Schatz Energy Research Center

Schatz Energy NEWS Summer 2019

Student researchers (Ellen Thompson, René DeWees, and Thalia Quinn) at the BLR Solar+ microgrid

The future of energy *Maia Cheli*

Wired magazine visited the Blue Lake Rancheria and the Schatz Center this spring to learn how microgrid systems create energy security during natural disasters. In his article, writer Matt Simon compares the Rancheria's microgrids to the evolution of personal computers — once novel assemblies that are now available out of the box.

Our Center's microgrid programs focus simultaneously on immediate site needs and on system replicability. Our goal is to make these clean energy technologies feasible for wide deployment, saving our planet while also saving our communities. Two of our projects currently under development were specifically designed with replicability in mind: the Solar+ microgrid at the Blue Lake Rancheria and the Redwood Coast Airport Renewable Energy Microgrid.

The Blue Lake Rancheria and Solar+

The Blue Lake Rancheria is host to two microgrids, both partially funded through the California Energy Commission's EPIC program. The main campus system went live in 2017 and provides energy security for the tribal government, hotel, casino, and site infrastructure including EV charging stations. A second, independent microgrid is now underway at the adjacent Rancheria gas station and convenience store, and will go live in the next few months. This smaller "solar+" project is being developed as a test case for stores and fueling stations across California. The primary project goal is to design an affordable microgrid package for statewide deployment — allowing these sites to operate throughout regional energy blackouts.

In May, our Solar+ team visited convenience stores and fueling stations across northern California. Assessing existing electrical infrastructure will help us identify how Solar+ could be scaled to most effectively meet site-specific needs. For the tour, Schatz Graduate Fellow Thalia Quinn was

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Features

HUMBOLDT STATE UNIVERSITY

A message from the Director *Arne Jacobson*

In 1989, two environmental resource engineering professors — Peter Lehman and Charles Chamberlin — began the Schatz Solar Hydrogen Project. In April, we celebrated the Schatz Center's 30th anniversary with a party attended by staff, faculty, and students, alongside members of our advisory board, project collaborators, and campus and community supporters. For me, the celebration was an inspiring and fun event with a wonderful group of people. It also provided an opportunity to reflect on our history and our future. I'd like to share three themes.

First, it is notable how much our team has grown. The initial core team for the Solar Hydrogen Project consisted of two founding directors and four students, with funding from Dr. Louis W. Schatz. Our group now includes nearly 50 people — including 10 faculty, 23 professional staff, and 16 students — and our annual budget has grown from $100K to nearly $7 million today.

Second, since the mid-1990s professional staff have played crucial roles in advancing our work, generating innovative ideas, managing projects, and mentoring students. They are truly a pillar of strength for our organization. During the celebration, we recognized four professional staff members who have been with the Center for more than half of its 30 years: Allison Hansberry, Marc Marshall, Greg Chapman, and Jim Zoellick. We are grateful for the substantial contributions they have made and for their continued leadership.

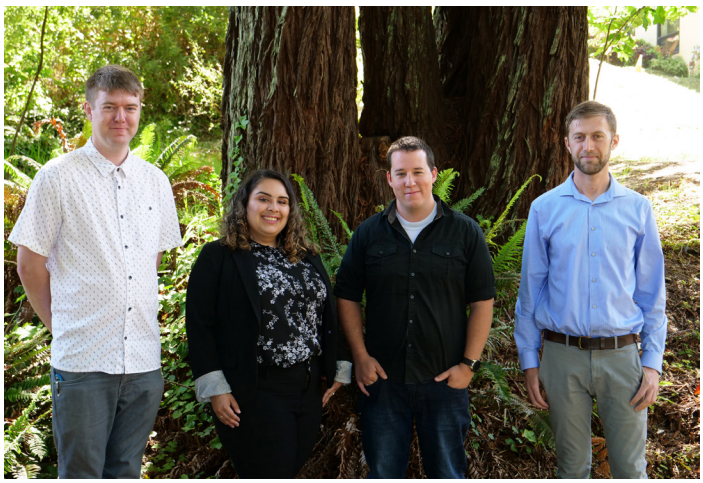
Third, much of our work continues to focus on the successful deployment of cutting-edge energy systems. Throughout the 90s, the Center was involved in developing hydrogen fuel cell vehicles and renewably generated hydrogen fuel, and in 1997 we deployed the first street-legal fuel cell vehicle in the United States. Mainstream manufacturers subsequently developed their own models, and fuel cell vehicles are now commercially available from companies including Toyota, Honda, and Hyundai.

