



# SERC

## ENERGY NEWS

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### Features

Clean Water Access for the  
Developing World

SERC Supports AC Transit's  
HyRoad Program

### In Every Issue

A Message From  
the Director

Project Updates

Looking Back

The quarterly newsletter of the  
Schatz Energy Research Center

**HUMBOLDT**  
STATE UNIVERSITY

## Clean Water Access for the Developing World

Peter Alstone

Here in Arcata, as in most places across the United States, we take our utility services for granted. Our homes and businesses are served with reliable (most of the time) electricity, natural gas, and clean water, but many people in the developing world are not so fortunate. Since 2007, SERC has helped expand electricity access with our work supporting the Lighting Africa and Lumina programs, which are focused on markets for affordable off-grid lighting devices. This past summer, we worked with Cascade Designs to provide clean water access for the developing world.

Cascade Designs manufactures a micro water treatment system called the Smart Electrochlorinator (SE200) that was developed in partnership with PATH, an NGO focused on supporting public health in the developing world. Running on 12 volt power, the device converts a salt solution to bleach that can be used to treat water by institutions and micro-entrepreneurs. Drawing on our experience with off-grid power and the developing world, SERC provided support to the SE200 project in three areas:

### We designed and built two prototype solar power kits for the device.

One kit (*right, top*) is designed for installation at a clean water kiosk and provides enough energy to treat up to 9,000 liters of water a day. It also provides some extra energy services that entrepreneurs will need, like LED lighting for their business and the ability to charge mobile phones. The plan is for Cascade Designs to use the kit in a pilot test of the SE200 off the electric grid. The other kit (*right, bottom*) is designed for mobile applications like disaster relief. It is housed in a rugged, waterproof case (about the size of a small suitcase) and provides enough energy to treat 3,000 liters of water a day.

### We made recommendations on sustainable business models for clean water entrepreneurs.

As one might expect, we found that significant sales volumes of treated water are needed for entrepreneurs to recoup their initial investment in clean water (and clean energy) technology. There are a lot of unknown factors in this nascent market.

### We helped Cascade Designs understand the landscape of carbon financing for clean water technology.

The low-tech alternative for water treatment is boiling,



Photo credits SERC.



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## A Message from the Director Peter Lehman

We had good news and bad news as 2011 came to an end. The recently concluded climate negotiations in Durban, South Africa have been called everything from a “landmark deal” (by the AP) to “modest” (by the NY Times). The best thing that came out of them is an elimination of distinction between the developed and developing countries so that we’re all in the same boat when it comes to facing up to this century’s biggest environmental challenge. We can only hope that all countries do pull together in a spirit of cooperation.



Unfortunately, other news is grim. Russian scientists have discovered huge plumes of methane, a potent greenhouse gas, bubbling up from the warming Arctic Ocean. Head of the research team Dr. Igor Semiletov said, “I was most impressed by the sheer scale and high density of the plumes, a scale not seen before.” This is another example of a positive feedback mechanism that accelerates global climate change—and another reason to act quickly to reduce carbon emissions.

But sometimes things seem to be going backwards. Just as the Durban talks concluded, Canada pulled out of the Kyoto agreement, the first country to officially renounce that responsibility (the U.S. never signed on to Kyoto). Developing its oil sands resource has a large carbon footprint and Canada doesn’t want to pay fines for all those carbon emissions. Meanwhile, Alberta Premier Alison Redford is touting the Northern Gateway pipeline to deliver oil sand petroleum to the Pacific Coast so it can be sold to China. That means that Alberta oil will have a market whether or not the Keystone pipeline to the U.S. is built. This all points to one thing—the only way to protect our planet from climate change is to put a price on carbon.

Turning to better news, things are hopping at the Schatz lab. Peter Alstone describes work we’re doing with Cascade Designs, manufacturers of great outdoor equipment. They’ve developed a micro-chlorinator for disinfecting drinking water supplies and we’ve been helping them by providing a photovoltaic energy system to make the unit operable in the field. It has the potential to provide safe water to millions. Jim Zoellick describes hydrogen safety training that he and I provided to 1st responders in the Bay Area in association with AC Transit’s new hydrogen station. Best of all, Jim and I got to drive a new fuel cell bus. Andrea Alstone reports on our ongoing effort to upgrade our hydrogen fueling station to 700 bar and Richard Engel reports on the very successful conclusion of our H<sub>2</sub>E<sup>3</sup> project. Finally, Jim describes our continuing energy

## SERC Supports AC Transit’s HyRoad Program Jim Zoellick

Alameda-Contra Costa Transit District, more commonly known as AC Transit, boasts the largest hydrogen fuel cell bus program in the United States, and one of the largest in the world. This places them on the leading edge introducing hydrogen and fuel cell vehicle technology. Their HyRoad fuel cell vehicle demonstration program has operated since 2000. This program includes fuel cell bus and light duty fuel cell vehicle operation, on-site hydrogen production, delivery and storage of hydrogen produced off-site, hydrogen vehicle fueling, hydrogen vehicle maintenance, safety training, and public education. Throughout the project period, SERC has partnered with AC Transit, providing education and outreach, training, and consulting services.

