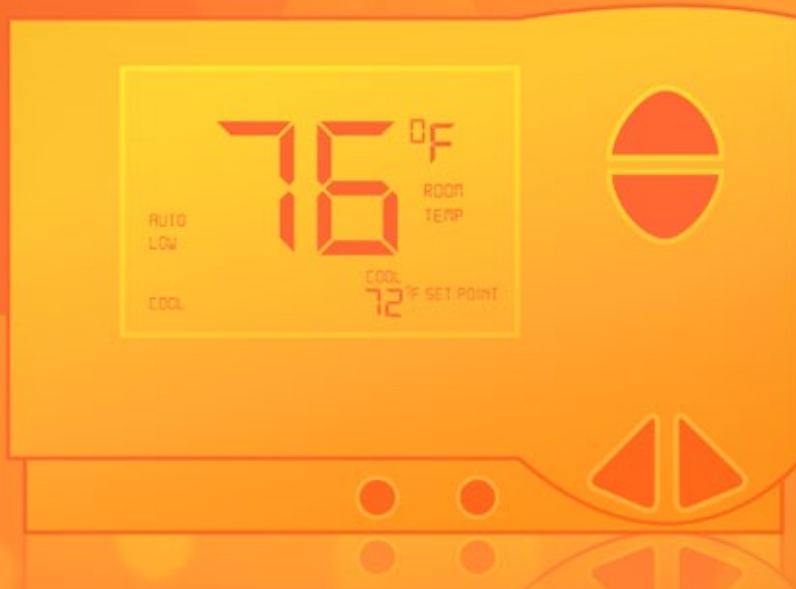


WESTERN COOLING CONNECTION

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Getting involved in this year's forum focused on
technologies for the retail environment pg. 4

LETTER FROM THE DIRECTOR

Annual Report

The 2011-2012 Annual Report on Cooling in the West looks back on another year in energy efficiency research and advocacy. From successfully testing and implementing an aerosol-based envelope sealant, learning about the relationship between water scale-build up and the interactions of calcium and magnesium, developed test protocols for RTU retrofits, to the successful change in government policy (Title 24) through our Fault Detection Diagnostics Initiative, WCEC has made a significant impact in energy efficiency and HVAC related research. To learn more about this year's work, download the full Annual Report here: <http://bit.ly/wcecAR2012>

Western Cooling Challenge Developments

Big news for the Western Cooling Challenge. We officially have another Western Cooling Challenge Certified manufacturer. The Trane Voyager DC passed our laboratory testing and is the second manufacturer to receive the prestigious honor of being Western Cooling Challenge certified. Also, WCEC finished the instrumentation from a sample of DualCool pre-coolers at Target in Palmdale, CA.

Energy Efficiency Forum: Revitalizing Retail

This forum is an outstanding opportunity for retail and restaurant professionals, facility managers, energy stakeholders, policy makers, and researchers to hear presentations of case studies, see new technology demonstrations, share insights and input, and connect with potential partners, investors, product suppliers, and service providers. We are currently looking for a few more speakers willing to present to a large audience on their experience with energy efficient technologies in a retail-based environment. Booth space is limited, so if you would like to reserve a booth, please contact our Outreach Coordinator, Paul Fortunato at pfortunato@ucdavis.edu.

In This Issue

WCEC has some exciting updates to our current projects and some new additions. Please note, we cannot cover every project in each Newsletter:

- > Energy Efficiency Forum: Revitalizing Retail
- > Featured article: Occupancy Sensing Adaptive Thermostats
- > Latest Projects and Updates
- > WCEC Outreach efforts timeline and notable visitors



Mark Modera, Director

mpmodera@ucdavis.edu

A handwritten signature in blue ink that reads "Mark Modera".

WCEC is an element of the Energy Efficiency Center at the University of California, Davis, with a mission to "partner with stakeholders to identify technologies, conduct research and development, disseminate information, and facilitate programs that reduce cooling system electrical demand and energy consumption in the Western United States."

