

centerline

Newsletter of the Center for the Built Environment at the University of California, Berkeley

Winter 2014

HIGH PERFORMANCE BUILDINGS *by the* NUMBERS



13,420



LEED PLATINUM *and* GOLD-CERTIFIED
PROJECTS WORLDWIDE

14%



U.S. ELECTRICITY *from*
RENEWABLE SOURCES

\$50B



POTENTIAL ANNUAL SAVINGS *from*
SMART BUILDING TECHNOLOGIES

600+

BUILDINGS *in the* CBE
SURVEY DATABASE

4,300,000



PEOPLE WORK OR LIVE IN
LEED-CERTIFIED BUILDINGS

36



CBE INDUSTRY
PARTNERS *in* 2014

Director's Note

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Dear Industry Partners,

This winter we welcomed new staff, reached significant project milestones, and engaged with a wide range of companies and individuals regarding CBE's latest research innovations. Last fall Paul Raftery joined our research team, bringing to CBE valuable knowledge and experience in design engineering, controls and energy simulation. Paul holds a PhD from the National University of Ireland, Galway, he is the recipient of a Fulbright Award and other accolades, and has already made himself an invaluable member of CBE's research team. You can read more about Paul on page 12.



We now have a patent pending for our innovative "personal comfort chair" that we presented at past membership conferences, and that we are currently testing in several field demonstrations. We have met with several company representatives and investors, and we hope to soon announce a licensing arrangement that will commercialize this technology. We provide an update on this work on page 6. On a related note, on April 23rd CBE will cosponsor a public symposium to bring together leaders from the commercial building sector and the cleantech communities, and this promises to be a provocative day of presentations and discussions. Details follow on page 13.

Finally, we wish to thank Assistant Researcher Wilmer Pasut, who is taking a new position at Padova University, Italy. He has made numerous original contributions since he first joined CBE as a post-doctoral researcher in 2011. And as always, we thank you, our Industry Partners, for your ongoing support and participation.

Sincerely,
Prof. Edward Arens
Director, CBE

Research Updates

CBE's Radiant Systems Research Moving Forward at Multiple Scales

The research team at CBE is studying radiant systems at widely varying scales, from detailed investigations of a single building, to broadly mapping significant buildings that showcase alternative approaches to radiant system design. The overarching goal of this work is to provide design and operations guidance to help industry professionals optimize radiant systems, as they are being rapidly adopted.

Sacramento ZNE field study

Last December we began our field study at the Sacramento Municipal Utility District (SMUD) East Campus Operations Center. The research team met with design team members and operations staff, and installed numerous sensors and data collection instruments that will document the building's performance. The objective of this work is to learn what makes the building successful in terms of both design and control, and to document and share this information with diverse industry stakeholders.

megawatt of photovoltaic power generation on-site, the building is one of the largest ZNE buildings completed to date. The five-story building houses administrative offices, meeting spaces, a café and fitness center, and showcases many energy efficient products and operational strategies. The windows include external shading and light refraction devices that direct daylight upwards, a geothermal exchange system linked to a chilled water tank, displacement ventilation on the first floor, a radiant system in office areas, and chilled



Rendering of the SMUD East Campus Operations Center in Sacramento, CA.
Image: Stantec.

Radiant systems are increasingly being adopted for use in ultra-low and zero-net energy buildings in North America, and form a core research area for CBE.

This particular building was selected as it includes an in-slab radiant system in open plan office areas, integrated with multiple technologies to meet the goal of reaching zero-net energy (ZNE) performance. At approximately 200,000 square feet and with one-

beams in enclosed interior spaces. Fittingly for a building owned by a municipal utility concerned about peak load reduction, the building will use no air conditioning after 2:00 pm each day, relying instead on thermal storage combined with occupant-

controlled desk and ceiling fans.

Additional details about the project, with architecture and engineering by Stantec, were featured last September in the [Sacramento Business Journal](#).

