

# SUSTAINABILITY TRACK

## Session 7



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# Whole Building Performance Measurement

Kim M. Fowler  
Emily M. Rauch

Pacific Northwest National Laboratory

GovEnergy, August 5<sup>th</sup>, 2008

# We've Begun. Here is what we've found so far...

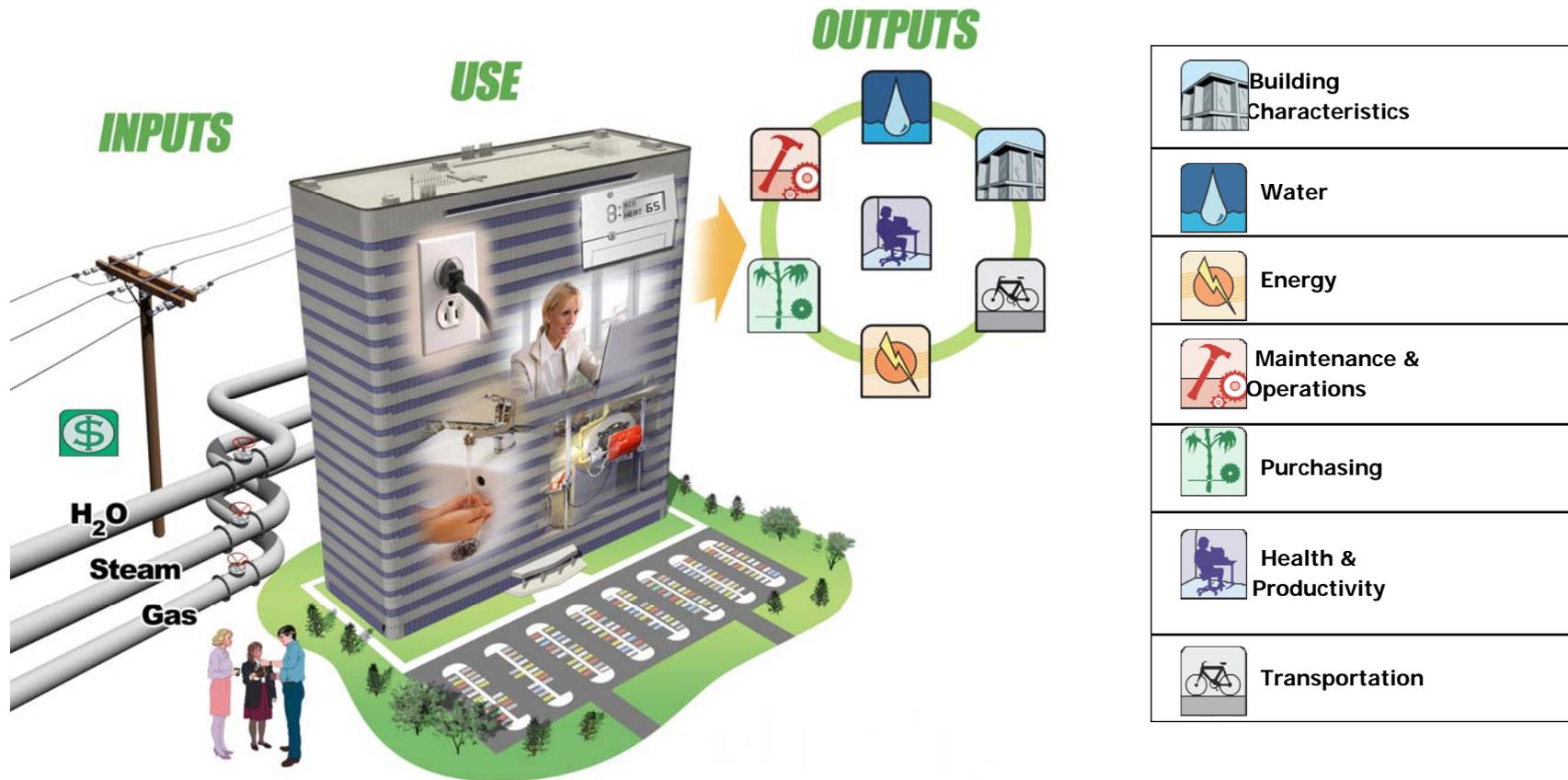
- ▶ Three major points based on the evidence
  - Sustainably designed buildings perform better than industry baselines
  - Design emphasis on a performance target equates to better performance
  - Consistent data collection allows for more accurate performance measurement analysis

**There is much more to do!**

# Overview

- ▶ What is Whole Building Performance Measurement (WBPM)
- ▶ Results from current government studies
- ▶ Strategies for WBPM
- ▶ Lessons learned

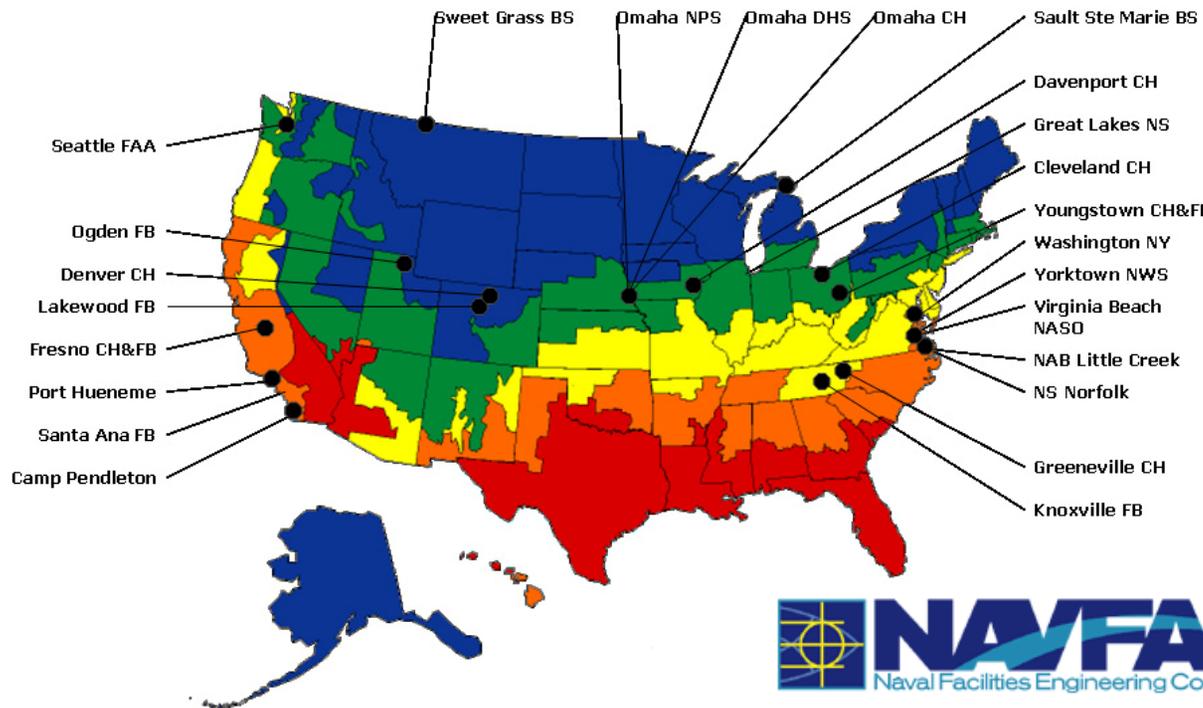
# What is Whole Building Performance Measurement?



Whole-Building Performance Measurement involves measuring, not estimating or modeling, actual building related performance.