Today, our work includes technologies ranging from renewable energy microgrids to off-grid solar systems. Our first solar microgrid went live at the Blue Lake Rancheria in 2017, and we have two more scheduled to launch in Northern California, in 2019 and 2021. Renewable microgrids address global climate change by (1) deploying low-carbon energy systems while (2) increasing onsite resilience through improved electrical reliability. This technology is now on the verge of going mainstream, with utilities such as Pacific Gas and Electric considering widespread deployment to mitigate wildfire risk and ensure reliable power for critical facilities.

A health clinic's rooftop solar system in rural Niger

Likewise, in West Africa we are engaged in projects to generate reliable electricity for rural health clinics. Where successful, these systems can provide life saving improvements for health services ranging from support for mothers during delivery of babies to vaccination and surgery. In partnership with regional and national organizations and the World Bank, we are developing a new approach to deploy and maintain off-grid solar systems in clinics across Nigeria and Niger.

It is my pleasure to welcome new members to the Schatz Center team. We have hired four new professional staff since the beginning of the year: Tanya Garcia, Eli Wallach, Ian Guerrero, and Max Blasdel. We are also pleased to welcome three incoming graduate student fellows who will join us in August: Aditya Singh (Christina and Jack West Fellowship), Kristine Stern (Blue Lake Rancheria Fellowship), and Amin Younes (Schatz Energy Fellowship). Finally, we have a dynamic crew of thirteen students working for us this summer. We are very glad to have them all on our team.



Eli Wallach, Tanya Garcia, Ian Guerrero, and Max Blasdel (left to right)

Happy summer, and goodbye until next time.

New Projects

Offshore wind feasibility study 2

As capital costs for offshore wind rapidly decrease and floating platform technologies come online, the northern coast of California is emerging as a promising site for the first offshore wind farm in the eastern Pacific. The region off Humboldt Bay is of particular interest due to its superior wind resource, existing deep water port, power interconnection capacity, and limited overlap with U.S. military operations.

To assess offshore wind feasibility for the northern California coast, we are conducting three complementary studies. (See schatzcenter.org/wind for a complete overview of our wind analyses.) Wind study #2 is being funded by the Bureau of Ocean Energy Management (BOEM) with matching funds from Pacific Gas & Electric (PG&E). This study will evaluate wind patterns and associated energy generation profiles, estimate transmission upgrades, and assess the economic viability of three wind farm models.

- Potential generation profile — In order to determine how offshore wind generation would align with regional and state energy needs, we will assess daily wind patterns and production capacity within potential lease areas.

- Transmission and interconnection — Large scale wind generation off California's northern coast would exceed the capacity of the region's electrical grid. Delivering power to larger load centers in California would require significant upgrades to transmission infrastructure. Upgrades and associated costs will be estimated.

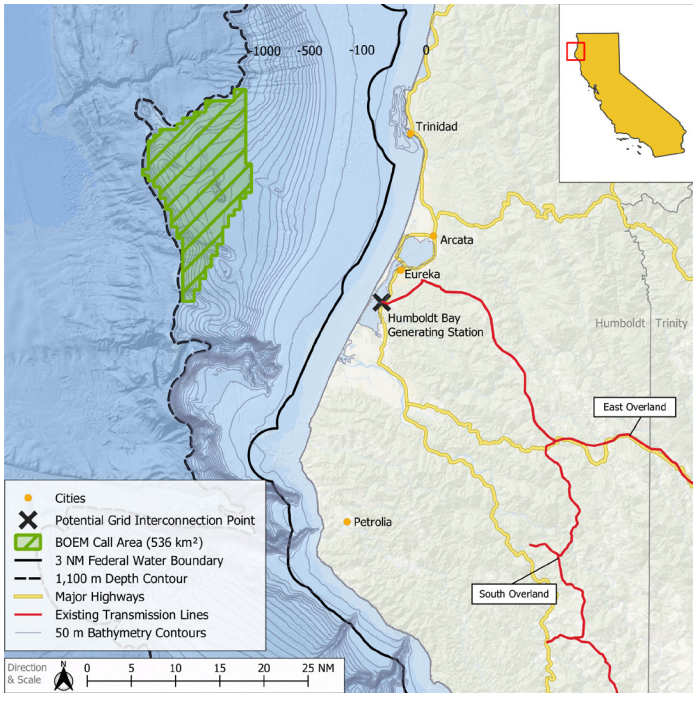
- Subsea cable transmission analysis — Energy could potentially be transmitted to the San Francisco Bay Area via undersea cable. The study will involve preliminary feasibility analysis for this possibility.