CBE Project Scientist Fred Bauman points out that in buildings with radiant systems, “thermal inertia” is a key consideration, and consequently the control strategy must be more sophisticated than with conventional variable air volume (VAV) systems. To evaluate the system operation and

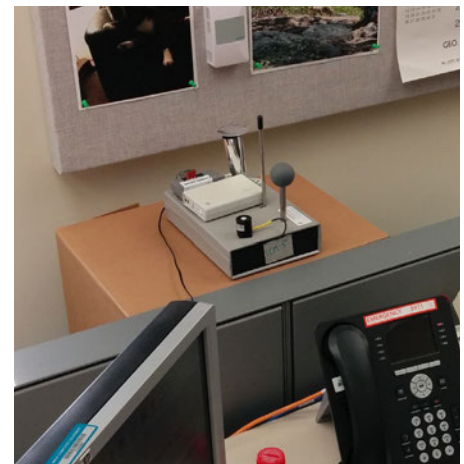


Open plan areas in SMUD's ZNE operations center feature exposed radiant ceiling slabs, vertically suspended acoustical panels, and ceiling fans. Photos: Caroline Karmann.

indoor conditions, the research team installed wireless "indoor climate monitors" (ICMs) developed at CBE, that will record temperature, relative humidity, air velocity, radiant (globe) temperature, CO₂ concentrations, and lighting levels. Additional sensors are being used to monitor slab surface temperatures and air temperatures from floor to ceiling level.

During the installation, the team also conducted acoustical measurements using hand-held meters. The team is currently monitoring winter operations, and this work will be repeated during the summer.

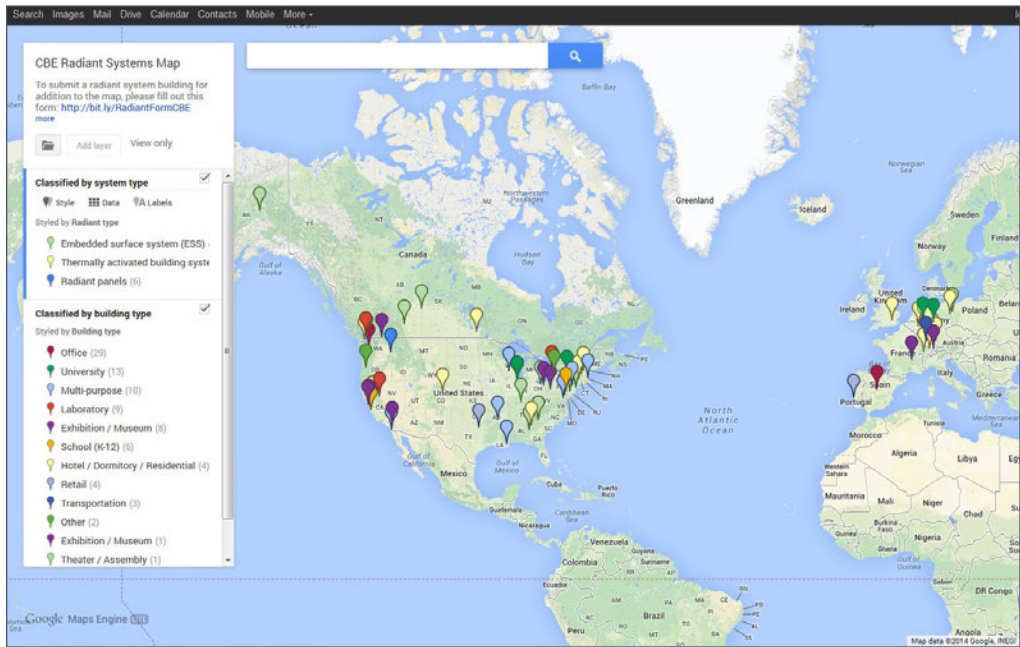
Preliminary analysis of the ICM and building management system (BMS) data reveals that changes to the operational strategy of the building may yield energy savings, and the research team plans to compare standard control programs with an optimized approach in different parts of the building. CBE Research Specialist Paul Raftery notes that radiant systems are often controlled much like air systems, which is far from the ideal strategy. Further updates on this field study will be provided at the CBE Industry Advisory Board Conference in April.



