

The Case for Cx: Updated Landmark Study Shows Evolution of Cx Costs & Benefits 2004-2018

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Prior Cx Cost Benefit Studies

THE COST-EFFECTIVENESS OF COMMERCIAL BUILDINGS COMMISSIONING A Meta-Analysis of Existing Buildings and New Construction in the United States

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An electronic version of this document and data forms are available at
<http://eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html>

Building Commissioning A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions

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Report Prepared for:
California Energy Commission
Public Interest Energy Research (PIER)

July 21, 2009

For a downloadable version of the report and supplementary information, visit:
<http://cx.lbl.gov/2009-assessment.html>

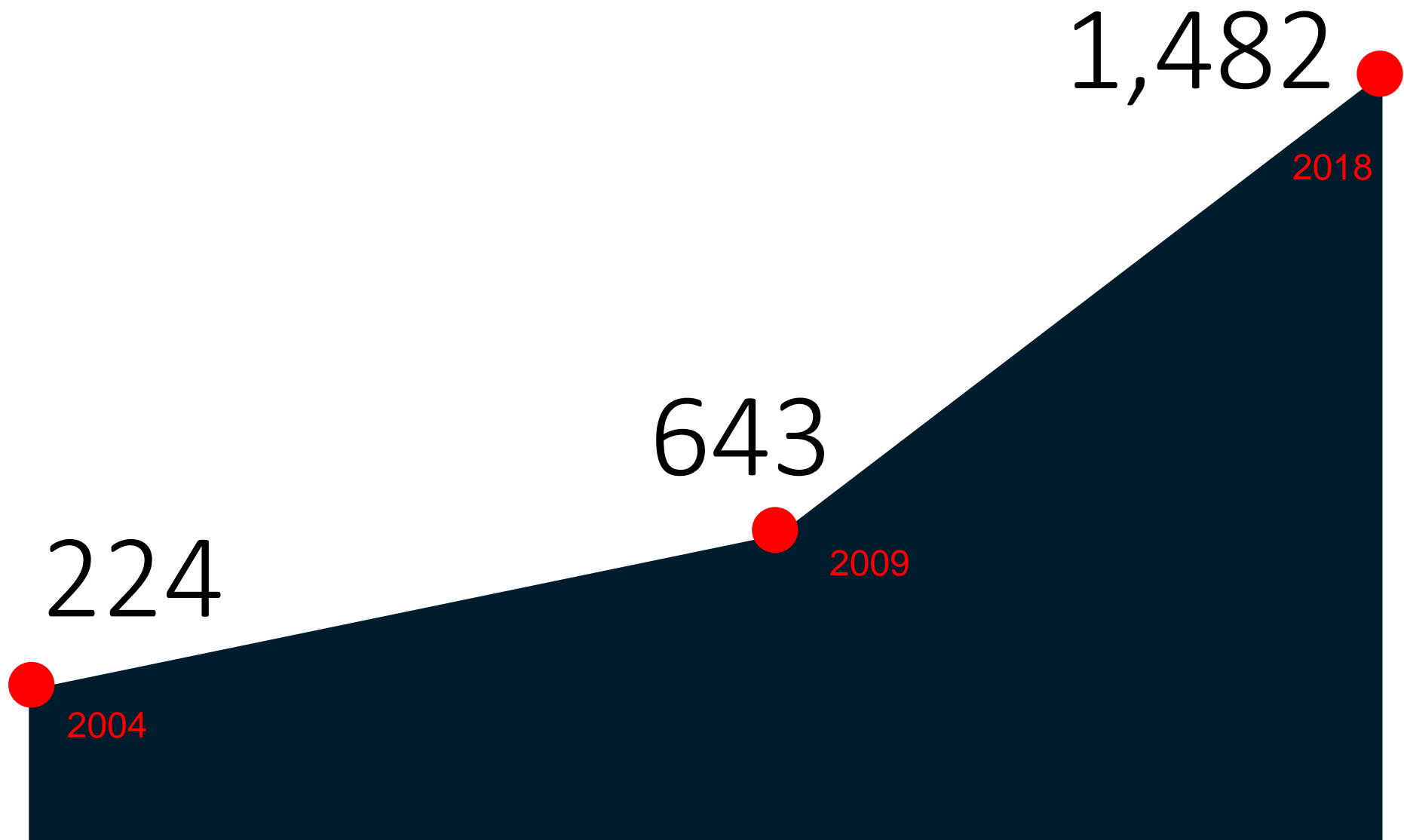
Sponsored by the California Energy Commission, Public Interest Energy Research Program, through the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Acknowledgements

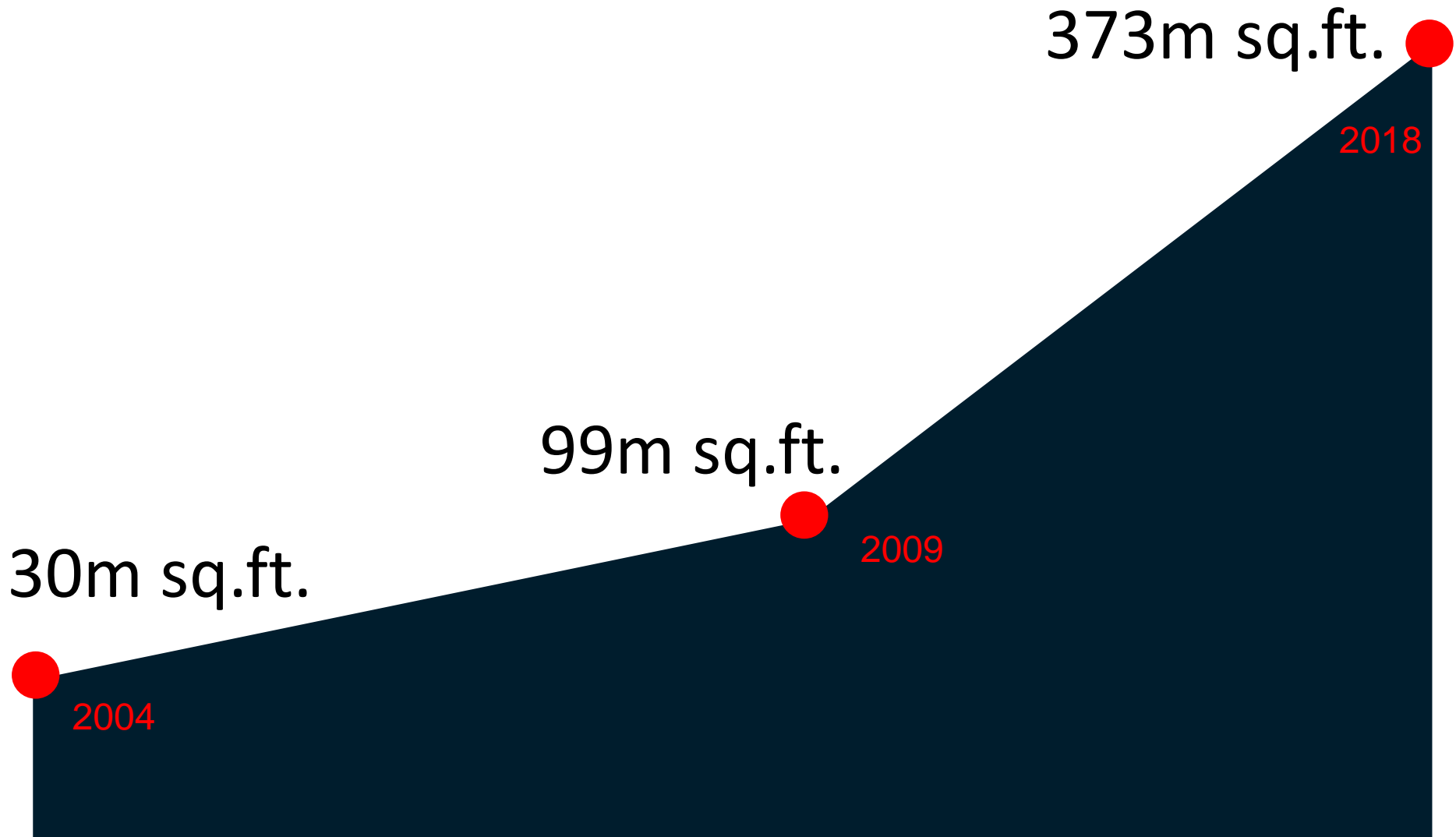
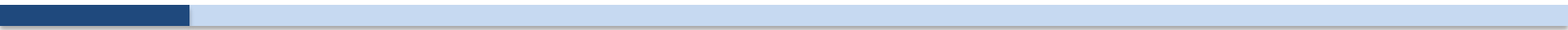
- Study funding
 - U.S. Department of Energy
- Berkeley Lab Team
 - Jessica Granderson
 - Eliot Crowe
 - Evan Mills
 - Claire Curtin
- Data providers for the study include:
 - Building Commissioning Association
 - ComEd
 - BC Hydro
- Support for data analysis review
 - Building Commissioning Association
- Complementary market survey
 - Building Commissioning Association



Number of Buildings in Study (cumulative)

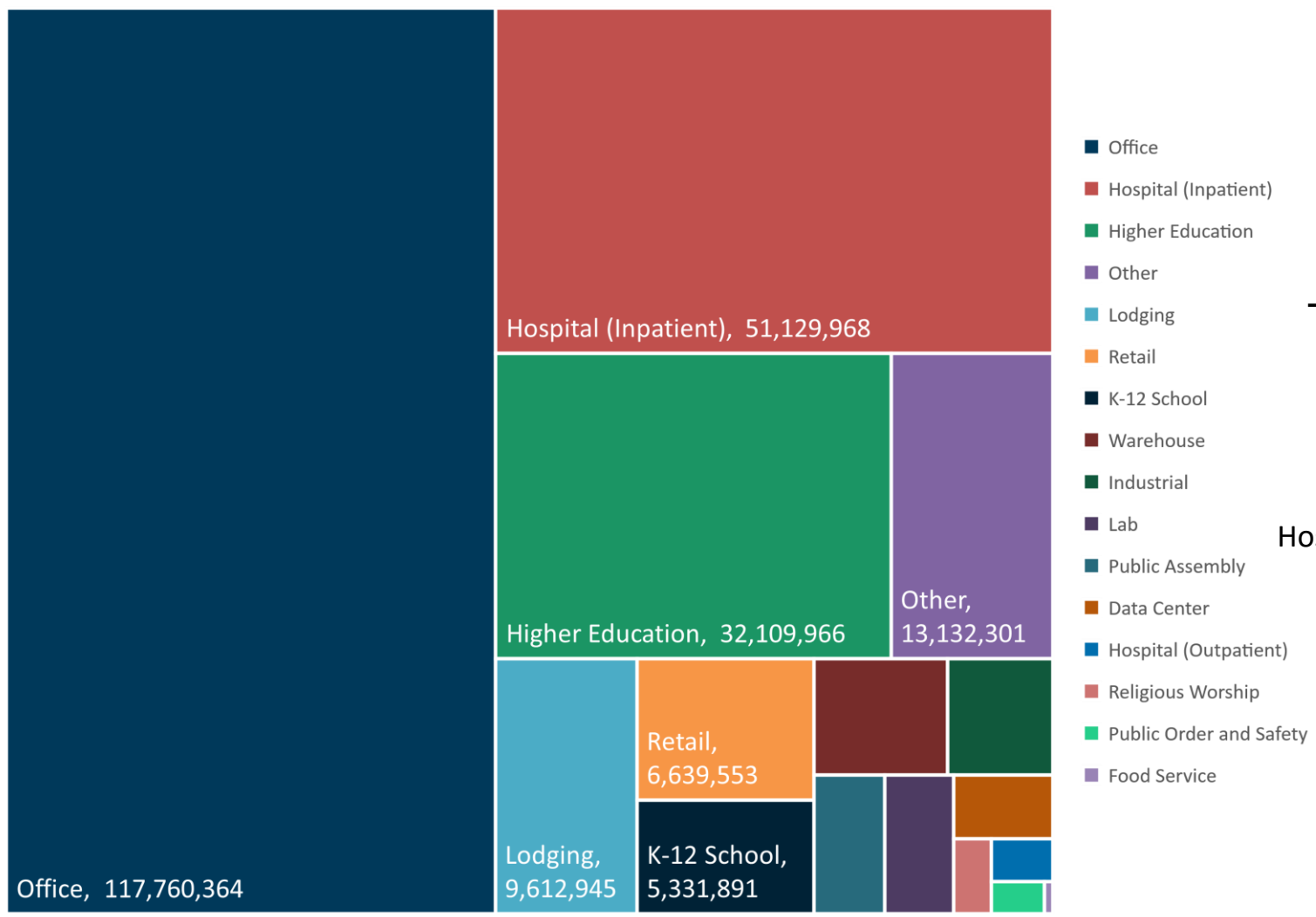


Study Square Footage (cumulative)



Market Sector Distribution: EBCx

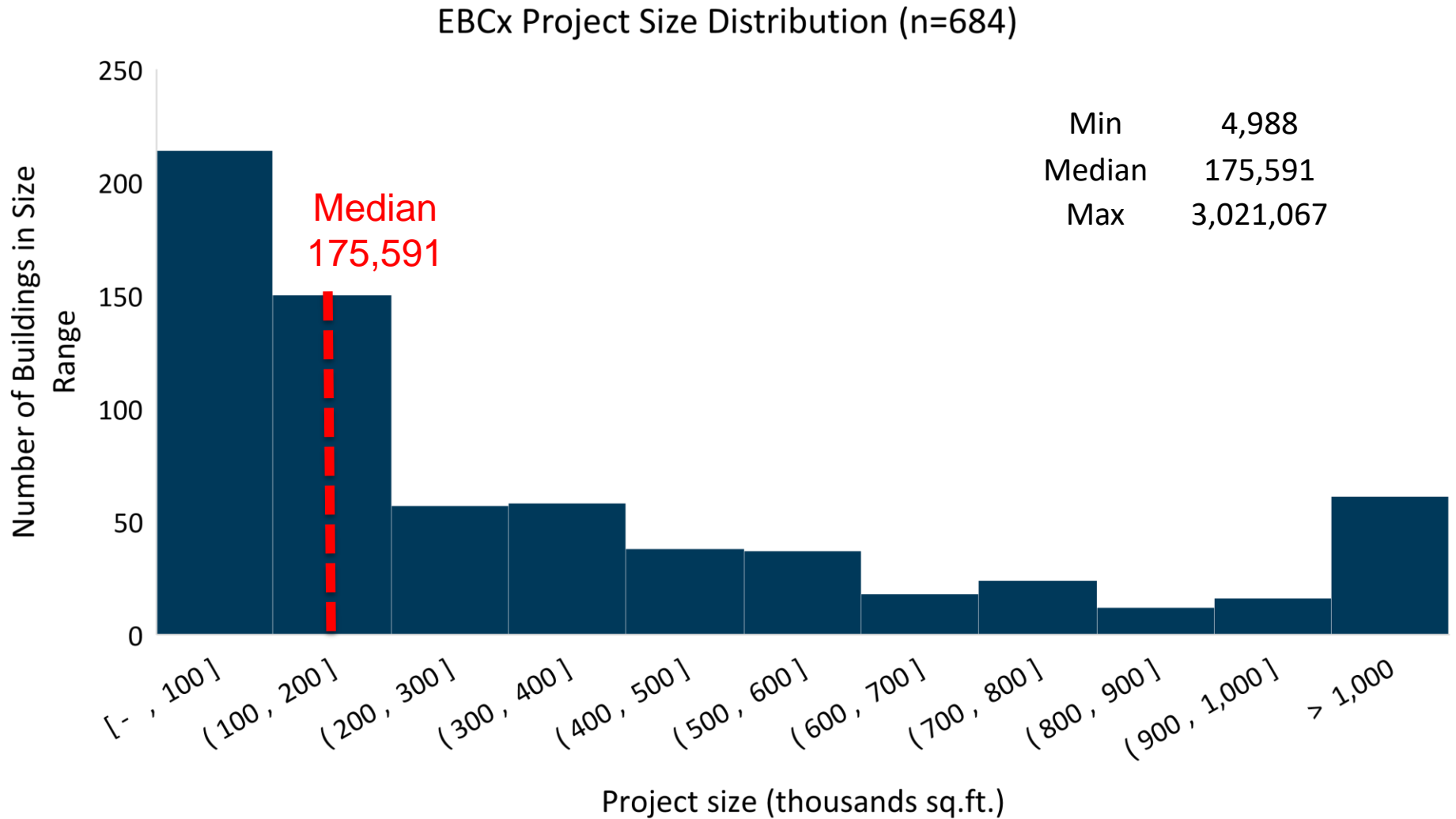
Market Segment, Square Footage, 2018 (EBCx)(Total 252 million sq.ft.)



