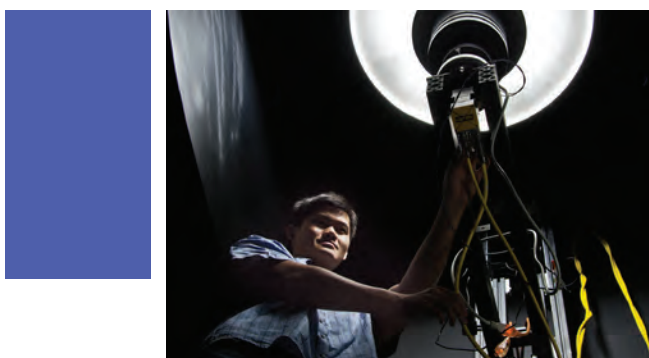


The First Five Years of Innovation



CONTENTS:

- 2 | Five Years of Innovation
- 4 | Board of Advisors
- 6 | Leadership Sponsors
- 8 | Milestones & Achievements
- 10 | Western Cooling Efficiency Center and Western Cooling Challenge
- 14 | Smart Lighting Initiative
- 18 | West Village: Zero Net Energy
- 22 | California Lighting Technology Center
- 26 | Program for International Energy Technologies
- 30 | Child Family Institute for Innovation and Entrepreneurship
- 34 | Market Assessment Assistance Program
- 36 | Multi-Tenant Light Commercial Project
- 38 | Students & Coursework
- 40 | Events & Collaboration
- 42 | Art Rosenfeld Chair in Energy Efficiency
- 44 | Sempra Chair in Energy Efficiency
Chevron Chair in Energy Efficiency
- 46 | Plug-In Hybrid & Electric Vehicle Research Center
- 50 | Center for Water-Energy Efficiency
- 52 | Food and Agriculture Industry
- 56 | Sociology and Behavioral Research



Welcome from Nicole Woolsey Biggart

Five years ago a broad community of prominent individuals and organizations founded the first academic research center to drive energy efficiency products and services into the marketplace. It was both an exciting and challenging mission. Exciting because the opportunity to reduce energy waste, save money, and mitigate environmental impact were large. It was challenging, too, because there were no models to emulate.

UC Davis was the first university to attempt to network regulators, energy producers, large end-users, and industry to accelerate the commercialization of efficient technologies.

The investment of talent, financial and political support was well justified, as you will see in the following pages.

The UC Davis Energy Efficiency Center is a vibrant, growing and effective collaboration that drives new solutions in lighting, heating and air-conditioning, and hybrid and electric vehicles. It has developed technological and socially appropriate energy solutions for the very poor in developing nations. Engineering, management, and agriculture students have learned how to analyze possible solutions for energy problems. They have taken those skills with them into new careers.

With the support of generous benefactors, the EEC has three endowed faculty chairs to support research and teaching in energy efficiency. We have educated the public and industry through a well-attended Roots of Energy Efficiency series in Silicon Valley and participated in Milken Institute seminars and conferences. Our faculty and graduate students regularly share their research at professional conferences around the world.

Our ambitions are growing. We are working with other universities who hope to emulate our success, which is both a compliment and a way of leveraging what we are learning. The Center for Water-Energy Efficiency launched this year and has the ambitious goal of saving both energy and water by helping policy makers and industry co-manage these two resources.

On our fifth anniversary, I invite you to celebrate our accomplishments and help us work toward our strategic goals for the future.

There is much for us to do and together we will make a difference.

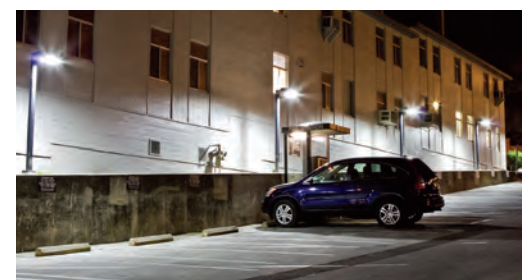


NICOLE WOOLSEY BIGGART

Director & Professor | Energy Efficiency Center

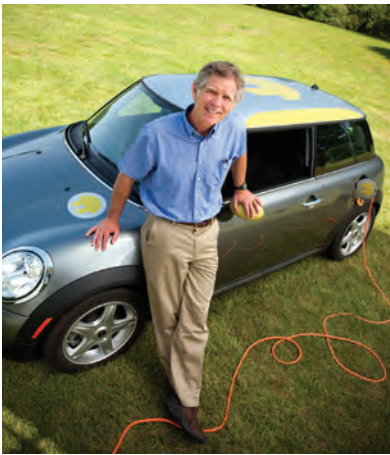
Professor of Management | Graduate School of Management

Chevron Chair in Energy Efficiency



Five Years of

UC DAVIS ENERGY EFFICIENCY CENTER EMERGES AS NATIONAL LEADER



Accelerate the development and commercialization of energy efficient technology and train future leaders in energy efficiency.

These are the goals of the UC Davis Energy Efficiency Center (EEC), the nation's first university-based center of excellence for energy efficiency.

The EEC was formed in April 2006 with a \$1 million grant from the California Clean Energy Fund (CalCEF). UC Davis matched that with \$1.3 million in operating and research funds, faculty time, and office and laboratory space. Further support came from eight Leadership Sponsors—Chevron Corporation, Edison International, Goldman Sachs, Microsoft, Pacific Gas and Electric Company, Sacramento Municipal Utility District, Sempra Energy and Walmart—that contributed the guidance of executive level leaders and \$500,000 each.

Collaborating to move energy efficiency forward

The Center works with inventors, utilities and investors to propel promising energy efficiency solutions—whether they are developed at UC Davis or elsewhere—toward the critical intersection of technology, business development, and successful commercialization.

Simply put, the EEC brings together those who devise new ways to save energy, those who finance their development, the manufacturers who make the products, and the industries and consumers who buy them.

As the EEC looks to the next five years, its leadership is committed to continued growth and increased impact. While the lighting, cooling and plug-in vehicle centers are in strong positions to increase their impact over time, increased emphasis will be placed on water energy efficiency, food processing and industrial energy efficiency, social science, market research, financing mechanisms, and user-interface optimization.

The EEC has “been very successful because of our eminent and powerful board of advisors, who have supported our efforts to advance energy efficiency,” says Nicole Biggart, EEC director and Chevron Chair in Energy Efficiency. “Their support has been well placed and we are leveraging it in multiple ways. We are making a difference in California and beyond.”

Bringing together talent and technology

The EEC brings together research talent from many areas of UC Davis: the California Lighting Technology Center, Western Cooling Efficiency Center, Plug-in Hybrid & Electric Vehicle Research Center, Center for Water-Energy Efficiency, Graduate School of Management and Child Family Institute for Innovation and Entrepreneurship.

Innovation

Campus researchers are also breaking new ground in areas that have previously gone unexplored but are vital to adopting energy efficient technologies — such as consumer behavior, market demand and organizational studies.

Others continue to join the EEC's mission. The California Energy Commission and Doris Duke Charitable Foundation, for example, have thrown their support behind a new effort to set standards for retrofitting neighborhood shopping centers and office buildings with energy efficiency technologies.

While the EEC relies on the broad expertise and technological discoveries of its researchers, its emphasis on market impact distinguishes it from other traditional university research centers.

CalCEF's initial investment has already paid off big dividends. In its first five years, the center has enabled UC Davis to:

- **Construct the nation's first zero net energy community**
- **Reduce energy consumption** for lighting on campus by 60 percent in a massive campus-wide demonstration project
- **Validate technology** that has the potential to cut energy use for air conditioning by half
- **Partner with people** from all corners of government and industry to change policy and bring new technologies to market
- **Develop an energy-efficiency curriculum** to teach future thought leaders and managers
- **Establish the Emerging Venture Analyst program**, through which UC Davis MBA students work directly with industry to commercialize energy-efficient technologies



“From my perspective, one of the most important ingredients to the early success as a center, has been the passion of the faculty, staff, and students. These talented people have an amazing commitment to our mission. They want to see their work published and commercialized. They are driven to get new technology into the hands of end-users, speed rapid adoption and diffusion, and create real market impact.”

—BEN FINKELOR

Executive Director | Energy Efficiency Center
UC Davis MBA 2004

Advisors Play a Key Role in Success

BOARD MEMBERS' ENERGY EXPERTISE INFORMS THE EEC'S PLANS FOR RESEARCH, FUNDING AND OUTREACH

“The EEC is playing a critical role fostering the commercialization and widespread adoption of energy efficient technology and developing the next generation of leaders in the field.”

— RALPH CAVANAGH

The Energy Efficiency Center owes much of its early success to its outstanding Board of Advisors. Distinguished leaders in industry, government, public interest organizations and academia serve on the EEC's Board of Advisors. The board brings a deep understanding of energy efficiency to UC Davis.

The Board meets approximately once every nine months with the EEC's director, faculty leaders, researchers, staff and students. Board members provide valuable insight and advice on research

opportunities, funding strategies, and outreach. The board assists in shaping the EEC's strategic goals and developing and expanding the network of EEC partners. Board members offer independent, expert advice on how the EEC can implement its mission to accelerate the commercialization of energy efficient technology and train future leaders in energy efficiency.

The board's support, wisdom and guidance are crucial to the EEC's success. Their service is deeply appreciated.

BOARD OF ADVISORS



ROB BERNARD
Chief Environmental Strategist
Microsoft Corporation



HELEN BURT
Senior Vice President
Pacific Gas and Electric Company



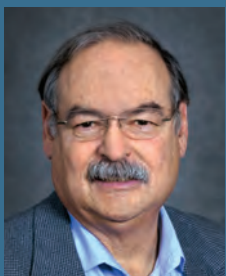
RALPH CAVANAGH
Co-Director, Energy Program and Senior Attorney
Natural Resources Defense Council



JIM DAVIS
President
Chevron Energy Solutions



JOHN DISTASIO
General Manager & Chief Executive Officer
Sacramento Municipal Utilities District



MARK LEVINE
Group Leader
China Energy Group
Lawrence Berkeley National Laboratory



AMORY LOVINS
Co-Founder, Chairman and Chief Scientist
Rocky Mountain Institute



MICHAEL NIGGLI
President and Chief Operating Officer
San Diego Gas and Electric Company



NANCY PFUND
Managing Partner
DBL Investors, LLC



ARTHUR ROSENFELD
Distinguished Scientist Emeritus
Lawrence Berkeley National Laboratory
Retired California Energy Commissioner

Message from the Chair

When we launched the Energy Efficiency Center, I had high hopes for what this organization could do to drive innovation in energy efficiency for California and the rest of the country. Increasing energy efficiency is our state's best hope to minimize the impacts of climate change, improve our energy security and reduce the cost of reliable energy services.

Today, five years later, the EEC has delivered on those initial aspirations.

I am honored to serve as the chair of the EEC Board of Advisors and to work with such a diverse and highly esteemed collection of fellow board members to support this center. The EEC's work is a great example of what the University of California can do to apply the best research and teaching to solve real world problems. The next five years will bring still more success.



MICHAEL PEEVEY

President | California
Public Utilities Commission

Chair | UC Davis EEC
Board of Advisors



CREE EDWARDS

Founder
eMeter



MIKE GARDNER

Vice President
Project Design and
Management
Walmart Stores, Inc.



KATHLEEN HOGAN

Deputy Asst. Secretary
for Energy Efficiency
U.S. Department of Energy



ANNE SHEN SMITH

Chief Operating Officer
Southern California
Gas Company



ROBERT WEISENMILLER

Chairman
California Energy
Commission



LYNDA ZIEGLER

Executive Vice President,
Power Delivery Services
Southern California Edison

BOARD OF ADVISORS EMERITI

PETER DARBEE

Chairman of the
Board, CEO and
President
Pacific Gas and
Electric Company
2008–2010

ANTHONY EGGERT

California Energy
Commissioner
2010

JOHN FIELDER

President
Southern California
Edison
2007–2010

EDWIN GUILS

Executive Director
Sempra Energy
2007–2009

LARRY KELLERMAN

Managing Director
Goldman Sachs
2007–2009

TOM KING

Chairman and CEO
Pacific Gas and
Electric Company
2007

WILLIAM MORROW

President and CEO
Pacific Gas and
Electric Company
2008

DAN REICHER

Director, Climate Change
and Energy Initiatives
Google
2007–2011

KIM SAYLORS-LASTER

Vice President, Energy
Walmart Stores, Inc.
2009–2011

CHARLES ZIMMERMAN

Vice President, Prototype and
New Format Development
Walmart Stores, Inc.
2007–2009

Leadership Sponsors

The following leadership sponsors have made significant financial contributions to support the Energy Efficiency Center's mission to accelerate the development and commercialization of energy efficiency technologies and to train future leaders in energy efficiency.



California Clean Energy Fund (CalCEF)

Founding sponsor, 2006

CalCEF makes equity investments in emerging clean energy technology companies. The fund expects to deliver market-based financial returns to its investors and positive environmental and economic returns to California, with a focus on PG&E's service territory. In addressing the energy challenge, CalCEF primarily focuses on areas of clean energy that have a history and established advantage in California, such as renewable generation and demand-side management. Financial returns are reinvested in the fund, enabling CalCEF to become a growing 'evergreen' fund.



Chevron

Sponsor since 2007

Chevron seeks, produces and transports crude oil and natural gas; refines, markets and distributes transportation fuels and other energy products; manufactures and sells petrochemical products; generates power; and develops and commercializes energy resources of the future, including geothermal, biofuels and other renewables. In 2006, Chevron formed a strategic research collaboration with UC Davis to pursue advanced technology aimed at converting cellulosic biomass into transportation fuels. Chevron Energy Solutions, a Chevron subsidiary, develops and constructs energy efficient and renewable power projects for institutions and businesses.



Edison International

Sponsor since 2007

Through its subsidiaries, Edison International generates and distributes electric power and invests in infrastructure and energy assets, including renewable energy. Headquartered in Rosemead, California, Edison International is the parent company of Southern California Edison, the largest electric utility in California, and the Edison Mission Group, a competitive power generation business and parent company to Edison Mission Energy and Edison Capital.



Goldman Sachs

Sponsor since 2009

Founded in 1869, Goldman Sachs is one of the oldest and largest investment banking firms in the United States. Its Environmental Policy Framework embodies the philosophy that capital markets can and should play an important role in addressing today's environmental challenges. The Goldman Sachs Center for Environmental Markets works with independent partners in the academic and non-government communities to examine market-based solutions to environmental challenges.



Microsoft

Sponsor since 2011

Microsoft is committed to environmental sustainability—from reducing the company's own environmental impact, to optimizing the energy and resource use of the IT industry, to leveraging IT solutions for global sustainability. Microsoft's commitment to environmental sustainability spans the company, from internal business practices, to the products they deliver and the solutions they enable, to their ongoing partnerships in support of environmental research and policy development globally. Collectively, Microsoft employees, their partners, and their technology are helping address sustainability challenges through innovation, more efficient processes, and deeper insight into and greater control of resource use and waste streams.



Pacific Gas & Electric Company

Sponsor since 2007

PG&E provides natural gas and electric service to 15 million California residents. PG&E's energy efficiency programs have saved more than 135 million megawatt hours of electricity—enough to supply 21 million homes for a year. PG&E is committed to supporting energy efficiency research and to implementing real-world energy solutions. Currently, 12 percent of the company's power mix comes from renewable sources, with a commitment to increase that to 20 percent by 2015. PG&E developed geothermal power sources more than 40 years ago and has invested millions of dollars in photovoltaic research.



