High Performance Facades: How Facade Design Methods Lead to Divergent Outcomes

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Case study overview

General Services Administration (GSA) case studies

- Two case studies, a renovation and new building
- GSA acts as the property owner for many federal buildings
- GSA Design Excellence Program
- Transparency in terms of process, costs and also the results
- GSA sponsored post-occupancy evaluations (POEs) of 22 buildings, with collected measured data and used CBE's occupant surveys
- Additional studies on these buildings

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CTG/SF via Flickr

Case study: San Francisco Federal Building

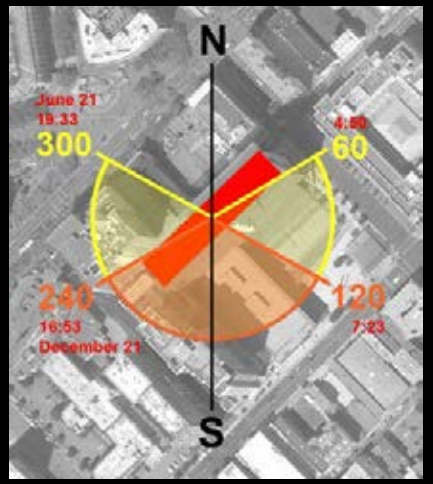
- Design Team Leaders
  - Morphosis
  - SmithGroup (architect of record)
  - Arup
- 70% of building is naturally ventilated, saving $11M in construction costs and $500K annual savings cited
- EnergyStar score 96

Field study featured in PhD dissertation by Kyle Konis (co-author of Effective Daylighting with High-Performance Facades)