Top 4 categories in 2009

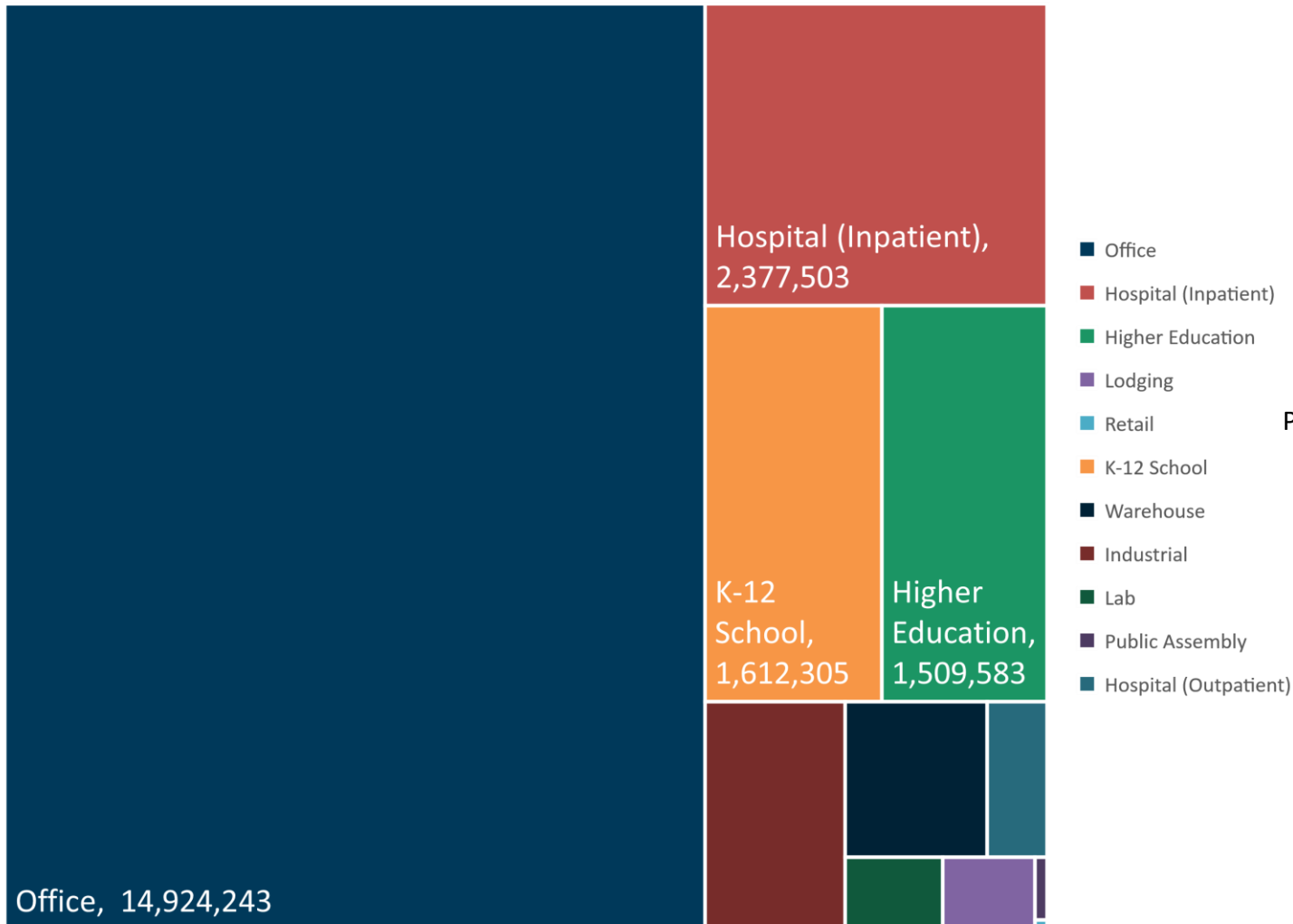
Office	44%
Higher Ed	13%
Lodging	11%
Hospital (Inpatient)	8%

Project Size Distribution: EBCx



Market Sector Distribution: NCCx

Market Segment, Square Footage, 2018 (NCCx)(Total 22,217,059 sq.ft.)

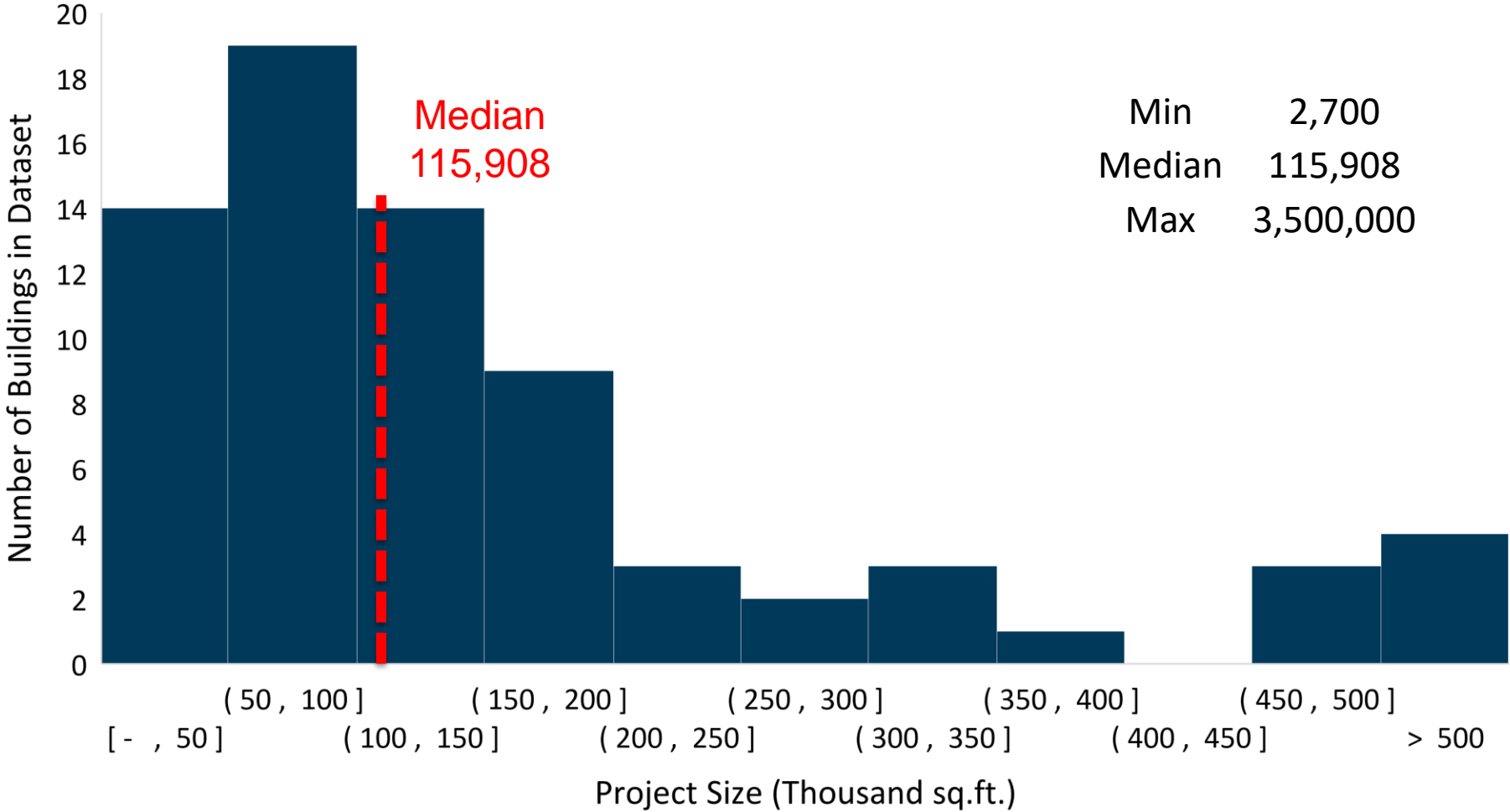


Top 3 categories in 2009

Public Order/Safety	26%
Laboratory	22%
Office	10%

Project Size Distribution: NCCx

NCCx Project Size Distribution (n=71)



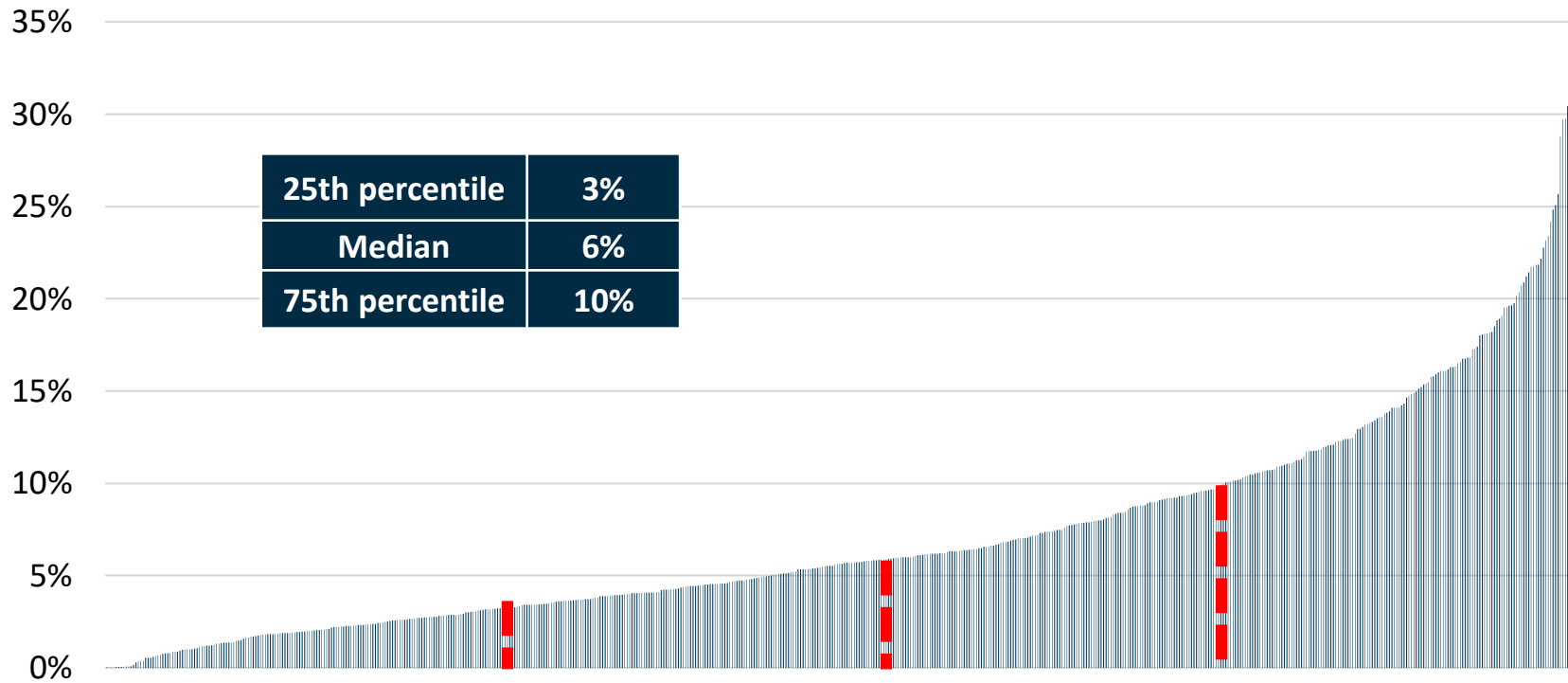
Sample Composition: Summary

- Significantly larger dataset compared to prior studies
- EBCx dataset largely drawn from 2 US states and British Columbia
- NCCx dataset spread more evenly across many states
- Office, hospital (inpatient), and education comprise the largest portions of both EBCx and NCCx datasets

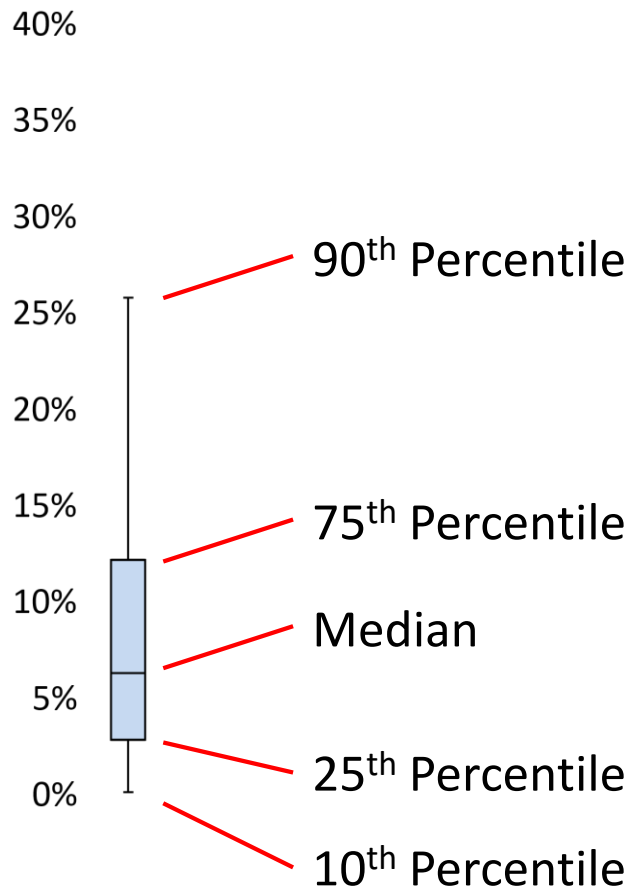
EBCX COSTS, SAVINGS, AND PAYBACK

EBCx Percent Savings

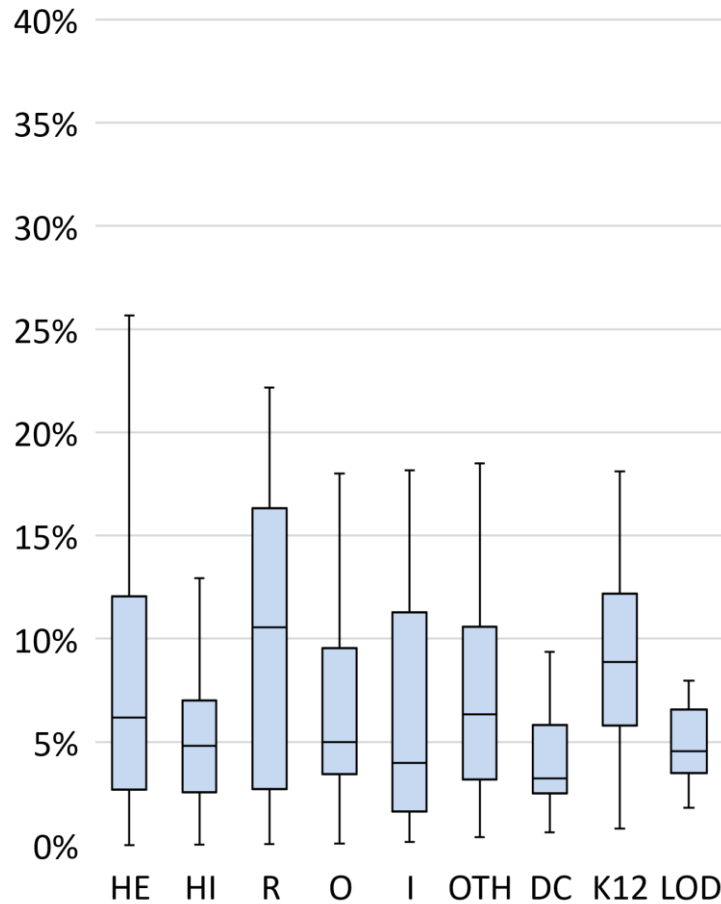
EBCx Percent Savings (Source Energy)(n=519)



