Havana rural microgrids

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When Hurricane Maria battered Puerto Rico in 2017, winds snapped trees and destroyed homes, while heavy rains transformed streets into rivers. But after the storm passed, the human toll continued to grow as residents struggled without electricity for months ve years later, power outages remain long and frequent.

To provide more affordable, reliable and sustainable electricity to underserved communities like these, scientists from the Department of Energy"s Oak Ridge National Laboratory are partnering with local organizations, nonprofits and universities to build resilience into independent microgrids powered by renewable energy. ORNL is developing a technology that will manage groups of small microgrids as a cluster, enhancing their reliability even when damaged.

Microgrids are small networks that generally have their own energy supply from nearby renewable sources like wind and solar. If battery storage is added, microgrids can be isolated and function independently in "island mode" when the broader utility network fails.

ORNL engineers Ben Ollis and Max Ferrari are leading a team to develop a microgrid orchestrator to deploy in the Puerto Rican town of Adjuntas. A community microgrid project is already being installed there, through a partnership between local nonprofit Casa Pueblo and the Honnold Foundation.

Honnold, which funds solar projects to reduce global energy poverty, is investing $1.7 million to create two microgrids with solar and battery storage, said Honnold project coordinator Cynthia Arellano. The solar arrays were installed last year and will be hooked to the remaining infrastructure being added this year.

That"s where ORNL steps in: Creating a novel orchestrator tool to manage a cluster of microgrids so they directly support and communicate with each other, making them more resilient during long power outages. For example, if one microgrid loses part of its solar generation, the adjacent microgrid could export power to its neighbor, minimizing the impact of the damage.

"I don"t know of a microgrid controller anywhere that can communicate and coordinate with another controller," Ollis said. "We"re designing an architecture for multi-microgrid controls, so any number of microgrids can operate independently but share information to an orchestrator that will predict when switching, routing and connecting should happen."

That isn"t just a matter of convenience. "A lot of people died after the hurricane, and many of the deaths were related to power failures," said Arturo Massol-Dey?, executive director of Casa Pueblo, which promotes fair and sustainable development around Adjuntas. This longtime community organization installed a solar array at its building in 1999. After Hurricane Maria, Casa Pueblo was able to share the electricity it generated with residents relying on home medical equipment such as respirators.

"We noticed how many people got sick who were pre-diabetic, or had high blood pressure, or were exposed to unhealthy living conditions and food - preventable conditions," said Massol-Dey?. "Energy security being interrupted is about quality of life, and there were long-term consequences in the community." Grassroots support for solar power built steadily as a result.

The Adjuntas microgrids include solar installations on the roofs of 13 businesses, whose owners agree to provide critical services like medicine, refrigeration and cell phone charging to residents during major power outages. In return, the businesses save money on electricity and avoid the use of expensive diesel generators during natural disasters, Ferrari said.

"ORNL deploying this kind of controller system is going to be a really powerful tool for the community," Arellano said. It"s unusual for so many businesses and owners to be linked by a microgrid, she added, and the infrastructure will support adding even more.

On a recent trip to Adjuntas, ORNL researchers met with local business owners to better understand their electricity use patterns. For example, when Ferrari visited the bakery, he learned what times refrigerators must run for the dough to rise properly. He and Ollis sought to identify the most critical electricity loads so they can design a system that focuses scarce power where it"s most needed.