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Features

In Every Issue

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HUMBOLDT STATE UNIVERSITY

Lighting Global Program Expands to Solar Home System Kits

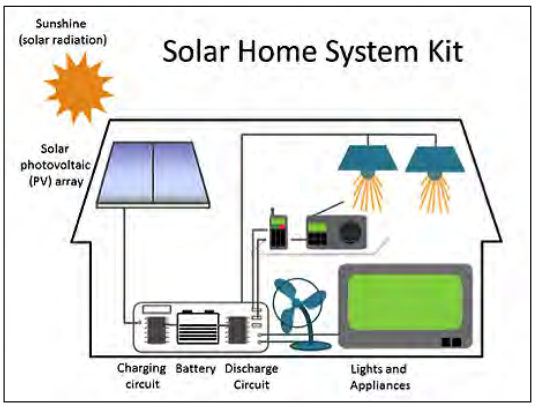
Meg Harper

Since 2008, we at SERC have worked with the Lighting Africa and Lighting Global programs to support the development of the off-grid lighting market. We currently manage the quality assurance program that has tested over 130 pico-solar lighting products, ranging from flashlights to lanterns to multi-light systems, from over 40 different manufacturers.

The Lighting Africa program has been a great success, with nearly eight million quality-verified pico-solar lights having been sold throughout Africa as of December 2014. This has inspired expansion of the effort to India and beyond through the Lighting Asia and Lighting Pacific programs. Bolstered by this success, the Lighting Global program is now focusing further along the electricity access continuum to support products that provide a wider range of energy services, beyond lighting and cellphone charging.

The decreasing costs of solar PV modules, rechargeable batteries, and LEDs have facilitated the development of larger plug-and-play solar home system kits at prices affordable to many in the off-grid market. Additionally, recent efficiency gains in DC appliances, such as reducing the power draw for a 20" color TV from over 20 W to less than 10 W, make it possible to power appliances with lower-cost solar home system kits. In response to these market trends and industry demands, the Africa Renewable Energy Access Program at the World Bank has tasked our team at SERC with expanding the existing test methods and quality assurance framework to cover these larger solar home system kits.

The systems covered by this extension will be plug-and-play direct current (DC) solar home system kits that can be installed by typical homeowners without the need to employ a technician. While products and kits with a peak power rating of less than 10 W are tested under the current quality assurance framework, the revised framework will cover kits from 10 W up to 100 W.



Plug-and-play solar home system kits can provide power for multiple appliances, such as lights, mobile phones, TVs and fans. The systems are often sold as complete kits (solar module, charge controller/battery box, lights and appliances) that can be assembled by the user. *(Image credit Meg Harper and Peter Alstone.)*

Over the past year, our team has worked with researchers from the Fraunhofer Institute of Solar Energy Systems (ISE) to develop a modified version of the existing quality assurance framework for larger kits. Both of our teams are committed to using the same set of principles to balance affordability, innovation, and rigor

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A Message from the Director

I spent much of the month of March traveling for project-related work. The travel included time in Africa (Ethiopia), Europe (Germany), and Asia (India and Bangladesh). Much of my attention during this time was on projects that have a strong solar energy dimension. I therefore would like to use this column to reflect on a few revealing trends and numbers related to the solar energy sector in these places and here at home in California.

I will start in Sub Saharan Africa, where sales of quality assured pico-solar products (i.e. off-grid solar products with a solar module smaller than 10 peak watts) have exceeded 7.5 million units over the past five years. Although we do not have detailed data for sales elsewhere in the world, the limited information that we do have about sales in Asia makes it clear that global sales during this period were well above 10 million units. While the adoption rates represented by these sales numbers still constitute only a small fraction of the over one billion people globally who do not have access to grid electricity, they do indicate that pico-solar systems are beginning to represent a real alternative for providing services such as electric lighting and mobile phone charging.

The rapid growth of pico-solar use for lighting and mobile phone charging has been enabled by a few key trends. On the technology front, declining prices and rising efficiency (or, more properly, rising lumen efficacy) for light emitting diodes (LEDs) have helped reduce the cost and improve the performance of pico-solar lighting systems. Falling prices for solar modules and lithium iron phosphate batteries have also been important, along with innovative business strategies for distribution and sales of pico-solar products. In addition, measures taken to support market development and to ensure product quality by programs such as Lighting Africa, Lighting Asia, and Lighting Global have helped enable expanded use of pico-solar technology.

