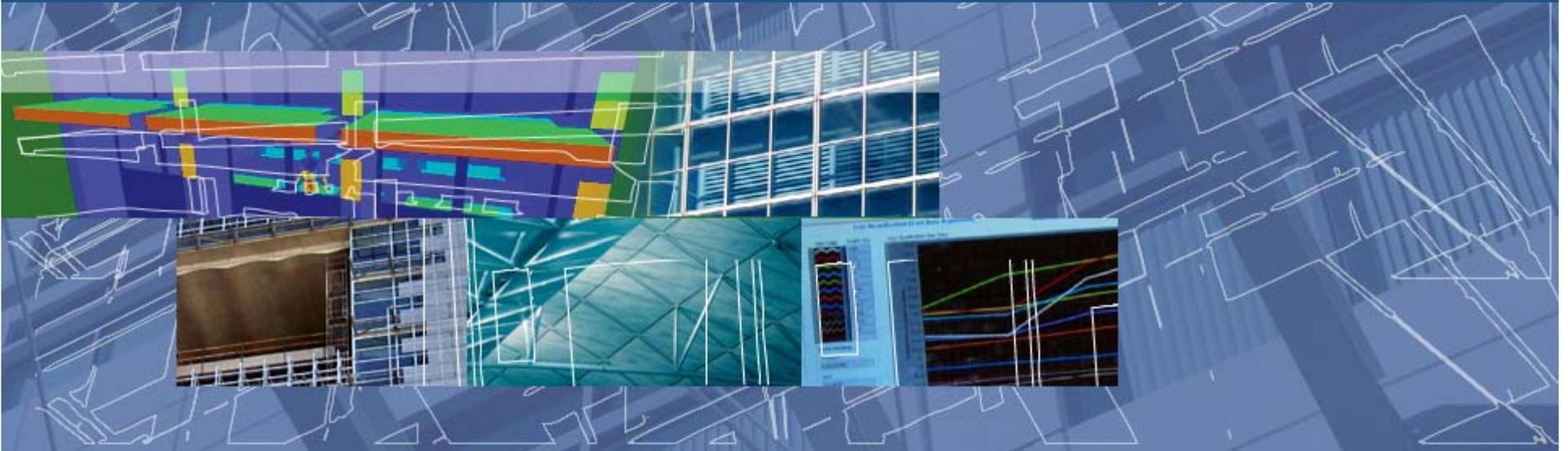


Evaluation Result from Green Building Performance

John Goins

Lead Researcher



CENTER FOR THE BUILT ENVIRONMENT MAY 2008

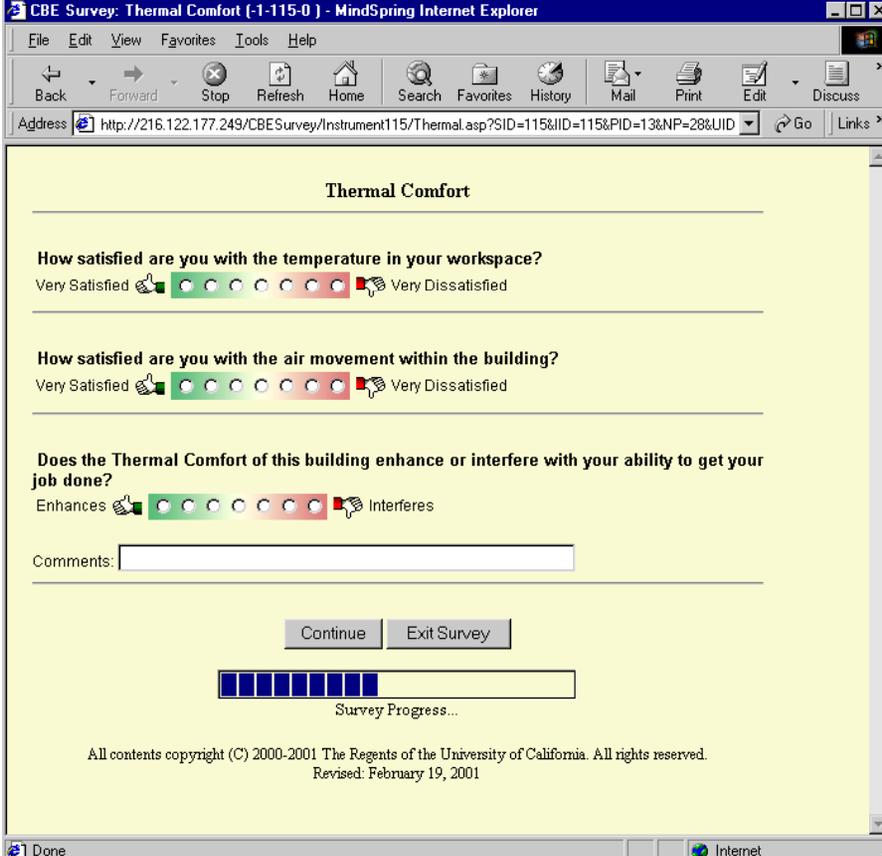


Outline

- 1. About CBE & the survey**
- 2. Why this is important**
- 3. Acoustics**
- 4. Thermal Comfort**
- 5. Air Quality**
- 6. Lighting**

CBE's Occupant IEQ Survey

- Standardized methodology for studying building performance from occupants' point of view
- Provide feedback to designers, owners, and operators
- Understand how buildings perform in practice
- Web format is inexpensive, fast, extensible
- Results can be used for:
 - Diagnostics
 - Benchmarking



The screenshot shows a web browser window titled "CBE Survey: Thermal Comfort (-1-115-0) - MindSpring Internet Explorer". The address bar shows the URL: <http://216.122.177.249/CBESurvey/Instrument115/Thermal.asp?SID=115&IID=115&PID=13&NP=28&UID>. The survey form is titled "Thermal Comfort" and contains three Likert scale questions:

- How satisfied are you with the temperature in your workspace?**
Very Satisfied (thumbs up) [Progress bar: 1 green, 4 white, 4 red, 1 thumbs down] Very Dissatisfied (thumbs down)
- How satisfied are you with the air movement within the building?**
Very Satisfied (thumbs up) [Progress bar: 1 green, 4 white, 4 red, 1 thumbs down] Very Dissatisfied (thumbs down)
- Does the Thermal Comfort of this building enhance or interfere with your ability to get your job done?**
Enhances (thumbs up) [Progress bar: 1 green, 4 white, 4 red, 1 thumbs down] Interferes (thumbs down)

Below the questions is a "Comments:" text input field. At the bottom of the form are "Continue" and "Exit Survey" buttons. A progress indicator shows 10 blue bars, with the first 4 filled, labeled "Survey Progress...". At the very bottom, there is a copyright notice: "All contents copyright (C) 2000-2001 The Regents of the University of California. All rights reserved. Revised: February 19, 2001".

Survey structure

Background



Location



Office Layout



Office Furnishings



Thermal Comfort



Air Quality



Lighting



Acoustics



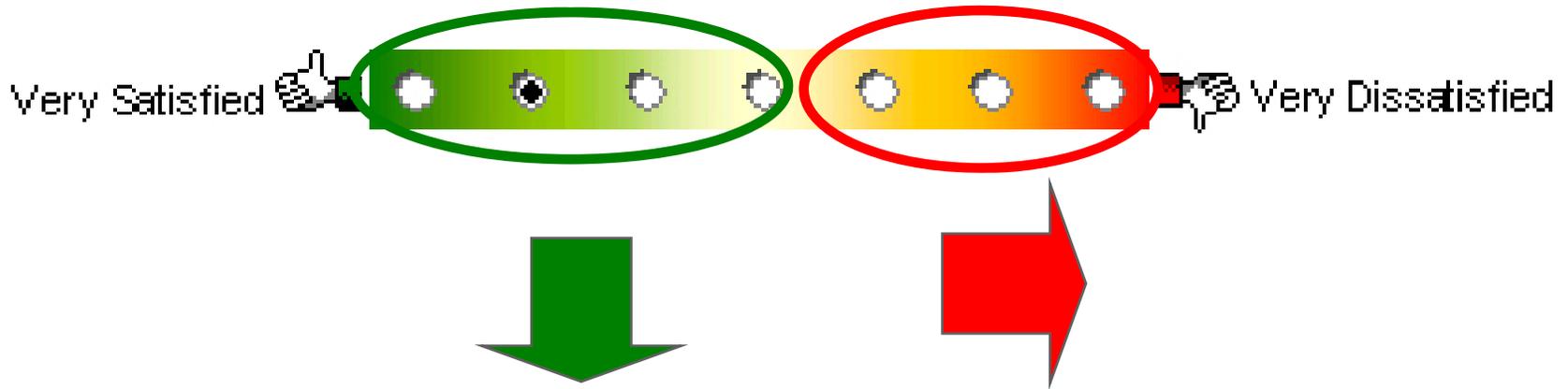
Clean/Maint



General
Comments

Drill-down questions

Satisfaction Scale



Drill-down questions

Lighting (continued)

You have said that you are dissatisfied with the lighting in your workspace. Which of the following contribute to your dissatisfaction? (check all that apply)

- Too dark
- Too bright
- Not enough daylight
- Too much daylight
- Not enough electric lighting
- Too much electric lighting
- Electric lighting flickers
- Electric lighting is an undesirable color
- No task lighting
- Reflections in the computer screen
- Shadows on the workspace
- Other:

Please describe any other issues related to lighting that are important to you.

