



SERC

ENERGY NEWS

Winter 2014

Volume 9, Number 1

Features

SERC Co-Hosts Woody Biomass Workshop

Moving Forward with the RePower Humboldt Plan

Lighting Laboratory Conducts Testing for Global LEAP Competition

In Every Issue

A Message from the Director

Project Updates

The quarterly newsletter of the Schatz Energy Research Center

HUMBOLDT
STATE UNIVERSITY

SERC Co-Hosts Woody Biomass Workshop

Jim Zoellick

Biomass energy is an important resource in Humboldt County and other heavily forested regions. Woody biomass residues include waste materials generated during timber harvest operations. Often referred to as slash piles, these materials are typically piled and burned in the forest. Small trees, limbs and brush cleared in fire hazard reduction efforts are another source of biomass that are often piled and burned. Under the right set of circumstances, these materials can be processed, transported and used as a renewable fuel source, providing environmental and economic benefits.

The [Woody Biomass Utilization Group](#) at the University of California, Berkeley has been working for many years to further the use of biomass energy. To accomplish this, they have hosted regional workshops throughout the state since 2006. This past fall they held a series of regional workshops with a focus on "community scale wood bioenergy." SERC co-hosted one of these workshops at the Humboldt Bay Aquatic Center in Eureka.

November 7th was a beautiful day on the Eureka waterfront, and we had an enthusiastic turnout of more than 60 attendees, as well as a full slate of dynamic speakers. One key topic at the workshop was an update on California Senate Bill 1122. This bill, enacted in September of 2012, directs investor-owned utilities in California to purchase 50 MW of biomass power from community-scale, distributed energy systems of less than or equal to 3 MW. The woody biomass fuel must be sourced from by-products of sustainable forest management, such as materials generated during fire threat reduction activities. This bill will create new opportunities for the development of distributed biomass energy systems.

Other topics covered during the workshop included siting and permitting, project financing, feedstock and technology, and regionally specific topics such as local case studies and projects. Presentations on local projects in which SERC is significantly involved included the [RePower Humboldt](#) planning project, which identified biomass energy as an important local renewable energy resource; the Blue Lake Rancheria biomass gasification project, where SERC is leading the design and installation of a local distributed biomass energy system; and the HSU Biomass Research and Development Initiative project, which is soon to get underway.



Left to Right:

The biomass workshop featured presentations and site tours, including the Community Scale Biomass Power System at Blue Lake Rancheria.

Photo credit: Jacob Pounds.

A Message from the Director

Happy New Year! I hope that 2014 is off to a good start for you all. The year promises to be a busy and productive one for the team at SERC. We have an exciting lineup of clean energy projects and activities across a number of subject areas.



In the energy access arena, we are in the final stage of negotiating a three-year, \$1.6 million contract with the International Finance Corporation to continue our work as the technical lead for quality assurance for the [Lighting Global initiative](#). Lighting Global is associated with the [Lighting Africa](#) and [Lighting Asia](#) programs, which support the development of markets for modern off-grid lighting and energy products. Under our contract, we will continue to manage the program's quality assurance testing and verification program for off-grid lighting products. We will also lead a strategic effort to update and expand the program, conduct laboratory and field research related to the effort, and engage with key industry stakeholders. Our work to date for IFC has helped support rapid expansion of the use of solar charged off-grid lighting and energy systems. For example, over 2.7 million off-grid LED lights that were quality assured through the program have been sold in Sub-Saharan Africa since 2009, and sales have been doubling annually. Sales in South Asian countries such as India are also high. We look forward to our continued participation in the effort to expand access to clean and affordable energy for people without access to grid power in the years to come.

