NPS Advances Energy Resilience, Sustainability Through Microgrid Research

MONTEREY, CALIFORNIA, USA, September 14, 2023 / EINPresswire.com/ -- Over the past five years, a multidisciplinary team of Naval Postgraduate School (NPS) faculty has been supporting the development of an energy renaissance of sorts with the potential to redefine what it means to be energy resilient. At the same time, the team is directly supporting the advancement of one of the fundamental pillars of Secretary of the Navy Carlos Del Toro's climate strategy, Climate Action 2030, to build climate resilience, ensuring facilities achieve mission in the face of a changing climate.

Naval Postgraduate School Professor Dr. Giovanna Oriti, center, is working with a team of NPS faculty and students on microgrids research. Other team members include (from left) U.S. Navy Lt. Cmdr. Olive Oliveros, Dr. Ron Giachetti and U.S. Army Capt. Abigail Staffnik.

Working with partners from Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) at Port Hueneme, Calif., and the University of Wisconsin-Milwaukee – and dozens of NPS students over the years – the team's innovative research into microgrids, and development of advanced tools to capitalize on them, is creating opportunities to advance resilience, sustainability, and deliver higher quality power to Department of Defense facilities worldwide.

Back in 2019, Dr. Giovanna Oriti of NPS' Department of Electrical and Computer Engineering and Dr. Douglas Van Bossuyt of the Department of Systems Engineering began working with Naval Station (NAVSTA) Rota, Spain. The group, which also included Dr. Ron Giachetti from Systems Engineering and Dr. Dan Nussbaum, Chair of the Energy Academic Group, readily identified a common concern in energy security. It proved to be just the beginning of a multi-year partnership, through primary sponsorship provided by the Naval Facilities Engineering Systems Command, supporting research in microgrid development and how the DOD can use them.

“The three pillars of energy security are reliability, efficiency and resilience,” explained Van Bossuyt. “There have already been great advances in reliability and efficiency, such as switching incandescent light bulbs out for LEDs. And over the past five years, with our students and partners working together, we’ve refined a baseline and definition for resilience.”

In simple terms, the NPS team describes resilience as the ability for a facility to take a punch, get back up, and be ready to take another punch. More specifically, through student research, the team has developed a simple numerical definition of energy resilience. On a graph of performance versus time, a facility begins at 100 percent capacity with everything powered and running smoothly. When a power-disrupting event occurs, the energy performance decreases. Over time, the facility will recover and return to an operational level. The area that represents the amount of time the facility experiences lower than operational power is its resilience.

“In the civilian world, there’s an understanding of what it costs when the power goes out. It’s ‘X’ dollars per hour when your steel mill shuts down because the power is out,” explains Van Bossuyt. “But it's extremely hard to put a dollar value on national security, so that's when we go to resilience. We need to have a certain level of assurance that, even if we have a hurricane hitting us or adversary action or the national grid goes down, we're still going to be able to execute our critical missions that impact national security.”

The team has focused on using microgrids and sustainable power sources to increase facility resilience. Microgrids are smaller, self-contained power systems with the ability to generate their own power. They can either work in grid connected mode where they are connected to the main utility grid or in island mode where they are disconnected from any utility grid.

Naval facilities can house deep-water ports, airfields, or both in one location. The NPS team has proposed that rather than running these facilities from one power source, bases be divided into multiple areas, each running on their own smaller microgrid that can be connected to or isolated from one another. If a full station blackout were to occur, the smaller microgrids can provide power to critical loads and then aggregate together and self-heal.

“We borrowed the idea from ships that have zonal power distribution,” says Oriti, whose work on the all-electric Zumwalt-class destroyer has made her an expert in this field. “When ships get hit on one side, they isolate the part that was hit and then they reconfigure the system and continue to operate the rest of the line.”

Decarbonization is another important facet of energy security. Microgrids integrate renewable energy sources, such as photovoltaic arrays, to add redundancy and sustainability to a base. Reliance on fossil fuel and fuel sources are a potential logistics weakness, and renewable energy sources allow the Navy to move towards the DOD’s long-term goal of net-zero emissions.

