SERC
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Features

In Every Issue

The quarterly newsletter of the Schatz Energy Research Center

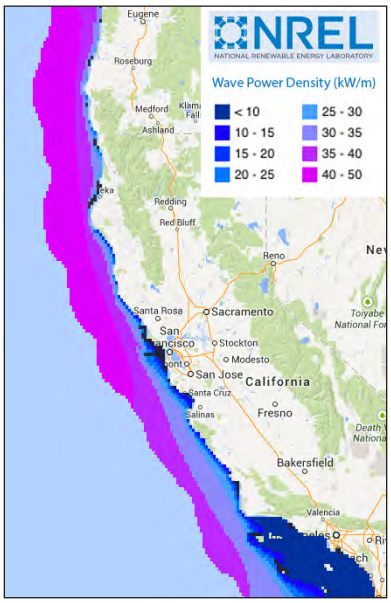
HUMBOLDT STATE UNIVERSITY

SERC Studies Potential Wave Energy Test Center Off California Coast

Colin Sheppard

Ocean waves represent a vast untapped energy resource that could someday become an important component of a diversified renewable energy portfolio. Each year, the equivalent of California's total demand for electricity passes through our coastal waters as wave energy. Because of this enormous potential, there is a budding wave power industry looking to harness this power by installing wave energy conversion devices in the open ocean.

The wave energy industry is still relatively young. No one is certain what particular type of mechanism will extract energy from the waves at the least cost. There are dozens of manufacturers with a variety of device designs in various stages of development and, while wave tanks can be used to test scale models, open-ocean testing is critical to proving these devices under real-world conditions. Since the infrastructure and permitting requirements to install devices in the ocean are expensive, the U.S. Department of Energy (DOE) is seeking to fund a wave energy test facility on the West Coast in order to reduce these barriers and jump start the technology.



The wave power resource off the coast of California and southern Oregon is substantial. *Source: NREL's MHK Atlas http://maps.nrel.gov/mhk_atlas.*

Right now, three sites are under consideration: Humboldt Bay, Vandenberg Air Force Base in southern California, and Newport, Oregon. The DOE has funded two feasibility studies to explore the potential of each site. The California sites are under study by a partnership between Humboldt State University, Cal Poly San Luis Obispo, and a variety of industry experts and stakeholders at the local, state, and national levels. SERC is leading the HSU team, which includes HSU faculty, the Redwood Coast Energy Authority, the Humboldt Bay Harbor District, and HT Harvey, a local consulting firm. The Oregon site is under study by researchers from Oregon State University. By this time next year, one of the three sites will be selected by DOE to receive implementation funding.

Humboldt Bay has a number of compelling advantages when it comes to offshore renewable development. It has the only deep-water port in California north of San Francisco Bay, the wave energy resource here is among the highest in the nation, and critical grid infrastructure already exists on our coast. Indeed, Pacific Gas & Electric studied our waters carefully during their WaveConnect project, which similarly sought to create a wave power test facility. Unfortunately, that project was abandoned for various reasons in 2011. In addition, the Humboldt Bay Harbor District has recently taken title to the former Freshwater Tissue Pulp Mill and is actively developing the site as a marine research and innovation park. The

(continued on page 4)

A Message from the Director

We were pleased to welcome HSU's new president, Lisa Rossbacher, to SERC last week for a tour and meetings with some of our staff. We look forward to working under her leadership in the years to come.

During President Rossbacher's visit, SERC Founding Director Peter Lehman and I provided a brief account of SERC's 25-year history and a summary of our current portfolio of projects. She then met with faculty and staff associated with SERC during her tour. My thanks go to everyone from our team who participated in the session for their professional and engaging presentations.

While preparing remarks for the meetings with the President, I was – once again – struck by the scope and diversity of SERC's clean energy project work. That same diversity is represented in this newsletter, which includes coverage of wave energy on the North Coast, electric vehicle infrastructure planning for the city of Delhi in India, field research about off-grid solar lighting and energy systems in Kenya, and alternative fuels for transportation in Northern California.