# What the government is doing?

- ▶ Side-by-side comparisons of green and typically designed buildings
- ▶ Green portfolio compared to industry & internal standards
- ▶ Designing and constructing green buildings with WBPM integrated into design, compared to typical buildings



## Sample Results and Findings from:

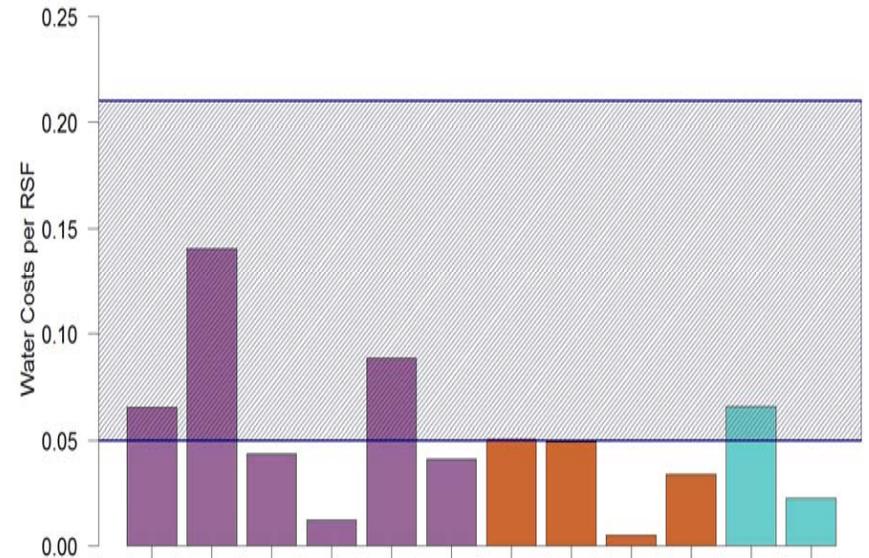
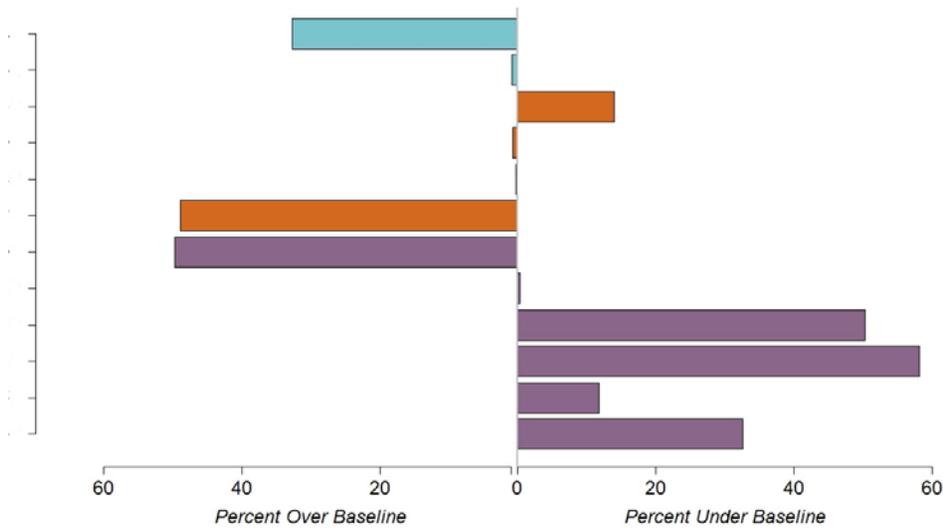
	<b>Metric</b>
<b>Water</b> 	Total Building Potable Water Use Indoor Potable Water Outdoor Water Use Process Water Use
<b>Energy</b> 	Total Building Energy Use Source Energy
<b>Maintenance &amp; Operations</b> 	General Building Maintenance Grounds Maintenance Janitorial Service
<b>Waste Generation &amp; Recycling</b> 	Solid Sanitary Waste Recycled Materials
<b>Occupant Satisfaction</b> 	Building Occupant Satisfaction and Self-Rated Productivity
<b>Transportation</b> 	Regular Commute

- ▶ 12 GSA Sustainably Designed Buildings compared to Industry Baseline data
- ▶ 5 Navy Sustainably Designed Buildings compared to 5 Navy Traditionally Designed Buildings