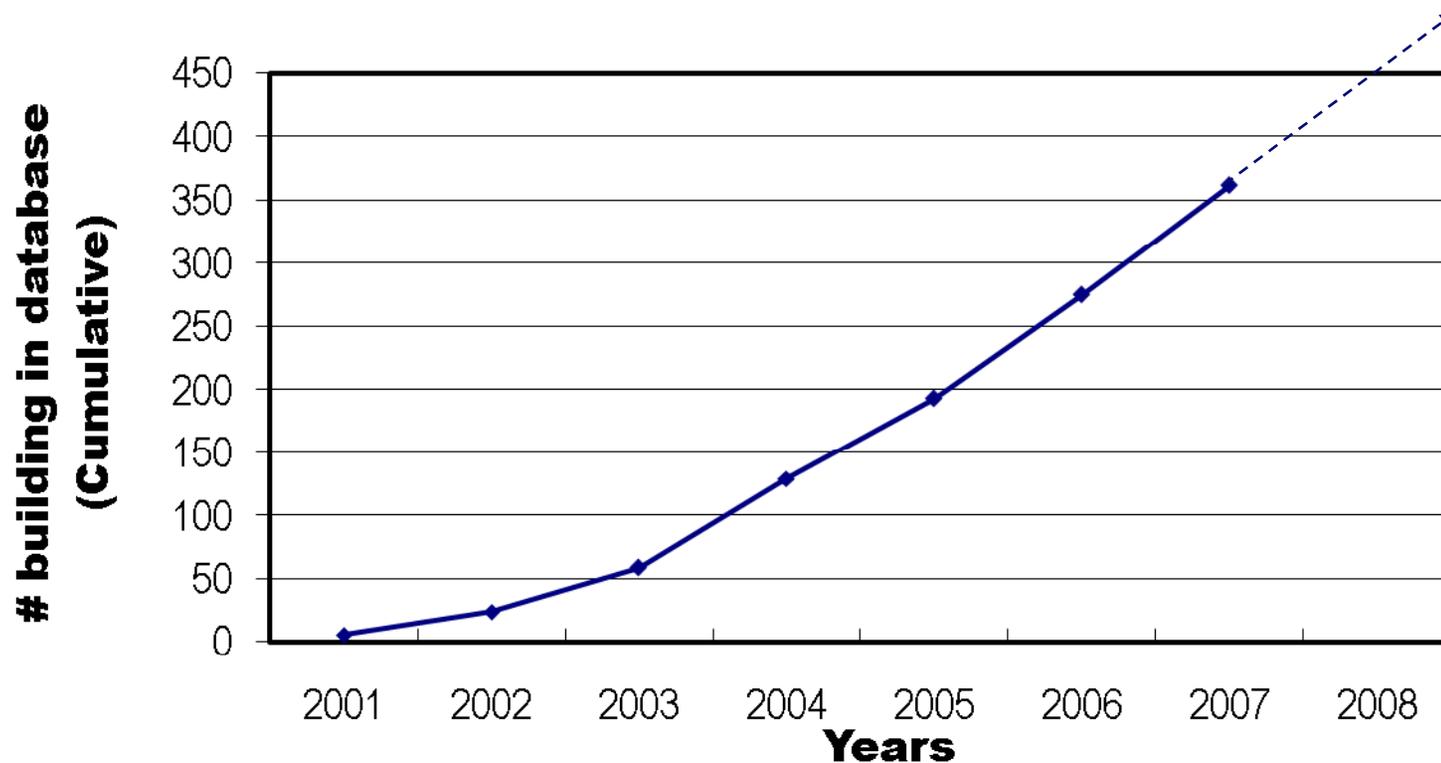
Survey Progress...

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Revised: July 11, 2003

- Sources of dissatisfaction
- Open ended-responses

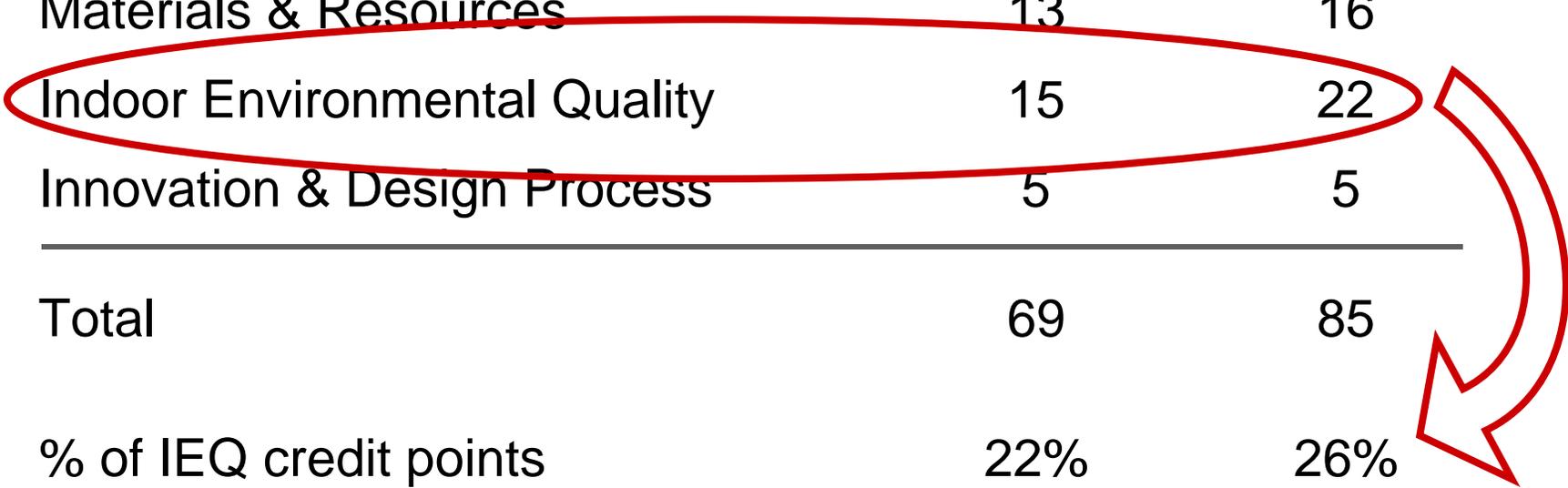
Benchmarking Database

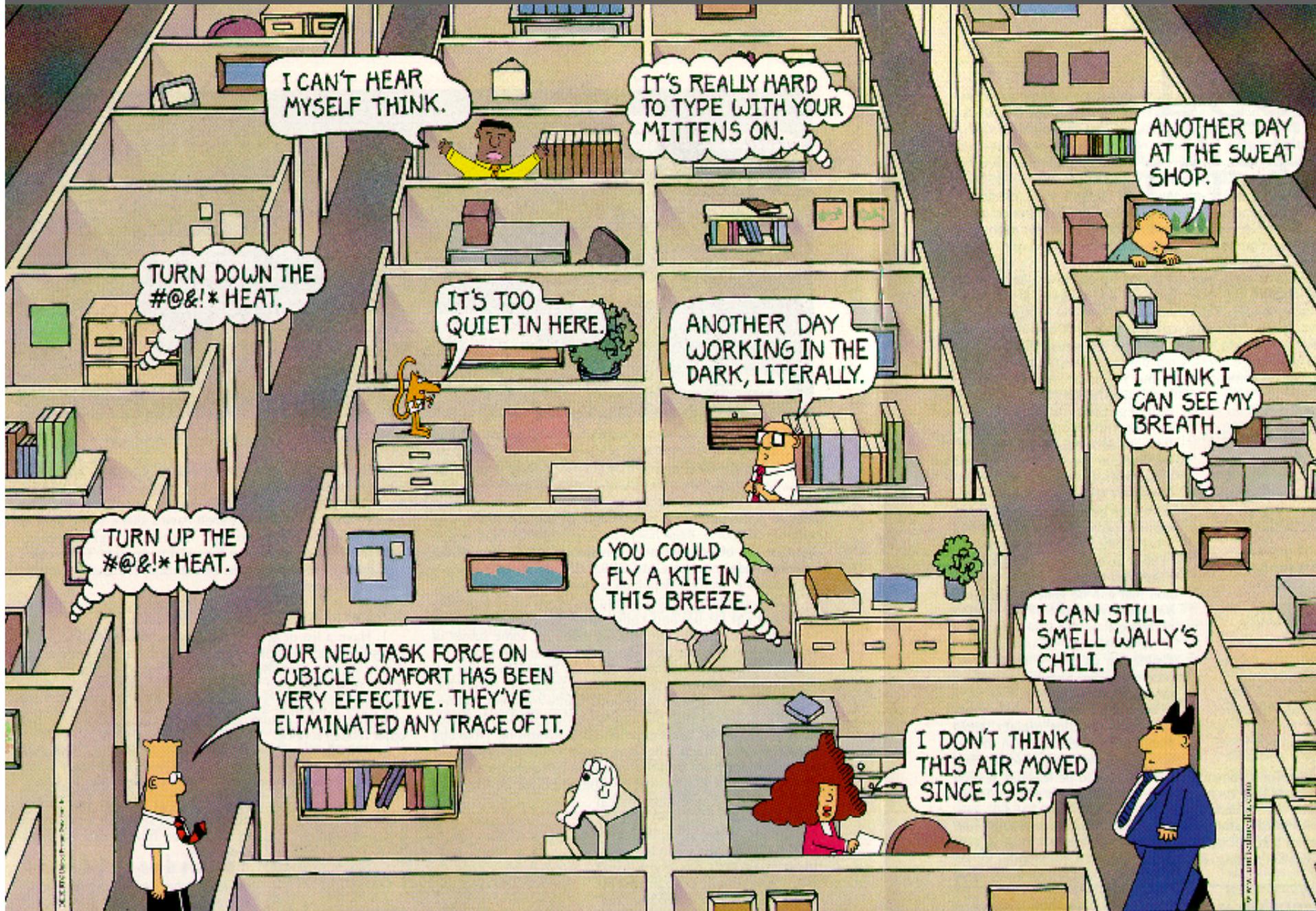
360+ buildings | 45,000 respondents | 3.6M data points



Categories in LEED – NC 2.1 & EB 2.0

	LEED - NC	LEED - EB
Sustainable Sites	14	14
Water Efficiency	5	5
Energy & Atmosphere	17	23
Materials & Resources	13	16
Indoor Environmental Quality	15	22
Innovation & Design Process	5	5
<hr/>		
Total	69	85
% of IEQ credit points	22%	26%





I CAN'T HEAR MYSELF THINK.

IT'S REALLY HARD TO TYPE WITH YOUR MITTENS ON.

ANOTHER DAY AT THE SWEAT SHOP.

TURN DOWN THE #@&!* HEAT.