EBCx Percent Savings by Market Segment



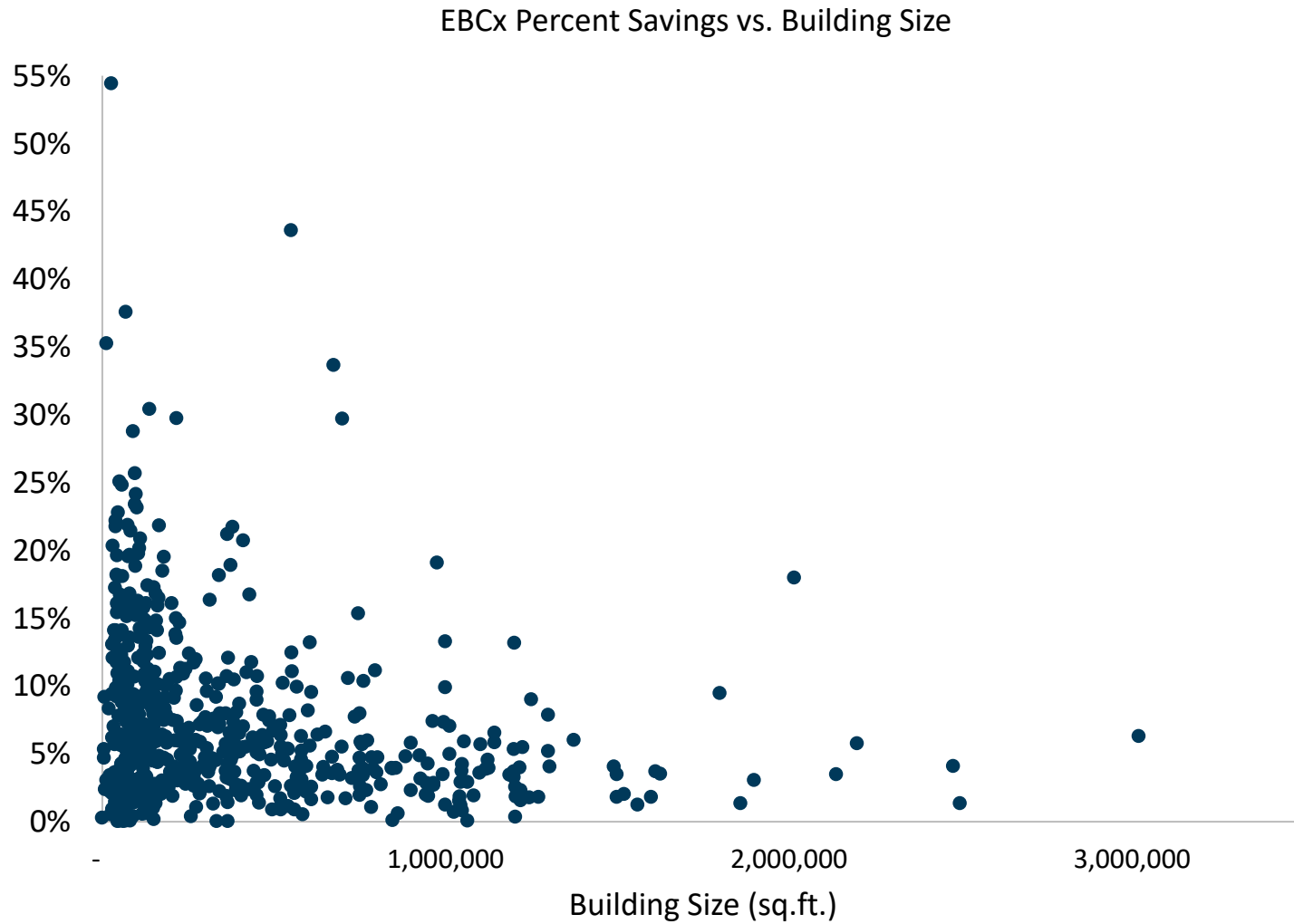
EBCx Percent Savings by Market Segment



Sample Size

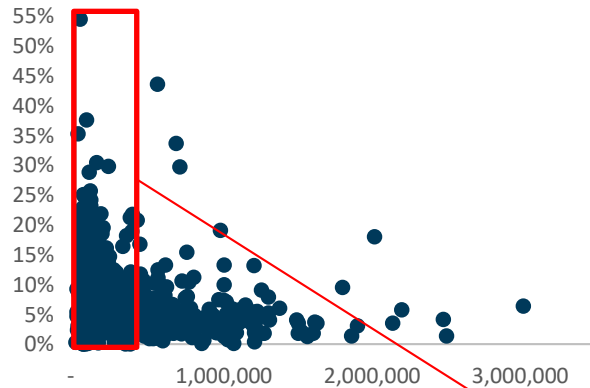
HE	Higher Ed.	112
HI	Hospital (Inpatient)	115
R	Retail	30
O	Office	194
I	Industrial	10
OTH	Other	42
DC	Data Center	15
K12	K-12 School	42
LOD	Lodging	17

EBCx Percent Savings by Building Size

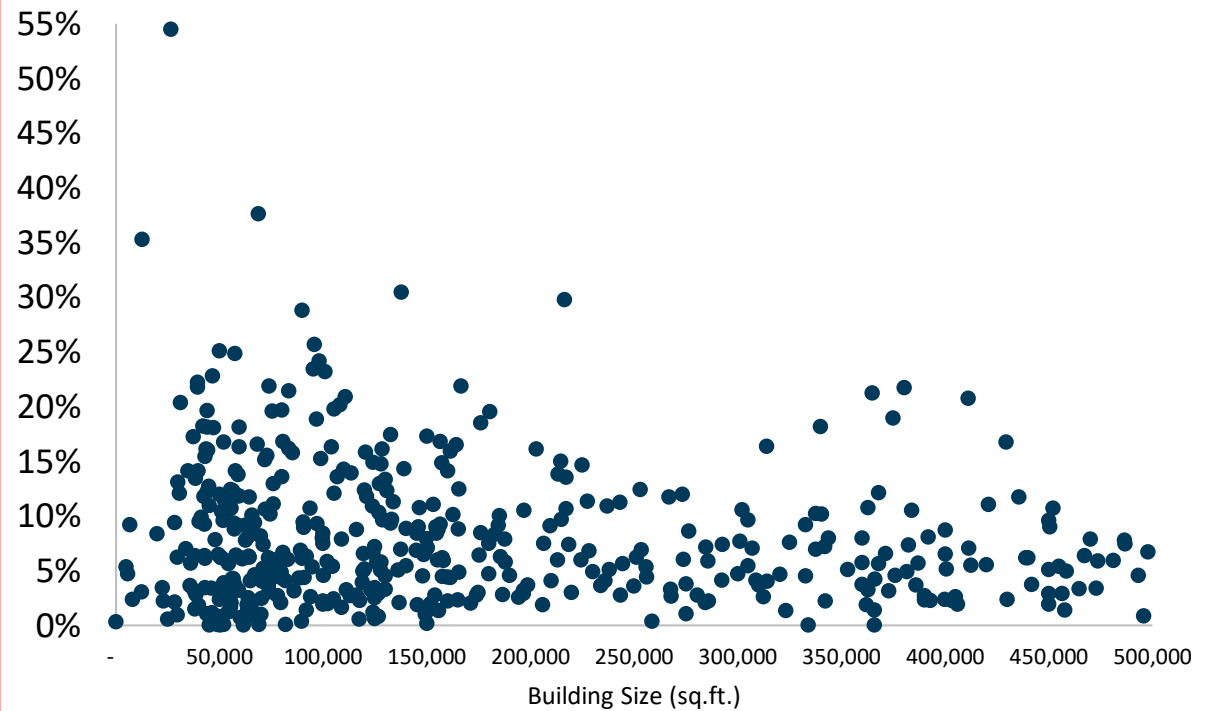


EBCx Percent Savings by Building Size

EBCx Percent Savings vs. Building Size



EBCx Percent Savings vs. Building Size (<500,000sq.ft.)



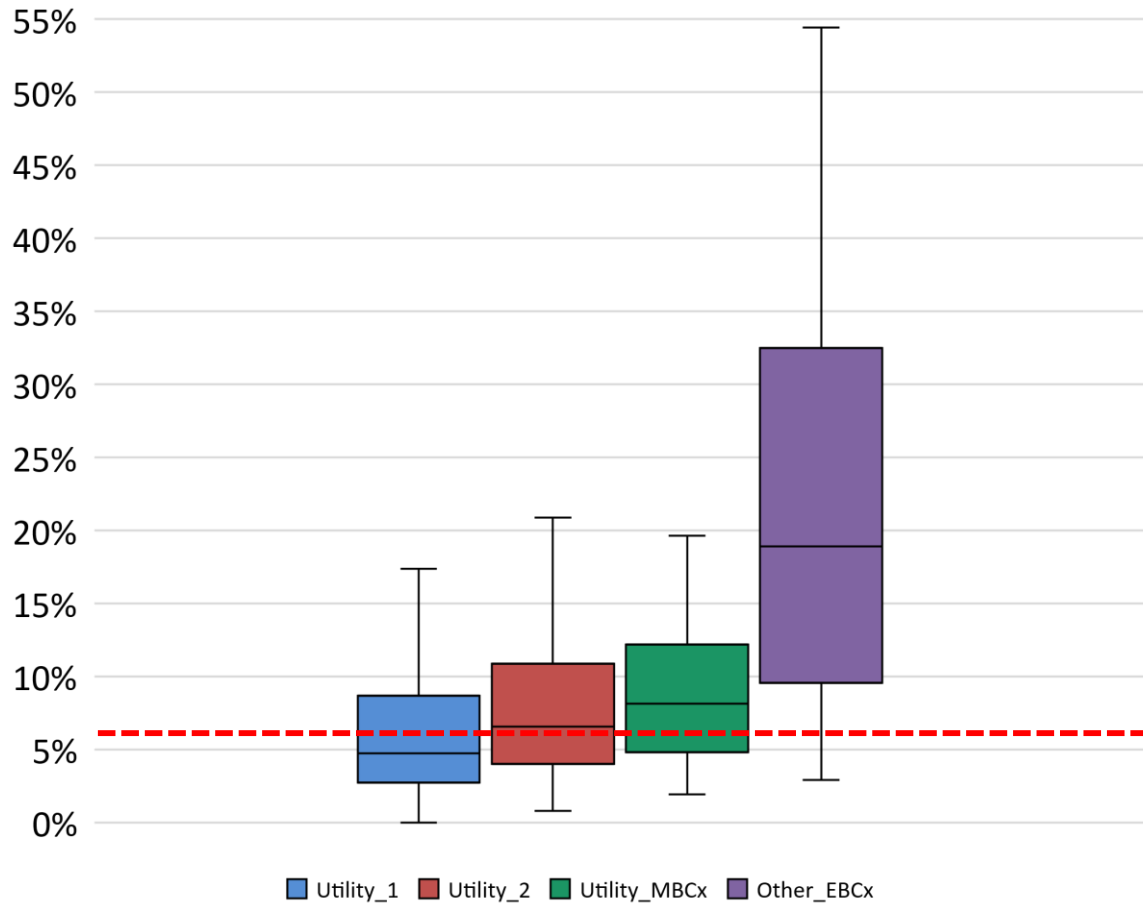
EBCx Percent Savings by Project Type

Project Type Characteristics

- **Utility EBCx Projects:**
 - Standardized scope, focused on energy savings
 - High rigor applied to review of savings estimates
 - Typically restricted budgets, but customer may have cash incentive to install measures
- **Utility MBCx Projects:**
 - Similar to Utility EBCx, but with additional budget/effort to install metering, and possibly a longer engagement period to uncover more measures
- **“Other”:**
 - Services offered direct to customers by commissioning firms. May target outcomes beyond energy savings (e.g. comfort). Scrutiny on savings calculations varies. Budget determined on a case-by-case basis.