WCEC Affiliates

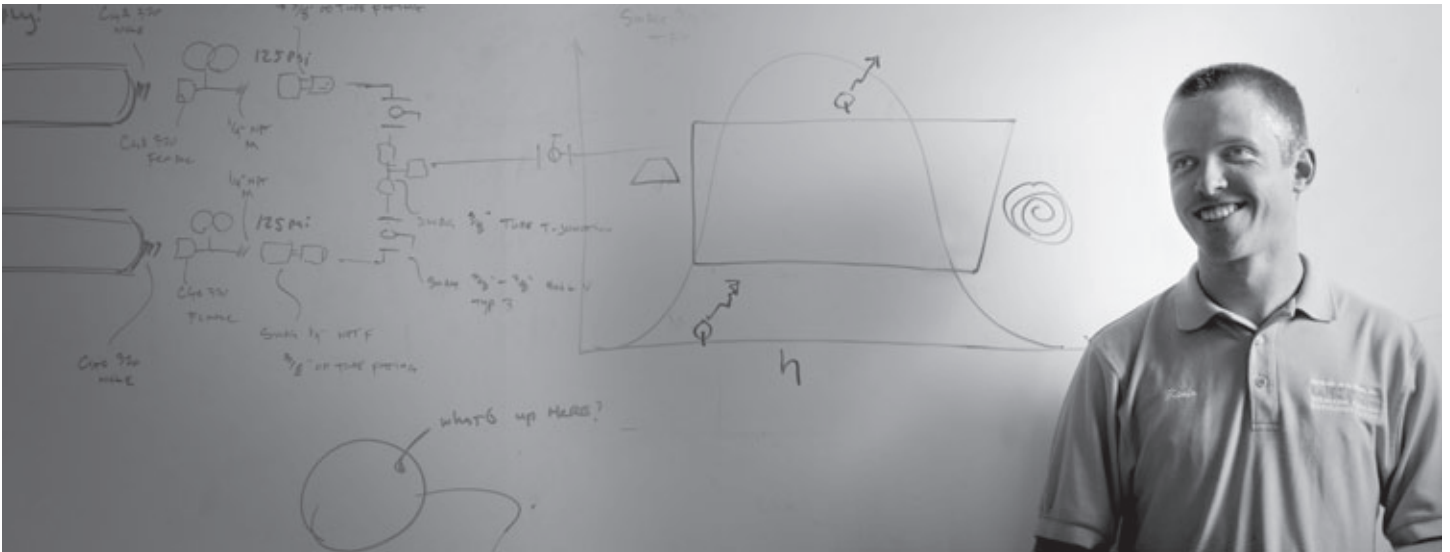
Beutler	Octus Energy	United Metal Products
Carrier	Pacific Gas and Electric	Uponor
Coolerado	Seeley	Viega
Davis Energy Group	Sempra Energy	Walmart
Integrated Comfort	Southern California Edison	Xcel Energy
Lennox	Speakman	Sacramento Municipal Utility District
Munters	Target	California Energy Commission
NV Energy	Trane	

WCEC Research Partners

National Renewable Energy Laboratory
New Buildings Institute
Lawrence Berkeley National Laboratory
Gas Technology Institute
Pacific Northwest National Laboratory
Oak Ridge National Laboratory
California Institute for Energy and Environment
Consol Energy

Personnel Updates

The WCEC would like to **thank Kevin Brown for all his hard work and dedication.** Kevin's last day with WCEC was August 29th. He is an exceptional co-worker and a great friend—WCEC would like to wish him good luck on his professional journey.



"Kevin was like the Swiss Army Knife of Research."

-Peter Breyfogle

"He was always involved in my education here. As a non-technical person, I truly appreciated how much detail and care Kevin showed when helping me understand some of the key concepts at the Center."

-Paul Fortunato

"What amazed me about Kevin was how he managed to get through his own workload, as he always had seemingly unlimited time to provide help and support to the rest of us."

-Will Allen

"One of the many things I admired about Kevin was just how much enthusiasm and dedication he has for this work."

-Theresa Pistochini

"Kevin was my 'captain' on a WCEC whitewater rafting trip. Despite the fact that we got dunked once, I felt confident in his helmsmanship. He was also my go-to guy when I needed something in the lab. We will all miss Kevin a lot."

-Kristin Heinemeier

"Kevin is one of the very few people on earth who have downloaded Wikipedia into their computer... and into their head!"

-David Grupp

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*Please let us know at **wcec@ucdavis.edu** if you would like to be added to or removed from our mailing list.*



UC DAVIS ENERGY EFFICIENCY FORUM: RE-ENERGIZING RETAIL

NOVEMBER 6th - 7th
at the UC Davis Conference Center

Energy efficiency upgrades aren't just good for the planet — they're good for business. Cost-effective improvements to lighting and HVAC systems enhance customer experience, raise real estate values, and, increasingly, improve customer relations and brand value. Recent studies also indicate that those companies investing in efficiency have stronger sales and attract more long-term investors.

