
Taking your building's pulse

Measuring actual performance

Cathy Turner, New Buildings Institute

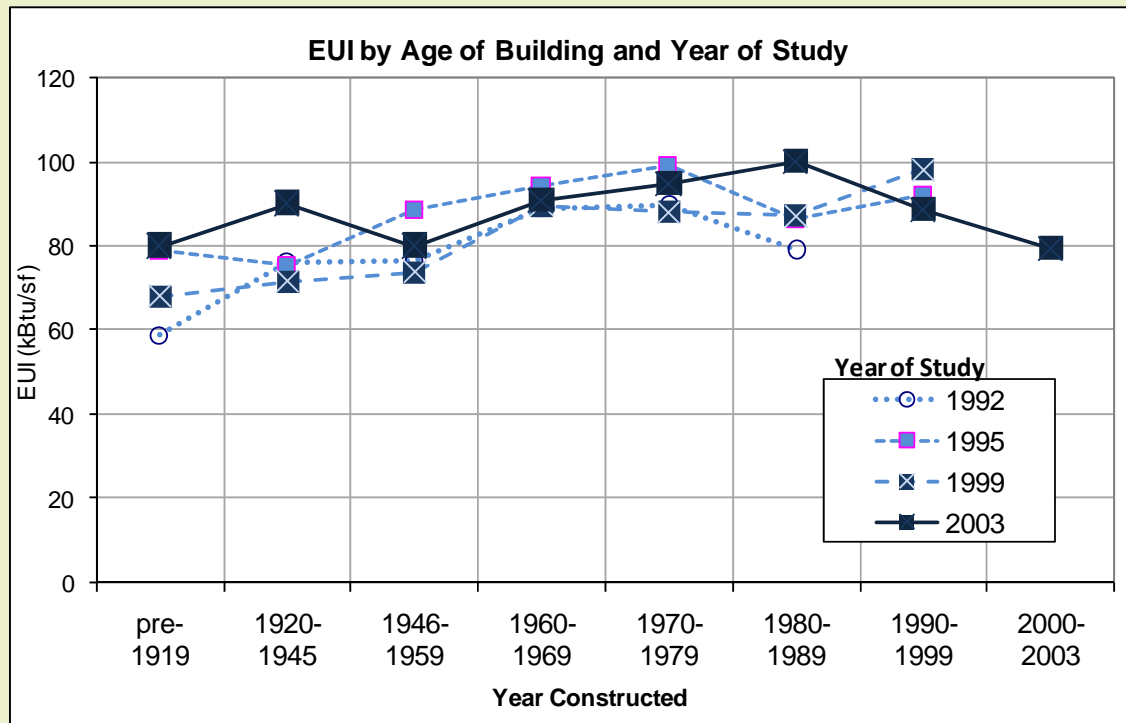
Quantifying building performance

- Background
- Recent LEED building performance results
 - Northwest
 - National
- Occupant satisfaction
- Moving forward

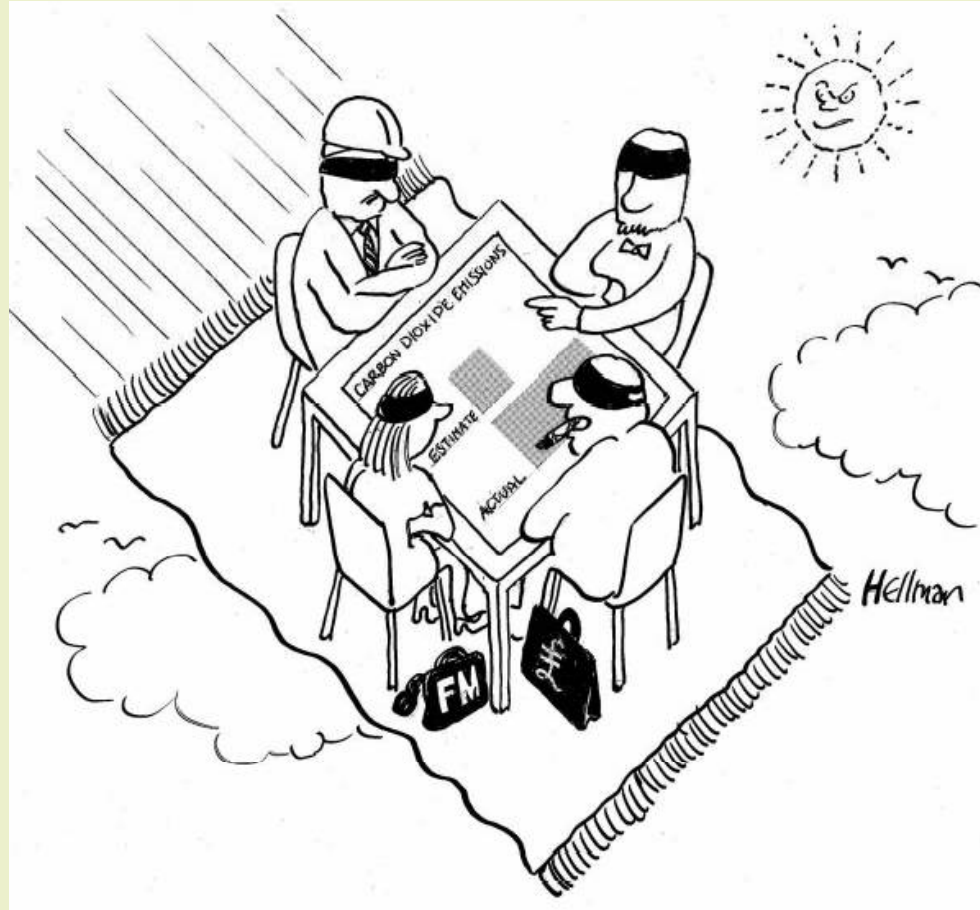
Do all new buildings perform better?

Commercial Building Energy Consumption Survey (CBECS)

Energy Use Intensities (EUIs) by vintage

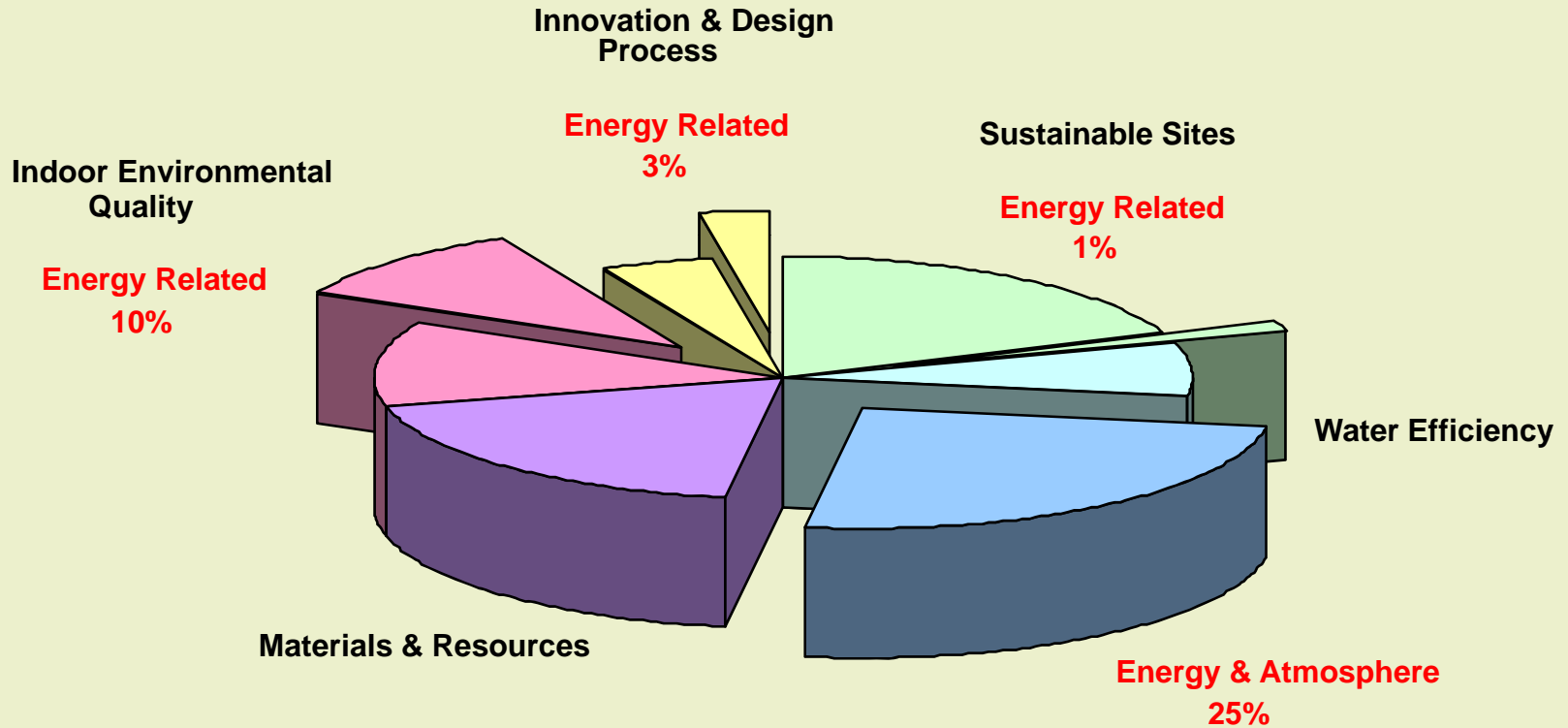


Do “green” buildings perform better?

