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Features

In Every Issue

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HUMBOLDT STATE UNIVERSITY

Promoting Nationwide Energy Efficiency Through Measurement and Performance-Based Rewards

Colin Sheppard

Over the last two years, SERC has been engaged in energy efficiency policy analysis at the national scale. The National Resources Defense Council's Center for Market Innovation contracted SERC to answer the question: Can progress in energy efficiency and energy conservation be tracked at the state level? If so, can a metric be developed to rank states and reward high performers? In short the answer is yes, but better data are needed before the government should begin to implement a program to reward states for energy performance.

Dr. Arne Jacobson and a team of SERC analysts (including Dr. Charles Chamberlin, Colin Sheppard, and Margaret Harper) took on the challenge. They developed a methodology for an aggregate, state-level metric of energy consumption intensity (ECI) in the residential sector and provided proof-of-concept simulations for each of the lower 48 states.

The methodology provides a tool for identifying changes in state energy consumption intensity (i.e. energy consumption per capita) after adjusting for changes due to year-to-year variations in weather. "Progress" is achieved by any state whose adjusted ECI is statistically decreasing over a given time period (5 years, for example). This measure of progress compares a state to its own baseline–rather than a national average–which gives all states an opportunity to compete on a level playing field.

SERC applied the method to the continental U.S. using historical data to see the metric in action. Between 1985 and 2007, progress (as defined above) was detected in California eleven times, the highest in the country. Seven progress years were detected in Washington, Nevada, and

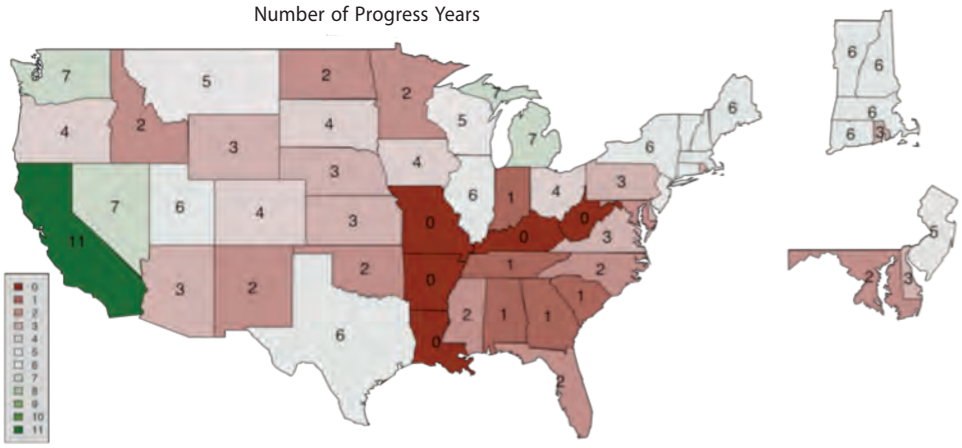

Figure 1: Number of years each state showed a decrease in adjusted energy consumption intensity between 1985 and 2007 (23 years).

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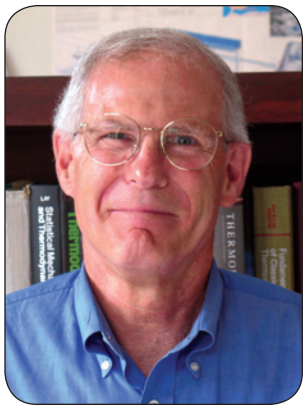
A Message from the Director

Peter Lehman



Just as I write this column comes the disheartening news that the Obama administration has called for opening vast tracts of the American seacoast to oil and gas exploration and exploitation. This is in addition to an earlier announcement from the President supporting the expansion of nuclear power generation in the U.S. This is evidently an effort to win political support from oil, gas, and nuclear interests in hopes of getting climate change legislation through Congress before the midterm elections in November.