► Sustainably designed buildings perform better than industry baselines

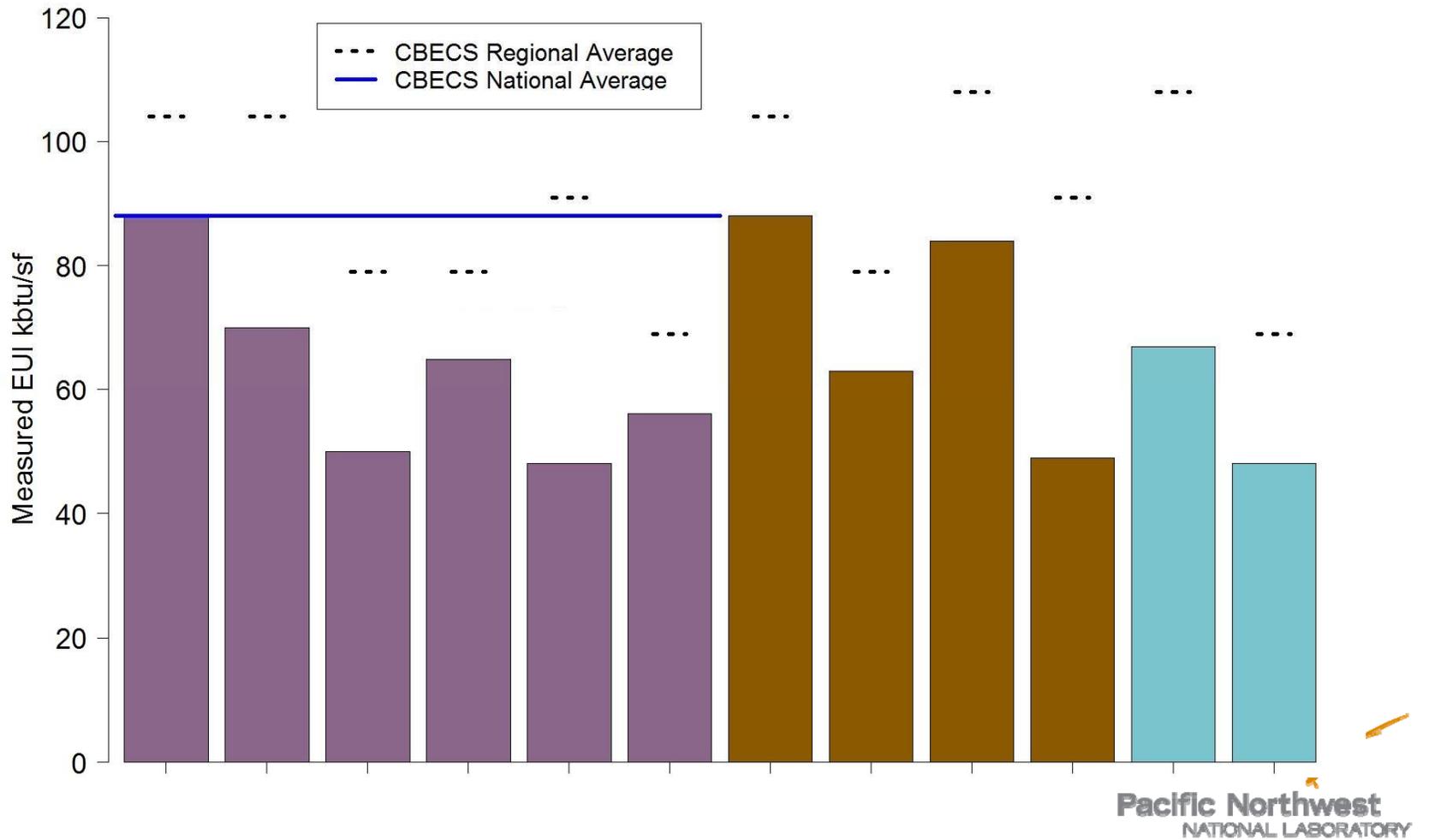


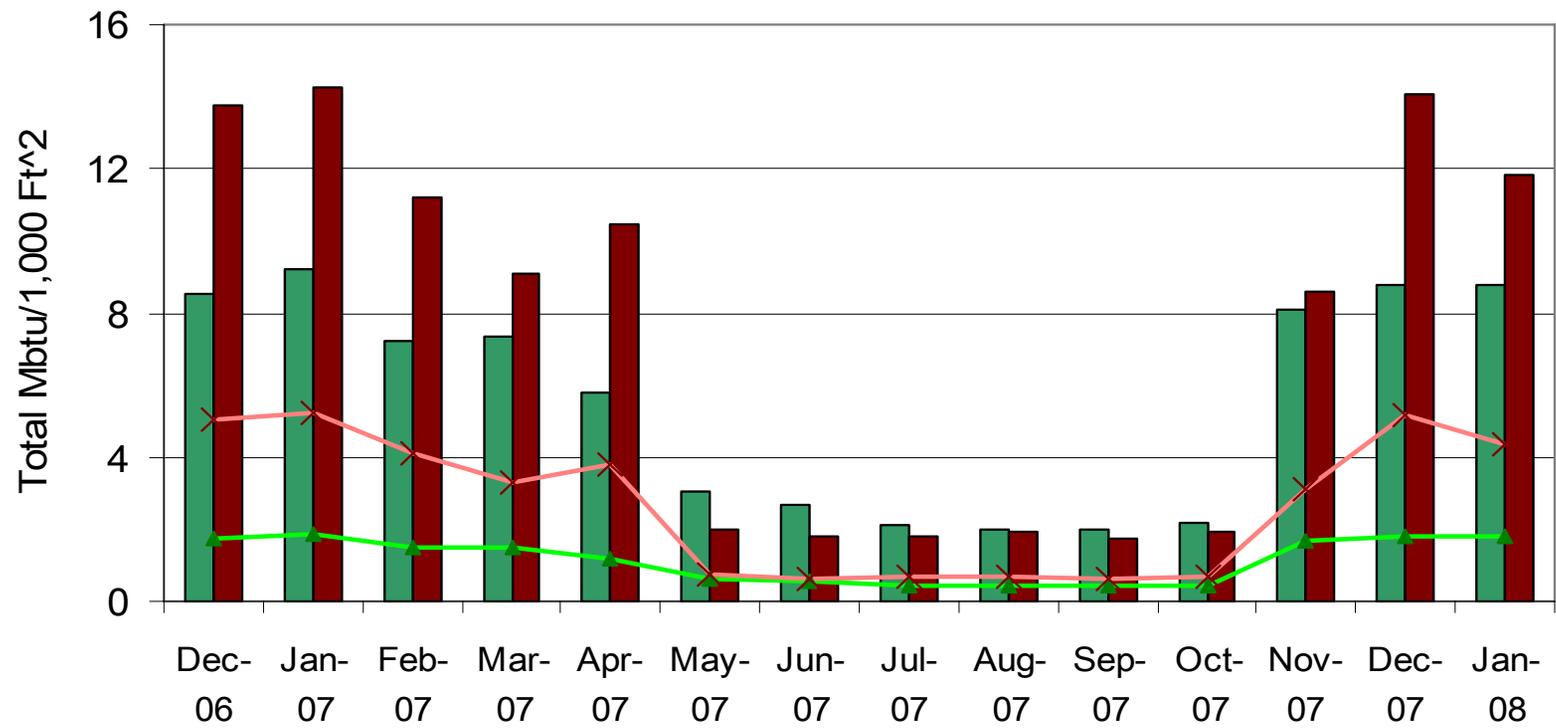
3% less domestic water use  
60% lower water cost