We will be similarly busy in the biomass energy arena. First, we are working closely with the [Redwood Coast Energy Authority \(RCEA\)](#) and the [Blue Lake Rancheria](#) on a project involving the development of a cutting edge biomass-fueled power system to be installed at the Rancheria. The system involves a gasifier that converts woody biomass fuel into a hydrogen-rich syngas, which is, in turn, processed for use in a proton exchange membrane fuel cell. This year is a pivotal one for the effort, as we aim to make considerable progress toward the goal of having an operational system in 2015. We will also continue work on the conversion of biomass into useful fuels and other valuable products using technologies such as gasification, torrefaction and densification. We are currently finishing up one project in this area, and anticipate starting a significant new project in the coming months (details forthcoming).

We also have several projects in hand on the clean transportation front, including analyses related to [electric vehicle infrastructure planning](#) for Humboldt County, several other counties in the northern Central Valley of California, and the city of New Delhi. We learned in December that a \$300K alternative transportation planning project (including electric vehicles and

Moving Forward with the RePower Humboldt Plan

Colin Sheppard

Last spring, SERC worked with the Redwood Coast Energy Authority (RCEA) to release the [RePower Humboldt Strategic Plan](#). The plan lays out long-term strategies and near-term implementation measures that can lead Humboldt toward a more sustainable energy future. Less than a year from the completion of that planning effort, we're pleased to report that a substantial number of the implementation measures are already under way, and SERC is actively involved in several of them.

- There are multiple efforts to utilize forest-based biomass resources in an ecologically sensitive and cost-effective manner.
- The U.S. Department of Energy is funding a study to revisit the idea of a pilot-scale wave energy facility offshore from Humboldt Bay.
- Locals and developers are still interested in harnessing wind and run-of-the-river hydro resources throughout the region.
- SERC is working with RCEA to complete a regional plan to support the adoption of electric vehicles.
- On the energy demand side of the equation, the efficiency programs at RCEA continue to grow and reach more local residents, businesses and schools.
- RCEA will soon implement a heat pump pilot study in the City of Blue Lake.

While not exhaustive, this list makes it clear that our local community is serious about pursuing the vision articulated in the RePower Humboldt Strategic Plan, and that we already have the momentum to make substantial progress over the coming years!

other alternative fuels) that we are conducting in partnership with RCEA and other regional partners was funded by the [California Energy Commission](#). Special thanks go to Jim Zoellick, Colin Sheppard and Kevin Fingerman of SERC and Matthew Marshall, Dana Boudreau, and Jerome Carman of RCEA for leading that proposal development effort. We may have even more work in this area soon, as we learn the outcome of additional submitted proposals.

Last, but certainly not least, we will participate in a feasibility analysis for the development of a wave energy technology test site in California in collaboration with [Cal Poly San Luis Obispo](#) and a number of additional partners, including local partners [RCEA](#), the [Humboldt Bay Harbor District](#), and [HT Harvey and Associates](#). The analysis, which is a \$750K effort funded by [U.S. Department of Energy](#), involves consideration of sites near Humboldt Bay and San Luis Obispo.

I can say with confidence that 2014 will not be a dull one here at SERC. We are holding on to our hats. Goodbye until next time.

Lighting Laboratory Conducts Testing for Global LEAP Competition

Robert Hosbach

With 1.3 billion people globally still living without access to reliable electricity, there remains an acute and persistent need for affordable, efficient, and quality off-grid appliances. For over five years, engineers at SERC, along with other independent consultants, have worked to support the quality assurance of off-grid lighting products through the [Lighting Africa](#), [Lighting Asia](#), and [Lighting Global](#) projects, jointly funded by the IFC and World Bank Group.

Due to our background in quality assurance testing and research for off-grid lighting appliances, SERC was approached to become the lead testing laboratory for the [Global Lighting and Energy Access Partnership \(Global LEAP\)](#) Off-Grid LED Lighting Awards. The Awards Competition is a [Clean Energy Ministerial](#) energy access program that “recognizes the highest quality, most energy-efficient products, and then promotes those products to off-grid market stakeholders.” The Collaborative Labeling and Appliance Standards Program is the Awards Operating Agent and Administrator conducting the competition.