IT'S TOO QUIET IN HERE.

ANOTHER DAY WORKING IN THE DARK, LITERALLY.

I THINK I CAN SEE MY BREATH.

TURN UP THE #@&!* HEAT.

YOU COULD FLY A KITE IN THIS BREEZE.

I CAN STILL SMELL WALLY'S CHILL.

OUR NEW TASK FORCE ON CUBICLE COMFORT HAS BEEN VERY EFFECTIVE. THEY'VE ELIMINATED ANY TRACE OF IT.

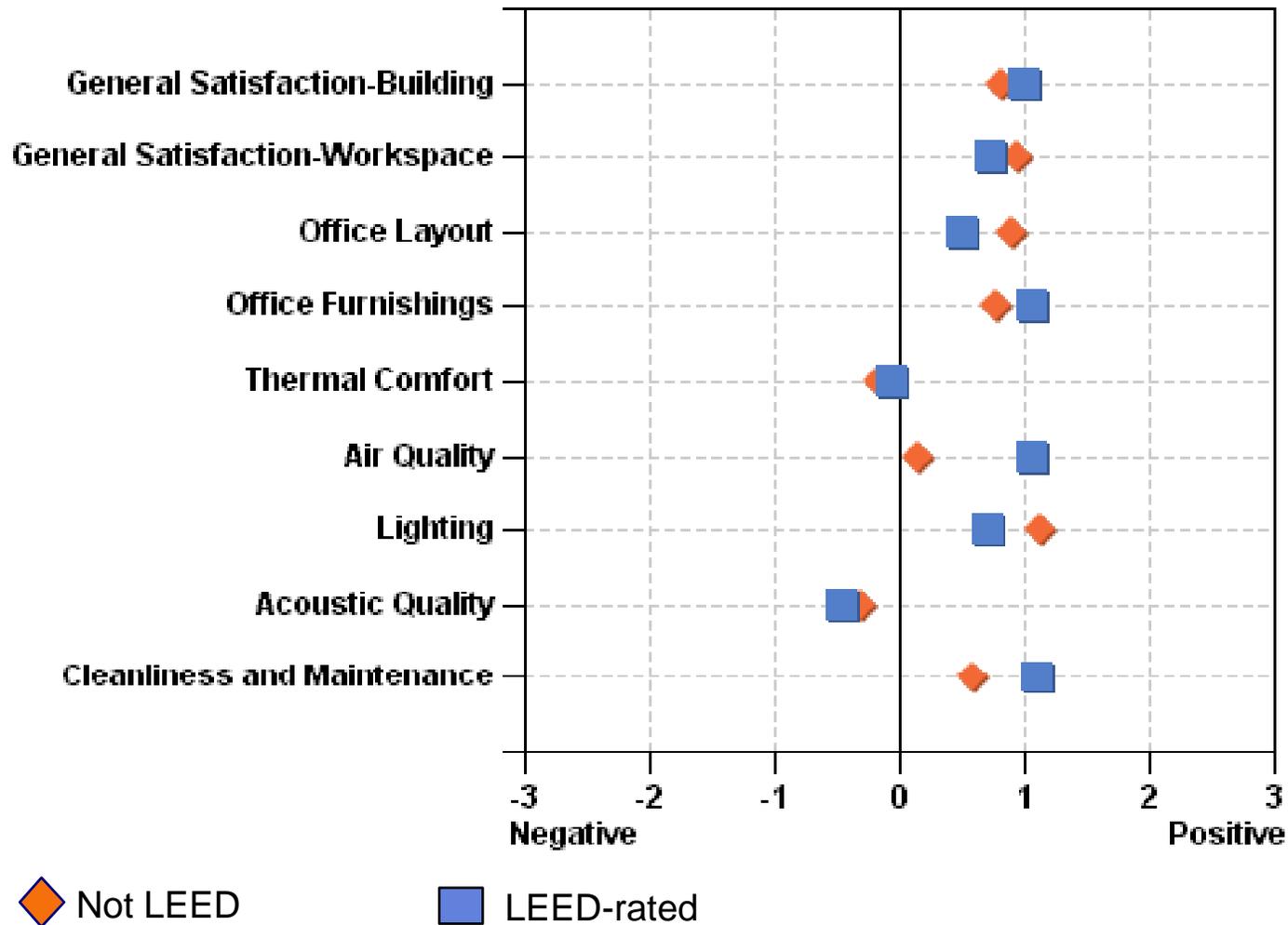
I DON'T THINK THIS AIR MOVED SINCE 1957.

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LEED versus non-LEED buildings