EBCx Percent Savings: 2018

EBCx Percent Savings by Project Type

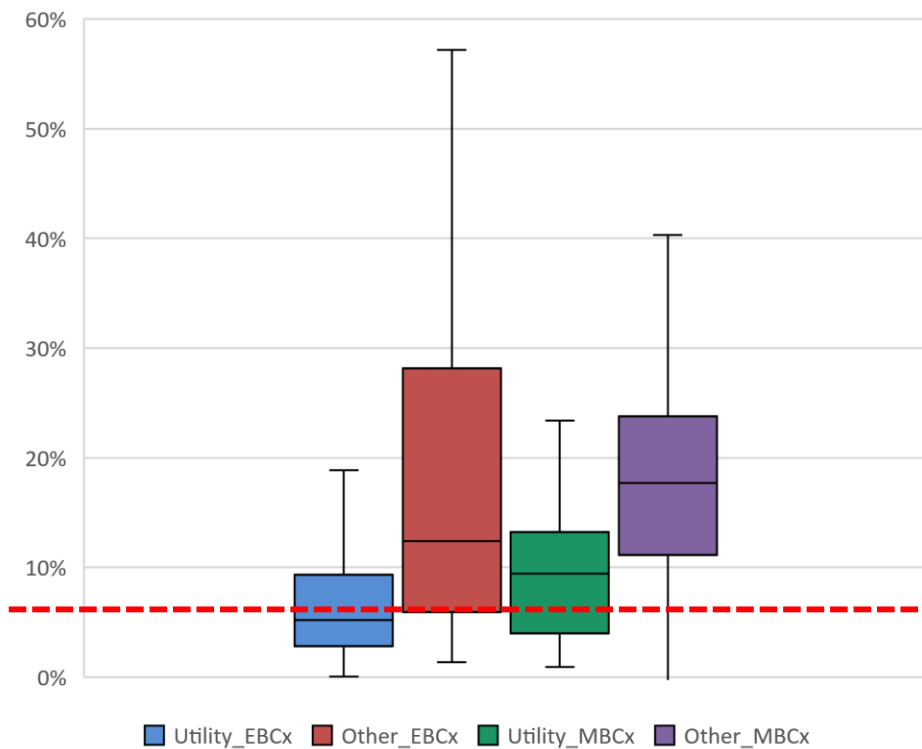


	Median	n
Utility_1	5%	411
Utility_2	7%	156
Utility_MBCx	8%	17
Other_EBCx	19%	13

Overall study
median 6%

EBCx Percent Savings: All Data Combined

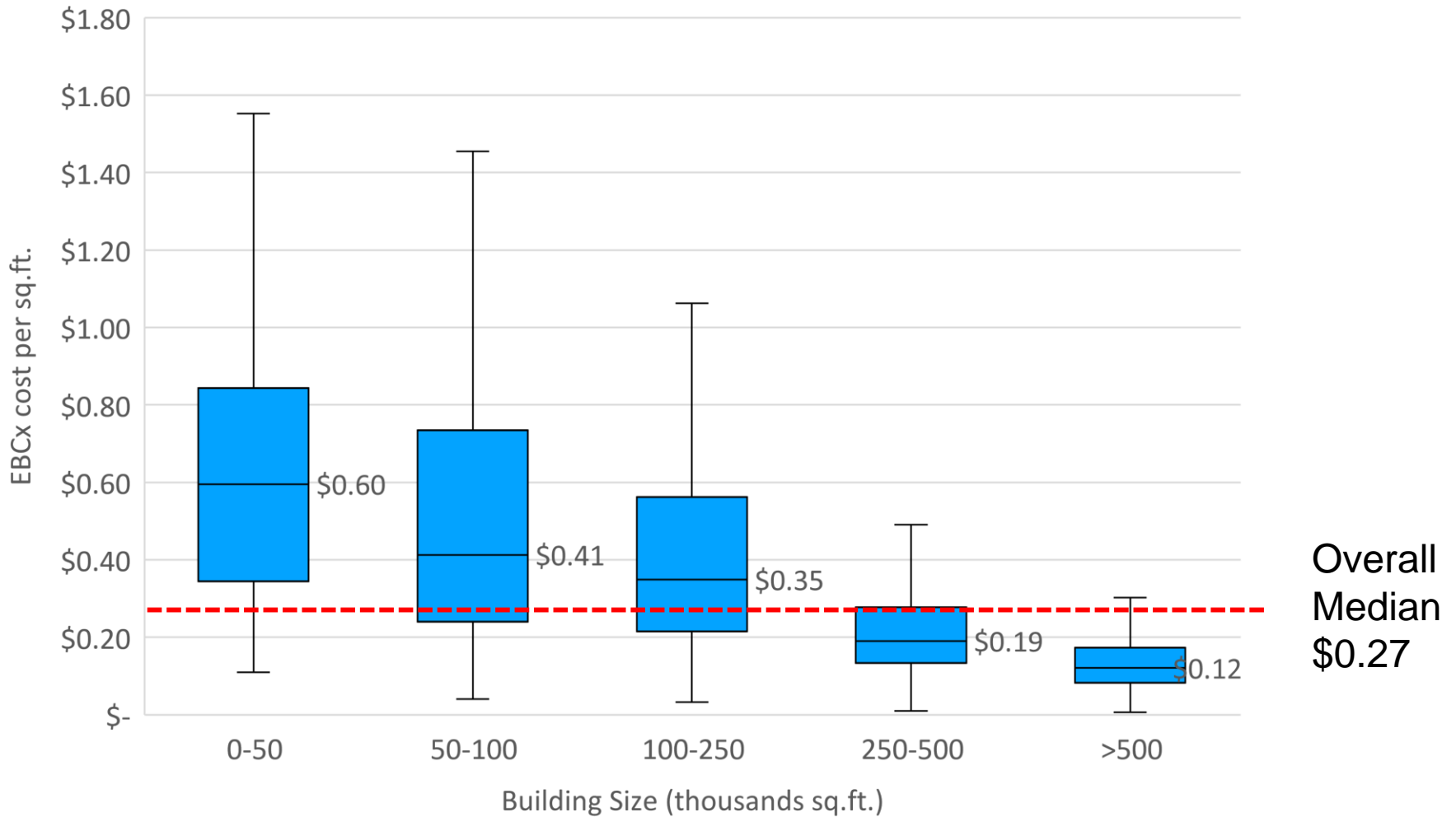
EBCx Percent Savings by Project Type (All Data)



	Median	n
Utility_EBCx	5%	533
Utility_MBCx	9%	41
Other_EBCx	12%	67
Other_MBCx	18%	40

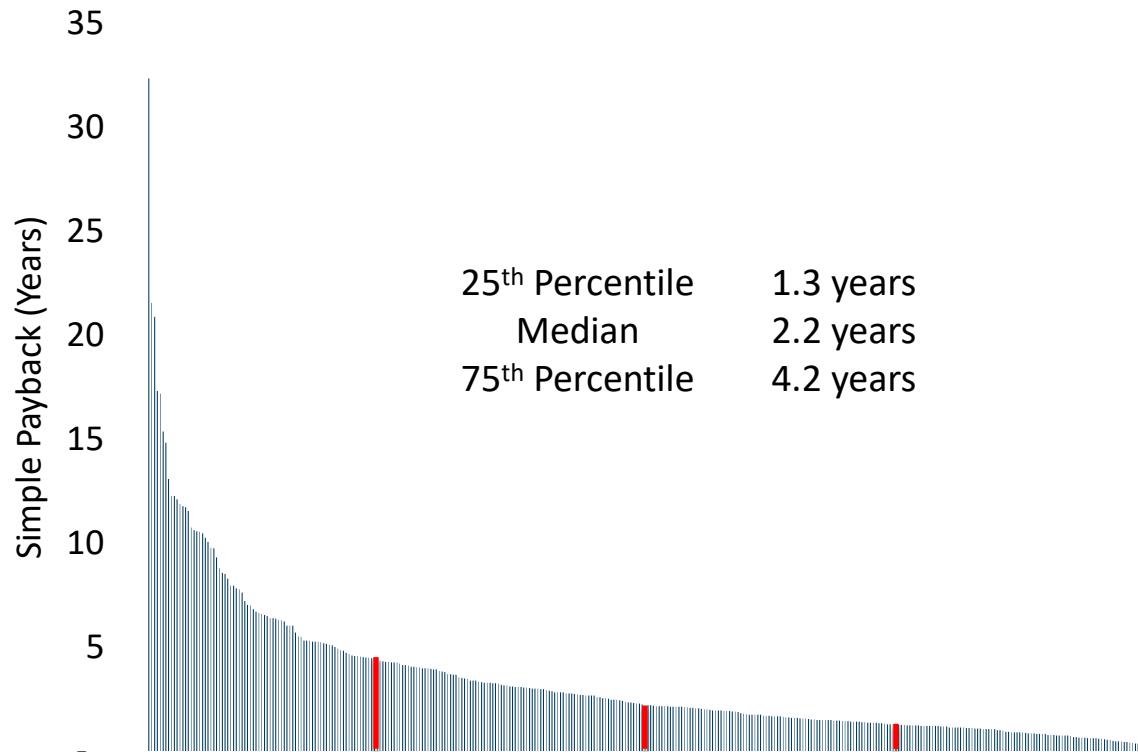
Overall
Median 6%

EBCx Cost by Building Size



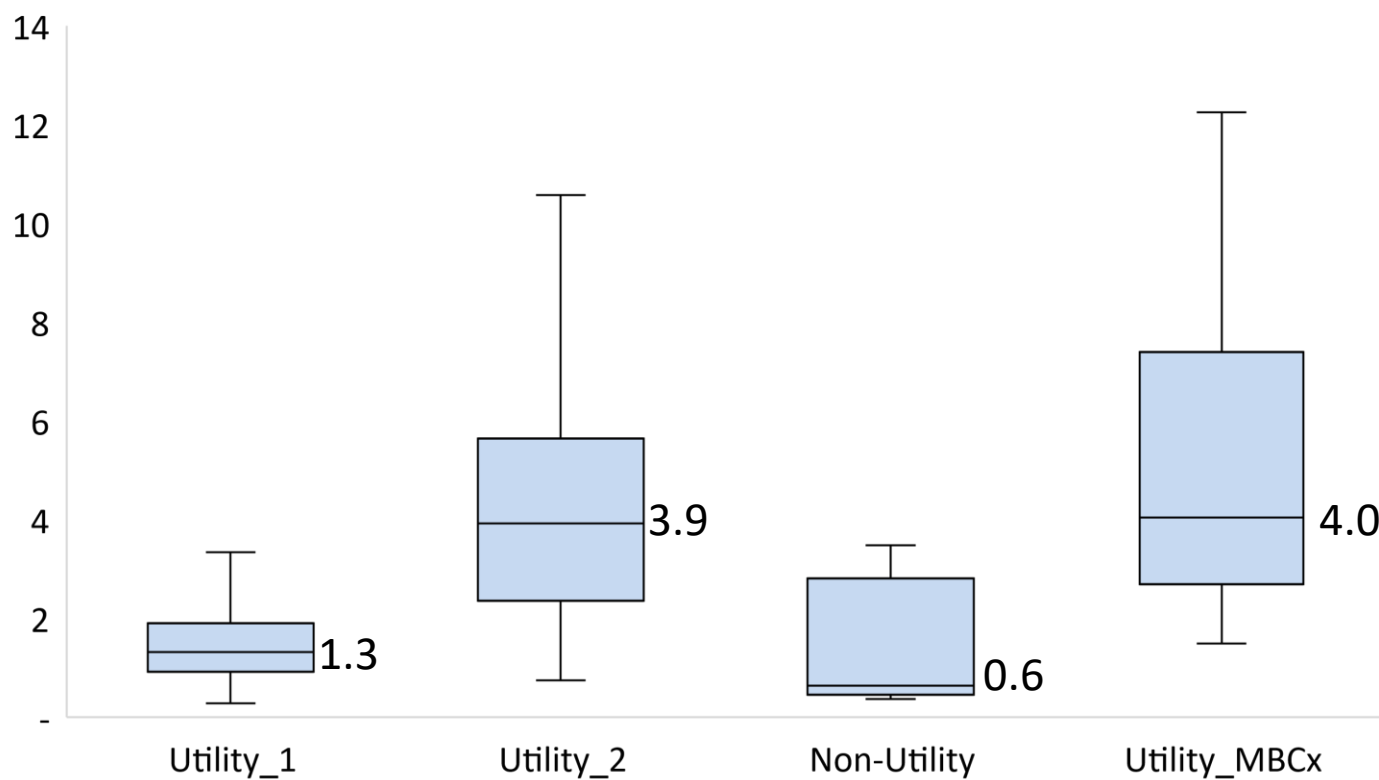
EBCx Simple Payback

EBCx Simple Payback (Years)(n=356)



EBCx Simple Payback by Project Type

EBCx Simple Payback (years) by Data Source (Adjusted to 2017, using Standard Energy Prices)(n=355)



Headline EBCx Metrics: All Data

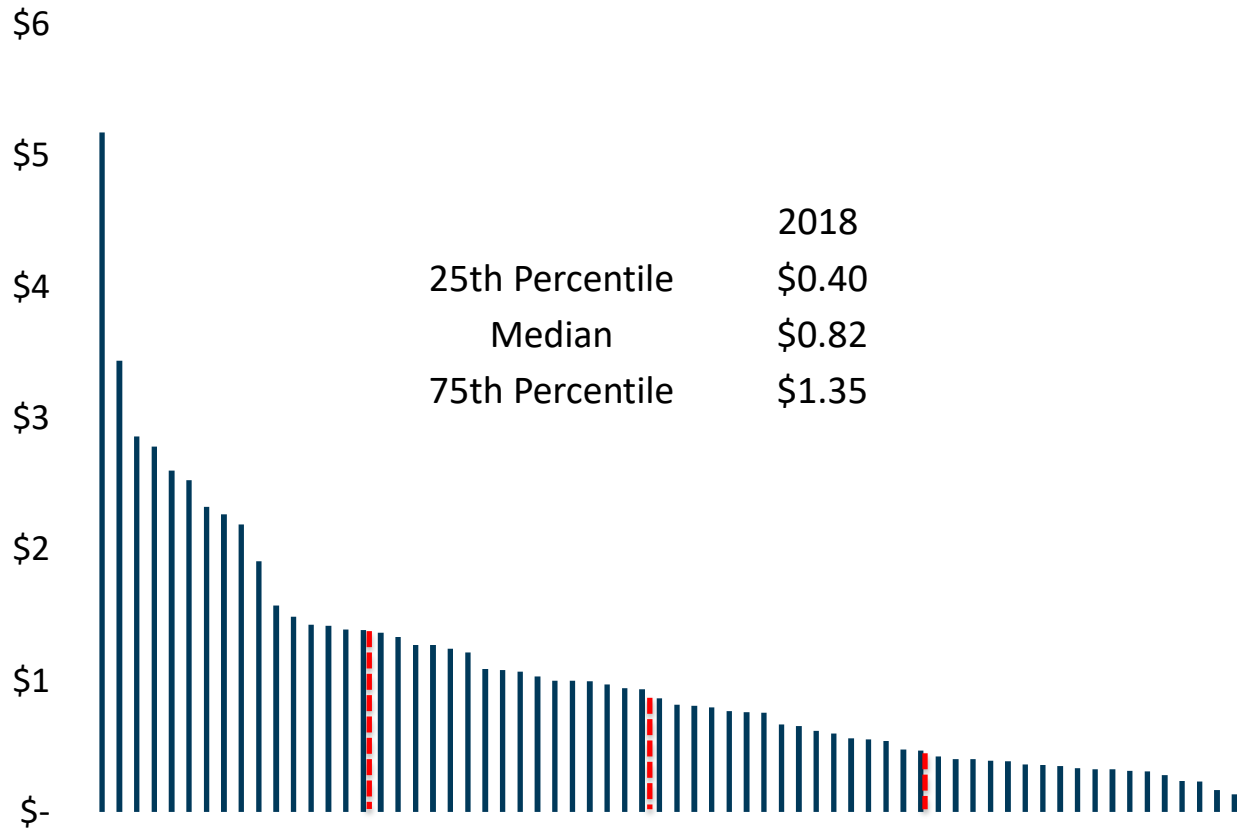


Metric	Median	Typical Range
Energy Savings	6%	3%-11%
EBCx Cost	\$0.27/sq.ft	\$0.15-\$0.56
Simple Payback	1.7 yr	0.8 – 3.5 yr

