

# ENERGY NOTES

News From the University of California Energy Institute



Dear Colleagues,  
Welcome to the  
inaugural issue of  
*UCEI Energy Notes*

The UC Energy  
Institute has been  
facilitating and  
encouraging energy

research within the University of California system since 1978. We are always looking for new and innovative means to reach out to the energy and policy research communities, and have developed this newsletter as our latest tool to communicate the tremendous energy research that is going on at the University of California.

UCEI will publish this newsletter quarterly to highlight intriguing energy research projects and people at UC,

review recent UCEI activities, and announce upcoming research events sponsored by UCEI. We would like to hear your reactions to the newsletter and suggestions for future articles that you think would be of interest to the energy community.

While UCEI *Energy Notes* reports on UC energy research, its distribution goes to all corners of the world. It is my hope that through communicating the innovative energy research performed here at the University of California, UCEI will open another avenue for fomenting continued energy research everywhere.

A handwritten signature in black ink that reads "SEVERIN".

Severin Borenstein  
Director

## Hybrid Drivetrain Increases Energy Efficiency, Marketability

**A** novel approach to hybrid transmission has been developed by Lung-Wen Tsai, Ph.D., a mechanical engineering professor in the Bourns College of Engineering at the University of California Riverside. Sadly, Dr. Tsai died unexpectedly last November, but he will be remembered as a leader who made many contributions to the field of mechanical engineering, including this unique hybrid transmission design.

Dr. Tsai's research, which was supported by UCEI, has yielded a highly efficient parallel hybrid drive transmission that, if incorporated into a vehicle drive system, could extend hybrid technology to more mainstream vehicle markets by using conventional automatic transmission components. Making hybrids more like conventional cars could make them more likely to achieve commercial acceptance.

Hybrid drive cars are powered by a combination of gasoline and electricity. Consumers are increasingly attracted to the new technology because it offers improved fuel economy and environmental benefits.

Tsai's parallel hybrid transmission is unique because it is based on conventional automatic transmission design, does not require a torque converter, and uses a single motor/generator unit, explains Gregory A. Schultz, Ph.D., who co-developed the design with Tsai. Because of the arrangement of the motor/generator with the gearbox, the transmission improves vehicle acceleration from a standstill compared to other hybrids on the market, Schultz explains. Also, since the design requires only one motor/generator unit, powertrain control is simpler than with other hybrids. For example, the Toyota Prius

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# Energy Notes Profile

Stephen Holland, Visiting Research Associate

Stephen P. Holland came to UCEI in August 2001 to gain further expertise in energy markets and policy. An economist at the Federal Trade Commission who had spent two years analyzing the impacts of energy industry mergers, Holland came seeking the collegial academic research environment for which the Institute is known. Originally, he planned to stay for just one year, but he extended his stay to a second year because of the stimulating nature of his work.

“UCEI is unique. The combination of people, their expertise, and their enthusiasm for policy development makes the Institute a valuable asset to the state and society,” Holland says. The constant interaction of engineering, policy and economics experts at UCEI enables researchers to have a real impact on the outcome of energy policy decisions, he says. “Our research is moving thinking along.”

As an example, Holland cites his project analyzing the effect of realtime pricing (RTP) on pollution. “This work has important implications both for electricity pricing policy and for pollution control,” he explains.

The research with Erin Mansur, a former UCEI student who is now an assistant professor at Yale, asks how realtime pricing of electricity will affect pollution. RTP will result in less electricity consumption in peak periods and more consumption in off-peak periods. This will reduce the variance of the daily electricity load, which could lead to two different scenarios. First, reducing the daily load variance may decrease pollution by reducing the need for generator start-ups and ramping. On the other hand, reducing the variance may increase pollution since it would result in more generation from the dirtier baseload generators. Preliminary estimates show that the second effect dominates in the “PJM” and “ECAR” electricity

reliability markets. (PJM includes parts of Pennsylvania, New Jersey, and Maryland, while ECAR includes parts of Ohio, Indiana, Kentucky, Michigan and West Virginia.) This implies that widespread adoption of RTP in these markets might actually lead to an increase in pollution. Holland and Mansur plan to extend this research to other markets and expect to find different results for regions with different supply characteristics.