Sacramento Municipal Utility District

SMUD

Sponsor since 2010

Recognized for its innovative programs in energy efficiency and renewable power, the Sacramento Municipal Utility District (SMUD) is the sixth-largest publicly owned utility in the country by customers served. Through its Greenergy® program, SMUD matches up to 100 percent of customer electricity needs with purchases of renewable resources. With its Home of the Future program, SMUD is designing and building true zero energy homes in the Sacramento area. SMUD also underwrites OurGreenCommunity.org, where people can share ideas about reducing the impact of carbon emissions.



Sempra Energy

Sponsor since 2007

Sempra Energy develops energy infrastructure, operates utilities, and provides related products and services to more than 29 million consumers on four continents. Sempra Energy serves the largest customer base of any energy utility in the United States through its California utilities: San Diego Gas & Electric Co. and Southern California Gas Co. Sempra is dedicated to investing in creative ideas and innovative approaches that can result in high-impact change in sustainability and the advancement of new environmental and energy technologies, infrastructure development and improvement, and support for people and communities in need.



Walmart

Sponsor since 2007

With nearly 6,500 stores in 14 countries, Walmart serves more than 100 million customers a week. Its Sustainable Value Networks program drives innovation in both everyday operations and products. Its Climate Change Initiative explores energy-efficient, high-performance LED lighting for parking lots and street lamps and examines potential technologies for interior LED lighting, variable-speed heating, ventilation, air-conditioning technology, and solar power. Walmart has committed to designing a store prototype that is at least 25 percent more efficient and to reducing greenhouse gas emissions in existing stores by 20 percent before 2012.

Five Years of Success



- UC Davis selected by CalCEF via competitive process to create the first university-based energy efficiency research center

- Curriculum created for first graduate level course completely dedicated to energy efficiency
- Inaugural Board of Advisors meeting with guest Susan Kennedy
- Western Cooling Efficiency Center launched, modeled after the successful Lighting Technology Center

- Recruitment of Mark Modera as Director of the Western Cooling Efficiency Center using the Sempra Chair in Energy Efficiency



- Chevron, Walmart, and Goldman Sachs join as Leadership Sponsors



2006



2007



2008



- Graduate School of Management Professor Andrew Hargadon named to lead center

- California utilities PG&E, Southern California Edison and Sempra Energy became founding EEC Leadership Sponsors: five-year pledges that cover 2007 through 2011
- Establishment of the Sempra Chair in Energy Efficiency
- First annual Green Technology Entrepreneurship Academy
- First of a series of PG&E and Edison Graduate Student Fellows hired and trained



- Founding Director, Institute of Transportation Studies Professor Dan Sperling served as Interim Faculty Director (2008–2009)

- UC Davis Energy Efficiency Center launched at April press event with both the Governor and the Chancellor celebrating the center opening



- Roots of Energy Efficiency Series (Part 1): EEC presented series of three forums exploring California's rich past—and promising future—as a global innovator of energy-efficient technologies and policies.
- Energy Efficiency Technology Impact Summits convened in Davis and San Diego



■ Initial report released on the potential for a zero net energy West Village Living Laboratory





- SMUD joins as Leadership Sponsor
- Establishment of the Chevron Chair in Energy Efficiency
- Roots Series (Part 2)

- Recruitment of Graduate School of Management Professor Nicole Woolsey Biggart as new EEC Director using the Chevron Chair in Energy Efficiency
- Kathleen Hogan of U.S. DOE joins Board of Advisors

- Board of Advisors meet in Southern California to discuss water-energy issues
- West Village opens doors, after raising over \$8 million in state and federal R&D funding, as the largest zero net energy community in the country

- We celebrate our Fifth Anniversary and the first faculty appointee to the Rosenfeld Chair in Energy Efficiency: Michael Siminovitch

2009

2010

2011

2012

- Board of Advisors meeting and Congressional Briefing held in Washington DC with special guest Cathy Zoi
- Program for International Energy Technologies (PIET) established with \$200,000 investment from the World Bank

- Lighting Technology Center moves into new facility with double the space
- Rosenfeld Symposium honors the retirement of Art Rosenfeld from the California Energy Commission and Roots Series (Part 3) attended by 350 people
- Center for Water-Energy Efficiency concept explored

- Launch of an integrated \$4.9 million Multi-tenant Light Commercial R&D project with funding from PIER and the Doris Duke Charitable Foundation, and in partnership with the DOE

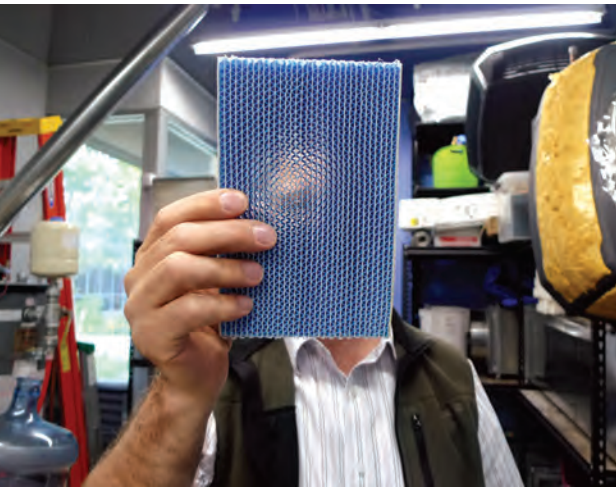


- Microsoft joins as newest Leadership Sponsor



- The Energy Efficiency Center hosts the first Energy Efficiency Forum—this one focused on Retrofitting Corporate Campuses, integrating across our expertise at the Lighting and Cooling Centers





The Western Cooling Challenge is a multiple winner competition that encourages HVAC manufacturers to develop climate-appropriate rooftop packaged air conditioning equipment that will reduce electrical demand and energy use in Western climates by at least 40% compared to current federal standards.



>> <http://wcec.ucdavis.edu>

Cooling Off Energy Use

WESTERN COOLING CHALLENGE BRINGS PROMISING AIR-CONDITIONING TECHNOLOGIES TO MARKET

Finding ways to increase cooling efficiency in new and existing buildings is the mandate behind the Western Cooling Efficiency Center (WCEC).

The first major undertaking of the Energy Efficiency Center, which was initiated with CalCEF's seed funding, was the launch of the Western Cooling Efficiency Center. Cooling is often described as the utility "load from hell" because it requires so much power yet it is used so infrequently during the year. Reducing this cooling load is of strategic importance to California and the rest of the Western States.

Much like (and modeled after) UC Davis' successful Lighting Technology Center, the WCEC is supported by the California Energy Commission (CEC), as well as industry affiliates, including utilities, manufacturers and contractors.

The Center teams with these industry stakeholders to stimulate the development of cooling technologies to reduce electrical demand, energy consumption and water consumption, not only in California, but in the 11 Western states with predominantly dry summer climates.

Competition Generates Promising Technologies

Many Western states are hot and dry, but use cooling systems that were designed for warm and humid climates, notes Mark Modera, director of the WCEC and Sempra Energy Chair in Energy Efficiency. With technologies specifically designed for the West's climate, he adds,

"we can dramatically reduce the energy used to cool our buildings."

One of the WCEC's first initiatives was to establish the Western Cooling Challenge in 2008. The Challenge aimed to accelerate the adoption of regionally appropriate cooling technologies for low-rise, nonresidential buildings, such as suburban retail and office buildings. Since the Challenge was issued, it has achieved a number of important results.

First, the Challenge inspired two manufacturers to design and produce new, highly efficient hybrid evaporative/vapor-compression Roof-Top packaged Units (RTUs) for cooling light commercial buildings. This is significant, as RTUs provide roughly 70 percent of the cooling in commercial buildings in California. These newly designed units are projected to reduce energy use and peak electricity demand by at least half.

One of the Challenge's winning manufacturers — Coolerado — used its success in the competition to attract venture capital investment to increase production capabilities, and will also team with other major equipment manufacturers to produce a new, larger-tonnage Challenge entry.

"We are extremely pleased that Coolerado's product exceeded our expectations," Modera notes. "Our target was a 50 percent reduction in energy use and peak electricity demand; the Coolerado tests indicate almost 66 percent energy use savings and over 60 percent peak-demand reduction."

continued



“Our target was a 50 percent reduction in energy use and peak electricity demand; the Coolerado tests indicate almost 66 percent energy use savings and over 60 percent peak-demand reduction.”

— MARK MODERA

Cooling Off Energy Use *continued*

Sponsorships Support Testing, Business Development

Another manufacturer — Speakman — recently delivered its Challenge entry to the National Renewable Energy Laboratory where it is currently being tested.

The Challenge has also received significant support from Southern California

Edison (SCE), which is paying for testing of larger equipment at Oak Ridge National Laboratory, for publicizing and promoting the program, and for performing advanced field testing of Cooling Challenge equipment in California. This augments support from the California Energy Commission’s PIER program and the California Institute for Energy and Environment (CIEE) for demonstrations

on the UC Davis campus and at a military facility in China Lake.

As the Challenge is ongoing, “it continues to attract promising new entries,” Modera says, including a recent one from Trane.

Retrofitting RTUs — as well as residential air conditioners — is another WCEC focus, as these units typically have a service life of 15 to 20 years. Collaborative projects with San Diego Gas & Electric and SCE are currently underway to significantly improve the performance of these units through retrofits. The first tests began in June 2011.

“Together with our affiliates and stakeholders, WCEC works as an authoritative and objective organization that helps create, test and implement new cooling technologies, helping California and the Western United States meet policy goals to reduce overall consumption,” Modera says.



“Together with our affiliates and stakeholders, WCEC works as an authoritative and objective third-party organization that helps create, test and implement new cooling technologies, helping California and the Western United States meet policy goals to reduce overall consumption.”

— MARK MODERA

Other projects currently underway at WCEC are:

- **Development and testing of an inexpensive gray water treatment system** for residential evaporative cooling systems, with funding from the California Energy Commission Public Interest Energy Research (PIER) program.
- **Development of a technology to reduce gas and electricity consumption** in any system that utilizes water for thermal distribution, such as those found in hotels, apartment and commercial buildings.
- **Research and design of In-Home Energy Displays (IHEDs)**, new products that give homeowners access to smart meter data to discover ways to improve home performance.
- **Testing of an aerosol process** to seal leaks in building envelopes, in a project funded by the Department of Energy Build America program.
- **Increasing industry support** through work on such projects as code change proposals for California’s Title 24 Energy Code, which is supported by PG&E. Among other activities, WCEC provided analysis of data collected from a Walmart radiant cooling system. WCEC has also joined a partnership with the Southwest Energy Efficiency Project (SWEEP).

Finding cool ways to bring business and technology together

As both a research scientist and an entrepreneur, Mark Modera knows how challenging it can be to develop practical, energy-saving technologies and then successfully bring them to market.

He has spent more than 20 years as a staff scientist at Lawrence Berkeley National Laboratory (LBNL), working on an array of research projects, including development of a research program focused on improving thermal energy distribution in buildings.

While at LBNL, he developed an aerosol-based duct sealing process and founded a business — Aeroseal, Inc.— to commercialize the technology.

“We found a solution to a problem that did not yet have an established market,” he recalls, and bringing it to commercial viability “was a huge risk.” After four years of 90-hour work weeks, the hard work eventually paid off, when Carrier, recognizing Aeroseal’s technical success and market promise, bought the business in 2001. The company retained Modera to help manage it.

In 2008 Modera joined the WCEC at UC Davis as Sempra Energy Chair in Energy Efficiency and professor of civil and environmental engineering and mechanical and aerospace engineering. He has been using his expertise in research, business, entrepreneurship,

regulatory environments and education to help the Center meet its mission to work with entrepreneurs, third-party affiliates and larger industries in bringing new energy-saving technologies to market.

In addition to his work at LBNL and WCEC, Modera has been active in the American Society of Heating, Refrigeration and Air Conditioning Engineers for more than 25 years, during which time he has chaired and served on many technical, standards and society-level committees. His publications span a vast range of research interests, including diagnostic tools for heat and mass transfer properties (e.g. dynamic thermal performance of buildings and components, air tightness, soil permeability); air flow modeling and measurement; energy efficiency policy; simulation tools and simplified models for buildings; wood combustion (efficiency, pollution production, third-world cook stoves); aerosol production and transport; and indoor air quality.

“It’s rewarding to be able to assist those small companies that need third party verification of their ideas and connect them to big companies with existing products that need these new ideas to meet their energy-reduction challenges,” Modera says. In 2012, Mark was named as an ASHRAE Fellow.



MARK MODERA

Director | Western Cooling Efficiency Center
Sempra Energy Chair
Associate Director | Energy Efficiency Center



“We found a solution to a problem that did not yet have an established market... and bringing it to commercial viability was a huge risk.”

A Bright Idea

SMART LIGHTING INITIATIVE REDUCING ENERGY CONSUMPTION BY 60 PERCENT



“ In our business we don’t typically get 50 percent savings, so we are quite enthusiastic with the results of the parking structure retrofit. It was a straightforward idea that worked very well.”

— **MICHAEL SIMINOVITCH**

Director | California Lighting Technology Center

Professor of Design

Associate Director | Energy Efficiency Center

Arthur H. Rosenfeld Chair in Energy Efficiency

One night during the 1973 oil crisis, physicist and eventual “Father of Energy Efficiency” Art Rosenfeld tried to save electricity by turning off his office mates’ lights.

Almost 40 years later, on the UC Davis campus, researchers, facilities managers and engineers are tackling a similar challenge, but they are working to implement it on a much larger scale.

The UC Davis Smart Lighting Initiative is going to be “one of the big energy saving success stories coming out of the Energy Efficiency Center,” says Michael Siminovitch, director of the California Lighting Technology Center (CLTC), associate director of the Energy Efficiency Center (EEC) and a professor of design.

Right now on the UC Davis campus, lighting accounts for 29 percent of all electrical consumption. Campus leaders intend to reduce electricity use for lighting by 30 million kilowatt-hours, or 60 percent, by the end of 2015. (The California Public Utilities Commission plans to reduce electrical lighting consumption statewide by 60 to 80 percent by 2020.)

The reductions will come by retrofitting lighting systems in parking garages and lots, corridors, offices, laboratories, bathrooms and other areas.

Retrofits Introduce LEDs, Sensors

Already, UC Davis is expected to save \$77,000 annually since introducing motion sensors and bi-level lighting controls in its three parking structures.

Prior to the Smart Lighting Initiative, the parking structures used high-pressure sodium lamps that emit a yellowish light. The lamps were on 24 hours a day, even if the garage was empty.

Now, the parking structures contain light-emitting diode (LED) and/or induction luminaires, which use less energy and have longer lifespans. The luminaires have two light output levels and occupancy sensors; they are off during daylight hours, on at 100 percent power at night, and reduced to 50 percent power when the structure is vacant. The system switches immediately from low to high light when occupancy is detected.

With the savings comes improved safety. The motion sensors make it easy to detect movement throughout the garage, and the white light produced by the induction lamps and LED luminaires offers better color rendering so occupants can distinguish between a black and blue car, for example.