To support the growing green retail trend, experts from the Energy Efficiency Centers at the University of California, Davis, have organized a special forum: Re-energizing Retail. The event is designed to help business owners make the best efficiency investments for their needs while reducing their energy consumption, lessening peak loads on utilities, and cutting carbon emissions.

WHAT WILL BE INCLUDED?

Presentations will address the needs of those who own or lease building space for grocery stores, restaurants and big-box retail stores, as well as those involved in open-area shopping centers or multi-story indoor malls. Breakout sessions will allow participants to tailor their experiences to their own goals and areas of interest.

WHO CAN ATTEND?

This event is open, by invitation and free of charge, to a select number of retail professionals, researchers, manufacturers, and utility partners.

REGISTER HERE TO ATTEND:

<http://bit.ly/eeforumattend>

WANT TO SPEAK AT THE FORUM?

Do you have experience with an energy efficient technology in the retail environment and would like to share your knowledge with your peers? Contact us today at:

Ben Finkelor

Executive Director,
Energy Efficiency Center
bmfinkelor@ucdavis.edu,
530-752-4909

RESERVE A BOOTH HERE:

<http://bit.ly/eeforumbooth>

OCCUPANCY SENSING ADAPTIVE THERMOSTATS

Removing human error from the HVAC energy use equation

Buildings, such as hotel rooms and university residence halls, are often mechanically conditioned to a constant set-point, regardless of whether or not they are occupied. This is a waste of energy and money, but has historically been the only way to manage temperature and indoor air quality without zealous manual regulation by users or facilities managers. Programmable thermostats that vary temperature set-points and ventilation according to pre-defined schedules do offer added system control and offer the possibility of energy savings. However, if occupancy patterns are not predictable, it is difficult to define a programmed thermostat schedule, and the potential for energy savings is diminished. Various emerging thermostat technologies employ occupancy sensing and adaptive learning algorithms to better align system operation to occupancy trends. WCEC is currently investigating the breadth of applicability for these technologies and the extent to which they may reliably offer energy savings.

Market Assessment

In theory, building types with highly predictable schedules could be served well enough by a programmable thermostat, and buildings with high relative occupancy would have little room for benefit from an occupancy sensing control. Buildings with unpredictable occupancy schedules and relatively low occupancy rates have the most to gain from thermostats that respond to occupancy, such as hotel rooms, conference halls, and multi-family common areas.

Setting a demand response schedule due to occupancy is only one energy savings factor for this technology. Another energy-use factor that can be ameliorated by these types of thermostats is the principle-agent problem. When users have no financial incentive for energy-wise management, many will just crank the setpoints to extreme, energy wasting temperatures. But these setpoints can be overridden by facility managers through the connected network of thermostats, wirelessly. In these cases, smart thermostat control can make an even more significant difference by negating wasteful behavior.