Indoor climate monitors developed at CBE communicate via a wireless mesh network to monitor indoor environmental variables.

Interactive map of significant radiant system commercial buildings

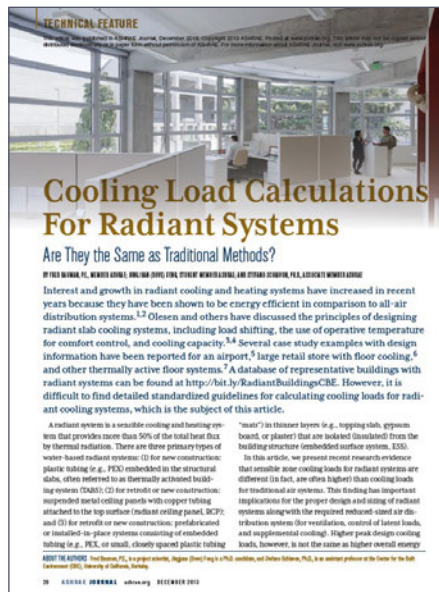
Working on a broader scale, CBE has created an [interactive map of commercial building radiant systems](http://bit.ly/RadiantFormCBE), that can be viewed by building or radiant system type. The map provides key project information and links for additional information. The project focuses on North American and European case studies, and is an attempt to showcase significant projects and best practices. CBE presented this ongoing work at the CBE Advisory Board Conference in October 2013, and we invite building owners and development teams to submit project information using the form linked from the map.



CBE launched an [interactive map for radiant system buildings](http://bit.ly/RadiantFormCBE) in fall of 2013, and invites project teams to contribute additional projects.

New radiant system design guidance

Finally, CBE's research team published in the December 2013 *ASHRAE Journal* a new article: [Cooling Load Calculations for Radiant Systems: Are They the Same as Traditional Methods?](http://www.ashrae.org/TechnicalResourcesLibrary/cooling-load-calculations-for-radiant-systems-are-they-the-same-as-traditional-methods), which describes key differences that will be significant to system designers and operators. The work was based on extensive energy simulations and laboratory tests that compared the dynamics and performance of radiant and air systems. The work was done with support from our friends at CBE Industry Partner [Price Industries](http://www.priceindustries.com), who provided CBE with access to their hydronic test chamber in Winnipeg, Manitoba, and support from Price technical staff.



Links and Publications

Overview of CBE Radiant System Research and Publications

<http://www.cbe.berkeley.edu/research/radiant-systems.htm>

CBE Radiant Systems Map

<http://bit.ly/RadiantBuildingsCBE>

Journal paper: Cooling Load Calculations for Radiant Systems: Are They the Same as Traditional Methods?

<https://escholarship.org/uc/item/6px642bj>

Publicity, Commercialization and Building Integration of CBE's Personal Comfort Chair

In recent issues of *Centerline* we described how a new office chair prototype developed at CBE will give people improved control over their workplace environment – and at the same time save HVAC energy. Over the past few months we have made great strides towards publicizing and commercializing this innovative chair concept, and adding features that will enable integration with building control systems.

Recent media coverage

Last December, CBE's work in this area was seen and heard in broadcast media. Two short pieces aired on Bay Area KGO radio as part of Leslie Brinkley's "Business Now" series. In addition, reporter Jonathan Bloom filmed a segment on the chair and other personal control devices in CBE's laboratory. The piece aired on Bay Area ABC News 7 and the [video is available online](#).

This media flurry added to the [publicity CBE received last fall](#) after we announced an award for significant funding to further develop and test the chair prototypes.