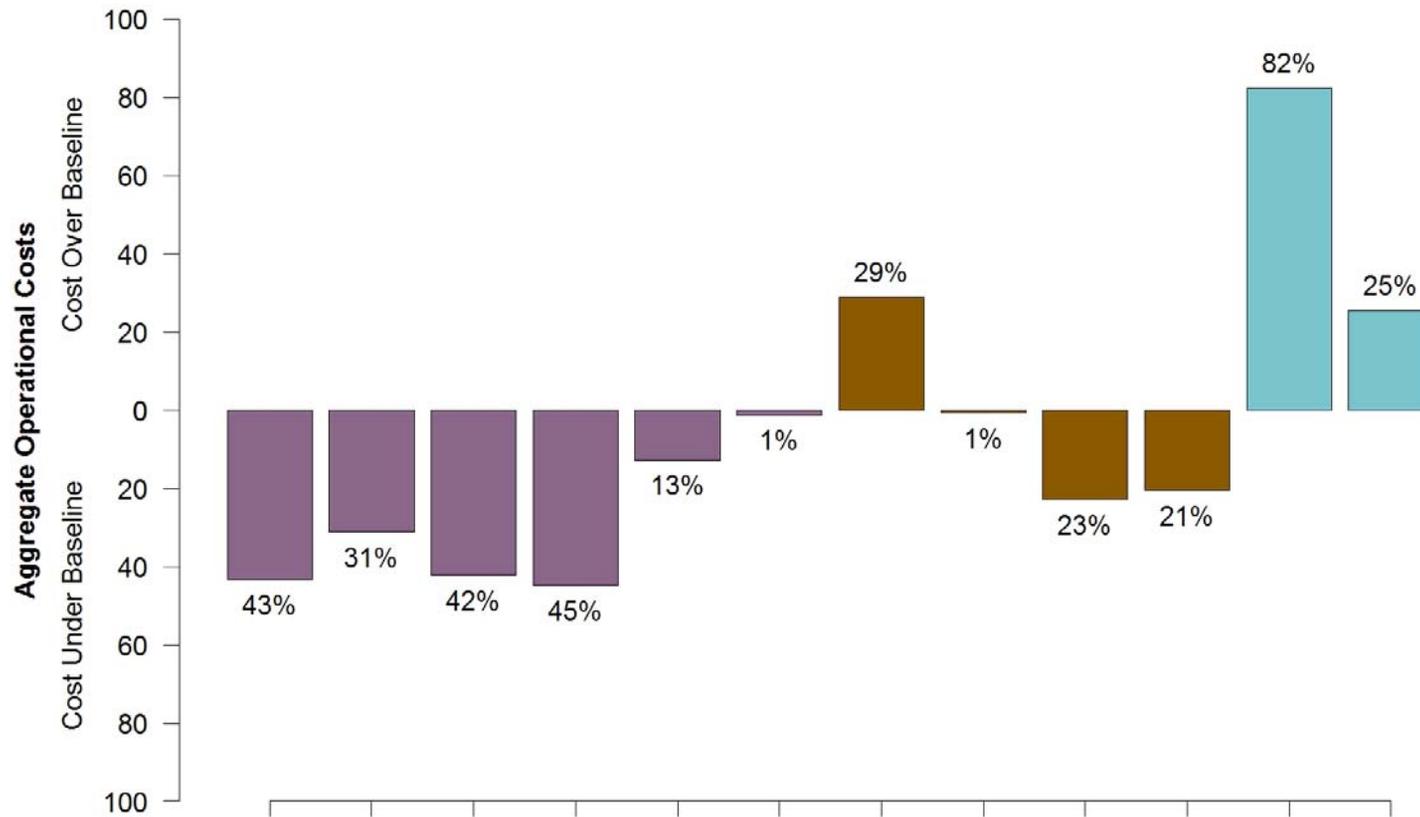
26% less energy use







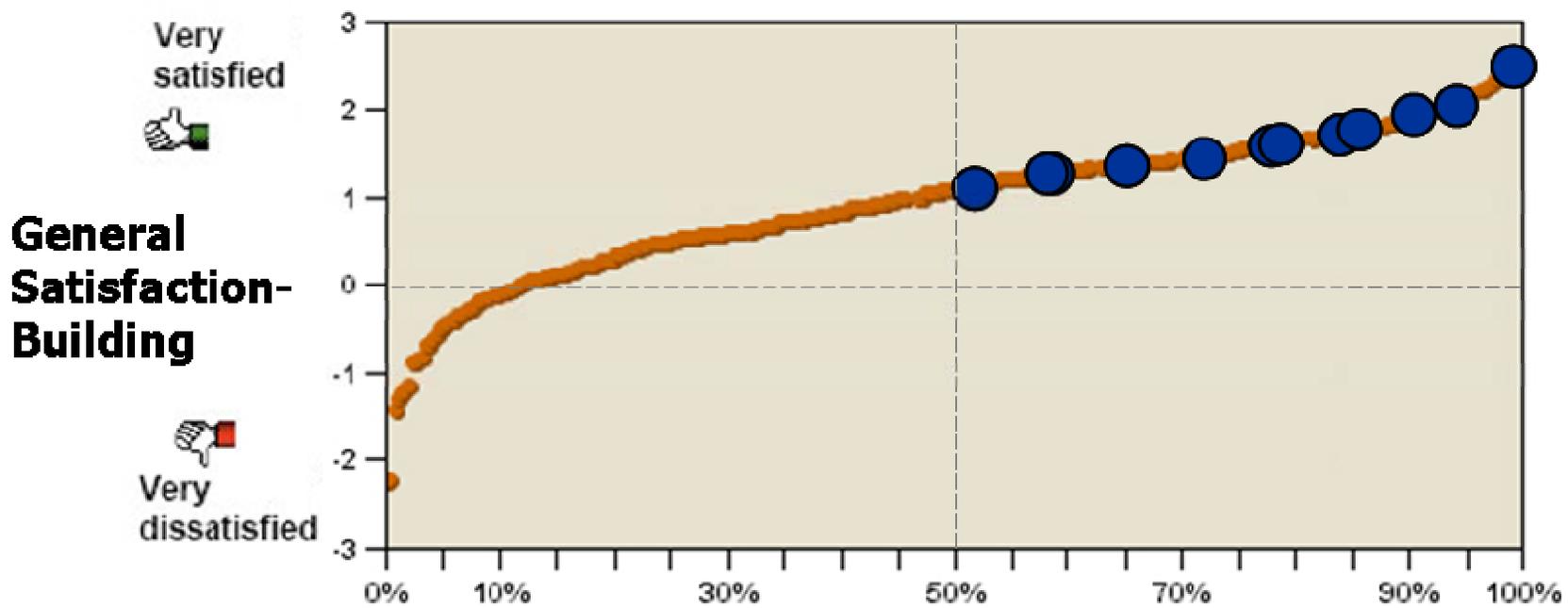
Cost 16% less to operate





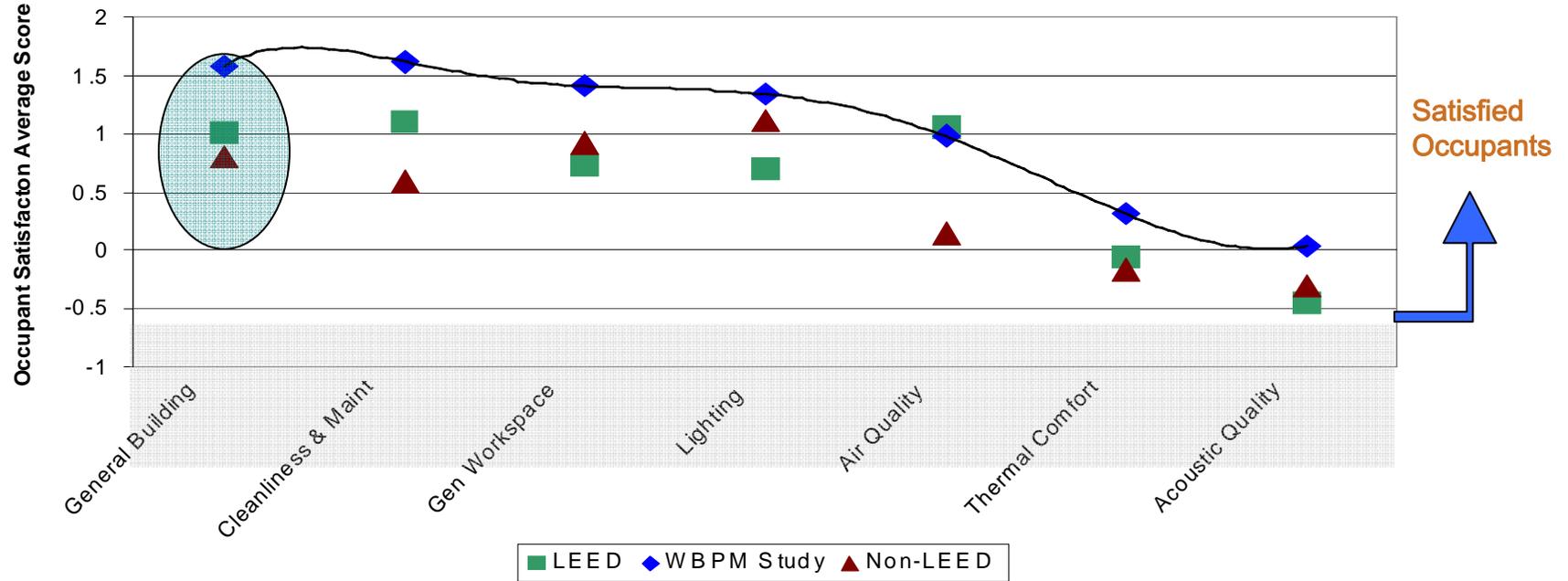


Building occupants 27% more satisfied





## Building occupants 27% more satisfied



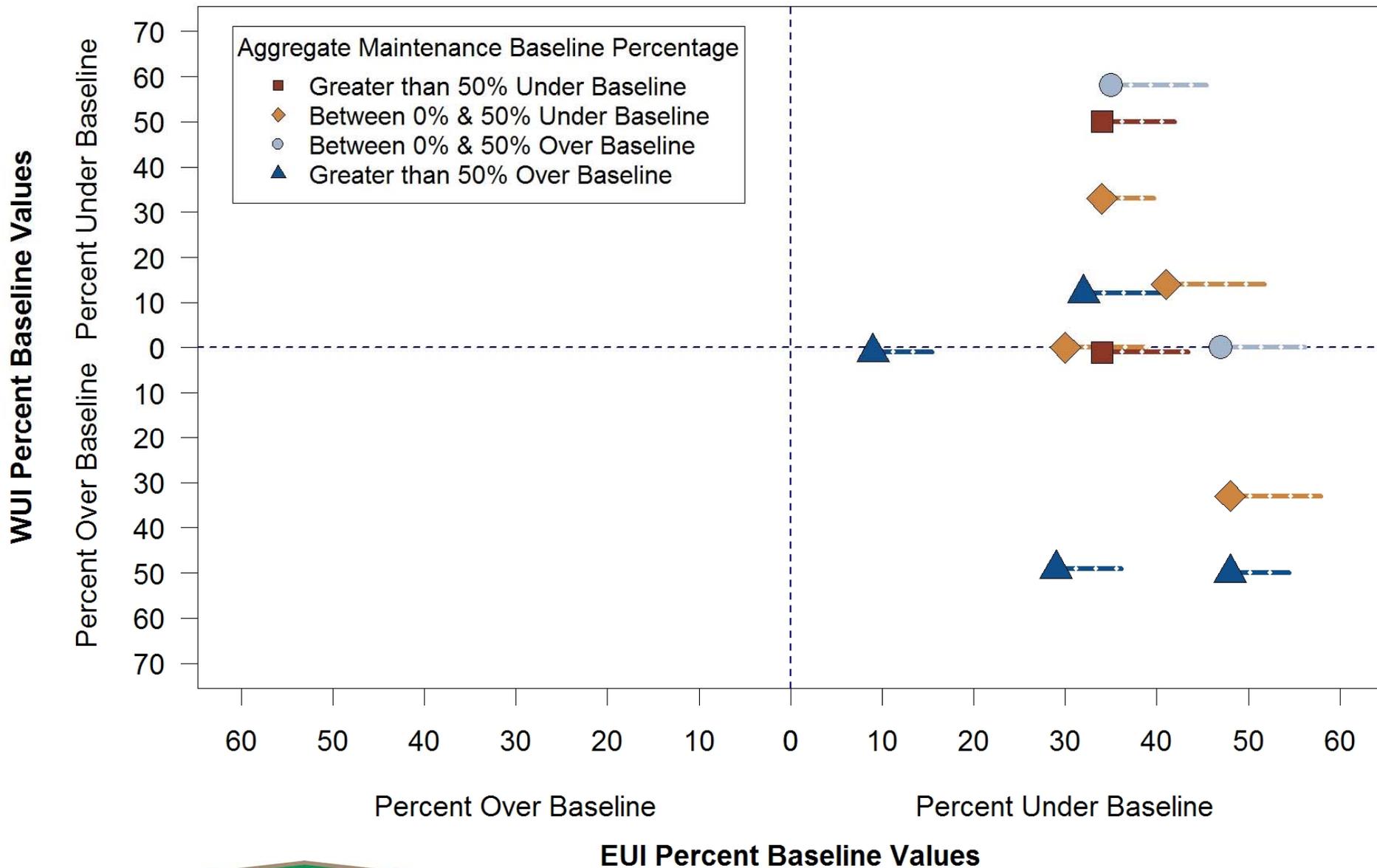


33% Fewer carbon dioxide equivalent emissions  
All buildings better than industry average

