



# SERC

## ENERGY NEWS

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### Features

**Indonesia Gasification Project and the Brazilian Experience**

**SERC to Develop University Hydrogen Curriculum**

**Student Work at SERC**

### In Every Issue

**A Message From the Director**

**Project Updates**

**Looking Back**

The quarterly newsletter of the  
Schatz Energy Research Center

**HUMBOLDT**  
STATE UNIVERSITY

## Indonesia Gasification Project and the Brazilian Experience

Ranjit Deshmukh

SERC is engaged in an exciting biomass to energy project in collaboration with the Renewable and Appropriate Energy Laboratory (RAEL) group at the University of California (UC) Berkeley. SERC and RAEL are studying the feasibility of using gasification of sugarcane residue, called bagasse, for efficient cogeneration (heat and electricity) in the sugar industry. The client, Indonesian Sugar Group, wants to set up low carbon sugar mills; in other words, mills that produce the most amount of heat and electricity per quantity of fuel. Gasification combined with gas and steam turbines has the potential to be more efficient than traditional direct combustion power generation systems. By installing high efficiency power generation systems, the mills will be able to produce surplus electricity that can then be exported to the grid. In addition to earning revenues through electricity sales, the mills stand to earn more by selling carbon credits through the Clean Development Mechanism (CDM) under the Kyoto Protocol.

To help the Indonesian Sugar Group make informed decisions, SERC is taking two approaches. One is to experiment with a small-scale 20kW gasifier that has recently arrived from India. The second is to develop thermodynamic and economic models of large-scale gasification plants and learn from other existing or planned gasification projects. This is where Brazil comes into the picture. Brazil has one of the largest sugar industries in the world and an equally large biomass-to-energy program in terms of ethanol production and power generation from bagasse. Earlier in June, I had the opportunity to visit Brazil and meet with various biomass-to-energy researchers and sugar industry experts. I was accompanied by Anand Gopal, former SERC engineer and present member of RAEL. The purpose of our trip was to learn about the Brazilian experience with gasification and the latest trends in their sugar industry.

We traveled to the Brazilian state of São Paulo, which has the largest sugarcane production in Brazil and subsequently the highest number of sugar mills and biomass energy research institutions. We visited the combustion and gasification laboratories at two different campuses of the University of São Paulo as well as the University of Campinas. The Instituto de Pesquisas Tecnológicas (Institute of Technology Research) at  
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Ranjit Deshmukh, Dr. Caio Sanchez, Professor of Mechanical Engineering at the University of Campinas, and Anand Gopal.

## A Message from the Director

Peter Lehman

As I write this, we have 15 students studying and working at the Center, our largest number ever. They range from graduate students serving as research assistants on various projects, to three undergraduate UNPEPPers working as summer interns on our 6th University-National Park Energy Partnership Program, to a local high school student helping with our HyTEC hydrogen education project. It's wonderful having all that student enthusiasm and energy at the lab.



Meanwhile, other Schatzers are out in the world. Co-director Arne Jacobson and grad students Peter Johnstone and Kristen Radecsky are in Kenya doing research comparing traditional kerosene lighting with modern LED lighting products. Grad student Ranjit Deshmukh just returned from Brazil where he investigated efforts there to utilize gasification and other technologies to utilize bagasse, the waste in sugar cane processing, to produce energy. Ranjit reports on his trip in this issue. Soon Ranjit and Arne will be joining UC Berkeley colleagues in Indonesia to report to the Indonesian Sugar Group on progress with our gasification project.

This is an exciting time for our new SERC facility. The Request for Proposals for a new SERC building was sent out seven weeks ago and design packages from design/build teams are due this week. Once they arrive, we will choose a winner and be on our way to a permanent home for SERC on the HSU campus.

And if opening design/build packages is not enough excitement, we received our first hydrogen vehicle this week. A hydrogen powered Prius, retrofit by Quantum Technologies, was delivered moments before this newsletter went to press. Meanwhile, project manager Greg Chapman and other Schatzers are busy bringing our newly completed fueling station on-line. In a short time, we'll have Humboldt County's first hydrogen vehicle on the road.

It seems that every time I write one of these quarterly columns, the price of oil has risen by a huge amount. In my last column, it had just cracked \$100/bbl; now it's near \$140. The heartening news is that Americans are finally taking action to reduce their energy use. That's a big step in the direction we have to go and good news for our planet.