- Economic viability — The economic viability and cost of electricity from three differently sized wind farms will be evaluated for the specific context of Humboldt County.

Our project will take the first in-depth look at the wind resource and transmission constraints in this region. Previous work has been done to characterize the general wind resource on the north coast, but we will be assessing project sizes and locations that are relevant to the current area being considered for lease. This project will provide a public report that describes the opportunities for energy generation and the expected costs of transmission upgrades. The final report for this wind study will be delivered to BOEM in May 2020.

A dredge ship and a fishing boat in the mouth of Humboldt Bay

The Humboldt Bay Generating Station (potential interconnection site)



Map of the BOEM Call Area outside Humboldt Bay

Designing an electrified transit system

California's transportation sector is responsible for more than 40% of the state's greenhouse gas emissions — even before adding "upstream" emissions from fuel extraction and refining. Alongside significant efforts to increase consumer adoption of cleaner vehicles, the California Air Resource Board aims for all public bus fleets to be zero-emission (ZEB) by 2040. Starting in 2029, public agencies can only purchase zero-emission buses (battery electric or fuel cell), and local transit authorities are required to submit a complete rollout plan by 2023.

The Humboldt Transit Authority (HTA) brought its first ZEB online in June 2019. This battery electric vehicle runs daytime routes between College of the Redwoods and Humboldt State. HTA owns and operates 33 buses across four transit systems, most of which have a 12 year lifespan as dictated by federal funding requirements.

Humboldt Transit Authority's first electric bus

To fully convert Humboldt's regional bus system from fossil fuel to electricity, we need to account for a future that includes climate change. Challenges include:

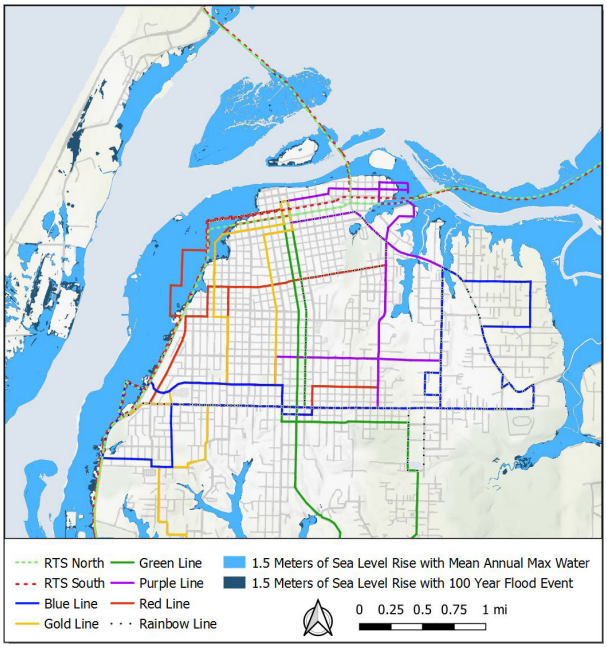
- If a power outage prevents charging, buses may be unable to make their regular schedules.
- Sea level rise, extreme weather events, and wildfires can impact charging station infrastructure and vehicle access.
- Emergency response plans may assign evacuation responsibilities to public transit fleets. Regional planners need to understand the capabilities and requirements of an electrified fleet.

Our recent work for HTA includes two projects: (1) collaboration on a microgrid design for HTA's main campus in Eureka, and (2) development of a climate resilient electrified transit plan. The microgrid design was completed this spring, and we will deliver the transit plan in 2020.

HTA Main Campus Microgrid: A microgrid at the HTA main campus would ensure that bus charging could continue even during an extended outage. We recently collaborated with McKeever Energy & Electric, Inc. to design a microgrid with a 362 kW solar array and over 500 kWh of battery storage. In standard conditions, the grid-connected system would provide 750 kW for bus charging, and 50 kW for public vehicle fast charging. During a power outage, the islanded microgrid would provide energy for up to 400-800 bus miles each day.