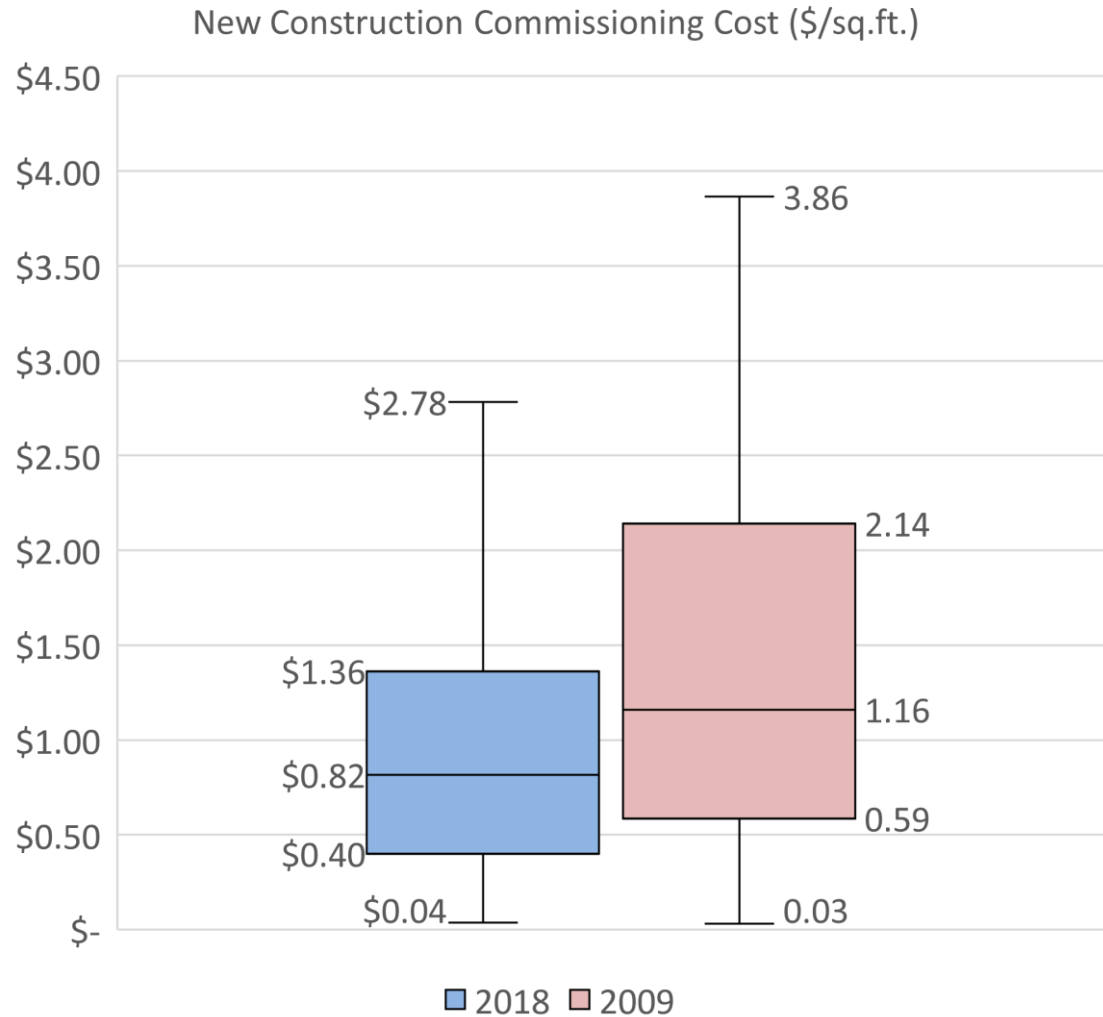
NCCX COSTS

NCCx Cost per Square Foot

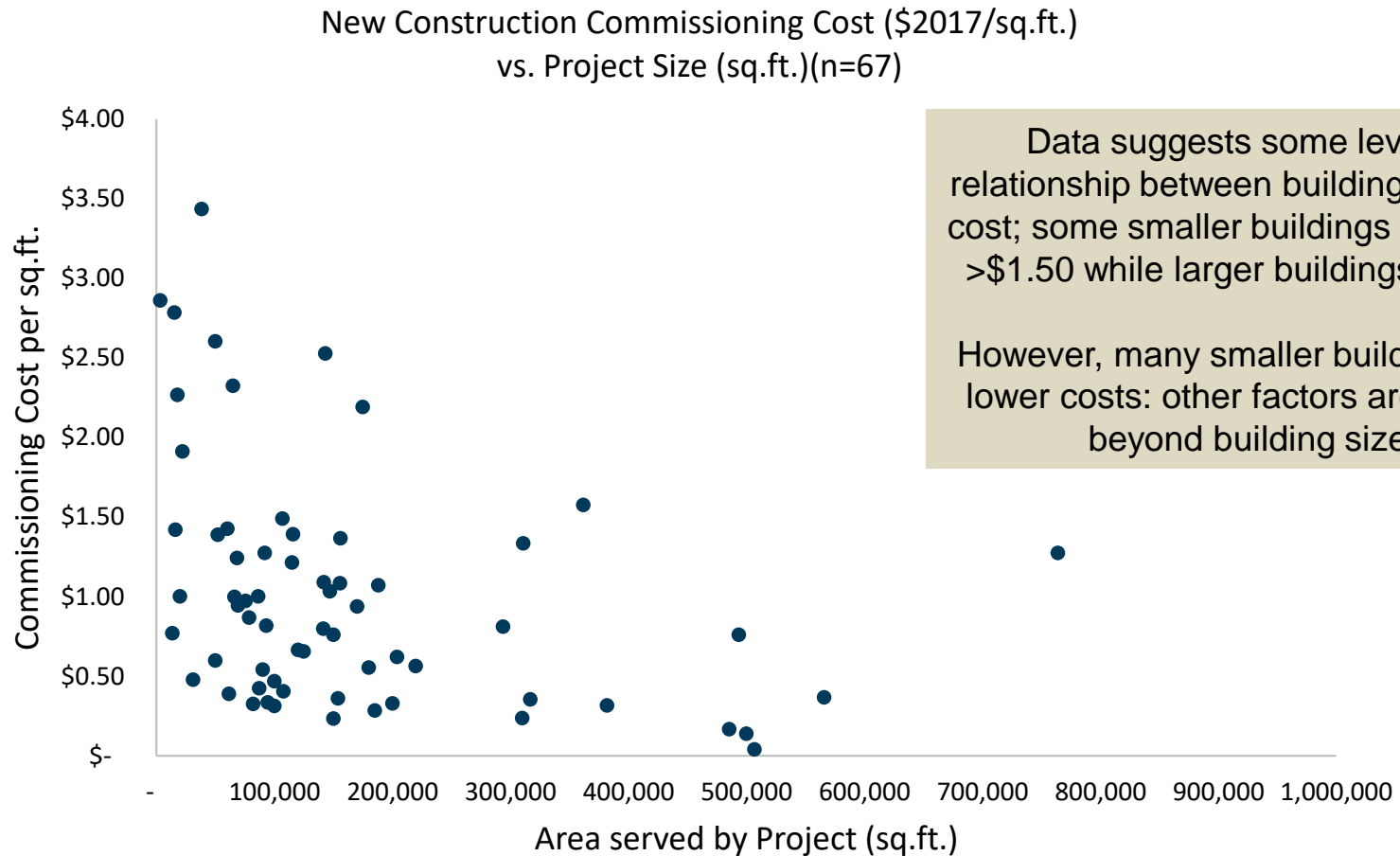
New Construction Commissioning Cost
(\$2017/sq.ft.)(n=67)



NCCx Cost per sq.ft., 2009 vs 2018

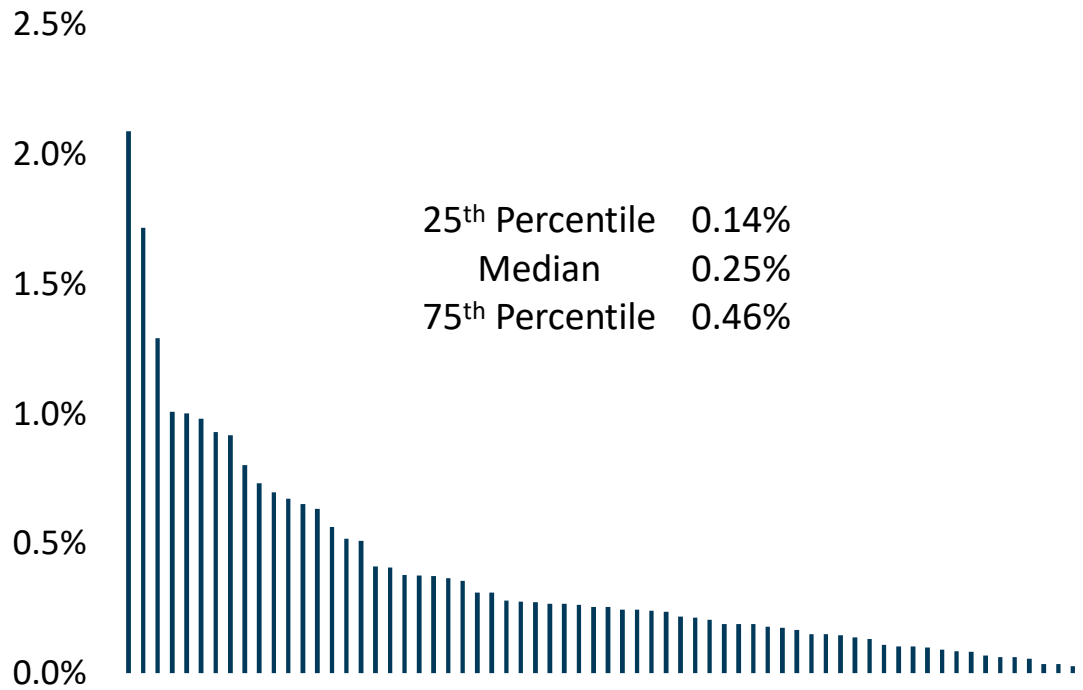


NCCx Cost vs. Project Size

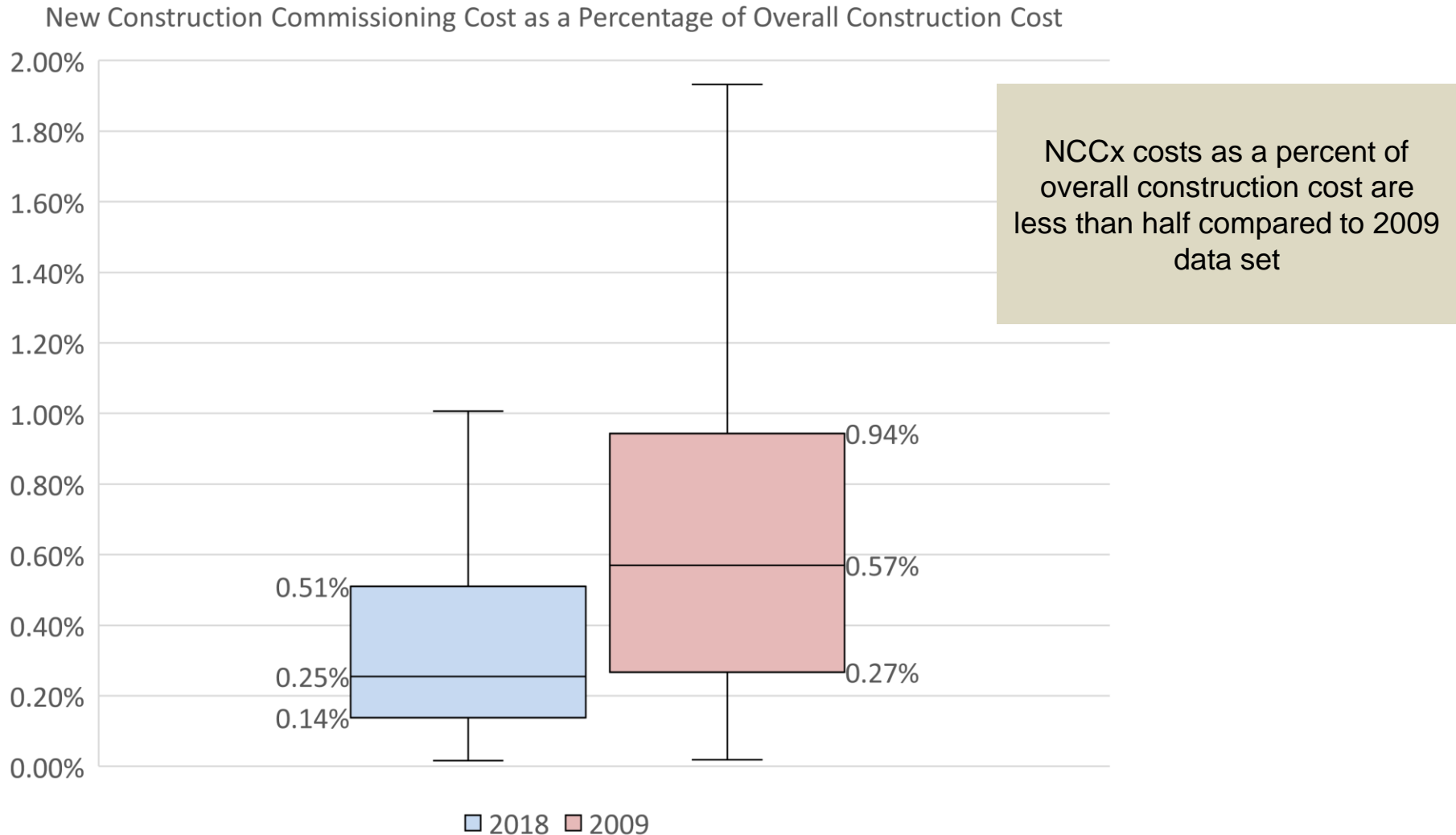


NCCx Cost as Percent of Construction

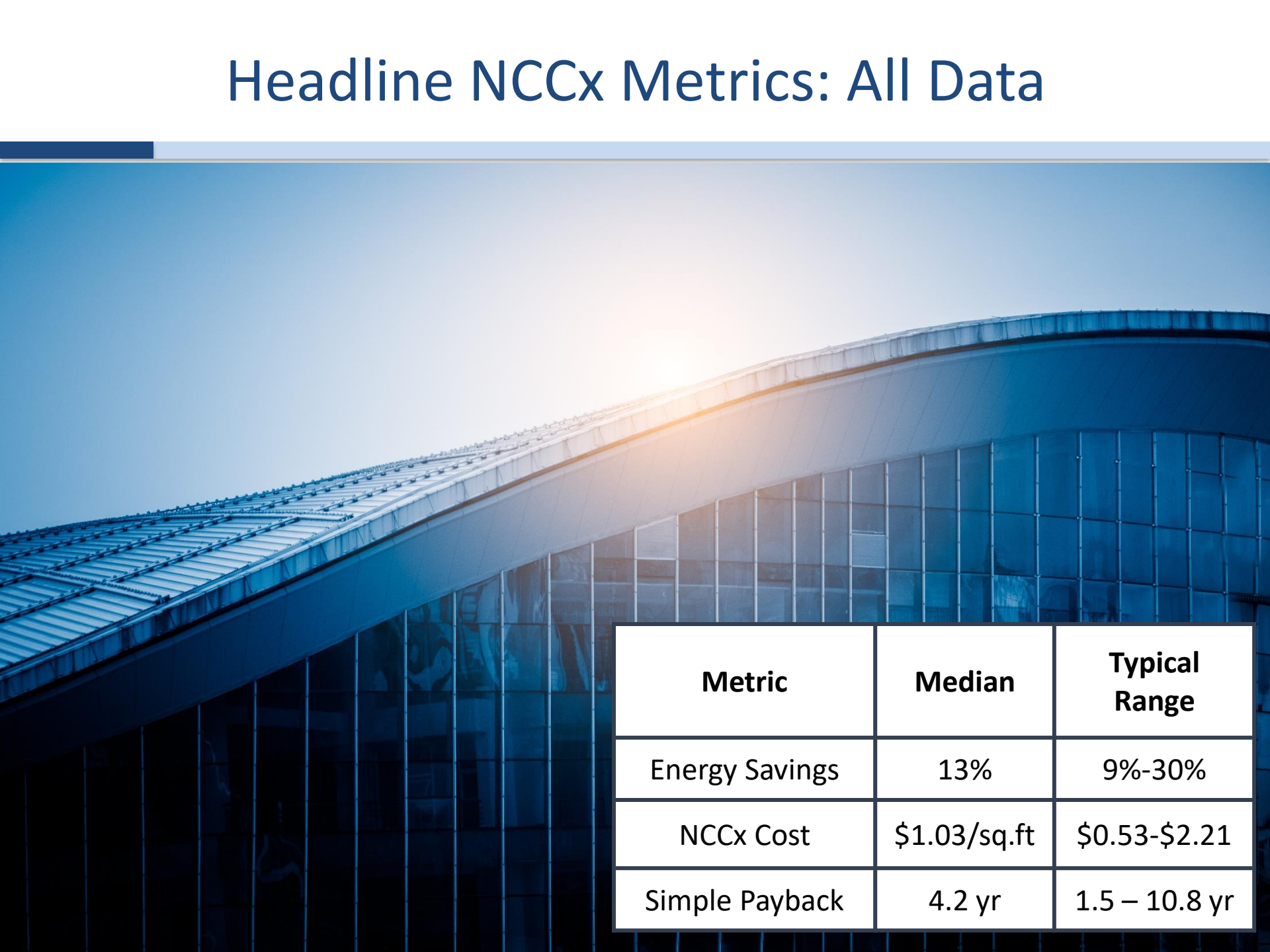
New Construction Commissioning Cost as a Percentage of Overall Construction Cost (\$2017)(n=67)