Images by K. Konis unless noted

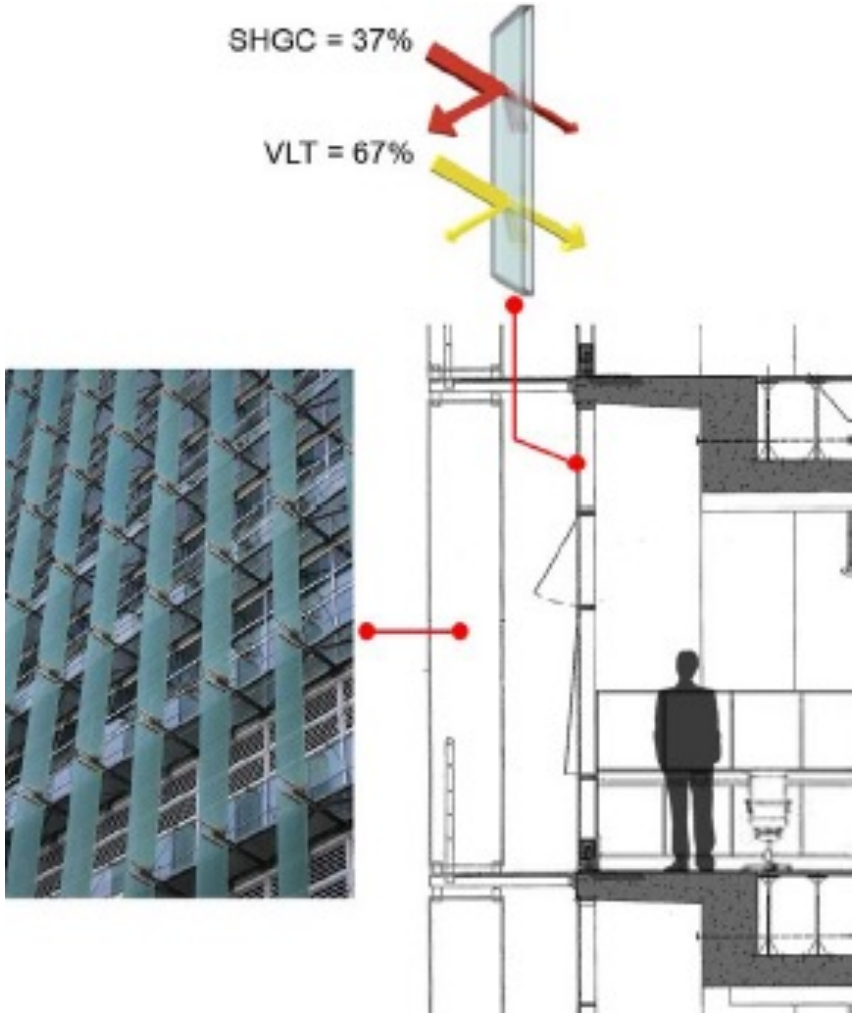
CTG/SF via Flickr

Northwest facade

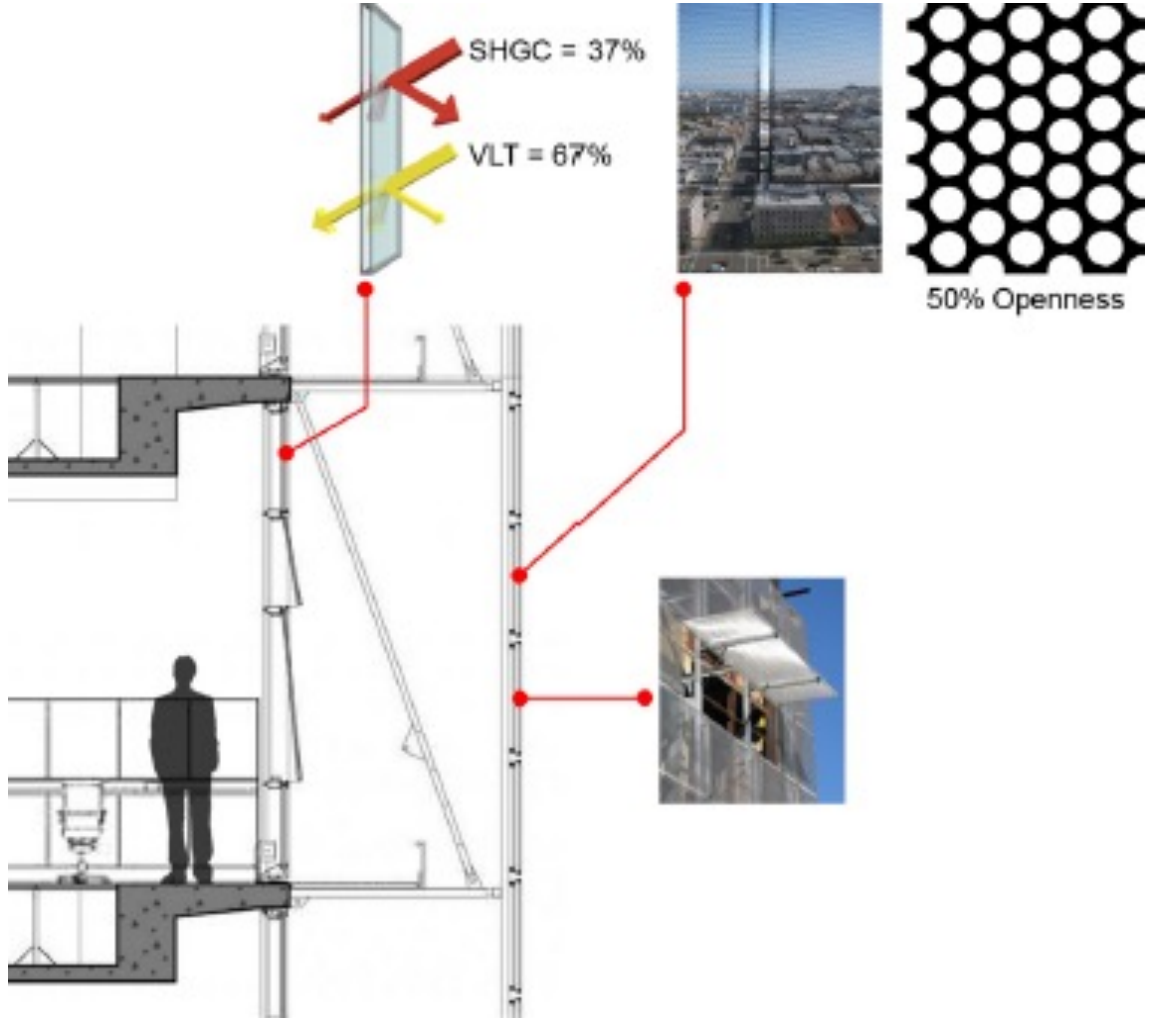


Southeast facade

SFFB facade sections

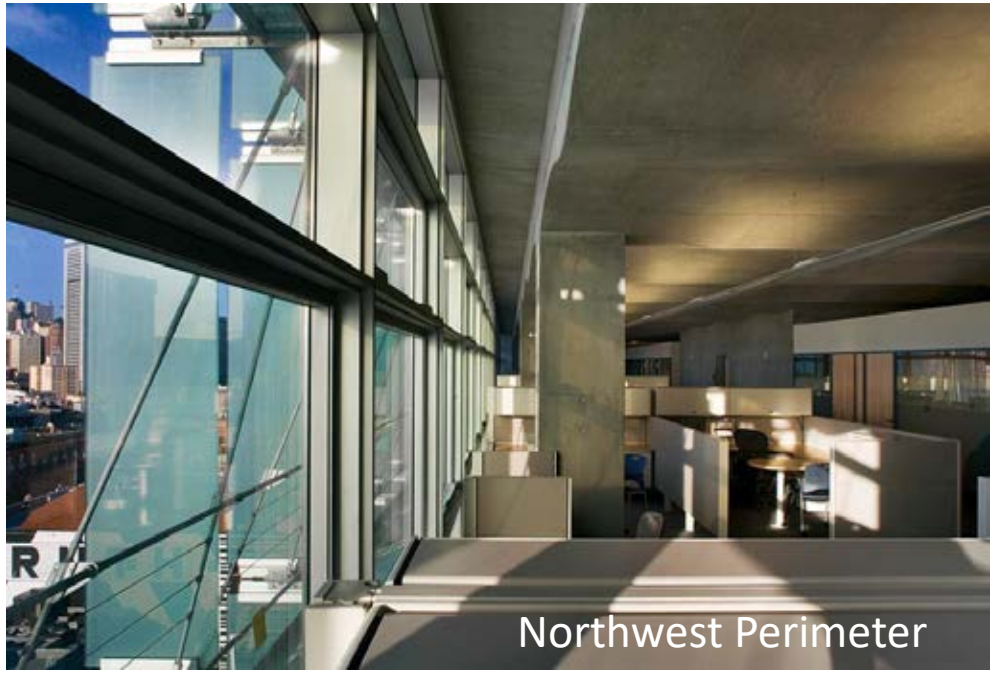


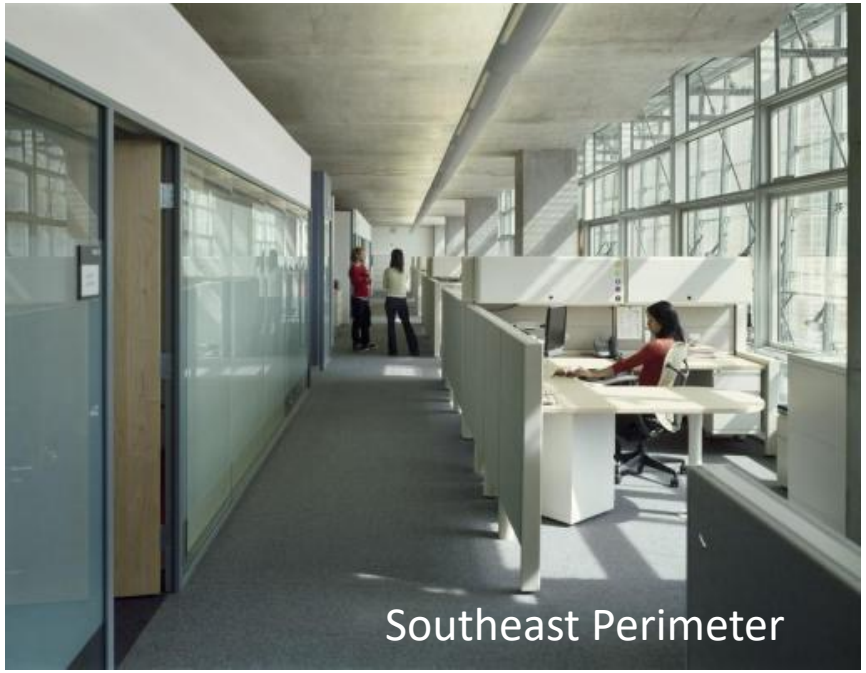
Northwest facade

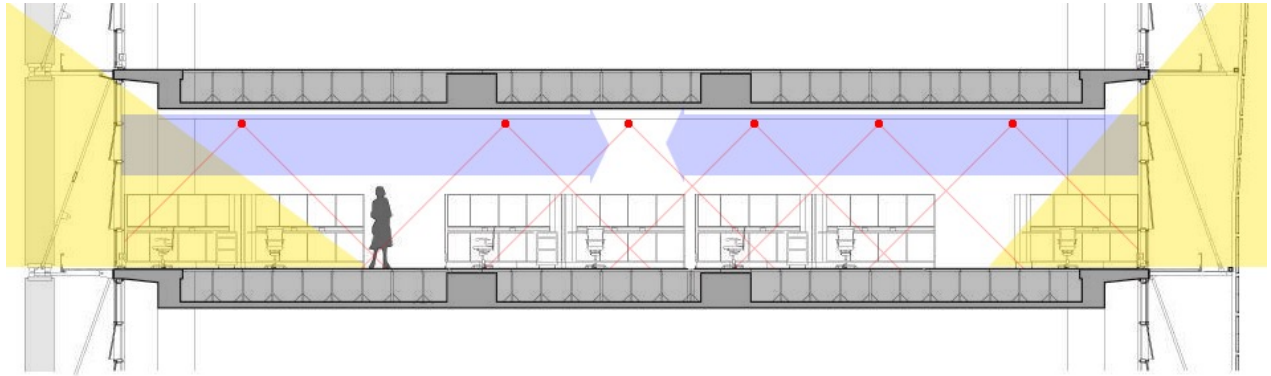


Southeast facade

SFFB facade strategy for ‘deep daylighting’