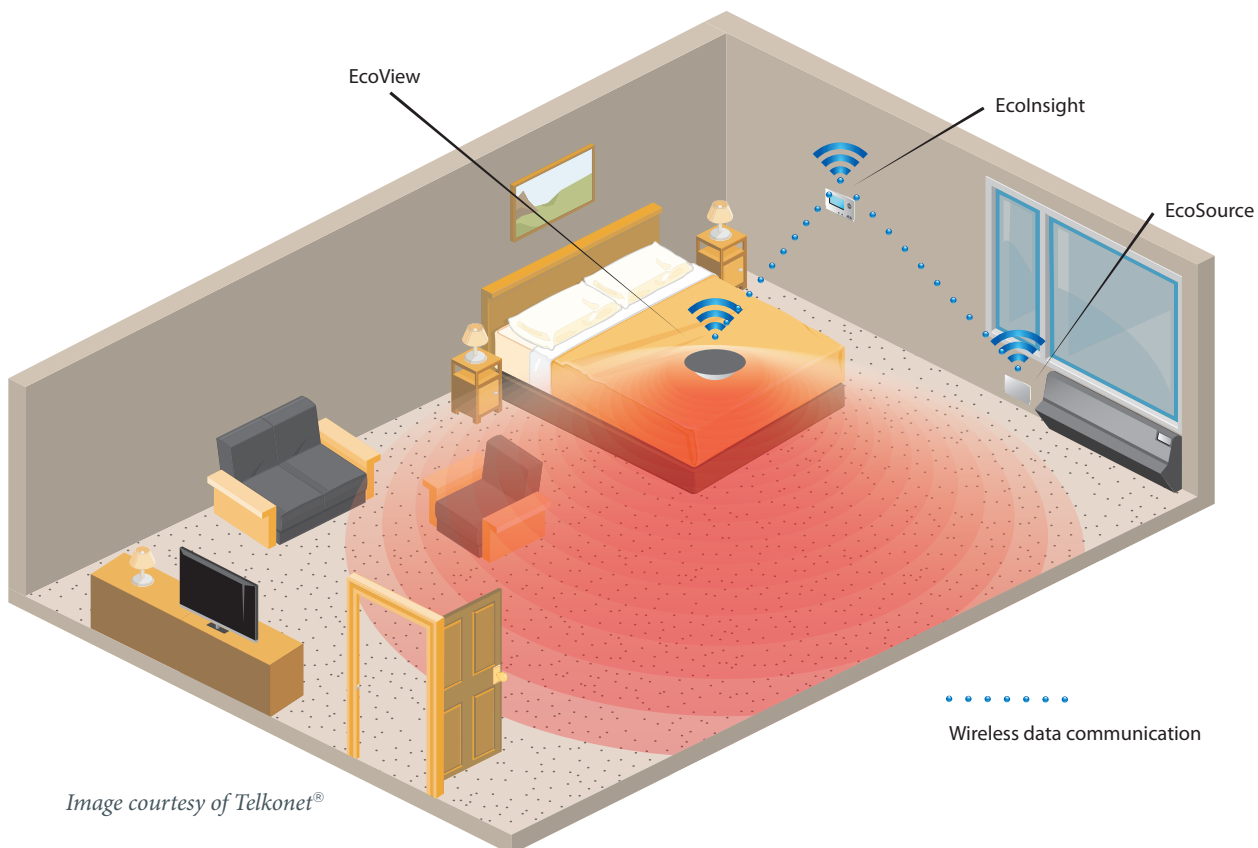
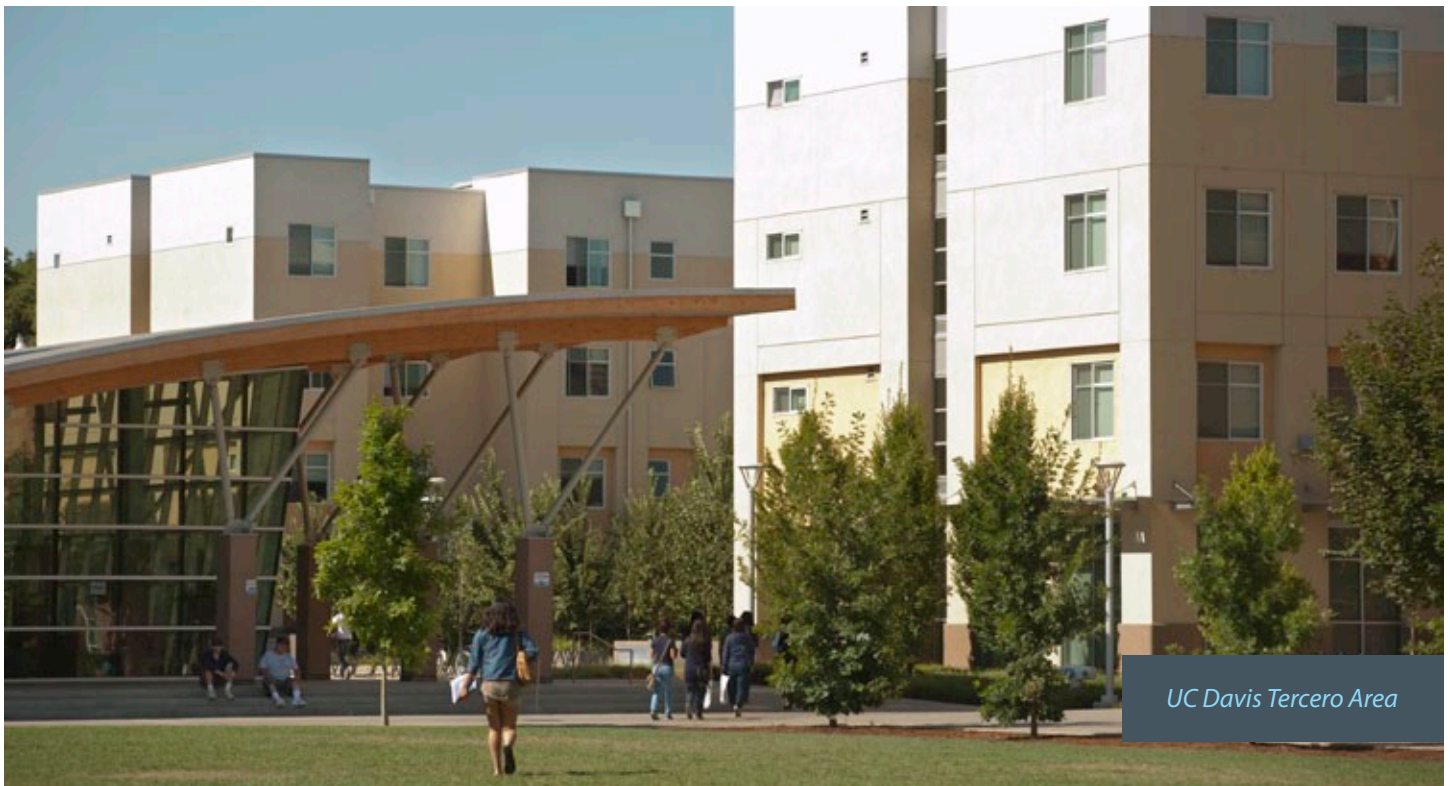