In a recently released CSEM working paper, “Investment Efficiency in Competitive Electricity Markets With and Without Time-Varying Retail Prices,” Holland and co-author Severin Borenstein explore competitive electricity markets when some customers do not face realtime prices. It is not surprising that competitive electricity markets will not attain the optimal investment and allocation of electricity unless all customers are on RTP. However, this paper demonstrates the surprising result that competition will not even attain the second-best optimal investment and allocation if all customers are not on RTP, because the equilibrium flat retail rate may be either higher or lower than optimal. They then show that a retail tax/subsidy applied to flat rate customers can be beneficial but that capacity payments, as proposed in many markets, are less beneficial than a simple retail tax/subsidy.

In addition to this research, Holland has continuing research interests in trading of emissions permits across time, the RECLAIM emissions permit market, collusion with exhaustible resources, water

project evaluation, and the economic theory of exhaustible resources.

Holland, who received his Ph.D. in Economics from the University of Michigan, continues his research work at UCEI through August 2003.



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# UC and CEC Sign Research Agreement

*Streamlines Process Across all Campuses*

**R**esearchers interested in conducting state-funded energy research at the University of California will find the process of applying for research awards easier now that the university has completed a four-year, \$20 million master research agreement with the California Energy Commission (CEC).

“This master agreement creates a mechanism through which the two agencies can cooperate,” explains Carl Blumstein, director of the California Institute for Energy Efficiency (CIEE), a branch of UC Energy Institute. “It streamlines the process and enables energy researchers in the UC system to work with the CEC without having to enter into individual contract negotiations for each project.”

Blumstein worked closely with David Mears, who negotiated the agreement for the university system. Mears directs the Research Administration Office in the Office of the President. “This new agreement simplifies the process tremendously,” says Mears. “The turnaround time is now the same day or the next day. That’s down from weeks of delay under the old process.”

CIEE will administer the agreement, which covers contractual details such as invoicing procedures, budget, travel and per diem, terms and conditions, and awarding subcontracts to the entities performing the research. The agreement also serves the CEC’s interests; its program

administrators benefit from having one point of contact for all 10 UC campuses.

The CEC’s Public Interest Energy Research (PIER) program is the funding source. PIER supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable and reliable energy services and products to the marketplace.

CIEE will offer CEC funds through competitive RFPs and noncompetitive agreements. The first two RFPs under the new agreement were for the Food Industry Energy Research Program, and PIER Environmental Area Exploratory Grant Program.

Finalizing the master agreement supports CIEE’s mission to plan and manage a statewide program of research and technology development aimed at advancing end-use

energy efficiency and productivity in California, Blumstein notes.

“It’s the culmination of several years of effort. It was a lot of work, but it is very rewarding because it will enable us to administer funds efficiently—so we can spend more time on research and less on administration,” Blumstein says.

Blumstein and Mears also credit Cheryl Raedel, Terry Surles and Gary Klein at the CEC, for their hard work and vision.

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# Educating Policymakers on Changing Energy Markets

**T**hey came from diverse backgrounds—federal and state regulation, utility business, journalism, and energy consulting—but shared a common interest to learn more about the cause and effect of change in California’s energy markets. About 100 people attended the Center for the Study of Energy Markets’ (CSEM) first annual Electricity Policy Conference in November in Sacramento. The conference was, in the words of one attendee, “a good start to addressing issues relating to the current state of California’s energy crisis.”

UCEI Research Director and CSEM Co-director James Bushnell opened by comparing and contrasting market power and market manipulation. The terms, often used interchangeably, have different meanings, Bushnell explained, especially in the context of California’s changing energy markets. An entity with market power typically has large assets such as physical production capability. An entity with the ability to manipulate the market usually has an information advantage. Both market power and manipulation were at play during California’s energy crisis, Bushnell said, but the dominant problem appears to have been market power.