Director of Transportation and Parking Services Cliff Contreras says he has already seen a 60 percent reduction in energy costs and expects the project will pay for itself within eight years.

“It’s been a win for everyone, a big one,” he says.

Siminovitch says some of the technologies used in the Smart Lighting Initiative grew out of a small demonstration of adaptive lighting in parking lots that

continued



Right now on the UC Davis campus, lighting accounts for 29 percent of all electrical consumption. Campus leaders intend to reduce electricity use for lighting by 30 million kilowatt-hours, or 60 percent, by the end of 2015.



>> <http://cltc.ucdavis.edu>

A Bright Idea *continued*

“UC Davis is uniquely able to serve as a model for virtually anyone who uses electric lights in California and beyond. If you are trying to cut your carbon footprint and lighting costs, you can find help here.”

— MICHAEL SIMINOVITCH



the CLTC conducted with the California Energy Commission and PG&E.

“In our business we don’t typically get 50 percent savings, so we are quite enthusiastic” with the results of the parking structure retrofit, he says. “It was a straightforward idea that worked very well.”

The Smart Lighting Initiative has been a joint effort between the CLTC and UC Davis’ forward-thinking facilities management team.

\$3 Million Savings Annually Projected

Sid England, assistant vice chancellor for environmental stewardship and sustainability, says CLTC provided the leadership, inspiration and technologies to get the initiative started. Then, a team of campus designers, engineers and facilities management personnel evaluated the technologies and began implementing those with the most promise.

“A few years ago Michael [Siminovitch] said we need to establish a goal for the campus, and that we have the right facilities, technology and people to be a

leader” in lighting efficiency, England says. “We got a group of facilities folks together to see what would be feasible, and when we looked closely at the CLTC analysis, we knew there was something doable there.”

When the initiative is complete in 2015, the campus will reduce its carbon footprint by about 6,650 metric tons of CO₂ equivalent and save an estimated \$3 million in electricity costs each year.

The parking structure retrofits are only a portion of the initiative. Fifteen interior and exterior demonstration projects have been installed so far, and they have saved more than 300,000 kilowatt-hours and 200,000 pounds of carbon emissions.

For example, one demonstration project cut energy consumption by an average of 43 percent simply by incorporating bi-level controls and occupancy sensors in three corridors of Bainer Hall, an engineering building.

A study of Bainer Hall prior to installation of the demonstration project showed the corridors were empty 82 percent of the time, but were lit at 100 percent power 100 percent of the time. Now, the corridors are lit with high-quality fluorescent overhead lights that

Other projects of the Smart Lighting Initiative include:

- **“Hybrid” bathroom luminaires** that combine LED night lights with conventional lights and occupancy sensors in Emerson Hall and Webster Hall dormitories. The luminaires turn off automatically if students forget to, and the lighting is reduced to a low-level at night.
- **Retrofit of more than 1,200 exterior points of light** with a networked system of dimmable, LED post-top lighting that saves energy, increases safety and enables easier analysis of energy consumption.
- **LED desk lamps and bi-level overhead lights** controlled by occupancy sensors, daylight sensors and people in Mrak Hall offices. Previously, over-head lighting in the 17 perimeter offices was controlled by two switches that delivered fluorescent lighting, even to workers with adequate daylight.
- **Non-electric tubular daylighting devices (TDD) and occupancy controls** in a laboratory at the Robert Mondavi Institute for Wine and Food Science. TDDs deliver daylight to interior spaces, reducing lighting energy costs and consumption.

operate at 50 percent power and increase to 100 percent when occupancy is detected.

Other Industries Adopting Smart Lighting

The impact of the Smart Lighting Initiative will eventually be felt beyond the UC Davis campus. Many of the new exterior lighting and control technologies implemented on campus will become required in the next iteration of Title 24, California's energy efficient standards for residential and commercial buildings.

"Part of CLTC's mission is to work in the policy realm, to affect policy and code change," says Siminovitch. "That is one of the true paths to change in the building world."

Other organizations are also looking to UC Davis technology to reap savings and energy reductions. Chevron Energy Solutions, a subsidiary of EEC leadership sponsor Chevron, is looking to take the best practices developed at UC Davis and incorporate them into the retrofits it is undertaking throughout California and the United States.

At Blue Diamond Almonds, a proposed retrofit for warehouses using induction fixtures with occupancy sensors could yield an 83 percent reduction in lighting energy costs, or \$365,000 over five years. EEC leadership sponsors Microsoft and Walmart, with Sierra Nevada Brewing Co., the U.S. Navy, two U.S. Air Force Bases, and California State and UC campuses, have also partnered with CLTC.

"UC Davis is uniquely able to serve as a model for virtually anyone who uses electric lights in California and beyond," said Siminovitch. "If you are trying to cut your carbon footprint and lighting costs, you can find help here."

Shedding light on an enormous opportunity to reduce energy consumption

When Michael Siminovitch was in graduate school, he was interested in three things: energy, design and making a difference. An advisor encouraged him to get into lighting technology because "it touched on the human aspects as well as the engineering aspects and had enormous opportunity" to reduce energy consumption.

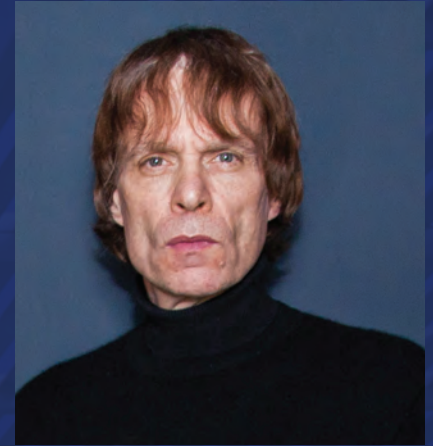
Since then, Siminovitch has received more than 20 awards for his research and design, attracted \$6 million in research funding and given close to 100 presentations on lighting technology. He has forged relationships with people at all levels of industry and government, established the first graduate program focused on lighting controls in the U.S, and consulted with industry and academic leaders in China.

Yet he says his biggest accomplishment is creating an environment at UC Davis that is "experimental and adventuresome" for the next generation of lightening technology students.

"To me it is all about ways of thinking," he says. "Energy efficiency has always been cloistered in the lab or hidden away in the back room. But it's not a single scientist, it's a group of people working together and with outside agencies."

Like the Energy Efficiency Center that he co-directs, Siminovitch promotes the idea that energy efficiency can't be achieved without collaboration.

Today the field is attracting a broad range of students with backgrounds in



MICHAEL SIMINOVITCH

Director | California Lighting Technology Center

Professor of Design

Associate Director | Energy Efficiency Center

Arthur H. Rosenfeld Chair in Energy Efficiency



design, engineering, architecture and even theatre, and they need to work together and with others outside of academia to move energy efficiency forward.

While many universities can provide students with a broad body of knowledge, UC Davis has a unique culture that gives students "an increased level of confidence and a willingness to experiment and engage with new ideas and new technologies," he says. "I'm most proud of the fact that we have established a place where this thinking is flourishing."

>> The UC Davis West Village is a showpiece of sustainability. The largest planned zero net energy community in the United States, it will produce as much energy as it consumes.



>> <http://westvillage.ucdavis.edu>



Breaking New Ground

WEST VILLAGE IS NATION'S LARGEST ZERO NET ENERGY COMMUNITY

In September 2011, 2,000 tenants moved into the nation's largest living laboratory for energy efficiency, right on the UC Davis campus. The UC Davis West Village is a showpiece of sustainability. The largest planned zero net energy community in the United States, it will produce as much energy as it consumes. The community is designed to enable residents to reduce their reliance on automobiles, limit energy consumption and take advantage of the local climate.

When complete, the \$280 million, 200-acre community will house about 4,500 students, faculty and staff and provide habitat and recreation buffer areas, retail business space, and recreation and study facilities.

California Lieutenant Governor Gavin Newsom called West Village “the most significant project of its type anywhere in the United States.”

“With all due respect to LEED (green-building certifications), that’s like hybrid cars — that’s yesterday,” Newsom said during a tour of West Village. “We’re talking about zero net energy. This is a demonstration of California’s excellence in sustainability and should set an example for the rest of the nation.”

Grants, Sponsorships, Support Groundbreaking Project

In 2007, UC Davis commissioned the newly established Energy Efficiency Center (EEC) to issue a comprehensive energy strategy for West Village that included efficiency measures and renewable generation to minimize energy demand.

The project has attracted a diverse group of partners. Chevron Energy Solutions, a subsidiary of EEC leadership sponsor Chevron Corporation, completed a feasibility study on zero net energy and helped shape the energy strategy. The EEC helped secure state and federal grants to support the West Village project, including a \$2 million grant from the California Energy Commission and funding from the California Public Utilities Commission and the U.S. Department of Energy. EEC leadership sponsor PG&E contributed to the planning and feasibility studies.

“PG&E is proud to be a part of this innovative development that will be a real-world living laboratory to benefit consumers here, as well as throughout the state and country,” PG&E Senior Vice President and Chief Customer Officer Helen Burt said when construction began.

West Village reflects the EEC’s commitment to bringing people from a wide range of sectors together to find energy efficiency solutions.

“The West Village project is a prime example of how our campus researchers are working with industry and government on real-time, real-world solutions to improve and enhance our living communities and address California’s environmental problems,” said UC Davis Chancellor Linda P.B. Katehi.

Achieving Zero Net Energy

UC Davis West Village relies on two strategies to achieve the zero net energy goal: aggressive energy efficiency measures and on-site power generation.



“We’re talking about zero net energy. This is a demonstration of California’s excellence in sustainability and should set an example for the rest of the nation.”

— GAVIN NEWSOM
California Lt. Governor

If built to code, the completed portions of UC Davis West Village would burn 22 million kilowatt hours of electricity a year. But by employing aggressive energy efficiency measures, planners project the annual total will come to about 11 million kilowatt hours, a 50-percent reduction.

The energy-efficiency measures include solar-reflective roofing, radiant barrier roof sheathing and extra insulation. Energy-efficient exterior lighting fixtures, indoor occupancy sensors and “daylighting” techniques will help the community use about

continued

Breaking New Ground *continued*

“The people who designed West Village said ‘Let’s make a village that reflects the way you expect to live, but in a way that has a much smaller footprint.’”

— TOM BEAMISH

UC Davis Associate
Professor of Sociology

60 percent less energy than if standard lighting had been used. A web-based tool enables energy monitoring by unit. And a smart phone app lets residents turn off lamps and plugged-in electronics remotely.

A four-megawatt photovoltaic system is expected to meet the energy needs of the first 1,980 apartment residents and commercial spaces.

On the horizon is a biodigester, based on technology developed at UC Davis, that would convert campus table scraps, and animal and plant waste into energy.

New Home to Energy Efficiency Center, University Innovation Hub

Several energy-related research centers, including the Energy Efficiency Center will relocate within West Village to create UC Davis' first "University Hub." As a prototype for future Innovation Hubs, this "U-hub" will enhance the living laboratory

of UC Davis West Village, serve as an incubator for innovation in sustainability and foster interactions with the private sector in the area of energy research.

Residents will be part of “living laboratory”

Ultimately, the community will be a testing ground for how residents adapt to and use energy-efficient technologies and designs in everyday life. Tom Beamish, a UC Davis associate professor of sociology who studies organizations, the environment and technology, will be on the leading edge of that research.

West Village is unique, Beamish says, because it integrates the best state-of-the-art energy-efficient measures into the way people live.

“The people who designed West Village said ‘Let’s make a village that reflects the way you expect to live, but in a way that

Working at the forefront of energy efficiency, on campus and beyond

Tre Borden wrote the book on UC Davis West Village. Literally.

As an Emerging Venture Analyst with the Energy Efficiency Center, Borden wrote a case study on West Village that not only documents the project but may help similar ones get off the ground and shape energy efficiency policy in the future.

“When people visit West Village they want to know how we made it happen,” Borden says. “The case study describes the lessons we learned, the pitfalls and barriers we encountered, and what people should have in place, based on

our experience, if they want to replicate this project.”

Borden didn’t always have green in his blood. He majored in East Asian Studies as an undergraduate at Yale University and operated his own business in New York City before deciding to pursue an MBA and a career that was “relevant to the future and something I could be passionate about.”

Before enrolling at the UC Davis Graduate School of Management, Borden interned for Sacramento Mayor Kevin Johnson’s office, where his research led

to the formation of the Greenwise Initiative, a regional program aimed at making the Sacramento region the nation’s premier incubator for clean technology and sustainability practices.

At UC Davis, Borden met and interviewed every person involved in or studying energy efficiency issues on campus. He attended governor’s meetings on renewable energy and met industry stakeholders in areas like lighting and wind and solar power. He interned in the legislative affairs department of the California Independent Systems Operator, researching energy legislation

has a much smaller footprint,'” he says. “They have bent over backwards to create a contemporary American lifestyle, but with fifty to seventy percent lower impact on the environment.”

Beamish says engineers typically aren't trained to understand how people live and work, and that end users often “interface with technologies in ways that nobody who built them envisioned.”

“I'm interested in how people plug in,” Beamish says. “We'll be looking at the way people wake up and make their toast and drink their coffee.”

“West Village is one of the very first places designed, built and inhabited like this, and the cutting-edge, brand-new lessons we get from it will be integral to moving forward so that West Village can be applied to similar communities across the county.”

Other sustainable design elements of West Village include:

- **Solar-reflective roofing**, renewable materials and thick exterior walls for added insulation
- **High-efficiency lighting fixtures**, air conditioning systems and appliances powered from on-site energy generation
- **Roof overhangs** and sunshades that mitigate solar exposure
- **Storm-water systems** to cleanse run-off and create habitat areas
- **Distributed solar thermal** on homes to pre-heat water
- **Biogas** coupled with a fuel cell to generate electricity
- **Energy monitoring** by unit via the internet and a smart phone app that lets residents turn off lamps and plugged-in electronics remotely
- **Bicycle and pedestrian pathways**, habitat and recreation buffer areas, on-site water retention, parks and greenways.



TRE BORDEN

UC Davis MBA 2011
 Former EEC Emerging
 Venture Analyst
 Southern California Edison
 Energy Efficiency Fellow
 Current Position: SMUD
 Project Manager | Smart
 Grid Implementation Team



and developing materials for legislators and energy stakeholders. He applied for and won a significant grant from PG&E to fund verification, monitoring and Phase 2 design at West Village.

Armed with his MBA and a raft of connections and knowledge in the energy efficiency field, Borden is poised to play a leading role in the Sacramento area's booming green economy. He recently joined SMUD as a project manager for its Department of Energy Smart Grid Investment Grant project.

“The EEC is really respected and it has allowed me to get my foot in the door at many places,” he says. “They treat us like we are competent people and the future of this industry. They invest a lot of time and energy and love to give us the most valuable experience possible.”

“When people visit West Village they want to know how we made it happen. The case study describes the lessons we learned, the pitfalls and barriers we encountered, and what people should have in place, based on our experience, if they want to replicate this project.”

Thinking outside the big box

UC DAVIS HELPS NATION'S LARGEST RETAILER CUT ENERGY USE

“It’s rewarding to create something in the lab and have it work in the real world, that is also a reliable and cost-effective solution.”

