end hour
       - Peak period start month
       - Peak period end month
     - Gross peak demand savings
       - Summer kW
       - Winter kW
   - This information will help PAs and electricity system planners understand the robustness of the reported peak demand impacts.

Program Characteristics and Metrics (3)

2. Contribution to resource adequacy and meeting infrastructure needs
   - *Do efficiency peak period definition(s) align with other system planning peak definitions (e.g., ISO/RTO, distribution system peak)?*
   - *Are peak demand impacts reported in energy efficiency documentation used in electricity system planning processes such as integrated resource planning and distribution system planning?*
   - Metric – Document peak demand impacts, using a clear and consistent definition, in all relevant electricity system planning processes.
   - This information will help PAs and system planners understand how the reported impacts contribute to resource adequacy of the bulk power system and distribution system infrastructure needs.
3. Contribution to state energy or utility/PA goal
   - *Do peak demand reductions from efficiency programs contribute to state energy goals or program administrator performance incentives (e.g., energy efficiency resource standards, peak demand reductions, air pollutant emissions reductions)?*
   - Metric – Identify contribution, in capacity (kW) or air pollutant emissions reductions (e.g., tons, ppm), toward achieving state or utility energy, capacity or emissions reduction goals.
   - This information provides important context for program impacts.

Program Characteristics and Metrics (4)

4. Motivation
   - *What is the driver for the energy efficiency program (e.g., reduce peak demand or reduce energy savings, meet all cost-effective requirement, reduce air pollutant emissions)?*
   - Metric - Stated driver for the program or portfolio in state law or PUC order, or stated goal of the program in a planning process.
   - This information will help PAs understand if programs designed to reduce peak demand are achieving their goal.
5. Demand Flexibility
   - *How can technologies included in an energy efficiency program provide dispatchable savings to contribute to demand flexibility as utility system peak periods shift over time?*
   - Metric – Document technologies included in the program that provide demand flexibility in PA reporting.
   - This information will help identify the cost and value of efficiency programs that provide demand flexibility.

Example of Standardized Peak Demand Reporting: Acme Electric Company Residential Lighting Program

Key Characteristic	Description	Metric
Program impacts	Engineering calculations are used to determine the peak demand reductions. The coincidence factor is derived from a lighting meter study for the utility in 2016. The next evaluation, measurement and verification update for this program is in Q4 2020. Savings are calculated as the average reduction during the peak period.	The utility only measures summer peak savings. • Peak period start hour: 2 p.m. • Peak period end hour: 6 p.m. • Peak period start month: June 1 • Peak period end month: September 30 • Program savings in CY19 were 25 MW
Contribution to resource adequacy and meeting infrastructure needs	• Program savings align with the ISO's passive demand resource performance period. • The peak demand reductions reported are not used in the utility's distribution system planning because the utility's distribution system peak does not align with the ISO's system peak. • Peak demand reductions from efficiency are estimated on an ad hoc basis in distribution system planning. See docket XX-XXXX.	
Contribution to state energy or utility/PA goal	The utility does not have a capacity reduction goal. The energy savings associated with the efficiency programs contribute to the utility's energy reduction goal and associated performance incentive. The Commission recently approved use of active demand measures in the energy efficiency program and a demand reduction goal and associated performance incentive is the subject of ongoing discussion. Peak demand reductions from energy efficiency programs contribute to the state's Clean Energy Standard. Efficiency produces a 0.01 ton per kWh saved emissions reduction.	
Motivation	The residential lighting program was established in 2004 to help residential consumers reduce their electricity bill. The program did not explicitly seek to produce peak demand reductions. The demand reductions associated with the program are included in the cost-benefit analysis of the program.	
Demand Flexibility	The residential lighting program measures include dimmable bulbs but not controls at this time. The multi-family, small commercial and prescriptive commercial lighting programs all contain occupancy sensor measures and lighting control measures.	

Potential Future Analysis

Potential Future Analysis

- *Reporting template and guidance documents.* Build on Berkeley Lab tools for data collection and reporting on efficiency program costs and savings (Rybka et al. 2015) to provide templates for states, utilities, and other program administrators to improve reporting on peak demand savings and costs. In particular, we could collaborate with state PUCs, investor-owned and public power utilities, and stakeholders to develop guidance for consistent methods to define peak periods and calculate and report peak demand savings.
- *Broaden data collection to include demand response programs.* Expand CSPD data collection to include utility demand response data for one region (e.g., MISO). To better understand the full picture of demand response savings this research would also identify the ISO/RTO demand response offerings and, if available, collect program cost and impact information. This research would explore the ability to aggregate demand response program data from utilities and ISO/RTOs for comparison and quantify the CSPD for both program types if possible.
- *Bigger and more diverse sample.* Collect and analyze data on peak demand savings for efficiency programs from additional states to *provide broader geographic* representation, larger sample size, more diversity and greater confidence in results. Additional data collection could focus on PAs with winter peaking systems. Our analysis thus far has focused on the cost of saving peak demand for summer peaking utilities.
- *Additional program specific analysis.* Focus program specific analysis on programs that have many measures but produce significant peak demand reductions (e.g., C&I custom, C&I general) to better understand what measures or end-uses are driving reductions. A case study approach could be used for a subset of PAs.

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