Whether or not Obama's political gambit is successful, there are several reasons to be dismayed. First of all, the climate change legislation that is now being considered is fairly weak and there are legitimate questions about whether or not the cap and trade system that is the cornerstone of the bill will work as planned. It's too bad we can't turn back the clock and resurrect to energy legislation that was introduced by Bill Clinton early in his presidency. That bill, with its carefully devised Btu tax, was the best energy policy yet proposed for America. Had we adopted it almost 20 years ago, our carbon footprint would surely be smaller than it is now.

Worst of all, this can't be good news for development of renewable energy. We at the Schatz lab continue to believe that we can meet a large fraction of our energy needs with renewable sources. But we won't be able to do so without a strong, sustained effort and that effort is undermined by a "business as usual" energy policy. Mr. President, we urge you to expand your efforts to develop renewable energy and please make sure those oil and gas people will help you out before dishing them out big favors.

National policy aside, we keep working on renewables. In this issue of our newsletter, Colin Sheppard reports on our efforts with the National Resources Defense Council to develop an energy metric for states so that states that demonstrate real energy savings can be rewarded. Meg Harper describes our work with Proton Energy Systems to test their new, more efficient electrolyzer cell stack. And Jim Zoellick provides updates on our HyTEC, Yurok, and RESCO projects. As Jim has reported earlier, RESCO is a real opportunity for Humboldt County to pioneer an energy system derived primarily from renewable sources.

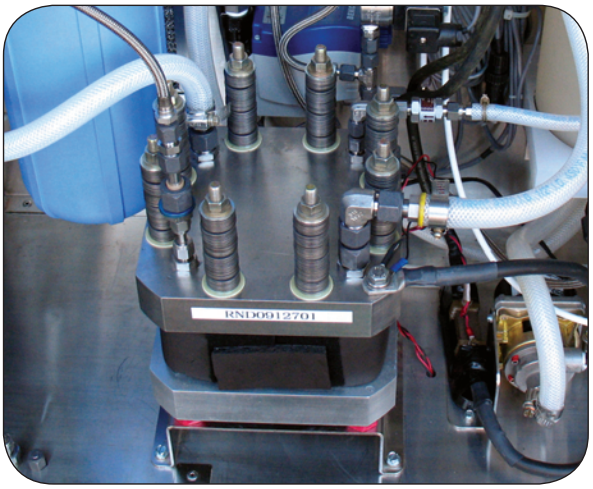
As our northern hemisphere turns its face toward the sun, we wish you all some beautiful, sunny spring days.

Testing the Performance of a New Electrolysis Cell Stack

Meg Harper

At last spring's National Hydrogen Association (NHA) conference, graduate research assistant Andrea Allen reported on the performance and efficiency of our hydrogen fueling station over its first full year of operation. During the conference, SERC director Peter Lehman and Andrea discussed the efficiency of the electrolyzer with representatives from Proton Energy Systems, the unit's manufacturer. With the desire to field test their new product, Proton offered to replace the current electrolyzer cell stack with a newer developmental model, designed for higher efficiency and lower cost. This new cell stack uses a bipolar plate design with a 70% part count reduction. Fewer parts result in an overall reduction in the interfacial resistances of the cell stack, which leads to better performance. In addition to replacing the electrolyzer cell stack, Proton recommended installing a valve to partially bypass the heat exchanger, allowing the electrolyzer to run at a higher temperature, which further increases the efficiency.

To test the performance and quantify the improved efficiency of the new cell stack, SERC senior research engineer, Greg Chapman first installed the heat exchanger bypass and we monitored the energy use of the original electrolyzer cell stack at normal operating temperatures and at elevated temperatures, as benchmarks of performance. The new cell stack was then installed and we collected similar data at the same temperatures. The testing definitively shows that the new cell stack uses the same current to produce hydrogen at a similar rate as the original cell stack, but operates at a lower voltage. This decrease in voltage results in a lower power draw and an approximately 8% increase in electrolyzer efficiency. Additionally and not surprisingly, we found that the efficiency of the electrolyzer increases substantially at higher operating temperatures. We will present the data from these tests of the original and new cell stacks' performance at this year's NHA conference from May 3rd - 5th in Long Beach, California.