As we expand our work, we also need to bring in new team members. I am happy to welcome Kyle Palmer, Malini Kannan, and Asif Hassan to SERC. Kyle and Malini were both hired to work on the lighting lab team, where they will engage in testing off-grid lighting and energy products in the context of SERC's role as technical lead for the Lighting Global Quality Assurance program. Kyle, an alumnus of the Environmental Resources Engineering (ERE) program at HSU, is re-joining SERC after several years of independent work. Malini came to us from UC San Diego, where she earned a BS in environmental engineering. Asif, who came to HSU this fall as a master's student in the Energy Technology and Policy (ETaP) program, is the Schatz Energy Fellowship recipient for 2014. He has a BS in electrical and electronic engineering from Islamic University of Technology in Bangladesh. It is great to have all three of them on our team.

I will close with a reminder that SERC and the ERE department at HSU are jointly conducting a search for a new tenure track faculty position. The selected candidate will divide time between teaching in the ERE department and conducting research at SERC. Applications are due on October 31, 2014. The expected start date is August 2015. Additional details are available here. Please pass this announcement on to anyone who might be interested to apply.

Goodbye to you all until next time.

Assessing the Costs and Benefits of Alternative Fuel Pathways

Manan Parikh

This summer, in partnership with the Redwood Coast Energy Authority (RCEA) and other key regional partners, SERC embarked on a two-year Alternative Fuels Readiness Planning (AFRP) project funded by the California Energy Commission (CEC). This project seeks to assess the potential for development of alternative transportation fuels such as electricity, hydrogen, and some biofuels in the North Coast region of California. Each of the counties in the region (Humboldt, Mendocino, Del Norte, Trinity and Siskiyou) presents different challenges with respect to vehicle fleet, terrain and fuel demand. SERC is leading the analytical work, focusing on the costs and benefits of various alternative fuel pathways, and RCEA will lead the stakeholder engagement and strategic planning process.

The goal for the analytical work is to explore ways for the North Coast region to achieve the 10% reduction in fuel carbon intensity by 2020 mandated under California's Low Carbon Fuel Standard (LCFS). The optimal mix of alternative fuel vehicles and refueling infrastructure will depend on a variety of factors including commodity prices, policy implementation, carbon markets, electric grid mix, incentive structures, and fuel technology development. The simulation model being developed by SERC will enable local and state agencies and other partners to target incentives and investments in light of these realities.

Our first task was to figure out how much gasoline and diesel is being consumed on a yearly basis in each of the five counties. This involved collecting data from Air Quality Management Districts, CalTrans, the CEC, and other sources that track transportation markets and emissions. Additionally, we have catalogued existing alternative fueling stations (such as electric vehicle chargers and biodiesel fueling stations) in the region, and any measurable amounts of fuel they dispense.

With fuel quantities in hand, we will soon complete our simulation model, conduct the alternative fuels portfolio analysis, and then explore the potential impact of incentives on the adoption of alternative fuels. Ultimately, we will present the products of our work to regional stakeholders in the context of a strategic planning process. Using the stakeholders' input, the team will set regional goals for alternative fuel adoption and define a roadmap to achieving a more sustainable transportation system.

ALTERNATIVE FUELS

The Northwest California Alternative Fuels Readiness Project

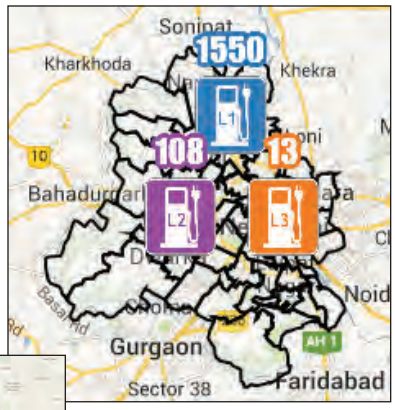
SERC Wraps Up PEV Modeling for Delhi, India

