



# SERC

## ENERGY NEWS

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The quarterly newsletter of the  
Schatz Energy Research Center

**HUMBOLDT**  
STATE UNIVERSITY

## SERC Delivers Stack-Outside-the-Box™ to Smith College

Mark Rocheleau

On October 9, SERC shipped its first-ever Stack-Outside-the-Box™ (S0tB™) to Smith College in Northampton, Massachusetts. This bench-top educational fuel cell system is initially being used by HSU and SERC alumna Denise McKay, now an assistant professor in the Picker Engineering Program at Smith, in her Engineering 390: Photovoltaic and Fuel Cell System Design class. The Picker Engineering Program is the nation's first and only accredited engineering program for women.

Denise contacted SERC because she was interested in a portable bench-top fuel cell system for laboratory use and demonstration purposes. Naturally she thought of SERC's Stack-In-a-Box® (SIB®), which she had helped to develop while still at SERC. (For more information about the SIB® see [www.schatzlab.org/projects/real\\_world/stack\\_in\\_box.html](http://www.schatzlab.org/projects/real_world/stack_in_box.html).)

Denise wanted the basic features of the SIB®, such as compactness and portability in a fully contained system, yet with a number of changes that would be more conducive to extended laboratory use. Consultations between SERC engineers and Denise resulted in the S0tB™. This new design has a number of improved features.

- The lack of a case allows the individual components to be located with fewer space constraints and more accessibility. This increases the visibility and manual access of the various components, enabling students to work more efficiently and understand system operation more easily.

- For ease of transportation the S0tB™ system operates on the hydrogen contained in a small lecture bottle, but when ongoing stationary use is expected, there is a port for connecting to a large industrial size K-bottle. This provides a much larger supply of hydrogen for extended operation.

- An eight-channel data acquisition system allows students to record operating data including cell voltages and stack temperature while varying the operating conditions. This will allow students to perform detailed measurements on the SERC fuel cell stack, or other stacks that Smith may acquire.

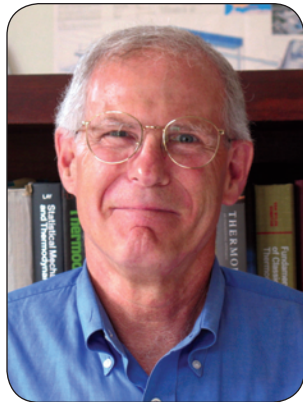


Professor Denise McKay (2nd from left) and her Engineering 390 class with their new S0tB™.

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## A Message from the Director Peter Lehman

There have been several firsts at the Schatz Center recently and you can read all about them in this newsletter. We are all very proud of our first Fulbright Scholar, Richard Engel. Richard won his prestigious award competing against many PhDs and as he describes in his article, will be helping Don Bosco University in El Salvador to establish an energy efficiency and renewable energy curriculum. We wish Richard all the best as he extends our promotion of clean and renewable energy to Latin America.



Another first is the arrival of the Toyota Highlander fuel cell vehicle. As Greg Chapman describes, he, Jim Zoellick, and I picked up the car recently from UC Berkeley's Transportation Sustainability Research Center (TSRC). Tim Lipman, co-director of the TSRC, arranged for us to test drive the Highlander as part of their program to evaluate its performance and consumer acceptance. It's been great fun to drive a fuel cell car that performs so well and to give rides to family, friends, and neighbors. And along with the hydrogen Prius we're already driving, we can now say that the addition of the Highlander is the beginning of a hydrogen fleet on the North Coast.

A third first is the delivery of our first Stack-Outside-the-Box™ to SERC alumna Denise McKay at Smith College. Mark Rocheleau reports on our design and production of the system, which is now in use in the engineering program at Smith. I had a chance to visit with Denise this fall, see their brand new \$85M Ford Engineering building, and Denise's labs in the new building. It is heartening to see one of our ex-colleagues doing so well.

In other articles, Richard Engel reports on our trip to UC Berkeley to deliver equipment and present a lecture in our DOE education project. And Jim Zoellick reports on progress with the RESCO project. We have great hopes that RESCO will enable Humboldt County to be a renewable energy pioneer.

I write this column as we are about to begin a new decade. The ten years that just passed were not the greatest, with wars, terrorist attacks, market meltdowns, and little progress on reducing carbon emissions. As we wish each other happy new year, let's hope that the next ten years brings a greater commitment to protect this beautiful planet of ours.