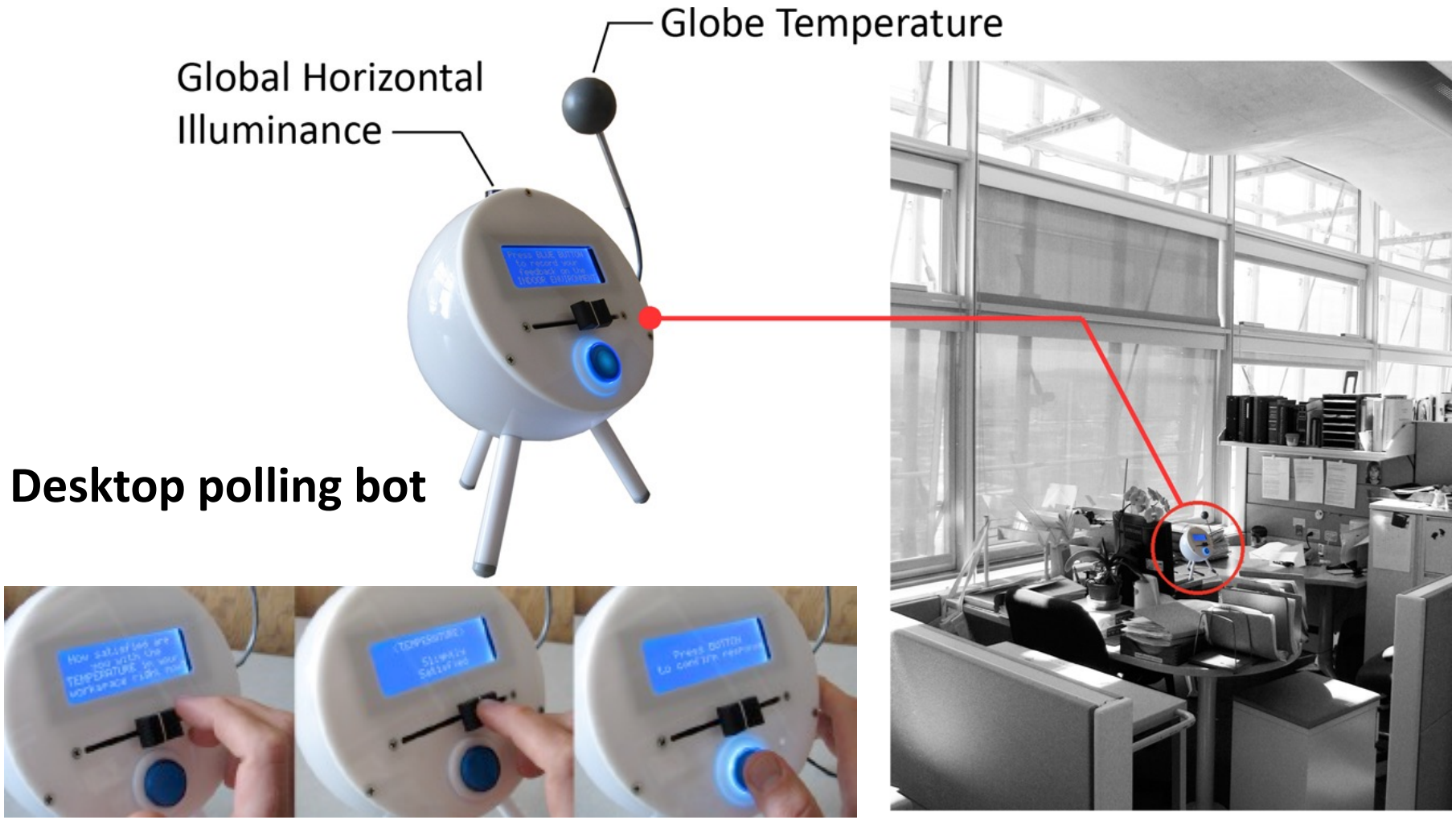
Images via Arup

SFFB facade strategy for ‘deep daylighting’