## SERC to Develop University Hydrogen Curriculum

Richard Engel

SERC received word in June that the U.S. Department of Energy (DOE) has selected us for negotiation of an award to develop hydrogen curriculum for California's public universities. Key elements of our proposal, submitted to DOE in December 2007, include:

- the creation of curriculum modules suitable for use in chemistry and engineering courses;
- design and fabrication of fuel cell test equipment and fuel cell/electrolyzer kits for laboratory use;
- student monitoring and analysis of real-world hydrogen fueling stations.

DOE will contribute approximately \$400,000 in funding, with nearly \$100,000 in cost share being added by SERC.

Our major partner in carrying out the three-year project will be the Institute of Transportation Studies at the University of California, Berkeley. Working in partnership with ITS, we will develop the curriculum modules and build the needed equipment during year one. In the second year, we will pilot test the curriculum and lab equipment in classrooms at UC Berkeley and Humboldt State University. We will expand the project to include other UC and California State University campuses in year three.

Additional project partners will include fuel cell industry leaders Jadoo Power Systems, Inc., Protonex Technology Corporation, UTC Power, and IdaTech LLC. These companies will provide summer internships for participating students.

## Student Work at SERC

Allison Oakland

SERC welcomes eight student employees to our program, a two-fold increase in just one month. Four Environmental Resources Engineering (ERE) students joined our project researching the quality, performance, and cost of electric lanterns using white light emitting diode (WLED) technology: Ryan Vicente, James Apple, and Andrea Yarberry are quantifying the effects of indoor air pollution associated with the use of kerosene lanterns in Kenya; Patricia Lai is researching the issues associated with battery disposal due to the replacement of kerosene lanterns with WLED lamps.

Also all ERE students are SERC's UNPEPP 2008 interns, Teresa Persons, Jeffrey Hinton, and Lucas Siegfried. The interns are charged with conducting an energy audit, designing a grid-connected photovoltaic system, and developing interpretive

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the University of São Paulo has been conducting research in biomass gasification for the last thirty years. Most of the gasifiers being tested at these institutions were fluidized bed gasifiers, a technology most suited for bagasse gasification. The various researchers that we met gave us much insight into the intricacies of gasification and were open to future research collaboration.

Brazil was in the process of planning two large-scale gasification plants. Pilot scale tests on the atmospheric fluidized bed gasifier by the Swedish company TPS Termiska were successful. The General Electric LM2500 gas turbine was also successfully tested on low calorific gas such as the product gas from biomass gasification. Unfortunately, due to bureaucratic and financial reasons, both projects were discontinued. However, many sugar mills in Brazil are pursuing CDM projects by installing high efficiency direct combustion systems that use high pressure boilers and turbines. We visited one such mill, the Santa Elisa sugar mill. Processing six million tons of sugarcane per year, this mill is one of the largest in Brazil. After the implementation of its CDM project, the Santa Elisa sugar mill now exports 60 percent of the electricity it generates to the grid.

We learned much from our Brazilian experience and cohorts; their reports and publications offer a plethora of information. We look forward to further collaborations with our new Brazilian colleagues.



A veritable mountain of bagasse at the Santa Elisa sugar mill in Indonesia.

#### Student Work (continued from previous page)

signage for the Redwood National and State Parks Headquarters in Crescent City, CA.

Finally, SERC welcomes our first-ever high school student intern, Nick Elsbree. Nick is a senior at Arcata High School and will be working on our HyTEC project. See the Project Updates section for more information about the HyTEC work Nick will perform during the summer.

## Project Updates

### Biomass Gasification Joe Purdon

The gasifier has safely arrived from India! It is currently being installed here at SERC (see photo, below) and we expect to be generating gas within a month or two. SERC also received the gas chromatograph (GC). This instrument will be used to analyze the producer gas from the gasifier. Over the past two months, we have been studying the accuracy and precision of the GC with calibration gas. This gas mimics what will eventually come from the gasifier. The GC appears to be functioning very well.