CO<sub>2</sub> Emissions (lbs/sf/yr)

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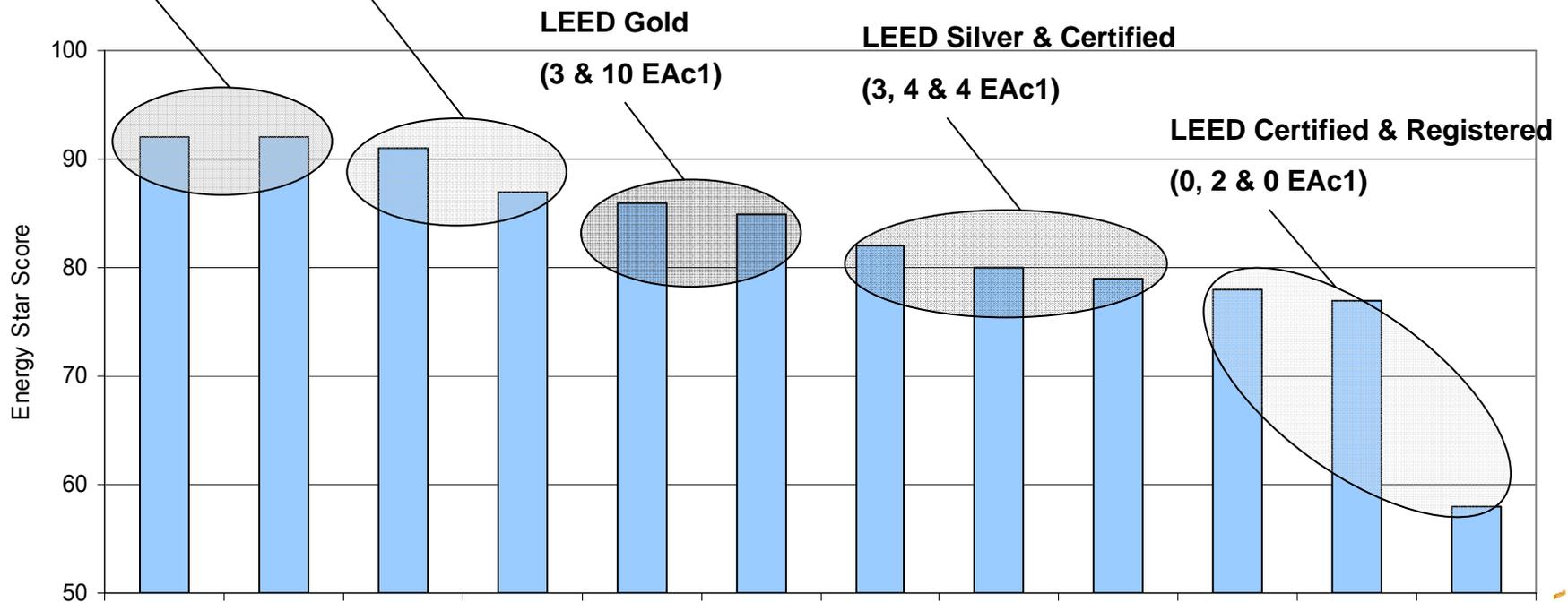
► Design emphasis on a performance target equates to better performance