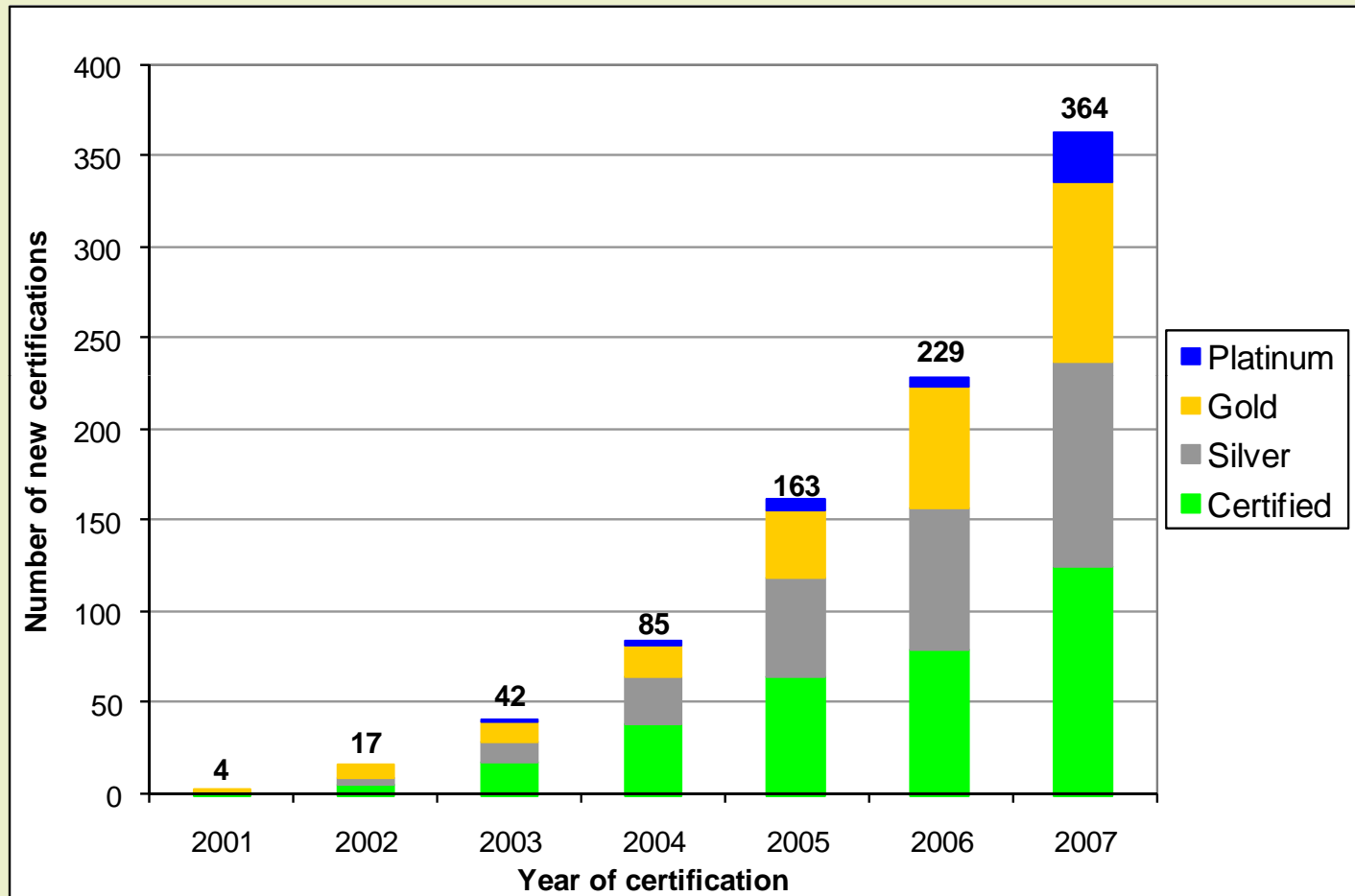


Does anyone know?

LEED New Construction (NC) Energy-Related Credits



LEED New Construction (NC) Certifications

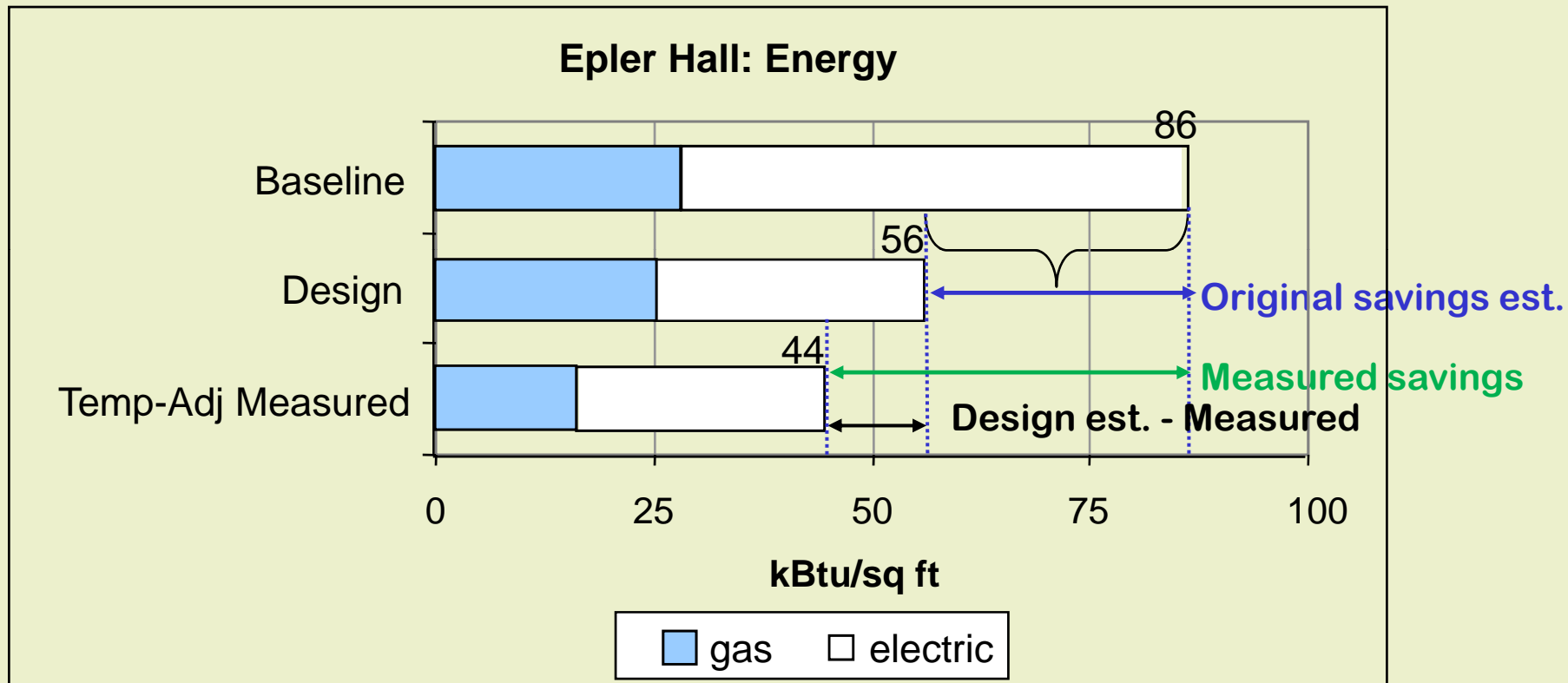


- Reaching the level to support aggregate studies

RECENT LEED PERFORMANCE RESULTS

- ❑ 2004 – 1 building
- ❑ 2005 – 11 buildings
- ❑ 2007 – 121 buildings

Epler Hall Energy Use Review (2004)



Measured usage compared to modeled energy

Energy Bill Savings Summary

- Direct Costs \$200,000
 - after Business Energy Tax Credit
- Direct Savings: initial (2004) calculation
 - using 3% real discount rate
 - \$34,000/year
 - 7 year break-even
 - **17% internal rate of return**
 - **Net \$400,000 present value over 25 years**

Energy Bill Savings Summary: Update

- Direct Costs \$200,000
 - after Business Energy Tax Credit
- Direct Savings: initial (2004) calculation
 - \$34,000/year
- At 2005 energy billing rates
 - \$39,000/year

Epler Energy + Water Savings:

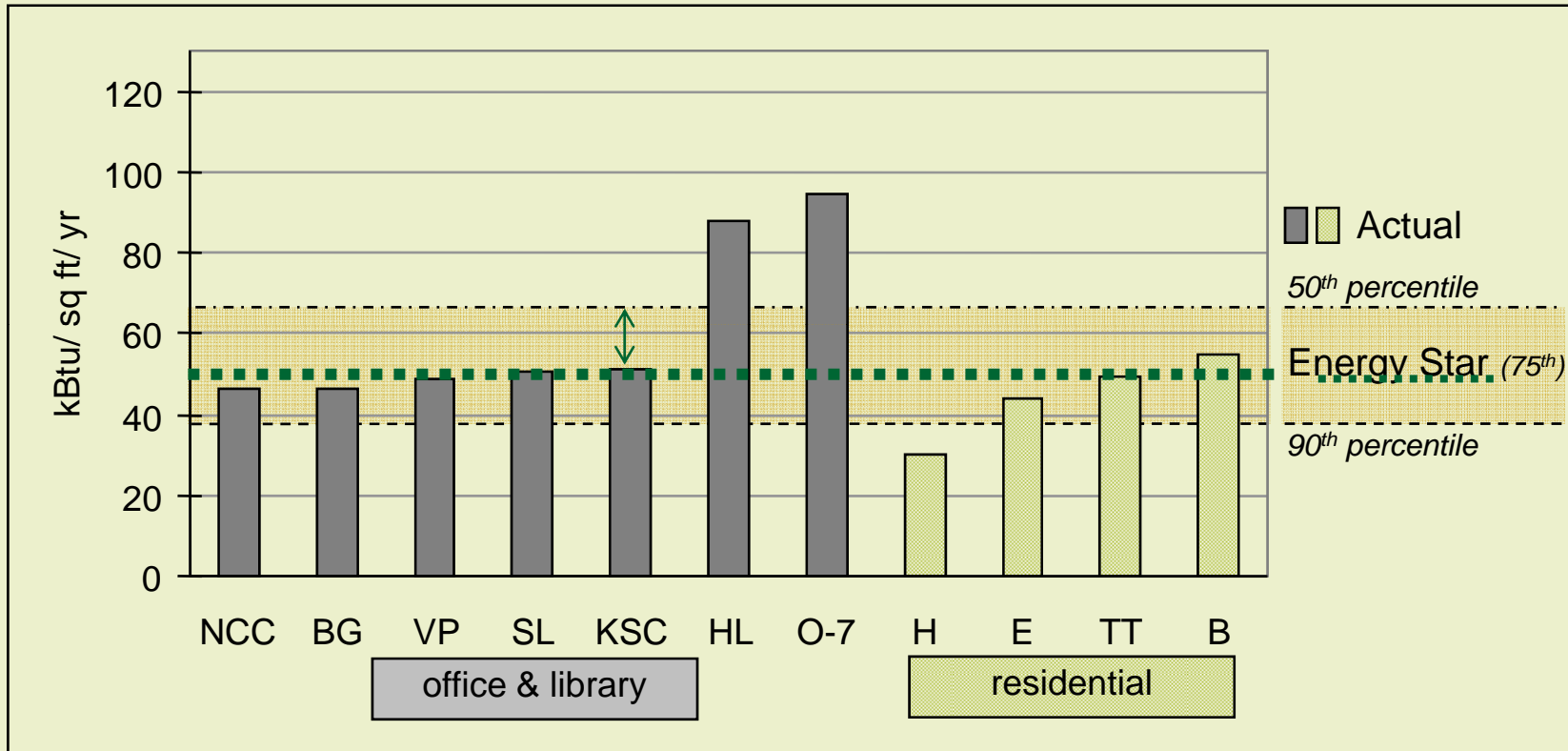
Present Value: 25-Years

■ Water	\$ 29,000
■ Sewer & Stormwater	\$ 90,000
■ <u>Energy</u>	<u>\$606,000</u>
■ Total	\$725,000