Average Scores by Category



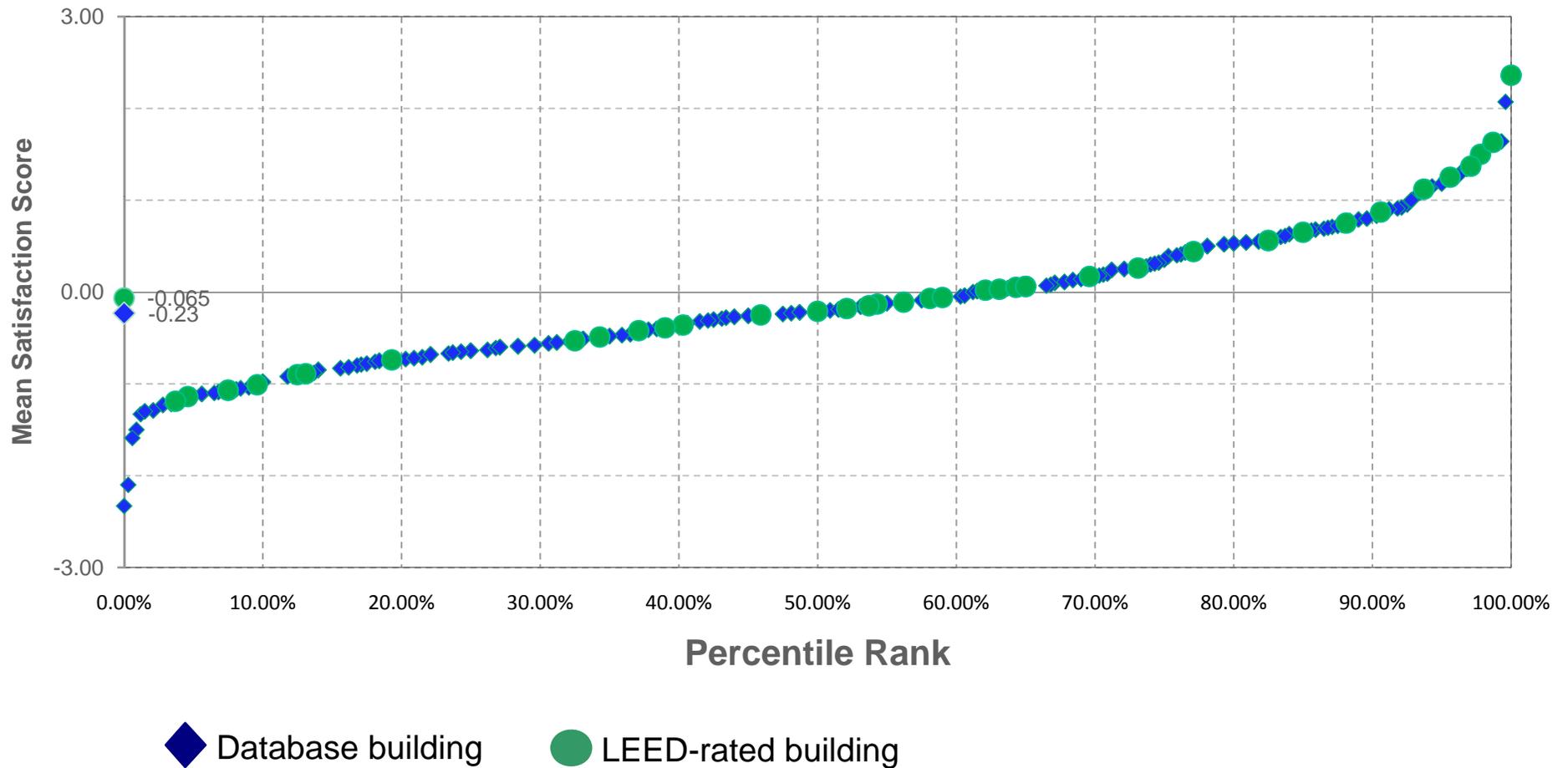
LEED versus new non-LEED buildings

Average Scores by Category

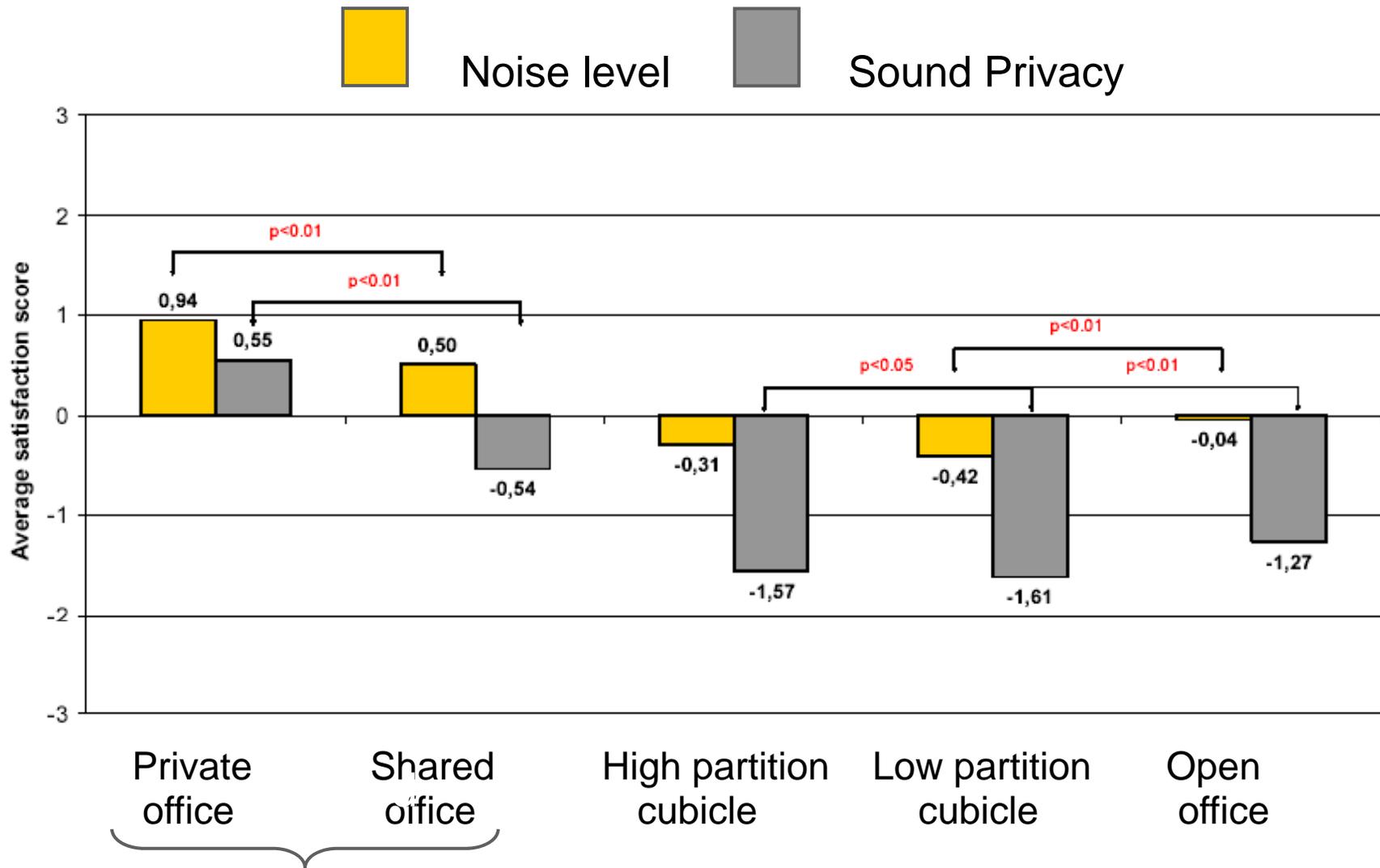


Acoustic Quality

Mean Scores- Acoustic Quality
LEED (n=39) compared to CBE database (n=284)



Acoustic average satisfaction score

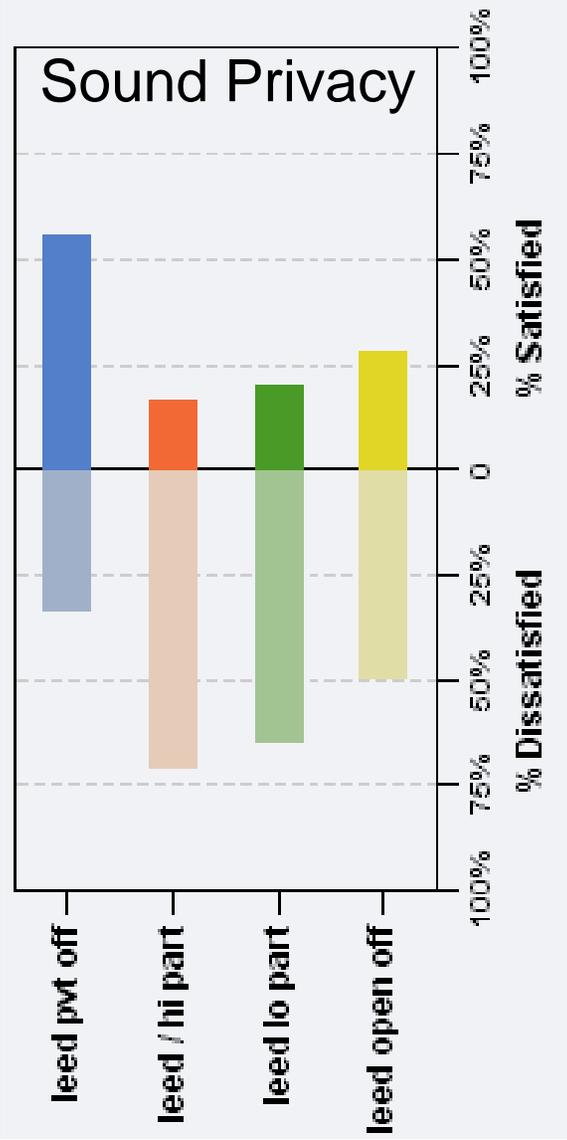
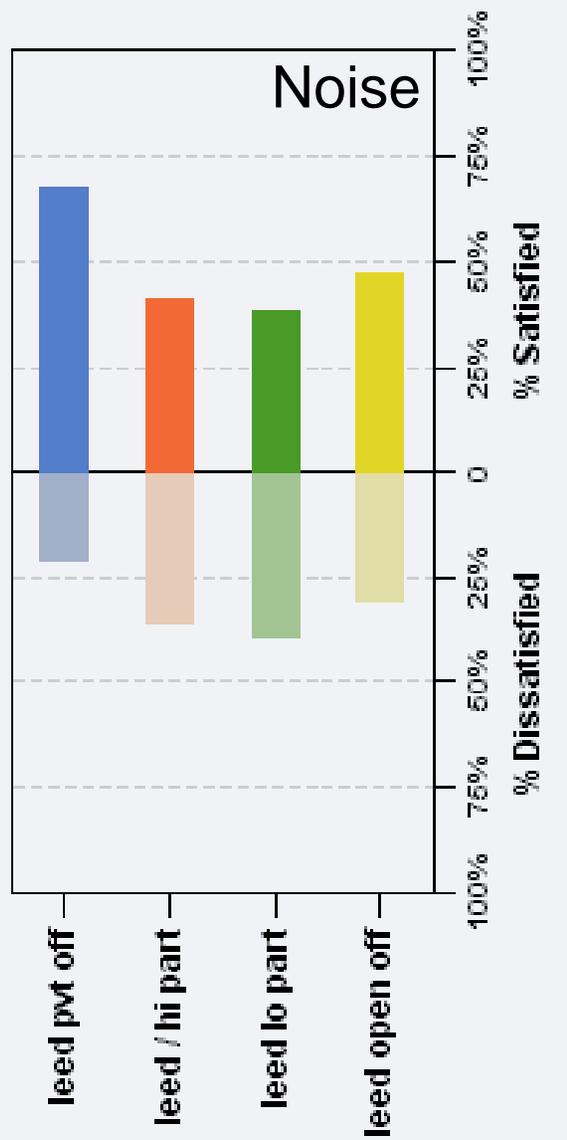


Sources of dissatisfaction

Of those expressing dissatisfaction with acoustics...

Rank	Source of dissatisfaction	Private office	Shared office	Cubicles with high partitions	Cubicles with low partitions
1	People talking on the phone	21%	50%	70%	83%
2	People overhearing private conversations	25%	40%	65%	71%
3	People talking in surrounding offices	15%	21%	45%	54%
4	People talking in the corridor	6%	12%	25%	27%
5	Telephones ringing	2.5%	8%	23%	31%
6	Office equipment	4%	5%	13%	14%

Acoustic % satisfaction in LEED buildings



Sources of dissatisfaction in LEED bldgs

Of those expressing dissatisfaction with acoustics...

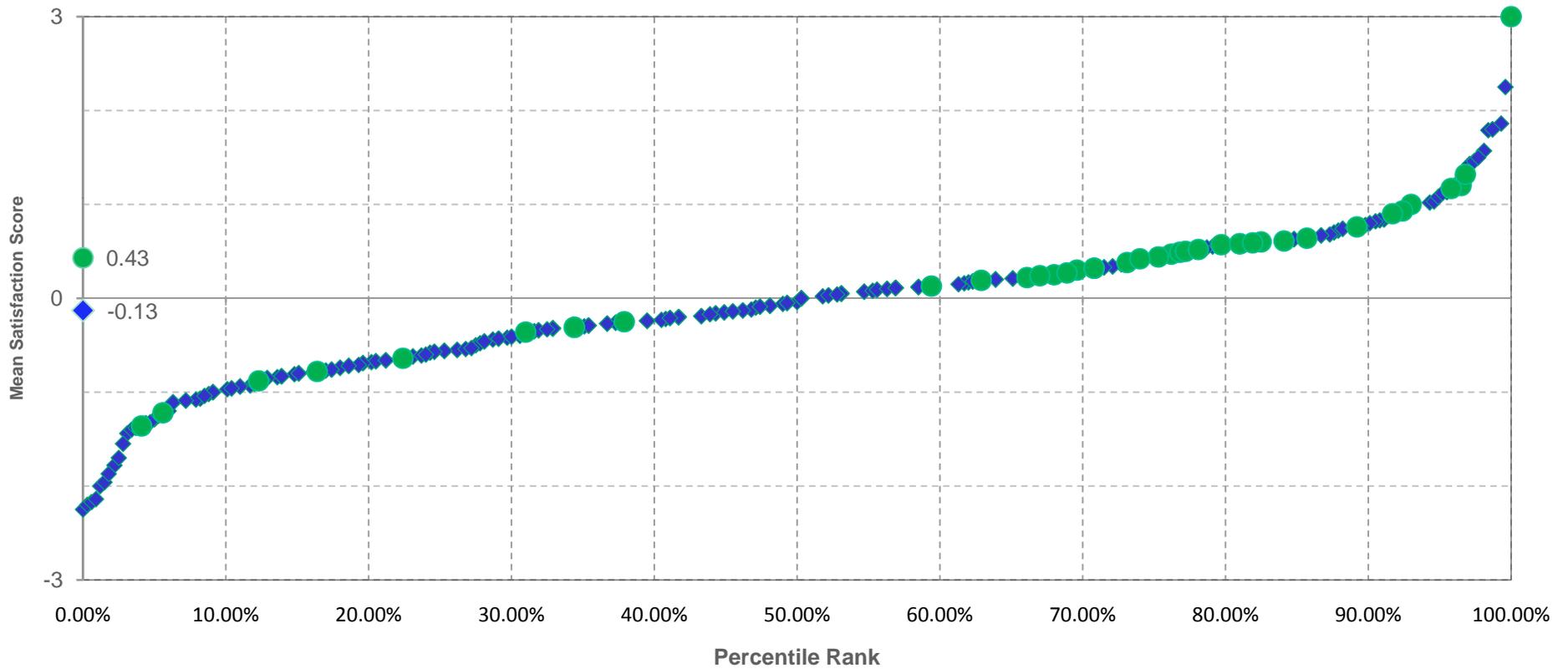
Rank	Source of dissatisfaction	Private office	Cubicles with high partitions	Cubicles with low partitions	Open Office
1	People talking in surrounding offices	52%	61%	54%	61%
2	People overhearing private conversations	48%	64%	54%	55%
3	People talking on the phone	33%	60%	52%	50%
4	Telephones ringing	17%	35%	38%	27%
5	Excessive Echoing	18%	26%	24%	22%
6	People talking in the corridor	6%	12%	25%	27%