## Energy Star scores and design intent align

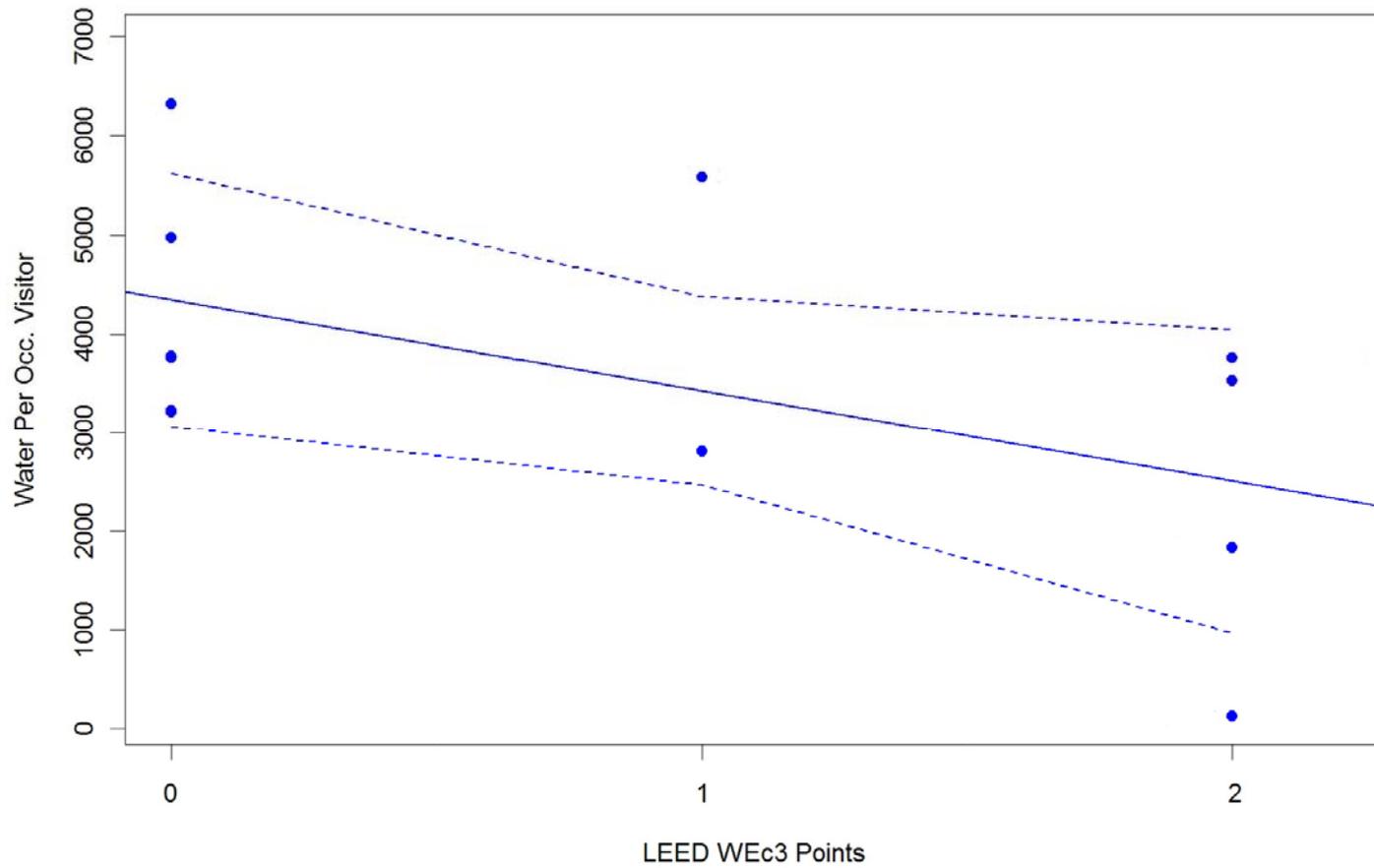
CA Energy Code  
Title 24

Energy Star

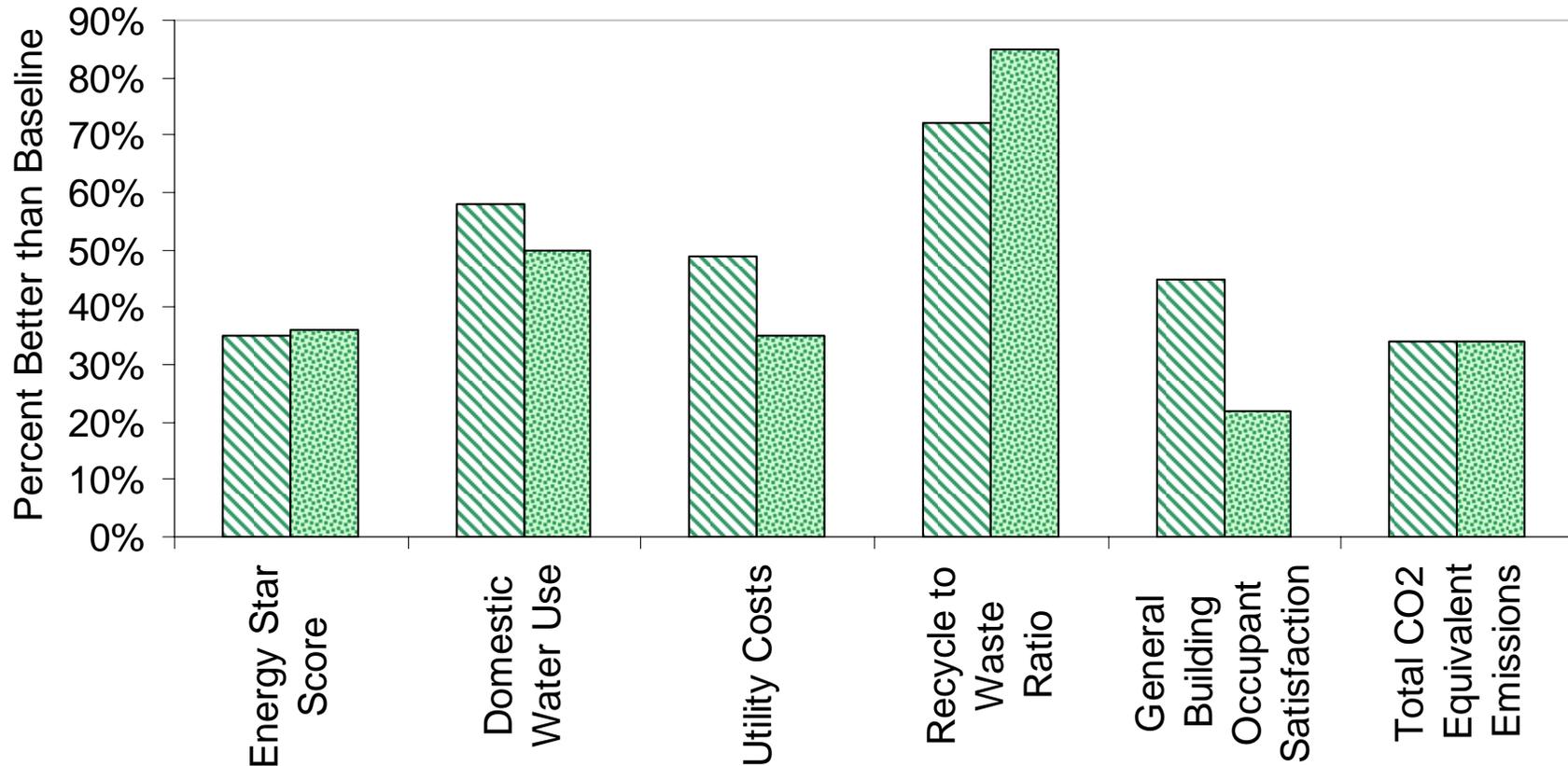




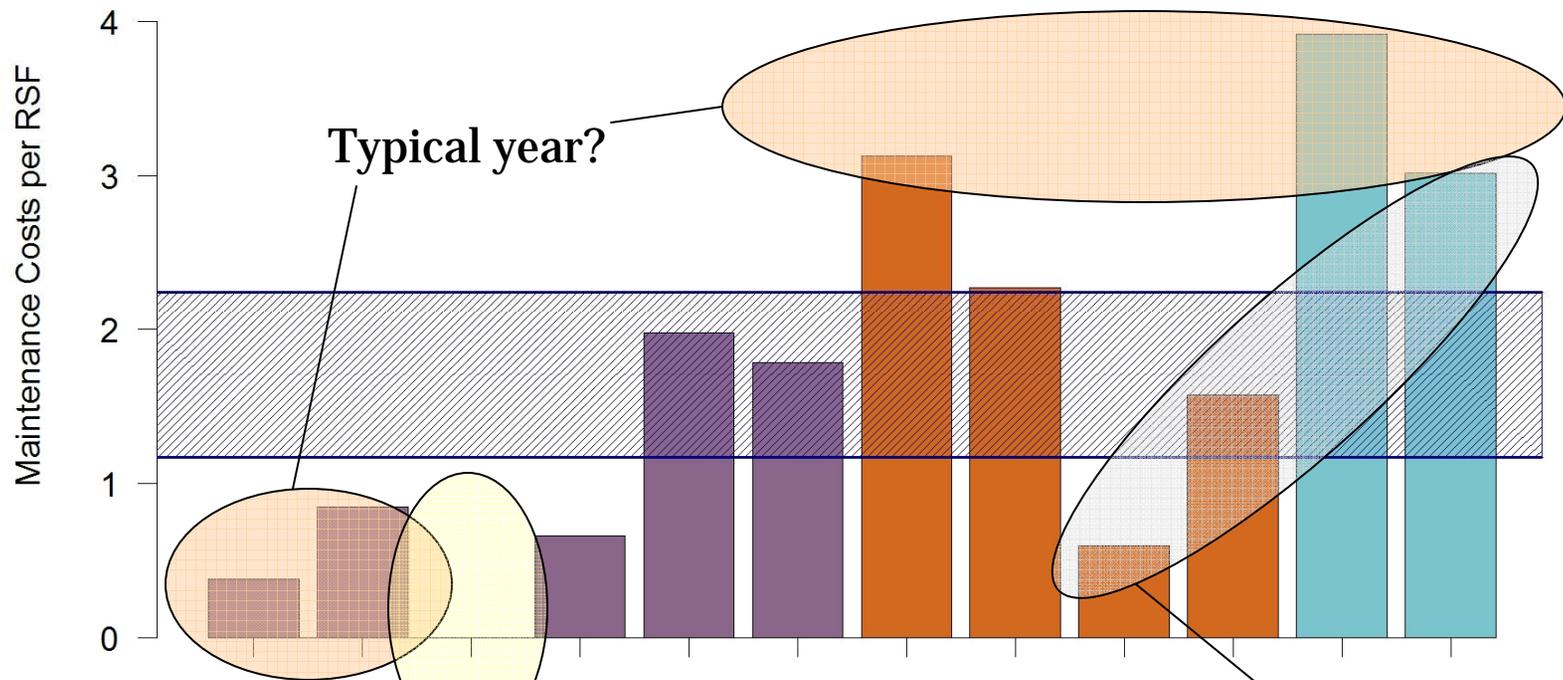
## Lower domestic water use with water design intent