❖ **7¼ % of total building cost**

Cascadia 2005 study:

NW LEED buildings vs Energy Star benchmarks



Benchmarks

- 65 kBtu/square foot: median from Energy Star Target Finder
- 36 kBtu/square foot: 90th percentile from Energy Star Target Finder

3. National LEED Study

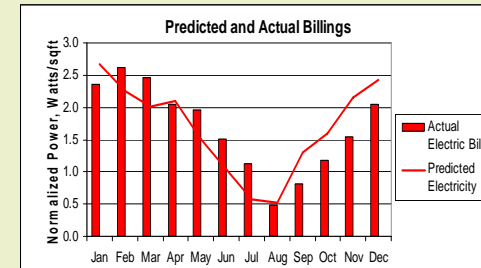
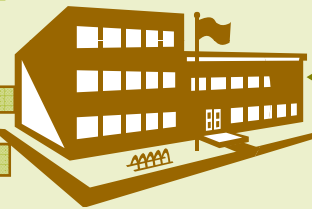
Objectives

- Evaluate measured performance in relation to:
 - Energy Star scores
 - Original modeling
 - LEED points
- Provide useful feedback to owners

Gathering Data

Consolidated study –
Aggregated data

Single building confidential reports to owners

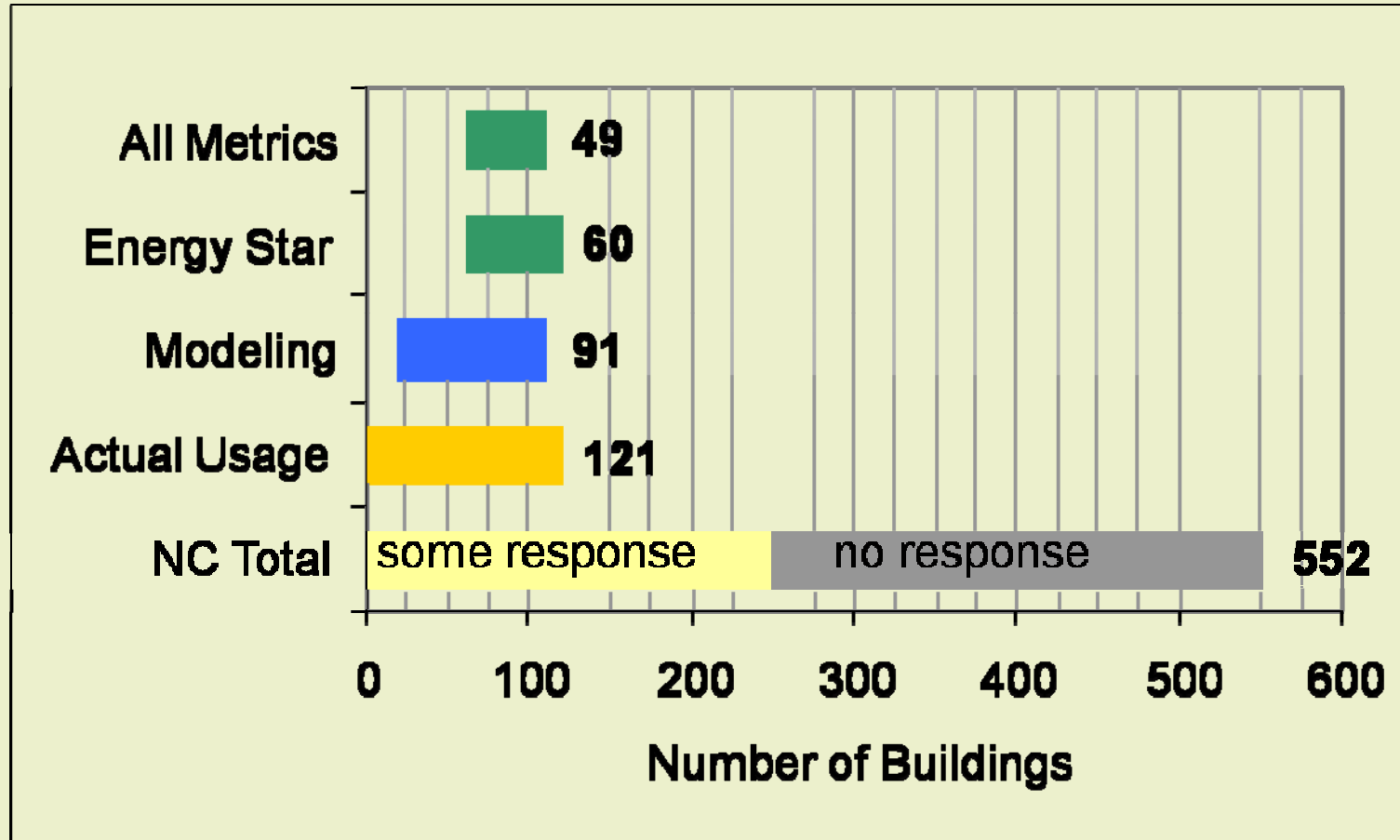


Building energy



Occupant comfort

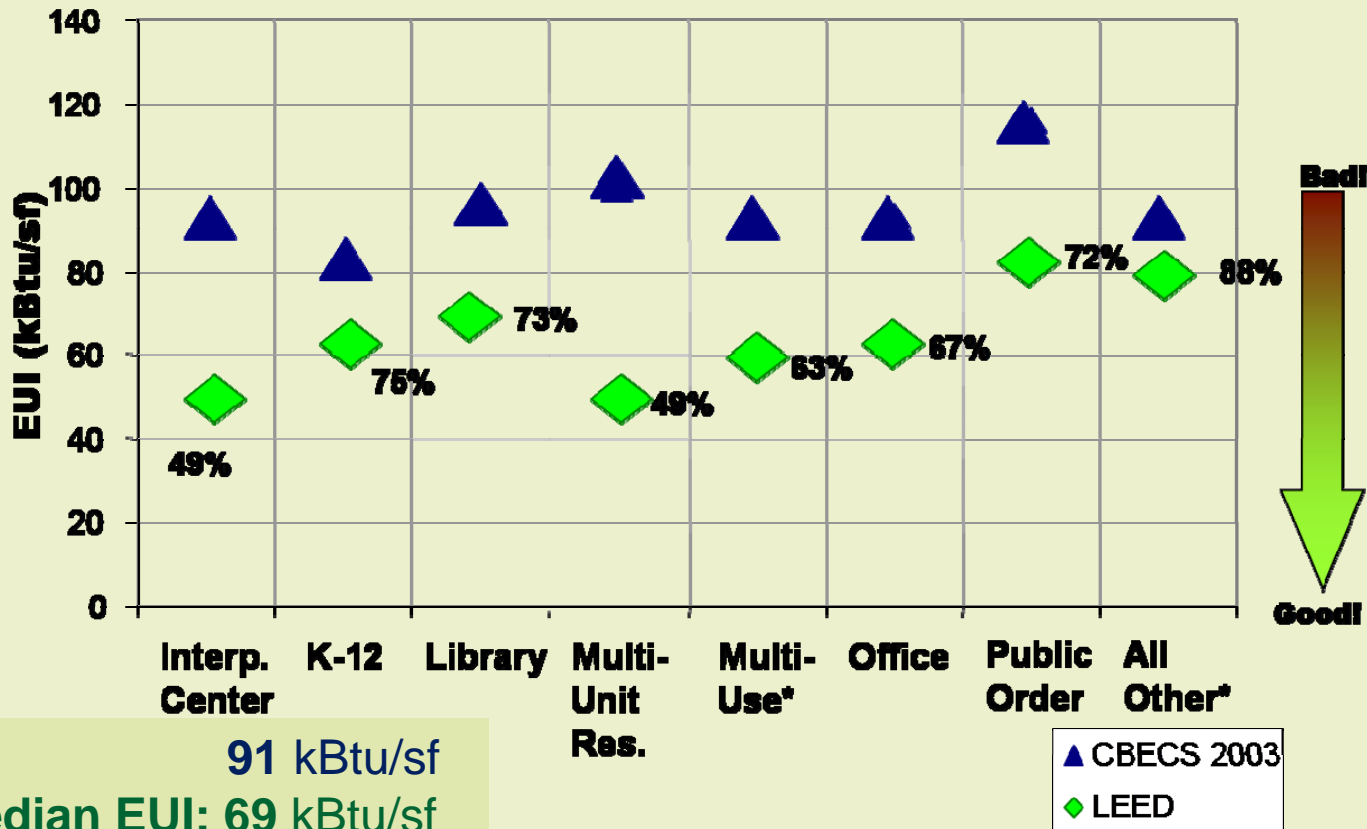
Multiple metrics



Average LEED savings of 25 – 30%

Compared to National Building Stock (CBECS)