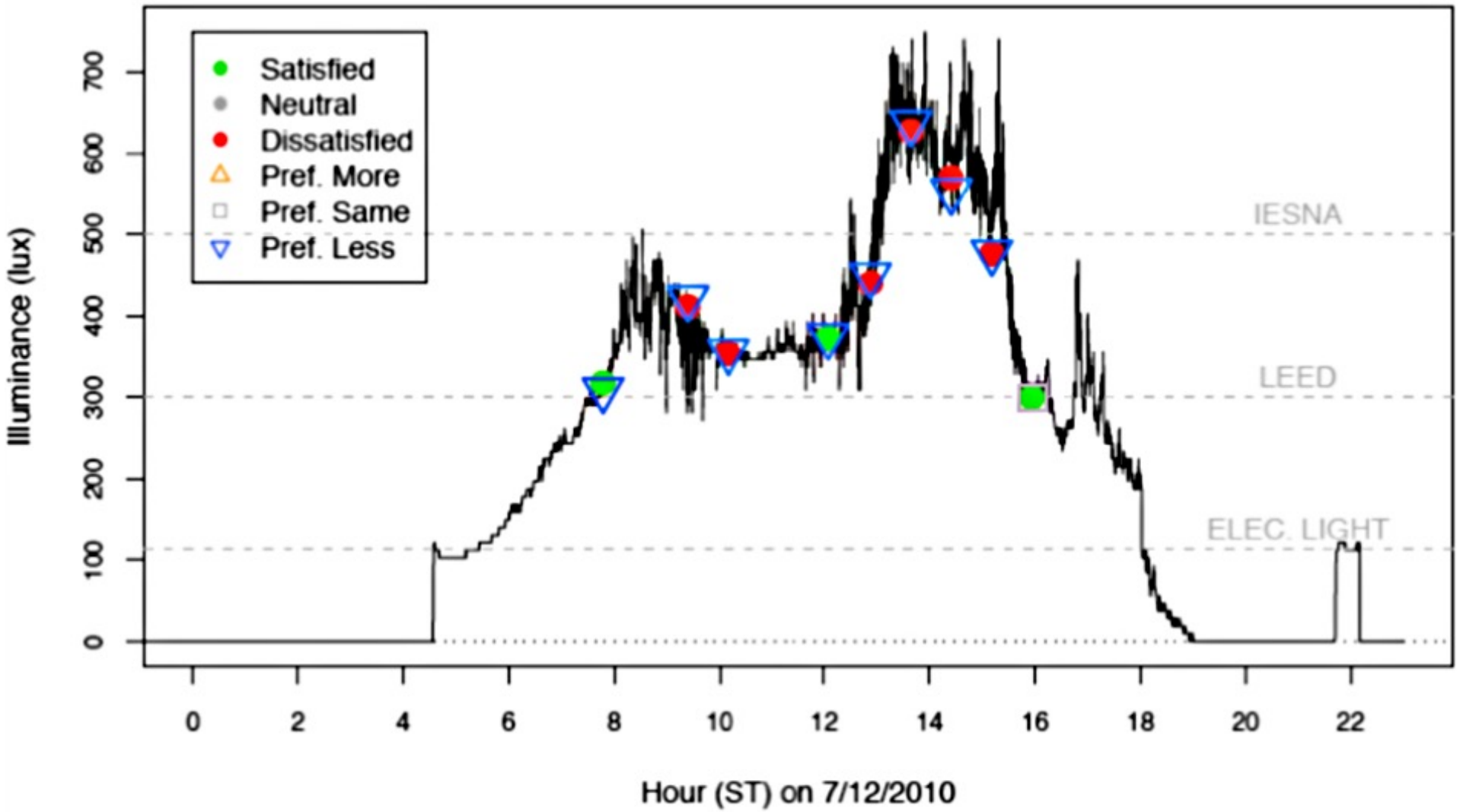
Anticipated conditions from rendering

Actual daylight and view seen in occupied building

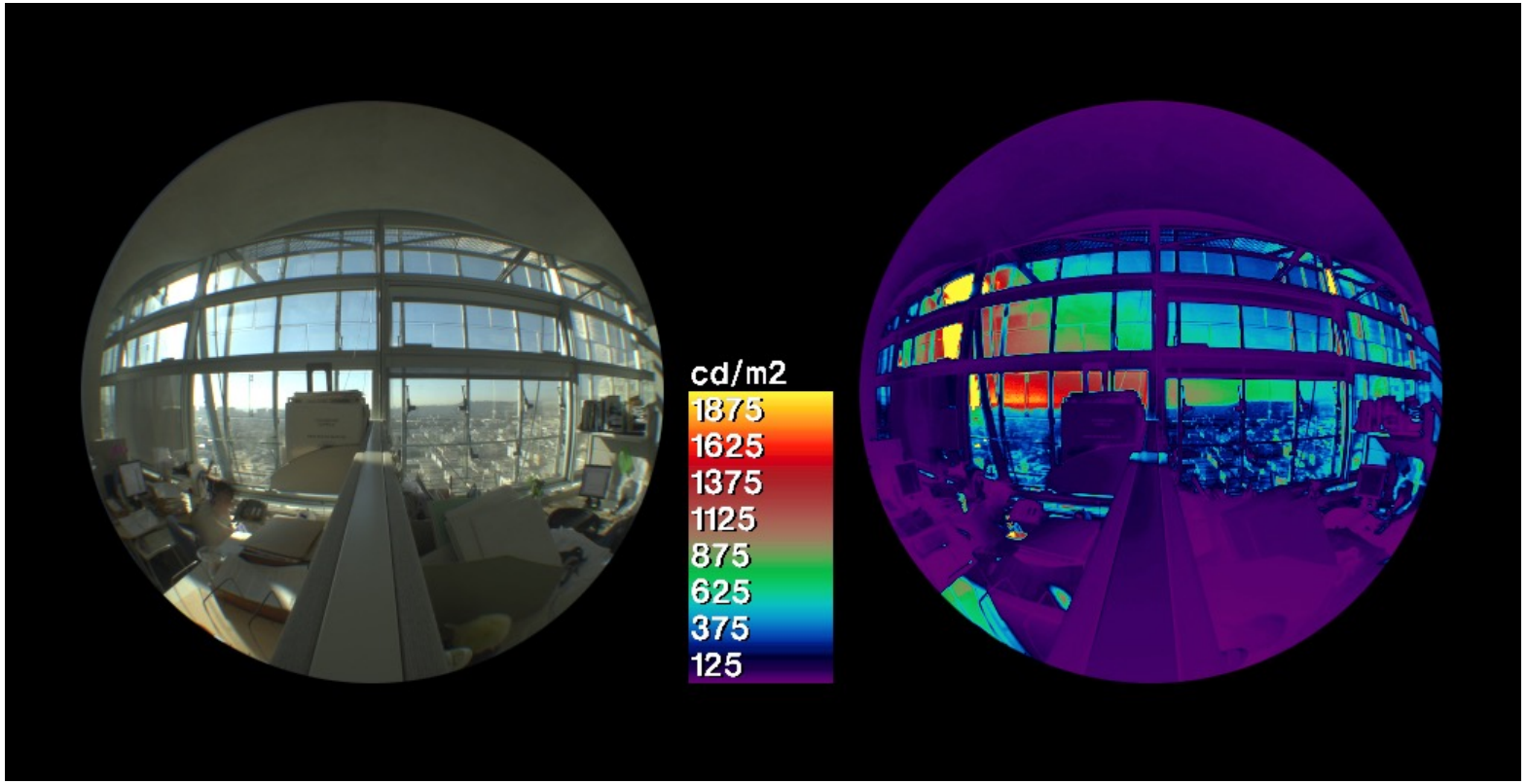
Field study combined subjective and physical measures