NCCx Cost as Percent of Construction



Headline NCCx Metrics: All Data



Metric	Median	Typical Range
Energy Savings	13%	9%-30%
NCCx Cost	\$1.03/sq.ft	\$0.53-\$2.21
Simple Payback	4.2 yr	1.5 – 10.8 yr

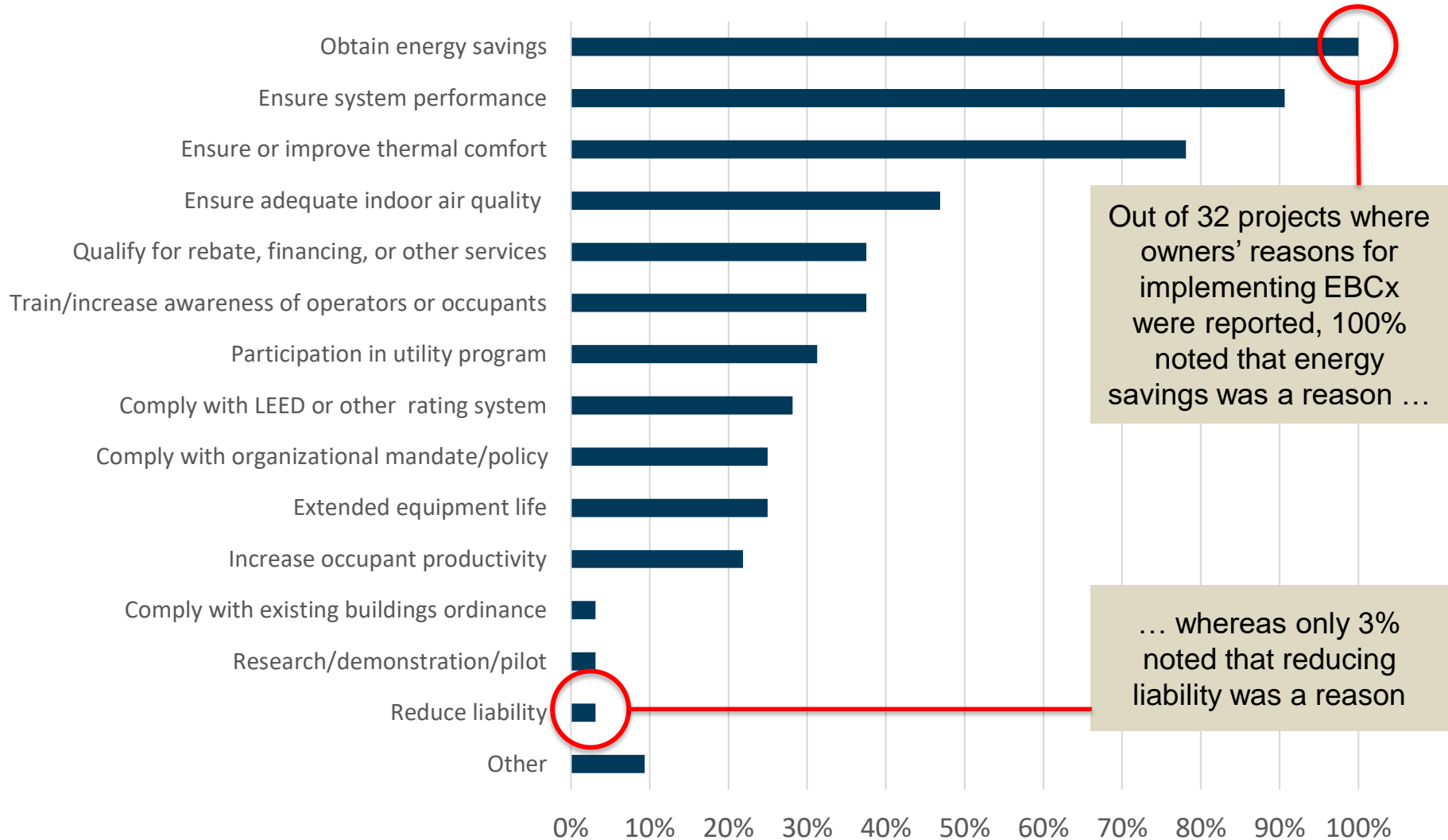
THE WHAT AND WHY

Reasons for Implementing Cx

- Data survey included questions relating to owner motivation for implementing Cx
- 15 possible reasons; respondents (Cx Providers) could choose multiple
- Results determined as: percent of projects where reason 'X' was one of owner's motivations

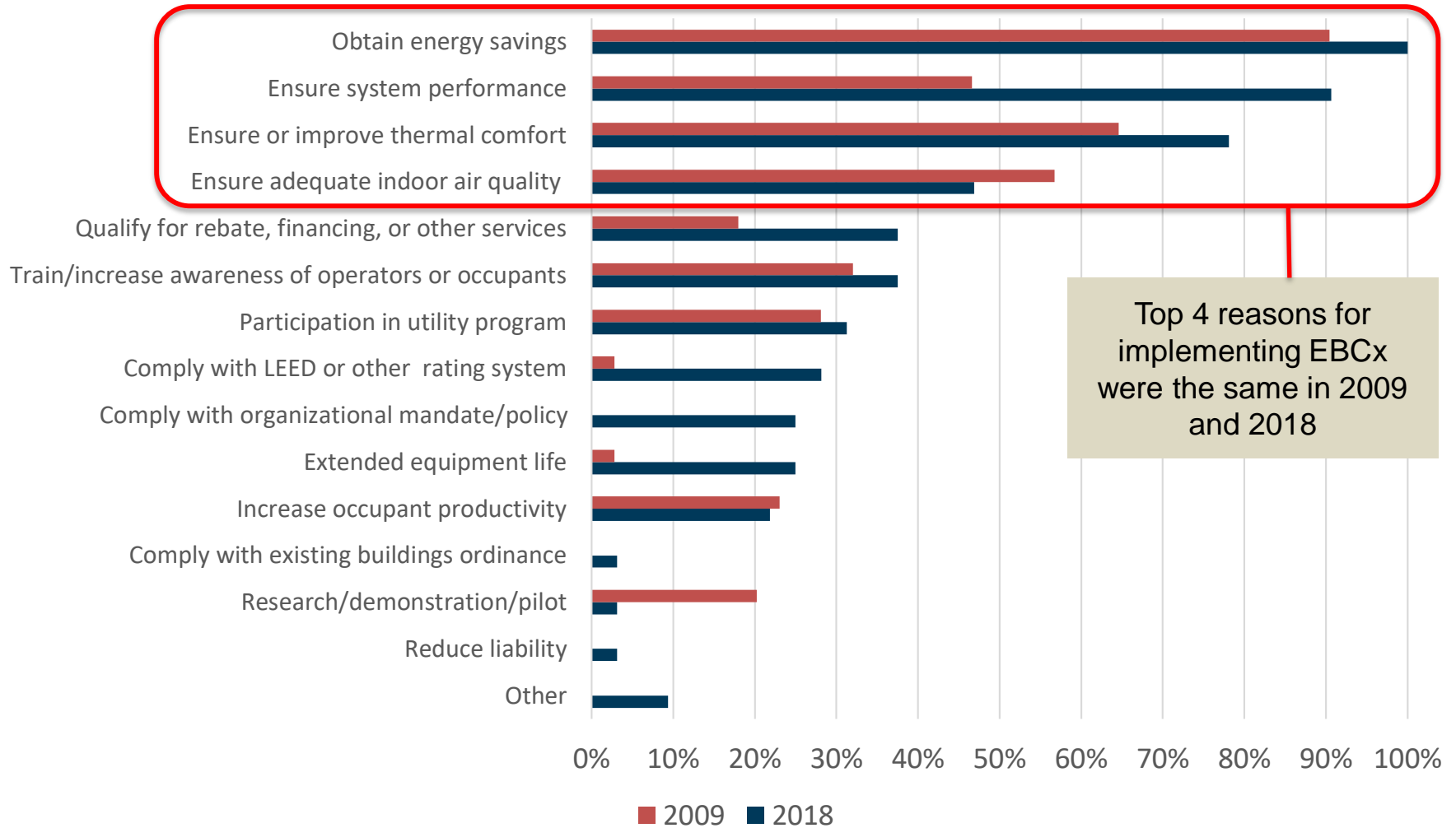
Reasons for Implementing EBCx

Fraction of reporting projects with reason (EBCx), 2018



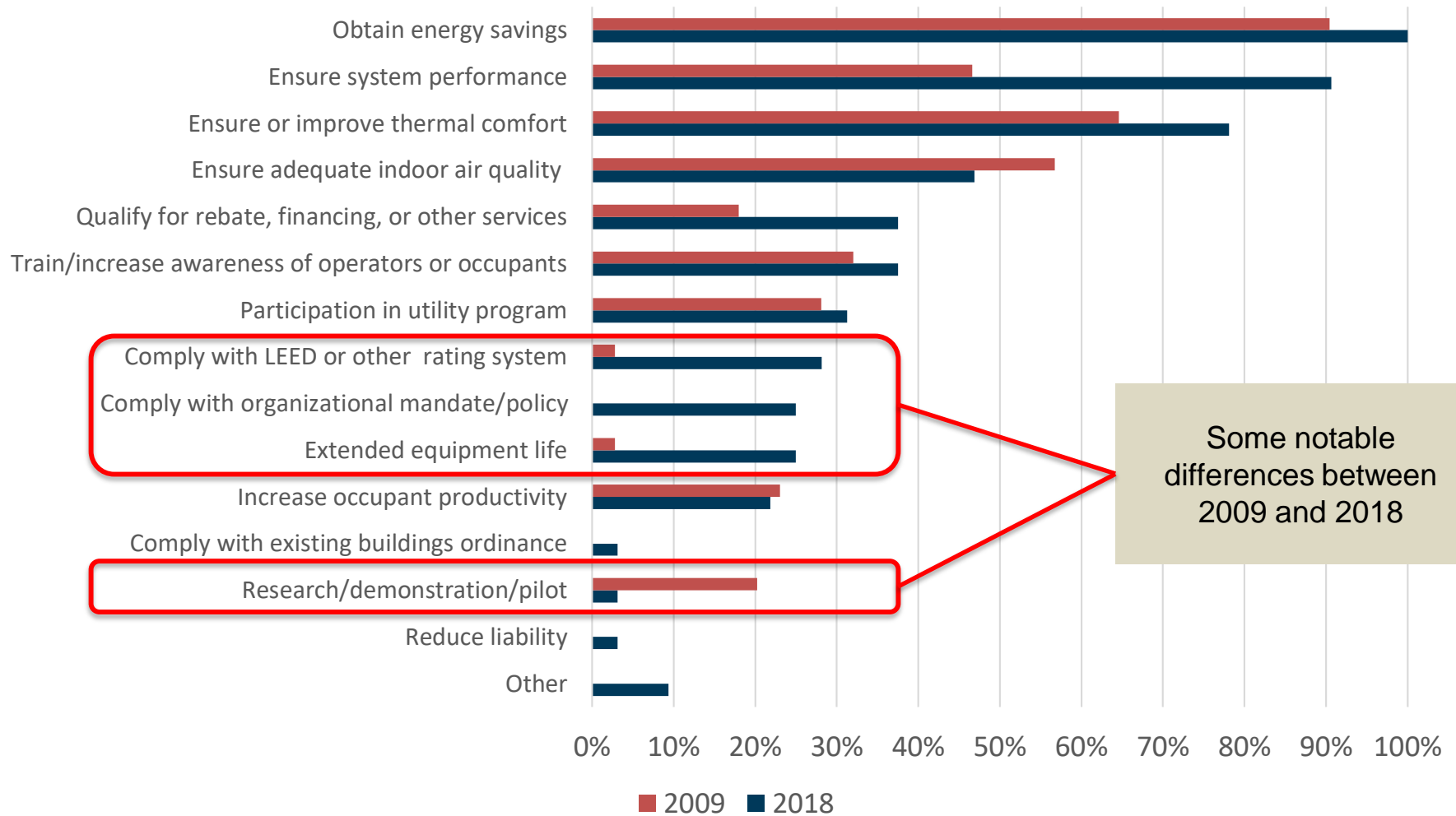
Reasons for Implementing EBCx: 2009 vs. 2018

Fraction of reporting projects with reason (EBCx), 2009 vs. 2018



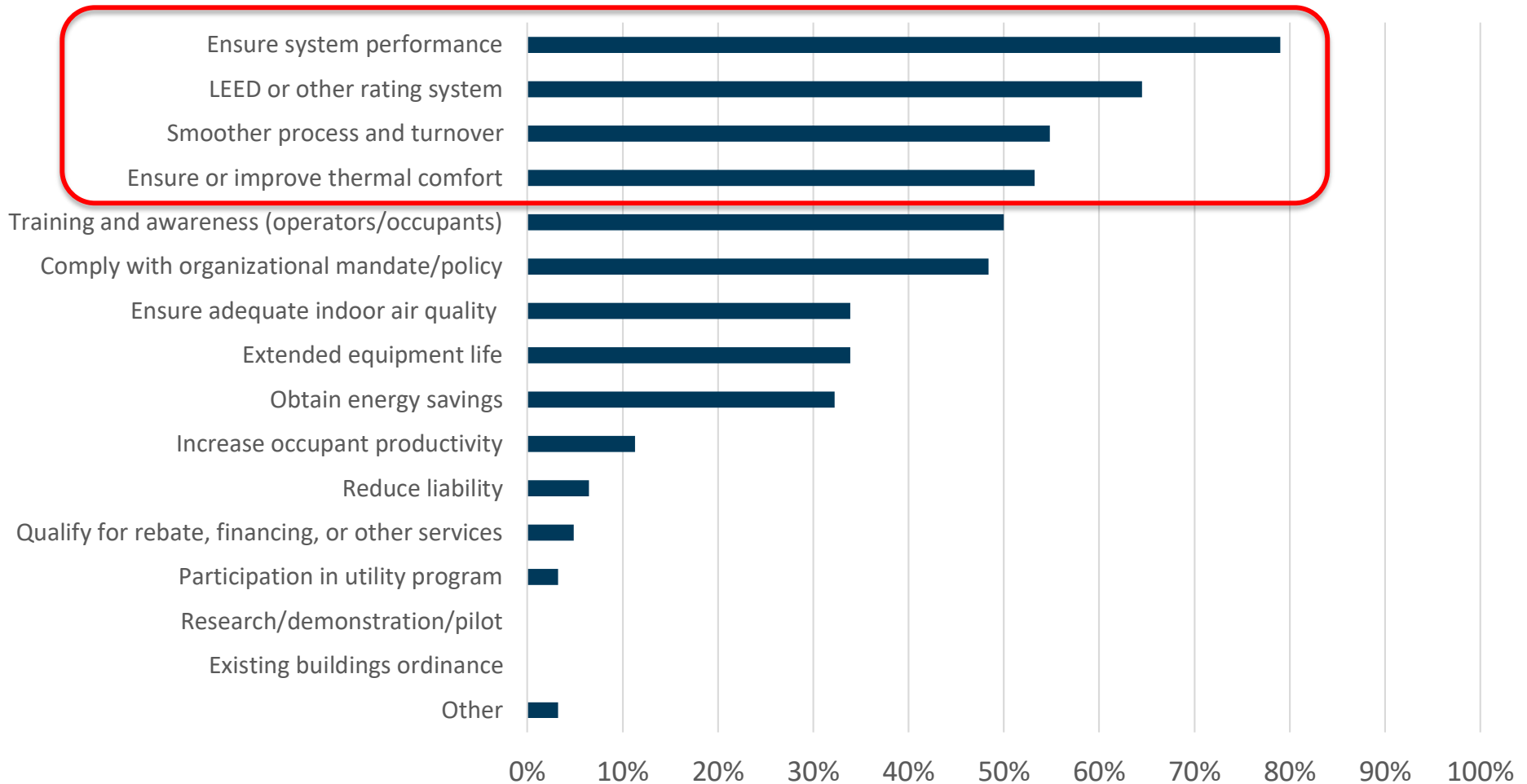
Reasons for Implementing EBCx: 2009 vs. 2018