Measured v.
Nat'l Avg



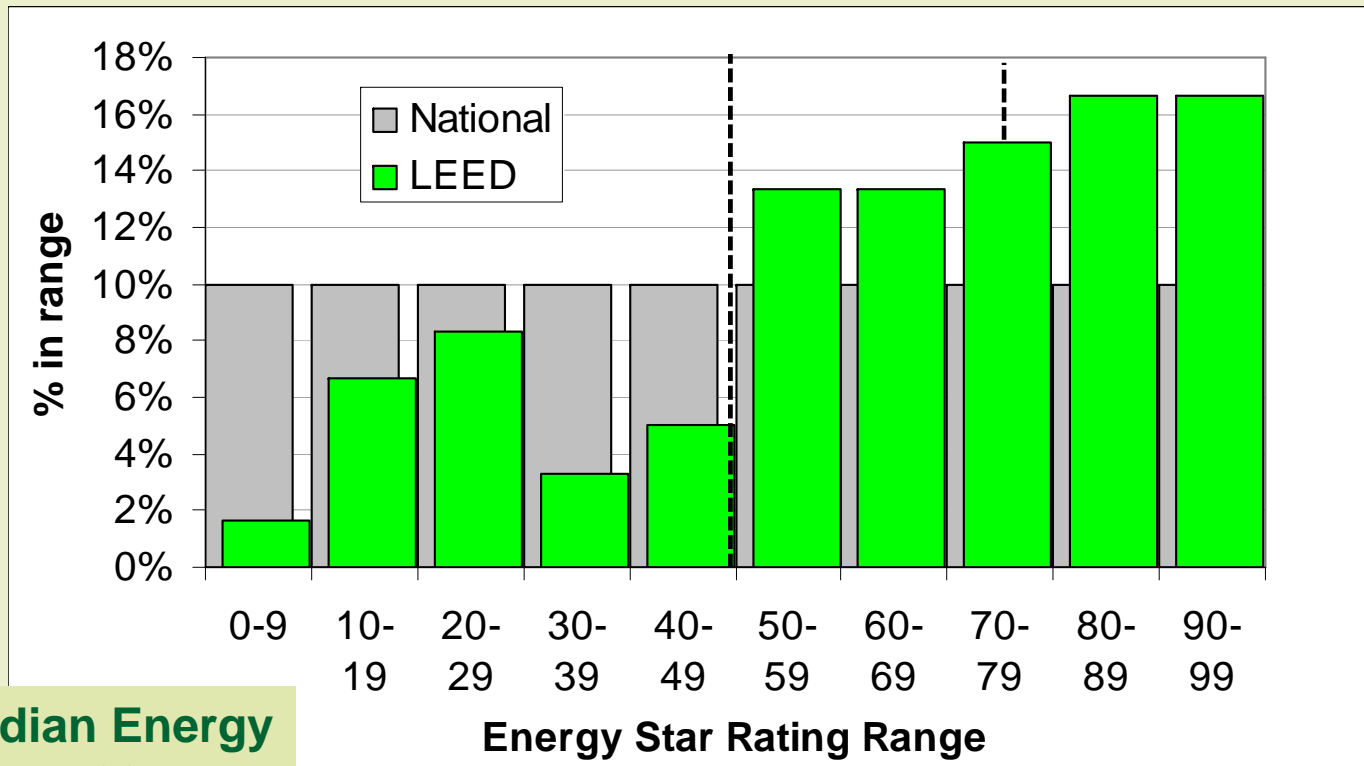
CBECS: 91 kBtu/sf
LEED Median EUI: 69 kBtu/sf

(*) these LEED type groups compared to CBECS all buildings

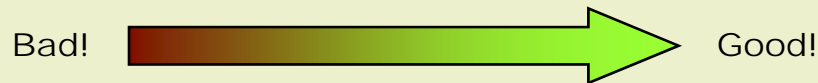
Average LEED savings of 25 – 30%

Refined Building Stock Comparison – Energy Star

Measured Energy Star rating



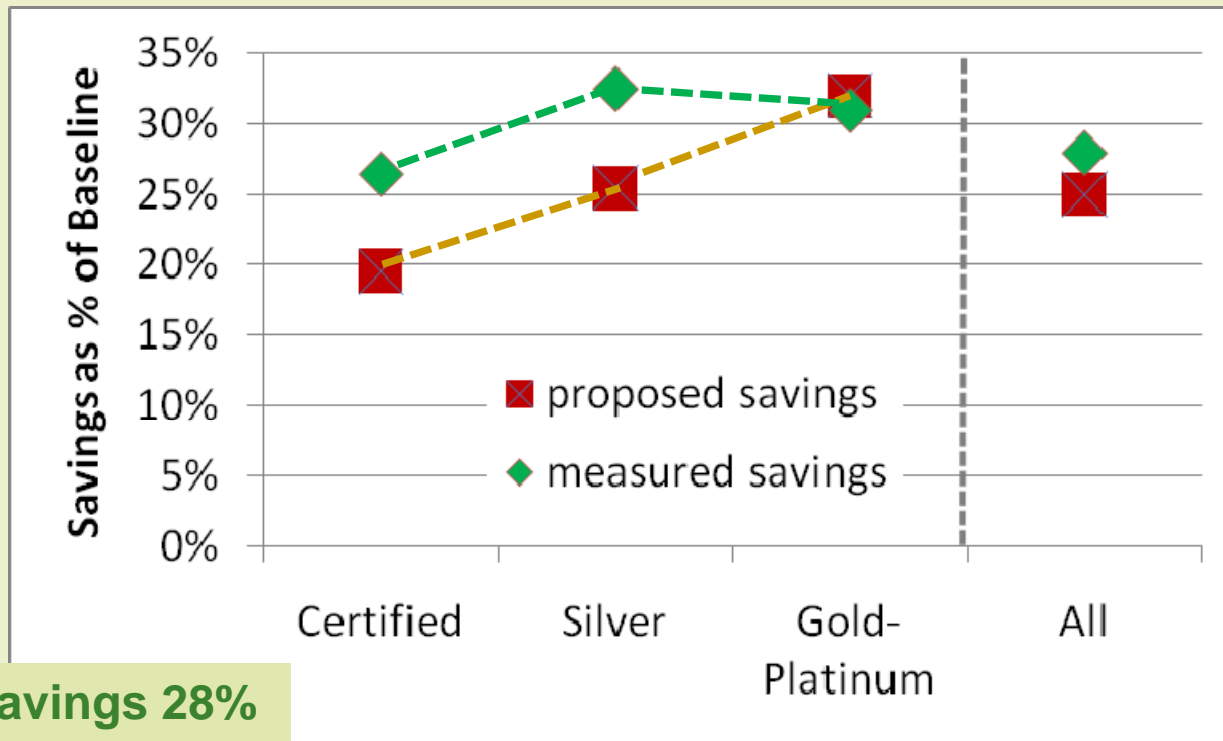
LEED Median Energy Star Rating: 68



Average LEED savings of 25 – 30%

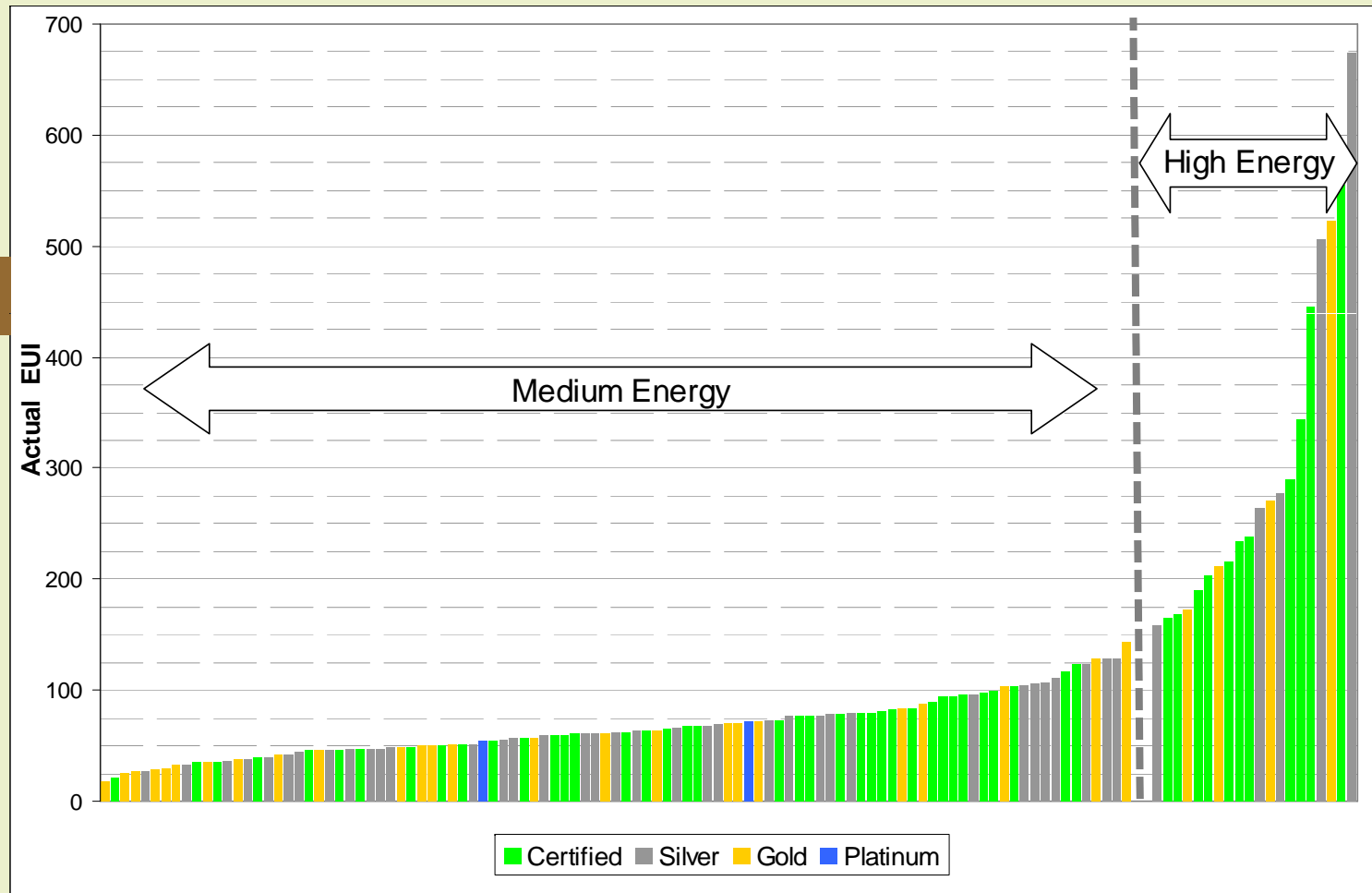
Measured and Design Compared to Baseline Modeling