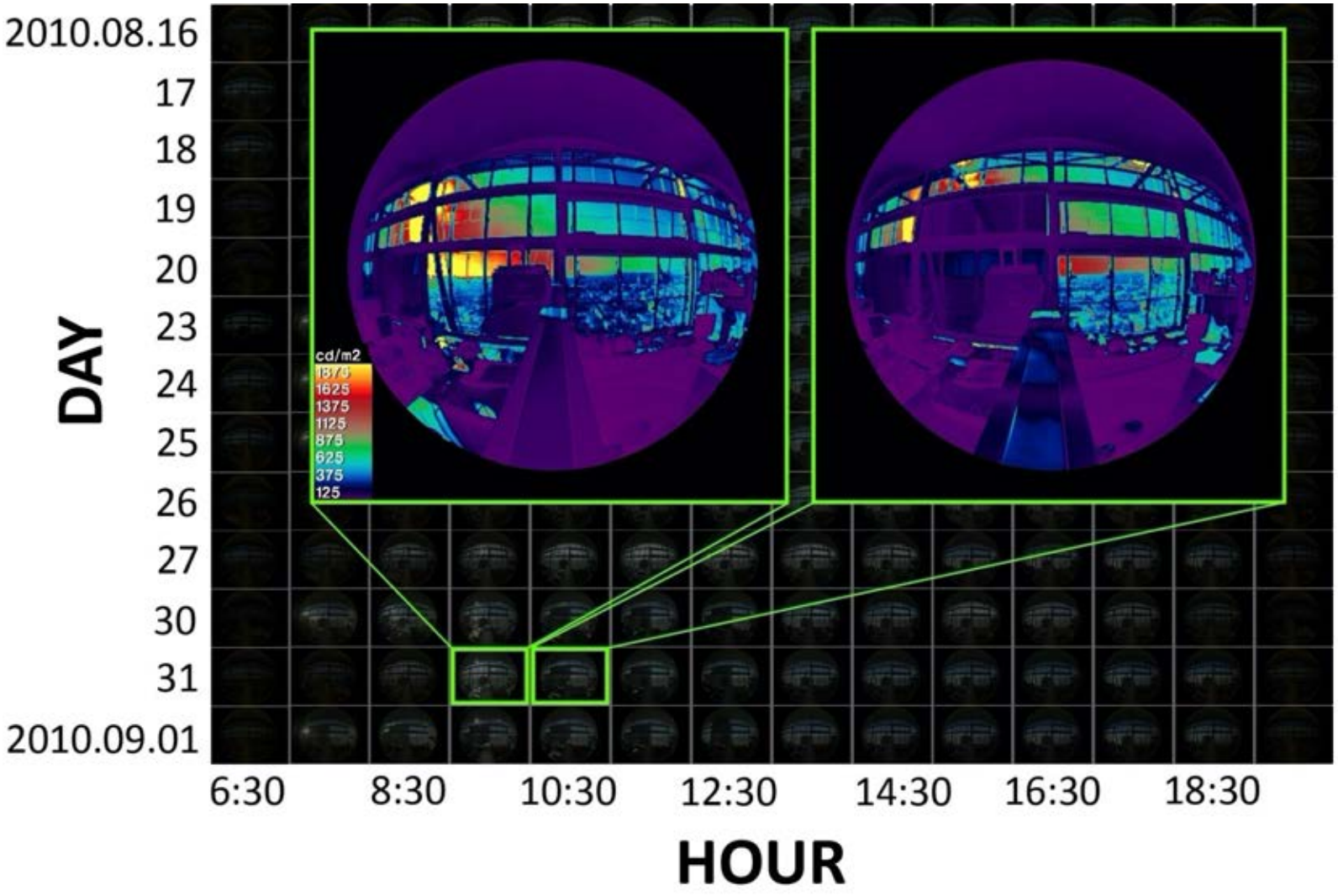
Desktop polling bot sample data



High dynamic range (HDR) imaging at workstations

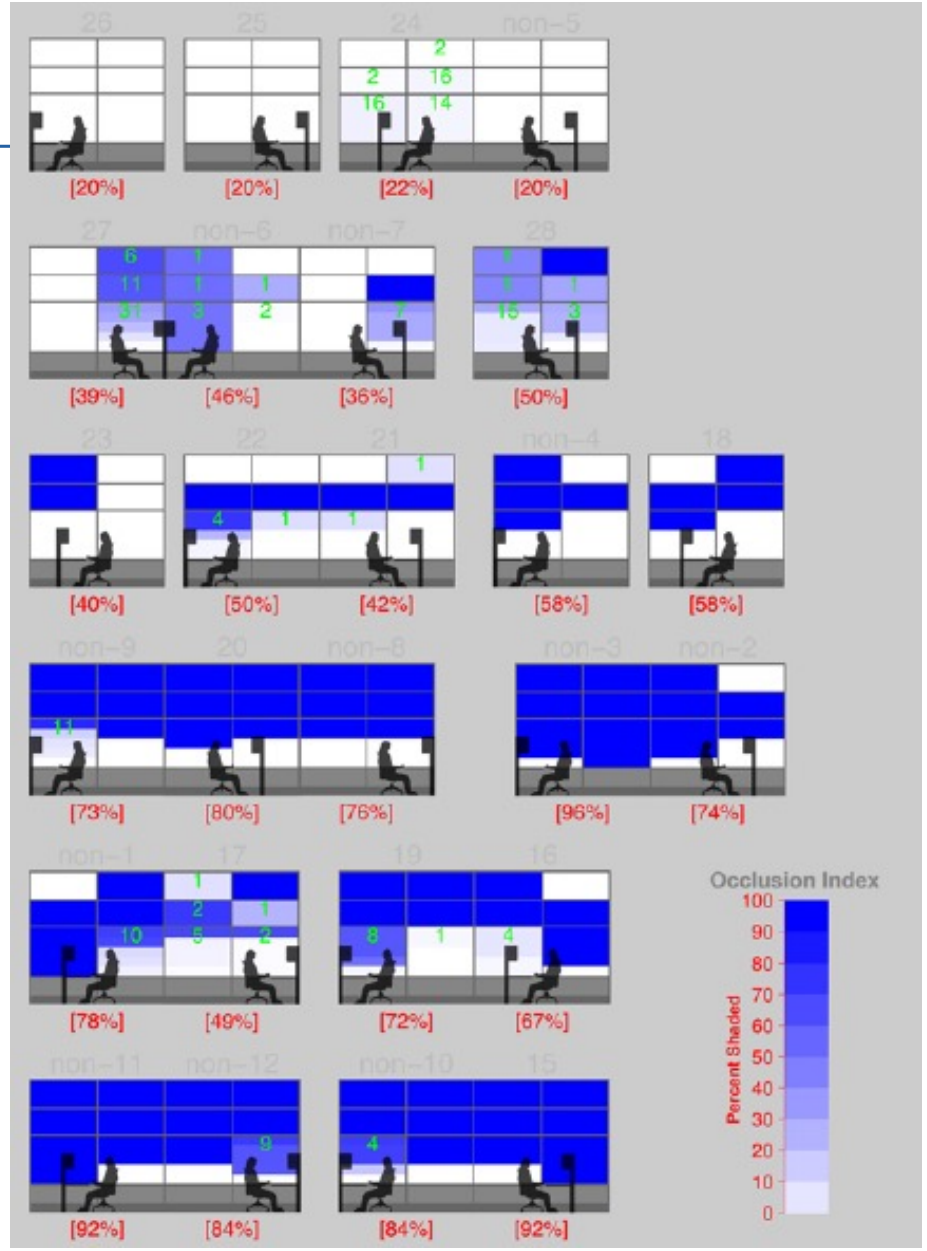


Deriving occupant shade use from HDR images



Summary of field study findings

- Ambitious program, good energy performance but occupant survey scores were low overall, requiring shade retrofits
- Shade study findings
  - Shades deployed frequently, use varied by individual, less by season or exposure
  - Even in shaded state, participants perceived daylight levels to be sufficient
- Energy tools are highly advanced, however resources for designing for, and predicting visual comfort lacking and/or underutilized



Summary of shade occlusion,
SE zones, summer 2010

Case study: Edith Green-Wendell Wyatt Federal Building Modernization

Design Team

- SERA
- Cutler Anderson Architects
- Stantec
- Interface
- PAE
- KPFF

Published as “Federal Office Building with an Integrated Facade,” 2015, M. Perepelitza, L. Petterson, K. Turpin and J. Riley

Images courtesy of SERA Architects

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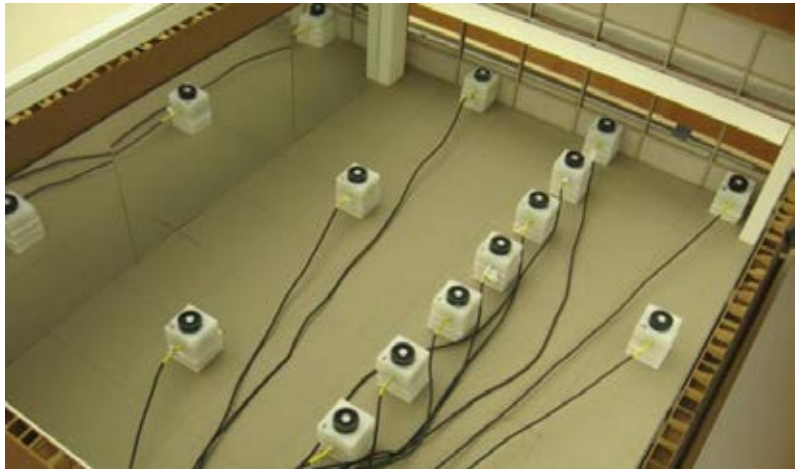
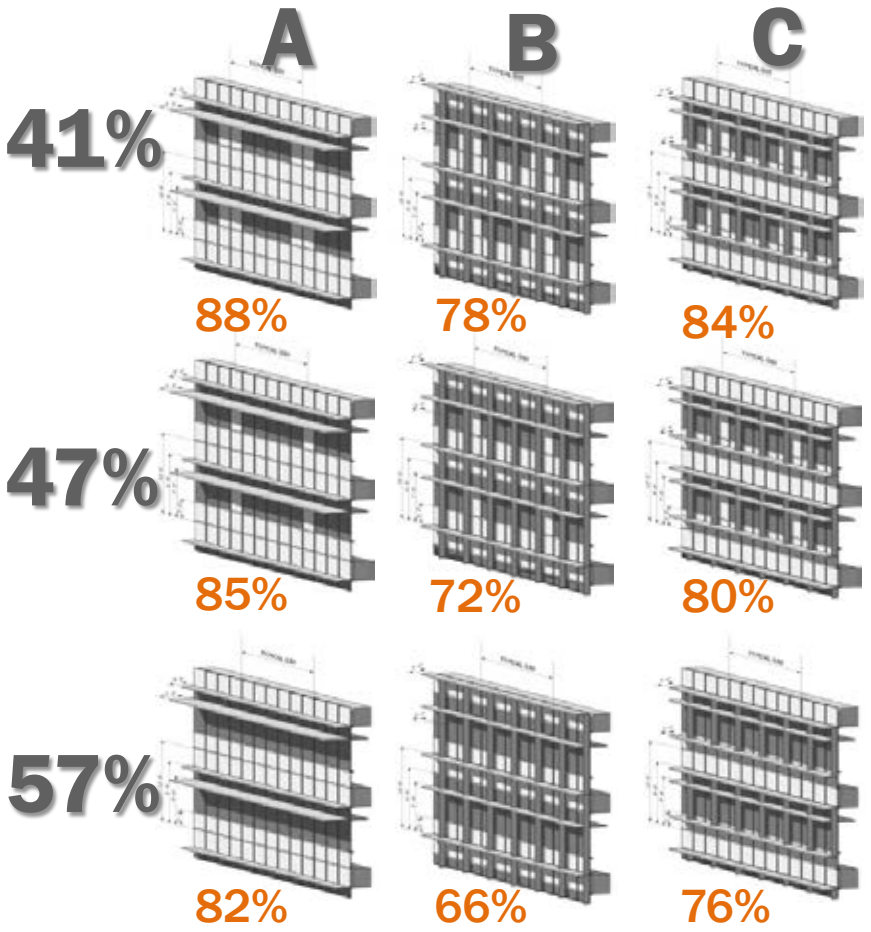
EDWW integrated design approach