— KONSTANTINOS PAPAMICHAEL

Big retail stores like Walmart are typically lit by skylights and photo sensor controlled florescent lamps, an energy-efficient combination. But, through a partnership between the California Lighting Technology Center (CLTC) at UC Davis and a Walmart store in West Sacramento, shoppers are browsing for bargains under a sophisticated lighting control system that is saving the store even more money on its energy bills.

CLTC was established in 2003, in partnership with the National Electrical Manufacturers Association, the California Energy Commission and UC Davis, to stimulate, facilitate and accelerate the development and commercialization of energy-efficient lighting and daylighting technologies.

Retailer Turns to CLTC to Improve Lighting Systems

Walmart had been focused for decades on increasing its energy efficiency, because electricity is such a large operating expense for the giant retailer. Walmart representatives learned about CLTC’s research on lighting technology—particularly on photo sensor controls—and approached them for help, because they were not satisfied with the systems they had been using, which either over- or under-dimmed the lights, causing complaints by occupants, or lost energy savings, respectively, according to Konstantinos Papamichael, CLTC co-director.

“These stores are basically big boxes with square holes in the roof,” Papamichael explains. Skylights provide relatively uniform daylight levels across the store and from the same direction as the electric lights. “If we could not find a reliable technical solution to maximize savings, we might as well forget about daylighting as a strategy for energy efficiency,” Papamichael notes.

New Systems Reduce Energy Cost by 50 Percent

CLTC laboratory research focused on increasing effectiveness of photo sensor controls using two photo

continued





➤ After extensive testing in the CLTC lab, the laboratory lighting prototype was installed in a portion of the West Sacramento Walmart store, resulting in an energy savings of about 50 percent.



➤ <http://cltc.ucdavis.edu>

Thinking outside the big box *continued*

sensors rather than one which has been the traditional approach. “This combination allows reliable differentiation in photo sensor signal changes due to daylight versus changes in reflectance of interior surfaces, such as merchandise and people,” Papamichael says.

After extensive testing in the CLTC lab, the laboratory prototype was installed in a portion of the West Sacramento store, resulting in an energy savings of about 50 percent over the savings of the system used in the rest of the store and without

any complaints from occupants. The technology has been licensed and more commercial products are expected.

“The partnership is a perfect collaboration between a corporation that was interested in even greater savings, and the CLTC’s mission to develop and commercialize effective technologies for energy efficiency,” Papamichael explains. “It’s rewarding to create something in the lab and have it work in the real world, that is also a reliable and cost-effective solution.”



Other CLTC projects include:

- **Partnerships with utilities, state and federal facility managers, and private corporations on adaptive lighting for exteriors.**

The goal is for all of California’s exterior lighting to integrate advanced controls for efficiency by 2020, which could result in a savings of from \$23 million to \$57 million.

- **In a collaboration with Southern California Edison, San Diego Gas & Electric, Pacific Gas and Electric Company and Sacramento Municipal Utility District, the CLTC is also implementing bi-level lighting**

based on occupancy indoors, in corridors, stairwells, hallways, closets and other unassigned spaces that are continuously lit, regardless of occupancy. CLTC studies show a potential savings of from 40 to 50 percent if bi-level lighting were used in these spaces.

- **UC Davis and the CLTC are collaborating on a Smart Lighting Initiative** to slash the amount of electricity used in university buildings and on the grounds. UC Davis intends to reduce its lighting use by more than 60 percent by 2015.

Helping innovative efficiency measures see the light of day

Konstantinos Papamichael holds an Architectural Engineering degree from the Aristotelian University of Thessaloniki, Greece, a Masters in Architecture from Iowa State University with major emphasis in Building Science and a minor in Energy Systems Engineering. He earned his Ph.D. in Architecture from UC Berkeley, with major emphasis in Design Theories and Methods and minors in Building Science and Computer Science.

During the last 30 years, 20 of which were spent at Lawrence Berkeley National Laboratory, Papamichael has been working on the development of energy efficiency strategies and technologies for buildings, focusing on fenestration systems and daylighting, as well as the integration of electric lighting and fenestration controls. Moreover, Papamichael has done extensive research and development on computer-based tools that facilitate energy and environmental impact considerations in building design decisions.

Papamichael participates in a wide range of academic and professional activities related to daylighting, electric lighting, energy and environmental impact and is author/co-author of more than 80 publications. His recent work in photo sensor



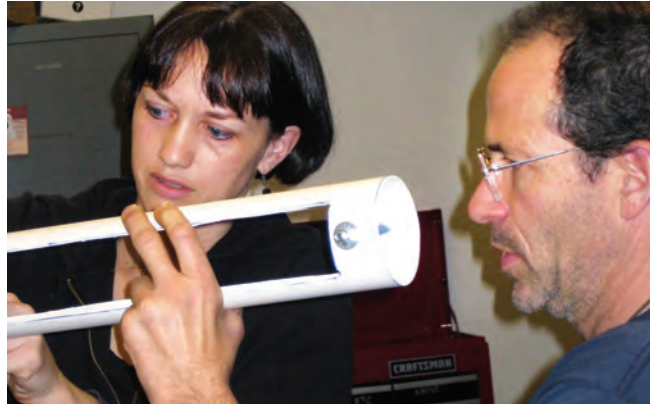
KONSTANTINOS PAPAMICHAEL

Co-Director | California Lighting Technology Center
Professor of Design
Associate Director | Energy Efficiency Center



based controls has resulted in three U.S. patents and a Progress Award from the Illuminating Engineering Society of North America (IESNA). He is currently the Chair of the IES Daylighting Committee and a member of the IESNA Daylight Metrics subcommittee, leading the development of the IES Recommended Practice for Daylighting. He is also the author of the *Daylighting Chapter of the Advanced Lighting Guidelines*.

“The partnership [with Walmart] is a perfect collaboration between a corporation that was interested in even greater savings, and the CLTC’s mission to develop and commercialize effective technologies for energy efficiency.”



UC Davis launched the Program for International Energy Technologies (PIET) in 2009, with the mission of moving inexpensive and efficient energy technologies into the marketplace of developing countries.



>> <http://piet.ucdavis.edu>

Making an Impact Around the World

INTERNATIONAL INITIATIVES ARE EXPANDING ENERGY EFFICIENCY ADOPTION AND EDUCATION AT HOME AND AROUND THE GLOBE

The mission of the UC Davis Energy Efficiency Center (EEC)—to accelerate the development and commercialization of energy efficiency technologies and to train future leaders in energy efficiency—reaches far beyond California, or even the United States. Its mission is being spread across oceans and continents.

Energy-Efficient Solutions for Developing Countries

Developing countries have an urgent need for low-cost, clean technologies. Recognizing this, UC Davis launched the Program for International Energy Technologies (PIET) in 2009, with the mission of moving inexpensive and efficient energy technologies into the marketplace of developing countries, according to Kurt Kornbluth, PIET founder and director.

PIET, in collaboration with the EEC, the Child Family Institute for Innovation and Entrepreneurship, the Institute of Transportation Studies, and the Energy Institute with funding from the National Collegiate Inventors and Innovators Alliance, has developed an ongoing, multi-disciplinary curriculum designed to enlist and educate UC Davis graduate students in finding tangible solutions to energy issues for clients in developing countries. PIET students—from business, engineering and the physical and social sciences—participate in D-Lab, a combination of graduate curriculum

and applied field research. Here, they gain hands-on, practical experience, such as creating charcoal from agricultural waste or constructing a battery from inexpensive, locally available components. Students are then assigned a project—as defined by an “in country” client—to solve real-world problems. Over the past two-and-a-half years, D-Lab students have completed projects in such countries as Nicaragua, Guatemala, Bangladesh, Zambia and Nigeria.

Solar Lights to Replace Kerosene or Candles in Zambia

This D-Lab project, dubbed “Lighting the Way Zambia,” was initially funded by the World Bank and The Richard Blum Center. With initial guidance from the California Lighting Technology Center (CLTC), students worked on designing and distributing inexpensive solar/LED lights to replace or supplement kerosene or candle use in Zambia and then Bangladesh. While the idea of replacing kerosene or candles with solar lights is not unique to PIET, Kornbluth notes, D-Lab teams have focused on designing an ultra low-cost product that customers can afford without financing and shop owners can make a profit on. The student-designed product has been field tested and “people like it. It’s getting good reception from shop owners, too, although the challenge has been pricing,” Kornbluth notes.



Community Energy Mapping in Nigeria

D-Lab students are working to develop and improve off-grid lighting for rural households in India and Nigeria that lack electrification, Kornbluth says. The goal is to create a renewably based micro-utility that will give villagers good light and cell phone charging. “Owned by the community or a local entrepreneur, it will be available for a fraction of what they are paying now for the same service,” he says.

Saving Energy in Japan

Since Japan was devastated by a massive earthquake, tsunami and nuclear power plant meltdowns in 2011, “the country has lost 30 percent of its electricity generating power,” notes Alan Meier,

continued

Making an Impact around the World *continued*

“Owned by the community or a local entrepreneur, [energy] will be available for a fraction of what they are paying now for the same service.”

— KURT KORNBLOTH

associate director of the EEC, and now an informal energy crisis consultant to the Japanese government, companies, universities and media. “Blackouts are a threat not only through the summer, but in the years to come,” and the natural disaster is only partly to blame, he notes. “Other plants are gradually being shut down for refueling and retrofits, and public resistance is preventing their restart.”

Meier’s many years of research have focused on understanding how people and machines use energy and the opportunities that exist to conserve it, particularly during an energy crisis. He spent a year at Waseda University in Japan and, more recently, three years at the International Energy Agency, and has studied energy crises in Alaska, Australia, New Zealand, Norway and California.

When California experienced an electricity crisis in 2001, Meier pioneered

a real-time display of electricity demand and supply, and the charts have most recently been adopted by the largest Japanese utilities. They are on display in Tokyo and other major cities, in subway stations, on TV and on many websites, he notes, and are being used in conjunction with media campaigns urging conservation.

“There isn’t time to make technical fixes, so people need to be reminded to use energy differently—switching off lights and escalators, raising thermostat settings—during a crisis,” he says. “In the long run, the Japanese will need to find new combinations of energy supply and consumption technologies that are sustainable from a technical, economic and political perspective.”

Educating in the Middle East

In 2011, the CLTC partnered with Chevron, a leadership sponsor of the EEC, to educate people in Qatar about the principles of

Inspiring a new generation to solve real energy problems in communities that need it the most

Kurt Kornbluth has had a lifelong interest in building and designing things, and is keenly interested in energy efficiency, international development and education. He feels truly fortunate that his work, as founder and director of PIET, perfectly suits all his passions.

Kornbluth obtained his bachelor’s degree in mechanical engineering at Michigan State, intending to begin a career in the auto industry. Corporate culture didn’t suit him, though, so after some international travel, he came to

San Francisco State University to obtain his master’s degree. While there, he met the founder of Whirlwind Wheelchair International (WWI), who invited him to manage and implement technology projects in Africa and Central America. He later led an eight-year project—a cooperative effort between the Finnish government, a local Zambian NGO and WWI—to establish a regional resource and training center for local residents to build wheelchairs.

He also has worked for DEKA—inventor of the Segway—and in 2004

worked at Massachusetts Institute of Technology with Amy Smith, creator of the D-Lab concept. “I knew I wanted to earn my Ph.D. and teach,” he says, and the program that suited all his passions most—renewable energy technologies, lifecycle analysis and international development—was at UC Davis.

Kornbluth went on to become a UC Davis Graduate School of Management Business Development Fellow and an Edison International Energy Efficiency Fellow with the Energy Efficiency Center, and obtain his Ph.D. in mechanical engi-

energy efficiency through the lens of lighting technology.

Chevron is one of over 30 global corporations with research space at the Qatar Science and Technology Park, a complex designed to attract companies and entrepreneurs from around the world who can contribute to the knowledge base in Qatar.

Chevron worked with staff at the CLTC and Delphi to design an energy-efficient teaching area where Qatar researchers, scholars and residents can learn about new lighting technology. The comprehensive, interactive display features a wall of working lamps that illustrates how different lamps render color differently, a model parking lot with solar lighting, and other examples of the latest technologies.

CLTC engineers are also advising the Qatar people on how to adapt technologies that will work well in the nation's climate. For example, will an LED lamp exposed to the desert heat wear out prematurely?

Championing Efficiency in China

CLTC director Michael Siminovitch has built relationships with people in the lighting industry worldwide. Now, the Chinese have enlisted his help to build collaborations that can improve energy efficiency in their country.

"Our style is predicated on collaboration," Siminovitch says of UC Davis. And for the past four years, he has encouraged Chinese manufacturers, government

agencies, utilities and universities to work together in the same way.

He is assisting in the establishment of the China Sustainable Lighting Center at the University of Beijing Graduate School, and the CLTC also has an agreement with Peking University to establish a lighting demonstration center there.

The Chinese collaboration is aimed at both "developing new technologies and design practices and helping students engage and address bigger issues, like making buildings more sustainable," Siminovitch says. "The EEC is really the only collaborative efficiency activity in California, and I hope the same idea will flourish in China."



“Over the past two-and-a-half years, D-Lab students have completed projects in such countries as Nicaragua, Guatemala, Bangladesh, Zambia and Nigeria.”

neering. When the concept of forming the PIET program was first introduced, Kornbluth sought, and received, a \$200,000 grant from the World Bank. The program was officially launched with that funding in 2009.

Over the past three years, through PIET, Kornbluth, his staff and D-Lab students have successfully tackled a number of

real-world energy projects for their clients in developing countries, creating low-cost and efficient solutions in the areas of off-grid lighting and micro-power, agriculture, renewable energy and sustainability, and energy efficiency.

KURT KORNBLUTH

Former EEC Emerging
Venture Analyst

Energy Efficiency Fellow |
Southern California Edison

Founder and Director |
Program for International
Energy Technologies (PIET)

Associate Director | Energy
Efficiency Center

To Market, to Market!

EEC AND INSTITUTE FOR INNOVATION AND ENTREPRENEURSHIP CULTIVATE RESEARCH IDEAS RIPE FOR PUBLIC CONSUMPTION

“We wanted the centers to bring together people who devise new ways to save energy, those who finance their development, the manufacturers who make the products, and the industries and consumers who buy and benefit from them.”

— ANDREW B. HARGADON

Researchers are experts in creating innovative ideas. Entrepreneurs, with the help of angel investors, venture capitalists, law firms and others, are experts in bringing the most promising ideas to market. Linking the two is the job of the UC Davis Child Family Institute for Innovation and Entrepreneurship (I2E).

University scientists and engineers in an array of fields—from microbiology to transportation, from computer science to environmental science and more—turn to the I2E for guidance on how their research can be successfully brought out of the lab and into the world. When the I2E teams with the Energy Efficiency Center, the focus is on advancing energy-saving technologies into the market.

The I2E was launched within the UC Davis Graduate School of Management in 2006, the same year the Energy Efficiency Center was created. Both were founded under the direction of Andrew Hargadon, the Charles J. Soderquist Chair in Entrepreneurship and professor of technology management for UC Davis' GSM.

“We wanted the centers to bring together people who devise new ways to save energy, those who finance their development, the manufacturers who make the products, and the industries

and consumers who buy and benefit from them,” Hargadon explains.