Measured
v. Design
Model

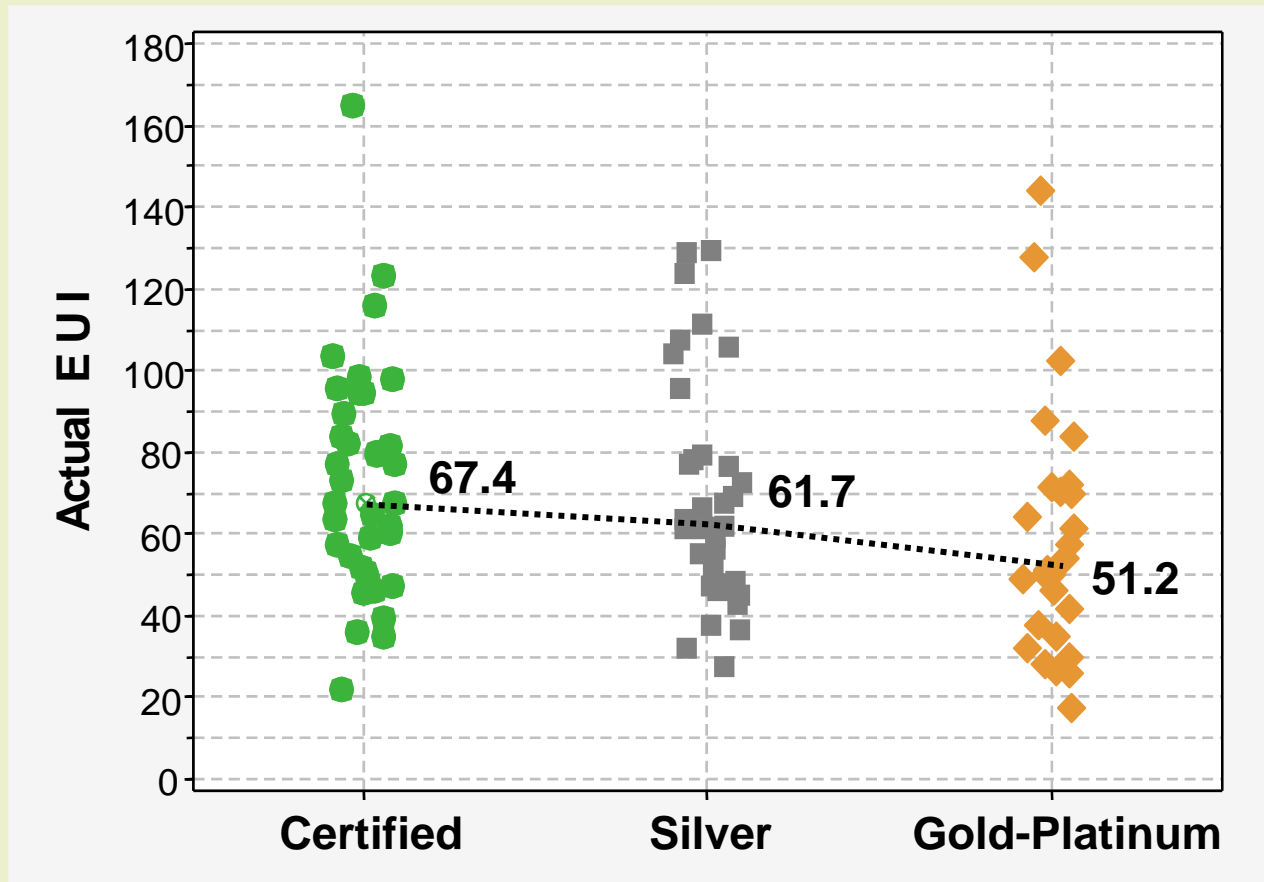


Measured Savings 28%
Proposed Savings 25%

Individual results are varied



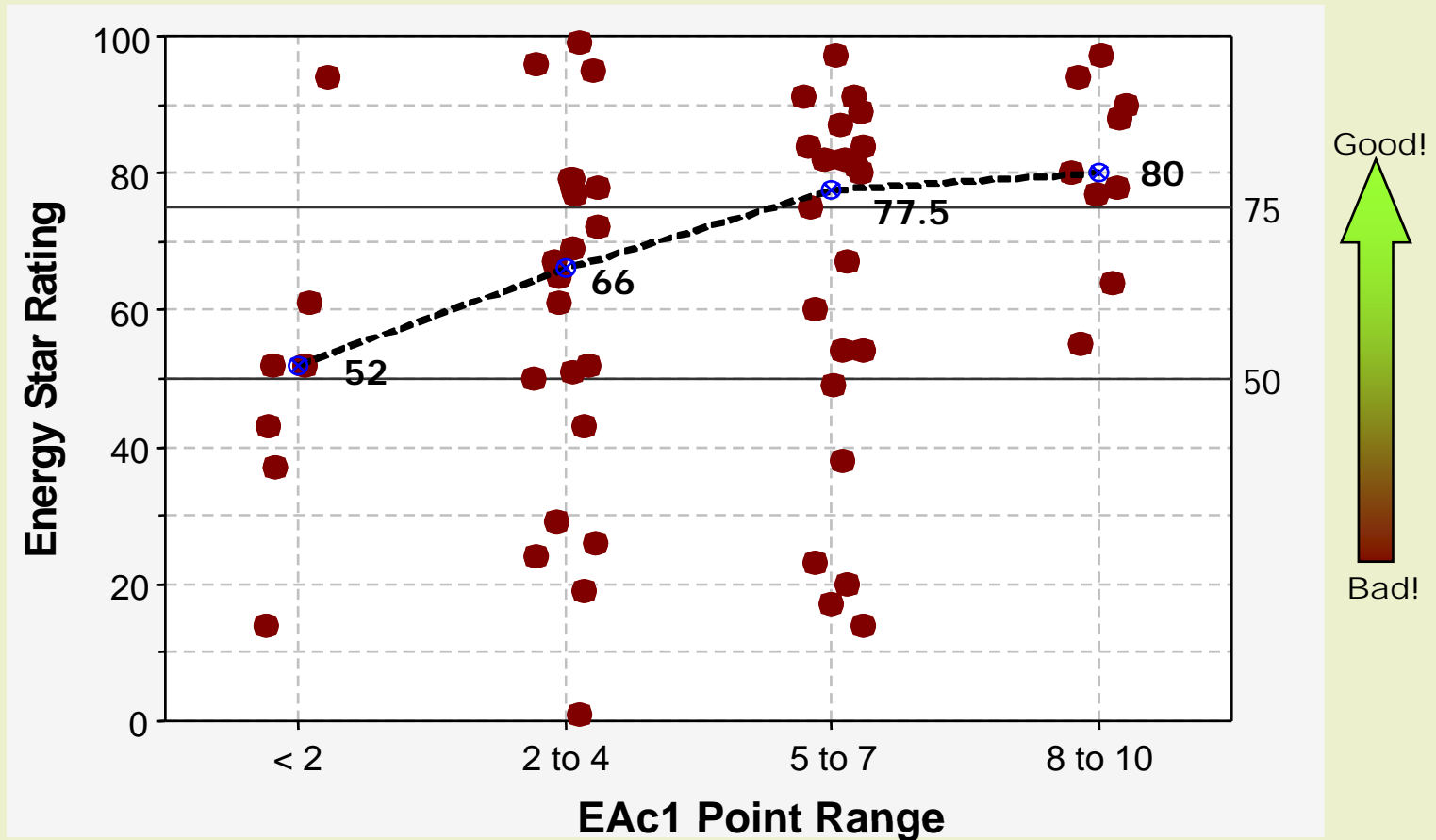
EUIs by LEED level



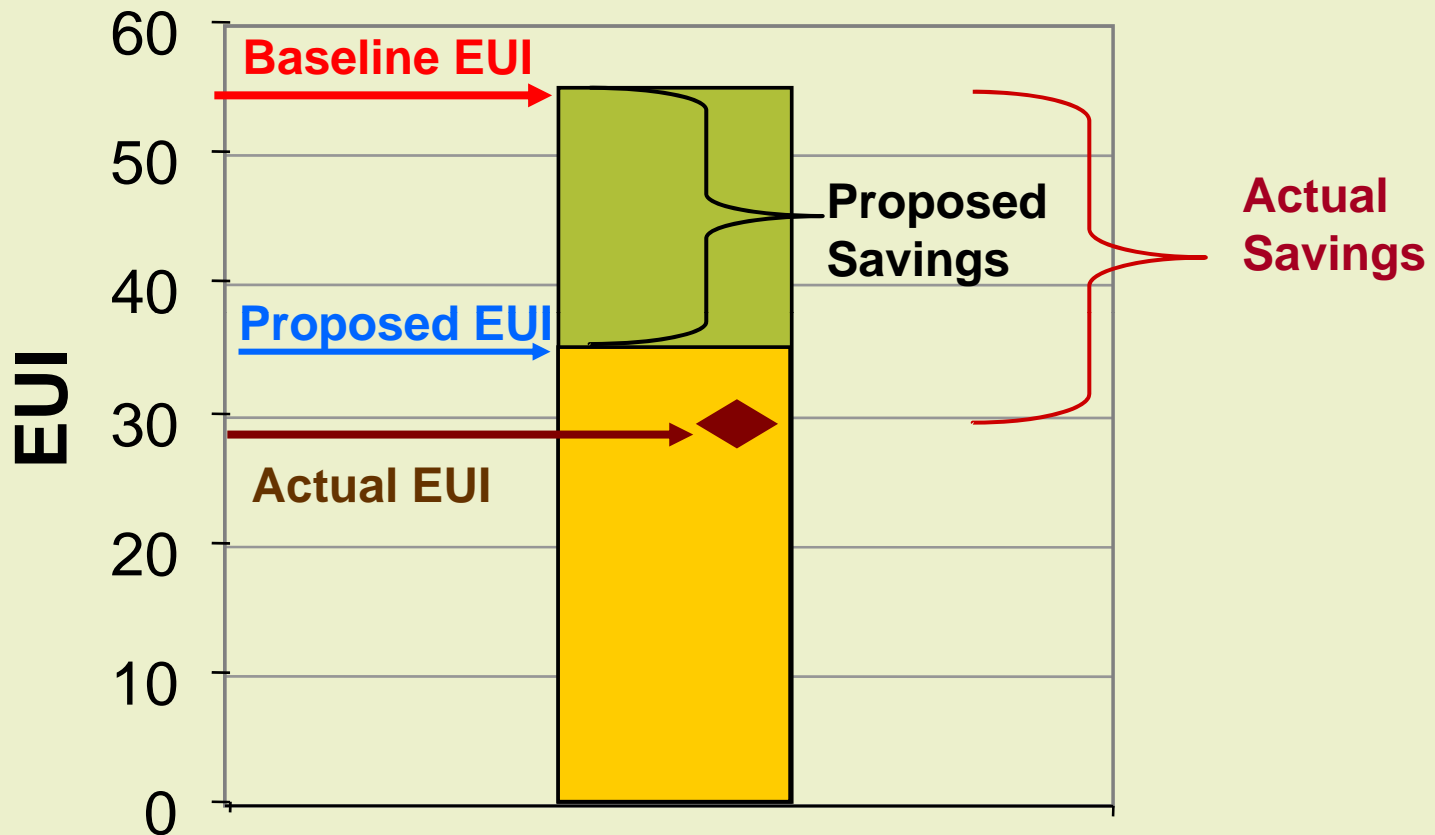
Measured detail

this and later slides based on just on the medium energy type buildings unless noted