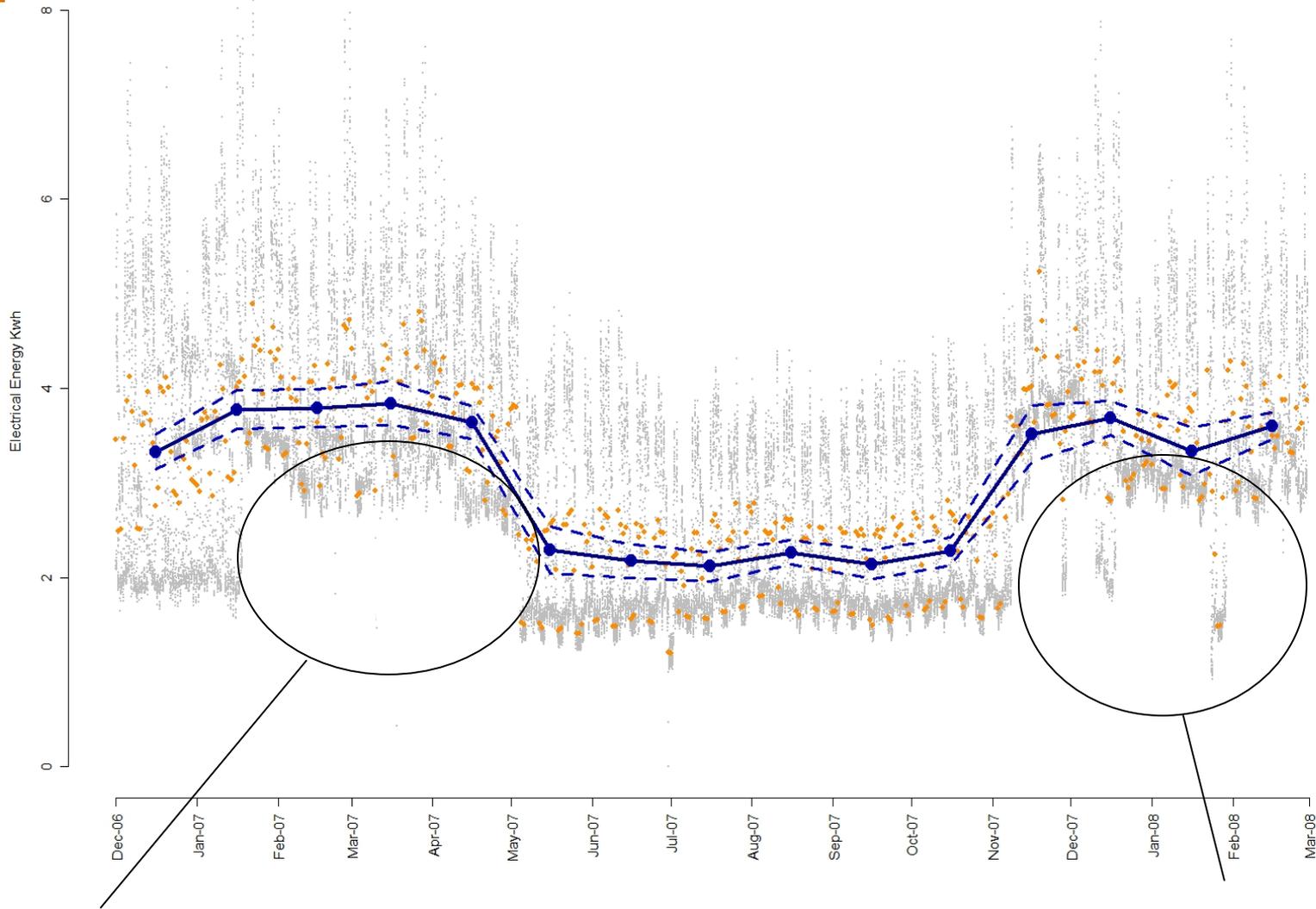
# LEED Gold buildings performed better than baseline for all metrics



- ▶ Consistent, detailed data collection allows for more accurate performance measurement analysis



Regional or building type differences?



Equipment error or change in base load?

Is this a repeat in load changes?  
Why does it drop off periodically?

# One more...

- ▶ Site specific data can inform building managers on building's performance

Metrics	Annual Performance Measurements		Annual Reporting Metrics	
	Water Use (gal)	800,414	Gallons per occupant	1,230
	Process Water Use (gal)	216,112	Water Cost per occupant	\$29.09
	Outdoor Water Use (gal)	160,083	Gallons per GSF	1.44
	Water Cost	\$5,468	Water Cost per GSF	\$0.04
	EnergyStar Score	87	Energy Use (kBtu) per GSF	49
	Energy Cost	\$5,958	Energy Cost per GSF	\$0.94
			Energy Emissions per building (metric tons CO <sub>2</sub> equiv)	1,397
	General Maintenance Cost	\$214,100	General Maint Cost per RSF	\$1.57
	Janitorial Services Cost	\$227,620	Janitorial Services Cost per RSF	\$1.67
	Grounds Maintenance Cost	\$4,000	Grounds Maint Cost per RSF	\$0.03
	Quantity of Maint Requests	180	Ratio of Maint Requests to Total Maintenance Jobs	0.14
	Quantity of Prev Maint Jobs	1,078		
	Solid Waste Generated (tons)	39	Solid Waste (lb) per occupant	3.67
	Solid Waste Cost	\$900	Solid Waste Cost per RSF	\$0.01
	Quantity Recycled (tons)	2	Solid Waste Cost per occupant	\$8.74
	Recycling Cost	-\$71	Ratio of Recycled to Solid Waste	0.06
	Survey # of Invitees	100	Survey Return Rate	54%
	Survey # of Respondents (n)	54		
	Commute Miles per occ (avg)	22	Commute Emissions per occ (metric tons CO <sub>2</sub> equiv)	2.56
	Commute fuel per occ (avg gal)	276		

# Who Cares?

- ▶ Owners of building portfolios
- ▶ Building managers and operators
- ▶ Building designers
- ▶ Researchers
- ▶ Financial Investors

Different parties ask different questions.



# The How, What and Why of WBPM

- ▶ How do sustainably designed buildings perform?
  - High level question, allows for summary data collection
- ▶ What design features offered significant performance impact?
  - Need more detailed data and ability to tie to design
- ▶ Why did the building perform the way it did?
  - Even more detailed data, analysis and interaction with building operators and occupants



# So, now you want to do WBPM...

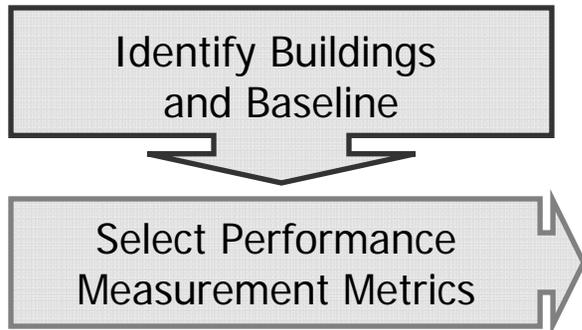
## ► Planning your study

- What question(s) do you want answered?
- What buildings will you include in your study?
  - Magnitude
  - Diversity
  - Baselines
  - Data availability
- How will you manage the study?
- Who will you share the results with?



# Developing a WBPM Project

## Project Initiation



	Building Characteristics
	Water
	Energy
	Maintenance & Operations
	Purchasing
	Health & Productivity
	Transportation



# Developing a WBPM Project

## Project Initiation

Identify Buildings and Baseline

Select Performance Measurement Metrics



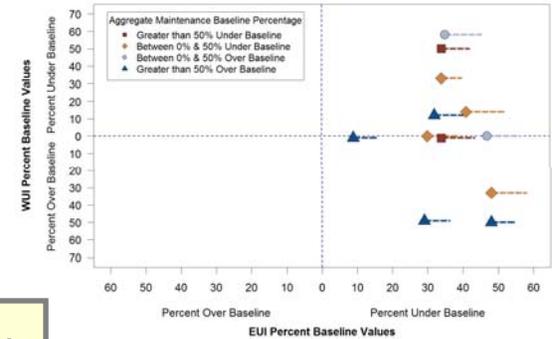
## Project Execution

Identify possible metering needs

Gather site characteristics data & establish collection system for metered and non-metered data

Measure building performance for minimum of 12 months

*Clarify data anomalies*



## Project Analysis

Compare Building Performance Data

Report Cost & Benefit Differences

# Lessons Learned

## ▶ Data Challenges

- Not all data equally available
- Difficult to collect consistent data from different buildings
- Data normalization needed for comparability
- More buildings' data needed for statistically significant findings