Uniting Business and Technology to Create Marketability

“Through both centers, university researchers, familiar with thinking in terms of science and technology, receive training that is a blend of science, technology, and business acumen,” adds Ben Finkelor, executive director of the EEC. “It helps them see how their ideas could have real world impact and value in the marketplace.”

Over the past five years, the two programs have successfully worked in concert to identify and develop the commercial potential of sustainable and energy-efficient technologies, and to prepare graduate students in engineering, science, and business to successfully build enterprises that will advance these technologies.

“Our success stories are just the tip of the iceberg,” says Hargadon. “We are successfully changing the culture of scientists, researchers, business leaders and policy makers. It's slow and steady, but there is a constant flow of good ideas and an increasing number of people who are finding good ways to get research out into the world.”

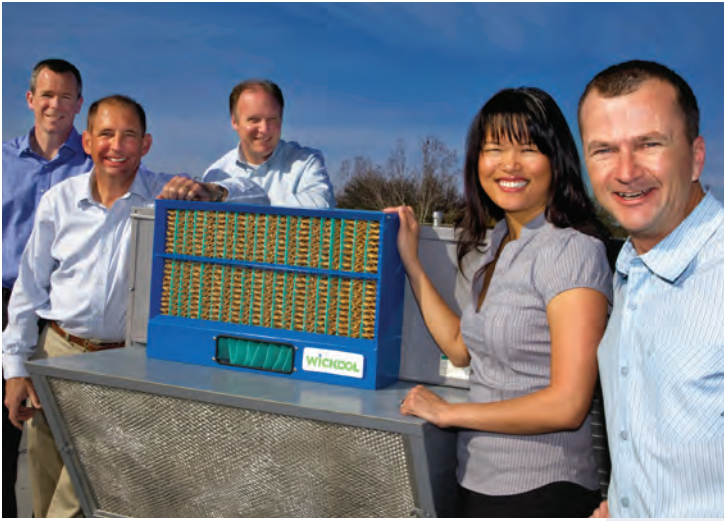


University scientists and engineers in an array of fields—from microbiology to transportation, from computer science to environmental science and more—turn to the Child Family Institute for Innovation and Entrepreneurship for guidance on how their research can be successfully brought out of the lab and into the world.



>> <http://entrepreneurship.ucdavis.edu>

To Market, To Market! *continued*



Establishing Promising Ventures and Collaborative Educational Opportunities

In the years since the centers were launched, several promising ventures have been realized and collaborative educational opportunities established, including:

- **WickKool.** This passive evaporative cooling technology for commercial rooftop HVAC units is based on technology developed by Dick Bourne, associate director of the UC Davis Western Cooling Efficiency Center. He joined forces with Siva Gunda, a doctoral student and Business Development Fellow at the Child Family Institute for Innovation and Entrepreneurship. The device, now licensed by Octus Energy, takes the condensation that forms on air conditioner coils and uses it to cool the air, making rooftop conditioners up to 9 percent more efficient. Successful testing was accomplished at Walmart and Target stores in West Sacramento.
- **Green Technology Entrepreneurship Academy (GTEA).** Modeled after UC Davis' successful Entrepreneurship Academy, the weeklong GTEA is the premier academic program for commercializing green tech and is a springboard for moving commercially viable green tech research ideas forward. The next GTEA will be held in June 2012. Get details at entrepreneurship.ucdavis.edu.

EEC founding director believes in the value of relationships, business relevance



ANDREW B. HARGADON

Professor of Management | Graduate School of Management

Charles J. Soderquist Chair in Entrepreneurship

Founder and Director | Child Family Institute for Innovation and Entrepreneurship

Founding Director | Energy Efficiency Center

As the founding director of both the UC Davis Child Family Institute for Innovation and Entrepreneurship and the Energy Efficiency Center, Andrew Hargadon is at the forefront of teaching, research, and practice in cross-disciplinary entrepreneurship.

Hargadon received his Ph.D. from Stanford University's School of Engineering, where he was introduced to the concept of designing solutions that were "one level above the problem. It was different than what everyone else was doing, and a valuable new approach."

He brought his passion for the art of blending product design and innovative engineering ideas to UC Davis' Graduate School of Management in 2001, when he joined the faculty as an assistant professor of technology management.

As EEC founding director, he built relationships with the three largest California investor-owned utility companies — PG&E, Sempra and Edison — and with the California Public Utility Commission, California Energy Commission, marketplace venture capitalists and entrepreneurs, and major end users such as Walmart and Chevron Energy Solutions.

As founder of the Child Family Institute for Innovation and Entrepreneurship, he developed a curriculum "for scientists to find the solutions that are one level up, to develop an idea that can be sustained in a business context... a solution that is good science and viable in the long run."

“The curriculum is designed for scientists to find the solutions that are one level up, to develop an idea that can be sustained in a business context... a solution that is good science and viable in the long run.”



The Value of Technology

MARKET ASSESSMENT ASSISTANCE PROGRAM GAUGES MARKETABILITY OF EMERGING TECHNOLOGIES

“You can reduce uncertainty and save dollars if you select the right project up front, and that requires choosing the best technology potential and the best market potential.”

— SIVA GUNDA
MAAP program director

Without buy-in from customers, even the most brilliant ideas for reducing energy use may never make it out of the lab. That is why the UC Davis Energy Efficiency Center (EEC) created the Market Assessment Assistant Program (MAAP) to help utility and energy companies evaluate the demand for emerging technologies.

“You can reduce uncertainty and save dollars if you select the right project up front, and that requires choosing the best technology potential and the best market potential,” says Siva Gunda, MAAP

program director and a former Emerging Venture Analyst and Southern California Edison International Energy Efficiency Fellow at the EEC.

Grad Students Provide Valuable Research, Analysis

MAAP taps into the brain power of UC Davis Graduate School of Management students, who learn to use a specially developed analytical framework, then work directly with clients to execute the market research.

According to Gunda, the MAAP framework mimics the technology assessment process utility and energy companies follow; it incorporates market research into the early stages of the process so companies can direct resources to the technologies with the strongest market potential.

“We help them scan the technology and evaluate how much energy it can save, the market size and the cost,” Gunda says. “We use these parameters to come up with an energy efficiency return on investment.”

This opportunity for real-world apprenticeships is exactly what prompted MBA student Chris Corcoran to attend UC Davis and get involved with the EEC.

“One of the things that sets this program apart, is that you can actually get hands-on experience early on here that will help you get a job,” Corcoran says.

Corcoran is currently working on a SMUD pilot project with Herter Energy Research Solutions to see if consumers



©2011 Ruud Lighting, Inc. – A Cree Company

MAAP has begun work on more than 11 market assessment projects. As an example, for Chevron Energy Solutions, MAAP is identifying demand among California cities for LED streetlights.

>> <http://eec.ucdavis.edu>

adjust their habits when they receive real-time information via their thermostats about how much energy they are using.

“It’s a combination of behavior and technology,” Corcoran explains. “If we give them the technology, will they change their energy consumption? We’re still in the early stages, but we have started to see a reduction in participants’ bill amounts.”

Real-world Projects Instill Collaboration Skills

Gunda says MAAP creates a laboratory environment in which students of business, social sciences and engineering practice what they learn on a real project.

“Our graduates are ready to work on Day One,” Gunda says. “They can speak the language, and companies consider their time at UC Davis as work experience. I don’t know of any other program that prepares future leaders in this industry so well.”

MAAP has begun work on more than eleven market assessment projects that are helping to “identify market value for emerging technologies from a customer perspective, a power company perspective and an energy services perspective,” Gunda says.

Current projects include:

- **For Chevron Energy Solutions**, identifying demand among California cities for LED streetlights.
- **For SMUD**, forecasting the likelihood of customers adopting efficient evaporative cooling systems, and how different rebate amounts would affect return on investment.
- **For PG&E**, researching product cycles and process flows in the lighting industry to help manufacturers achieve compliance with codes and standards.

“Our graduates are ready to work on Day One. They can speak the language, and companies consider their time at UC Davis as work experience.”

— SIVA GUNDA



Innovating the way companies evaluate and assess energy efficient technologies

Siva Gunda’s career at UC Davis began with a bang. In 2008, the PhD candidate in Mechanical Engineering won the “Little Bang” business competition for designing WicKool, a retrofit unit that improves the efficiency of rooftop air conditioning units.

But his lasting legacy at the Energy Efficiency Center may be the creation of the Market Assessment Assistance Program (MAAP).

While doing a 12-week internship in emerging technology at PG&E, Gunda was tasked with researching how utility companies evaluate emerging technology. He discovered that utilities don’t often have time for assessments, and when they do,

their engineering-heavy workforce is typically most comfortable assessing the technological feasibility, not the market potential, of a given idea.

“Even though something has technological potential, it may not have market potential,” says Gunda, a former Southern California Edison Energy Efficiency Fellow and Business Development Fellow.

Armed with this discovery, Gunda established MAAP to help utility and energy companies assess the market value of emerging technologies. He currently oversees a team of MBA researchers who are evaluating technologies for agencies in California and across the United States.



SIVA GUNDA

Director | Market Assessment Assistance Program

Energy Efficiency Fellow | Southern California Edison

Business Development Fellow

Building on the Past, Investing in the Future

NEW PROJECT LIGHTS THE WAY FOR RETROFITTING AGING COMMERCIAL BUILDINGS

“We want to get demonstration projects on the ground so utility companies and policymakers can learn from what works, and get effective programs to scale quickly.”

— BEN FINKELOR

Executive Director |
Energy Efficiency Center

One of the biggest challenges in energy efficiency today is reducing energy consumption in existing commercial buildings, particularly “light” Class B and Class C properties like neighborhood shopping centers and office parks. These buildings typically have multiple tenants but one owner, thus no clear-cut solution for who should invest in energy-efficient retrofitting.

Enter the UC Davis Energy Efficiency Center (EEC), which in 2011 launched the Multi-Tenant Light Commercial (MTLC) project to develop demonstrations of and best practices for whole building retrofits specifically for this sector of the commercial real estate market.

Making Aging Buildings More Efficient

According to EEC Executive Director Ben Finkelor, by 2050, 75 percent of buildings will be those that exist today.

“We have to start retrofitting because the new buildings being built today are drastically more efficient than the existing building stock.” Finkelor explains. “Aging buildings are the biggest challenge we face, but it is also an opportunity to reinvest in our infrastructure.”

The project has already attracted participation from a wide range of stakeholders: The California Energy Commission awarded a \$2 million grant that was

matched by other funders and the Doris Duke Charitable Foundation gave \$350,000 to expand the project’s impact outside California. Several EEC leadership sponsors are involved as well, including PG&E, Southern California Edison, SMUD and San Diego Gas & Electric. Tennessee Valley Authority, Wells Fargo and others are also partners.

In August 2011, the EEC sponsored a two-day meeting of utility company representatives, contractors, building owners, tenants and regulators to discuss viable whole-building retrofit strategies.

“The idea is to bring together a comprehensive group of stakeholders and have them work on the problems and test solutions,” Finkelor explains. “We want to get demonstration projects on the ground so utility companies and policy makers can learn from what works, and get effective programs to scale quickly.”

The Multi-Tenant Light Commercial project’s two-dozen objectives include:

- **Developing retrofit recommendations for interior lighting, building envelopes and lighting controls** that will reduce lighting energy consumption and demand in MTLC buildings by 25 to 45 percent.
- **Decreasing cooling energy consumption and peak electricity demand** in existing MTLC facilities by 30 to 50 percent.



>> <http://eec.ucdavis.edu/events/mtlc.php>

- **Assessing the importance of factors that affect marketability of energy efficiency measures**, such as financing options, technology bundling or direct install programs.
- **Demonstrating integrated retrofit packages** in three buildings in PG&E, Southern California Edison and Sempra utility territories.
- **Demonstrating that energy consumption in MTLT buildings** can be reduced by at least 30 percent through energy-efficient retrofit packages.

Engaging Target Market to Find Results

Finkelor says many technologies needed for such retrofits already exist—such as efficient lighting, advanced controls for lighting and air conditioners, and daylighting systems. The challenge is overcoming the obstacle of “split incentives”—tenants don’t want to invest in technology because they may not remain in the building long enough to recoup costs, and the owner is not paying the utility bills so has no incentive to reduce costs.

Marco Pritoni, a doctoral student working on the project, says the business-oriented approach the EEC is known for distinguishes the MTLT project.

“This is special because there have been different initiatives in this market before, but none that tested the market itself,” Pritoni says. “We are going to engage the market and study the market at the same time we develop the technology applications.”

For grad student, “now is the time” to make strides in energy efficiency

Marco Pritoni was born and raised in Italy, so when he says one American consumes twice as much energy as one Italian, he knows what he is talking about.

“There is a lot of energy waste in the United States,” he says simply. But a lot of waste means a lot of room for improvement.

As a doctoral student working on the UC Davis Energy Efficiency Center (EEC) Multi-Tenant Light Commercial project, Pritoni is primed to help make those improvements.

“This is the right place and the right moment” for energy efficiency, Pritoni says of his work at UC Davis. “There is a convergence of industry, government, young people and researchers of the energy crisis in the 1970s.”

Pritoni works for the Western Cooling Center at UC Davis and will explore potential solutions for the MTLT market, such as adding evaporative cooling technology to air conditioning systems.

“Our final goal is understanding the market, figuring out the technology and giving tools to utility companies so they can create a program,” he explains. “It’s aimed at the particularities of this market.”

Pritoni is a former Edison Energy Efficiency Fellow. Prior to joining

the EEC program, he worked as a production manager for manufacturing companies in Italy and as a senior research associate for Lawrence Berkeley National Labs.



MARCO PRITONI

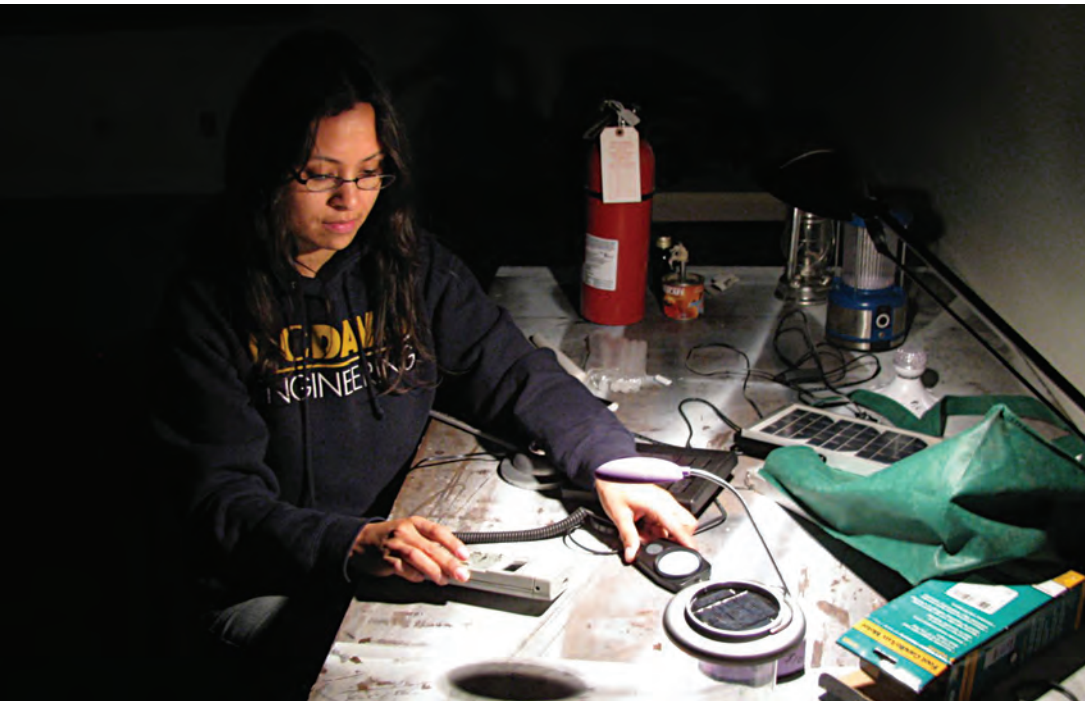
EEC Emerging Venture Analyst
Southern California Edison
Energy Efficiency Fellow
Ph.D. Student | Western
Cooling Efficiency Center



“Our final goal is understanding the market, figuring out the technology and giving tools to utility companies so they can create a program. It’s aimed at the particularities of this market.”