Energy Star scores by Energy Optimization (EAc1) points



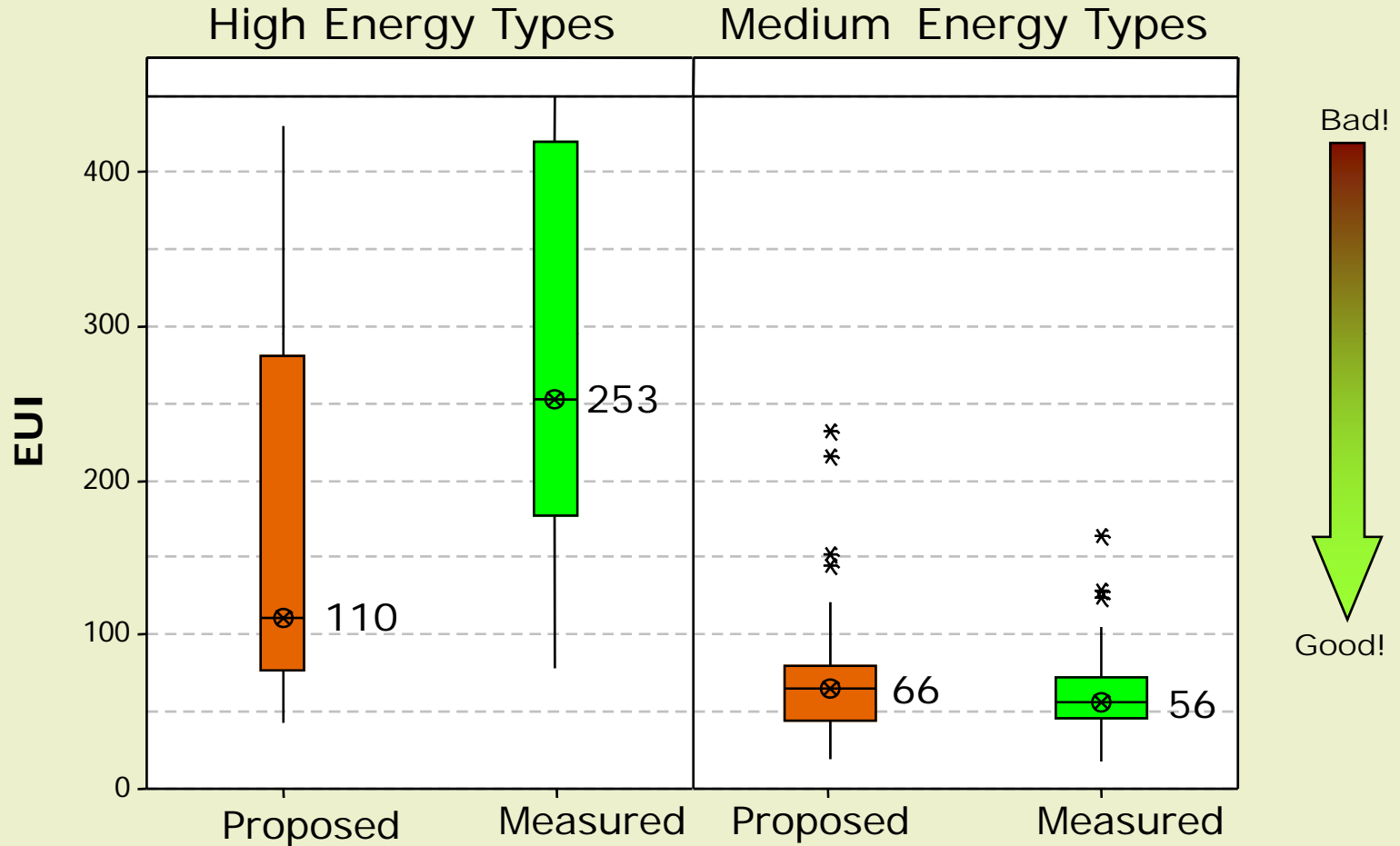
Modeling savings terminology



Measured v. Modeled Limitations

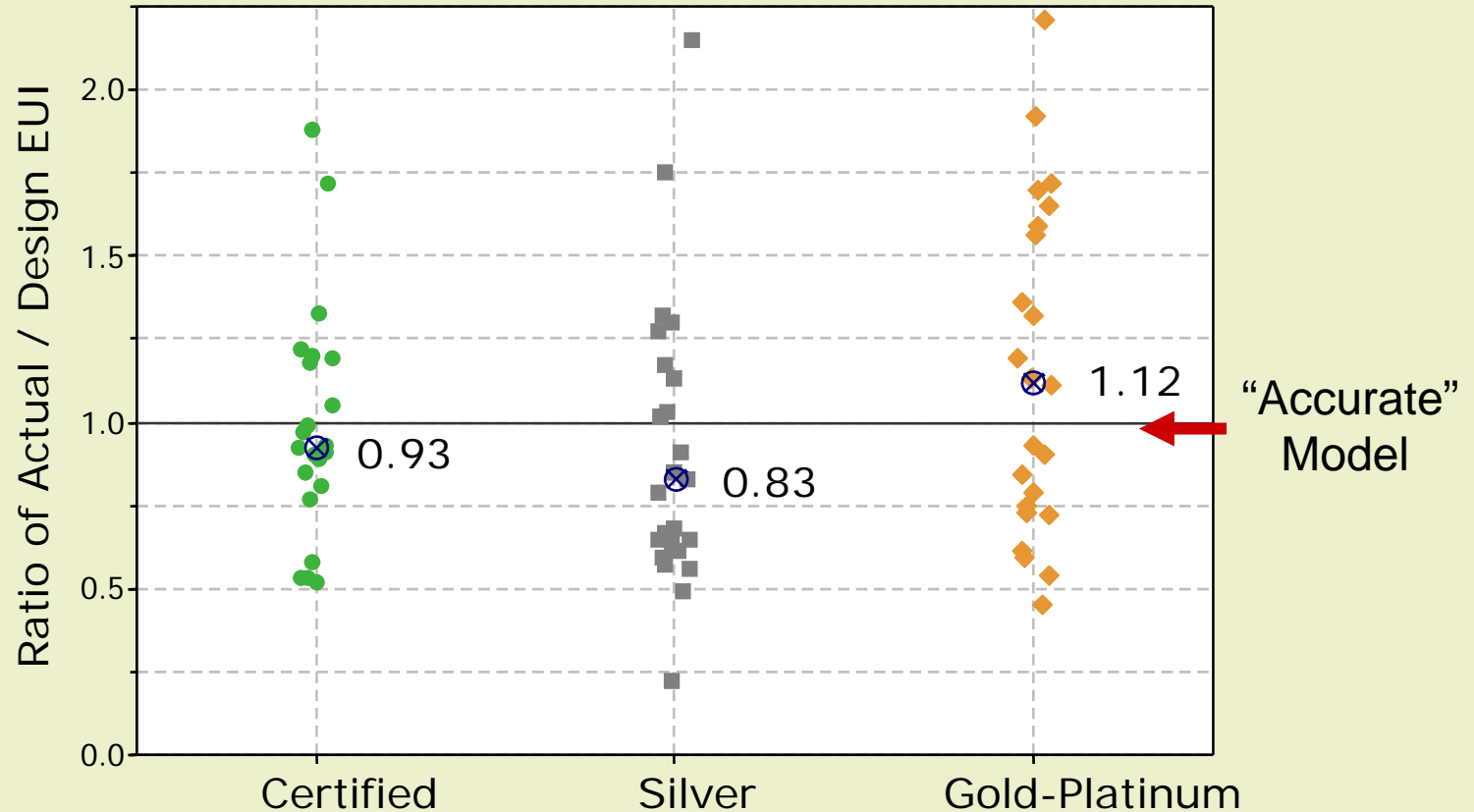
- Modeling used for
 - Predicting relative performance
 - Evaluating alternative efficiency measures
 - Determining LEED NC credits
 - Predicting absolute performance?
 - Performing expected life cycle cost analysis
 - Benchmark for future performance
- Refinements for precise measured comparisons
 - Expected v. actual occupancy, schedules?
 - As-designed v. as-built?
 - As-designed v. as-occupied?