## SERC Engineer Richard Engel Headed to El Salvador as Fulbright Scholar

As Humboldt County settles into another rainy winter, SERC senior research engineer Richard Engel is headed for a sunnier locale. Richard has been awarded a Fulbright grant to help Don Bosco University in El Salvador develop a degree program in renewable energy and energy efficiency. During his semester at Don Bosco, Richard will:

- teach a seminar course on energy topics directed at graduate students and energy industry professionals;
- consult with faculty on renewable energy program development;
- assist the university in creating a sustainable energy institute;
- explore opportunities to install a renewable energy demonstration project at the Don Bosco campus.

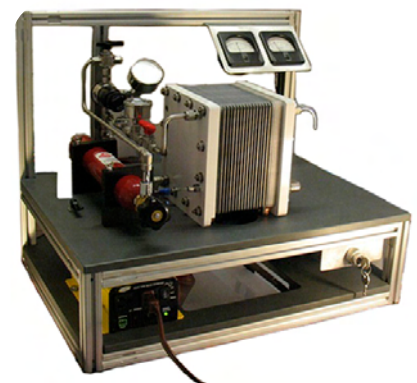
Richard is excited to return to Central America, where he served as a Peace Corps volunteer in Honduras a decade ago. He will be accompanied by his wife Basilia, whom he first met in Honduras. "I look forward to working on a project where I can merge my career interest in energy and my continuing fascination with Latin American culture," says Richard.

Richard hopes to bring home valuable lessons about energy education and the use of clean energy in developing countries when he returns to SERC in July.

*Stack-Outside-the-Box™ continued from page 1*

- This system has two cooling fans (versus just one in the SIB®), which will allow for extended runtime at high power levels.

According to Denise, her Engineering 390 students were clamoring for her to set up and run the SOTB™ with them as soon as it arrived. When they were finally able to take the system for a test spin, Denise said that the SOTB™ "operated like a champ."



The Stack-Outside-the-Box™.

# Road Testing Toyota's New Generation Hydrogen Fuel Cell Car

Greg Chapman

SERC recently acquired a brand new hydrogen fuel cell vehicle from UC Berkeley's Transportation Sustainability Research Center (TSRC). The smog-free vehicle is a 2009 Toyota Fuel Cell Hybrid Vehicle (FCHV-adv), and as the manufacturer states, "It is one of the most technologically-advanced vehicles on the planet." SERC is helping the TSRC road test and acquire operational data for the vehicle.

Built on Toyota's Highlander mid-sized sport utility vehicle platform, the FCHV-adv is a zero-emission vehicle equipped with a 100-kilowatt PEM fuel cell, four high-pressure hydrogen fuel tanks, an electric motor that directly drives the front wheels, a nickel-metal hydride battery, and a power control unit. Maximum fuel pressure in this new generation vehicle has been doubled from 350 bar to 700 bar giving the car a range of over 400 miles on a full tank. The sophisticated power control unit determines the division of energy between the fuel cell stack and the battery to power the vehicle and is similar to the mechanism that manages the engine and battery in the Toyota Prius.



SERC Senior Research Engineer Greg Chapman takes the newly acquired Toyota Fuel Cell Hybrid Vehicle out for a test drive.

Starting with a tank that was three-quarters full, SERC director Peter Lehman, senior research engineer Jim Zoellick, and I drove the car 275 miles from TSRC's headquarters at the Richmond Field Station home to Arcata. The fuel cell and electric motor drive train is powerful, quiet, and accelerates smoothly, making it a joy to road test. Along with our previously acquired hydrogen powered Prius (see SERC newsletters v.1, #2 and v.3, #3), the addition of the Highlander expands SERC's hydrogen vehicle fleet to two, the only hydrogen vehicles on the North Coast.

## Project Updates

### H<sub>2</sub>E<sup>3</sup> Project Delivers Equipment and Lecture to UC Berkeley

Richard Engel

On November 12, SERC's Hydrogen Energy in Engineering Education (H<sub>2</sub>E<sup>3</sup>) project achieved a major milestone with the delivery of a fuel cell test station and a dozen benchtop fuel cell/electrolyzer kits to University of California, Berkeley. Director Peter Lehman, faculty research associate Eileen Cashman, and H<sub>2</sub>E<sup>3</sup> project manager Richard Engel made the trek to UCB to hand off the newly completed equipment, all built in-house at SERC.

While at UCB, Peter and Richard demonstrated the test station and presented a well-received lecture on fuel cells to nearly 200 undergrad and grad students in a course on energy and society taught by Dr. Dan Kammen of UCB's Energy and Resources Group.