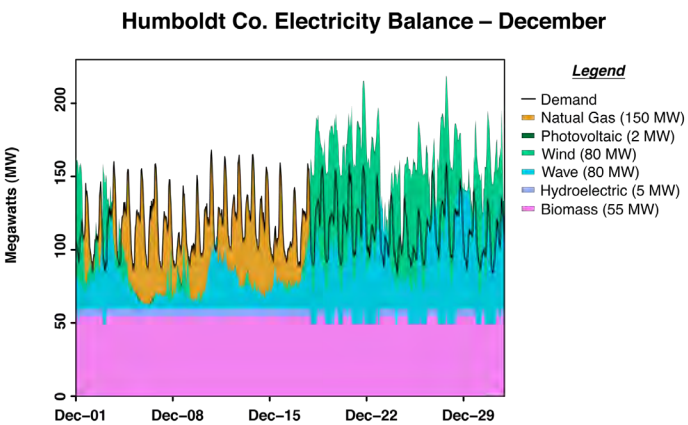


The new cell stack in place inside the HOGEN® electrolyzer.

Project Updates

RESCO Study

The Humboldt County Renewable Energy Secure Community (RESCO) study is off to a strong start. We began the project in November of 2009 and since that time we have developed a single-node electricity dispatch model, gathered data on local renewable energy resources and local electricity demand, researched energy storage technologies, worked with NREL to obtain and customize economic impact assessment models, and collected renewable energy cost data. Using our dispatch model we have examined some preliminary scenarios for renewable energy development in Humboldt County. The figure below shows the output from our model for one such scenario for the month of December. In this particular case, renewable resources, primarily in the form of biomass, wind, and wave power, supply 86% of the electricity demand for the month.



We are early on in our research and there are still a lot of complicated issues we need to tackle. To help us in our efforts we just held our first Professional Advisory Committee (PAC) meeting. We had fourteen participants, including seven people who participated remotely via phone and web conference. The feedback we received from our PAC was positive and helpful, and it will improve the quality of our study by helping us make sure our results are both realistic and relevant. This will be critical in developing a strategic plan that actually gets implemented. After all, our ultimate success in this effort will not be judged based on the quality of our final report, but instead by the megawatts of new capacity of renewable energy generation that is actually brought on-line in Humboldt County.

HyTEC

The Hydrogen Technology and Energy Curriculum (HyTEC) project has been underway since 2004, and after much hard work we are nearing a momentous milestone. In collaboration with SERC and the Lawrence Hall of Science at UC Berkeley, LabAids, Inc. is about to begin offering a commercial version of our HyTEC curriculum. The cornerstone of the curriculum is a bench-top electrolyzer and fuel cell kit that high school students will work with in their chemistry or other physical science courses. With this bench-top kit, students will produce hydrogen via electrolysis and then use the hydrogen to power a small fuel cell and run a fan motor. Students will collect data while running the lab experiment and will use the data to estimate the energy conversion efficiency of the fuel cell.
The design of the fuel cell/electrolyzer kit is based on a prototype that SERC developed as part of the HyTEC project. We then worked with LabAids to turn our prototype kit into a commercial product that could be produced in large quantities at reasonable cost.

In addition to the bench-top kit, the curriculum consists of six activities. Students begin and end the curriculum exercise by participating in a role-play activity where they examine the use of fuel cell buses as a way of meeting sustainable transportation goals for a city government. In between the bookend role-play activities, students learn basic chemistry concepts, such as oxidation-reduction reactions, heats of reaction, gas laws, and stoichiometry, all in the context of hydrogen and fuel cells.

We're very excited to see this curriculum about to hit the streets. LabAids will begin marketing and supporting the curriculum nationwide later this year.