Modeled EUI ranges



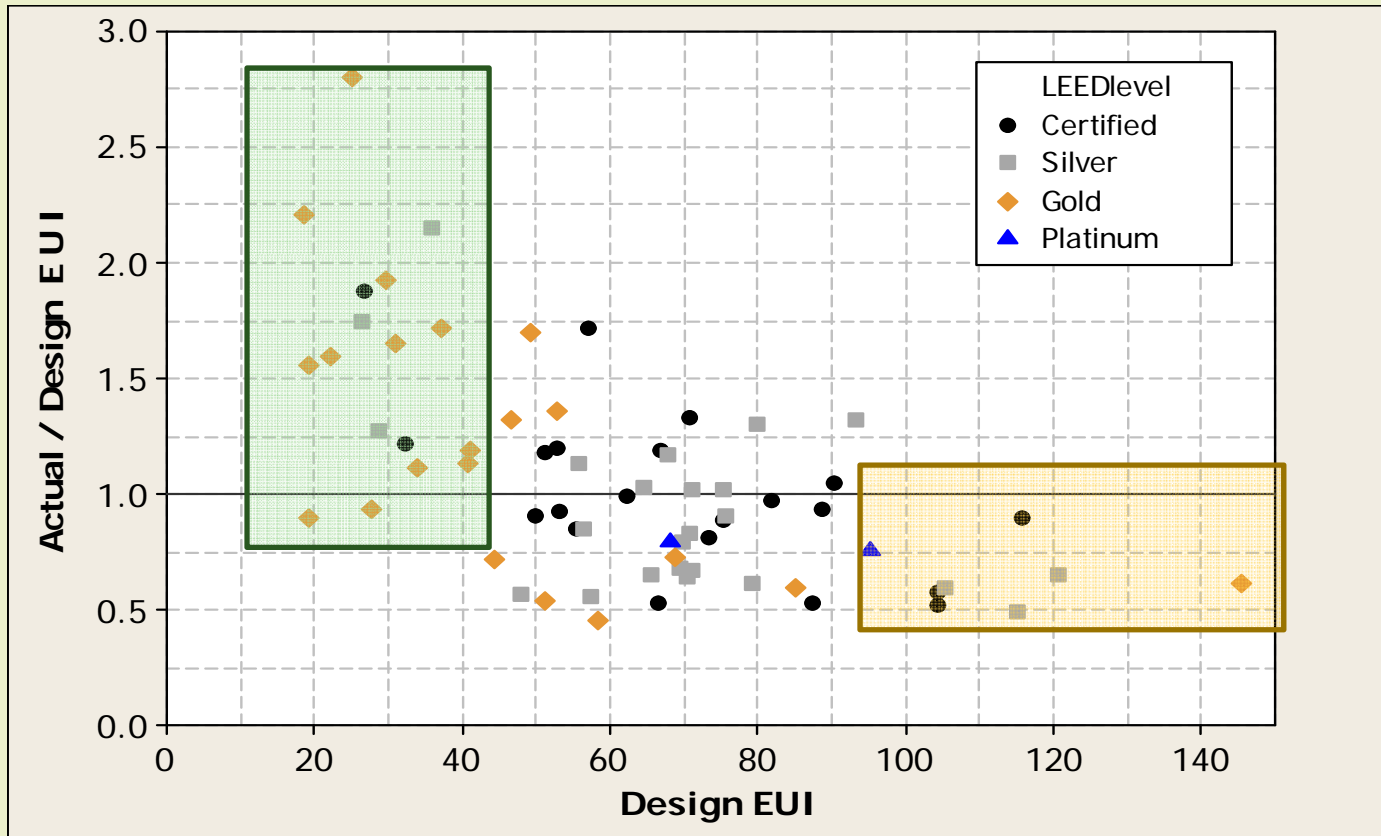
Measured
v. Design
Detail

Actual to Design ratios vary

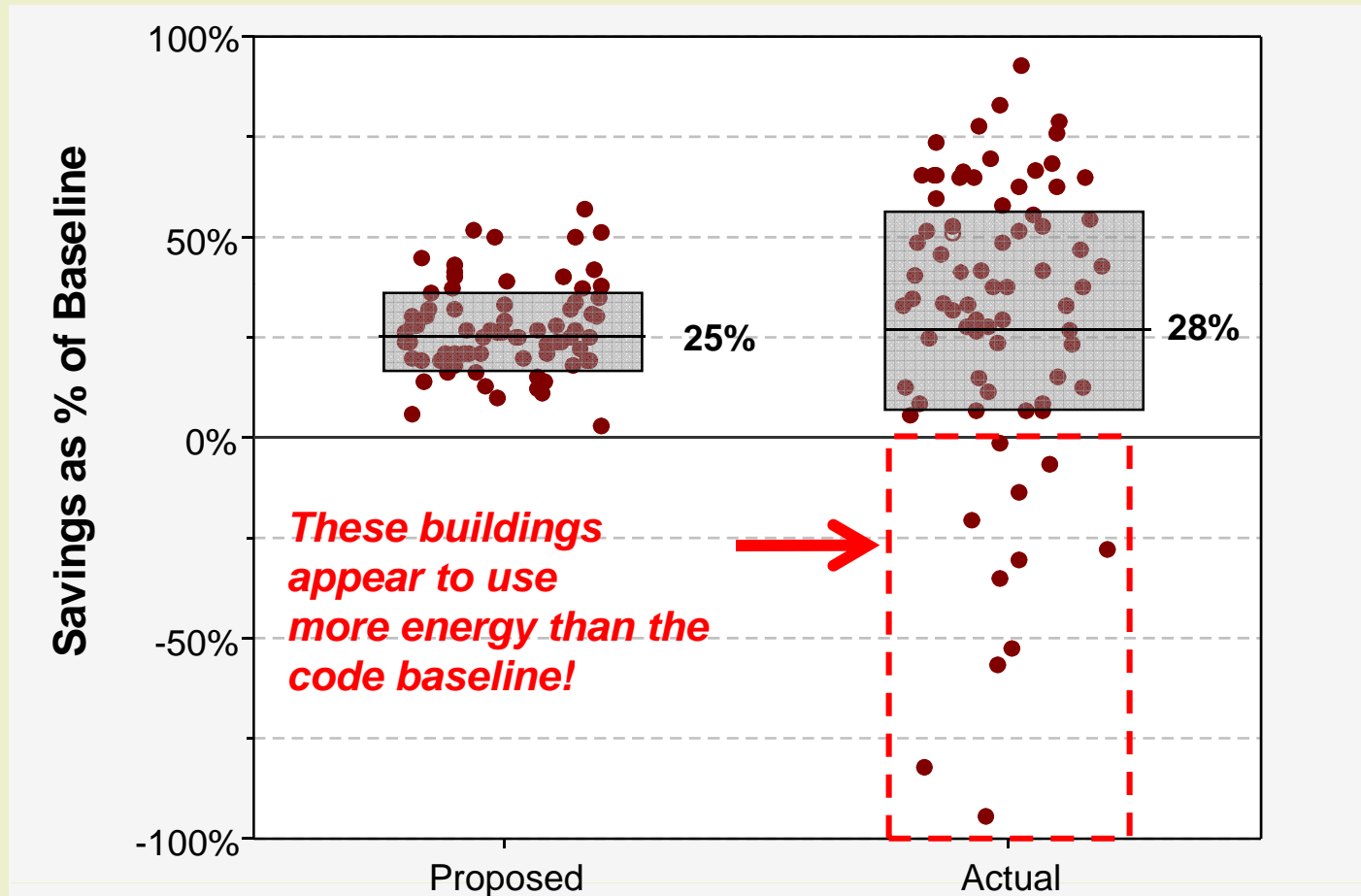


Models are more optimistic at lower predicted EUIs

Measured
v. Design
Detail



Actual savings vary



LEED Study Conclusions

- Consistent average savings 25 – 30%
- Wide variability suggests need for:
 - better understanding of actual performance drivers
 - improved modeling guidance
 - more actionable feedback to owners
 - easier access to energy data
 - program refinements to support good performance

Full study report available at www.newbuildings.org

What do the occupants think?

- Survey approach
 - On-line survey; All who work in the building invited
 - Office response rates typically 40% to 75%
 - Residential response rates minimal without communication

- Sample questions

4. Temperature in your primary work location

For each of the following areas, select the level that best describes your primary workspace.