The motivation for AC Transit’s HyRoad program comes in part from a California Air Resources Board (CARB) fleet rule established in February 2000. This rule set more stringent emission standards for urban buses and promoted the advancement of zero emission buses. Transit agencies were required to choose a compliance path, either alternative fuel or diesel. For those who chose the diesel path, such as AC Transit, they were required to adopt clean diesel technologies and to procure zero emission buses at a rate of 15% of all new bus purchases beginning in 2008. Although the zero emission bus purchase requirement was postponed and is currently under review, AC Transit has continued to move forward with their HyRoad program.

In the first few years of the HyRoad program, AC Transit tested a couple of early fuel cell bus designs and installed a small electrolytic hydrogen station at their Richmond Division. Then in 2004, the HyRoad program leapt forward. AC Transit partnered



Emeryville firefighters pose in front of the latest AC Transit fuel cell bus during a SERC hydrogen awareness and safety training. *Photo credit SERC.*

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efficiency work for the Yurok Tribe.

We enjoyed the sunniest fall anyone can remember in Humboldt County, and so far winter is looking to follow suit. On another sunny winter day (!), here’s best wishes for a bright, new year.

## AC Transit's HyRoad Program *(continued from page 2)*

with Chevron Technology Ventures to design and build a hydrogen energy station at their East Oakland Division. This station included two reformers capable of generating 150 kg of hydrogen per day. It was commissioned in 2006, and served a newly acquired fleet of three fuel cell buses. In the five years that it operated, the station dispensed over 56,000 kg of hydrogen fuel. The fuel cell bus fleet traveled over 267,000 miles in normal passenger service, and achieved 1.6 to 2.0 times better fuel efficiency than their diesel counterparts. In support of this effort, SERC provided hydrogen safety and awareness training for AC transit staff, local fire fighters, and other emergency first responders.

AC Transit is now underway with the latest phase of their HyRoad program. They have recently installed a new hydrogen fueling station at their Emeryville Division. This station was designed and installed by Linde and features on-site hydrogen generation via solar powered electrolysis, as well as storage of liquid hydrogen that is transported from off-site via cryogenic tanker truck. The station stores over 2,500 kg of hydrogen and is designed to fuel buses and passenger vehicles at pressures of both 5,000 psig and 10,000 psig. This station will support a fleet of twelve new, state of the art fuel cell buses. This newest phase of the program is part of a larger demonstration project called Zero Emission Bay Area (ZEBA) that involves five transit agencies in the San Francisco Bay Area. SERC supported AC Transit in this latest phase by participating in design and safety review meetings for the hydrogen station, providing public outreach services, and providing training for emergency first responders from Emeryville and Oakland.

With this latest effort, AC Transit continues to lead the way in demonstrating and adopting hydrogen fuel cell vehicle technology in the US. At the same time, the development of hydrogen fueling infrastructure and the demonstration of fuel cell vehicles continues at a more rapid pace in Europe and Asia. All of these efforts are helping to pave the way for the automotive industry's anticipated 2015 commercial launch of hydrogen fuel cell vehicles in select places around the world.

For more information on AC Transit's HyRoad program visit [www.actransit.org/environment/the-hyroad](http://www.actransit.org/environment/the-hyroad).



Peter Lehman, Jaimie Levin and Jim Zoellick at the new Emeryville hydrogen fueling station. Jaimie is Director of Environmental Technology and the Fuel Cell Program Manager at AC Transit.  
*Photo credit Erik Tudbury.*

# Project Updates

## Yurok Energy Upgrade Complete *Jim Zoellick*

The Yurok Tribe recently completed energy upgrades at their Klamath and Weitchpec Tribal offices. This included the installation of a 15.7 kW AC solar electric array in Weitchpec and energy efficiency upgrades at both locations. As reported in our Fall 2011 newsletter, SERC provided the Tribe with technical support for the project. This included services from start to finish.

Initially, SERC helped the Tribe secure American Recovery and Reinvestment Act (ARRA) funding for the project and worked with the Tribe to define the scope of project activities. In addition to ARRA funding, SERC helped the Tribe secure a rebate from the California Solar Initiative program. This offset part of the cost of the solar electric system.

Once the Tribe secured funding, SERC developed a preliminary design for the Weitchpec office solar electric system. This information was then used to develop a bid specification, and SERC supported the Tribe throughout the contractor bidding process. When the solar electric system and energy efficiency upgrades were complete, SERC verified proper installation of the equipment, including performance testing of the solar electric array.