Climate Resilient Electrified Transit Plan: The HTA Climate Resilient Electrified Transit Plan will be composed of two components:

- Electric charging infrastructure report — To date, there is no standard methodology for spacing electric vehicle charging infrastructure along an established route. We are currently developing a GIS-based model to optimize the number and location of charging stations that will need to be built, while maintaining existing routes and schedules.
- Climate risk and adaptation report — Sea level rise, wildfires, and extreme weather events will present new challenges to an electrified fleet. We recently completed a literature review to clarify the predicted impacts of climate change within Humboldt County. Next, we will assess the associated risks to our current bus routes and planned charging stations. Recent sea level rise studies for Humboldt Bay suggests that without intervention, several routes could be recurringly underwater before 2100. We are also working to identify emergency response activities for which public transportation could be utilized.



Bright blue areas represent the average yearly maximum inundation. Overlapping bus routes would be underwater during these events.

Project Updates

Solar +

Mark Marshall explains how batteries are utilized at the BLR Solar+ site

The Solar+ project at the Blue Lake Rancheria (BLR) is fast approaching completion. This summer, we are working closely with the BLR and with our project partners at Lawrence Berkeley National Laboratory to connect the final pieces of hardware and software for the Rancheria's fueling station microgrid. Once the project is commissioned and operational, we will run a range of experiments on the advanced controls that form the core of the system.

When we started this project in 2017, we knew that finding microgrid solutions that work for small-to-medium commercial buildings was important — but we could not have predicted how wildfires would intensify the need for these systems. Electric utilities on the West Coast are now using Public Safety Power Shutoff events to reduce wildfire risk by deenergizing parts of the grid. We have already had one of these events in PG&E's service territory this summer, impacting ~22,000 customers, and expect more to come. Because fueling stations provide critical services not only for evacuees but also for first responders in high risk fire districts, maintaining electricity at these stations has become a wildfire mitigation goal.

Our May technical advisory meeting focused on resiliency and disaster preparedness. Designing microgrids that can keep critical facilities online during blackouts is emerging as a key area of our work. As our Solar+ project enters the deployment and reporting phase, we will seek ways to connect our results with this emerging challenge.

Recent events

Clean cooking

Nicholas Lam attended the Pathways to Clean Cooking 2050 conference in Wexford, Ireland this May. The conference brought together researchers and practitioners to discuss strategies to increase access to clean and affordable residential energy services — in particular, ways to satisfy cooking needs without increased use of fossil fuels.

Nick presented on research we are conducting in Nepal to assess how the introduction of electric cooking appliances and biogas systems affects residential energy use, household air quality, and particulate exposure. This research project, Clean Cooking Nepal, is being conducted in collaboration with LEADERS Nepal in Kathmandu, with financial support from the Clean Cooking Alliance.

The conference culminated in the development of a declaration outlining sectoral needs and commitments — calling for, among other items, a prioritization of initiatives that provide immediate emissions reductions and social benefits through sustainable cooking to the communities most vulnerable to climate change.

California offshore wind hearing

On May 3rd, Mark Severy provided testimony to a hearing on offshore wind power convened by the California Joint Committee on Fisheries and Aquaculture. The hearing — "California's Fisheries and Wildlife: Can they co-exist with Offshore Wind Energy Development?"— was chaired by California State Senator Mike McGuire.

Mark's testimony provided background on the opportunities, concerns, and challenges for offshore wind development on the north coast. He described the Schatz Center's current research into the benefits and impacts to economic development, stakeholders, our environment here in Humboldt County. Visit schatzcenter.org/wind for the latest project information.

Off-grid solar conferences in Amsterdam

On June 17-18, Arne Jacobson and Kim Thorpe, along with colleagues from CLASP, represented the Lighting Global Quality Assurance team at the Global Off-Grid Lighting Association's (GOGLA) annual member conference in Amsterdam, Netherlands. GOGLA is a trade association with over 150 members from the off-grid solar industry.