Chair patent pending

The project team has also been involved in protecting the intellectual property of the chair's innovative concepts. Working through UC Berkeley's Office of Intellectual Property & Industry Research

Alliances (IPIRA), CBE now has a patent pending, and a [non-confidential disclosure](#) is posted on the IPIRA website to connect with potential licensees. IPIRA's Curt Theisen notes that his office has been in discussions with interested parties regarding licensing of the chair concept, and CBE has hosted a number of visitors from industry who have expressed interest in commercializing the technology.



Assistant Researcher Wilmer Pasut appeared on a [segment on CBE's personal comfort chair](#) that was featured in Bay Area news last December.

Ongoing field evaluation

Our research team is continuing field testing and evaluation of 28 chair prototypes, along with foot warmer and desk fans, in two buildings on the Berkeley campus, one having air conditioning and one without. With new funding from the California Energy Commission ([High Tech Meets High Touch](#), in *Centerline* summer 2013), CBE is contracting with a local manufacturer to build 50 additional chair prototypes. The new chairs will have advanced features and an interface that will allow users to control the chair in novel ways, and occupants' preferences can be integrated with building control systems. A prototype of this new interface was developed by Berkeley PhD student Michael Anderson, from the Department of Electrical Engineering and Computer Science (EECS), and demonstrated on campus in December.

We are also collaborating with Oakland startup Building Robotics, EECS and other campus groups to test new approaches for improving occupant comfort and control. Included in the studies is Building Robotics' recently unveiled "[Comfy](#)" building control system, that allows occupants in commercial buildings to indicate preferences for heating and cooling, and allows them to interact with other occupants and directly with a building's HVAC system. CBE's research team hopes to integrate this type of whole-building functionality as the new chair prototypes are developed and tested. We will provide an update on CBE's personal comfort research at our April Advisory Board meeting, and Building Robotics will be a presenter at the April 23rd symposium on cleantech in the building sector (details on page 13).



Advanced controls and wireless networking capabilities for the personal comfort chairs, desk fans and footwarmers were demonstrated by UC Berkeley students Michael Anderson (seated) and Joseph Bynoe.

Micro Weather Stations Inform Outdoor Comfort Research and Climatic Design

Getting accurate climate data at the scale of a specific development is an ongoing challenge for design teams, as publicly available data may not be sufficiently reliable or complete for climate-responsive design. However, new advances in sensing and communication are making do-it-yourself weather monitoring feasible, while also enabling widespread sharing of climate data.

Researchers at CBE recently configured and installed a compact weather station as part of a demonstration for a [City Lifecycle Management](#) (CLM) software tool, developed by UC Berkeley students and researchers in collaboration with UC Berkeley's i4Energy Center and SIEMENS. The weather station is located at the proposed future site of the [Richmond Bay Campus](#) (RBC), where new research facilities for Lawrence Berkeley National Laboratory (LBNL) and UC Berkeley are planned.

CBE's Edward Arens and Marc Fountain spent two afternoons last December installing the weather station on top of a ten-meter aluminum tower. The device is being used to collect site-specific climate data that will be uploaded into the CLM software tool for outdoor comfort analysis (though such data

could equally be used for climatically responsive design.)

The [Hobo U30](#) model was purchased with the required plug-and-play sensors already installed, so the project team needed only to configure the sampling rates and data transmission parameters. The self-contained and fully wireless system uses photovoltaic panels to keep the batteries charged, and data are collected via a mobile phone network, uploading data every two hours. The unit is monitoring four

metrics – wind speed and direction, temperature, and relative humidity – with spare capacity for more data points. The [data may be viewed online](#) in near real-time.

Weather stations are available at a wide range of price points; the cost of the professional-grade U30, as configured for the RBC installation, is approximately \$2,000 (plus an annual \$300 mobile data subscription), making such devices affordable for many research and design projects.

Research Specialist Marc Fountain assembles the 10-meter weather station tower.