Finally, SERC provided staff training and education and outreach services to the Tribe. This included the installation of a performance monitoring system for the solar electric array, as well as an interactive educational display in the lobby of the Weitchpec Tribal Office. The interactive display features a touch screen monitor that provides information about the project and allows viewers to check out the hourly power output from the solar array. SERC also developed a web page and a brochure to help with the Tribe's outreach efforts. The website can currently be viewed at [www.schatzlab.org/projects/yurok/web/index.html](http://www.schatzlab.org/projects/yurok/web/index.html).



*Top:* Project Manager Jim Zoellick checks the shading profile for the Weitchpec solar electric array. *Bottom:* Research Engineer Kyle Palmer tests the interactive touch screen display in the lobby of the Weitchpec Tribal Office. *Photo credits SERC.*



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## Hydrogen Energy in Engineering Education

Richard Engel

In September we brought the Hydrogen Energy in Engineering Education ( $H_2E^3$ ) project to a successful conclusion. Over the three years the project was supported by the U.S. Department of Energy, five universities adopted the curriculum for use in engineering, chemistry, and environmental science courses. In the closing months of the project, we completed our last instructional videos and provided DOE with a draft final report, currently undergoing review. The project will remain alive via its website ([www.hydrogencurriculum.org](http://www.hydrogencurriculum.org)), and we're always interested in talking with educators who wish to adopt the curriculum. The hydrogen experiment kits and fuel cell test stations featured on the project website can be made to order; please contact us for a quote. We're now in the process of seeking funding and partners to continue development and dissemination of the curriculum and commercialization of the lab equipment.

## HSU Hydrogen Fueling Station Upgrade

Andrea Alstone

The HSU Hydrogen Fueling Station high-pressure upgrade is underway. The principal design work is complete and all major equipment has been ordered. The new high-pressure compressor should arrive at HSU any day now. HSU Plant Operations will begin work to expand the east block wall and run new electrical service to accommodate the new compressor. Once Plant Operations is finished, SERC engineers will begin plumbing the high-pressure hydrogen lines that make up the new dispensing system. Testing and commissioning of the upgrade is targeted to begin in early spring.

Once the upgrade is complete, we will be able to fill the Toyota FCHV-adv vehicle to its rated capacity of 700 bar (10,000 psi), giving it a range of over 400 miles. The vehicle, currently on loan from UC Berkeley, is a recent arrival at HSU. Our former FCHV-adv was returned at the request of Toyota. It logged over two years of service in and around Humboldt County, and was replaced with the current vehicle in mid-Fall. The "new" vehicle was built at the same time as the former, and had previously been in service in the Los Angeles area.

## Clean Water Access (continued from page 1)

which requires a lot of fuel and results in significant greenhouse gas emissions. There is a United Nations Clean Development Mechanism methodology to count carbon credits from low-carbon alternatives, and the SE200 requires about 10,000 times less energy to treat water than boiling – plus, it runs on solar power to boot. Carbon financing could help overcome the cost barrier for many entrepreneurs.

For more information on the SE200 visit [www.path.org/projects/safe-water-electrochlorination](http://www.path.org/projects/safe-water-electrochlorination).

# Looking Back

**7 years ago...**SERC began its Docent Program. Our docents are motivated Humboldt State University (HSU) students and community members interested in a renewable energy future. Docents educate the general public and K-12 and university students about clean energy technologies. They attend community events and career fairs, speak as guest lecturers in classrooms, and facilitate presentations at SERC. Our program offers interactive lectures, hands-on activities, and physical demonstrations tailored to fit the age and focus of the audience. To learn more visit [www.schatzlab.org/education/ed\\_outreach.html](http://www.schatzlab.org/education/ed_outreach.html).

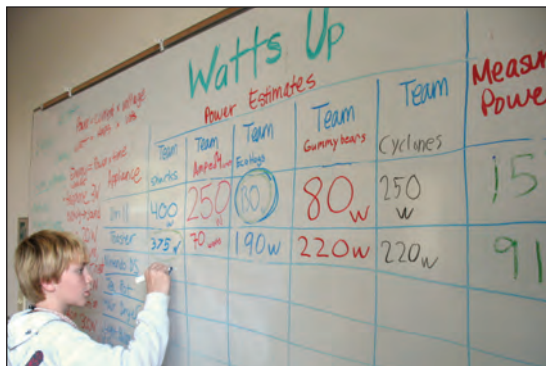


Photo credit SERC.

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 Fuel Cell and Hydrogen Energy Association, the International Association for Hydrogen Energy, the International Solar Energy Society, and the American Solar Energy Society.

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