Research Capabilities at the Center for the Built Environment (CBE)

University of California, Berkeley
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CBE Overview

Consortium framework

- CBE collaborates with industry leaders to improve the performance of buildings by providing timely, unbiased research on building technologies, design strategies and operations.

Primary research program areas include

- Building HVAC Systems
- Indoor Environments
- Building Facade Systems
- Human Interactions
Field studies

Approaches
- Controlled intervention studies
- Advanced data collection and analysis
- Indoor sensing and monitoring

Building system types
- Variable-air-volume with reheat
- Radiant cooling and heating
- Underfloor air distribution
- Displacement ventilation
- Mixed-mode/Natural ventilation
- Personal comfort systems

ARTIC, Anaheim  ↑
David Brower, Berkeley  ↗
SMUD, Sacramento  →
IDeAs Z², San Jose  ↘
Delta HQ, Fremont  ↓
Field studies

Sutardja Dai Hall (SDH): Living Lab

- Houses the Center for Information Technology Research in the Interest of Society (CITRIS)
- 141,000-ft² building at UC Berkeley houses office space, laboratories, and classrooms.
- Deliberately designed and built as a living laboratory with multiple meters and submeters.
- Siemens Apogee Building Automation System (BAS) that controls a “best practice” variable-air-volume (VAV) reheat system for space conditioning of the 135 zones.
- BAS and WattStopper lighting system are accessible through BACnet. BACnet points are mapped and used for sophisticated control sequence testing.
Field studies (Example)

Time-averaged ventilation (TAV)

- HVAC controls intervention study conducted in Sutardja Dai Hall.
- Goal: Demonstrate new advanced control strategy for reducing zone ventilation rates in a real operating building.
- Background: Minimum airflow set-points are typically higher than ventilation requirements.
- TAV showed a reduction in fan (15%), reheat (41%), and chilled water (23%) energy.

![Graph showing zone ventilation rate with three labels: Baseline ventilation rate (Mean = 41.4%), Desired ventilation rate (Mean = 12.8%), Intervention ventilation rate (Mean = 15.7%).]
Field studies

Indoor environmental sensing and monitoring

- CBE uses portable instruments (mobile carts and wireless sensor networks) to conduct field studies of indoor environments and HVAC performance.
- CBE’s unique toolkit uses a wireless mesh network with a web-based data collection, analysis, and reporting application.
- It allows real-time evaluation of IEQ with a focus on advanced HVAC systems.
Laboratory studies

Types of lab studies
- Thermal comfort
- Air movement
- Air quality
- Wearable sensing
- Automotive cabin systems

Human subject experiments
- Human response to different thermal and physical environments.

Physical testing
- Performance of different space and personal conditioning devices and systems.
Laboratory Studies

Controlled Environment Chamber

- This full-scale test room resembles a contemporary office while allowing precise control over temperature, humidity, ventilation and lighting.
- The facility has been used for groundbreaking studies of thermal comfort, ventilation performance, and indoor air quality (with and without human subjects).
- CBE’s advanced skin-temperature-controlled thermal manikin allows the direct measurement of heat exchange between a human body and the surrounding thermal environment.
Automotive cabin studies

Laboratory tests
- Full-scale mockups used to study effectiveness of cabin conditioning innovations
- Prototype assessment using qualitative smoke-flow visualization, IR camera

Simulation studies
- Advanced Berkeley Model was created with automotive industry funding
- Simulates 16 body parts to predict local and overall comfort and sensation
Boundary layer wind tunnel

- Boundary layer wind tunnels simulate characteristics of natural wind impacts on a building or community.
- Researchers use flow visualization, velocity and turbulence intensity measurements to understand the air flow.
- The tunnel can be used for studies of wind effects around and within buildings, and to study innovative air measurement technologies.