Yurok Wind and Hydro Feasibility Study

SERC has been working with Austin Nova and others at the Yurok Tribe to assess the feasibility of developing wind and hydroelectric energy resources on the Yurok Reservation. In the fall of 2008 we installed stream gauging stations on Pecwan and Ke'Pel creeks, and in September of 2009 we installed a 50 meter wind monitoring tower atop the McKinnon Hill ridge. Since then we have collected a substantial amount of wind and hydro data, and we are now prepared to begin analysis of these data to see if energy development projects are feasible.

Colin Sheppard will be analyzing the wind speed data to determine its energy production potential. This will include choosing potential wind turbines and modeling the energy output from these turbines. If possible, we will attempt to correlate the data we have collected with longer term data records at nearby sites (like School House Peak) to improve the confidence in our results. We will also assess the cost to install and operate a wind energy system and determine the economic feasibility of such a project.

On the hydroelectric side of things we recently hired Kevin Jensen, an Environmental Resources Engineering senior at Humboldt State University, to analyze the stream flow data we have collected. Kevin's work will include an assessment of expected stream flow throughout the year. As with the wind data, we will attempt to correlate the data we have collected

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Promoting Nationwide Energy Efficiency - continued from page 1

Michigan, and several states were close behind with six years of progress (see Figure 1).

We are continuing with our analysis work. In particular, a handful of states are being singled out for detailed research–a process we call "ground-truthing." These include Washington, Texas, Vermont, Missouri, and California. Our goal is to identify specific events and policies within each state that help explain what we see in their overall trend. While these connections do not provide definitive proof of our methodology, they do increase our confidence that the metric is responsive to real changes in residential energy consumption.

Through this research and our ground-truthing efforts, we continue to build the case that it is possible to track trends in state energy consumption intensity, even with the imperfect data sets that are currently available. With improvements in data collection, the methodology could be a powerful tool for policymakers to identify and reward high performing states. We are in conversation with managers at the Energy Information Agency and elsewhere in the Department of Energy to develop specific recommendations for these improvements.

Detailed reports of the analysis and ground-truthing effort are available for download at www.schatzlab.org/projects/psep.

Project Updates - continued from prior page

with longer term stream flow and precipitation records in an attempt to arrive at a more certain estimate of actual energy production potential. We will develop a preliminary design and cost estimate for installation of a run-of-river hydroelectric generator, and based on the estimated cost and energy production potential, we will determine project feasibility.

We expect the results will be complete later this year, so watch our future newsletters for the outcome of this project.

Looking Back

7 years ago...SERC completed a feasibility study on implementing anaerobic digestion technology as a means of dairy manure management on Humboldt County dairy farms. The project was funded by the State of California Community Development Block Grant, and the study was submitted to the Humboldt County Economic Development Office. The study found that the smaller pasture-based dairies of Humboldt County appear to be ill-suited for the implementation of anaerobic digestor technology, but that a suitable dairy could effectively use a plug flow digester as part of their manure management plan. Read the full study at www.schatzlab.org/projects/community/community_feasibility.html.

New SERC Building

Though delayed in coming, the final permit for the new Schatz building has been issued. The delay caused work to slow for several weeks, but now things are humming. The rough plumbing and wiring are almost complete and once done, work can begin in earnest on finish work in the interior. Finishing off the roof and exterior will follow closely. We're meeting next week to choose furniture for our new workspaces. It's a thrill to tour through the construction site now as the interior framing is complete and it's easy to see all the spaces delineated and imagine what the finished rooms will be like.

We're still planning on a grand opening in early September though that date is now in some jeopardy because of the recent delays. We'll keep you posted. In the meantime, stay apprised of building progress via a time-lapse movie at www.youtube.com/watch?v=15Pf7Vp6V9Y.

SERC Energy News is published 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, Meg Harper, Kevin Jensen, 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.

Visit us at www.schatzlab.org E-mail: serc@humboldt.edu