In Bangladesh, pico-solar use is still at an early stage, but the market for larger solar home systems, most of which have solar modules ranging from about 20 to 60 peak watts, is the largest in the world. Over the past decade, over 3.5 million solar home systems have been sold in Bangladesh through the Infrastructure Development Company Limited (IDCOL) program. In 2014, sales through the IDCOL framework averaged sixty thousand systems per month. This innovative and successful program builds on Bangladesh's existing micro-lending financial institutions to enable sales of household solar systems to rural families under reasonably favorable loan terms. Going forward, solar home systems markets in Bangladesh and elsewhere stand to benefit from increased availability of super-efficient direct current (DC) appliances and sales models that utilize mobile banking and other forms of information and communication technology to help make solar systems more affordable.

SERC continues to contribute to development of the off-grid solar sector by leading implementation of the Lighting Global quality assurance program. As noted in Meg Harper's article, we are currently collaborating with colleagues from the Fraunhofer Institute for Solar Energy Systems in Germany to expand the existing quality assurance framework, which focuses on pico-solar products, to include larger solar home system kits (i.e. systems with solar modules rated at up to 100 peak watts). While the focus of our visit to Germany was on off-grid solar, the topic of grid-based solar use came up regularly. Germany has been a leader in solar photovoltaic (PV) technology adoption, in large part due to aggressive government policies in support of the sector. In 2014, Germany generated 6.9% of its electricity from solar PV systems, and on a few particular days more than 50% of its electricity came from solar power. However, in the last few years, Germany has reduced its support for adoption of solar PV, and sales have dropped rapidly from their peak of 7.6 GW of installed capacity in 2012 to about 3 GW in 2014. Nonetheless, we all owe Germany for their leadership in generating demand for solar and therefore in helping to reduce the cost of PV modules and associated equipment. The precipitous decline in solar module prices over the past decade is due in no small part to Germany's aggressive pro-PV policies during that period.

Back at home in California, solar PV utilization continues to grow. In 2014, solar technology accounted for over 5% of electricity generation, up sharply from about 2% in 2013. As we work to support continued development of the solar industry across all of these countries, we should seek to ensure a positive and stable regulatory and market environment wherever possible.

Goodbye until next time.

Engineering Research Assistant Janoah Osborne leads a Solar Lighting Workshop at HSU's Campus Center for Appropriate Technology. The workshop is designed to inform participants about our off-grid lighting efforts and provide hands-on learning opportunities with solar lighting products.

Project Updates

RePower Humboldt: Biomass-Fired Fuel Cell Power System Jim Zoellick

The 175 kW biomass-fired fuel cell power system being installed at the Blue Lake Rancheria is nearly complete. The Proton Power gasifier has been installed and gone through initial start-up procedures, including heating up the gasifier to temperature and running the flare. The gas compression system (rotary claw compressor, syngas ballast tank, and reciprocating compressor) has been tested and the control strategy has been confirmed. The Xebec pressure swing adsorption (PSA) hydrogen purifier is installed and ready for testing, and the Ballard PEM fuel cell is in place and has undergone pre-commissioning. Most of the peripheral systems (biomass feed, control, fire alarm and life safety, cooling, and ventilation) are complete or very near completion. Our next steps will be to obtain a fuel with a moisture content no greater than 40% (wet basis); begin making syngas; test and confirm syngas quality; and then fully commission the PSA and fuel cell system, as well as the fully integrated system. We submitted a draft final report to the CEC in March, but work on the system will continue over the next few months until we achieve full system operation and performance testing. Following these activities a revised final report will be submitted.

The Proton Power biomass gasifier installed at the Blue Lake Rancheria.

BRDI Waste to Wisdom: Remote Power Generation and Summer Testing Mark Severy

SERC continues work on the BRDI Waste to Wisdom project, a three-year, multidisciplinary project to study pathways to convert forest residuals – or slash piles – into valuable energy and agricultural products at processing sites near timber harvest locations. Many of the potential processing sites do not have access to electricity, so SERC has been analyzing various methods to power this industrial equipment in remote locations. With help from the Environmental Resources Engineering capstone design course, SERC completed a technical and economic feasibility analysis comparing various remote power generation technologies, including waste heat recovery, biomass gasification, solar photovoltaic, and others. The results from this paper study indicate that a biomass gasifier is likely to outperform the other technologies in terms of mobility, cost, reliability, and environmental impact.

After presenting these finding to the U.S. Department of Energy, the funding agency for this project, we procured a mobile, 20 kW biomass gasifier *(similar to the one in the photo at right)* from All Power Labs in Berkeley, CA. Once it arrives, we will begin a series of tests to evaluate whether its performance will meet the requirements to operate in the demanding conditions of a forest-landing site.