Generation Next

COURSEWORK PREPARES STUDENTS TO BE FUTURE LEADERS IN ENERGY EFFICIENCY FIELD



Lighting Technology Center, has distinguished the EEC as the nation's foremost university center for energy efficiency technology commercialization and education. "It's not just about the technology," notes Alan Meier, associate director of the EEC and instructor of graduate courses on energy efficiency. "It's about business, economics, behaviors and public policy, and how we connect them. Students from all disciplines get a good grasp of the logic of energy efficiency, then take it back to their own fields and apply it to their own kinds of problems."

In its first five years, the EEC expanded energy efficiency education to include:

- **New courses for advanced undergraduates and master's degree students.** New courses and seminars are being developed and taught in the Department of Civil and Environmental Engineering, four courses in lighting energy efficiency are offered in the design department, and additional course offerings are being developed across campus. A formal undergraduate minor in energy efficiency began in 2010.
- **Professional and continuing education.** Extension and remote learning certificate programs designed for working professionals are under way. Existing courses are being offered in daylighting and post-harvest energy reduction methods and technologies. New courses are under development in cooling and energy management. Through the UC Davis Child Family Institute for

“It's not just about the technology. It's about business, economics, behaviors and public policy, and how we connect them.”

— ALAN MEIER

When UC Davis formed the Energy Efficiency Center (EEC) in 2006, one of its main charges was to train future leaders in energy efficiency. The university initially drew upon as many as 32 faculty members from 11 departments to work with the EEC, and since then, many other internationally acclaimed experts in the energy field have been recruited to join the effort. Their work, combined with UC Davis' existing Institute of Transportation Studies (ITS) as well as the California

>> <http://eec.ucdavis.edu>

Innovation and Entrepreneurship, Entrepreneurship Academies are held four times a year, and one specifically focuses on green technology. During the Academies, science and engineering graduate researchers join faculty, investors, entrepreneurs and business experts to focus on market opportunities for research ideas.

- **Internship programs.** Internships are being combined with coursework and a speaker series to provide upper-division undergraduates and graduate students with the knowledge, skills and connections to drive energy efficiency technologies to market in their future careers.

- **Business development education.** This critical component of EEC's education and commercialization work is hosted by the Graduate School of Management. In partnership with the UC Davis Child Family Institute for Innovation and Entrepreneurship, the EEC places graduate students engaged in energy efficiency research in week-long and year-long entrepreneurship programs. The center also hires Emerging Venture Analysts from a pool of Business Development Fellows and talented MBA and engineering students, then trains them to conduct market analysis and business modeling activities, in conjunction with the EEC leadership sponsors.

- **Experiential learning and field work.** The EEC also collaborates with the UC Davis Program for International Energy Technology (PIET) to accelerate and develop energy efficient technology solutions that transfer to developing countries. PIET students—from business, engineering, and the physical and social sciences—participate in D-Lab, a combination of graduate curriculum and applied field research. Here, they gain hands-on, practical experience, such as creating charcoal from agricultural waste or constructing a battery from inexpensive, locally available components.

Tapping video game technology to increase energy efficiency

Can the next best energy-saving solution be found within a Microsoft Xbox?

That's the question—and the challenge—being issued to UC Davis students by Alan Meier, associate director of the Energy Efficiency Center.

New gaming technology available through the Xbox's Kinect uses voice and facial recognition, motion sensing and skeletal tracking in its newest games. Gaming enthusiasts use the technology to play tennis against video opponents or carry on conversations with avatars. But, Meier wonders, could this technology be used to increase energy efficiency in our homes, by controlling home electronics or the heating or cooling systems?

He is challenging students from an array of academic disciplines to answer that question. Students are meeting to investigate and prototype environmental controls and sensors based on the Kinect technology, and can gain college credit in the process.

"What if students determine that motion sensing could detect when you shiver and then turn up the heat, or turn it down when you mop your brow?" he asks. "I have no idea where this will go, but it's important to at least ask the question."



ALAN MEIER

Associate Director | Energy Efficiency Center

Visiting Scientist & Researcher | Energy Efficiency Center

Senior Scientist | Lawrence Berkeley National Laboratory



“What if students determine that motion sensing could detect when you shiver and then turn up the heat, or turn it down when you mop your brow? I have no idea where this will go, but it's important to at least ask the question.”

Events and Collaborations

BRINGING LEADERS IN ENERGY EFFICIENCY TOGETHER

The forums proved to be powerful educational tools and a tremendous opportunity to bring together industry leaders and stakeholders for high-level discussions.



As a national leader in energy efficiency, the UC Davis Energy Efficiency Center created a variety of high-profile events aimed at bringing people from all sectors of the field together and increasing awareness of energy efficiency technologies.

The Roots of Energy Efficiency

The Energy Efficiency Center partnered with Chevron to present three forums, called “The Roots of Energy Efficiency,” that explored California’s rich past and promising future as a global innovator of energy-efficient technologies and policies.

The forums capitalized on the EEC’s unique ability to bring together high-

level government, industry and academic leaders and to educate future leaders.

The first installment in October 2008 focused on policy innovations in energy efficiency and how they can promote and even initiate energy efficient initiatives.

At the second forum in April 2009, entrepreneurs, inventors, innovators and those who implement their new technologies met at the Tsakopoulos Library Galleria in Sacramento to show new technologies that have emerged and are in the process of being implemented in the area of energy efficiency, as well as those that ought to be developed.

In June 2010, the third and final forum convened at the Computer History Museum in Silicon Valley. Leaders in policy, industry and academia discussed and debated how California can maintain its leadership position in the field and best leverage its investments in smart energy to achieve energy efficiency innovation and consumer adoption.

The forums proved to be powerful educational tools and a tremendous opportunity to bring together industry leaders and stakeholders for high-level discussions. All three sessions were videotaped, posted on the EEC website and viewed more than one million times.



>> <http://eec.ucdavis.edu/events.php>



Washington, D.C. Events

In May 2009, with newly elected President Obama's administration and the 111th Congress actively considering an energy and climate bill, the timing was right for the EEC to bring its mission statement to Washington, D.C. We invited our Board of Advisors to meet in the nation's capitol and convened not only their thought leadership and guidance, but also included future DOE Deputy Undersecretary Cathy Zoi in the discussions. The Center facilitated two events that showcased California lessons in energy efficiency and how the California experience could apply and impact conversations at the federal level.

In a roundtable discussion on the afternoon of May 19, the EEC brought together leadership at both the U.S. Department of Energy and the U.S. Environmental Protection Agency to discuss ways to maximize the impact of recovery funding dollars in energy efficiency.

In a congressional briefing later that evening, board members made presentations emphasizing California's track record in technology and policy innovation, making the case for aggressive

energy efficiency policy solutions that might be considered on a national scale. These events provided a strong foothold for the center to establish a presence and relationships with key agencies and policy makers in the nation's capitol.

Energy, Organizations and Society (EOS) Workshop

This first-ever workshop was held at UC Davis in October 2011 to engage a broader community of researchers—such as social scientists and management scholars—in energy research.

Participants from leading research institutions in the United States, Canada and the United Kingdom presented papers on the organization, politics and transformation of energy sources and uses globally.

The workshop, made possible with support from the EEC and the UC Davis Graduate School of Management, featured keynote speaker Charles Perrow, professor of sociology at Yale University and visiting professor at Stanford University's Center for International Security and Cooperation.

UC Davis Energy Efficiency Forum

In November 2011, UC Davis hosted the first annual EE Forum, which focused on Retrofitting Corporate Campuses and brought together key industry and vendor stakeholders, leading facility managers, policy makers and researchers who are striving to adopt and demonstrate advanced energy efficiency strategies in their commercial buildings.

The Forum provided a venue for sharing best practices, and generated a powerful exchange of connections and knowledge. The Center intends to hold its next annual Forum on the topic of Re-Energizing Retail.

Endowed Chair Honors Art Rosenfeld

EEC SPONSORS, INDUSTRY LEADERS AND DONORS CONTRIBUTE \$1 MILLION

“The Rosenfeld Chair will recognize in perpetuity Art’s unmatched contributions in essentially creating the field of energy efficiency, and will bring great prestige to this area of academic study.”

— NICOLE BIGGART

Director | Energy Efficiency Center



When you screw in a compact fluorescent lamp, push the power button on your hybrid vehicle or gaze through a skylight, you can thank Art Rosenfeld.

Considered the “Father of Energy Efficiency,” Rosenfeld made this point to politicians, power-industry moguls, policy makers, engineers and average citizens with the precision of a particle physicist and the practicality of a child of the Great Depression: “The cheapest energy is what you don’t use.”

Rosenfeld believed that conserving energy is cheaper and smarter than building power plants, and starting in the 1970s, he provided California energy regulators the data they needed to enact some of the most progressive efficiency standards in the world.

A Permanent Connection

Rosenfeld was a founding board member of the UC Davis Energy Efficiency Center (EEC) and now his name is attached to one of the foremost energy efficiency research positions in the nation: The Arthur H. Rosenfeld Chair in Energy Efficiency at UC Davis.

“I am delighted that a chair in my name will help UC Davis in perpetuity,” Rosenfeld said. “UC Davis founded the nation’s first university center for energy efficiency. The campus uses its service mission and proximity to Sacramento to convene science, policy and commerce to bring efficiency to the public.”

EEC Executive Director Ben Finkelor said, “With Art as one of our key mentors

and advisers, we have made dramatic strides in our first few years.”

According to the Los Angeles Times, Rosenfeld’s research led to regulations that “yielded about \$30 billion annually in energy savings for California consumers... eliminated air pollution that’s the equivalent of taking 100 million cars off the roads...”

For example, Rosenfeld promoted the use of reflective white roofs to combat climate change; such roofs have been mandatory on new commercial buildings in California since 2005 (and are seen throughout the UC Davis campus).

Rosenfeld’s contributions to the field are so great that a unit of measurement is now named after him. One Rosenfeld unit represents the energy savings needed to replace the annual generation from a single 500-megawatt coal-fired power plant (about the amount used annually by a U.S. city with a population of 250,000).

Unmatched Contributions to the Energy Efficiency Field

Rosenfeld has been science adviser for the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy; a long-time member of the California Energy Commission, which leads the state’s energy initiatives; and a board member of the California Clean Energy Fund, a public benefit corporation dedicated to making equity investments in clean energy companies. He is a professor emeritus of physics at the University of California, Berkeley, and co-founder and former director of the Center for Building

Science at Lawrence Berkeley National Laboratory. In June 2011, Rosenfeld received the Global Energy International Prize for his contributions to the field of energy efficiency, established by Russian scientists in 2002 “for outstanding scientific achievements in the field of energy which have proved of benefit to the entire human race.”

UC Davis Chancellor Linda Katehi said that the Rosenfeld Chair in Energy Efficiency will be a natural fit with the university’s broad commitment to sustainability leadership.

“Our goal is to make this a sustainable second century for our campus while we continue our leadership in energy research and innovation, and the all-important step of commercialization,” Katehi said. “Dr. Rosenfeld’s work is an inspiration to us, and serves as an example of the transformative effect that is possible when science and public policy are linked.”

The Arthur H. Rosenfeld Chair in Energy Efficiency will recognize and support an exceptional member of the energy efficiency faculty at UC Davis. The chair holder will promote the Energy Efficiency Center’s mission to accelerate the commercialization of energy-efficiency technologies, teach future leaders in energy efficiency, and conduct critical policy-supporting research.

The endowed fund will also help the chairholder hire graduate students, provide seed money for research projects and pay for expenses related to exploring new ideas.

Many of the EEC’s leadership sponsors contributed to the Arthur H. Rosenfeld Chair in Energy Efficiency, including PG&E, Southern California Edison and Sempra (\$100,000) and Chevron and Goldman Sachs (\$50,000–\$60,000).



Professor Michael Siminovitch named to the Rosenfeld Chair

Professor Michael Siminovitch has been named the first faculty appointee to the Rosenfeld Chair in Energy Efficiency.

As director of the California Lighting Technology Center (CLTC), he has developed the center into one of the leading lighting research and development centers in the country. Siminovitch has cultivated numerous partnerships with industry for technology transfer of efficient lighting systems. He has had great influence on public policy in California, giving advice on energy efficient lighting to regulatory agencies, lighting manufacturers, and the building design community.

In addition, he holds numerous patents in this research area. Siminovitch’s research portfolio in the area of energy efficiency and his engagement with both industry and government in this field make him the ideal senior faculty member to be the first holder of the Rosenfeld Chair in Energy Efficiency.



“ Dr. Rosenfeld was my advisor in graduate school. His ideas on energy efficiency influenced and guided my studies and, ultimately, my career. I am really honored to receive this chair, particularly because it bears his name. ”

— MICHAEL SIMINOVITCH

Director | California Lighting Technology Center
Professor of Design
Associate Director | Energy Efficiency Center
Arthur H. Rosenfeld Chair in Energy Efficiency

Sempra Energy Creates First Endowed Chair in Energy Efficiency at UC Davis

“We are pleased to support California’s [energy] initiatives by creating an endowment that stimulates new and innovative energy-efficiency research that will help reduce greenhouse-gas emissions and preserve our energy resources.”

— DONALD E. FELSINGER

Chairman and Chief Executive Officer | Sempra Energy

Shortly after the launch of the Energy Efficiency Center, Sempra Energy announced a \$500,000 contribution to the Energy Efficiency Center (EEC) dedicated to promoting the EEC and its efforts to implement, inform, encourage and facilitate energy-efficiency solutions within the building, transportation, agriculture and food-production industries. Sempra Energy is the parent company of San Diego Gas & Electric and Southern California Gas Co.

The June 2007 gift included funding of a \$400,000 endowment for the Sempra Energy Chair in Energy Efficiency, one of the first energy-efficiency chairs at a major U.S. university.

The remainder of the contribution provided \$100,000 of financial support of the EEC Technology Impact Summits, a series of research activities and workshops that studied the energy-efficiency applications required to implement California’s Global Warming Solutions Act of 2006, also known as AB 32.