Acoustics - Key findings

- **Priority:**
Of the 9 core survey categories, acoustics causes the greatest dissatisfaction
- **Partition Height:**
Acoustic satisfaction will not be improved much by making cubicles higher
- **Partition vs. None:**
Occupants in open office more satisfied with acoustics than occupants in cubicles

Thermal comfort

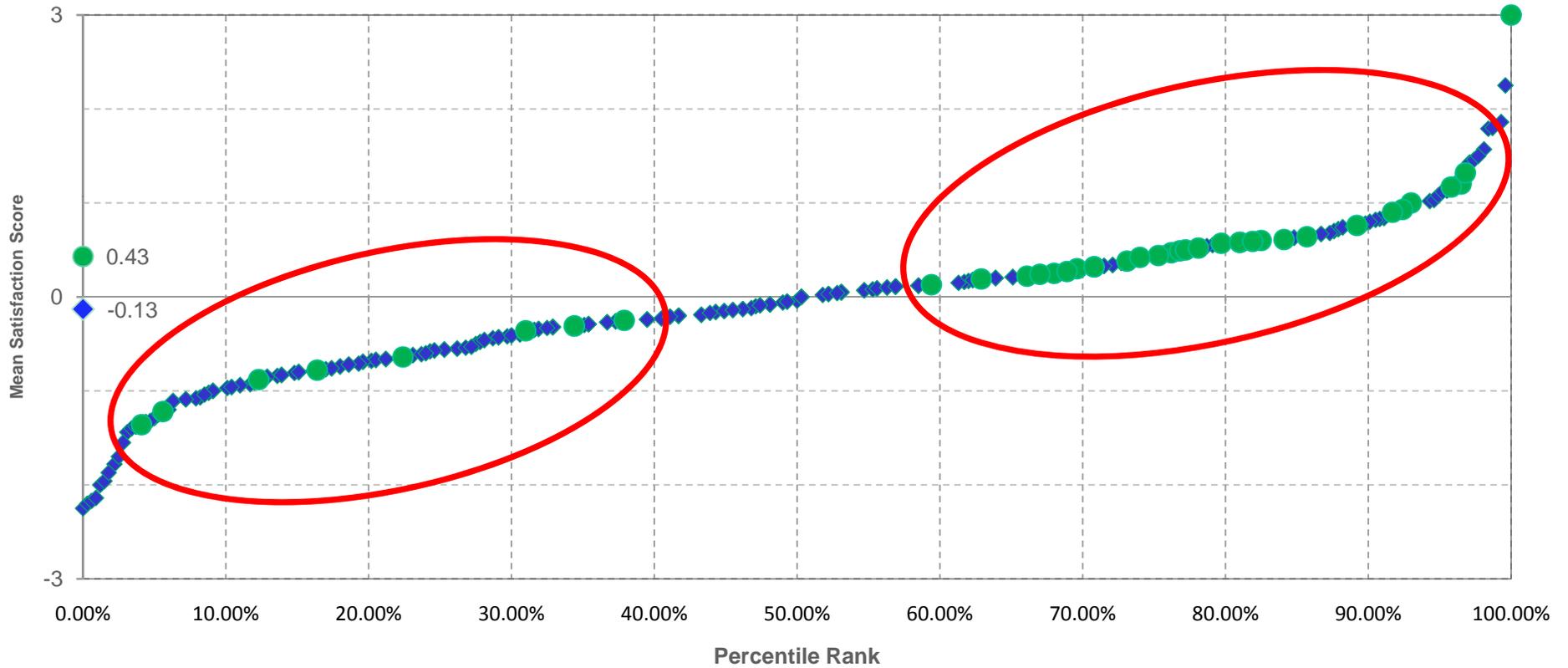
Mean Scores- Thermal Comfort LEED (n=39) compared to CBE database (n=284)



◆ Database building ● LEED-rated building

Thermal comfort

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



◆ Database building ● LEED-rated building

Thermal comfort

- **Standards define acceptable indoor environment:**
“Conditions in which more than 80% of people do not express dissatisfaction”
 - ASHRAE Standard 55-2004 (Thermal comfort)
 - ASHRAE Standard 62.1-2004 (Air quality)
- **And others even more restrictive! (90% threshold)**
 - ISO Standard 7730:1994 (Thermal comfort)

How satisfied are you with the temperature in your workspace?

Very Satisfied    Very Dissatisfied

Top 3 (>0): satisfied 

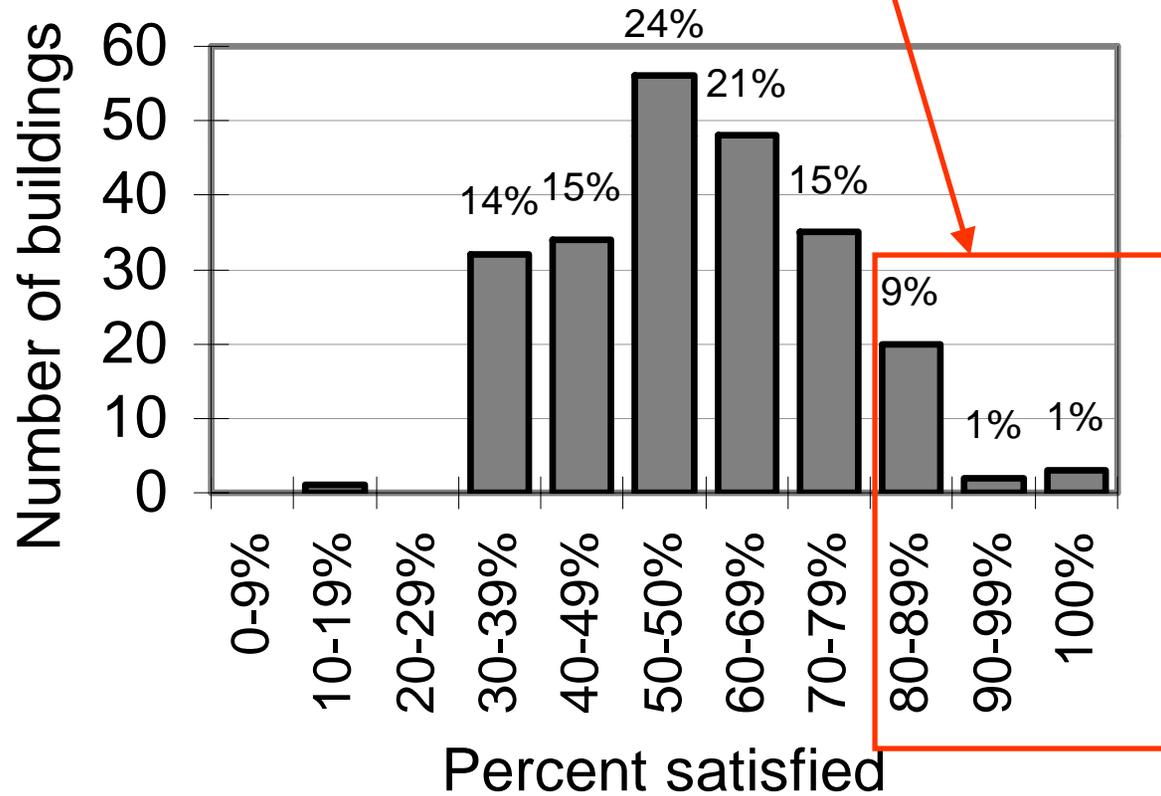
(CBE satisfaction threshold)

Top 4 (>=0): not dissatisfied 

(acceptability standard)