With the gasifier being fabricated and a torrefier and a briquetter being prepared for shipment, it's shaping up to be an exciting and eventful spring and summer of biomass fieldwork. SERC will lead the effort to test the torrefier, briquetter, and gasifier generator set at a forest-landing site in Big Lagoon, CA. We will measure the performance characteristics of each machine with a variety of biomass feedstocks recovered from timber harvest operations here in northern California. In addition to testing these machines individually, their synergy in an integrated system will be evaluated by connecting them together. For example, we will conduct experiments to densify torrefied biomass and to evaluate whether the gasifier generator set can reliably provide electricity to the other machines. Having these three commercial-scale technologies at a single site provides a unique testing and demonstration experience.

To prepare for this fieldwork, we have been busy developing the testing matrices, procuring feedstocks, detailing our instrumentation plans, preparing our data analysis tools, and coordinating associated logistical issues. The entire BRDI team is looking forward to a productive season of data collection and analysis that will help address the key issues posing a barrier to recovery and utilization of forest residual waste.

Alternative Fuel Readiness Planning Kevin Fingerman

Last year, in partnership with the Redwood Coast Energy Authority (RCEA) and other key regional partners, SERC

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Solar Home System Kits (*continued from page 1*)

in developing standards and test methods for the solar home system market.

To push forward on the development of the framework, members of the SERC team recently traveled to Freiburg, Germany to meet with our colleagues at Fraunhofer ISE. We spent a week meeting and working with the team in Germany, and tackled some of the more difficult issues in the quality assurance framework, such as how to reliably measure system performance and assess appliances that are included with the kits.

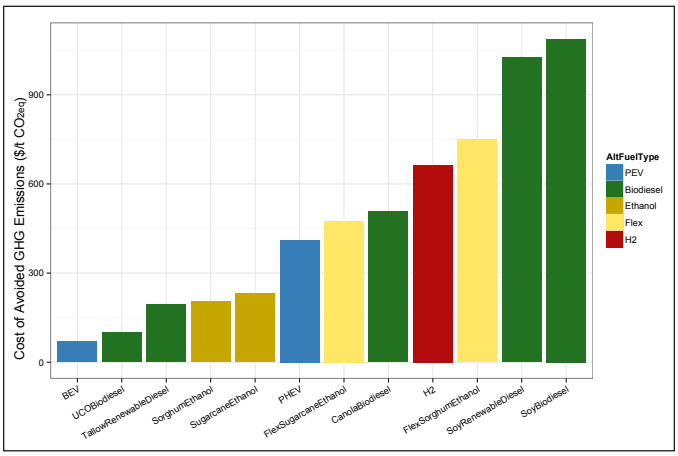
We are currently pilot testing this extended framework on five solar home system kits and plan to test five more in the coming months. Once we have finalized the test methods, we will submit them for adoption by the International Electrotechnical Commission. Throughout the process, we are relying on stakeholder consultations with manufacturers, development organizations, test labs, the Global Off-Grid Lighting Association, financial institutions and others to improve the quality assurance framework.

If you are interested in our continued progress on this project, contact us at shs@lightingglobal.org, or visit the Lighting Global stakeholder page.

SERC team members Tom Quetchenbach, Meg Harper, Kristen Radecsky, and Arne Jacobson with Fraunhofer ISE team members Martin Jantsch, Georg Bopp, Norbert Pfanner, and Friedemar Schreiber.

Project Updates (*continued from page 3*)

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.



Marginal Abatement Cost (MAC) for each of the fuel pathways considered. Presented here is aggregate marginal cost above a conventional fuel/vehicle baseline. These costs include fuel cost as well as any incremental vehicle or distribution infrastructure cost required for a given fuel type.

The goal of the SERC-led analytical work is to explore pathways for the North Coast region to achieve the 10% reduction in average fuel carbon intensity by 2020 mandated under California's Low Carbon Fuel Standard (LCFS). To this end, we have recently finished developing a simulation model, drawing on price data for fuels, vehicles, and distribution infrastructure, as well as analysis of regional transportation trends and fuel life cycle greenhouse gas (GHG) emissions. The model allows us to simulate the economic efficiency of GHG reduction via each fuel pathway individually as well as for a suite of technologies deployed to meet the LCFS target. It offers a nuanced understanding of the systems in question, enabling us to evaluate the impact of changing fuel and vehicle prices, electric grid carbon intensities, and other factors on the cost of GHG abatement through alternative fuel deployment.

Outputs of this analysis are being used by RCEA as it engages with both public and private sector transportation energy stakeholders across the region. This collaboration will lead to the development of a strategic plan for deploying a more sustainable transportation system in the North Coast of California.

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The mission of SERC is to promote the use of clean and renewable energy.

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