During the conference, Arne and Kim met with company representatives from new and established companies to discuss current and future changes to the Lighting Global Quality Assurance program. They also attended sessions on GOGLA's policy advocacy work and consumer protection

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efforts, and new technologies being developed for pay-as-you-go providers.

On June 19, Kim and Arne attended the Efficiency for Access roundtable in Amsterdam. This meeting brought together industry leaders involved in supporting the off-grid household and productive use appliance market — with a focus on fans, televisions, refrigerators and solar water pumps. Results from Dalberg's 2019 State of the Off-Grid Appliance Market report were presented, followed by small group meetings to identify market research gaps and next steps. (The full report will be available in July through the Efficiency for Access site.) The Efficiency for Access team also introduced a new data platform, Equip Data, that compares performance data for major off-grid appliances. During the session, Arne delivered a presentation related to our Off-Grid Refrigeration Systems (OGReS) research, which is being carried out jointly with 60 Decibels with support from the Energy Savings Trust.

Reflections from the field *Jim Zoellick*

I had the pleasure of attending the Solar Energy Innovation Network (SEIN) Symposium in Denver in early June, and while I was there I got to visit and tour the National Renewable Energy Laboratory in Golden, Colorado. I have wanted to visit NREL since I was 18 years old, Jimmy Carter was in the White House with solar hot water panels on the roof, and I was reading Amory Lovins' "Soft Energy Paths." In those days NREL was known as the Solar Energy Research Institute, or SERI.

Jim Zoellick at NREL's Energy Systems Integration Facility

Today NREL is a state-of-the-art research facility that embodies the sustainable energy mission they pursue. I toured their award-winning LEED Platinum office building, which employs simple architectural traits that allow natural daylighting throughout the four story structure. It is a net zero building that features energy efficient design practices as well as rooftop solar PV on the building and adjacent carport. I also toured their Power Systems Integration Laboratory, which includes power-hardware-in-the-loop (PHIL) and control-hardware-in-the-loop (CHIL) microgrid testing facilities. Quite the exciting tour for an energy nerd who is working on microgrid projects.

The SEIN Symposium was very engaging. Folks from the Rocky Mountain Institute facilitated the symposium and ensured that participants connected on a one-to-one level by having us engage in several group processes. I met people from all over the United States who are working on community scale solar projects. I came away from the event encouraged by the commitment and sense of purpose that all of my symposium cohorts displayed. There is a lot of good sustainable energy work going on all over the country, and that gives me hope!

Schatz in the schools

HSU Robotics Camp students explore solar circuits at the Schatz Center

This spring, we were visited by students from Six Rivers and Arcata High, Mount Shasta Middle, and Cutten Elementary. We participated in the Redwood Environmental Education Fair, the annual GATE Academy, and the Afterschool Visiting Professionals program at Pacific Union. We brought energy workshops to Freshwater, Hydesville, Union Street Charter and Arcata elementary schools... and tabled at the Fuente Nueva and Lafayette science nights, the Plant and Seed Fair, and for career day on the HSU campus!

In June, we explored solar circuits with the HSU Robotics Camp, and brought renewable energy activities to the Yurok Tribe's youth camp, held at the mouth of the Klamath River. It's exciting to work with young people across the north coast, so many of whom are already deeply committed to understanding and protecting the earth.

Student Research

The 2019 Schatz student research team

Cassidy Barrientos builds an incubator to measure biomass decay

Summer 2019 student research

This summer, thirteen students are engaged in research at the Center.

- WIND: Julia Anderson, Ciara Emery, and Tina Ortega are examining the economics, stakeholder benefits and concerns, and energy resource potential for offshore wind in the Humboldt/Mendocino region.
- ENERGY ACCESS: Chih-Wei Hsu, Elizabeth Van Skike, and Grishma Raj Dahal are testing and modeling off-grid solar products, and use and emission patterns associated with fuel-based cookstoves, generators, and refrigeration.
- TRANSPORTATION: Alejandro Cervantes and Chih-Wei Hsu are assisting with our electric bus charging model for HTA transit. Anh Bui is developing EV load profiles and investigating driver flexibility metrics for demand response potential.
- MICROGRIDS: Anthony Rodriguez is developing data analysis techniques to assess the economic benefits associated with microgrids, with a focus on the Solar+ project at the Blue Lake Rancheria. Scott Machen is implementing a benchtop proof-of-test for controlling EV charging stations within a microgrid.
- BIOENERGY: Terry Franklin and Carisse Geronimo are analyzing biochar sample quality, while Carisse and Cassidy Barrientos are measuring emissions from biomass pile decay.