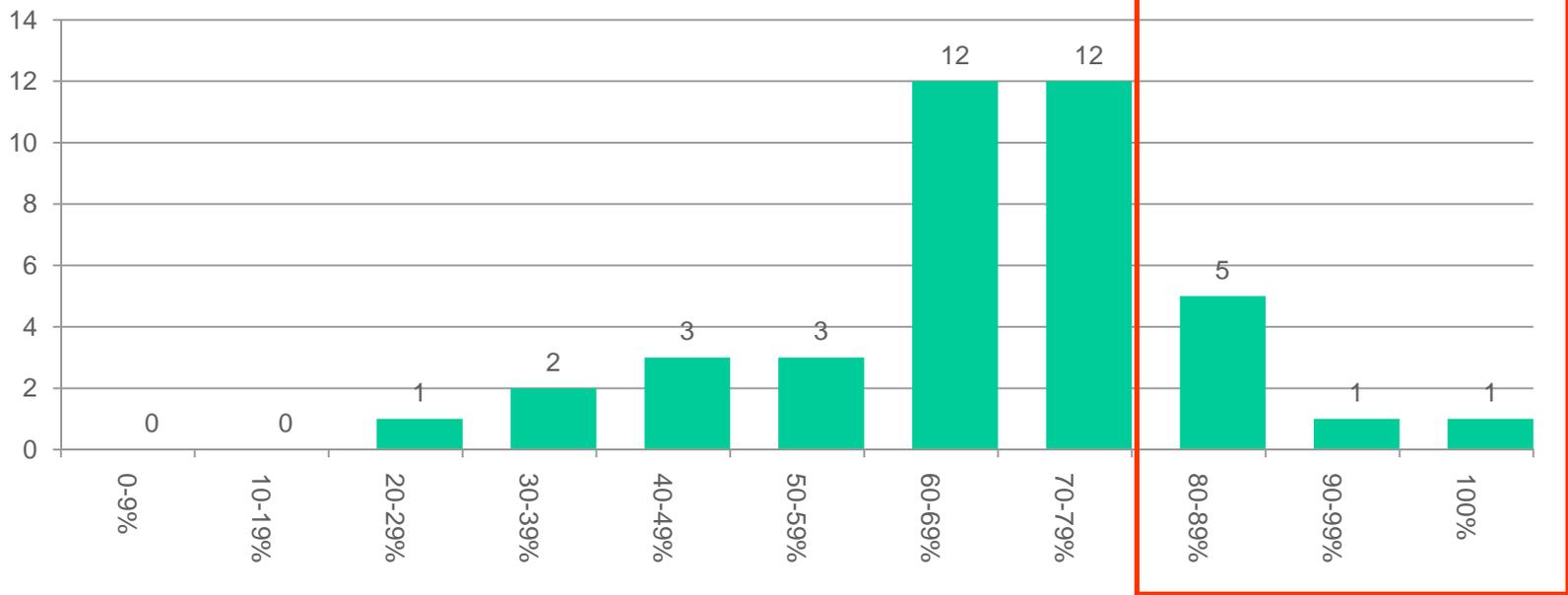
Thermal comfort

11% of buildings meet 80% acceptability standard



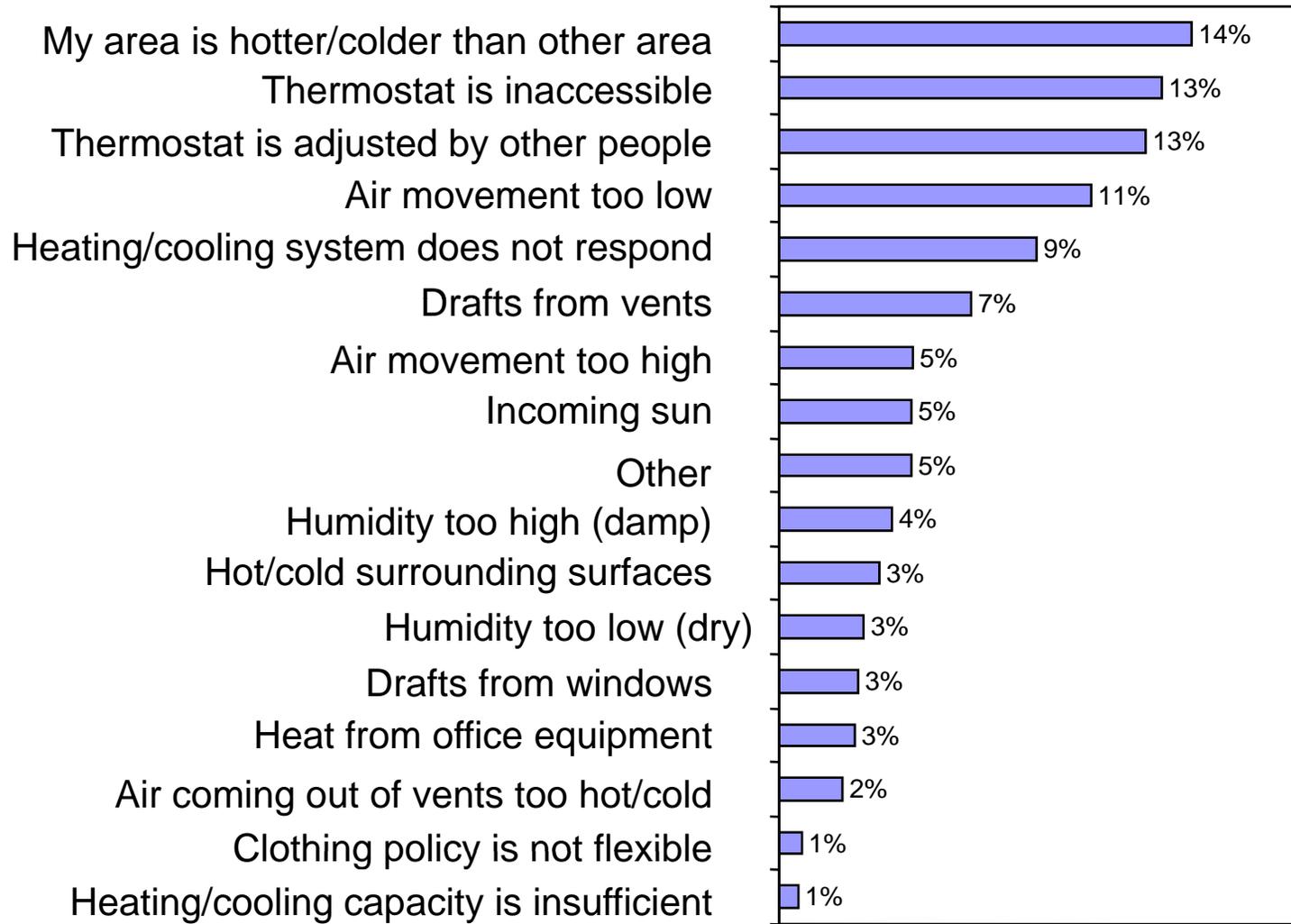
Thermal comfort in LEED buildings

“How satisfied are you with the temperature in your workspace?”



Sources of thermal discomfort

Source of dissatisfaction with temperature in CBE survey database
(one-person/one-vote) (total number of complaints = 32,806)

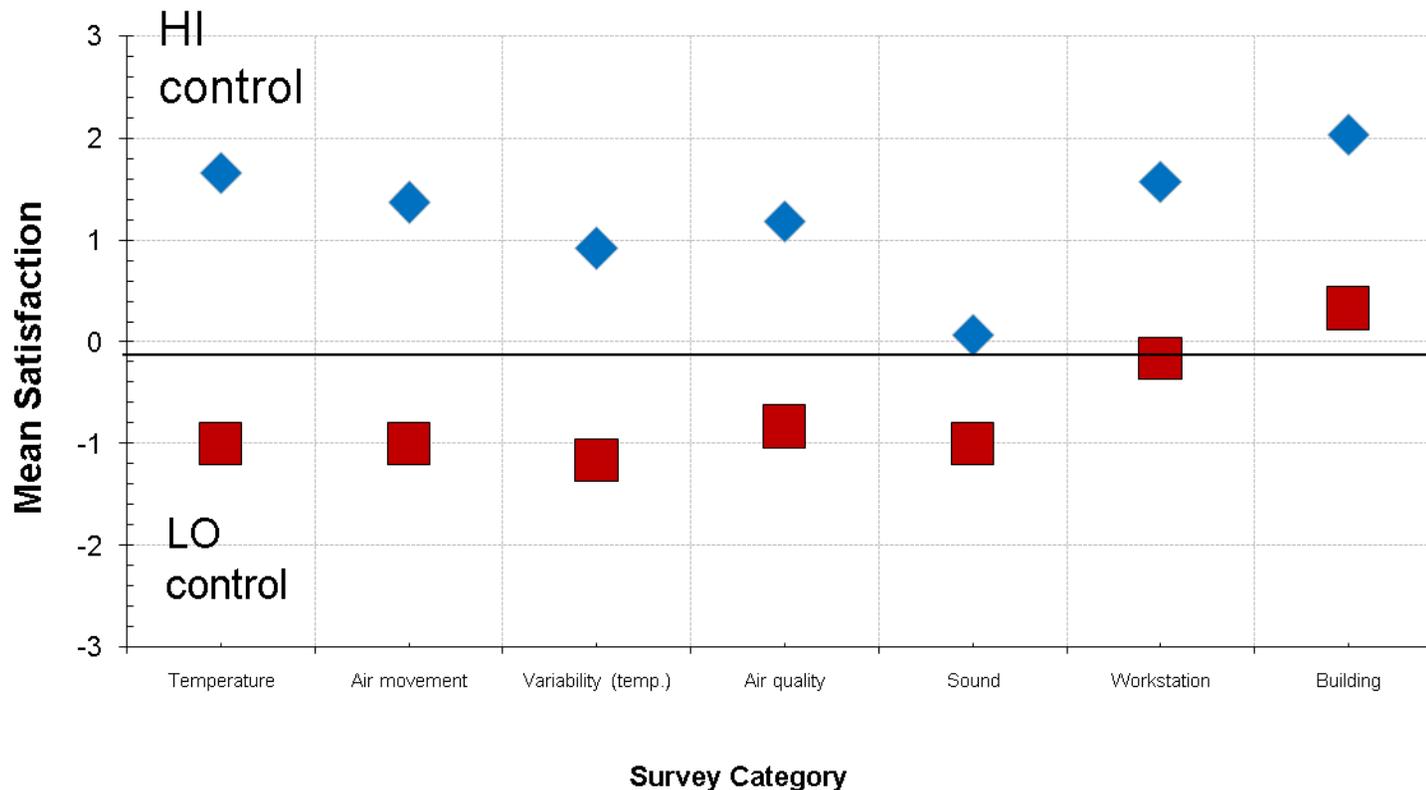


Sources of thermal discomfort in LEED bldgs

Rank	Source of dissatisfaction	
1	My area is hotter/colder than others	13%
2	Thermostat is inaccessible	13%
3	Thermostat is adjusted by other people	13%
4	Heating/cooling system does not respond quickly enough	12%
5	Drafts from vents	11%
6	Air movement too low	4%

Thermal comfort strategy -- personal control

People with high degrees of personal control over their environment report higher levels of satisfaction and perceived productivity than those with lower degrees of personal control.