Image courtesy of Telkonet®



UC Davis Tercero Area

Field Research

Over the past year WCEC has observed the installation of Telkonet's EcoInsight® in several university residence halls. The technology is an occupancy sensing adaptive thermostat that allows space temperature to drift by several degrees during vacant periods. The thermostat learns the rate at which a heating and cooling system can respond and will operate to ensure that a room can recover from a set back within a reasonable time once it is re-occupied.

Each thermostat has an on-board infrared motion detector that senses when a room is occupied. Vacancy in a room triggers adjustment of the active set-point, which allows temperature to drift and results in a reduced duty cycle for the conditioning and ventilation systems. The system incorporates an on-board light sensor and logic to distinguish between vacancy and a nighttime condition where occupants are sleeping. Additionally, if the thermostat is not ideally located to clearly observe occupancy, Telkonet can incorporate a remote occupancy sensor that communicates wirelessly with the thermostat.

Telkonet applies a learning algorithm called Recovery Time™ which continually adapts the set-back temperature for unoccupied periods such that a room can recover quickly upon the occupant's return. Facility managers are able to program an acceptable recovery time, and the thermostat learns how quickly

the associated mechanical system is able to respond, allowing the room temperature to drift only so far that it can return to the occupied set-point within the allotted time. The algorithm is designed to adapt to changes in season, and in mechanical system characteristics such as a switch between heating and cooling mode. The set-back response can also be tiered such that after a long period of vacancy, temperature is allowed to drift even further; achieving added savings over unoccupied weekends or vacations. In addition to these adaptive control strategies, facility managers can select absolute limits for the set-back temperature to avoid damage to building materials and equipment. During occupied periods, users are allowed temperature control, although facility managers may limit the selectable set-point bandwidth to avoid excessive heating or cooling by residents.

WCEC's study focused especially on Bixby Hall. The building is a five-story high-rise dormitory constructed in 1965, with a two pipe fan coil system for heating and cooling. Ventilation for the building is provided by windows and a single constant speed air handling unit that serves all of the corridors and bathrooms. Prior to the study, each room had unrestricted manual thermostats that allowed students to drive the room temperature as they preferred. After the retrofit, each room had one Telkonet thermostat to control the individual room fan coil.

Results

Through review of a season of field observations, we find that these adaptive control schemes reliably shift temperature set points during vacant periods, and that there is a clear relationship between vacancy and reduced energy consumption (in this case, UC Davis uses a network of chilled water). However we also find that the energy savings achieved is sensitive to the application in which the thermostats are installed. In one building, we observed no energy savings at all because the thermostats only held limited sway over operation for the building heating and cooling. In other buildings, even while runtime for individual room fan coils was reduced significantly, we believe that adjacent rooms may pick up some of load from rooms following a set-back schedule.