From the fellows: *Carisse Geronimo*

Hello! I am a graduate student in the Energy, Technology and Policy option of the Environmental Systems program at HSU, and the first recipient of the Donald and Andrea Tuttle Fellowship for Clean Energy Studies. Currently, I am working on a team led by Dr. Sintana Vergara on characterizing greenhouse gas emissions from stored woody biomass. My thesis will be closely related to this topic, as my primary research interests are in waste, its potential reuse for energy, and climate impacts.

I started attending HSU in the fall of 2018, a few months after graduating from CSU Bakersfield. There, I completed the coursework for a B.S. in Biology with a concentration in Biotechnology. My past research work has involved various spectroscopic techniques for characterization of lysyl oxidase, an enzyme that creates connective tissue links between collagen and elastin, and plays a role in cancer cell metastasis. I am grateful for my time in biochemistry research, but I am excited to shift gears into renewable energy work. I am happy to be living in Humboldt County, where the community focus on sustainability and resource conservation is inspiring me to do my best work.

Carisse Geronimo demonstrates biomass pile testing

The future of energy - continued from page 1

joined by René DeWees and Ellen Thompson. Ellen and René just completed a year on the Solar+ team as student researchers, while Thalia recently presented her master's thesis on solar+ microgrid costs at gas station and convenience stores in California.

Resiliency needs are intimately tied to location. As Thalia explains, "Recent discussions with fueling station representatives have illuminated the importance of resilient systems during emergency events such as wildfires. These stations support first responder agencies and allow citizen evacuation during natural disasters, making them a prime location for the installation of Solar+." Through interviews with industry specialists and by carefully documenting a variety of site layouts, we hope to build a flexible, best-fit system that addresses common needs.

The Redwood Coast Airport

From its remote location nearly 300 miles north of San Francisco, the Redwood Coast Airport serves 136,000 residents in a county that spans 3,500 square miles. Located beside the runway is also the regional Coast Guard Air Station, which monitors and provides search and rescue for 250 miles of rugged coastline.

We are currently developing a solar+battery based microgrid for the airport and Coast Guard station that will ensure uninterrupted electrical service in the event of a natural disaster, precautionary de-energization of the grid, or other power outage. The solar arrays will have a capacity of more than 2 MW, and will be coupled with an 8 MWh battery storage system.

Planes on the tarmac at the Redwood Coast Airport

The airport microgrid is funded by the California Energy Commission, with the explicit goal of creating a business case for microgrids. The system will be owned and maintained by the Redwood Coast Energy Authority (RCEA), on land leased from the airport. As the local community choice aggregator, RCEA is responsible for making power purchases on behalf of its customers (including the airport), while Pacific Gas & Electric (PG&E) provides the transmission and distribution system for that power.

The airport microgrid's first objective is to provide onsite resiliency, so 2 MWh will always be retained in the battery storage. Additional generation will also be retained in storage until it is needed by the macrogrid — typically after nightfall, when the state's solar arrays stop producing. At this point, RCEA will sell its excess energy generation via CAISO, California's wholesale electricity market, allowing the state to make ideal use of distributed solar.

This airport system will be the first front-of-the-meter, multi-customer microgrid in PG&E's service territory — and will be accessible from the PG&E distribution control center. We are currently working with the utility to develop an experimental microgrid tariff that will define the rules of interconnection and compensation for these enhanced resiliency systems. Development of the tariff and establishing a path for CAISO participation are critical steps for widespread microgrid deployment, from both a regulatory and a fiscal perspective.

The Redwood Coast Airport Renewable Energy Microgrid will go live in early 2021.

For the latest project news, visit **schatzcenter.org/news**

The mission of the Schatz Energy Research Center is to promote the use of clean and renewable energy.

The Schatz Center is led by Arne Jacobson (Director), Peter Lehman, (Founding Director), and Charles Chamberlin (Co-Director).
Our 40+ member team includes faculty and research associates, engineers and professional staff, docents, and student research assistants.
Our expertise includes design, deployment, research, and policy development
in off-grid energy access, renewable energy systems, microgrids, bioenergy, and clean transportation.

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