$p < 0.05$
 $N = 93$

Thermal comfort strategy -- personal control

- **Window blinds or shades**
- **Operable window**
- **Thermostat**
- **Portable heater**
- **Permanent heater**
- **Room air-conditioning unit**
- **Portable fan**
- **Ceiling fan**
- **Adjustable air vent in wall or ceiling**
- **Adjustable floor air vent (diffuser)**
- **Door to interior space**
- **Door to exterior space**

Thermal comfort strategy -- personal control

- Personal control over environmental conditions has a positive impact on occupant satisfaction

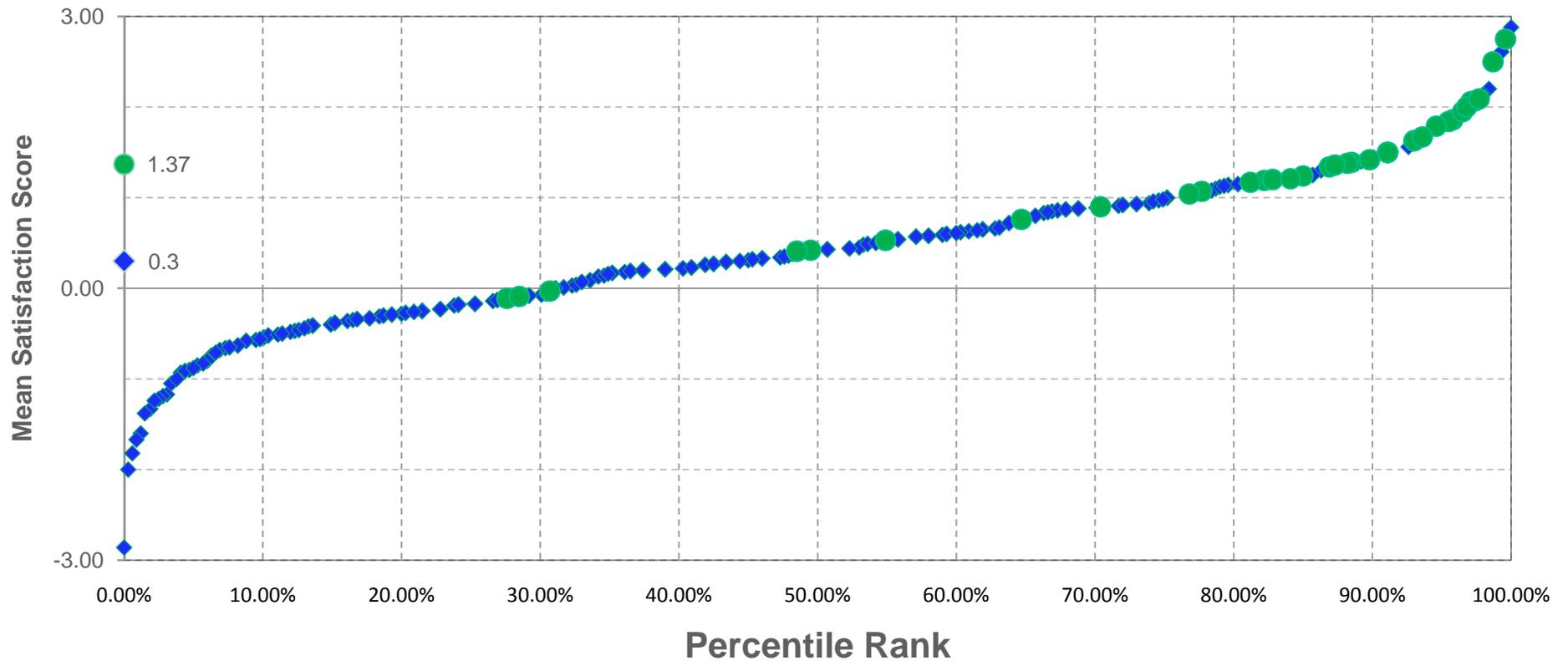
- Personal devices that compensate for building conditions can indicate dissatisfaction

	% satisfied*	N
All occupants	58%	32,749
No thermostat	56%	29,313
Thermostat	76%	3,437
Difference	20%	
No operable window	57%	30,018
Operable window	67%	2,732
Difference	10%	
No portable heater	59%	29,435
Portable heater	44%	3,315
Difference	-15%	
No portable fan	60%	25,422
Portable fan	51%	7,328
Difference	-9%	

*(>=0 on the -3 to +3 satisfaction scale) (p<0.01)

Air Quality

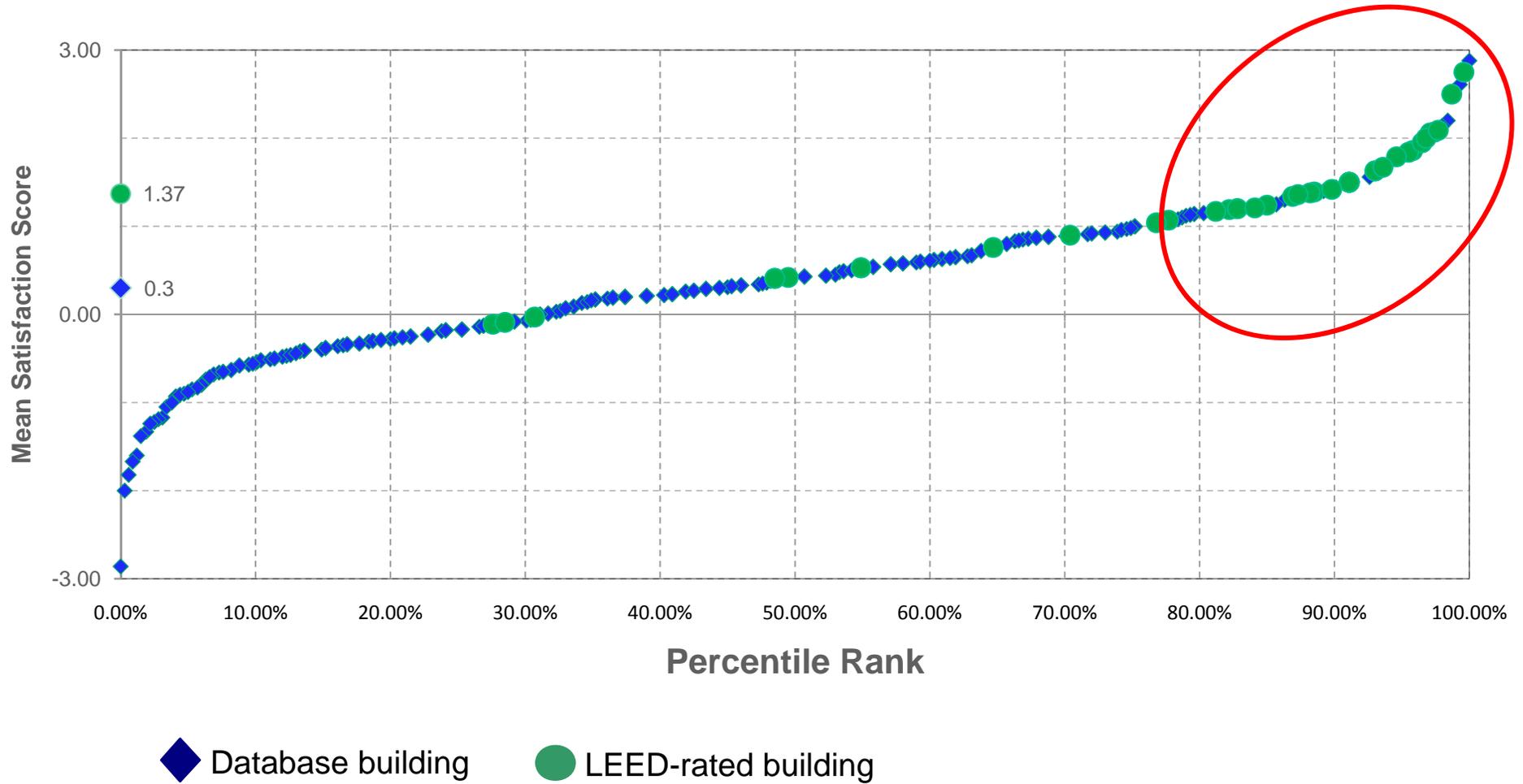
Mean Scores- Air Quality LEED (n=39) compared to CBE database (n=284)