“California’s initiatives to address global warming, increase energy efficiency and reduce reliance on traditional energy sources have blazed a trail for the rest of the nation to follow,” said Donald E. Felsinger, chairman and chief executive officer of Sempra Energy at the time of the gift. “The Sempra Energy companies and our customers have been leaders in energy efficiency. We are pleased to

support California’s initiatives by creating an endowment that stimulates new and innovative energy-efficiency research that will help reduce greenhouse-gas emissions and preserve our energy resources.”

“Sempra Energy’s support will enable the EEC to extend California’s leadership in energy and climate policy, technology and education by attracting experts focused on bringing near-term energy efficiency solutions forward,” said Andrew Hargadon, director of the EEC in 2007.

“Increasing energy efficiency is our state’s best hope to minimize the impacts of climate change, improve our energy security and reduce the cost of reliable energy services,” said Lisa Bicker, then president of the California Clean Energy Fund. “Establishing the Sempra Energy Efficiency Chair sends a clear signal that California will continue to lead in this critical area by attracting new bright talent to the field of energy efficiency.” The Sempra Energy Chair in Energy Efficiency was key in recruiting Mark Modera to his position as director of the UC Davis Western Cooling Efficiency Center (WCEC) in 2008. Modera’s experience as both a national laboratory research scientist and entrepreneur made him uniquely qualified to lead the emerging WCEC with its dual focus on research and industry ties. The chair provides a reliable source of funding that helped the EEC attract a world-class leader to campus.



Chevron Chair in Energy Efficiency Advances Teaching, Research in Energy Efficiency

Chevron Corporation gave UC Davis \$2.5 million to create a permanent leadership position for the campus' Energy Efficiency Center. The gift established the Chevron Chair in Energy Efficiency, to be held by the faculty director of the EEC and provided \$500,000 in additional funding to be used at the director's discretion for the Energy Efficiency Center.

Speaking at the event announcing the Chevron gift, in January 2009, UC Davis Chancellor Larry Vanderhoef said: "Chevron's endowment will ensure long-term strategic leadership for the Energy Efficiency Center. By bridging long-term research with real-world applications, the director will guide the center in its goal of commercializing groundbreaking technologies, powering economic progress and helping to conserve resources."

"Advancing energy efficiency, which is the cheapest, cleanest and most abundant form of new energy, is critical to the challenge of meeting the world's growing energy needs," said John McDonald, Chevron vice president and chief technology officer. "California has been a pacesetter in energy efficiency, so it's fitting that one of the state's leading universities and California's largest company should partner on the next generation of energy efficiency."

In 2010, after a national search, a former dean of UC Davis Graduate School of Management, Professor Nicole Woolsey Biggart, was appointed EEC faculty director and Chevron Chair in Energy Efficiency.

"With her extensive academic and administrative leadership experience, Professor Nicole Woolsey Biggart is perfect for this key leadership role," said Steven C. Currall, dean of the Graduate School of Management.

Professor Biggart served as Dean from 2003 to 2009. As an internationally recognized expert in organizational theory and management of innovation, her research covers economic and organizational sociology, firm networks, industrial change and social bases of technology adoption. She has studied and published on the barriers to implementation of energy efficient technologies in the commercial building industry.

"Energy is the life source for our economy and diverse sources of it are critical to our future," Biggart said. "Reliance on cheap energy is no longer possible; we need to use our ingenuity and thoughtful use of energy resources. Energy efficiency is by far the most effective and least expensive 'new fuel.' The UC Davis Energy Efficiency Center is playing a lead role in its advancement on a global scale."

"Advancing energy efficiency, which is the cleanest and cheapest form of alternative energy, is a commitment that



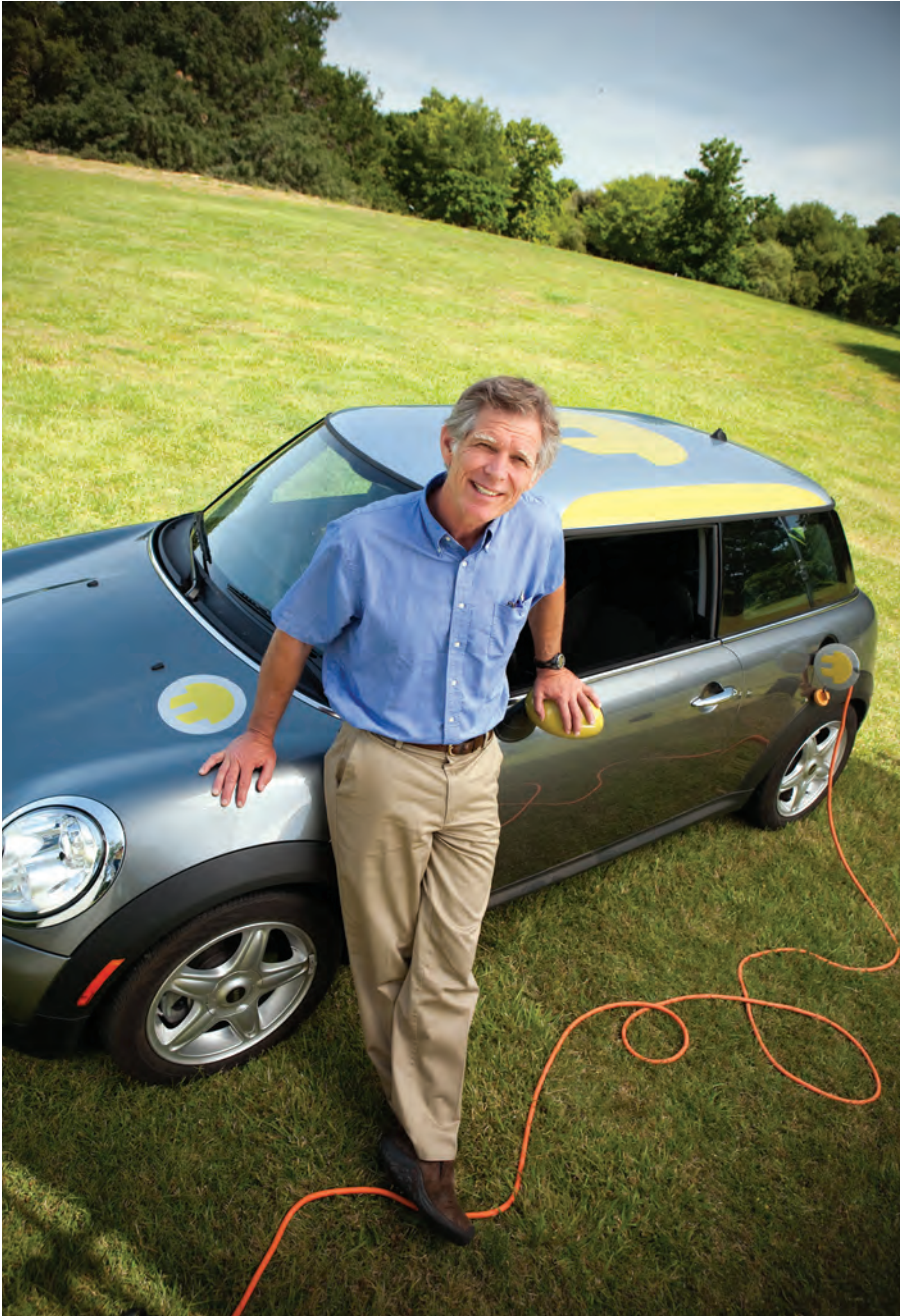
both Chevron and UC Davis share," said Jim Davis, president of Chevron Energy Solutions. "Nicole has a deep understanding of technology adoption, and her proven ability to develop innovative business clusters will play a critical role in the success of the UC Davis Energy Efficiency Center."

As the Chevron Chair in Energy Efficiency, Biggart works to expand the impact of the center's research programs through interdisciplinary collaboration, education, outreach and commercialization of technologies. She is developing UC Davis' strong links to utility, regulatory, policy and commercial interests, working together to improve energy efficiency at the state, national and international levels.

“California has been a pacesetter in energy efficiency, so it's fitting that one of the state's leading universities and California's largest company should partner on the next generation of energy efficiency.”

— JOHN MCDONALD

Vice President and Chief Technology Officer | Chevron



> The PH&EV Research Center serves a critically important role in the Energy Efficiency Center's mission to work with researchers and inventors to promote promising energy efficiency solutions — particularly in the area of transportation.



>> <http://phev.its.ucdavis.edu>



Plugged in to Progress

HYBRID AND ELECTRIC VEHICLE RESEARCH TAKES OFF

Hybrid technology has come a long way over the past 10 to 20 years, says Dahlia Garas, program manager at the Plug-in Hybrid & Electric Vehicle (PH&EV) Center at UC Davis' Institute of Transportation Studies (ITS), as designers have improved vehicle aerodynamics, powertrains and battery life. However, much more remains to be done, and the PH&EV Center is behind a lot of it.

The PH&EV Research Center serves a critically important role in the Energy Efficiency Center's mission to work with researchers and inventors to promote promising energy efficiency solutions—particularly in the area of transportation—and then team with public and private partners to bring the product to market. Since the Research Center was formed in 2007, it has conducted a wide range of projects on Plug-in Electric Vehicle (PEV) technology, consumer behavior and policy, while also building collaborative partnerships with key PEV leaders in the automotive and utility industries and government.

The PH&EV Center has also successfully been meeting its mandate to train future leaders. The Center draws upon the expertise of staff and faculty of the UC Davis Institute of Transportation Studies, its numerous graduate and post-graduate students, and its more than 20 years of research in alternative and electric vehicles.

Although there are other alternative transportation research centers in the United States, “we are unique in that the state of California has invested in us,” Garas notes. “We’re looking into the most pressing questions, and our research has

led to better understanding the consumers and market for plug-in hybrid and electric vehicles, as well as improved understanding of the potential impacts on the grid.”

“The Research Center’s first three years were a resounding success, and we achieved significant research and developmental milestones,” notes Director Tom Turrentine.

During this time, the PH&EV Center:

- **Developed strategic partnerships**, research, and readiness road maps for California
- **Worked in close collaboration** with California utilities, the Electric Power Research Institute and others to organize the annual “Plug-In” conferences, dedicated to addressing plug-in vehicle issues
- **Completed a number** of consumer studies
- **Analyzed the impact** of vehicle charging
- **Evaluated plug-in hybrid** and electric vehicle batteries and powertrains
- **Improved modeling systems** for measuring the lifetime social cost and emissions of PH&EV vehicles.

Improved Battery Charging Technology

Using UC Davis' state-of-the-art battery testing laboratory, Andy Burke and his researchers evaluated commercially available lithium automotive batteries of various chemistries and tested battery cells on their response to PHEVs and battery electric vehicles (BEVs), cell safety and stability. Tests revealed which battery



chemistry combinations would offer the fastest-charging applications and superior life cycle characteristics. The next step is to work with Center for Computational Science and Engineering, UC Berkeley, AeroVironment Inc. and San Diego Gas & Electric Company—a sponsor of the Energy Efficiency Center—to research viable second-life applications for spent batteries.

Social Lifetime Costs of Plug-in Hybrid and Electric Vehicles

Research conducted by Mark Delucchi focused on the comparisons between internal combustion engine (ICE) vehicles and PHEVs of the same vehicle type, and evaluations were made on the social and lifetime cost differences between the two. PHEVs were found to reduce gasoline consumption by 50 to 90 percent, and

continued

Plugged in to Progress *continued*

“The Research Center’s first three years were a resounding success, and we achieved significant research and developmental milestones.”

— TOM TURRENTINE

PHEV emissions are 20 to 50 percent lower than ICE vehicles.

The Center is now working with Nissan, ECOTality and San Diego Gas & Electric on a project studying the rollout of Nissan Leaf and Chevy Volt vehicles in San Diego. The project will examine use and recharge patterns and appropriate placement of charging stations, among other things.

Consumer Demand and Energy Use Field Research

Automakers may be unsure about the potential market for PHEVs and EVs, and utilities and regulators need to better understand how consumers may use these vehicles, Garas says. In a field study conducted by ITS-Davis research engineer Ken Kurani, 13 converted plug-in Toyota Prius vehicles were field-tested in 70 Northern California households for six weeks each. Data on driver response and charging patterns were collected and the

results have helped automakers, utilities and regulators better understand how consumers will use these cars.

Another consumer research study involved BMW MINI E vehicles. In a partnership with ITS, the Technical University Chemnitz in Germany and Oxford Brookes in England, researchers followed 150 households in Los Angeles and New York as they used MINI E vehicles during a one-year lease. Findings were positive and indicated that although drivers needed some time to adapt to these special cars, they did like the power of the MINI E, found the car’s 100-mile range was acceptable, and recommended that chargers be located at regional recreation destinations.

The Research Center is also working with Chevrolet, Toyota and Chrysler to develop demonstration projects in Northern California.



Steering drivers to energy reduction through dashboard design

Dashboards on hybrid or battery-powered vehicles are very different from the dashboards most drivers are familiar with.

Depending on the manufacturer, hybrid dashboards may include colorful gauges that indicate fluctuating battery levels, or when the vehicle has switched from the battery to gas engine. All good information to have, of course, but not specifically designed to motivate drivers to increase their fuel efficiency, according to research conducted by Tai Stillwater,

a former EEC Emerging Venture Analyst and Chevron intern and now postdoctoral scholar with the Plug-In Hybrid & Electric Vehicle Research Center.

Stillwater recently received his Ph.D. in transportation technology and policy from the Institute of Transportation Studies after completing a doctoral study that examined dashboard dynamics, driver behavior and preferences, and the possibility all may be combined to increase fuel economy.

Stillwater’s studies examined “how people may change their fuel use behaviors based on a customizable dashboard interface.”

His research also delved into how drivers would want that feedback, based on personal goal-setting preferences, and if they would prefer to receive the feedback via graphics, chimes or warning bells.

During an early review of literature on dashboard interfaces, Stillwater found there hasn’t been much consistency among auto manufacturers, especially

California Energy Commission Funding to Continue; New Research Areas Identified

In 2010, the California Energy

Commission's (CEC) PIER Program agreed to continue funding research at the Center for another three years. During this time, Turrentine says, research should focus on the following three areas:

Battery Affordability, Second Life

Research teams will examine ways to improve affordability of vehicle batteries and will include development and testing of battery second life use applications. A secondary emphasis will evaluate battery recycling practices.

Plug-in Vehicles, Impact on the Smart Grid, and Consumer Use

Over the next decade, the California electrical system will evolve toward a

smart grid, and an increased demand for renewable energy and electric vehicles will play an important role. PH&EV researchers will study consumer use data and look to minimize electric vehicle impact based on that use. Researchers will also design and test smart grid household interfaces, as well as research the impact of fast charging on the electric grid. For these projects, PH&EV will partner with Nissan, ECOtality, San Diego Gas & Electric, Idaho National Laboratory and the California Public Utilities Commission.

“With the sustained support from the California Energy Commission, many collaborations, and the momentum of a historic market launch of plug-in hybrid and battery electric vehicles in 2011, we

have been able to stay ahead of rapid developments in this dynamic arena. We look forward to beginning new projects with a wide range of partners,” Turrentine says.



TAI STILLWATER

Former EEC Emerging Venture Analyst
Current Position: Postdoctoral Scholar |
Plug-In Hybrid & Electric Vehicle Center

with an emphasis on maximizing fuel economy in hybrids, “probably because they’ve been more focused on driver comfort or commercial applications.”