We also obtained a few thousand pounds of wood chips and are currently air drying a portion of the chips. The wood can only be dried to a moisture content of about 20% in ambient air. Eventually, a dryer will be built that utilizes a self-regenerating dessicant system which will allow us to uniformly dry the chips to uniform moisture contents as low as 5%. Stay tuned for future updates on this exciting project.

### HyTEC Andrea Allen

This summer we are pleased to have Nick Elsbree, an Arcata High School senior, as a student intern. Nick will be working with SERC staff on our HyTEC project. HyTEC is a collaborative project between SERC and the University of California Berkeley's Lawrence Hall of Science to educate high school students about hydrogen and fuel cells. The curriculum includes labs in which students electrolyze water to produce hydrogen and run a fuel cell. Currently SERC manufactures the electrolyzers and fuel cells in house. In an effort to offer the HyTEC curriculum more widely, we are seeking manufacturers to mass-produce the HyTEC equipment including the fuel cells. We have received fuel cells from four different manufactures to test. Nick will run the HyTEC experiment with each of the sample fuel cells to determine which ones will work best with our equipment. He will also run long term tests using our fuel cell test bench to determine which of the fuel cells have the best performance over time. We look forward to working with Nick this summer and eagerly await the results of his analyses.

### HSU Hydrogen Fueling Station Greg Chapman

We are excited to report the arrival of the Toyota Prius and are planning to begin vehicle operation in July. With construction

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# Making Global Connections

On April 24 SERC hosted a visit by a delegation of visitors from Nigeria. The group of young industry and financial professionals toured northern California courtesy of Rotary International. One of the delegation members, Tosin Eleshinnla, was particularly interested in seeing SERC's new fueling station. Tosin is contracts manager for Chevron's exploration and production division in Nigeria.



## Fueling Station Update *(continued from previous page)*

complete and the arrival of the first hydrogen vehicle, the commissioning of the hydrogen fueling station is the final step before putting the station in service. The commissioning phase includes system testing and the initial station start-up. SERC engineers have already successfully completed the comprehensive testing of the stations hydrogen, electrical, safety and auxiliary sub-systems. Initial start-up will occur in the next few weeks.

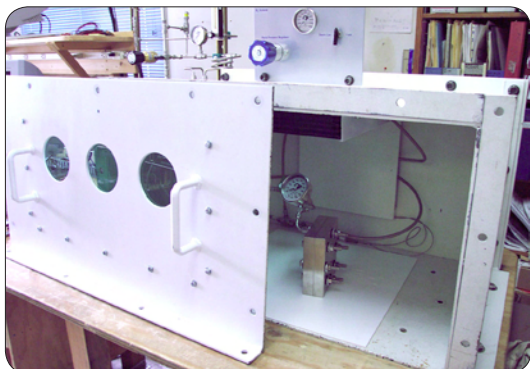
The station grand opening is scheduled for September 4, 2008. Be sure to check our fueling station web page at [www.schatzlab.org/h2stn](http://www.schatzlab.org/h2stn) for further announcements and updates.

SERC Engineer Richard Engel (third from left) poses in front of the HSU Hydrogen Fueling Station after leading a tour for visitors from Nigeria. Tosin Eleshinnla is second from left.

## Looking Back

### 3 years ago

With funding from the California Energy Commission's Energy Innovations Small Grant (EISG) program, SERC designed, built, and tested a prototype high pressure proton exchange membrane (PEM) electrolyzer. The electrolyzer was successfully operated at pressures of up to 2,000 pounds per square inch. If commercialized, high pressure PEM electrolysis could eliminate the need for energy-intensive mechanical compression of hydrogen and increase the overall efficiency of hydrogen energy systems. Visit [www.schatzlab.org/pemelectrolysis](http://www.schatzlab.org/pemelectrolysis) for more information and to read the final report.



**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. Research and administrative staff include Andrea Allen, James Apple, Greg Chapman, Ranjit Deshmukh, Nick Elsbree, Richard Engel, Keith Glenn, Ray Glover, Jeffrey Hinton, Peter Johnstone, Patricia Lai, Marc Marshall, Allison Oakland, Kyle Palmer, Teresa Persons, Joe Purdon, Kristen Radecky, Mark Rocheleau, Scott Rommel, Colin Sheppard, Lucas Siegfried, Ryan Vicente, Michael Winkler, Andrea Yarberry, and Jim Zoellick.

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