**A second Electricity Policy Conference will be planned for next fall.**

UCEI Director and CSEM Co-director Severin Borenstein discussed the value of retail price signals. If realtime pricing had been an option after deregulation, California might have avoided the extremes of the energy crisis; the absence of price response, he said, provided a direct invitation to market power.

Borenstein also gave a second presentation on stranded costs, direct access and exit fees.

Stanford University Economics Prof. Frank Wolak discussed resource adequacy in wholesale electricity markets. He argued that traditional notions of resource adequacy do not apply in a market context, where price has a more direct influence on supply. Price-responsive demand was a crucial, yet under-emphasized, element of current plans for ensuring resource adequacy, Wolak said.

Attendees spoke highly of the event. Even one attendee who did not always agree with the assumptions underlying economic analysis or with the policy prescriptions that follow from that analysis found it valuable to “hear the economists’ perspective, consistently and clearly articulated.”

A second Electricity Policy Conference will be planned for next fall.

## Executive Education Course Offers Insight Into Energy Regulation and Markets

**F**orty professionals from around the country and Latin America participated in CSEM’s Executive Education Course in January on Economic Fundamentals of Electricity Regulation and Markets. The two-day course, jointly sponsored with the UC Berkeley Haas School of Business and the UC Davis School of Management, was held at UC Davis’s continuing education center in Sacramento.

Drawing heavily on the tools of economics and finance, the course covered the regulatory and public policy issues that deregulation and the ensuing California crisis have raised. It evaluated the impacts and consequences of different strategies in the context of the electricity market’s

continuing changes.

Participants who completed surveys found the course educational and helpful in their careers. One respondent wrote: “Excellent background and insight into the market. [My] understanding of market concepts improved greatly.”

UC Energy Institute Director Severin Borenstein, and UCEI Research Director James Bushnell lead the program. Borenstein is also E.T. Grether Professor of Business Administration and Public Policy at the Haas School of Business. Bushnell is also a lecturer at the Haas School of Business.

transmission is an electromechanical machine that needs two motor/generators to function, and therefore requires more complicated controllers and extra electronics hardware. Because of its simplicity, Tsai's design could easily be incorporated into any of the hybrid platforms available today, Schultz adds.

Tsai's design is highly efficient for three reasons: the gearbox arrangement eliminates the need for a torque converter, which is typically an inefficient transmission component; the hydraulic pump used in all automatic transmissions can be electrically driven in this arrangement, thus reducing its power consumption; and, for a given vehicle power rating, less torque is required from the engine,



The assembled prototype parallel hybrid transmission.

thus allowing for smaller automatic transmission clutch packs, and reducing parasitic drag in the transmission. Schultz estimates a hybrid vehicle using this transmission could achieve over 50% improvement in fuel economy compared to a comparable conventional vehicle.

Schultz studied with Tsai at the University of Maryland in College Park, where Tsai taught for more than 14 years before joining the faculty at UC Riverside in 2000. Schultz began working with Tsai as a master's student in 1999, and completed his doctoral dissertation on the parallel hybrid transmission only weeks before Tsai passed away. Working together, Schultz and Tsai built the prototype and tested it on a dynamometer. They applied for a patent, and a notice of issuance has been granted.

"Dr. Tsai was recognized as one of the top mechanisms researchers in the world," Schultz says. "It was an honor to work with him." While at the University of Maryland, Tsai established a world-renowned research and education program in robotics and mechanisms. He had also been a research engineer with the General Motors Corporation and Hewlett-Packard Company.

Schultz hopes to continue development of the design—in Tsai's honor—by testing it in a vehicle. The design has been presented to several automakers. While they have expressed interest in the concept, they have not taken formal steps to test or incorporate it into a vehicle.

Schultz believes one of the greatest benefits of this design is its ability to apply hybrid technology in passenger cars in a more mainstream fashion, using conventional parts. "If the industry goal is to build hybrid cars that the American public likes and will buy, our design, with its automatic transmission, improved performance, and simpler manufacturing process, creates a more marketable product," Schultz explains.