6. Overall temperature comfort

Uncomfortable Comfortable

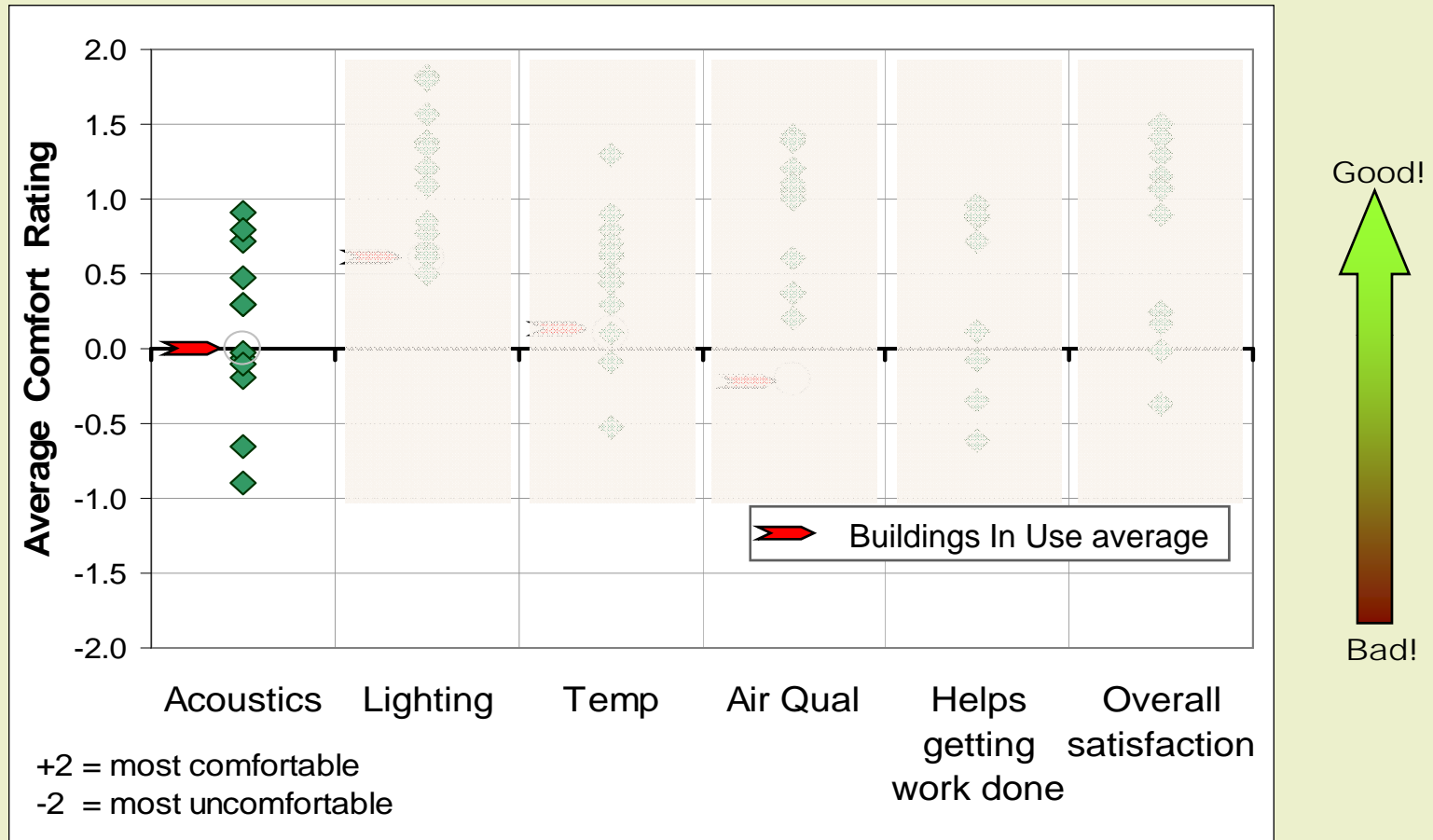
7. How cold it gets

Too cold Comfortable

8. How warm it gets

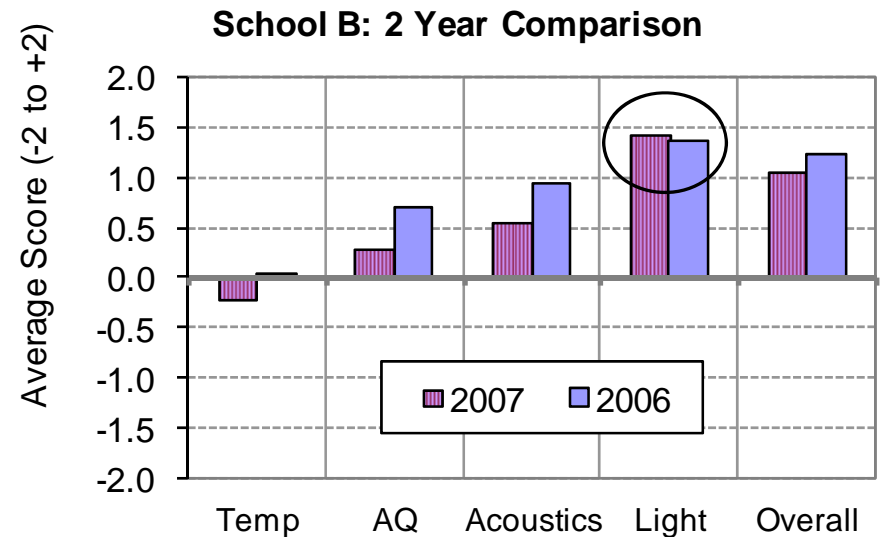
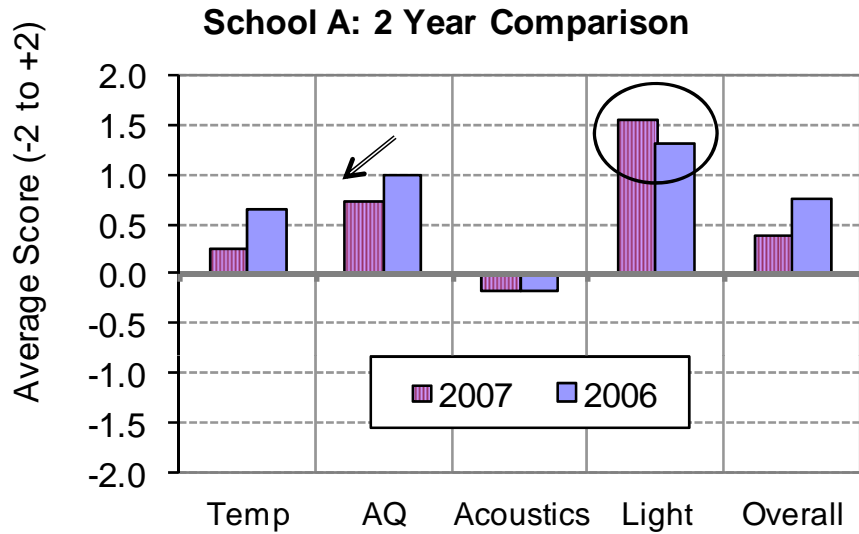
Too warm Comfortable

Occupant functional comfort



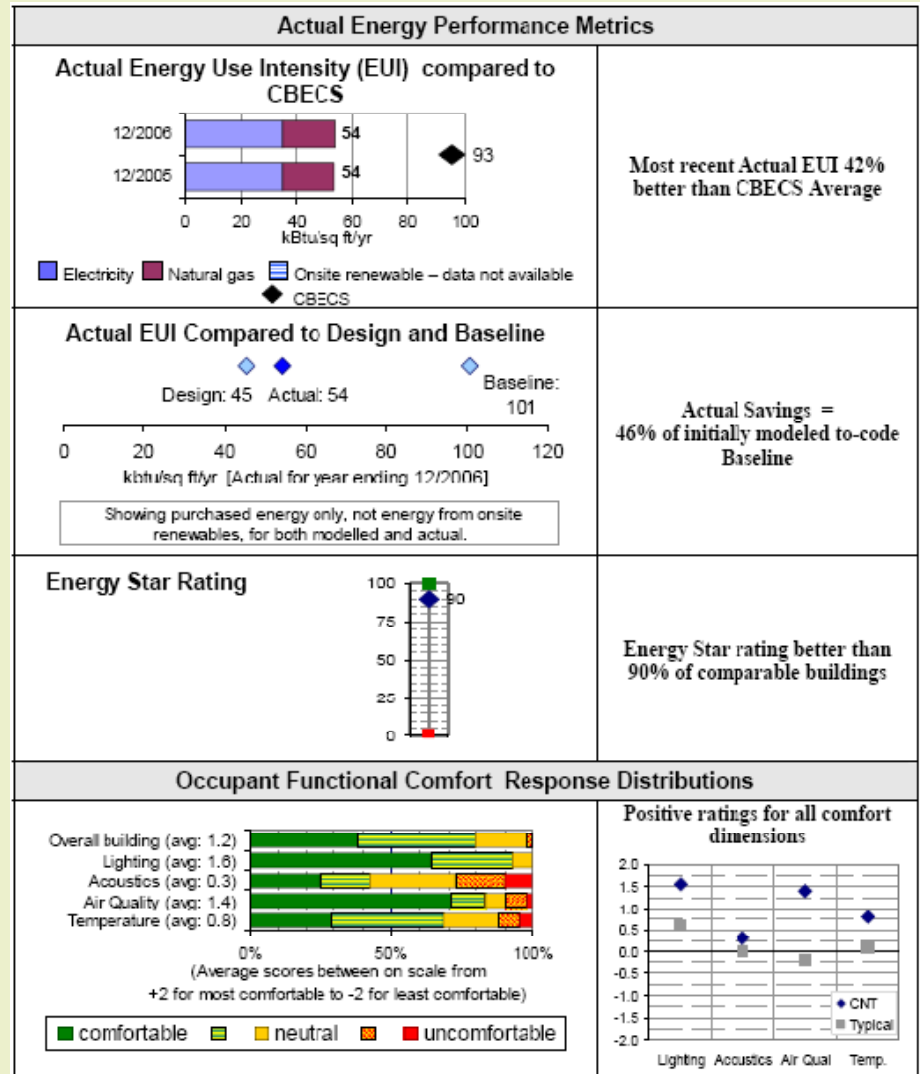
LEED energy study

New and Nearly New building feedback



Combined metrics snapshot

- Measured v. National Average
- Measured v. Modeled
- Energy Star rating
- Occupant comfort



CBE study: thermal comfort in new buildings

Mean Scores - Thermal Comfort
LEED (n=39) compared to CBE database (n=284)



Graph provided by UC Berkeley Center for the Built Environment (CBE)

MOVING FORWARD: MEASURED PERFORMANCE INITIATIVE

- Feedback for multiple audiences:
 - Owners/operators
 - Financial decision makers
 - Design community
 - Program and policy managers

Who needs feedback?

Audience	Feedback Needs	Uses
Owners & operators	<ul style="list-style-type: none">▪ Whole building report cards▪ Action-oriented guidance▪ Results-responsibility alignment	<ul style="list-style-type: none">▪ Prioritize enhancements▪ Baselines for tracking progress

“In the case of green building, the risks of not moving quickly enough almost certainly will outweigh the risks of moving too quickly.”
Andrew Nelson, RREEF

“Everyone agrees we have a problem, but no one has told me what to do about it”
LEED building owner

“It was a perfectly good building until people moved in.”
Steve Fry, Washington Dept of Ecology

Who needs feedback?

Audience	Feedback Needs	Uses
Financial decision-makers	<ul style="list-style-type: none">▪ Market return impacts▪ Cost and savings of EEMs▪ Productivity impacts	<ul style="list-style-type: none">▪ Appraisal, marketing, leasing▪ New building design decisions

“It’s essential to translate energy usage to cost savings.”

Leanne Tobias, Malachite LLC

“77% of corporate space users would pay a premium to rent or buy green space”

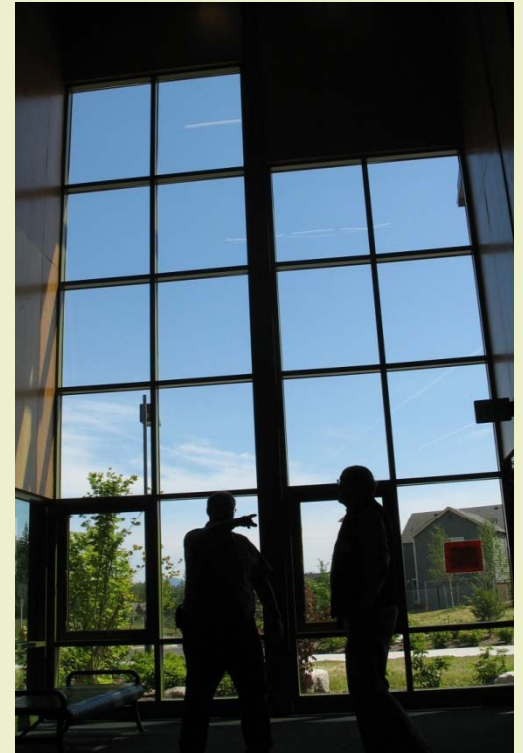
CoreNet, Jones Lang LaSalle

“Green doesn’t cost *more*; It just costs *different*.”

Gary Christensen

Common needs

- Focus on the marketplace
 - Accessible reporting
 - Actionable information
- Measure the basics
 - Usage by month and fuel
- Support multiple layers
 - Whole building, primary components, diagnostic detail
- Develop the right benchmarks
 - Common metrics
 - Data gathering and aggregation tools



A few activities underway

- Financial
 - CoStar Database, Davis Langdon report, IPD Environment code
- Metrics & Benchmarking tools
 - ASHRAE protocols
 - Portfolio Manager and Target Finder enhancements
- New studies and data-gathering approaches
 - Performance studies
 - Databases: DOE's High Performance Buildings database, Green Building Alliance-DASH
- Programs
 - USGBC Existing Buildings O&M refinement
- Communication channels

Wayfinding tools

Measured Performance Materials

Filter for:

Sort by:

Topic = **Financial**
Found: **4 resources**

Title	Author	Year	Brief Description	Topics
Cost of Green Revisited	Matthiessen, L.F., Morris, P., Davis Langdon	2007	Reviews the cost/sf of 221 buildings, comparing LEED and non-certified.	Financial
Does Green Pay Off?	Miller, Spivey and Florance for NAIOP	2007	Preliminary results from a comparison market and occupancy factors for green and non-green (Energy Star or LEED) class A office space from the CoStar database	Financial
Green Building Finance Consortium website	Muldavin, S., Green Building Finance Consortium	ongoing	The site's Resources pages have GBFC publications, links to many other finance articles/sites, and a database of article references searchable by topic, author or title.	Financial, Market Research
Greening of U.S. Investment Real Estate	RREEF	2007	Study of institutional investment in green real estate, including comparisons of LEED, Energy Star, and conventional market performance based on the CoStar database	Financial

www.newbuildings.org/MeasuredPerformance.htm

In Review



- Growing interest in measured results
- Recent LEED building performance
 - Consistent average savings
 - Variability shows room for improvement
- Moving forward requires
 - Accessible data
 - Meaningful benchmarks
 - Actionable reporting
 - Communication channels