Various system operating data was collected from Bixby Hall in fifteen minute periods over the course of several months in 2012. Figure 1 plots the fan coil duty cycle for one room as a function of outside air temperature for both occupied and unoccupied periods. The duty cycle in this case is the number of seconds of operation

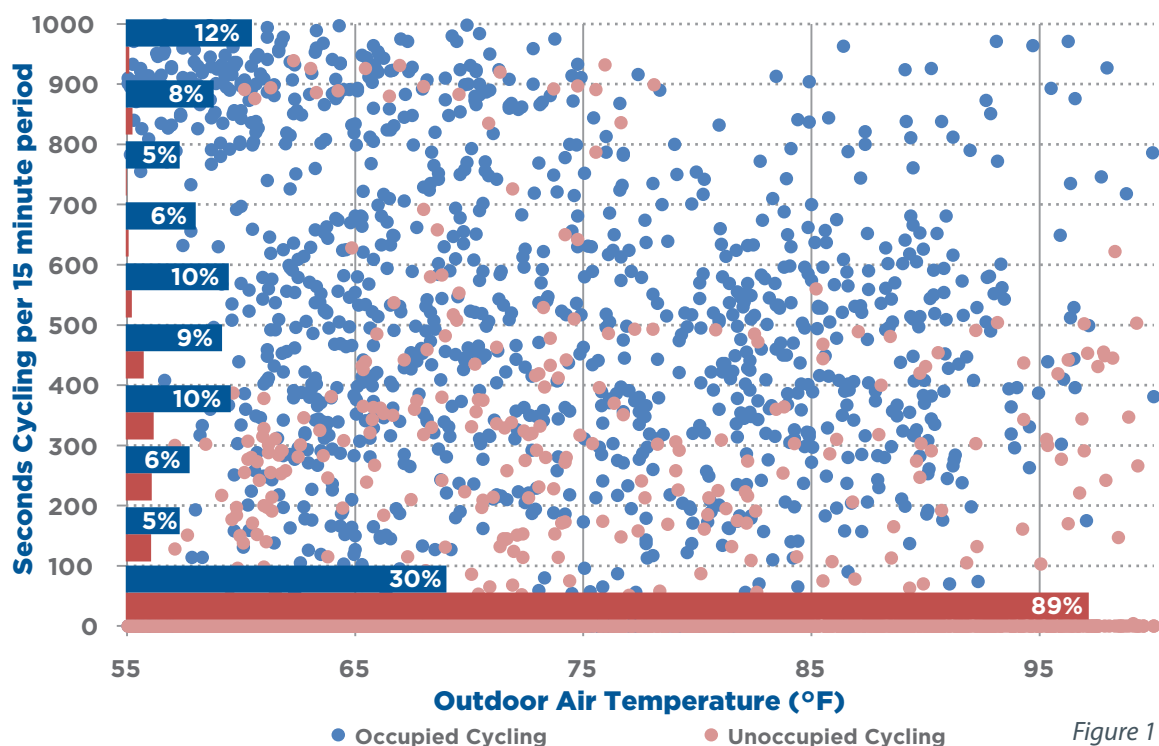



Figure 1

within each record period. The chart records every period in the month of May 2012. The vertically oriented histogram shows the frequency that the duty cycle is within a certain range. Interestingly, there is not a clear trend between outside air temperature and duty cycle since there are too many other factors that influence the load within a particular room. Nicely, for vacant periods the driving duty cycle is reduced dramatically. In fact, for vacant periods, the fan coil remains off nearly 90 percent of the time.

Path Forward

Monitoring for Bixby Hall will continue for the next several months, and measured energy consumption will be used to develop a more complete analysis of savings due the Telkonet system. Additionally, since this study, we have observed several other installations in similar residence halls.

In the near future we will compare each of these buildings side-by-side. We will control the thermostats for each building in various ways to better test for exactly how much energy savings is owed to the occupancy-sensing adaptive scheduling control strategies. 