Fraction of reporting projects with reason (EBCx), 2009 vs. 2018



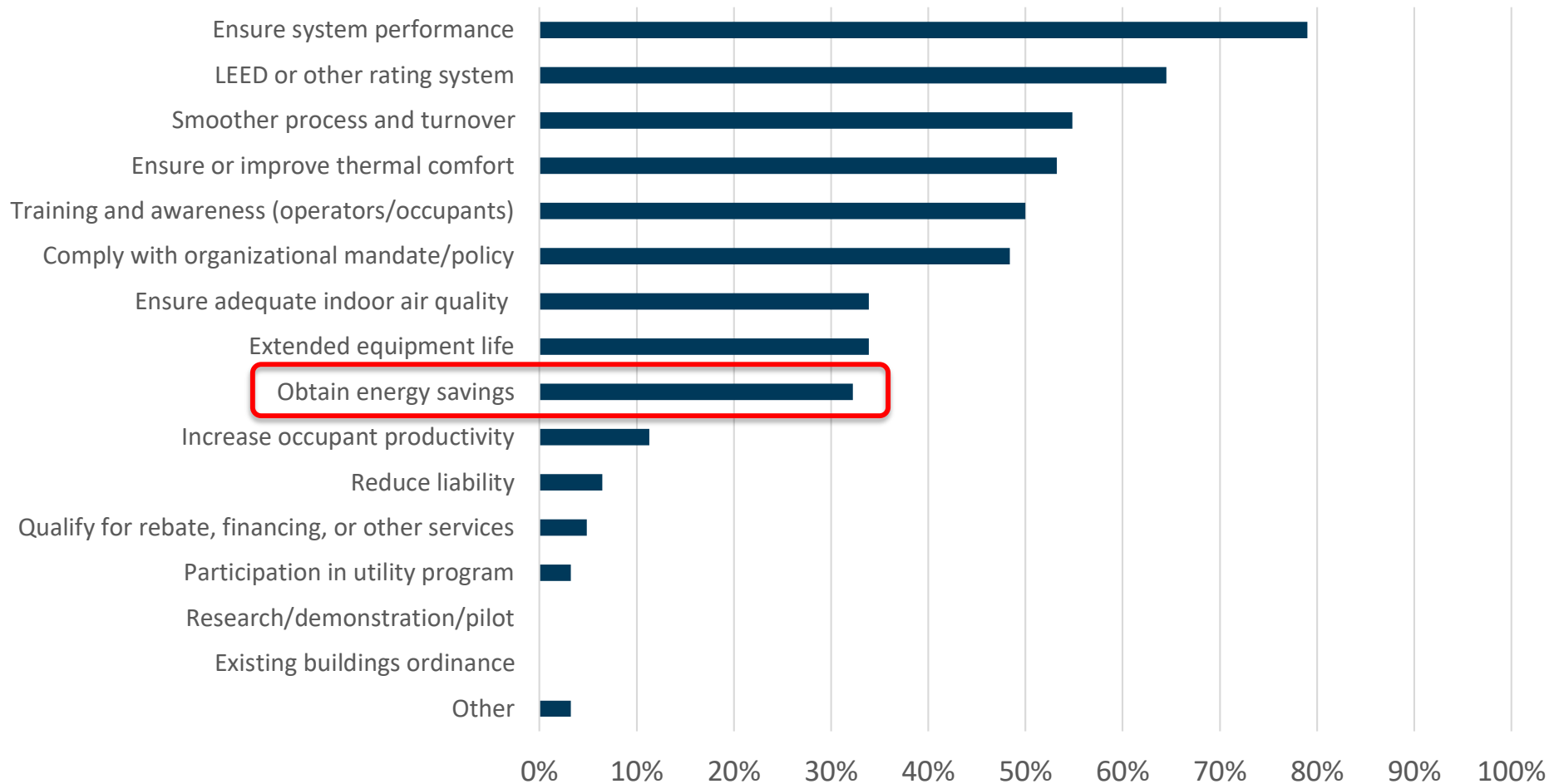
Reasons for implementing NCCx

Fraction of reporting projects with reason (New Construction), 2018 (n = 62)



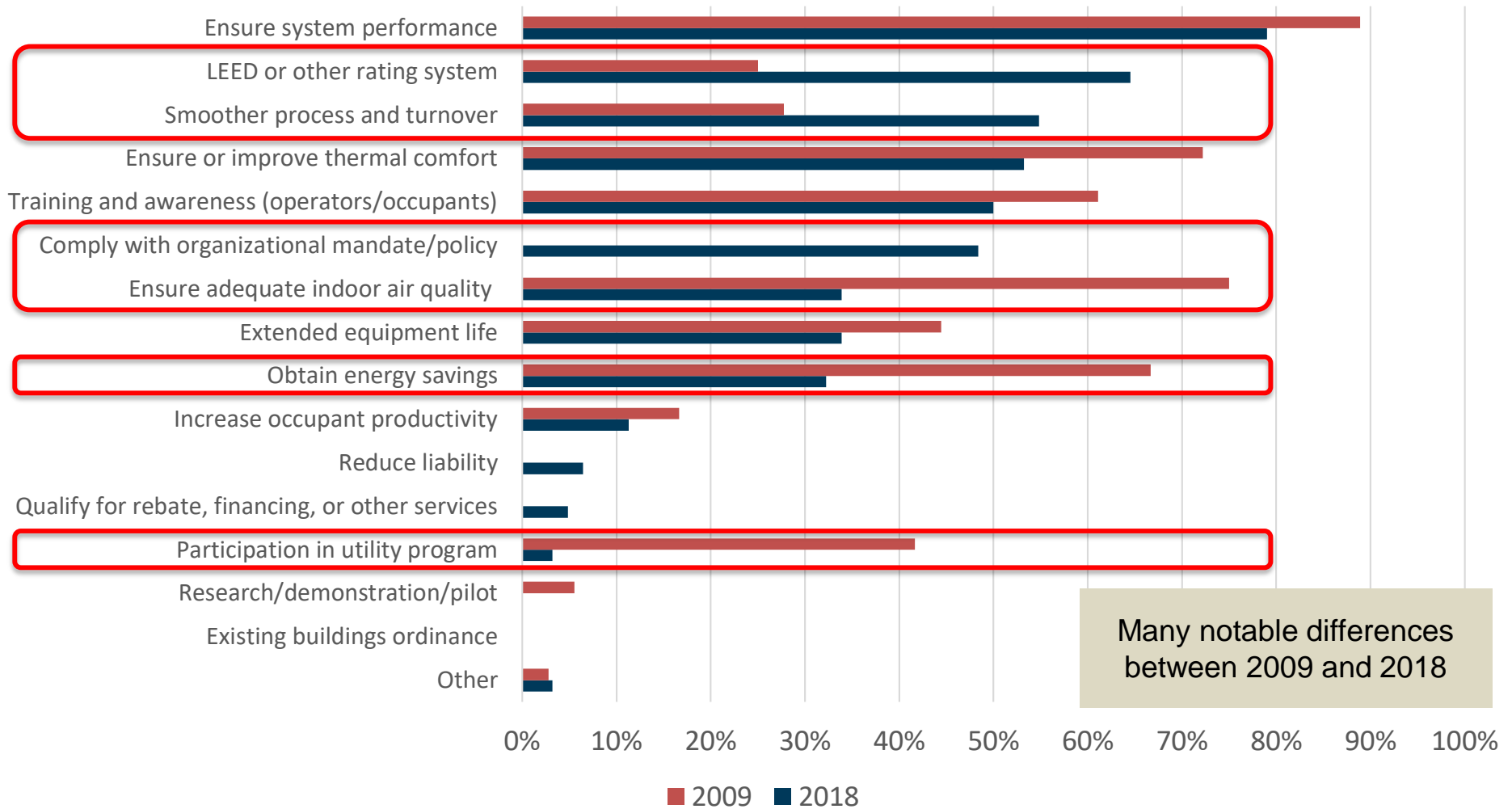
Reasons for implementing NCCx

Fraction of reporting projects with reason (New Construction), 2018 (n = 62)



Reasons for implementing NCCx

Fraction of reporting projects with reason (New Construction), 2009 vs. 2018

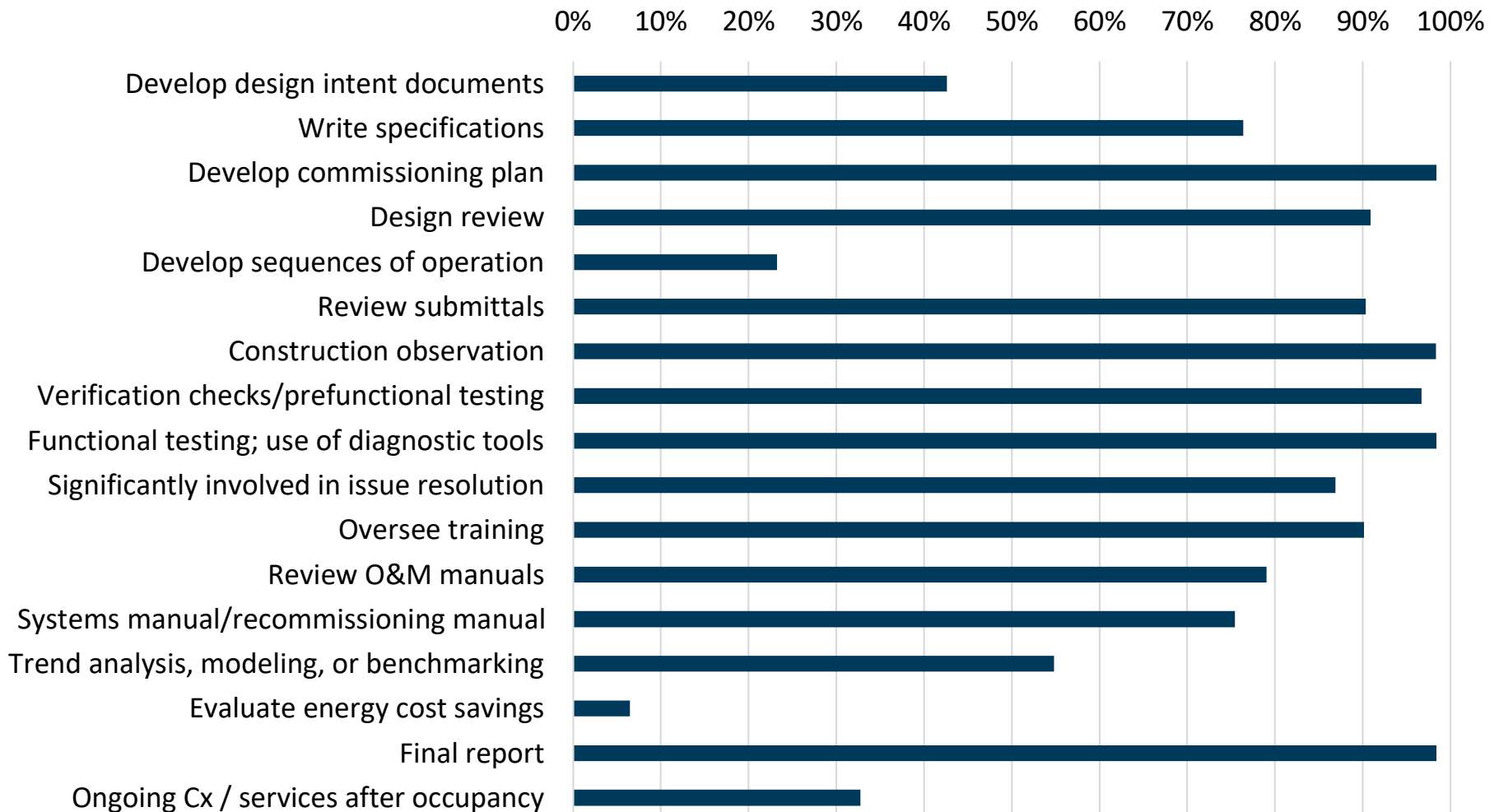


NCCx Scope of Work

- NCCx best practice calls for Cx Provider involvement from pre-design stage through to occupancy
- Implied linkage between quality of Cx, Cx cost, and the comprehensiveness of Cx scope
- Data survey asked or list of items included in NCCx scope

NCCx Scope of Work

Activities included in New Construction Commissioning Scope (n=62)

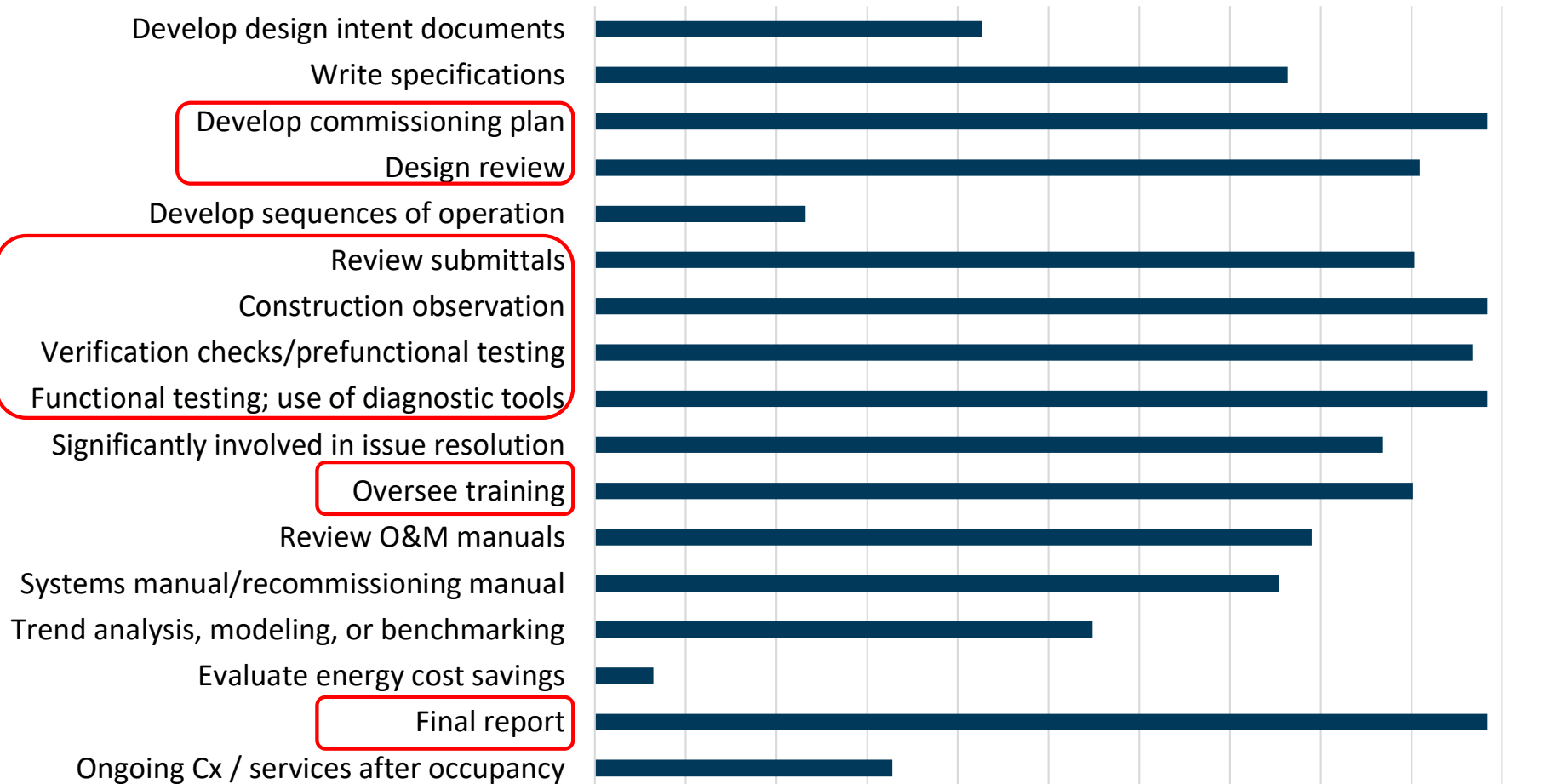


NCCx Scope of Work

Activities included in New Construction Commissioning Scope (n=62)