The Awards Competition consists of two judging rounds, the first of which was completed in November. Our team is preparing to thoroughly test the LED lighting products that passed the first judging round—a process that will take the next few months to complete. The results generated at SERC will be evaluated by an independent, expert judging panel to determine the best LED products in each nomination category. The Awards will culminate with the announcement of the winners at the fifth Clean Energy Ministerial (CEM5) gathering in Seoul, Republic of Korea in May 2014.



Left to Right: SERC Director Arne Jacobson and Research Engineers Kristen Radecky and Robert Hosbach use an integrating sphere to measure the light output of a lighting product.

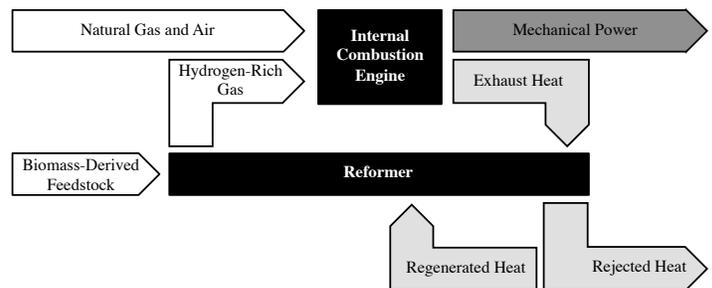
Project Updates

Aqueous Phase Reformation: New Pathway for Renewable Biomass to Offset Fossil Fuels

Dave Vernon

I've been leading a new area of research aimed at offsetting natural gas consumption with hydrogen produced from biomass-derived sugars or waste glycerol from biodiesel production. The process utilizes waste heat in the exhaust from internal-combustion-engine power plants to drive chemical reactions that produce hydrogen. The hydrogen can then be blended with the primary natural gas fuel in order to enhance combustion. Hydrogen-enriched combustion can increase efficiency by up to 20% and reduce emissions of NOx by more than 95%.

The current project is focused on understanding the use of catalysts in [aqueous phase reformation \(APR\)](#) processes to speed up chemical reactions so that medium-temperature waste heat can be used to reform a wide range of plant based feedstocks.



Waste heat from engine exhaust is used to convert the feedstock into hydrogen rich gas. The hydrogen produced in the reformer will be mixed with natural gas and air in the combustion engine to increase efficiency and reduce emissions.

Mark Severy recently graduated with a M.S. in Environmental Resources Engineering from HSU. His thesis modeled the waste heat resources available from large internal-combustion-engine power plants like the one at the Humboldt Bay Generating Station. His work demonstrates that, depending on engine type and operating conditions, there is sufficient waste heat to replace a significant portion of the natural gas with hydrogen produced from waste glycerol left over from biodiesel production. His work also shows that water vaporization in APR can consume a significant portion of the recovered waste heat. By raising the APR pressure, this water vaporization could be reduced. We are currently applying for grants to experimentally investigate high-pressure APR.

BLR Biomass Project

Jim Zoellick

A key element of our [RePower Humboldt](#) vision is to use the county's extensive biomass resource to produce electricity for local consumption. The goal of the Blue Lake Rancheria (BLR) Biomass Project is to do just that. We plan to gasify redwood

(continue on page 4)

Project Updates *(continued from page 3)*

sawdust from our mills, use it to produce hydrogen fuel for a fuel cell, and generate electricity for BLR's hotel and casino complex. The system will be the first of its kind.

The project has a short timeline and we have a tremendous amount of work to accomplish before the March 31, 2015 project end date. Thankfully, we are making good progress and we see a successful path forward.

The key stages of the BLR project include system design, equipment procurement, installation, start-up and commissioning, testing and evaluation, and final reporting. We are currently in the design phase. Before finalizing the selection of major system components we need to pin down the composition of the syngas ("syngas" is short for synthetic gas and refers to the gas that comes from the gasifier when biomass is heated in the absence of oxygen). We are now working with project partner [Proton Power, Inc.](#), the gasifier manufacturer, to have their syngas tested. The test will be performed by a third party vendor, the [Shaw Group](#) (recently acquired by Chicago Bridge and Iron Works, or CB&I).