Marc Fountain points out some of the considerations for the installation, “Through a mix of careful eye-balling, luck, and determination, we now have a weather station that is within one degree of south in orientation, which is important for accurately measuring wind direction. The nearby trees and buildings are lower than our tower, and the more significant eucalyptus groves are far enough away to filter only a small compass sector.”

He notes, however, that the installation did include some challenges. “It took two afternoons because the soil was so full of rocks that our initial approach to anchoring the guy wires using large earth augers was untenable. We – or I should say mostly Ed – pounded three-foot lengths of one-inch pipe into the ground with a sledgehammer.”

Accurate site-specific climate data has many uses today, including energy simulation, bioclimatic building design, outdoor comfort prediction, and integration with tools such as the CLM software. In the future, it’s conceivable that data from micro weather stations could potentially be shared through a platform for user-generated content, along the lines of Flickr or Wikipedia.

The panoramic view of the site (bottom) shows the mostly unobstructed site of the installed tower.



Partner News

Sustainability Leader Yost Grube Hall Architecture (YGH) Joins CBE Consortium

In November, CBE welcomed to its industry membership [Yost Grube Hall Architecture \(YGH\)](#), a 50-person Portland, Oregon, firm providing architecture, interior design, and master planning services for clients in the Pacific Northwest and internationally. Founded in 1964, the firm's work is diverse, ranging from university buildings and embassies to corporate headquarters and commercial facilities. Each of their projects share YGH's commitment to design that is in harmony with the environment, community, client values, and user needs.

Sustainability is a core value at YGH which affects every choice they make, from how they design buildings to how they manage their own office. Their expertise in sustainability is founded on over 35 years of experience designing green building projects based on project-specific research, leading to innovative solutions. Somewhat unique for a mid-sized northwest architectural firm, YGH has a 35-year history of work in the developing world, where minimal resources are a reality. YGH projects for USAID, the US Department of State and a number of US multinational firms in developing nations of Africa, the Middle East and Central Asia have honed their understanding that the best solutions start with



Central Oregon Community College Science Building, Bend, OR. Photo: C. Columbres.

passive, simple, and efficient designs that utilize local resources and respond to local culture and climate.

As leaders in sustainable design, YGH developed the State of Oregon's current sustainable design standards for new construction and designed the first LEED Gold buildings for the State of Oregon, the Oregon State Board of Higher Education, the California State University system, and for the US General Services Administration (GSA) Region 9. YGH also designed the first LEED Platinum higher education building for the State of Washington.

YGH was an early signatory to the AIA 2030 Commitment and remains committed to project energy and



Humboldt State University Behavioral and Social Sciences Building, Arcata, CA. Photo: Pete Eckert.

CBE Partner HOK Teaming with UC Berkeley Studio One Studio and Symposium

(New member YGH continued)

water metrics as design targeting tools. The firm is also an early supporter of Health Product Declarations and a sponsor of the International Living Future Institute. They regularly work with their clients to understand how projects are performing and to build on that knowledge through their next project together.

Joining the Center for the Built Environment was a natural addition to YGH's arsenal, explains YGH Sustainability Director Lona Rerick, AIA, LEED AP BD+C. "YGH is a learning organization that emphasizes project-based research as the foundation for sustained design excellence. CBE membership gives us access to a proven set of post occupancy surveys, robust design tools, growing project performance databases, and invaluable opportunities for peer to peer sharing. YGH is excited to join this group of thought leaders to share what we learn with our staff, clients, consultants and other partners to enrich our collaborative process going forward."

In early February, UC Berkeley's Department of Architecture hosted the third annual [Studio One Symposium](#). The event was organized in conjunction with a year-long professional design studio directed by UCB Assistant Professor M. Paz Gutierrez, in collaboration with CBE Industry Partner HOK.

The public symposium, entitled "The Nature of Programming Matter — Programming Matter and Nature," convened leading architects, artists, material scientists, thinkers and educators who discussed research and design applications of biomimicry — the solution of problems by imitating systems and elements from nature.