> 80%

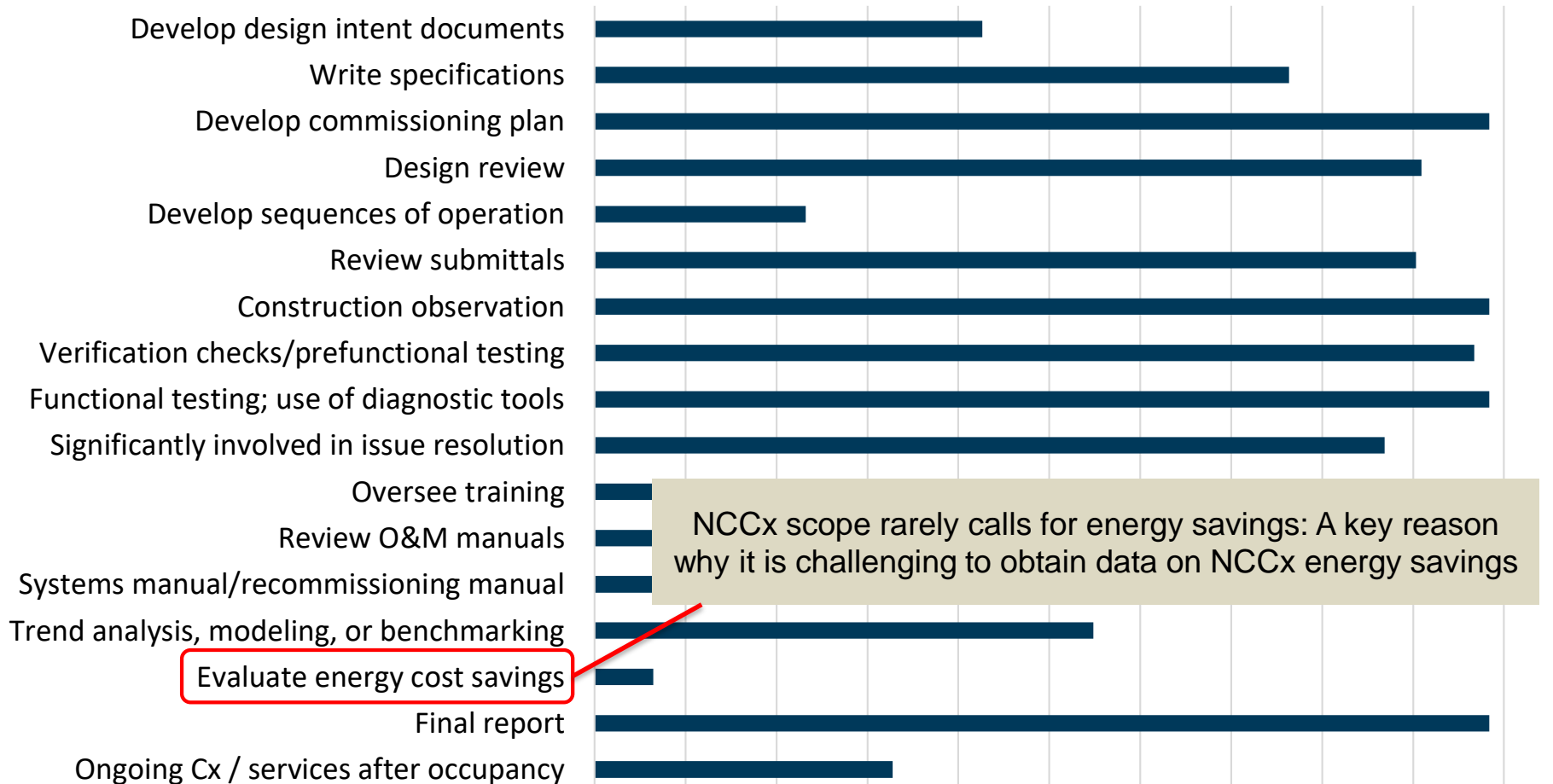
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%



NCCx Scope of Work

Activities included in New Construction Commissioning Scope (n=62)

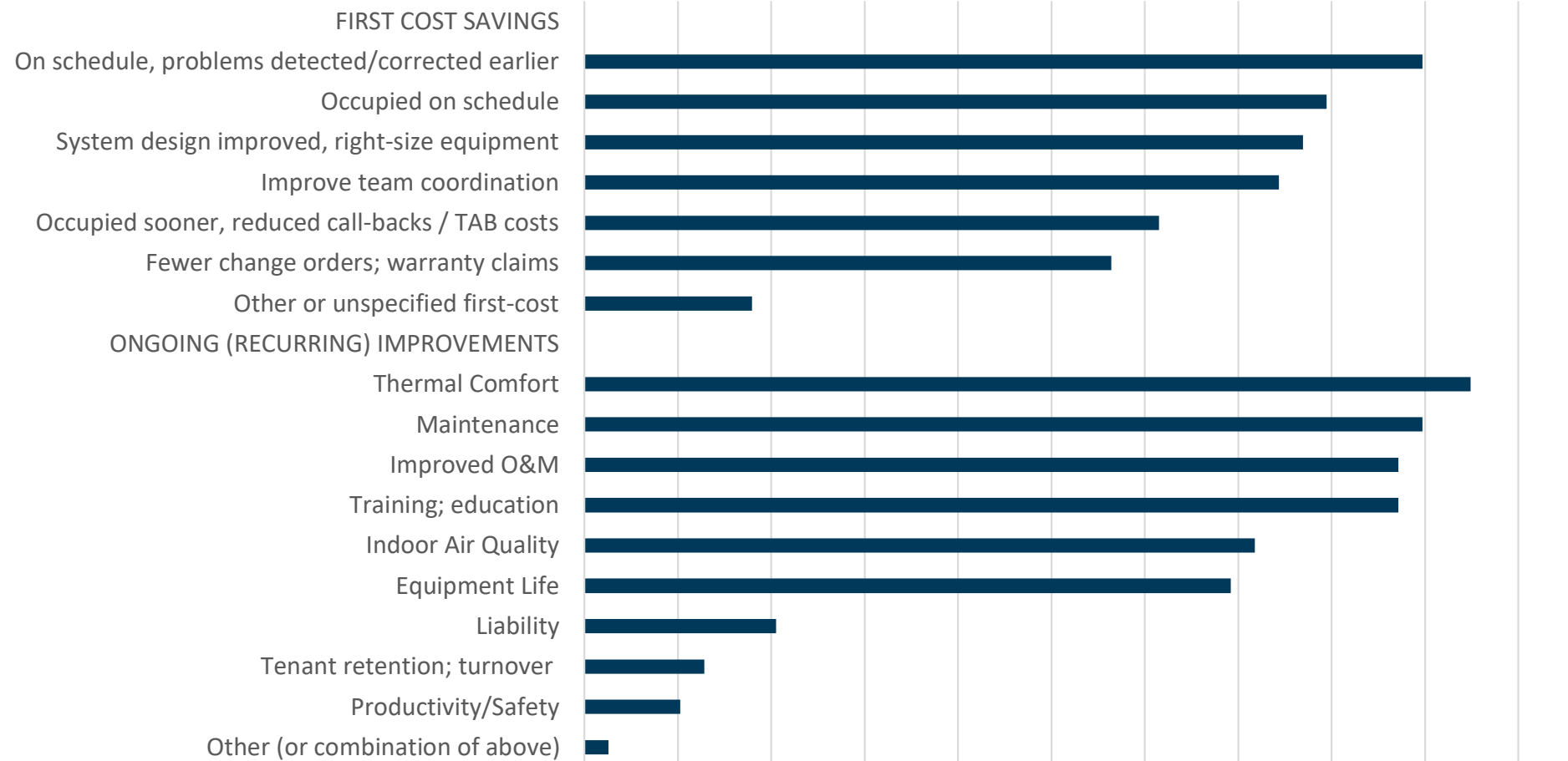
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%



Non-Energy Benefits of NCCx

Percent of Projects Reporting Non-energy Benefits (New Construction)(n=39)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%



Non-Energy Benefits of NCCx

Percent of Projects Reporting Non-energy Benefits (New Construction)(n=39)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

FIRST COST SAVINGS

- On schedule, problems detected/corrected earlier
- Occupied on schedule
- System design improved, right-size equipment
- Improve team coordination
- Occupied sooner, reduced call-backs / TAB costs
- Fewer change orders; warranty claims
- Other or unspecified first-cost

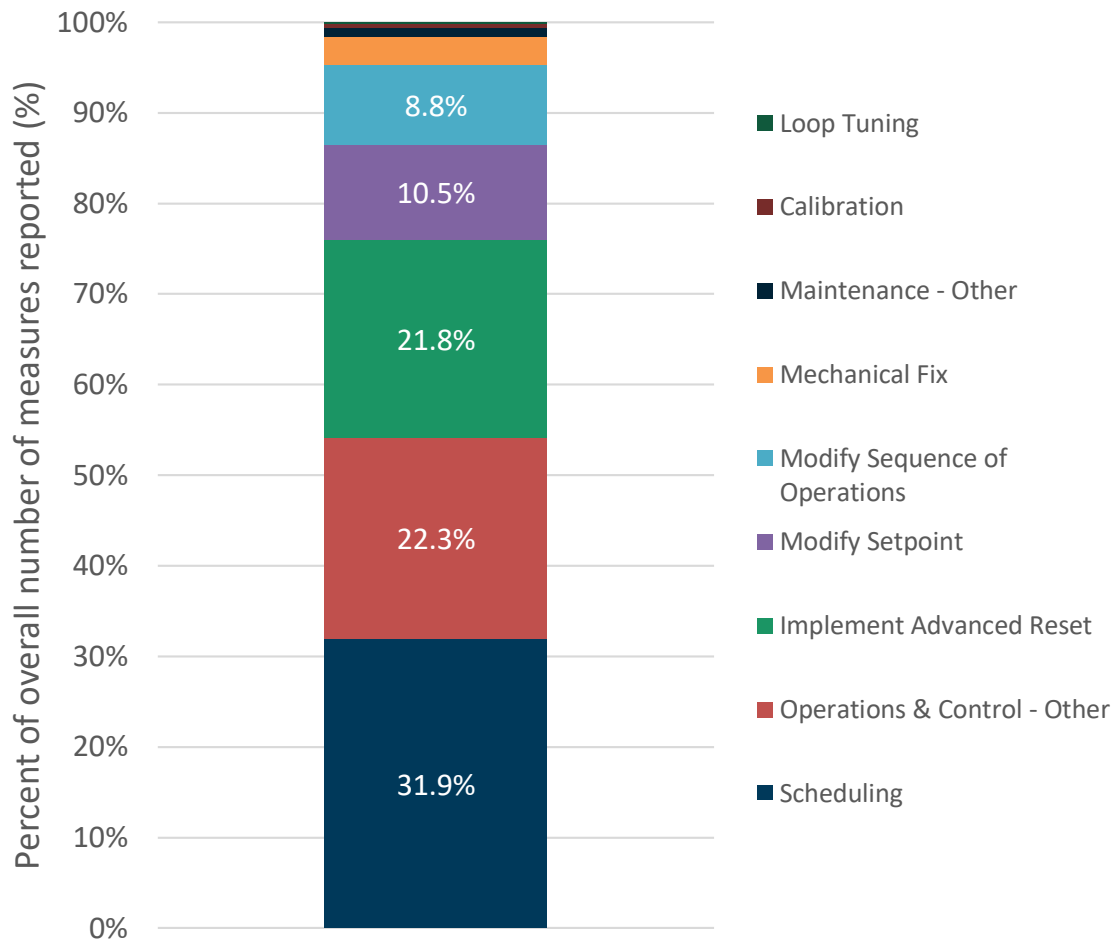
ONGOING (RECURRING) IMPROVEMENTS

- Thermal Comfort
- Maintenance
- Improved O&M
- Training; education
- Indoor Air Quality
- Equipment Life
- Liability
- Tenant retention; turnover
- Productivity/Safety
- Other (or combination of above)

10 high-value non-energy benefits reported on over two thirds of projects, impacting construction project first costs and ongoing benefits

EBCx Measures Implemented

Utility Program EBCx Measure Types (n = 3,695 measures, 503 projects)



- A total of 3,695 installed EBCx measures were reported, across 503 projects: 7.3 measures per projects
- Top 5 measure types account for 95% of the reported measures
- Detailed data on measures not available for NCCx

Key Findings: EBCx

1. Utility EBCx programs shown to reliably offer cost effective savings in the 3%-10% range, at scale
2. Energy Savings
 - a. Median 6%, typical range 3%-11%
 - b. MBCx or EBCx outside utility programs could hit 10%-20% range (but data is limited)
 - c. 2018 median down from 2009, though looking at project type suggests no major market shift (changes more likely due to sample composition)
3. Simple Payback
 - a. Median 1.7 years. Range generally 0.8 and 3.5 years payback
 - b. Median \$0.27 project cost per sq.ft., with a typical range \$0.15-\$0.56
 - c. Projects at lower percent savings can still be highly cost-effective
4. Owners' reasons for implementing EBCx: Top 4 are unchanged from 2009 study

Key Findings: NCCx

1. NCCx Cost

- a. \$0.82 per sq.ft., typical range \$0.40-\$1.35, compared with median \$1.16 in 2009 study
- b. 0.25% of overall construction cost, compared with median 0.57% in 2009 study
- c. Difference in 2018 and 2009 sample composition makes it difficult to conclude true shift in market costs for NCCx, though there is anecdotal evidence costs have reduced
- d. Larger projects tend to have lower cost per sq.ft., and market segment also has an impact on cost

2. Savings and Payback: insufficient data for updating 2009 results

- a. Survey responses report that only 6% of projects include scope item to evaluate energy savings

3. NCCx Scope of Work

- a. For projects in 2018 dataset, >90% of Cx Providers were involved at the design review stage
- b. Engagement of Cx provider for post-occupancy services is still low

4. Non-Energy Benefits

- a. 10 high-value non-energy benefits reported on over two thirds of projects, impacting construction project first costs and ongoing benefits