His research found hybrid drivers did prefer the option of a goal-oriented approach and would appreciate the opportunity to set personal goals based on such factors as achieving a specific mileage — say 50 miles per gallon — or overall fuel economy, total amount of fuel used, or CO2 emissions.

Stillwater believes this research will help manufacturers design dashboard interfaces that will influence driver behavior toward even greater fuel economy.

He is applying similar research to a project for the EEC’s Western Cooling Efficiency Center, focused on how homeowners might use their thermostats for better efficiency.

Where Water and Energy Meet

CENTER FOR WATER-ENERGY EFFICIENCY SETS THE PACE IN AN UP-AND-COMING RESEARCH FIELD

“Coordinating the use of both water and energy resources can optimize operational objectives in many sectors, such as reducing peak load for electricity utilities or reducing energy costs of water supply systems.”

— FRANK LOGE

It takes a lot of water to produce the energy we use and the food we eat, and that’s a pressing concern for California, where water and energy resources are already stressed by increasing demand, higher prices and worries about impacts on environment.

Conserving water can translate into energy conservation. Ferreting out opportunities to do just that is the task assigned to the UC Davis Center for Water-Energy Efficiency (CWEE).

CWEE was formed in 2009 with a mission to research, develop and disseminate information about efficient technologies and integrated policies “that will conserve both the water embodied in energy and the energy embodied in water,” according to Frank Loge, CWEE director and UC Davis professor of civil and environmental engineering.

Recognizing the Link Between Water and Energy Consumption

“Public policy and business practice have treated water and energy as separate resources, but they are inexorably linked,” Loge explains. “As much as 14 percent of water consumed nationally is used to produce energy and almost 20 percent

of electricity used in California is spent moving, using and treating water.”

“There are huge opportunities for realizing tremendous energy conservation through water conservation, but it’s an abstract concept for many,” adds Ned Spang, program manager for CWEE and a Ph.D. candidate at the Fletcher School at Tufts University. “Coordinating the use of both water and energy resources can optimize operational objectives in many sectors, such as reducing peak load for electricity utilities or reducing energy costs of water supply systems.”

In addition to collaborative research assignments with the UC Davis’ Western Cooling Efficiency Center to examine cooling-related water use and projects to study water treatment and graywater systems, among others, CWEE has also partnered with the Child Family Institute for Innovation and Entrepreneurship (I2E) to commercialize viable water and energy conservation technologies. One excellent example of this research, initiated by Loge and completed by several UC Davis students, focused on developing a system to convert wastewater into biodegradable plastic.

“The process reduces the amount of energy it takes to make plastic by about



>> <http://cwee.ucdavis.edu>

50 percent, and greenhouse gas emissions by 30 percent,” Loge says.

With grants and venture capital funding obtained with the assistance of the I2E, the technology is now being further developed and marketed by Micromidas, a company located in West Sacramento.

Building Partnerships, Strategies for Conservation

CWEE researchers have also begun the process of examining California’s existing institutional and political structure — with its many overlapping jurisdictions, regional interests, business and policy issues—for areas that may impede water-related energy efficiency, and identifying technologies, policies and ideas that could enhance that efficiency.

CWEE is also building relationships with core agencies and water energy experts within California to develop a solution-oriented strategic plan for energy and water conservation. To this end, the CWEE organized the first-ever executive roundtable discussion “Addressing California’s Water-Energy Challenges” in June 2011. Held in partnership with the Southern California Leadership Council and with sponsorship from Southern California Gas Company and San Diego Gas & Electric, the event brought together high-level executives of energy and water utilities, academic institutions, investment groups, economic development programs and environmental consulting firms to start a dialogue about California’s current and future water-energy efficiency issues.

The roundtable called for the creation of a working group that will study solution-oriented plans for conserving water and energy in California, and the UC Davis Energy Efficiency Center and CWEE have already taken the lead in assuring that happens.

Helping people and the planet through technology and policy change

Frank Loge is director of the Center for Water-Energy Efficiency (CWEE) and a professor in the UC Davis Department of Civil and Environmental Engineering. Loge obtained his Ph.D. in 1998 from UC Davis. Because of his strong personal interest in the relationship between energy, water and health, he immediately embarked on an academic career focused on the fields of water and wastewater treatment.

Prior to joining the UC Davis faculty in 2004, he was an assistant professor at Washington State University. There, he served as the director of the Center for Water Reuse, was a member of the Washington Blue Ribbon Committee on water conservation and reclamation, and served as technical advisor to the National Oceanographic and Atmospheric Administration Northwest Fisheries Science Center.

Loge returned to UC Davis in 2004 and was recruited as director of the newly formed CWEE in 2009. He says the assignment is a good match because of his passion for water conservation and his work as an advocate of fundamental research to advance knowledge and the development and deployment of commercial technologies and system-based policies — both of which will combine to improve the quality of the environment and the human lives.



FRANK LOGE

Director | Center for Water-Energy Efficiency (CWEE)
Professor | Department of Civil and Environmental Engineering





Food for Thought

FOOD AND AGRICULTURE INDUSTRY IS OVERFLOWING WITH OPPORTUNITIES TO CONSERVE ENERGY

The food and agriculture industry, with its large, power-guzzling processing facilities,

is ripe to adopt new energy efficiency measures. With its long agricultural history, UC Davis is primed to lead the way in supporting the industry as it adopts new energy efficient practices. The Energy Efficiency Center has already begun work in this area, with the following initiatives:

Efficiency is Brewing

Sierra Nevada Brewery has long been on the leading edge of energy conservation. According to Sustainability Coordinator Cheri Chastain, the company has decreased energy consumption by 20 percent and generated about 75 percent of its electricity on site over the last five years.

In 2009, the Chico, California-based brewery enlisted the California Lighting Technology Center (CLTC) to reduce the energy it expends on lighting.

The project focused on a 3,700-square-foot specialty bottling facility within the brewery. It included daylight harvesting and retrofitting existing luminaires with occupancy sensors, bi-level ballasts and wireless dimmers.

Maintenance manager Pat Canney says the CLTC's recommendations addressed the unique needs of a brewing and bottling facility.

"If we can get by with just natural light through the skylight, that is what the system does," Canney explains. "But there

is also a manual override if we need full brightness to inspect bottles and glass."

Sierra Nevada received a rebate from the PG&E Savings by Design program to complete the work, and Canney says the retrofit should pay for itself in three years through cost savings. The company is now looking at retrofitting another area with a programmable, networked control system that uses occupancy sensors to deliver lighting only to areas where people are working.

"It's the focus of the brewery to be the most energy-efficient operation, from front to back, in every aspect of our operation," Canney says. "Lighting is another thing we look at to make sure we are doing the best we can."

“It’s the focus of the brewery to be the most energy-efficient operation, from front to back, in every aspect of our operation. Lighting is another thing we look at to make sure we are doing the best we can.”

—PAT CANNEY



Food for Thought *continued*

“We constantly feel the pressure of the water shortage and the damage being done to the environment. We have an obligation and a responsibility to develop new technology to address these issues.”

— ZHONGLI PAN

Saving Time, Energy in the Food Processing Industry

The food industry is the state’s third largest energy user, so reducing its consumption is vital, says Zhongli Pan, an associate adjunct professor in the Department of Biological and Agricultural Engineering.

Pan is experimenting with infrared technology, which is more efficient than convective heating, such as hot air, because it delivers heat directly to the food product without heating the air around it.

For example, his team has used infrared technology to cut the time required to freeze-dry food by 40 percent. The infrared process removes up to 50 percent of the water from the product, reducing the time needed in the costly freeze-drying process.

The technology can also be used on rice—one of California’s largest crops. Typically it takes about 15 to 20 minutes to remove 2 percent of the moisture from rice because it must be done at low temperatures that won’t crack the rice. But Pan’s team has achieved an ever better result—removing 3 to 4 percent of the moisture in just one minute of heating—with infrared technology.

They are also applying the technology to other food processing practices, such as roasting almonds, another important California crop. They have reduced roasting time by as much as 60 percent by using infrared technology to heat the almond before it is placed into the more costly and energy-consuming hot air roasting process.

Cultivating ideas that cut energy consumption

The agriculture and food production industries have great potential to cut energy consumption, and UC Davis alumna Josaphine Buennagel is making it happen.

As Senior Program Manager for PG&E’s Energy Efficiency Group, she assesses the energy-saving potential of emerging technologies in the agricultural and food processing market and facilitates industry adoption.

“We work to speed up technology adoption by directing research toward products that our customers find most necessary and most feasible for integration into current business practices and facility layouts,” Buennagel explains.

Buennagel worked in the telecommunication and wine industries before earning an MBA from UC Davis, where she was an Emerging Venture Analyst and PG&E Energy Efficiency Fellow at the Energy Efficiency Center. In 2007, she created a business plan for Professor Zhongli Pan’s food drying and blanching technology (see above).

“My understanding of energy issues and energy efficiency, knowledge of the wine and food processing industries, and the skills and knowledge I developed in the UC Davis MBA program made me an attractive candidate” to PG&E, she says.

When applied to the blanching process, infrared technology can eliminate the need to use water or steam and protect the integrity of the food. Common water blanching practice is to put the produce in hot water, which not only uses water but can cause loss of nutrients. Infrared heat eliminates the need for water altogether and leaves the nutrients intact.

Another unique application developed by Pan's group is using infrared heat to peel fruits and vegetables, eliminating chemical and water usage, producing a high-quality product, and easing the impact on the environment.

Pan has received funding from the California Energy Commission, California League of Food Processors, California

Department of Food and Agriculture and private companies to build demonstration units for the blanching and peeling technologies and says several companies are already very interested in the commercialization potential.

"We constantly feel the pressure of the water shortage and the damage being done to the environment," he says. "We have an obligation and a responsibility to develop new technology to address these issues."

Biogas Energy

Researchers and students at UC Davis are turning table scraps into energy thanks to the leadership of Biological and Agricultural Engineering professor Ruihong Zhang.

Zhang's "anaerobic phased solids digester" processes tons of table scraps from campus dorms, manure from the campus dairy, agricultural waste from the campus's agricultural research fields, and other campus waste into electric power, diverting it from landfills to the energy grid and eventually to homes.

The technology has been licensed from the university and adapted for commercial use by Clean World Partners (CWP).

CWP along with Zhang are studying the feasibility of a biodigester capable of helping meet the zero net energy goals at UC Davis West Village.



JOSAPHINE BUENNAGEL

UC Davis MBA 2007

Former EEC Emerging Venture Analyst

PG&E Energy Efficiency Fellow

Current Position: Senior Program Manager | PG&E



“We work to speed up technology adoption by directing research toward products that our customers find most necessary and most feasible for integration into current business practices and facility layouts.”

Understanding Human Nature

SOCIAL SCIENCE RESEARCH HELPS DETERMINE WHY PEOPLE ADOPT ENERGY EFFICIENT TECHNOLOGIES

“There are multiple forms of rationality, like acting in a way that is consistent with a belief or ethic. Energy consumption is a big problem and if we only have one vision for solving it, we are going to be very limited.”

— DINA BISCOTTI



Ask behavioral economists what motivates people to adopt energy efficient technologies, and they may simply say “saving money.” Ask a sociologist like Dina Biscotti the same question, and you’ll get answers like “peer influence,” “moral logic” and “social recognition.”

Biscotti, a postdoctoral scholar with the UC Davis Energy Efficiency Center (EEC), is currently researching how social institutions like churches and schools can spread energy efficiency technologies.

‘Peer Pressure’ for Positive Change

“This is a powerful way to diffuse a new technology or idea,” Biscotti explains. “People have a reason to adopt a new behavior if they believe a friend or church member believes in it.”

Biscotti is studying organizations like Interfaith Power and Light (IPL), which promotes energy efficiency and renewable energy and helps congregations of all faiths reduce their carbon footprint.

“Often action is informed by talking to people you trust in the group you interact with,” Biscotti explains. “In the case of IPL, members are installing compact fluorescent lamps (CFL) to be ‘faithful stewards of Creation.’ They do it because they see it as being consistent with their faith.”

Other organizations she is examining include One Change, a Canadian volunteer organization that distributes CFLs door-to-door, and the PIRG Energy Service Corps, which trains college students to teach schoolchildren about energy efficiency and to conduct basic energy assessments and home weatherization for community members.

Social science research like Biscotti’s will become a mainstay of the EEC in the years to come.

Energy Use as a Social Phenomenon

Sociology Professor Tom Beamish studies social constructs and how they affect individual behavior. People are inherently collective, he says, and while individuals exist, they do so in the context of others.

“In order to understand technology adoption, you have to understand everything that goes along with being collective, as opposed to an individual,” Beamish says. “There is really no thorough understanding of energy use as a social scientific phenomenon.”

EEC Director Nicole Biggart says that scientists have a “tightly held belief that technology will take care of everything,” but it is important to be culturally, socially and politically sensitive to the changes that technology can bring.

In October 2011, Biscotti, Biggart, and Beamish organized a workshop on the UC Davis campus for social scientists and management scholars who study energy. The team hopes to secure grant funding to make it a yearly event.

“I want us to move beyond this vision of the sole, self-interested, utility maximizing, rational, calculating, individual that behavioral economists think we all are,” Biscotti says. “There are multiple forms of rationality, like acting in a way that is consistent with a belief or ethic. Energy consumption is a big problem and if we only have one vision for solving it, we are going to be very limited.”

Researching how relationships influence behavioral change

Dina Biscotti was inspired by and learned from UC Davis Energy Efficiency Center Director Nicole Biggart. Now, she is working alongside her mentor to better understand what leads people to adopt energy-saving technologies and practices.

Biscotti met Biggart when she took her graduate seminar in economic sociology. After Biscotti earned her Ph.D. in sociology, Biggart recruited her to the EEC, where she is studying how social relationships and social institutions can be leveraged to change behavior.

Biscotti presented her research findings at a 2011 workshop on renewable energy called “The Road to a 100 Percent Renewable Energy System” and is writing a chapter about Interfaith Power and Light (IPL) and its work to promote energy efficiency for a book about religion and organizations.

As part of her research, Biscotti attended California Interfaith Power and Light’s “Energy Oscars” at Grace Cathedral in San Francisco, where congregations were recognized for their accomplishments in reducing energy consumption.

“Winners had organized ride sharing to services and discovered creative ways to finance the installation of solar panels on houses of worship,” she explained. “IPL’s success illustrates how action can be informed by talking with people you trust in the groups you interact with.”



DINA BISCOTTI

Lecturer | Department of Sociology
Postdoctoral Scholar | UC Davis
Energy Efficiency Center





University of California, Davis
One Shields Ave.
Davis, CA 95616

**UNIVERSITY OF
CALIFORNIA, DAVIS**

CHANCELLOR

Linda P. B. Katehi

**DIRECTOR OF ENERGY
EFFICIENCY CENTER**

Nicole Woolsey Biggart

**EXECUTIVE DIRECTOR OF
ENERGY EFFICIENCY CENTER**

Ben Finkelor

**SENIOR DIRECTOR OF
COMMUNICATIONS**

Sylvia Wright

WRITERS

Alexis Raymond
Sally Wyatt
Sumiko Hong

PHOTOGRAPHERS

Kathreen Fontecha
Paul Fortunato
Karin Higgins

DESIGN

Page Design Group

MARCH 2012