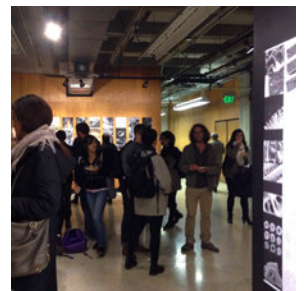
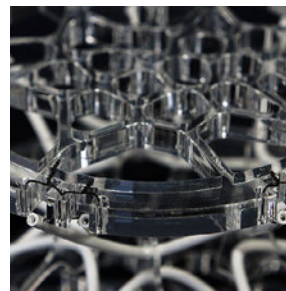
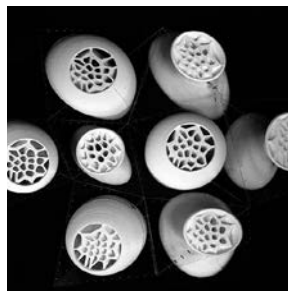
Since its inception three years ago, Studio One has addressed the theme of the geography of the San Francisco Bay, and in the current year layers on the additional concepts of biomimicry and the "programming" of materials. Through their design efforts the studio participants are exploring

methodologies that are central to Prof. Gutierrez's work, including research on biologically inspired technologies being conducted in collaboration with scientists from bioengineering, civil, and environmental engineering.

Professor Luisa Caldas is teaching a [seminar associated with the studio](#), in which students use simulation tools such as DIVA-for-Rhino to study daylight and energy in their studio projects. She notes that biomimicry can be approached at different scales: at the functional level of materials, as a metaphor for building design, or as a model for the design process.

Paul Woolford, design director for HOK's San Francisco practice, and others from HOK supported the studio through lectures, reviews and sponsorship. He shares [insights on the role of biomimicry in design](#) for *Wired*.

An overview of the symposium discussion was posted by John Parman on his blog at [dessintexte.blogspot.com](#).



Left and center: Student work by Ali Nasiri presented at the symposium.
Bottom: Opening reception. Photo: John Parman.

People

Simulation and Controls Expert Brings New Capability to CBE Research Effort

Last fall Paul Raftery became the newest member of CBE's research team. We first had the opportunity to work with Paul in 2008 when he was working at Lawrence Berkeley National Laboratory (LBNL) as a Fulbright scholar. At that time, the David Brower Center was under construction, and Paul worked with CBE's research team to conduct [detailed simulations of the building's hybrid UFAD/radiant system](#), demonstrating this highly energy-efficient approach (and later confirmed by the building's EnergyStar score of 99.)

During his tenure at LBNL, Paul helped develop a tool to automatically translate the geometry of architectural models into energy modeling software, thus saving time for project teams and reducing human error. He also developed a new method for calibrating energy models to detailed measured data, which he later demonstrated at the Intel manufacturing campus in Dublin, Ireland. He was awarded a PhD in Engineering from the [National University of Ireland, Galway](#) based on this research, and

he also holds a degree in Mechanical Engineering at [Cork Institute of Technology, Ireland](#).

Paul is currently involved in several projects at CBE, including the SMUD field study in which the research team plans to test a range of control strategies for the radiant slab system (described on pages 3-4). He is also investigating the effects of a variety of approaches for modelling furniture in buildings, and how this affects cooling loads particularly for non-traditional HVAC approaches such as UFAD or radiant systems.

Before joining CBE, Paul worked as a facilities engineer for a biomedical device manufacturer where he focused on clean room conditioning, energy auditing, and precision gas mixing systems. He also worked as a senior research engineer at the IRUSE Group to develop an automated fault detection and diagnosis tool for large industrial air handling units. The solution won the ICT Invention of the Year award. Paul was also a founding member of IBPSA-Ireland and is an active member of IBPSA-World.