Our Latest Projects & Updates

(Only a partial list of projects currently being researched. Check wcec.ucdavis.edu for more information on other concurrent projects)



Water Management Breakthroughs

To better understand how water management affects evaporative equipment over time, WCEC has continued to study the impacts of water-use options in our testing of the Aquachill (a residential water-cooled condenser unit) which, with the addition of Erica McKenzie, has led to several significant findings. First, we've shown through testing, that (once again) it was hard to kill the thermal performance of evaporative equipment—even after 11,000 gallons of water use with no bleed, the condenser unit only lost approximately 30% of its efficiency. Second, WCEC learned about the differences in how calcium and magnesium (the minerals most commonly associated with scale creation) behave as they precipitate. Because of its low solubility, calcium was observed to be largely or entirely precipitated in all systems at all bleed rates tested. This indicates that for supply water with elevated calcium concentrations, an increased bleed rate may actually increase the total mass of scale formed (i.e., increased bleed may hurt rather than help).

However, magnesium, which has a solubility level 1000X greater than calcium, was more effectively removed by the bleed. Under a no-bleed condition, a vast majority of the magnesium precipitated out, but when bleed was introduced, the mass and percentage of magnesium precipitated dropped off quickly. At the

high-bleed condition, magnesium was not found to contribute to mineral scale. These findings, along with the four concurrent studies underway on various water use/treatment options, will substantially expand knowledge on how to optimize water use in evaporative cooling systems.

RTU Performance, Western Cooling Challenge

This year the Western Cooling Challenge (WCC) completed the evaluation of a unit that just missed WCC benchmarks, but still achieved significant energy savings at an attractive price point. Additionally, the Challenge achieved a significant milestone with its first entrant from a major manufacturer (Trane) meeting the WCC benchmarks and becoming WCC Certified. We are optimistic that we will receive an entry from another major manufacturer as well. At this time, we are installing and monitoring 19 WCC units including 4 Trane Voyager DCs, 3 Seeley Climate Wizard add-ons, and 11 DualCool add-ons at various locations around California. WCEC is also evaluating and determining how to broaden the scope of the Challenge to include DOAS units (Dedicated Outdoor Air Systems). Our first DOAS unit being monitored is the new Munters EPX 5000 at the City of Temecula Civic Center.





RTU Performance, Rooftop Unit Retrofits

Our work testing energy efficient RTU retrofits has progressed substantially. WCEC developed test protocols for RTU retrofit testing and in June submitted these protocols into the ASHRAE standards development process. While waiting for the completion of our new laboratory at West Village, we've been testing and validating our RTU retrofit protocols at Davis Energy Group on three different evaporative products: Daikin EneCut, Mist Ecology's AC Spritzer and the Cool and Save unit.



Fault Detection & Diagnostics

WCEC's research helped change Title 24 to now require some form of FDD implementation in all new RTUs effective January