In March 2023, NPS students and faculty were joined by their NAVFAC EXWC and University of Wisconsin partners on a tour of four DOD facilities in Europe, headlined by a visit with their

longtime collaborators at NAVSTA Rota, where they were able to see in person the results of their partnership. The tour was also an opportunity to survey and expand their work with three additional installations in Italy: U.S. Army Garrison (USAG) Italy in Vicenza, Naval Air Station (NAS) Sigonella, and Naval Support Activity (NSA) Naples.

U.S. Navy Lt. Cmdr. Olive Oliveros, a student in the Department of Operations Research, was able to join the group for the first two weeks during the visits to Rota, Spain and Vicenza, Italy. Her thesis focused on creating a benchmark to represent power distribution systems on naval bases so they can be easily analyzed.

“The Navy doesn’t currently have a standard way to model a power system on a naval base because bases are all fairly different,” explained Oliveros. “On this trip, I was able to collect real data on these different installations and use that as a baseline for how we’re going to model a typical naval installation.”

“The power of data analytics lies in its ability to align your data with a well-defined model,” she continued. “By doing so, you can effectively communicate valuable insights to your commanding officer, enabling them to make informed and optimal decisions supported by data-driven evidence.”

Oliveros’ thesis is co-advised by Van Bossuyt, as well as Dr. Dan Eisenberg, Assistant Professor in the Department of Operations Research and Director of NPS’ Center for Infrastructure Defense. Critical infrastructure defense is closely tied to power systems and the need for energy resilience and microgrids.

“NPS has undertaken a monumental effort to foster community connections, mirroring the collaborative approach I experience in my own work across various departments,” says Oliveros. “Drs. Oriti and Van Bossuyt deserve immense credit for unifying researchers from diverse corners of NPS and establishing strong partnerships … Their commitment to sharing and collaborating sets an impressive precedent for knowledge exchange and advancement.”

In addition to their partnership with Rota, Oriti and Van Bossuyt have also been working with a team to support microgrid efforts at NAS Sigonella. In 2020, the Sigonella energy manager approached NPS with an interest in designing microgrids for the installation. Rather than design a unique microgrid, the team began work on a web-based tool that Sigonella and others could use to design and install their own microgrids based on specific needs and power sources.

The result, the Open-Source Microgrid Design Planning tool, now exists publicly online and is designed to improve standardization and reproducibility of naval power systems.

Sigonella tested the tool, successfully designed a microgrid, and plans to install two in the next year based on their work with NPS. As part of the trip to Sigonella, Oriti and Van Bossuyt hosted four hours of training in both English and Italian to support technicians and help prepare the

base.

“While there are several free microgrid tools available, there are none that optimize a microgrid for resilience and, in particular, with application to military facilities,” said Oriti. “We are opening up a new definition and a new field with our students and with this work.”

Since the program began five years ago, NPS researchers are proud to note that their broader efforts to increase energy security, and standardize microgrid access, has involved close to 100 NPS warrior-scholars. They have produced theses, capstones, and journal articles to support the efforts with Rota and Sigonella, as well as new, emerging technologies. Some of the current projects include building small, replicable microgrids that fit into a container so they can be shipped, as well as the design of microgrid building blocks that can be used in combination like Legos.

The work also aligns with the Climate & Security Network’s efforts with the NPS-Stanford Doerr School partnership and NPS’ role as co-lead of the Navy Decarbonization Research Consortium. The NPS team brings the microgrid expertise to the Consortium and is coordinating with Stanford microgrid efforts in Half Moon Bay, Calif., to advance toward installation resilience.

Van Bossuyt underlined the importance and breadth of their work with energy security.

"If you don’t have power, you don’t have things like access to water or the ability to remove sewage from a facility. You don’t have the ability to keep food cold or cook it, so it will spoil. Secondarily, you might not be able to power schools so kids and their caretakers will have to stay home, or air conditioning that keeps mold from overrunning buildings can fail,” he explained.

“Very quickly, you realize that there’s not much we can do in the modern military without power at these bases,” Van Bossuyt continued. “We’re building up a library of things that we’ve seen and the solutions to them so that we can provide the Navy with the energy security necessary for a safe and sustainable future.”

- Watch Dr. Oriti’s NPS Provost Lecture Series presentation, “What Will Keep the Lights On? Microgrids, Energy Security and Climate Change”, here: https://www.youtube.com/watch?v=4edBNWRW51A
- Learn more about the Energy Academic Group: https://nps.edu/web/eag

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