- High performance facade enabled the use of highly efficient HVAC option of hydronic radiant ceiling panels with dedicated outside air system (DOAS) for ventilation.
- Radiant can serve only a peak cooling load below 20-30 Btu/hr/sf
- HVAC, exterior shading and lighting largest contributors to energy savings
- Higher ceilings and reducing mechanical space were additional goals

Energy Conservation Measures Recommended	Target	Percent Saving
Wall U-value	U value 0.044	2.2%
Glass U-value	U value 0.25	2.7%
Glass Percentage	40%	2.0%
Shading Exterior		
- Fixed East / South fins		7.0%
- West fins		
Daylighting		
Variable Speed Fans		2.5%
Energy Efficient Lighting	lpd = 0.5	6.0%
Radiant Heating & Cooling		11.0%

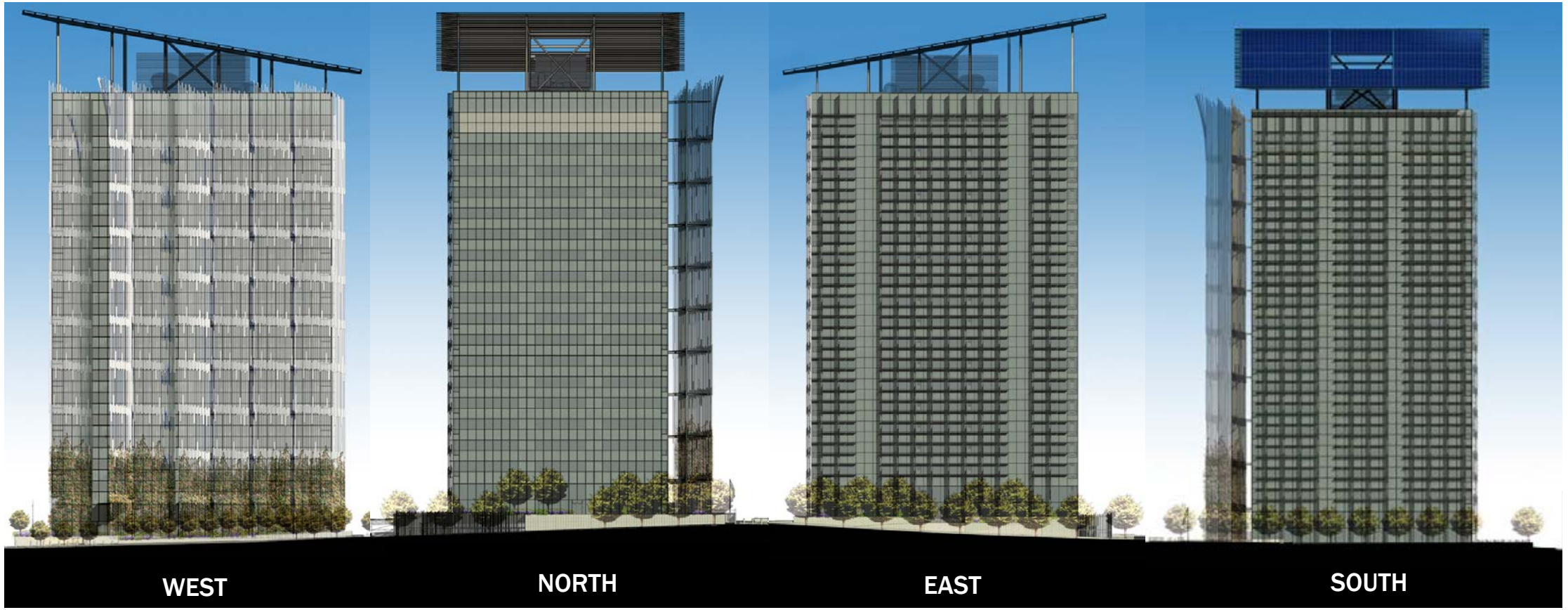
EGWW shading and daylighting analysis using physical models





% annual shading, south facade

EGWW elevations tuned for solar orientation



Reeds cover facade | **No shading** | **Vertical and horizontal shades**

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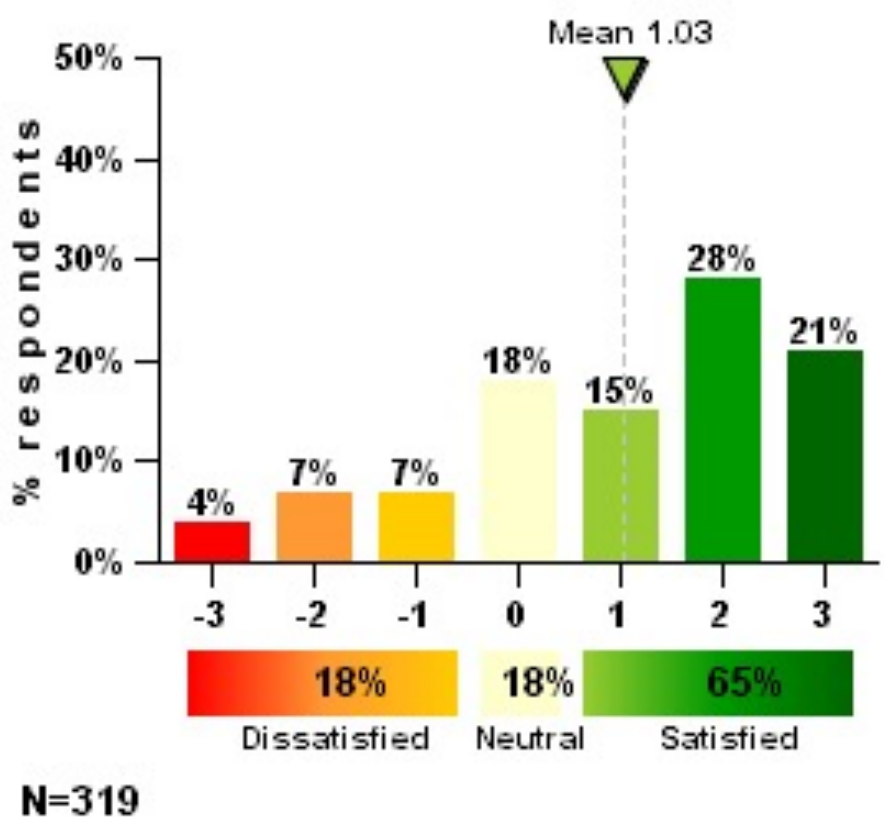
Summary of EGWW post-occupancy study

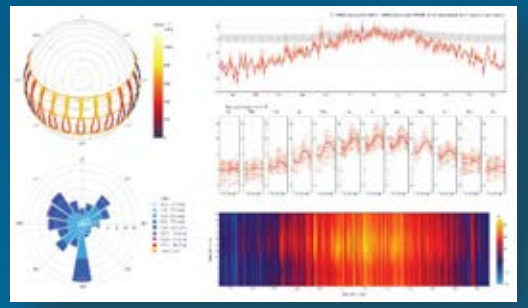
- Used CBE occupant survey for pre- and post-occupancy evaluation
- Average survey results good; however filtering by zone and floors identified problems with thermal comfort and glare from low sun angles
- Measured energy energy use of 31.5 Kbtu/sf/yr, 45% below code baseline and 61% below original building
- Annual energy cost reduced by $306K

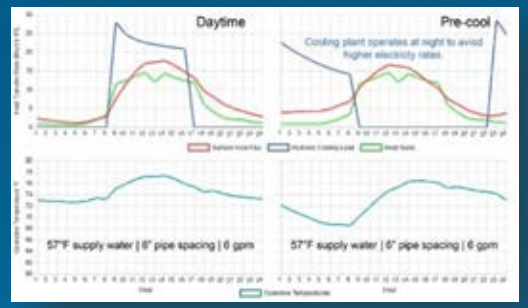
How satisfied are you with the amount of daylight in your workspace?