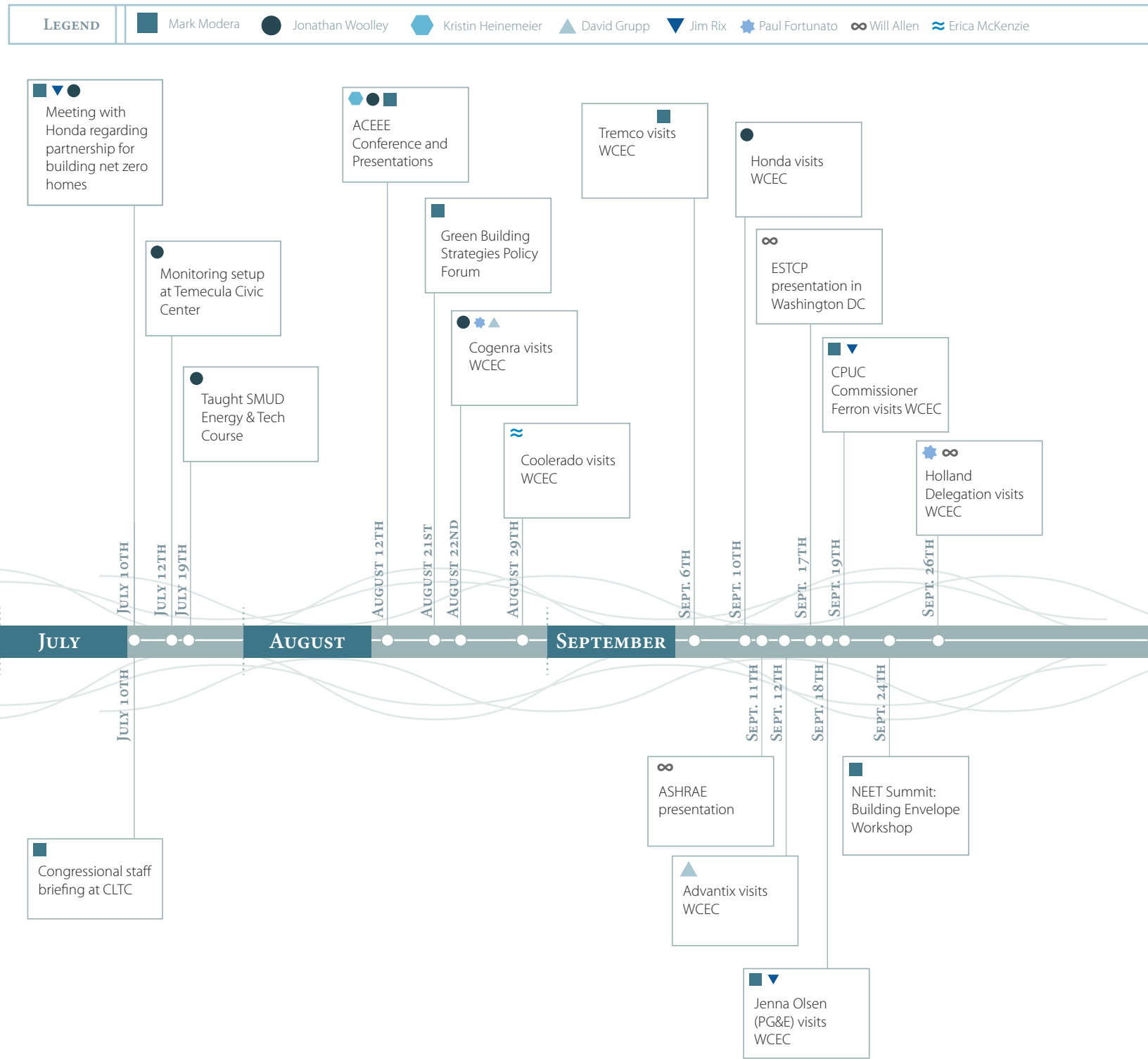
2014. As newer units replace older ones, the energy savings enabled by mandatory FDD will have a significant impact on energy use in the coming years. The case study is available at: wcec.ucdavis.edu/literature/

Additional Research Projects

WCEC initiated and completed a number of other research projects over the past year, several of which were inspired by interactions with our Affiliate partners:

- » **HVAC Technology Demonstrations:** Analyzing data from the Gallagher Hall LEED Platinum building to verify energy efficiency gains, and collaborating with LBNL on a laboratory efficiency study
- » **HVAC Behavioral Research:** Compiling data from over 270 Southern California Edison (SCE) customers on end-user HVAC maintenance behavior perspectives. Deploying an In-Home Energy Display (IHED) study at various locations to determine if social, goal-oriented and HVAC system performance alert information will motivate energy conservation
- » **Occupancy Sensing Thermostats:** Monitoring the use of Telkonet's occupancy sensing thermostats in Bixby dormitory at UC Davis and evaluating the viability of other smart thermostats
- » **Phase-Change Materials:** PCMs can dramatically improve the thermal carrying characteristics of water in hydronic systems. WCEC is evaluating, testing and selecting the appropriate PCMs, and building a prototype system to evaluate performance
- » **Multi-Tenant Light Commercial:** Developing integrated, turn-key retrofit solutions with the CLTC and creating procedures/associated tools required to evaluate and recommend appropriate retrofit packages for this complicated and oft-neglected market sector
- » **Modeling for Indirect Evaporative Coolers:** Developing modified effectiveness-NTU method for evaporative heat exchangers. Lab testing to validate initial findings
- » **Multi-Family Ventilation:** Researching/evaluating current codes and standards and characterizing current building practices pertaining to ventilation systems. We will shortly move into ventilation performance analysis and then into field testing, ultimately improving analytical methods for evaluating the effectiveness of multifamily ventilation systems
- » **Graywater Treatment for Evaporative Cooling:** Primary treatment phase study is nearing completion. Building and testing a biological oxidation process as a secondary water treatment 

WCEC NOTABLE OUTREACH EVENTS TIMELINE



WCEC NOTABLE VISITORS TIMELINE