We expect the gas to be predominantly hydrogen with carbon dioxide and carbon monoxide impurities. Hydrogen is the fuel that will power the fuel cell. Carbon monoxide is detrimental to fuel cell operation and must be removed. The gas will be cleaned up to a purity of greater than 99.9% hydrogen using a pressure swing adsorption unit, or PSA. We are working with project partner [Xebec Adsorption, Inc.](#) to design and provide a PSA that will meet our requirements.

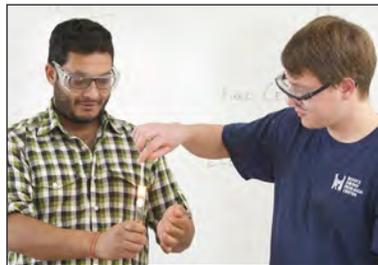
Once we know the syngas composition, we will also be able to specify other key components, including gas compressors and buffer storage tanks needed in the system. The final component in the system, the fuel cell generator, has already been purchased by the Rancheria and is sitting on their property. It is a 175-kW Ballard ClearGen™ fuel cell. Over the next 15 months we will be very busy working to complete this project, and we will be sure to take a few moments each quarter to up-date you on our progress. It's exciting to be working on this state-of-the-art energy system right here in our backyard.

SERC Presents "Fuel Up with Hydrogen" Workshop for GATE Academy *Allison Oakland*

Every January, local K-8 students converge on HSU for the annual [GATE Academy](#). This event, coordinated by the [Humboldt County Office of Education's Gifted and Talented Education \(GATE\) Program](#), provides GATE students with exciting learning opportunities not typically found in the classroom. SERC has participated in the GATE Academy since 2005.

This year, SERC docents Greg Pfothenhauer and Yaad Rana led 6th-8th grade students through an engaging and interactive hydrogen fuel cell lab activity. Using [HyTEC](#) equipment, students electrolyzed water to produce hydrogen fuel. They then used this hydrogen to run a fuel cell and operate a small fan. The lab activity began with a brief introduction to hydrogen and hydrogen fuel cells, and the role hydrogen may play in our

energy future. To bring the topic of hydrogen fuel out of the lab and into the real world, the workshop culminated in a tour of the [HSU Hydrogen Fueling Station](#) and Toyota FCHV-adv fuel cell vehicle.



Clockwise: GATE Academy students use a hydrogen fuel cell to power a fan; students pass a flaming splint over a test tube to test for hydrogen gas; SERC docents Yaad and Greg demonstrate the procedure to test for the presence of oxygen gas in a test tube.

[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. 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 California Hydrogen Business Council, the International Association for Hydrogen Energy, the International Solar Energy Society, and the American Solar Energy Society.

SERC advisory board members are Rick Duke, Shannon Graham, Dan Kammen, David Katz, Jaimie Levin, David Rubin, Jeff Serfass, and Andrea Tuttle.

SERC co-directors are Arne Jacobson, Peter Lehman, and Charles Chamberlin. Faculty research associates are Andrea Achilli, Kevin Fingerman, and David Vernon. Research and administrative staff include Nick Bryant, Allison Campbell, Greg Chapman, Richard Engel, Meg Harper, Andy Harris, Robert Hosbach, Ian Hunter, John Hunter, Billy Karis, Amit Khare, Patricia Lai, Marc Marshall, Allison Oakland, Carolyn Ortenburger, Tom Quetchenbach, Kristen Radecky, Mark Rocheleau, Mark Severy, Colin Sheppard and Jim Zoellick. SERC docents are Jake Coniglione, Chet Jamgochian, Onomewerike "Robo" Okumo, Greg Pfothenhauer, and Yaad Rana.

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