Andy Harris

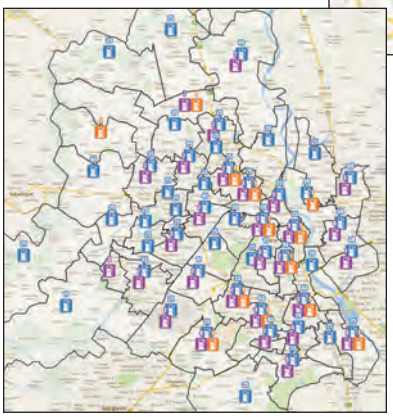
SERC recently finished a study applying our agent-based Plug-in Electric Vehicle Infrastructure (PEVI) model to the city of Delhi, India. Partnering with Lawrence Berkeley National Labs (LBNL), we were able to combine our model with an advanced vehicle performance model to make recommendations for siting electric vehicle (EV) charging infrastructure in Delhi.

While we have used the PEV model previously for northern California, applying the model to Delhi brought new challenges. We had to abandon many of the assumptions underlying our earlier California models – for example, we could no longer assume that every driver had access to a charger at home.

It comes as no surprise that the results of our Delhi study differed from our California studies. Whereas the California results favor medium- to high-power Level 2 and DC Fast chargers, the Delhi results heavily favor Level 1 chargers, which charge at half the rate as Level 2 chargers. Our base scenario recommendations are shown below. These include 1,671 chargers at a price of $1.6 M; of these, 1,550 were Level 1 chargers, representing approximately half of the overall cost. The map of Delhi shows the distribution of different power chargers throughout the city.



Right: Recommended EV chargers at 1% fleet penetration (~10,000 drivers). Level 1 chargers (blue) make up nearly half of the cost, with Level 2 (purple) and DC Fast (orange) chargers accounting for about 30% and 20% of the cost, respectively.



Left: Recommended placement of EV chargers at 1% fleet penetration (~10,000 drivers). Level 1 chargers are in blue, Level 2 chargers are in purple, and DC Fast chargers are in orange. For this scenario, it was assumed that half of all drivers had access to home charging.

In addition to the above recommendations, our analysis revealed several key lessons to help with future planning:

- Access to home charging alone is not enough to get drivers everywhere they need to go.
- Battery-swapping stations, despite their refill speed, are too expensive to be a cost-effective solution for Delhi.
- Heavy congestion makes EVs impractical for many drivers, particularly when air-conditioning is used in the vehicle.

With India's National Electric Mobility Mission Plan targeting 400,000 EVs nationwide by 2020, the next five years promise many lessons for supporting drivers through strategic siting of chargers.

Project Updates

BRDI Waste to Wisdom

Dave Carter

In late July, Marc Marshall, Mark Severy, and I traveled to Pueblo, Colorado to conduct testing on a biochar production machine manufactured by Biochar Solutions Incorporated (BSI). The purpose of our three-week trip was to collect experimental data for use in evaluating stand-alone operation (i.e. without an external source of energy to power the process) of the biochar unit as part of the BRDI project.

Biomass conversion technologies (BCTs), such as the BSI biochar machine, can create higher market-value products in near-woods environments, justifying the transport of these products to market. This in turn could allow fuels reduction and forestry residual management projects to be implemented in greater numbers thereby reducing greenhouse gas emissions and the risk of catastrophic wildfires. One of the goals of the BRDI project is to explore whether stand-alone operation of BCTs improves the economic and environmental benefits of removing slash and other woody residues from the forest.

We spent the first week in Pueblo installing instrumentation on the machine and setting up the data acquisition system. During the second and third weeks, we conducted experiments producing biochar with various biomass feedstocks. The

Left: Biochar unit with instrumentation installed for testing. Right: Infrafred image of biochar unit flare during operation.