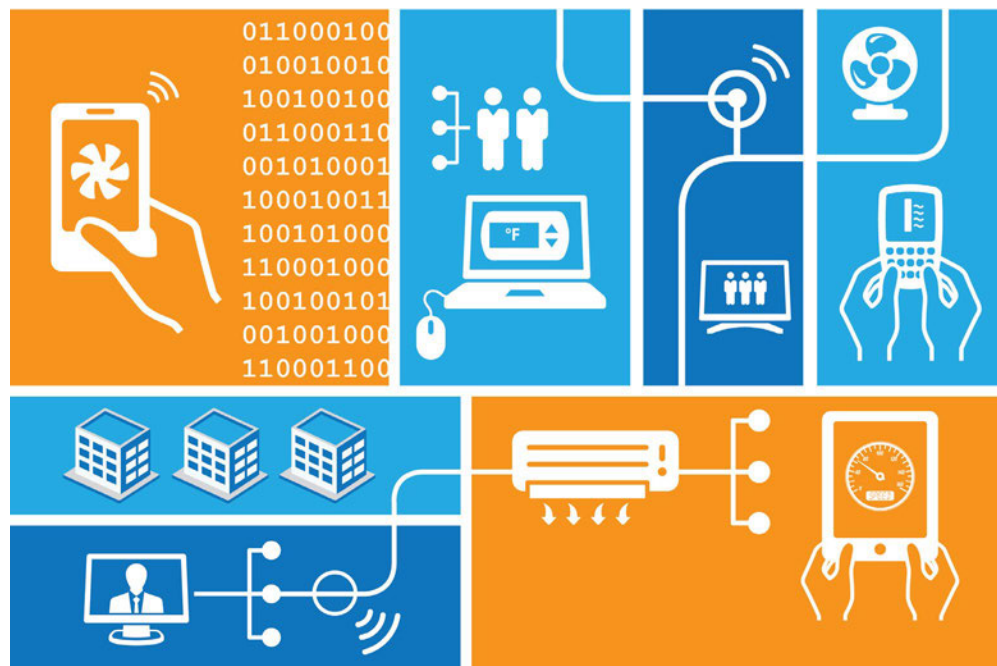


April Symposium on Cleantech Innovations in the Commercial Building Sector

The goal of this event is to promote useful dialogue among commercial

The April 23rd event is free and open to the public. Please use the registration links at right for the San Francisco class or the live webcast.

Register for the live webcast:
www.pge.com/pec/classes/6886.htm



Industry Partners at the Center for the Built Environment

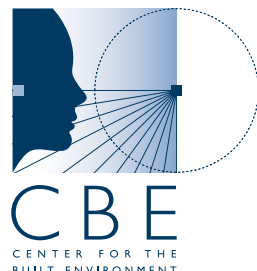
CBE's research is supported and guided by a consortium of industry partners, a diverse group of building industry leaders who are working to advance the design and operation of commercial buildings through their collaborations with CBE.

The Center's membership includes the following firms and organizations:

Affiliated Engineers, Inc.
Armstrong World Industries
Arup*
Big Ass Fans
California Energy Commission
Charles M. Salter Associates
DIALOG
EHDD Architecture
HGA Architects and Engineers
Integral Group Membership Team:
 Integral Group
 CPP
 DPR Construction
 P2S Engineering
 Perkins+Will
LPA Inc.
Mary Davidge Associates
Pacific Gas & Electric Company
Price Industries

REHAU
RTKL Associates
San Diego Gas & Electric
Skidmore, Owings & Merrill (SOM)
Southern California Edison
Syska Hennessy Group
Tate Access Floors*
Taylor Membership Team:
 Taylor Engineering
 Atelier Ten
 HOK
 Southland Industries
 Swinerton Builders
U.S. Department of Defense
U.S. General Services Administration
Webcor Builders*
WSP Flack + Kurtz
Yost Grube Hall Architecture (YGH)
ZGF Architects

* founding partner



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