◆ Database building ● LEED-rated building

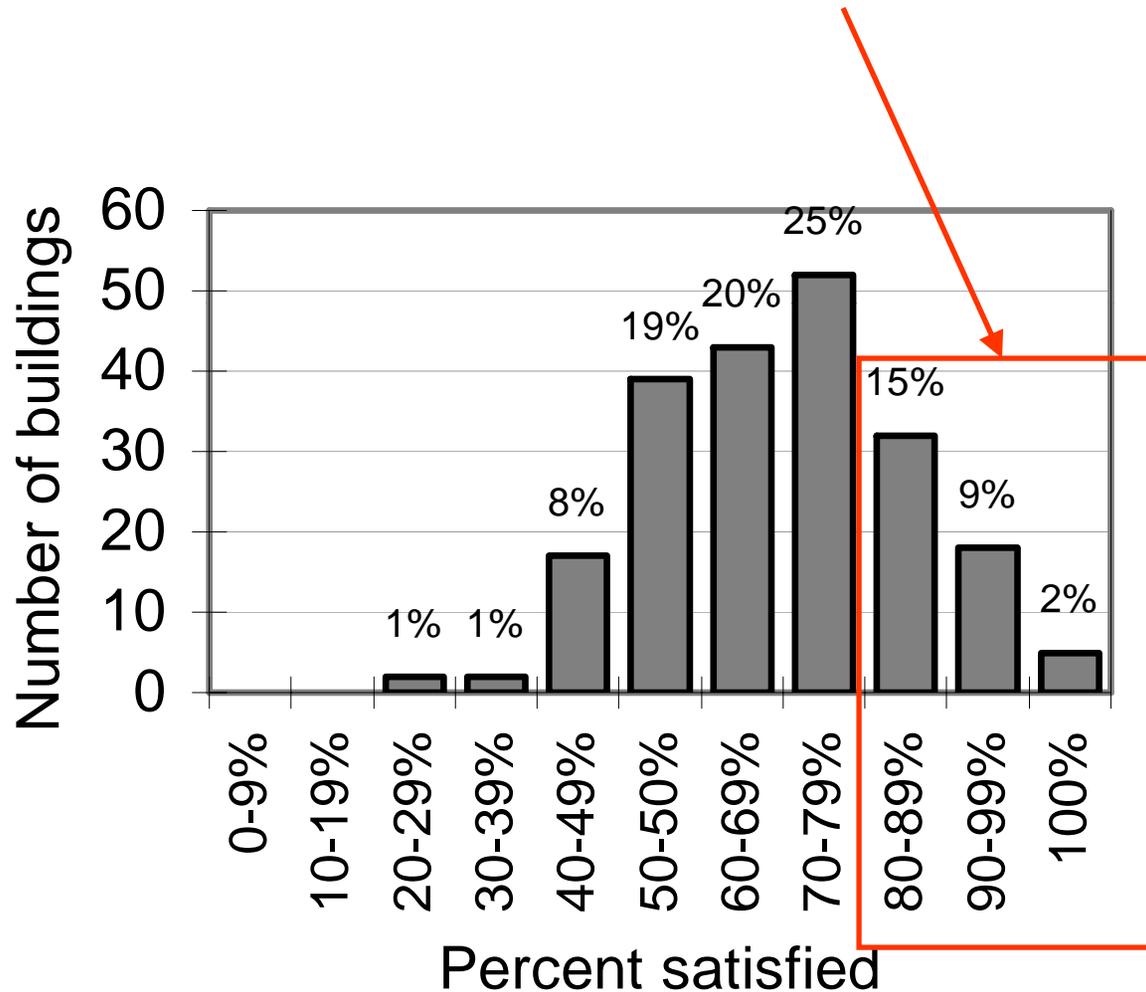
Air Quality

Mean Scores- Air Quality LEED (n=39) compared to CBE database (n=284)



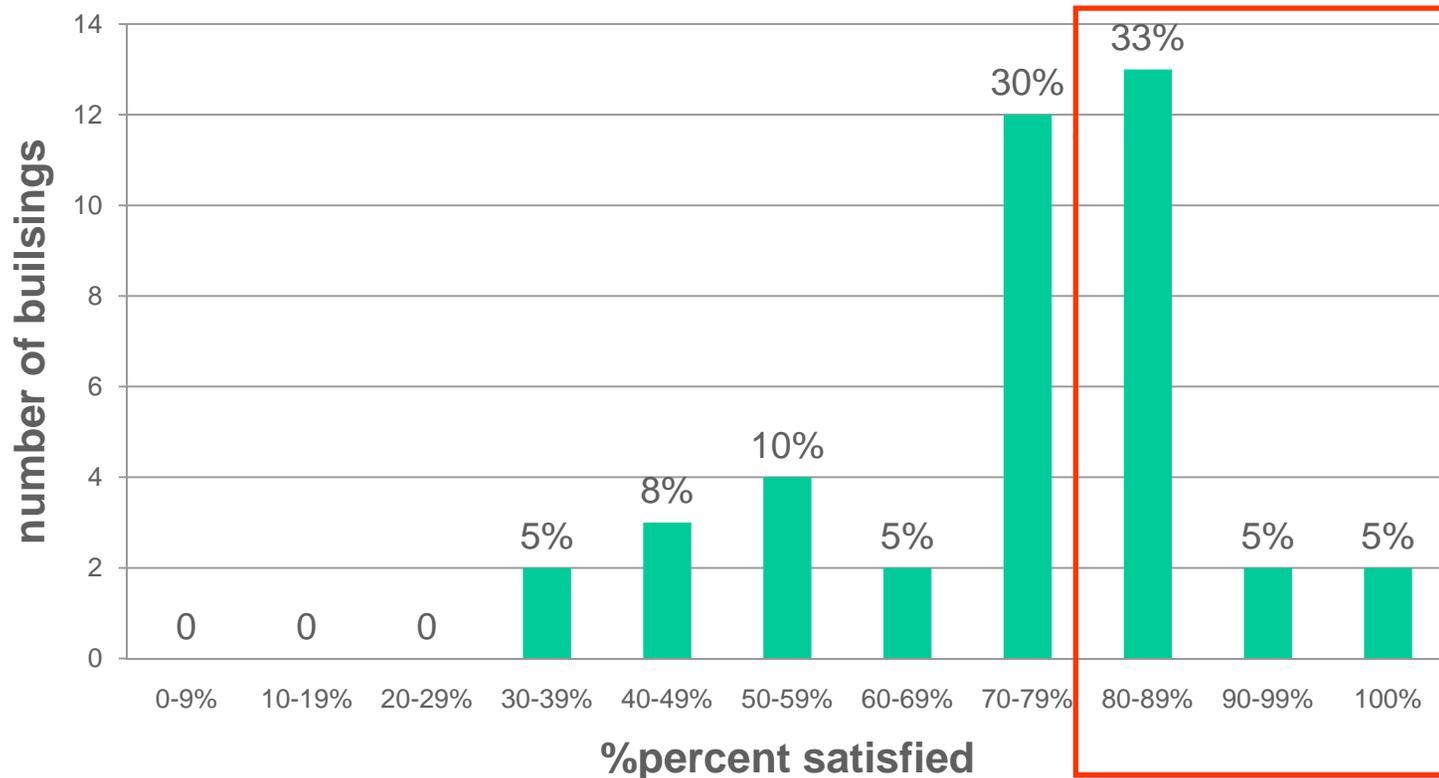
Air quality satisfaction

26% of buildings meet acceptability standard



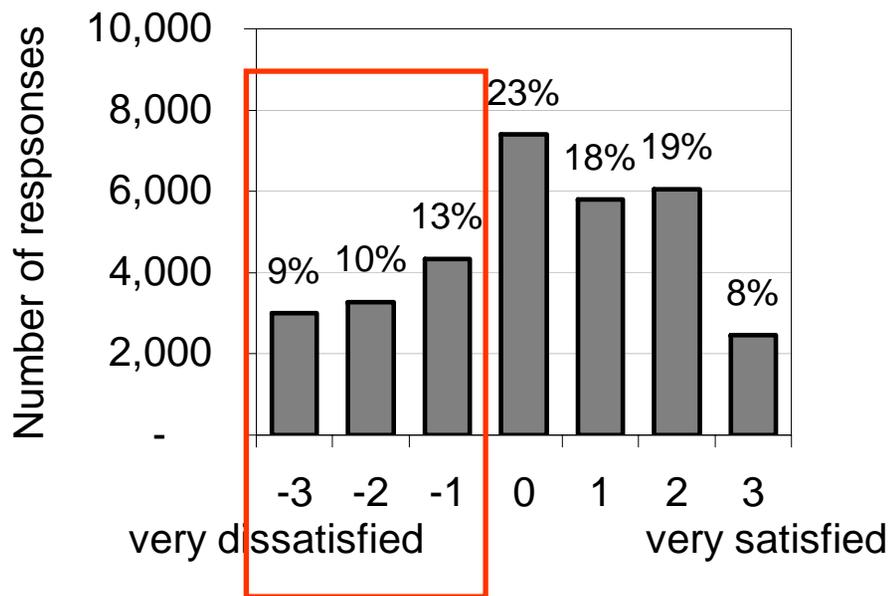
Air quality satisfaction in LEED buildings

43% of buildings meet acceptability standard



Air quality satisfaction

“How satisfied are you with the air quality in your workspace (i.e. stuffy/stale air, cleanliness, odors)?”



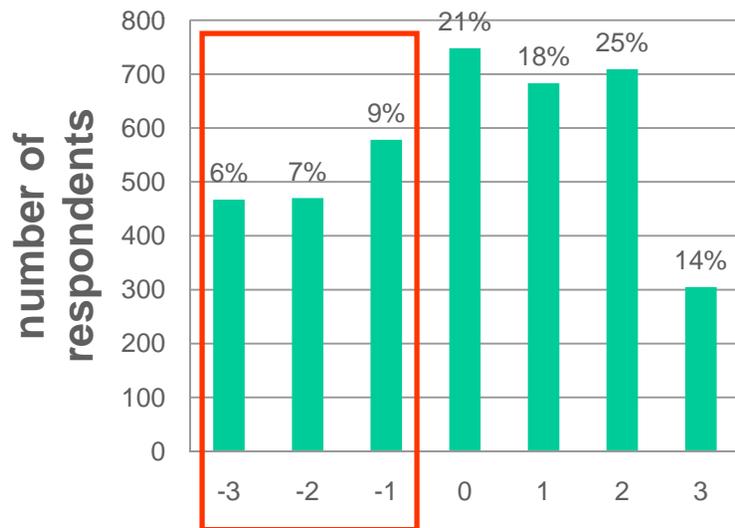
Overall: 32% of respondents dissatisfied

Among those who were dissatisfied with their air quality, major complaints were (in order):

Air is stuffy/stale	74%
Air is not clean	67%
Air is smelling bad	51

Air quality satisfaction in LEED buildings

“How satisfied are you with the air quality in your workspace (i.e. stuffy/stale air, cleanliness, odors)?”



Among those who were dissatisfied with their air quality, major complaints were (in order):

Air is stuffy/stale 71%

Air is not clean 57%

Overall: 22% of respondents dissatisfied

Why LEED does well in air quality

- **Focus on air quality in LEED EB & NC**
- **Newer buildings**
- **Not definitive; more research needed**

Questions/discussion

John Goins

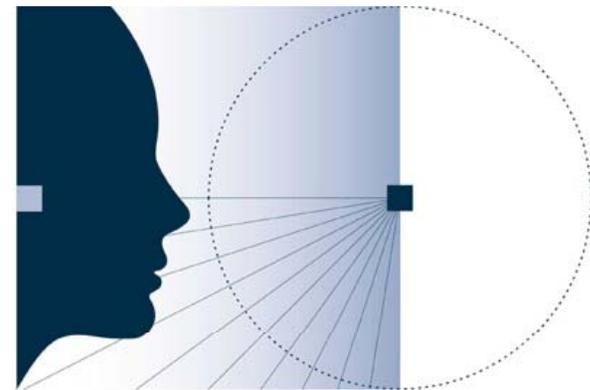
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Survey demo

www.cbesurvey.org

Center for the Built Environment

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