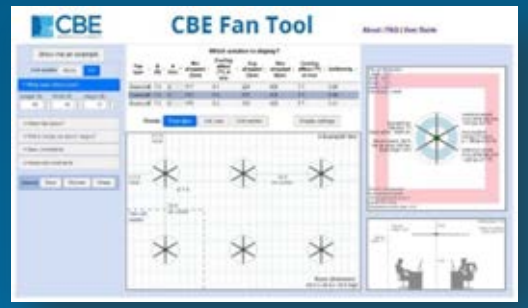


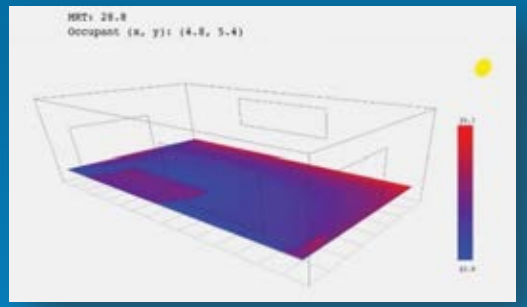
CBE tools and resources

https://cbe.berkeley.edu/resources/tools/









CBE occupant satisfaction survey

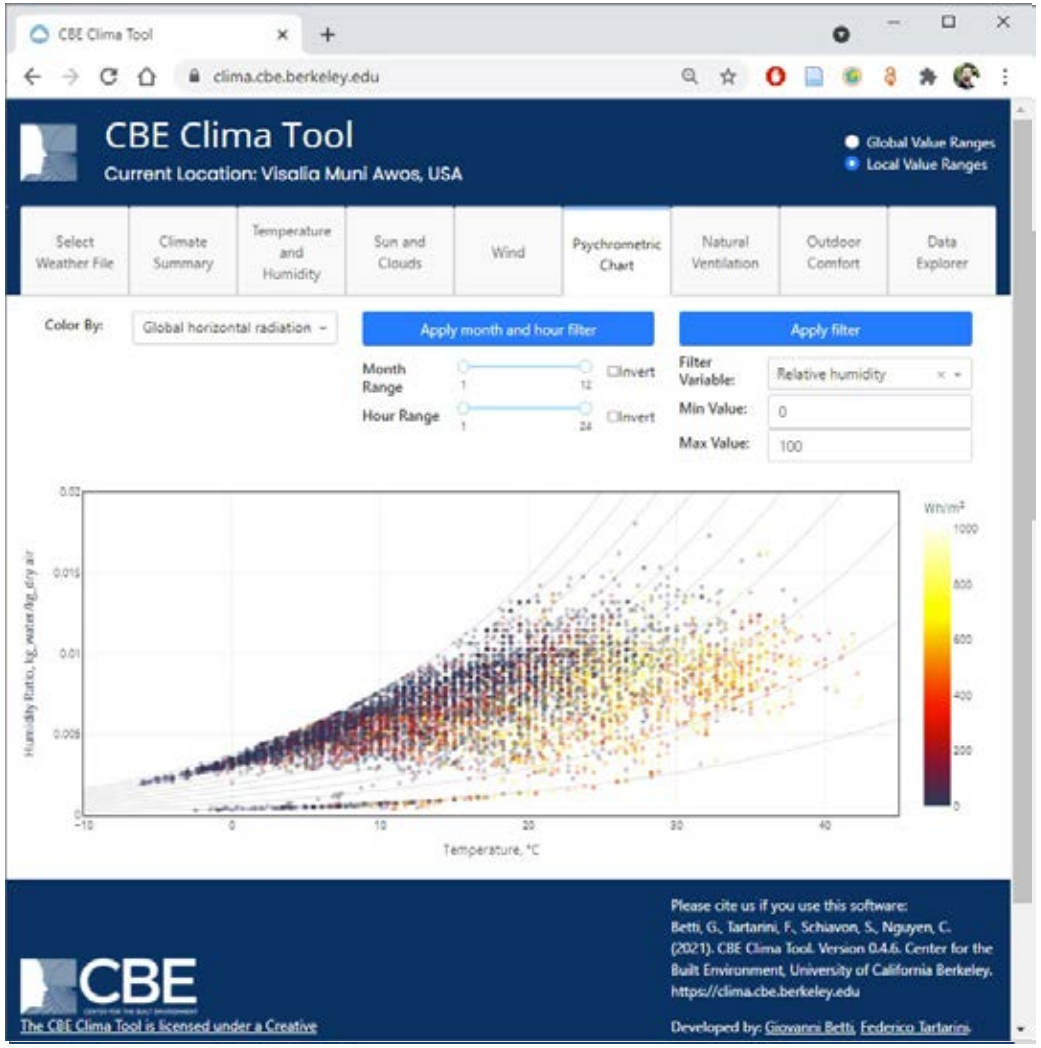
- Standardized method for studying building performance from occupants' point of view
- Rich database valuable for evaluation of new technologies and for:
  - Feedback
  - Diagnostics
  - Benchmarking
  - Research
- Versions for offices and other building types

cbe.berkeley.edu/survey

Clima: A new tool for climate analysis

- Choose from ~30,000 weather files
- Visualize high level summary plots
- Generate sunpath, wind rose, psychrometric chart, heat map, and more specialist plots
- Create custom visualizations, filter by datetime or weather data features
- Explore outdoor comfort metrics
- Download data and high-resolution images