The test station includes an eight-cell, 500-Watt fuel cell stack, also designed and built by SERC. The test station will be used by upper division UCB engineering students to learn hands-on how fuel cells are tested by researchers and manufacturers. The benchtop kits will be used in introductory engineering and thermodynamics courses to explore how fuel cells and electrolyzers can be used to convert chemical energy to electricity and vice versa.

During Richard's leave from SERC (see related story), Eileen will take over as interim project manager for H<sub>2</sub>E<sup>3</sup>. In spring semester 2010, the project will bring more fuel cell lectures and lab activities to a variety of classes at HSU and UCB, while outreach gets underway to identify other UC and CSU campuses that will participate in the project during its third year. The project also aims to place students in summer internships with fuel cell manufacturers who are partners on H<sub>2</sub>E<sup>3</sup>.



(l to r) SERC's Richard Engel and Peter Lehman and UC Berkeley's Tim Lipman and Dan Kammen gather around the fuel cell test station during its delivery to UCB. Photo by Eileen Cashman.



## RESCO Study Kicks Off Jim Zoellick

SERC has begun work on a Renewable Energy-based Secure Community (RESCO) study for Humboldt County. (See SERC Energy News v.4, #2 for more information about RESCO.) The objective of the research is to assess the feasibility of developing local renewable energy resources to meet 75% to 100% of the local electricity demand as well as a significant fraction of heating and transportation energy needs. The project team, including SERC, the Redwood Coast Energy Authority, and Pacific Gas and Electric Company, attended a kick-off meeting at the California Energy Commission in early November.

With the project now up and running, we are hard at work gathering data and developing our analysis methodologies and models. We are also putting together a Professional Advisory Committee (PAC) to provide guidance for our research. We currently have secured commitments for PAC participation from individuals at Pacific Gas and Electric Company, Humboldt County Community Development Services Department, the Northern California Power Agency, and the National Renewable Energy Laboratory (NREL).

We are also collaborating with NREL to analyze RESCO economic impacts in Humboldt County. SERC graduate student research assistant Adam Schumaker working with his mentor, SERC faculty research associate Steve Hackett, applied for and won an NREL internship to develop the economic impact assessment tools

we will need for our analysis. Adam will be spending several weeks at NREL over the Spring semester to complete the work. Congratulations to Adam and Steve on their efforts that will be a big boost to the success of the RESCO project.

## SERC Building Keeps Growing



Despite a good dose of rainy Humboldt winter weather, the new SERC office/lab building keeps progressing. The staff offices on the second floor (foreground) are now being framed. The framing for the labs and shop on the floor below is complete. See [www.schatzlab.org/about/facilities/building.html](http://www.schatzlab.org/about/facilities/building.html) for the most recent pictures.

## Looking Back

**4 years ago...**SERC helped the Yurok Tribe to obtain a grant from the U.S. Department of Energy aimed at building the Tribe's own human capacity in the energy field. SERC engineers trained Tribal staff and Yurok community members in energy efficiency and renewable energy. We helped the Tribe to hire temporary field staff to conduct a house-by-house energy needs assessment on the Reservation. We also helped the Tribe to launch an energy education campaign. Our final report to the Tribe highlighted the findings of the field work and recommended actions to follow up on these findings. To view the final project report and other project-related materials, go to [www.schatzlab.org/projects/community/yurok\\_capacity.html](http://www.schatzlab.org/projects/community/yurok_capacity.html).



**SERC Energy News** is published quarterly by the Schatz Energy Research Center at Humboldt State University.

The mission of SERC is to promote the use of clean and renewable energy in our society. SERC meets its mission by performing research and developing new technology; designing, building, operating, and demonstrating clean and renewable energy systems; providing training for professionals; and educating the public about a sustainable energy future. SERC's affiliation with the Environmental Resources Engineering program at HSU provides a rare opportunity for undergraduate and graduate engineering students to acquire hands-on experience with cutting-edge energy technologies.

SERC is a member of the National Hydrogen Association, the International Association for Hydrogen Energy, the International Solar Energy Society, and the American Solar Energy Society.

SERC co-directors are Peter Lehman, Charles Chamberlin, and Arne Jacobson. Faculty Research Associates include Eileen Cashman and Steven Hackett. Research and administrative staff include Andrea Allen, James Apple, Christopher Carlsen, Greg Chapman, Richard Engel, Ray Glover, Meg Harper, Peter Johnstone, Patricia Lai, Marc Marshall, Tirian Mink, Allison Oakland, Tom Quetchenbach, Mark Rocheleau, Scott Rommel, Adam Schumaker, Colin Sheppard, Alina Taalman, Jennifer Tracy, and Jim Zoellick.

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