(continued on page 4)

Wave Energy Test Center *(continued from page 1)*

site could potentially be used as a base of operations for wave energy device manufacturing, deployment, and maintenance.

It's important to note that a test center will not move forward in Humboldt or elsewhere without a thorough community engagement process that carefully examines the potential social and environmental impacts of development. In addition, both the Vandenberg and Newport sites, which are competing with Humboldt for the test center, have their own considerable advantages.

Wherever the national wave energy test center is sited, all of the western coastal states will eventually play a role in the development of commercial-scale wave energy. This project is an excellent opportunity to put some thought into our strengths and gaps as a host site. And adding to the possibilities for offshore development, the wind energy resource off our coast is also phenomenal and offshore windpower shares most of the same requirements in terms of infrastructure and permitting. No matter how this unfolds, the work happening now is an important stepping-stone toward the greater goal of a sustainable energy future.

Project Updates *(continued from page 3)*

variations in feedstock included tree species, particle size, anatomical distribution, percent contamination, and moisture content. Additional experiments led to design changes in the feedstock drying system and the air injection system for the flare.

The machine generates significant heat while operating *(see photo previous page)*. Some of this thermal energy is used for drying feedstock and some is used to preheat fresh air that is injected into the flare for complete combustion. Beyond the heat used for those purposes, there is a significant amount of high quality thermal energy that could potentially be used to generate electricity to power the machine at a forest landing site. Over the coming months, we will analyze the data and evaluate technologies that could be paired with the biochar machine to generate process electricity for stand-alone operations in near-woods environments.

Lighting Lab: Solar a Dominant Power Nick Bryant

For the past five years, SERC has helped lead the development of the Lighting Global quality assurance framework for small, solar-powered lights sold in countries ranging from Kenya to India. In 2009, a team of researchers from SERC, working with sponsorship from the Lighting Africa program (Lighting Global and Lighting Africa are associated programs of the World Bank Group), found that solar lamps represented a single-digit fraction of the off-grid lights available in markets in selected Kenyan towns. A follow-up visit in 2012 found that solar lamps had expanded to about a third of market share in these towns. This year when we returned to the same Kenyan towns, we discovered that solar products now represent a large majority (over 70%) of the total sales volume of off-grid lights in the market. Given that kerosene wick lamps and cheap, dry-cell battery flashlights had dominated the off-grid lighting market, the shift toward solar-powered LED lights represents a huge step forward in improving energy access for the rural poor.

In partnership with the Energy Resources Group at UC Berkeley, the team broadened the scope of the research to include mapping the supply chain for solar lights in Kenya and investigating the growing potential for pay-as-you-go financing for solar home systems and small solar lights. Through dozens of meetings with distributors, micro-finance institutions, private companies, and NGOs in Nairobi, we were able to observe the positive impact of Lighting Africa's engagement with key market stakeholders. The biggest decision-makers in the off-grid lighting supply chain are now dealing almost exclusively with products that meet the Lighting Global minimum quality standards. Looking forward, there is still much work to do. For example, many retailers still sell substandard off-grid lighting products, and there is a need to engage with these vendors and their customers to ensure they have information about product quality and performance when they look to buy an off-grid lighting product.

SERC alum Peter Alstone *(front)* and UC Berkeley graduate student Dimitry Gershenson *(back)* interview retailers in Kericho, Kenya.

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 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, Dave Carter, Greg Chapman, Allison Hansberry, Meg Harper, Andy Harris, Asif Hassan, Malini Kannan, Amit Khare, Ga Rick Lee, Marc Marshall, Carolyn Ortenburger, Janoah Osborne, Kyle Palmer, Manan Parikh, Greg Pfotenhauer, Tom Quetchenbach, Kristen Radecsky, Mark Rocheleau, Mark Severy, Colin Sheppard and Jim Zoellick. SERC docents are Isabel Contreras, Julia Gomez, Chrisotpher Long, Murielle Manka, Jason McMack, Lorenzo Pagano, and Yaad Rana.

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