### Parallel Hybrid Design Advantages

- **Operational Flexibility.**  
The design can operate in a variety of modes.
- **Manufacturability and Reliability.**  
The design is based on a conventional automatic transmission, using existing parts and hardware. Existing manufacturing facilities, tooling, and processes can be used to produce the transmission. This translates to reduced cost.
- **Automatic Transmission Shift Quality.**  
As an automatic transmission, it appeals to American consumers.
- **Simple and Compact.**  
Many parallel hybrid designs use two motors—one functioning primarily as a generator and the other as a traction motor. In other applications two traction motors are required. This design only requires one motor/generator set. It is, therefore, less expensive, lighter, simpler, and easier to control. The complete design includes one electric motor, a compound planetary gear set, and four clutches. The electric motor is integrated with the transmission mechanism.
- **Performance.**  
The design results in better "launching" characteristics (the forward motion generated from standstill), higher torque, and improved acceleration. It does not require a torque converter and therefore avoids efficiency losses that can occur with a torque converter.
- **Failsafe.**  
Engine or motor alone can drive the vehicle.
- **Dual Applications.**  
The design can be used in either a front-wheel drive or rear-wheel drive application.

### Additional Reading: Reports Available Through UCEI

1. Tsai, Lung-Wen (2002). "Feasibility Study of a Novel Parallel Hybrid Transmission." UER-354-FR (final report).
2. Tsai, L. W. and Schultz, G. (2002). "A Motor-integrated Parallel Hybrid Transmission," in Proc. of the ASME 2002 Design Eng. Technical Conf., Montreal, Sept. 29-Oct. 2, p. MECH-34363. New York: American Society of Mechanical Engineers; Working Paper EDT 001.
3. Tsai, L. W.; Schultz, G.; and Higuchi, N. (2001). "Novel Parallel Hybrid Transmission," J. Mech. Design 123, p. 161.

# Short Takes

*Important Information and Upcoming Events*

## POWER Conference March 14

UC Energy Institute's Eighth Annual POWER Conference is scheduled for Friday, March 14 at the Joseph Wood Krutch Theatre on the Clark Kerr Campus, UC Berkeley. Organized by UCEI's Center for the Study of Energy Markets, this conference presents the work of leading researchers on electricity industry restructuring. Conference Sponsors: California Energy Commission, California Independent System Operator, Pacific Gas & Electric, Sempra Energy, Mirant, and Southern California Edison. Details: <http://www.ucei.org/conf2003/progr2003.htm>

## Three New Working Paper Series

Announcing three additions to UCEI's Working Paper Series, the goal of which is to disseminate UC energy research to academic and non-academic audiences, and to foster innovative energy research:

- The Energy Policy and Economics Working Paper Series addresses the economic, policy, and regulatory topics associated with critical energy issues.
- The Energy Development and Technology Working Paper Series stresses applied research on scientific and technical energy problems.
- The Fundamental Science of Energy Working Paper Series emphasizes basic scientific questions underlying energy issues.

## Welcome Visiting Researcher Professor Catherine Waddams!

On a short sabbatical from the University of East Anglia in England, Prof. Waddams is at UCEI through the end of April 2003. While at UCEI, Prof. Waddams will continue her work on energy consumption and supply choices by low-income consumers.

## CSEM Seminars in Berkeley & Davis

Energy researchers present their latest findings at semi-monthly seminars held on the UC Berkeley and Davis campuses. Look for the latest schedule at [www.ucei.org/seminar\\_spring03.html](http://www.ucei.org/seminar_spring03.html)

## UCEI Moving in 2003

UCEI's office will move twice this year as part of the Berkeley campus's ongoing effort to more efficiently house its academic, research and administrative programs. UCEI is now located at 2510 Channing Way, across the street from the old location. Watch the UCEI web site for new phone numbers and details on the second move later this year.

## UCEI Web Site – Up To Date Info

Need to know UCEI's new address? Looking for the Spring Seminar schedule? Want more info on the Working Paper Series, new grant or visiting researcher opportunities? Check the UCEI web site at <http://www.ucei.org>



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