## ▶ Coordination

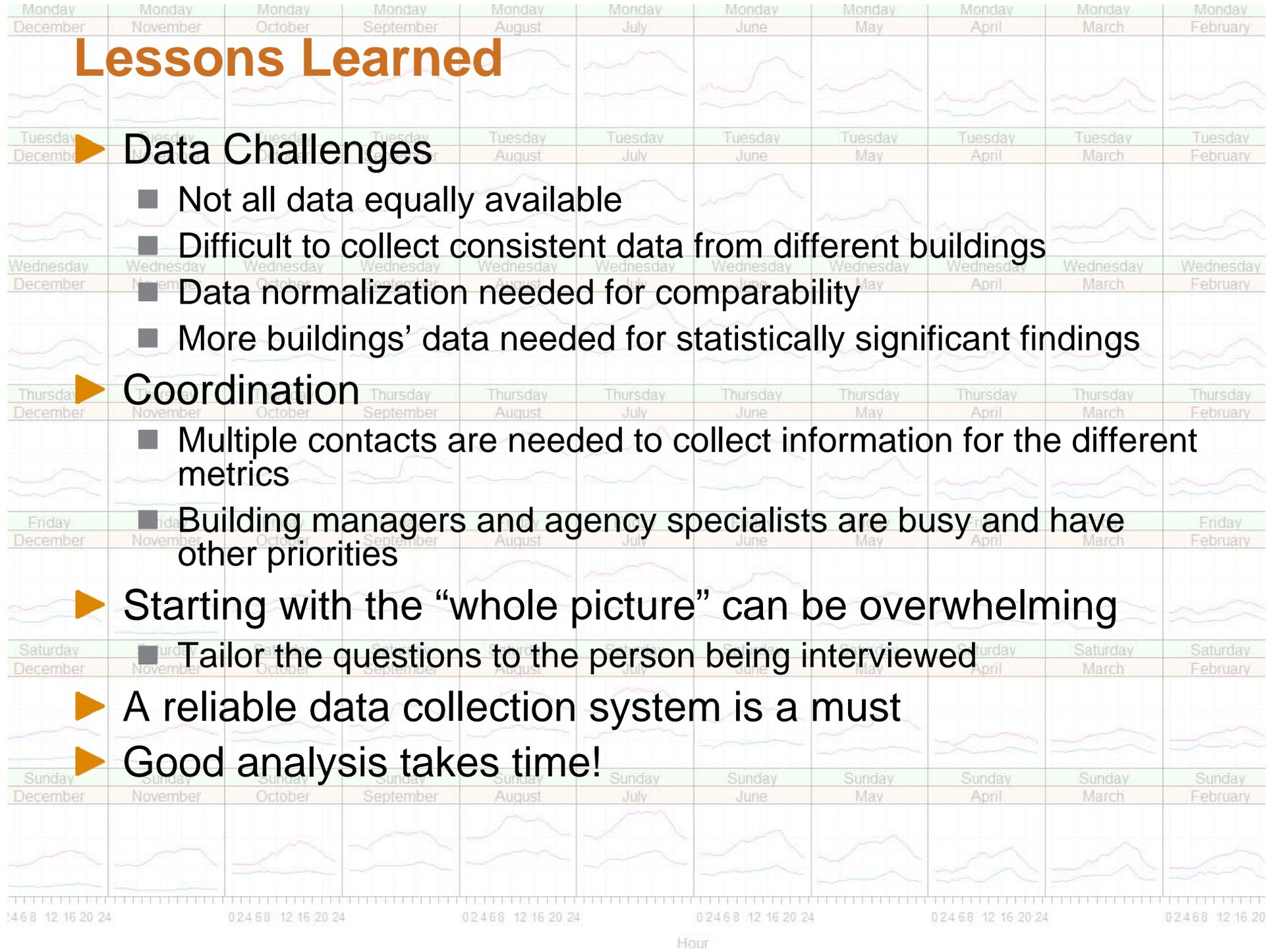
- Multiple contacts are needed to collect information for the different metrics
- Building managers and agency specialists are busy and have other priorities

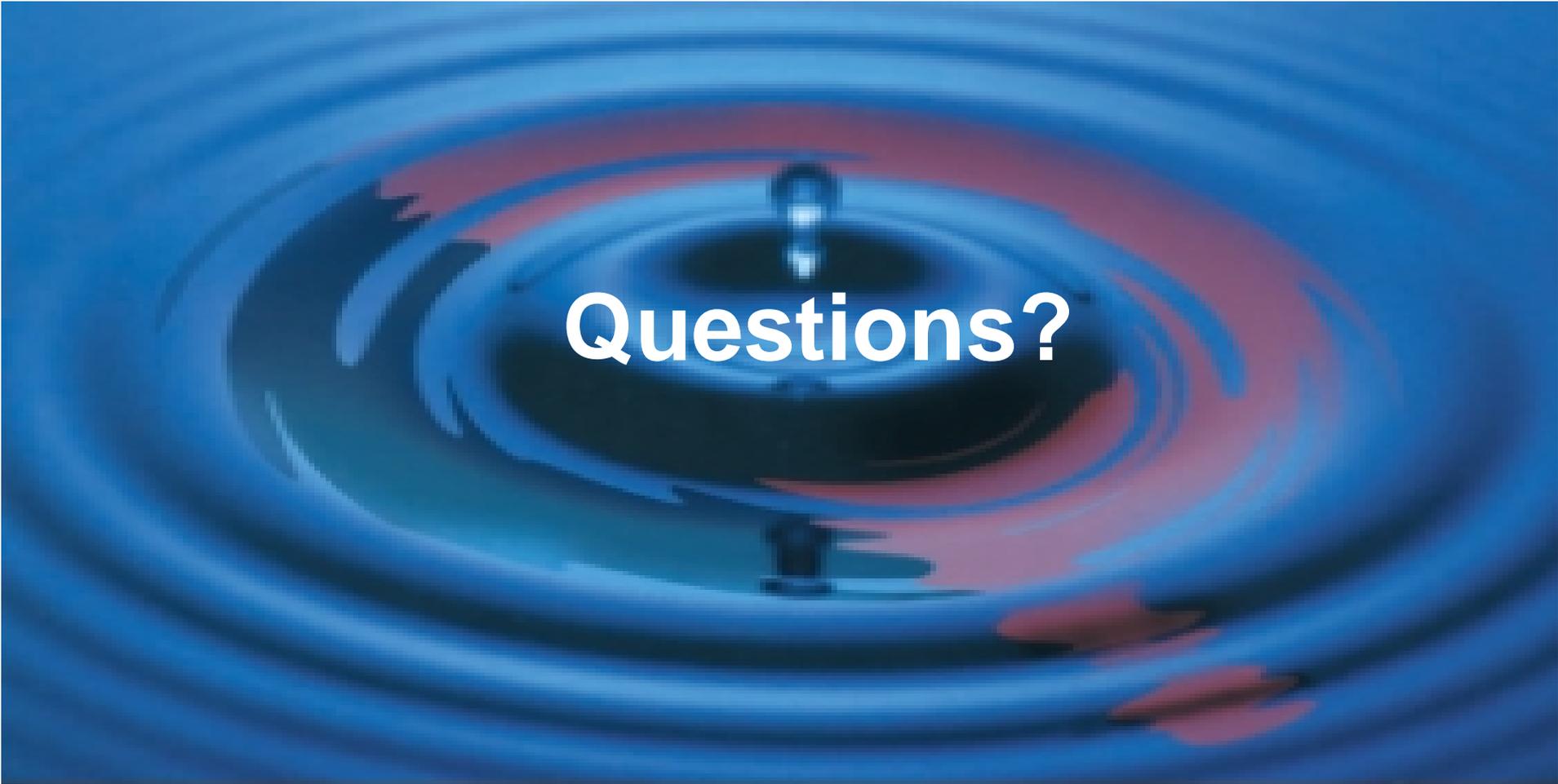
## ▶ Starting with the “whole picture” can be overwhelming

- Tailor the questions to the person being interviewed

## ▶ A reliable data collection system is a must

## ▶ Good analysis takes time!





Questions?

Kim M. Fowler

[kim.fowler@pnl.gov](mailto:kim.fowler@pnl.gov)

WBPM Protocol:

<http://www1.eere.energy.gov/femp/pdfs/pnnl15217.pdf>