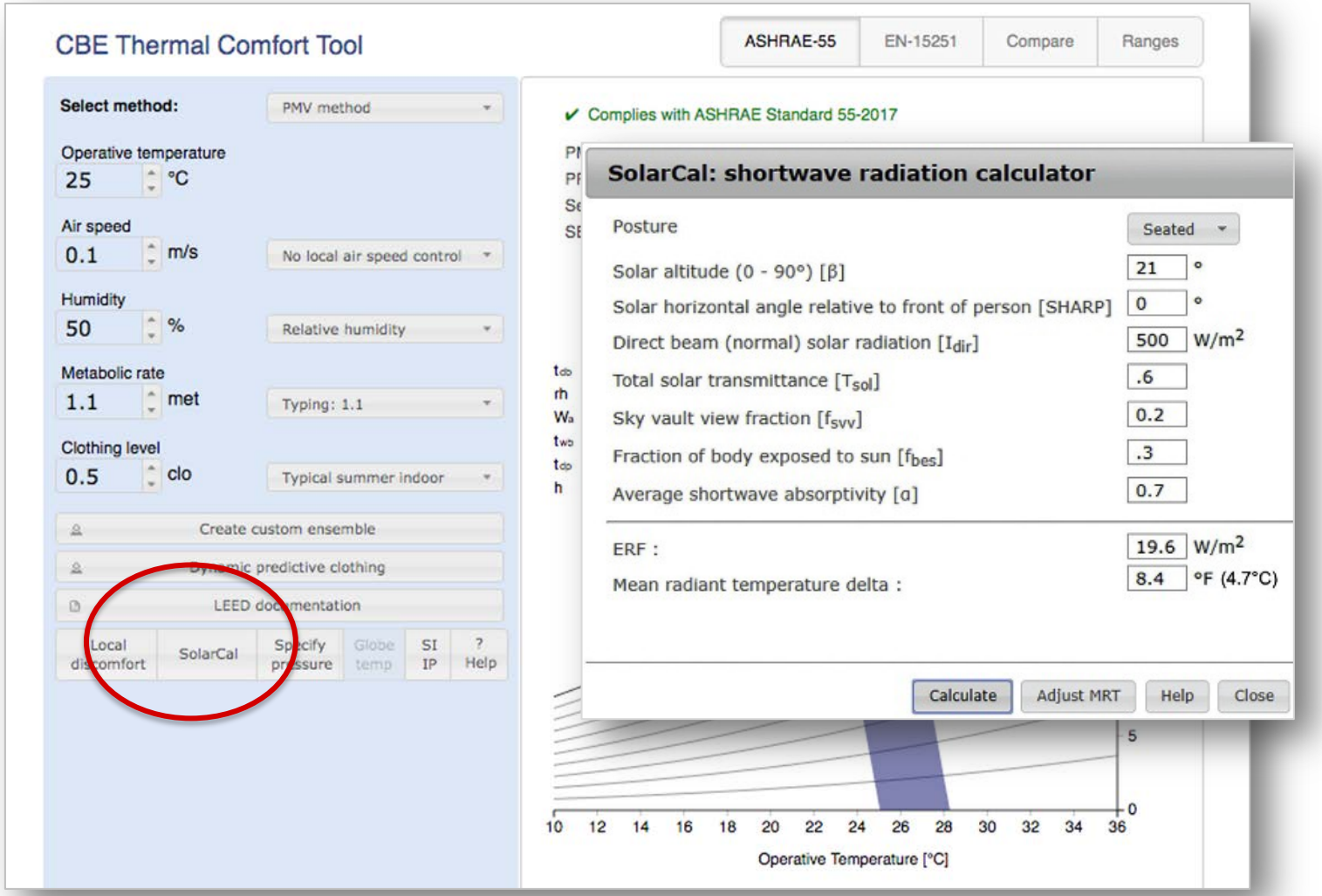
clima.cbe.berkeley.edu



Online thermal comfort tool with SolarCal module

- A tool to quickly asses the impact on thermal comfort due to solar gain from windows
- New capability for online CBE thermal comfort tool
- Consider sun position, solar transmittance, sky view, body area exposure
- Output effective temperature due to solar

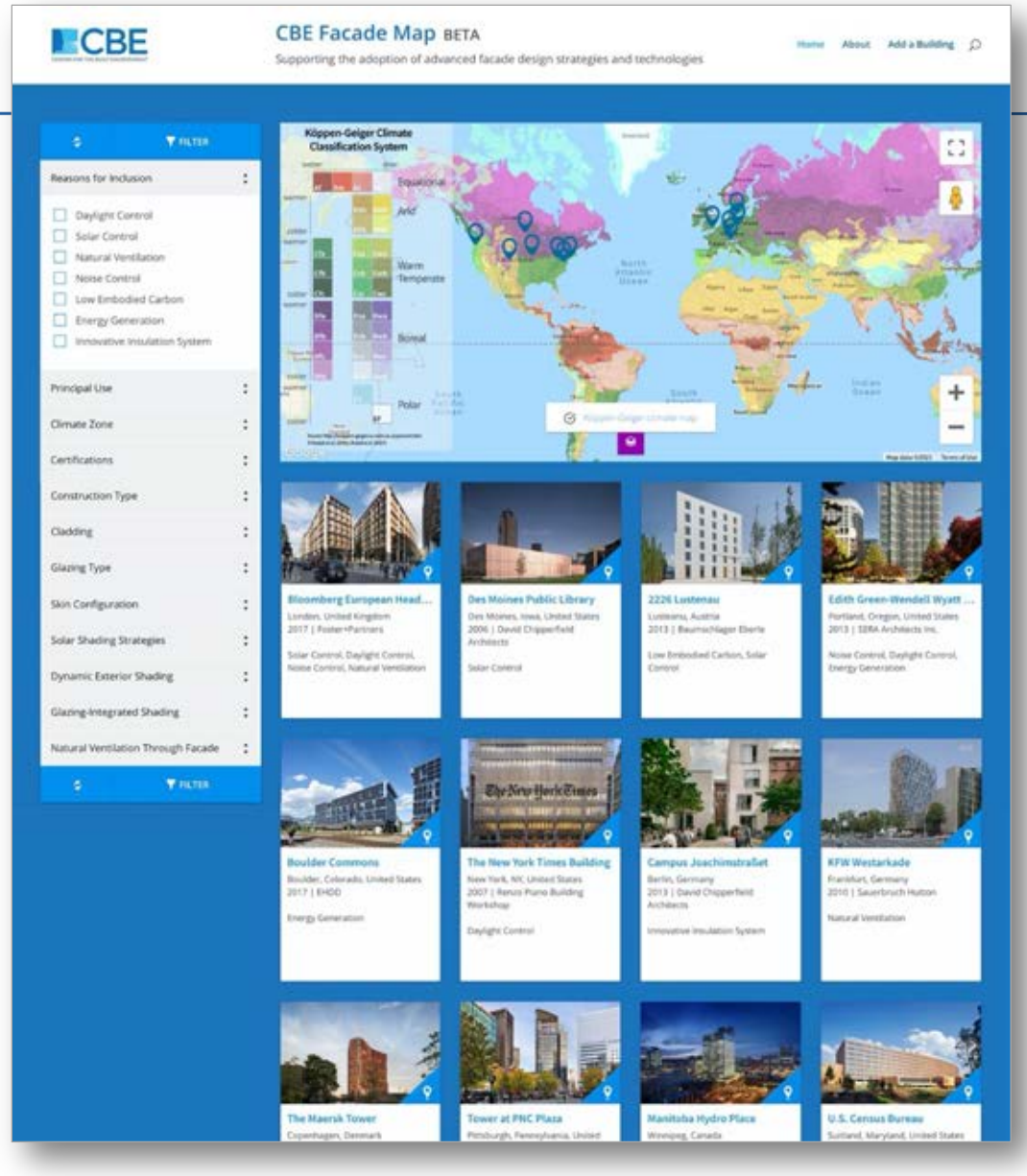
comfort.cbe.berkeley.edu



CBE Facade Map

- An online geographical catalogue of buildings demonstrating integrated advanced facades worldwide
- Several criteria for inclusion
- Taxonomy of building and facade characteristics
- Engaging with design teams to identify projects and collect project data
- Looking for projects to add

facademap.cbe.berkeley.edu



CBE Facade Map examples

Boulder Commons
Boulder, Colorado, United States
2017 | EHDD

Energy Generation

Bloomberg European Headquarters
London, United Kingdom
2017 | Foster+Partners

Natural Ventilation, Solar Control, Daylight Control, Noise Control

Edith Green-Wendell Wyatt Federal Building
Portland, Oregon, United States
2013 | SERA Architects Inc.

Energy Generation, Noise Control, Daylight Control

Website
cbe.berkeley.edu

Tools
cbe.berkeley.edu/resources/tools/

Email
LEHRER@berkeley.edu

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